

OPEN SANDY GRASSLANDS OF THE BAKONY REGION

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The vegetation of the sandy areas in the Carpathian Basin is well-searched, but not evenly explored. The present publication discusses well separable samples from the margins of the Bakony region (Transdanubia, Hungary), Bakonyalja (Fenyőfő, Bakonyszentlászló, Bakonyszücs, Nagytevel), the margin of the Southern Bakony (Hegyész, Sáska, Sümeg) and the Balaton Uplands (Salföld, Szentbékállá), of some stands of the three important open sandy grassland plant associations (named *Festucetum vaginatae*, *Festuco vaginatae-Corynephorretum*, *Thymo angustifolio-Corynephorretum* units). The paper describes the status of the *Festuco-Corynephorretum* stands and those of the open sandy grasslands dominated by *Stipa pennata*. Besides, samples of a calciphobe sandy grassland dominated by *Koeleria majoriflora*, so far having been sampled near Nagytevel, are also given. In Bakonyalja the *Festuco vaginatae-Corynephorretum* stands just in the environs of Fenyőfő and Bakonyszentlászló are characteristic. Evolvement of these stands apparently is abrogated by disturbing effects including glades of *Festuco vaginatae-Pinetum sylvestris*, forest edges, margin of recultivated bauxite-mine on pioneer sandy surfaces). It is observed that *Thymo angustifolio-Corynephorretum* is the only characteristic plant community of the limeless sandy surfaces of Bakonyalja (Nagytevel, Sümeg, Hegyész, environs of Sáska and the margin of the Kál Basin) are comprising the most typical species *Corynephorus canescens*, *Rumex acetosella*, *Thymus serpyllum*, *Hypochoeris radicata*, and *Jasione montana*.

Key words: *Festucetum vaginatae*, *Corynephorretum canescentis*, sandy grassland, Bakony region

INTRODUCTION

The recognition of the specific features of the sandy steppe vegetation was significant in establishing the basic phytogeographical characters of the Carpathian basin and in describing the region's vegetation (KERNER 1863, BORBÁS 1884, 1900, TUZSON 1914, RAPAICS 1918, BOROS 1958, SOÓ 1931, ZÓLYOMI 1958, BORHIDI 1997). KITAIBEL Pál (see WALDSTEIN and KITAIBEL 1802–1812, GOMBOCZ 1945) already observed some typical plant taxa of the sandy areas of the Great Hungarian Plain. The first vegetation and the coenological papers also mention the peculiar sandy steppe vegetation, first by giving descriptions at formation level (KERNER 1863, TUZSON 1914), and then at association level (RAPAICS 1925a, SOÓ 1930). The latter papers, indeed, are the bases of Hungarian classical coenology. With the published samples of open sandy grassland dominated by *Festuca vaginata* (*Festuca vaginata* – *Ephedra distachya* ass.) of Káposztásme-gyer RAPAICS (1925a) provides the foundation of the method and nomenclature of phytocoenology; SOÓ (1930) gives a more detailed description, a synthetic table

and a sketch of succession of the sandy steppe in the region of the Danube–Tisza Interfluve (Duna–Tisza köze).

There is an abundant literature discussing the vegetation of sandy areas in the Carpathian Basin. The publications of SOÓ (1930), MAGYAR (1933), HARGITAI (1940), ZSOLT (1943), BOROS (1953), KÁRPÁTI and KÁRPÁTI (1954), PÓCS (1954), and ZÓLYOMI (1958) describe the sandy grasslands of Kiskunság and the Pest Plain in great detail. STURC (1997) summarises the accumulated knowledge of the sandy flora and vegetation in the surroundings of Szabadka (Subotica), by comparing these to other sandy areas such as Kiskunság and Deliblát in many respects. Of these areas, BORBÁS (1886), BERNÁTSKY (1910) and WAGNER (1914) give a clear picture of the sandy steppe vegetation cover, which then was further elaborated by STEPANOVIĆ-VESELIČIĆ (1953) and BUTORAC (1999). The detailed works of RAPAICS (1916, 1925b), BOROS (1929), SOÓ (1933a, 1939), ASZÓD (1936) describe the sandy vegetation of Nyírség. BOROS (1944) draws the attention to the sandy area dominated by beany vegetation types of the “Székelyföld” (Szeklerland) area of Transylvania. POLGÁR (1912, 1941) provides the first account of the sandy vegetation of the Little Hungarian Plain (Kisalföld), followed by BORHIDI (1956) on the grassland associations of the region and the margin areas. BORBÁS (1900) and SOÓ (1933b) describe the sandy vegetation of areas south of Lake Balaton, BORHIDI (1958, 1959) discusses the sandy vegetation and phytogeography of southern Transdanubia (mainly Inner Somogy (Belső-Somogy)), while TIHANYI (1965) presents his observations of the sandy vegetation of Darány. LÁJER (2004) gave a detailed study of the current status of the South Transdanubian *Teesdalia nudicaulis* stands and *Corynephorus* grasslands. Recently LÁJER (2006) has overviewed the Hungarian sandy grasslands dominated by *Corynephorus canescens* and presented three relevés of the Bakony region.

Because of his significant work in the exploration of the wider region’s sandy vegetation, KLIKA (1934) is worth mentioning, who published the samples of “*Festuca vaginata*-*Dianthus serotinus*” association examined along the River Morava, from where subsequently KRIPPEL (1954) published the *Thymo angustifolii*-*Corynephorum* association.

Presently, intensive botanical researches are being carried out on significant sandy areas of Hungary, mainly in the region of the Danube–Tisza Interfluve and in the Nyírség. These investigations (FEKETE *et al.* 1988, FEKETE 1992, KÖRMÖCZI 1989, KÖRMÖCZI and BALOGH 1990, MATUS and TÓTHMÉRÉSZ 1990, MATUS 1996, KERTÉSZ *et al.* 1993, MARGÓCZI 1995, BAGI 1997, 2000, GOSZ *et al.* 1999, BARTHA 2000, 2001, BARTHA *et al.* 2003, CSECSEKITS and RÉDEI 2001) have significantly improved our knowledge and understanding of the succession of otherwise well-known vegetation units (BORBÁS 1884, RAPAICS 1925b, SOÓ 1930,

MAGYAR 1933, HARGITAI 1940, ZSOLT 1943, BORHIDI 1956, PRÉCSÉNYI 1981), the interspecific interactions. Through microcoenological examinations and fine-scale mapping these also shed light on the rules which govern the development of vegetation patterns, the phenomena of vegetation dynamics and the understanding of the degradation processes. Long-term ecological researches (KOVÁCS-LÁNG *et al.* 1998, 1999) make clearer the phenomena of landscape-scale approach (MOLNÁR and BOTTA-DUKÁT 1998, BÍRÓ and MOLNÁR 1998). On a national scale our knowledge of sandy vegetation associations is profuse and comprehensive (FEKETE 1998), nevertheless there are some unanswered questions and, from the classical point of view of coenology, some insufficiently explored regions (mainly sandy surfaces on the margins of mountains) require further study.

Such area is the Bakony region, especially its marginal sandy foothills. As for the sandy vegetation of the Bakony region, the most particularly searched area is the region between Fenyőfő and Bakonyszentlászló, covered with sandy Scots pine forests ("Fenyőfői Ósfenyves", mainly *Festuco vaginatae*-*Pinetum sylvestris* (SOÓ 1931) 1971). PÁL KITAIBEL made the first observations in 1799 by describing his impressions and recording some of the important plant species there (GOMBOCZ 1945). Several studies (GÁYER 1927, DORNYAI 1927, ZÓLYOMI 1936, RÉDL 1942, FEKETE 1964) discussed the flora and the question of the indigeneity of the pine forest dominated by *Pinus sylvestris* L. indented with dry grasslands on sandy dunes. SOÓ (1931) recognised the unique composition of these sandy Scots pine forests and published the first combined coenological samples of the forest and the neighbouring patches of sandy steppes. MAJER (1988) published a monograph of Scots pine forests around Fenyőfő, lately PÓCS (1995) and BARTHA (1999) gave a clear description and KEVEY (2001) published his ideas on this topic. As for the sandy grasslands of the Little Hungarian Plain (Kisalföld), BORHIDI (1956) shows how certain typical endemic, Ponto-Pannonian and continental plant species (*Colchicum arenarium* W. et K., *Tragopogon floccosus* W. et K., *Ephedra distachya* L., *Alyssum tortuosum* W. et K., *Echinops ruthenicus* (Fisch.) M. B., etc.), normally occurring in the sandy areas of the Danube-Tisza Interfluve, decrease in number as we move from east to west in the region. The same author also publishes tables of the coenological relevés named *Festucetum vaginatae danubiale*, *Festucetum vaginatae arrabonicum*, and *Festuceto-Corynephoretum arrabonicum*, providing also 3 relevés each from the two latter units of the sandy grassland associations around Fenyőfő and Bakonyszentlászló. As for the vegetation of other sandy areas of the Bakony region, there are only some references in floristical publications focusing on other subjects; FEKETE *et al.* (1961) published *Corynephorus canescens* (L.) P. B. as coming from the area near Homokbödöge-Nagytevel with the remark "auf Sand massenhaft". Recently, some

new details regarding the well-known occurrences of mass species on calciphobe sandy grasslands and some other sandy plant species have appeared in BAUER (2001, 2004) and BAUER *et al.* (2004).

Concerning the system of plant associations of Hungary, BORHIDI (2003) discusses the following open sandy grassland associations from Transdanubia:

(1) *Festuco dominii-Corynephorum* (Borhidi 1958) 1996. Remark: BORHIDI (1996) narrows the meaning of the name *Festuco vaginatae-Corynephorum* Soó in Aszód 1935 used earlier for the stands of the Transdanubian calciphobe sandy grasslands, the latter one is considered the endemic association of the Nyírség, the vicariant association of the Transdanubian grasslands; and he also discusses both associations in different order. In the sandy grasslands of the Little Hungarian Plain and along the River Morava the *Festuca vaginata* W. et K. subsp. *dominii* (Krajina) Soó association is typical.

(2) *Thymo angustifolii-Corynephorum canescentis* Krippel 1954.

(3) *Festucetum vaginatae* (Rapaics ex Soó 1929) emend. Borhidi 1996. Remark: BORHIDI (1996) gives a more specific interpretation of description.

Various Central European plant association monographs (see MUCINA *et al.* 1993, POTT 1995, BORHIDI 2003) discuss the sandy plant associations based on the publications mainly of KLIKA (1931, 1934), SOÓ (1933a,b, 1957), TÜXEN (1937, 1967), KRIPPEL (1954), BORHIDI (1956). As for the lime-poor sandy grasslands of a more Atlantic influence, dominated by *Corynephorus canescens*, several relevés were published (LIBBERT 1940, KNAPP and ACKERMANN 1952, OBERDORFER 1957, FUKAREK 1961, PHILIPPI 1973, KORNECK 1974, HOHENESTER 1967). The ecological characteristic features of these grasslands were examined from several aspects (VOLK 1931, BERGER-LANDEFELDT and SUKOPP 1965, JECKEL 1984, JENTSCH *et al.* 2002, JENTSCH and BEYSCHLAG 2003).

The importance of well-documented, classical phytocoenological works – despite the well-known limits of the methodology – is acknowledged even today (BAGI 1991, 1998, FEKETE 1995, BARTHA 2000). These are essential references for nature conservation and vegetation mapping and also for any biogeographical syntheses which require a thorough documentation of our quickly transforming natural environment. For the sake of a more objective comparability of coenological samples, BAGI (1998) suggests the establishment of a reference database for associations based on the Zürich-Montpellier method, which analyses according to flora regions.

The present article intends to introduce the open sandy grasslands of the Bakony region (looked upon here as a unique geomorphological phenomenon) and based on the classification of coenological samples, to place these into the larger

picture of a plant association system combining the author's own and published relevés.

MATERIALS AND METHODS

The Bakony region (administrative Hungarian landscape-geographical name: Bakonyvidék) is the largest mesoregion of the Transdanubian Mountains. It includes the Keszthely Mountains, the Tapolca Basin, the Balaton Uplands, the southern and northern Bakony, and the Bakonyalja (ÁDÁM *et al.* 1988). Significant surface sandy occurrences can be found at the Bakonyalja, on the western margin of southern Bakony, in the Tapolca Basin and in the basins of the Balaton Uplands (mainly in the Kál Basin) (BENCE *et al.* 1990, BUDAI *et al.* 1999). At foothill areas of the mountains sand beds of various size can be found around the territory of the supposed abrasion platforms of the Pannonian Sea from the Mio-Pliocene (Pannonian) period. In the Bakony the erosion of thickly piled up pebbles, sand and clay cover was already in progress, taking place parallel with the uplift of the area, which process also continued in the Pleistocene. The erosion contributed to the formation of the piedmont sand and pebble nappe in a complex way, and during the drier climate periods these surfaces continued to change through the process of deflation. These sandy substrates, sand beds have a varied lime content, which may be attributed to the lithological variety of the nearby eroded areas made up of Triassic dolomite, Triassic, Cretaceous period, Eocene limestones, pebble, conglomerate, etc. In addition, certain changes have occurred as post-effects (leaching, lime-concretion in different layers, exsurgences).

The present paper publishes relevés of open grassland stands from around Fenyőfő, Bakony-szentlászló, Bakonyszűcs on the Bakonyalja (sandy surfaces of varied lime content), from the areas near Nagytevel (limeless sandy surfaces), near Hegyesd, Sáska, Sümeg in the southern Bakony and near Salföld and Szentbékáll in the Balaton Uplands (limeless silica sand surfaces) (Fig. 1, Table 1).

The vegetation was sampled with the BRAUN-BLANQUET (1964) quadrat method (using 2 m × 2 m quadrates). Altogether, 85 coenological relevés representing the Bakony region (Tables 2–5) are published here. Nomenclature of the plant names follows SIMON (2000); JÄGER and WERNER (2002) in the case of species native outside Hungary; ERZBERGER and PAPP (2004) for the bryophytes; (SIMON 1991) for the lichen taxa; and BORHIDI (2003) for the plant association. The statistical analyses were performed with SYN-TAX 2000 (PODANI 2001) programme package.

Published samples of a few previously described units were used for the comparative evaluation of relevés: BORHIDI (1956) "*Festucetum vaginatae arrabonicum*", "*Festuceto-Corynephorretum arrabonicum*". Because of the quadrat size was different from ours, these were considered as presence-absence matrix analyses. Of the results of the performed multivariate statistical analyses we present two diagrams: (1) the results of the principal coordinates analysis (PCoA) containing our samples [matrix containing AD values] (Fig. 2), and (2) showing the principal component analysis (PCA) based on a presence-absence matrix including our samples and those of BORHIDI from Fenyőfő and Bakony-szentlászló (Fig. 3). By analysing the binary matrix our objective was to avoid that the higher AD values of some dominant species make unwanted influence on the results, and that the actual differences of species composition do not determine the ordination. While describing the stands of separating units we also considered the conclusion of the PCA diagram biplot representation.

Table 1. Basic data of the samplings (serial number = Nr., code of the coenotaxon's abbreviation (groups = Gr.), locality, date, height above sea level in m, total cover (%) = TC, cover of the cryptogam level = CC).

Nr.	Gr.	Locality	Date	Height	TC	CC
1.	Fv	Fenyőfő: Köles-dűlő (Legelő-dűlő)	29.06.2000	280	65	1
2.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	29.06.2000	280	50	3
3.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	29.06.2000	280	40	3
4.		Fenyőfő: Agyaglyuk-völgy	29.06.2000	240	50	1
5.		Fenyőfő: Agyaglyuk-völgy	29.06.2000	240	60	3
6.		Fenyőfő: Kuruc-erdő (Ősfenyves)	29.06.2000	250	60	5
7.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	60	3
8.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	40	1
9.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	40	1
10.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	50	1
11.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	50	5
12.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	40	1
13.		Fenyőfő: Köles-dűlő (Legelő-dűlő)	13.06.2001	280	40	3
14.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	60	1
15.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	60	1
16.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	50	5
17.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	40	0
18.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	40	1
19.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	50	3
20.		Fenyőfő: Mennydörgő-hegyi-legelő	15.07.2005	275	40	5
21.		Bakonyszentlászló: Tilos-fenyő	20.06.2005	250	50	0
22.		Bakonyszentlászló: Tilos-fenyő	20.06.2005	250	60	3
23.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	60	1
24.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	50	0
25.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	70	1
26.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	60	5
27.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	50	1
28.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	50	5
29.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	70	3
30.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	40	0
31.		Bakonyszücs: Legelő-dűlő	04.05.2004, 28.08.2004	240	50	1

Table 1 (continued)

Nr.	Gr.	Locality	Date	Height	TC	CC
32.		Bakonyszücs: Legelő-dűlő	04.05.2004, 28.08.2004	240	60	5
33.		Bakonyszücs: Legelő-dűlő	04.05.2004, 28.08.2004	240	60	3
34.	FvS	Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	50	5
35.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	60	3
36.		Fenyőfő: Kuruc-erdő (Ősfenyves)	29.06.2000	240 m	50	5
37.		Fenyőfő: Kuruc-erdő (Ősfenyves)	29.06.2000	240	40	0
38.		Fenyőfő: Közlegelő	04.05.2004	270	50	1
39.		Fenyőfő: Közlegelő	04.05.2004	270	50	1
40.		Fenyőfő: Közlegelő	04.05.2004	270	50	3
41.	FvC	Fenyőfő: Kása-mező	13.06.2001	280	30	0
42.		Fenyőfő: Kása-mező	13.06.2001	280	30	0
43.		Fenyőfő: Kuruc-erdő	13.06.2001	250	40	1
44.	Br	Bakonyszentlászló: Hangos-Fenyves	15.07.2005	240	10	0
45.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	10	0
46.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	10	0
47.		Bakonyszentlászló: Hangos-Fenyves	15.07.2005	250	10	0
48.		Bakonyszentlászló: Ráncsa	15.07.2005	250	20	0
49.	Cc	Nagytevel: Öreg-hegy-alja	13.06.2001	250	30	0
50.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	50	1
51.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	40	0
52.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	40	0
53.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	50	1
54.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	40	1
55.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	30	3
56.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	30	0
57.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	40	0
58.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	40	1
59.		Nagytevel: Csuszkati-dűlő	29.06.2005	250	60	1
60.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	50	1
61.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	60	1
62.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	60	3
63.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	40	0
64.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	50	3

Table 1 (continued)

Nr.	Gr.	Locality	Date	Height	TC	CC
65.		Nagytevel: Öreg-hegy-alja	29.06.2005	250	40	5
66.		Nagytevel: Csuszkati-dűlő	29.06.2005	250	70	3
67.		Nagytevel: Csuszkati-dűlő	29.06.2005	250	70	1
68.		Nagytevel: Csuszkati-dűlő	29.06.2005	250	70	1
69.		Sáska: Bükk-oldal, Szarvas-völgy	18.06.2001	230	50	10
70.		Sáska: Bükk-oldal, Szarvas-völgy	18.06.2001	220	50	8
71.		Sáska: Bükk-oldal, Szarvas-völgy	18.06.2001	220	60	3
72.		Hegyesd: Bükk-oldal	18.06.2001	230	50	1
73.		Hegyesd: Bükk-oldal	18.06.2001	230	50	5
74.		Hegyesd: Bükk-oldal	18.06.2001	230	70	3
75.		Hegyesd: Bükk-oldal	18.06.2001	220	60	5
76.		Hegyesd: Bükk-oldal	18.06.2001	220	60	5
77.		Sümeg: Templom-domb	27.06.2002	200	40	10
78.		Szentbékállai: Kő-hegy	18.05.2004	190	60	15
79.		Salföld: Kisörspuszta, Kőmagas	13.07.2002	150	40	10
80.		Salföld: Kisörspuszta, Kőmagas	13.07.2002	150	50	3
81.	CcK	Nagytevel: Öreg-hegy-alja	13.06.2001	250	80	3
82.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	70	3
83.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	70	3
84.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	80	1
85.		Nagytevel: Öreg-hegy-alja	13.06.2001	250	70	1

RESULTS AND DISCUSSION

85 coenological samples of the open sandy grasslands of the Bakony region are published here. Of these, 33 samples (Tables 2–3, group of Fv) of the grasslands, most typically dominated by *Festuca vaginata*, and 7 samples (Table 3, samples from 34 to 40, group of FvS) dominated by *Stipa pennata* L. in the region of Fenyőfő and Bakonyszentlászló, have been considered natural stands. (Although knowing earlier land use in the area, and that there is ongoing small-scale grazing even today, these cannot be seen as primary, intact stands.) We also recorded some stands of vegetation typical of recently (for the past few years) heavily disturbed areas and secondary sandy surfaces (Table 4, samples from 44 to 48, group of Br), and grasslands characterised by the common occurrence of *Festuca vaginata* and *Corynephorus canescens* (Table 4, samples from 41 to 43, group

of FvC). At other smaller sandy areas of the Bakony region, the open sandy grasslands include those dominated mainly by *Corynephorus canescens* (Tables 5–6, samples from 49 to 80, group of Cc), and we also present the coenological samples of an interesting grassland stand (Table 6, samples from 81 to 85, group of CcK) dominated by *Koeleria majoriflora* Borb. from one of the sample areas near Nagytevel.

The species cover of moss and lichen taxa does not appear in the tables, since these data were not recorded in 2000–2001, and in our investigations these were of secondary importance. In the majority of samples the cover of cryptogam level was below 5% (Table 1), which can probably be related to grazing in the majority of the sample areas. However, *Tortula ruralis* (Hedw.) Gaertn., Mey. et Scherb. and *Hypnum cupressiforme* Hedw. were observed as frequent, along with lichens *Cladonia rangiformis* Hoffm., *Cladonia convoluta* (Lam.) P. Cout., *Cladonia magyarica* Vainio, *Cladonia chlorophaea* (Flörke ex Sommerf.) Sprengel in sandy grasslands dominated by *Festuca vaginata*. In the sandy grasslands near Fenyőfő *Cladonia subulata* (L.) Weber ex Wigg., *Cladonia subrangiformis* Sandst. and

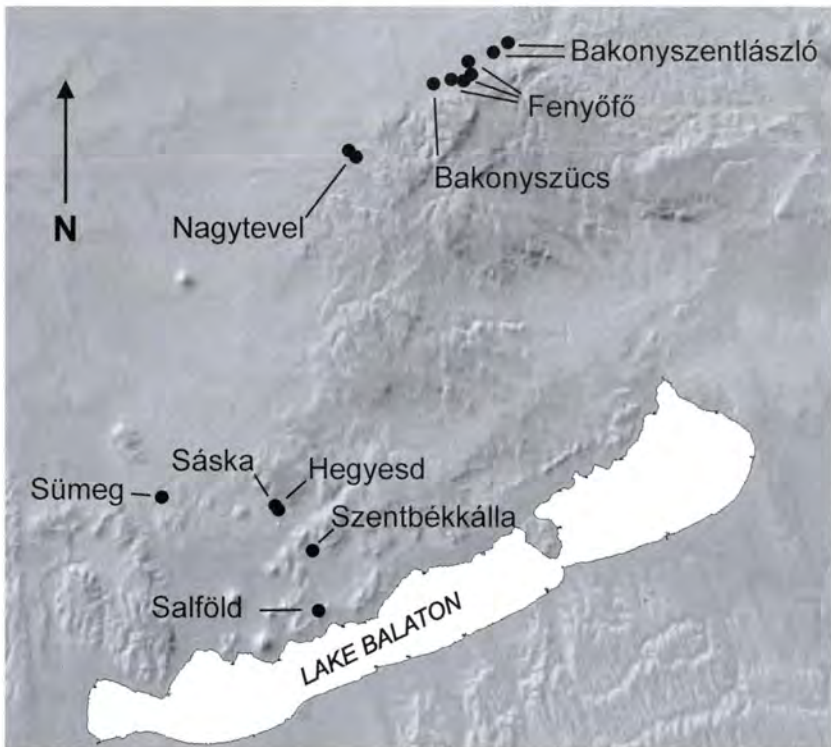


Fig. 1. Sampled areas in the Bakony region.

Table 2. Samples of the *Festucetum vaginatae* (Fv group 1/Fenyőfő).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Festuca vaginata</i>	4	3	3	3	3	3	3	2	1	1	2	1	1	3	3	2	2	2	3	3
<i>Artemisia campestris</i>	1	1	-	2	1	-	2	1	2	2	2	1	1	1	-	-	-	-	-	-
<i>Euphorbia seguieriana</i>	-	+	+	1	1	2	-	-	1	2	1	2	1	+	+	1	+	1	+	-
<i>Thymus serpyllum</i>	-	-	1	-	+	-	-	-	+	-	-	1	1	-	2	2	1	2	1	1
<i>Teucrium chamaedrys</i>	1	1	1	-	-	-	-	2	+	1	+	-	+	-	-	-	+	-	1	+
<i>Potentilla arenaria</i>	1	1	+	1	1	-	1	+	+	-	-	1	1	-	-	-	-	-	-	-
<i>Dianthus arenarius</i>	-	-	-	1	2	2	-	-	-	-	-	-	-	2	-	-	-	-	-	-
<i>Carex liparicarpus</i>	1	+	+	-	+	-	-	-	-	-	-	1	1	-	1	+	1	1	-	-
<i>Helichrysum arenarium</i>	-	-	-	-	+	-	1	-	-	-	-	1	1	-	1	1	+	-	-	-
<i>Sanguisorba minor</i>	1	1	+	-	-	-	+	1	-	-	-	+	+	-	1	+	-	-	-	+
<i>Seseli osseum</i>	1	+	+	1	+	-	-	+	-	+	-	1	1	-	-	-	-	-	-	-
<i>Hieracium echioides</i>	-	-	1	-	-	-	1	1	-	+	+	-	1	-	+	+	-	-	-	-
<i>Centaurea arenaria</i>	-	-	-	-	-	-	+	1	1	-	-	1	1	-	-	-	-	-	+	-
<i>Sedum sexangulare</i>	1	1	+	-	-	-	+	1	-	-	-	+	+	-	-	-	-	-	-	-
<i>Koeleria cristata</i> agg.	-	-	1	1	1	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-
<i>Polygonum arenarium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	1	2	+
<i>Minuartia verna</i>	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	-	-	-	-	-
<i>Arenaria serpyllifolia</i>	-	-	-	+	+	-	-	-	-	+	+	+	-	-	-	+	+	-	-	-
<i>Poa bulbosa</i>	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-	+	+	-	-
<i>Eryngium campestre</i>	1	-	+	+	+	-	+	1	-	-	-	+	+	+	-	-	-	-	-	-
<i>Silene otites</i>	1	+	1	+	+	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-
<i>Trifolium arvense</i>	-	-	-	-	-	-	1	+	+	+	1	-	-	-	-	-	-	-	-	-
<i>Agropyron repens</i>	-	-	1	-	1	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Calamagrostis epigeios</i>	-	-	-	-	-	1	1	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Jasione montana</i>	-	-	+	-	-	-	1	+	-	-	-	+	+	+	-	-	-	-	-	+
<i>Euphorbia cyparissias</i>	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	+	-	-	1	-
<i>Centaurea micranthos</i>	1	1	1	+	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anchusa officinalis</i>	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Bromus squarrosus</i>	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	+	-
<i>Crepis tectorum</i>	-	-	-	-	-	-	+	+	-	+	-	+	-	-	-	-	-	-	-	-
<i>Medicago minima</i>	-	-	-	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-	-	-
<i>Erysimum diffusum</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-
<i>Petrorhagia saxifraga</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+
<i>Dianthus pontederæ</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Phleum phleoides</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-

Other taxa: **1:** *Anthoxanthum odoratum* +, *Echium vulgare* +; **2:** *Veronica prostrata* 1, *Pulsatilla pratensis* subsp. *nigricans* 1, *Anthoxanthum odoratum* +; **3:** *Senecio vulgaris* +, *Scabiosa ochroleuca* +, *Seseli annuum* +; **4:** *Cerastium semidecandrum* +, *Potentilla alba* +, *Thesium arvense* +; **5:** *Chondrilla juncea* 1, *Arabidopsis thaliana* +, *Seseli annuum* +, *Tragopogon dubius* +; **6:** *Peucedanum oreoselinum* +, *Cerastium semidecandrum* +, *Gypsophila fastigiata* 1; **7:** *Chondrilla juncea* 1, *Berteroa incana* +, *Galium verum* +, *Potentilla argentea* +, *Tragopogon dubius* +; **8:** *Plantago lanceolata* +, *Berteroa incana* +, *Potentilla argentea* +, *Senecio jacobea* +, *Tragopogon dubius* +; **9:** *Sedum hillebrandtii* +; **10:** *Silene conica* +, *Sedum hillebrandtii* +, *Potentilla argentea* +; **11:** *Trifolium campestre* +, *Silene conica* +, *Veronica praecox* +; **12:** *Pimpinella saxifraga* agg. +, *Hypericum perforatum* +, *Galium verum* +, *Scabiosa ochroleuca* +; **13:** *Plantago arenaria* +, *Linnaria genistifolia* +, *Pulsatilla pratensis* subsp. *nigricans* +, *Plantago lanceolata* +, *Galium verum* +, *Senecio jacobea* +, *Seseli annuum* +; **14:** *Cynodon dactylon* 1, *Vicia angustifolia* +, *Hypericum perforatum* +; **15:** *Cynodon dactylon* +, *Pimpinella saxifraga* agg. 1; **16:** *Asperula cynanchica* +; **17:** *Bothriochloa ischaemum* 1, *Crepis rheadifolia* +, *Veronica praecox* +; **18:** *Juniperus communis* 2; **19:** *Erophila verna* +; **20:** *Scabiosa ochroleuca* +, *Veronica praecox* +

Cladonia cenotea (Ach.) Schaer. are characteristic, but occur in smaller quantities. The moss species *Ceratodon purpureus* (Hedw.) Brid., *Polytrichum juniperinum* Hedw., *Polytrichum piliferum* Schreb. ex Hedw., *Racomitrium canescens* (Hedw.) Brid., and *Tortula ruralis*, along with the lichen species *Cladonia rangiformis*, *Cladonia chlorophaea*, and *Cladonia pyxidata* (L.) Hoffm. were recorded in sandy grasslands dominated by *Corynephorus canescens*.

PCoA ordination of the samples showed the existence of separated groups (Fig. 2). On the basis of the separation of the samples it is presumed that the acidic-basic character is component 1 (axis 1), and the closing of the stands is component 2 (axis 2). The open grasslands are represented by calciphobe *Corynephorum* samples (Cc), *Festucetum vaginatae* samples (Fv) on more basoid surfaces and intermediate samples qualified as *Festuco-Corynephorum* (FvC) described earlier. The separation of slightly closer stands, having similar species composition, dominated by *Stipa pennata* (FvS) from the Fv group is of small degree, and the separation of *Koeleria majoriflora* (CcK) samples adjoining *Corynephorum* is more conspicuous because of the greater differences in the species composition and cover values.

In the *Festucetum vaginatae* grasslands (Fv-group) of the Bakonyalja *Euphorbia seguieriana* Necker, *Thymus serpyllum* L., *Teucrium chamaedrys* L., and *Artemisia campestris* L. were the most frequent besides the dominant grass species. In the sandy region of Fenyőfő–Bakonyszentlászló *Dianthus arenarius* L. subsp. *borussicus* Vierh., *Peucedanum arenarium* W. et K., *Polygonum arenarium* W. et K., *Sedum hillebrandtii* Fenzl., *Fumana procumbens* (Dun.) Gren. et Godr., *Gypsophila fastigiata* L. subsp. *arenaria* (W. et K. ex Willd.) Domin, *Hieracium echinoides* Lumn., *Helichrysum arenarium* (L.) Moench, *Centaurea arenaria* M. B. ex Willd., *Potentilla arenaria* Borkh., *Draba nemorosa* L. may be highlighted for

their (partly) phytogeographical importance in the Pannonian region. Here, *Silene conica* L., *Plantago arenaria* W. et K., *Corispermum nitidum* Kit. can be mentioned on more disturbed patches. During sampling the majority of these plants were proved to occur rarely and locally (appearing only in some parts of the region) on the sandy areas. The local appearance of *Scabiosa canescens* W. et K., in the grasslands along the railway embankment of Tilos-fenyő and Hangos-Fenyves (Bakonyszentlászló) is also important. The observation of *Epipactis atrorubens* Hoffm. ex Bess. (Bakonyszentlászló: Tilos-fenyő) also belongs to those absent in the coenological samples. *Pulsatilla pratensis* (L.) Mill. subsp. *nigricans* (Störck) Zamels, *Chamaecytisus austriacus* (L.) Link, *Seseli osseum* Cr., *Silene otites* (L.) Wib., *Chrysopogon gryllus* (Torn.) Trin., and *Stipa pennata* – dominant on closer sandy grasslands – is typical among the forest steppe species not connected to sand bedrock. The samples (FvS group) characterised by the dominance of *Stipa pennata* are slightly separated from the other *Festucetum vaginatae* samples (Fig.

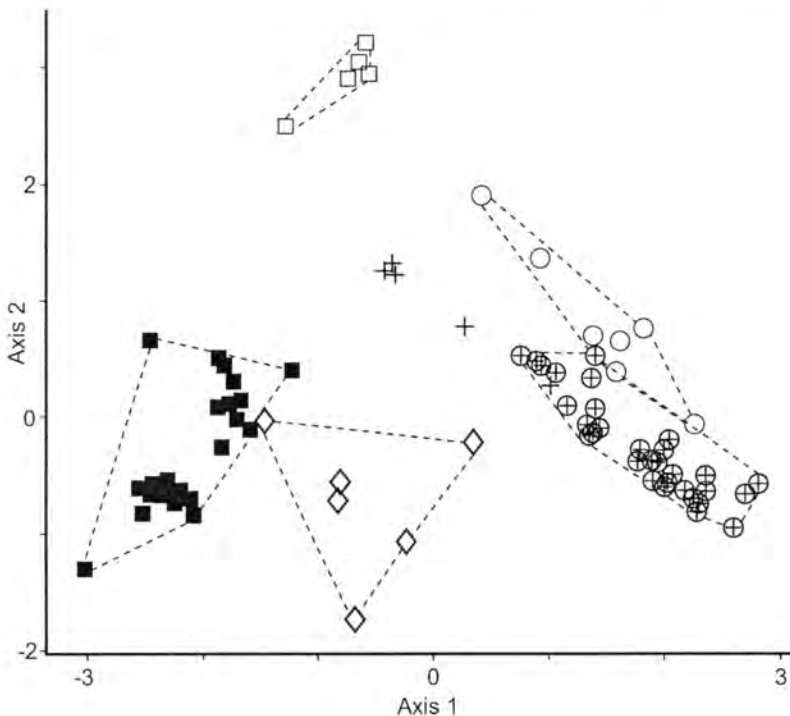


Fig. 2. Principal coordinates analysis (PCoA) of the samples (based on AD values). (Key to signs: crossed circle = samples of Fv group; empty circle = samples of FvS group; cross = samples of Br group; rhombus = samples of FvC group; full square = samples of Cc group; empty square = samples of CcK group).

Table 3. Samples of the *Festucetum vaginatae* (Fv group 2/Bakonyszentlászló) and the *stipetosum pennatae* (FvS group).

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
<i>Festuca vaginata</i>	2	3	3	3	3	3	3	3	4	2	3	3	3	2	2	2	3	–	2	1
<i>Stipa pennata</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	2	3	2	2	3	3	3
<i>Euphorbia segueriana</i>	1	–	+	1	2	2	1	2	+	1	+	–	+	2	–	1	1	–	1	–
<i>Dianthus arenarius</i>	2	–	2	–	1	1	–	1	1	–	–	–	–	+	2	–	1	–	–	–
<i>Thymus serpyllum</i>	–	–	–	–	2	1	2	+	1	1	–	–	–	–	–	–	–	1	1	–
<i>Artemisia campestris</i>	–	–	–	–	–	–	–	–	–	–	1	2	1	–	–	–	–	1	1	1
<i>Teucrium chamaedrys</i>	–	–	+	–	–	+	–	–	–	–	1	–	–	1	–	–	–	2	1	1
<i>Euphorbia cyparissias</i>	–	1	–	–	–	–	+	–	+	–	1	1	–	+	1	–	–	1	+	+
<i>Fumana procumbens</i>	–	–	+	1	+	1	–	–	+	2	–	–	–	–	–	–	1	–	–	–
<i>Potentilla arenaria</i>	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	+	1
<i>Carex liparicarpus</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	+	1	+
<i>Sedum sexangulare</i>	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	1	+
<i>Carex praecox</i>	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–
<i>Koeleria cristata</i> agg.	–	–	–	–	–	–	–	–	–	–	1	1	1	–	–	–	–	–	–	–
<i>Silene otites</i>	–	–	–	–	–	+	+	–	–	+	–	1	–	+	–	–	–	–	1	+
<i>Poa bulbosa</i>	–	–	–	–	+	+	–	–	–	+	1	–	+	–	–	–	–	1	–	–
<i>Peucedanum oreoselinum</i>	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–
<i>Pimpinella saxifraga</i> agg.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	+	+
<i>Sanguisorba minor</i>	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	+	1
<i>Seseli osseum</i>	–	–	–	–	–	–	+	1	–	–	–	–	–	–	1	–	–	+	–	–
<i>Scabiosa ochroleuca</i>	–	–	–	+	+	–	+	+	–	–	1	–	–	+	+	+	–	–	–	–
<i>Cerastium semidecandrum</i>	–	+	–	–	–	–	–	–	–	–	+	+	+	–	–	–	–	1	+	+
<i>Gypsophila fastigiata</i>	+	–	–	1	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
<i>Medicago minima</i>	–	–	+	–	+	–	+	–	–	–	+	+	+	–	–	–	–	–	–	–
<i>Petrorhagia saxifraga</i>	–	–	–	+	–	+	+	–	+	–	–	–	+	+	–	–	–	–	–	–
<i>Arenaria serpyllifolia</i>	–	–	+	–	–	–	–	+	–	–	+	+	+	–	–	–	–	–	–	–
<i>Erophila verna</i>	+	–	–	–	–	+	+	+	–	–	–	–	–	–	–	–	–	–	–	+
<i>Helianthemum ovatum</i>	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–
<i>Eryngium campestre</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	+	–	+
<i>Scabiosa canescens</i>	+	1	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
<i>Peucedanum arenarium</i>	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
<i>Dianthus pontederiae</i>	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	1	–	–	–	–
<i>Centaurea arenaria</i>	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	+
<i>Chamaecytisus austriacus</i>	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 3 (continued)

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
<i>Hypericum perforatum</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+
<i>Trifolium arvense</i>	+	–	–	–	–	–	–	+	–	–	–	–	–	+	–	–	–	–	–	–
<i>Draba nemorosa</i>	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
<i>Erysimum diffusum</i>	–	–	–	–	–	–	–	–	+	–	–	+	–	–	–	–	–	–	–	–
<i>Veronica prostrata</i>	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	1	+	–

Other taxa: **21:** *Arrhenatherum elatius* 1, *Robinia pseudoacacia* (juv.) +, *Achillea collina* +, *Carex micheli* +, *Hieracium echinoides* +, *Linaria genistifolia* +, *Quercus cerris* (juv.) +; **22:** *Pseudolysimachion spicatum* +, *Allium scorodoprasum* +, *Galium verum* +; **23:** *Senecio jacobea* +; **24:** *Pinus sylvestris* (juv.) 1, *Erigeron annuus* +, *Viola hirta* +, *Calamagrostis epigeios* 1; **25:** *Allium flavum* +; **26:** *Senecio jacobea* +; **27:** *Hieracium pilosella* agg. +; **28:** *Achillea collina* +, *Taraxacum erythrospermum* +; **32:** *Ornithogalum umbellatum* +, *Poa angustifolia* +, *Cynodon dactylon* +, *Vicia angustifolia* +; **33:** *Poa angustifolia* 1, *Minuartia verna* +, *Sedum hillebrandtii* +; **34:** *Pseudolysimachion spicatum* 1; **35:** *Saxifraga bulbifera* +, *Valerianella locusta* +, *Hieracium bauhini* +, *Hieracium pilosella* agg. 1, *Clinopodium vulgare* +, *Carex micheli* +; **36:** *Asparagus officinalis* 1, *Centaurea micranthos* +, *Calamagrostis epigeios* +, *Dactylis glomerata* +, *Melica transsilvannica* +; **37:** *Minuartia verna* +, *Arabidopsis thaliana* +; **38:** *Festuca pseudovina* 1, *Luzula campestris* +; **39:** *Orchis morio* +, *Hieracium bauhini* 1, *Cruciata pedemontana* +, *Muscari comosum* +, *Luzula campestris* +, *Crataegus monogyna* (juv.) +, *Seseli annuum* 1; **40:** *Chrysopogon gryllus* 1, *Saxifraga bulbifera* +, *Cruciata pedemontana* +, *Myosotis arvensis* +, *Arabis glabra* +, *Seseli annuum* +

2) on the basis of the standardised PCoA of cover value. The PCA ordination based on presence-absence matrix (Fig. 3) showed that the isolation of the FvS group cannot be verified, because of the lack of major differences of species composition. The subassociation level of separation – *Festucetum vaginatae stipetosum pennatae* – is reasonable for the *Stipa pennata* grasslands of the Bakonyalja, which is parallel to the subassociation type of maintenance of grasslands dominated by *Stipa borysthena* Klokov in the stands on the area of the Danube–Tisza Interfluvium (see BORHIDI 2003).

During our samplings in the area of “Fenyőfői Ósfenyves”, *Corynephorus canescens* seemed to be a rarer element as opposed to the earlier samplings (BORHIDI 1956, MAJER 1988). The stands matching the description of *Festuco-Corynephorum* (see BORHIDI 1956, 1958, 1996) can be found mainly on the recently disturbed patches, in glades, on road slopes of regenerating vegetation adjoining forests, and on sandy surfaces formed by bauxite pit recultivation. The actual patch-like occurrences of *Corynephorus* and the appearance partly as a co-grassland establisher with *Festuca vaginata* seems secondary in the region of Fenyőfő (BORHIDI (2003) also mentions that it can appear secondarily). The frequent occurrence of *Calamagrostis epigeios* (L.) Roth, *Euphorbia cyparissias* L., *Ambrosia artemisiifolia* L. also refers to this fact. This vegetation type is not typical – and

it was not so earlier – on the fairly dry lime sandy steppes, e.g. the pasture of “Mennydörgő-hegy”, “Közlegelő”, which were more remote from forests and were grazed moderately. The reason for this can be found in the microclimate, which is drier and more extreme than in the areas not covered with forests, in the presence of grove-like forests of *Pinus sylvestris* and in the unfavourable water regime of the sandy soil barely covered with vegetation. The Atlantic climatic effects cannot re-

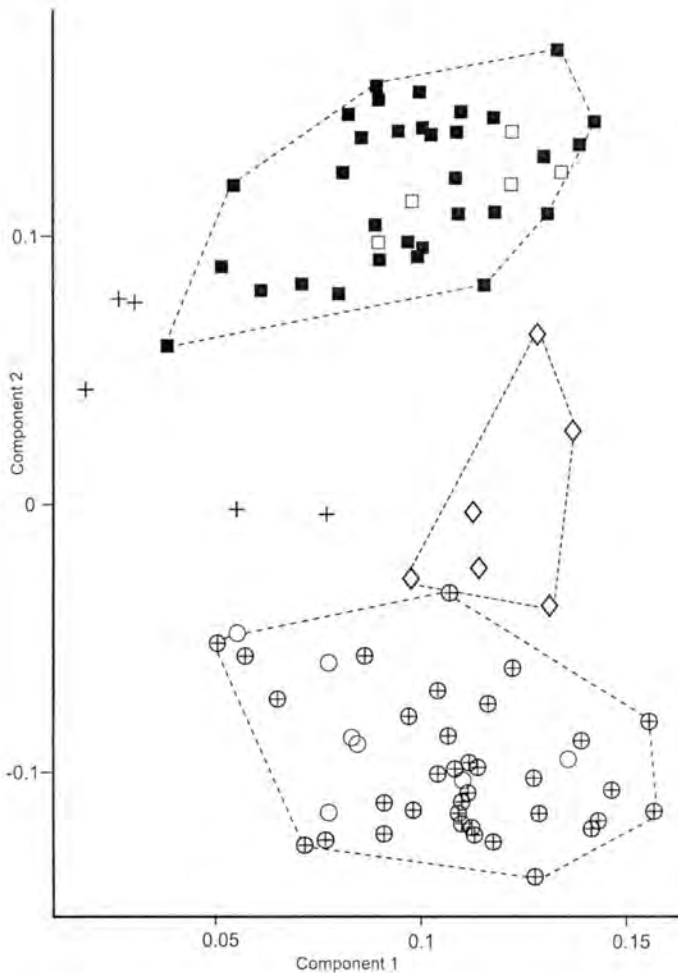


Fig. 3. Principal component analysis of the samples (based on presence-absence matrix). (Key to signs: crossed circle = samples of Fv group; empty circle = samples of FvS group; cross = samples of Br group; rhombus = samples of FvC group; full square = samples of Cc group; empty square = samples of CcK group).

Table 4. Samples of the *Festuco vaginatae-Corynephorum* (FvC group) and the secondary sandy grasslands on disturbed surfaces (Br group).

	41	42	43	44	45	46	47	48
<i>Festuca vaginata</i>	–	1	2	–	–s	–	1	2
<i>Corynephorus canescens</i>	2	2	1	–	–	–	–	–
<i>Corispermum nitidum</i>	–	–	–	1	1	2	2	1
<i>Bromus tectorum</i>	–	–	–	2	2	–	+	–
<i>Ambrosia artemisiifolia</i>	+	+	+	1	+	+	1	+
<i>Eragrostis minor</i>	–	–	–	–	–	1	+	1
<i>Peucedanum oreoselinum</i>	1	+	1	–	–	–	–	–
<i>Sedum telephium</i> subsp. <i>maximum</i>	+	1	1	–	–	–	–	–
<i>Artemisia campestris</i>	1	1	–	–	–	–	–	–
<i>Sedum sexangulare</i>	1	1	–	–	–	–	–	–
<i>Trifolium arvense</i>	+	+	1	–	–	–	–	+
<i>Dianthus pottederae</i>	–	–	1	–	–	–	–	–
<i>Pinus sylvestris</i> (juv.)	–	1	–	–	–	–	–	–
<i>Calamagrostis epigeios</i>	+	+	+	–	+	–	–	–
<i>Euphorbia cyparissias</i>	+	+	+	–	–	–	–	+
<i>Carex praecox</i>	+	–	+	–	–	–	–	–
<i>Chondrilla juncea</i>	–	–	–	+	–	+	–	+
<i>Scabiosa ochroleuca</i>	+	+	+	–	–	–	–	–
<i>Conyza canadensis</i>	–	–	+	+	–	–	–	–
<i>Koeleria cristata</i> agg.	+	+	–	–	–	–	–	–
<i>Petrorhagia prolifera</i>	–	+	+	–	–	–	–	–
<i>Rumex acetosella</i>	–	–	+	–	–	+	–	–
<i>Jasione montana</i>	+	–	–	–	–	–	–	–
<i>Silene conica</i>	–	–	–	–	–	–	–	+
<i>Silene otites</i>	+	–	–	–	–	–	–	–
<i>Euphorbia seguieriana</i>	+	–	–	–	–	–	–	–

Other taxa: **41:** *Potentilla argentea* +, *Quercus cerris* (juv.) +, *Senecio vulgaris* +; **42:** *Minuartia verna* +, *Veronica praecox* +; **43:** *Cerastium semidecandrum* +, *Crepis tectorum* +, *Hypericum perforatum* +, *Poa compressa* +, *Populus alba* (juv.) +, *Senecio jacobaea* +, *Teucrium chamaedrys* +, *Trifolium campestre* +; **44:** *Achillea collina* +; **48:** *Pimpinella saxifraga* agg. +

ally predominate mosaic-like stands (adjoining forests). The “Ősfenyves” indented with clearings – earlier being of woodland pasture character – has been grazed with sheep for a long time (see MAJER 1988), which also supposes the definite effects of treading on vegetation as a result of grazing around the open areas of forests. Half a

Table 5. Samples of the *Thymo angustifolio-Corynephorum* (Cc group 1/Nagytevel).

	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
<i>Corynephorus canescens</i>	2	2	2	3	3	2	2	2	2	2	3	3	3	2	3	3	2	3	3	3
<i>Jasione montana</i>	+	+	+	-	-	1	-	-	-	+	1	+	-	+	+	1	2	1	+	-
<i>Koeleria majoriflora</i>	+	+	-	+	+	+	-	+	+	1	-	-	+	-	-	-	1	-	-	2
<i>Poa angustifolia</i>	-	+	-	+	+	+	-	-	-	+	-	-	-	-	-	1	-	2	2	-
<i>Hieracium pilosella</i>	-	-	-	-	-	+	-	+	-	-	+	1	-	2	+	-	-	1	1	-
<i>Dianthus pontederac</i>	-	1	+	-	+	1	1	+	+	+	-	+	+	1	+	+	+	+	-	-
<i>Silene otites</i>	1	1	+	-	-	-	-	+	-	+	+	-	-	-	+	-	+	+	-	-
<i>Verbascum phlomoides</i>	+	1	+	+	-	-	+	-	+	+	-	-	1	-	-	-	-	-	-	-
<i>Trifolium arvense</i>	+	-	1	-	+	1	-	-	-	-	-	-	-	-	-	-	-	-	+	-
<i>Trifolium campestre</i>	+	+	+	+	+	+	+	+	+	+	-	+	-	-	-	+	-	1	+	
<i>Conyza canadensis</i>	+	+	-	+	+	+	+	+	+	+	+	-	-	-	-	1	+	-	-	+
<i>Anthemis ruthenica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	1	1	-
<i>Rumex acetosella</i>	-	-	-	-	-	-	-	-	-	1	+	-	+	+	+	-	+	+	+	-
<i>Thymus serpyllum</i>	-	-	1	+	+	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-
<i>Ambrosia artemisiifolia</i>	+	+	+	+	1	1	+	1	1	+	+	+	-	+	+	-	-	-	-	-
<i>Potentilla argentea</i>	-	-	-	+	1	-	-	-	-	+	+	1	1	-	+	+	-	+	+	-
<i>Galium verum</i>	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+	-	-	1	1	1
<i>Centaurea micranthos</i>	-	-	-	1	1	-	-	1	-	-	+	+	-	+	-	-	-	-	-	-
<i>Euphorbia cyparissias</i>	+	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	+	+
<i>Chondrilla juncea</i>	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	+	-	-	-	-
<i>Petrorhagia saxifraga</i>	1	1	-	-	+	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Teucrium chamaedrys</i>	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1
<i>Euphorbia seguieriana</i>	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carex hirta</i>	-	-	1	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+
<i>Lotus corniculatus</i>	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	1	+
<i>Hypochoeris radicata</i>	-	+	-	-	-	-	-	-	-	-	-	1	-	+	+	-	-	-	-	-
<i>Petrorhagia prolifera</i>	+	+	+	-	-	+	+	-	+	+	-	-	-	-	+	-	-	-	-	-
<i>Erysimum diffusum</i>	+	-	-	+	+	-	+	-	+	-	-	-	-	-	+	+	-	-	-	-
<i>Scleranthus annuus</i>	-	-	-	-	-	-	+	-	-	-	+	-	-	-	+	+	+	-	-	-
<i>Cerastium semidecandrum</i>	-	+	+	-	-	-	-	-	-	-	+	-	+	-	-	-	-	+	-	+
<i>Erigeron annuus</i>	-	-	+	+	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	+
<i>Leontodon hispidus</i>	-	-	-	-	-	+	+	-	-	-	-	+	-	-	+	+	-	-	+	-
<i>Matricaria maritima inodora</i>	-	-	-	-	+	-	-	-	+	-	1	-	-	-	-	-	-	-	-	-
<i>Arrhenatherum elatius</i>	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	+	+
<i>Pimpinella saxifraga</i> agg.	+	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	+

Table 5 (continued)

	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
<i>Carlina vulgaris</i>	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	+
<i>Crepis tectorum</i>	+	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Poa compressa</i>	-	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Achillea collina</i>	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Moenchia mantica</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-
<i>Aira caryophylla</i>	-	-	-	-	-	-	-	-	-	-	+	+	-	+	-	-	-	-	-	-

Other taxa: **50:** *Sedum sexangulare* +, **51:** *Bromus tectorum* +, *Carex praecox* +, *Echium vulgare* +; **53:** *Apera spica-venti* +; **54:** *Agrostis capillaris* +; **58:** *Poa bulbosa* +; **60:** *Artemisia campestris* 1, *Hieracium bauhini* +; **61:** *Erophila verna* +; **62:** *Poa bulbosa* +, *Veronica verna* +, *Centaurea pannonica* +, *Sisymbrium orientale* +; **63:** *Crepis rheoadifolia* +; **64:** *Crepis rheoadifolia* +, *Cynodon dactylon* +; **65:** *Luzula campestris* +; **66:** *Artemisia campestris* +, *Peucedanum oreoselinum* +; **67:** *Anthoxanthum odoratum* +, *Elymus repens* 1, *Centaurea pannonica* +, *Cynodon dactylon* +, *Scabiosa ochroleuca* +, *Vicia lathyroides* +; **68:** *Agrostis capillaris* 1, *Anthoxanthum odoratum* 1, *Berteroa incana* +, *Crataegus monogyna* (juv.) 1, *Muscari comosum* 1, *Peucedanum oreoselinum* +, *Plantago lanceolata* +, *Scabiosa ochroleuca* +

century ago it was also characteristic as shown by the samplings of BORHIDI from 1953 and 1955. It supposedly repressed in the region of the "Ősfenyves" compared to the earlier spread of *Festuco-Corynephorretum*, which is related to (1) the area having been declared protected (1954) and so grazing in the forest areas practically ceased, (2) destruction caused by the open bauxite mining operations in some parts of the "Ősfenyves" – according to BARTHA (1999) on natural patches. In connection with the supposed secondary state of *Corynephorus* patches, it is important to mention that HARGITAI (1940) also expressed a similar opinion on the sandy grasslands of the region near Nagykörs. In the area of the Danube–Tisza Interfluve he considers *Corynephorus canescens* as an indicator of the originally lime-rich, sandy, leached, nutrient-poor patches. According to him *Festucetum vaginatae* and the *Festucetum vaginatae corynephoretosum canescentis* (*Festuceto-Corynephorretum*) units mentioned in his article can be perfectly separated physiognomically, but he could not trace any important ecological or "sociological" differences. *Corynephorretum* thus can be deduced from *Festucetum vaginatae*, and he considered it the "weak species variant", which appears following soil destruction (the actual name of these grasslands in the area of the Danube–Tisza Interfluve: *Achilleo ochroleucae-Corynephorretum* (HARGITAI 1940) BORHIDI 1996). According to HARGITAI (1940) such a sharp borderline could not have been formed between the two units (in the *Corynephorus* stands there are continental, Ponto-Mediterranean and Mediterranean elements) because of the semiarid climate of

Table 6. Samples of the *Thymo angustifolio-Corynephorum* (Cc group 2/Hegyesd, Sáska, Salföld, Szentbékálla) and the *koelerietosum* (CcK group).

	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
<i>Corynephorus canescens</i>	3	3	4	3	2	1	3	3	3	3	3	3	+	1	–	–	+
<i>Koeleria majoriflora</i>	–	–	–	–	–	–	–	–	–	–	–	–	3	3	3	3	3
<i>Rumex acetosella</i>	1	+	1	+	1	1	–	1	1	2	+	+	–	–	+	–	–
<i>Jasione montana</i>	1	+	–	+	1	+	1	+	–	1	–	+	1	+	+	+	+
<i>Conyza canadensis</i>	+	+	+	1	2	2	–	–	–	–	–	–	+	–	–	–	–
<i>Cynodon dactylon</i>	+	+	+	+	1	3	+	+	–	–	–	–	–	–	–	–	–
<i>Hypochoeris radicata</i>	–	+	–	–	+	–	+	–	–	–	–	–	–	–	–	+	–
<i>Ambrosia artemisiifolia</i>	–	2	–	2	+	–	+	–	–	–	–	–	+	+	+	+	–
<i>Erophila verna</i>	–	+	–	–	+	+	–	–	–	–	+	–	–	–	–	–	–
<i>Euphorbia cyparissias</i>	–	–	+	–	+	–	–	+	+	–	–	–	–	–	–	–	–
<i>Dianthus pontederæ</i>	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	+	1
<i>Silene otites</i>	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	+	1
<i>Verbascum phlomoides</i>	–	–	–	–	–	–	+	–	–	–	–	–	1	1	+	1	–
<i>Festuca rupicola</i>	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
<i>Thymus serpyllum</i>	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
<i>Berteroa incana</i>	–	–	–	–	–	+	–	–	–	–	–	–	1	–	–	–	+
<i>Peucedanum oreoselinum</i>	–	–	–	–	–	–	–	–	–	–	–	+	1	–	–	–	+
<i>Scabiosa ochroleuca</i>	–	+	–	–	–	–	–	–	–	–	–	–	+	+	+	+	+
<i>Hieracium pilosella</i>	–	–	–	–	–	–	+	–	–	–	–	–	–	+	+	+	+
<i>Carlina vulgaris</i>	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–	+
<i>Galium verum</i>	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	+	+
<i>Poa angustifolia</i>	–	–	–	–	–	–	–	–	–	–	–	–	+	–	+	–	+
<i>Aira caryophyllæ</i>	–	–	–	–	–	–	–	–	–	1	+	–	–	–	–	–	–
<i>Pimpinella saxifraga</i> agg.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	1
<i>Veronica verna</i>	–	–	–	–	–	–	–	+	+	–	–	–	–	–	–	–	–
<i>Calluna vulgaris</i>	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–

Other taxa: **69:** *Filago arvensis* +, *Luzula campestris* +; **70:** *Quercus cerris* (juv.) +; **71:** *Pinus sylvestris* (juv.) 2, *Arenaria serpyllifolia* +; **72:** *Arabidopsis thaliana* +, *Petrorhagia saxifraga* +, *Vulpia myuros* +; **73:** *Petrorhagia prolifera* +; **74:** *Petrorhagia prolifera* +; **75:** *Agrostis capillaris* 1, *Juniperus communis* (juv.) +, *Myosotis stricta* +, *Vicia lathyroides* +; **76:** *Anthemis ruthenica* +, *Bromus tectorum* +; **77:** *Filago arvensis* +; **78:** *Carex praecox* 1, *Poa bulbosa* 1, *Myosotis stricta* +, *Lychnis viscaria* +, *Anthoxanthum odoratum* +, *Gagea bohemica* +, *Geranium pusillum* +, *Ornithogalum umbellatum* +, *Orchis morio* +, *Sedum sexangulare* +; **79:** *Luzula campestris* +, *Quercus cerris* (juv.) +; **80:** *Arenaria serpyllifolia* +, *Lychnis viscaria* +, *Cerastium semidecandrum* +, *Hieracium umbellatum* +; **81:** *Crataegus monogyna* (juv.) +, *Trifolium arvense* +; **82:** *Leontodon hispidus* +, *Muscari comosum* +, *Erysimum diffusum* +, *Plantago lanceolata* +; **83:** *Leontodon hispidus* +, *Teucrium chamaedrys* +; **84:** *Arrhenatherum elatius* 1, *Bromus erectus* sl. 1, *Carex caryophyllæ* 1, *Chondrilla juncea* 1, *Lotus corniculatus* +; **85:** *Lotus corniculatus* +, *Matricaria maritima inodora* +, *Muscari comosum* +

Kiskunság – a situation also mentioned by VOLK (1931) with regard to the sandy regions along the Rhine referring to the *Weingärtneria* ass. (= *Corynephorus canescens*) – *Koeleria glauca* ass. According to the examinations of VOLK (1931) the soil-reaction value is a determining habitat factor, where at pH = 4.7–5.8 the acidophilous *Weingärtneria* ass., and with pH = 7–8.2 obviously the basiphilous *Koeleria glauca* ass. grasslands can typically develop (according to the given table, however, *Corynephorus* is present as an accompanying species in the majority of these grasslands). In the western part of the Bakonyalja and the Little Hungarian Plain, because of phytogeographical reasons, we cannot find several continental, Ponto-Pannonian and endemic species typical of the Central Hungarian stands in the *Festucetum vaginatae* stands (see BORHIDI 1956), yet these become more and more frequent out of the typical accompanying species of *Corynephorus* grasslands *Jasione montana* L., *Rumex acetosella* L. in some places in the *Festuca vaginata* grasslands. Thus similarly to the publication of VOLK (1931), the borderline between the calciphilous (Fv) and calciphobe grasslands (Cc) is not sharp here either. The recognition of *Festuco-Corynephoretum* also proves that it can be perceived as a transitional association, whose stands can be found on typically neutral (pH = 6.5–7.5) sand in the region near Fenyőfő. The formation of *Festuco-Corynephoretum* can be explained with a number of factors. The alternation of sandy surfaces of varied lime content, the Atlantic climatic effects, and the above mentioned factors of land use history altogether play a determining factor in the development of the grassland whether be of the stand of *Festuca vaginata* or *Corynephorus canescens* character, or characterised by both species in certain cases. The grasslands representing the latter one are not only known in the Little Hungarian Plain, the Bakonyalja and Belső-Somogy (BORHIDI 1958), but on the basis of published relevés, along the sandy areas of the River Morava “*Festuca vaginata*-*Dianthus serotinus*-Ass.” as seen in KLIKA (1934), also mentioned by BORHIDI (1958) (see *F.-C. moravicum*). CHYTRÝ and TICHÝ (2003) also refer to this association on the basis of the statistical evaluation of referent database sampling material from the territory of the Czech Republic. The intermediate state of *Festuco-Corynephoretum* can be verified from an ecological and area-geographical aspect. On a European scale this association is situated between *Spergulo-Corynephoretum canescentis* association, which is typical on more Atlantic and acidic sandy dunes of the northwestern part of Central Europe, and *Festucetum vaginatae*, which is typical of more continental and mainly basic sandy steppe grasslands of the Carpathian basin. Because of the geographical position and the phytogeographical characters of the Bakony region, this transition can be found here on a regional scale, which is also reflected in the PCA diagram of the presence-absence matrix (Fig. 3).

The species-poor, but relatively heterogeneous samples of the Br group represent the rather degraded sandy grassland stands typical of the Bakonyszentlászló–Fenyőfő area, and the secondary pioneer vegetation of disturbed surfaces with *Bromus tectorum* L., *Eragrostis minor* Host, *Chondrilla juncea* L. and *Corispermum nitidum*, *Festuca vaginata*, *Ambrosia artemisiifolia*.

In the case of the supposed sandy grasslands situated in other, more southern, parts of the Bakony region (Nagytevel, Sáska, Hegyesd, Salföld, Szentbékállá, Sümeg), the limeless quartz sand bedrock (through its natural presence) excludes the appearance of basofrequent species, thus the more typical species of the *Festuca vaginata* associations are absent (for phytogeographical reasons) from the flora of these sample areas. From a coenosystematical aspect these *Corynephorus canescens* grasslands (Cc group) can be identified mainly with the *Thymo angustifolio-Corynephorum* association, but it is indisputable that its probable stands are not so typical. Some major species of *Corynephorum* (*Spergula morisonii* Boreau, *Carex arenaria* L.) of the Atlantic dune vegetation in Germany (*Spergulo vernalis-Corynephorum canescens* (Tx. 1928) Libbert 1934, *Violo-Corynephorum* Böcher 1941) gradually disappear south-eastward (they partly reach the region of Marchfeld), and according to our knowledge they are not present in the Hungarian flora. *Teesdalia nudicaulis* (L.) R. Br. is an exception, which can be found in certain areas of southern Transdanubia. Besides *Corynephorus canescens*, in the stands of the Bakony region *Jasione montana* and *Rumex acetosella* are frequent, but *Potentilla argentea* L., *Hypochoeris radicata* L., *Hieracium pilosella* L., *Scleranthus annuus* L., *Thymus serpyllum* are infrequent, although these are typical species forming associations. Some important species of the locally nutrient-poor sandy and pebble surfaces (e.g. *Calluna vulgaris* (L.) Hull, *Moenchia mantica* (L.) Bartl., *Gagea bohemica* (Zauschn.) Schult. et Schult., *Aira caryophylla* L.) can also be found in the samples. It impedes the coenotaxonomic classification of stands besides the generally typical species poorness (less constant and subconstant species) that these may be taken over by weeds easily. The great frequency of several weed species – being one factor also turned out to be significant during the statistical evaluation – refer to severe disturbance of the majority of sampling areas (*Ambrosia artemisiifolia*, *Conyza canadensis* (L.) Cronq.), *Cerastium semidecandrum* L., *Scabiosa ochroleuca* L., *Erysimum diffusum* Ehrh., *Silene otites*, *Euphorbia cyparissias* do not show relation to any of the other types of the more frequent species of the sandy grasslands of the Bakonyalja. The latter two statements have also been confirmed by the representation of the PCA biplot.

Near Nagytevel (Öreg-hegy-alja) the open *Corynephorus* grasslands are adjacent to grasslands dominated by *Koeleria majoriflora* (CcK) on certain closer ar-

eas. Based on species frequency and subfrequency, the grasslands characterised by *Silene otites*, *Jasione montana*, *Carlina biebersteinii* Bernh. ex Hornem., *Scabiosa ochroleuca*, *Hieracium pilosella* and *Ambrosia artemisiifolia* species make up a smaller group (CcK) separated from the other sample groups on the basis of the classification considering the cover values (Fig. 2). But if we perform the analysis on the presence-absence matrix, these samples go into the *Corynephorum* (Cc) group, similarly to the above mentioned *Festucetum vaginatae* and *F. v. stipes-tosum pennatae*. The *Koeleria majoriflora* grasslands sampled near Nagytevel can be traced back from *Thymo angustifolio-Corynephorum* of Transdanubia, and we feel justified to consider it a new subassociation (*koelerietosum majoriflorae* n. subass.). I mark column 14 (sample 82) in Table 6 as a type sample.

In the *Corynephorus canescens* grasslands the proportion of free sandy surfaces is typical. The more considerable cover of cryptogam level – basically by *Polytrichum* spp. – was typical only in some of the more undisturbed areas (samples 69–71 at Sáska, sample 79 at Salföld, and sample 78 at Szentbékálla). Because of their isolated location (and that these were not grazed as opposed to the other sample areas) these are smaller grass patches; the grassland near Sáska can be found on a clearing of the *Juniperus communis* patch on a bushy grassland, and the grassland of Salföld is situated in an area closed by a sand pit and a road lined with black locust (*Robinia pseudo-acacia*). The sampled stand near Szentbékálla can be found on a less disturbed area (where minimal treading is seen basically from walking tourists, but not being comparable with the effects of grazing), in a remote place that is a protected area (“Szentbékállai Kőtenger”), with major presence of cryptogams (*Ceratodon purpureus*, *Polytrichum piliferum*, *Racomitrium canescens*, *Tortula ruralis*). In the other examined *Corynephorus* grasslands the low presence cryptogams is supposedly related to the impacts of the actual land use disturbances, mainly deriving from the treading of grazing animals. JENTSCH *et al.* (2002) discusses clearly the impacts of different animal disturbances, and the seasonal changes of the proportion of vegetation and free sandy surfaces, with an important statement that mosses (especially *Polytrichum piliferum*) are the dominant recolonisers following mainly the smaller disturbances (*e.g.* caused by ants), some phanerogams (*Corynephorus*, *Teesdalia*, *Spergula*, etc.) are more competitive on areas disturbed by rabbits. JENTSCH and BEYSCHLAG (2003) analyse the possibilities of maintaining *Corynephorum* grasslands being repressed in Germany. The authors claim that the small-scale disturbances are important for the preservation of the *Corynephorum* stands (especially in maintaining the mosaicism) since otherwise the strongly closing cryptogams would hinder the establishment of phanerogams. Grazing, however, is harmful, and as a result of this thermophilous

ruderal grasslands develop, and after significant effects (because of their typical weak seed pool) they are unable to regenerate.

Except for the patches in the region of “Fenyőfői Ósfenyves” and the “Szent-békkállai Kőtenger”, the above presented sandy grasslands of the Bakony region are not given significant attention from a natural protection point of view. As opposed to the relative species weakness and because of their weak regenerating potential, especially the calciphobe sandy grasslands (mainly those at Nagytevel, Hegyesd) should be paid more attention to. In addition, the border regions of the protected areas also has to be extended near Fenyőfő–Bakonyszentlászló in order to preserve this phytogeographically important place with all its protected species.

CONCLUSIONS

Several associations of the open sandy grasslands are recognized from the sand-beds of the margins of the Bakony Region. In the environs of Fenyőfő and Bakonyszentlászló the dominant association of the open sandy grasslands on the sandy surfaces with changing calcic-amount (it comprehends both calcareous and acidic patches) is *Festucetum vaginatae*. Here, more recently, a few stands of the *Festuco vaginatae-Corynephorretum* association have also been recognised. These suffer from a number of disturbing effects. The *Festuco vaginatae-Corynephorretum* association exists in the glades of *Festuco vaginatae-Pinetum sylvestris*, at forest edges, and in the margin of recultivated bauxite-mine on pioneer sandy surfaces. Earlier this could have been more frequent in areas of the so called forest-grazing, which was a typical form of local land use in the region of Fenyőfői Ósfenyves. On limeless sandy surfaces of the Bakonyalja (Nagytevel, Sümeg, Hegyesd, environs of Sáska and the margin of the Basin of Kál) basically only calciphobe sandy grasslands (*Thymo angustifolio-Corynephorretum*) are characteristic. The most characteristic, marker species in the stands are *Corynephorus canescens*, *Rumex acetosella*, *Jasione montana*, *Thymus serpyllum*, *Hypochoeris radicata*.

* * *

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