original scientific article
received: 2005-09-07

UDC 574.3:581.9(497.4)

IS VARIETY OF SPECIES-RICH SEMI-NATURAL *MESOBROMION* GRASSLANDS DETECTABLE WITH FUNCTIONAL APPROACH?

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ABSTRACT

The aim of the study was to compare how the relevés of species-rich dry grasslands (classis Festuco-Brometea*) in Central and Eastern Slovenia differ among each other on the basis of floristic composition and of 11 Plant Functional Traits (PFTs). On the basis of floristic structure and cover values, the relevés were classified in three well separated clusters. In the PCA ordination, the first axes suggested a gradient of soil pH, while the second, floristically based gradient, was interpreted as soil humidity. On the basis of selected traits, 3 PFTs were clustered, but not clearly interpreted. Despite differences in environmental parameters across Slovenia (climate, geographical position, altitude, soil conditions) and variety of land use disturbances – drivers of floristic variety, no discernible difference in vegetation structure in terms of selected plant traits were perceived by PCA ordination. It could be concluded that secondary dry grasslands share rather uniform functional types with not clearly detectable structural differences among them.*

Key words: dry grasslands, plant functional traits, plant functional types, *Festuco-Brometea*, land use, Slovenia, PCA, vegetation

LA VARIETÀ DEI PASCOLI ARIDI SEMI-NATURALI RICCHI DI SPECIE *MESOBROMION* È DISTINGUIBILE CON L'APPROCCIO FUNZIONALE?

SINTESI

Lo scopo del presente studio era quello di confrontare le differenze in composizione floristica e 11 caratteristiche funzionali della pianta (PTFs) di rilievi di pascoli aridi ricchi di specie (classi Festuco-Brometea*) nella Slovenia centrale ed orientale. Sulla base della struttura floristica e dei valori di copertura i rilievi sono stati classificati in tre gruppi ben separati. Nell'ordinamento PCA il primo asse propone un gradiente del pH del suolo, mentre il secondo gradiente floristico viene interpretato come umidità del suolo. Tre PFTs sono stati inoltre raggruppati in base alle caratteristiche selezionate, ma non sono stati chiaramente interpretati. Nonostante le differenze nei parametri ambientali da un capo all'altro della Slovenia (clima, posizione geografica, altitudine, condizioni del suolo), e la varietà di disturbi legati all'impiego del suolo – piloti della varietà floristica, l'ordinamento PCA non ha percepito differenze discernibili nella struttura della vegetazione in termini di caratteristiche funzionali della pianta selezionate. Gli autori concludono che i pascoli aridi secondari condividono tipi funzionali della pianta uniformi che tra loro non presentano differenze strutturali chiaramente visibili.*

Parole chiave: pascoli aridi, caratteristiche funzionali della pianta, tipi funzionali della pianta, *Festuco-Brometea*, impiego del suolo, Slovenia, PCA, vegetazione

INTRODUCTION

Vegetation science has been essentially based on species composition, which has been needed for vegetation description, but this view has been criticized (*e.g.* Grime, 1979; Ghiselin, 1987). There has been an increasing interest in using non-phylogenetic based classifications when predicting the dynamics of vegetation rather than their taxonomic identity (Gitay, 1999; Cornelissen *et al.,* 2003). On a large scale, predictions based on plant species are geographically bound (Woodward & Cramer, 1996). On a small scale, species are in some instances so broad and variable that by describing communities by species composition we may not perceive relevant patterns of vegetation occurring below the resolving power of species (Diaz *et al.*, 1992). Classifying plant species according to their taxonomy has strong limitations when it comes to answering important ecological questions at the scale of ecosystems, landscapes or biomes (Woodward & Diament, 1991; Keddy, 1992; Körner, 1993). These questions include those on responses of vegetation to environmental variation or changes, notably in climate, atmospheric chemistry, land use and natural disturbance regimes. A promising way for answering such questions (and many other ecological questions) is by classifying plant species on functional grounds (Diaz *et al.*, 2002). These alternative classes are often referred to as plant functional types (PTFs) or groups (Grime *et al.*, 1988; Leishman & Westoby, 1992; Gitay & Noble, 1997).

Classifying plants according to morphology and reproductive attributes has a long history in botany and plant geography (Kleyer, 1999). Functional classifications of species were already searched for by natural philosophers and ecologists. Theophrastus (ca. 300 B.C.) classified plants into trees, shrub, and herbs (Morton, 1981). This and some other classifications used in the past may be viewed as predecessors of what are now called plant functional types (Kleyer, 1999). An example still in practice is the life-form approach of Raunkiaer (1934), modified and improved by Ellenberg & Mueller-Dombois (1974). Although introduced long time ago (Raunkiaer, 1934; Grime, 1977; Noble & Slatyer, 1980; Box, 1981, 1996), the concept of PFTs has received new attentions as a possible framework for predicting ecosystem response to human-induced changes at a global scale (Diaz & Cabido, 1997).

The aim of the study was to test if the territory of Slovenia, covering only 21,000 km^2 (here even excluding the Alps and the sub-Mediterranean), is enough variable to support different functional types consisting secondary dry grasslands. Environmental conditions (climate, phytogeographic position, altitude and soil parameters) are quite different across Slovenia, and Slovenian vegetation is considered one of the most diverse in the world outside the tropics in terms of species numbers (Watts, 2004).

In this paper we aim to identify main types of Slovenian secondary semi-dry grasslands of *Bromion erecti* alliance (class *Festuco-Brometea*) on the basis of floristic composition and 11 plant functional traits. The data set includes 67 relevés of Central and Eastern Slovenian semi-dry grasslands and matrix with 11 traits recorded on 155 plant species. Our main objectives were: (1) to search for 11 selected plant functional traits (PFTs) for plant species occurring on semi-dry grasslands of *Mesobromion* alliance in Central and Eastern Slovenia, using the literature and herbaria sources; (2) to identify PFTs in Slovenian semi-dry grasslands on the basis of selected traits; (3) to compare community types derived from plant functional classification based on traits and classification based on species.

Plant functional types are non-phylogenetic groupings of species and can be defined as groups of plant species sharing similar functioning at the organismic level, similar responses to environmental factors (*e.g.* temperature, water availability, nutrients, fire and grazing), and/or similar roles in (or effects on) ecosystems or biomes (*e.g.* productivity, nutrient cycling, flammability and resilience) (Walker, 1992; Chapin *et al.*, 1996; Nobble & Gitay, 1996; Diaz & Cabido, 1997; Lavorel *et al.*, 1997; Grime, 2001). Species comprising a functional type share a set of key functional traits.

According to Allen & Starr (1982), the functional type is a multi-species level of organization, lying above the population but below the community (*cit.* Hunt *et al.*, 2004). They could also be characterized as plant strategies, which can be defined as groupings of similar or analogous genetic characteristics, which recur widely among species or populations and cause them to exhibit similarities in ecology (Grime, 2002).

The first step in defining PFTs is to choose a list of key traits that are believed to be important for both understanding and prediction of phenomena relevant for our research. The sets of traits or types differ among applications (Woodward & Cramer, 1996). The traits must be observable expressions of forms or behaviours defining plant types that are responsive, in terms of occurrence or performance, to changes in ecosystem conditions.

Plant traits can be obtained by measurements in the filed, laboratory, or from the literature. They usually refer to **life-history** (life span, life-cycle), **morpholog**y (plant height, lateral spread, life form, spinescence, specific leaf area (SLA), leaf size ...), and **regeneration** (*e.g.* seed characters - size and mass, recruitment frequency, dispersal mode, ability to reproduce vegetative, flowering period ...).

MATERIAL AND METHODS

Material

Slovenia, situated at ca. 46°N, 14°E in the contact area of the Alps, Dinarids, Mediterranean and Pannonian plain, has a relief consisting of plains, hilly regions, highlands, mountains etc. 40% of the land is underlain by carbonate rocks, mainly well karstified and dolomatised (Watts, 2004).

We analysed 10 published (Škornik, 2003) and 57 unpublished (Škornik, 2000) vegetation relevés of *Bromion erecti* dry and semi-dry grassland (order *Brometalia erecti*, class *Festuco-Brometea*). Relevés were collected in Central, Eastern, South- and North-eastern Slovenia using standard procedure of the Braun-Blanquet approach (Braun-Blanquet, 1964; Westhoff & van der Maarel, 1973; Dierschke, 1994). For analysis of plant traits, we selected all the species, which were present in at least 5% of the relevés. The total number of species considered was 155.

Plant traits selection

In choosing key traits we followed different literature sources (Hodgson *et al.*, 1999; Kahmen *et al.*, 2002; Cornelissen *et al.*, 2003). For the purpose of this study we compiled a data-base of 11 morphological, life-history and regeneration traits, measurable at the individual plant level, using the literature data, data from herbaria and supplemented by our own observations. The scale of measurement of plant traits was originally continuous or categorical, but they were all transformed into categorical scales for analyses (Tab. 1).

The list of traits with description of classes in matrix and the source of information are presented in Table 1.

The procedure of this study was to classify the species of Slovenian species rich semi-natural *Mesobromion* grasslands into species groups of similar functional traits by using multivariate statistics.

Data analysis

To identify the main dry grassland types, we built a 155 species x 67 relevés matrix (all matrices available by authors on request). This matrix was then subjected to standard multivariate classification (agglomerative cluster analysis) and ordination techniques (PCA) (software SYN-TAX 2000 (Podani, 2001)).

The scales of measurements of plant attributes were originally continuous, categorical or binary, but they were all transformed into categorical or binary scales prior to the analysis. In order to identify groups of species with similar traits, we built an 11 traits x 155 species matrix. We submitted the matrix to a Principal Component Analysis (PCA) based on correlation matrix

Tab. 1: Plant traits, recorded on 155 vascular plant species of dry and semi-dry grasslands from Central, South, North-eastern and Eastern Slovenia with description of classes in matrix. Scales of measurement were originally categorical (cat), continuous (cont) or binary (bin).
Tab. 1: Rastlinski znaki, zbrani za 155 rastlinskih vrst suhih in polsuhih travišč iz osrednje, južne, severovzhodne in vzhodne Slovenije z opisi razredov v matriki. Originalni podatki so v obliki kategorij (cat), zvezni (cont) ali binarni (bin).

Trait		Classes in the matrix
Life form [3, *]	cat	1 = Chamaephytes
		2 = Geophytes
		3 = Hemicryptophytes
		4 = Phanerophytes
		5 = Therophytes
Life cycle [3, *]	cat	1 = Annual
		2 = Biennial
		3 = Perennial
Growth form [3, 5, *]	cat	1 = Tussocks
		2 = Rosette
		3 = Leafy stem
		4 = Rosette and leafy stem
Plant height [1, 4 ***]	cont	1 = < 5 cm
		2 = 5 – 25 cm
		3 = 25 – 75 cm
		4 = 75 – 125 cm
		5 = 125 – 150 cm
		6 > 150 cm
Stolons [1, 3, 5, *]	bin	0 = Absent
		1 = Present
Rhizomes [1, 3, 5, *]	bin	0 = Absent
		1 = Present
Storage organs [1, 3]	cat	1 = Absent
		2 = Tubers
		3 = Bulbs
		4 = Rhizomes
Spinescence [1, 4, **]	bin	1 = None
		1 = Present
Hairiness [1, 3, 4]	cat	1 = No
		2 = Low
		3 = High
Flowering start [1, 4, ***]	cat	1 = in March or earlier
		2 = in April
		3 = in May
		4 = in June
		5 = in July
		6 = in August or later or before leaves in spring
Potential allelochemicals [1, 2]	bin	0 = Absent
		1 = Present

Data source for traits:
[1]Hegi (1958, 1963, 1964, 1965, 1966, 1987a, 1987b); [2]Petauer (1993); [3]Martini *et al.* (1999); [4]Poldini (1991); [5]Rothmaler (1995); [6]Heywood (1995); [7]Heywood *et al.* (1980, 1972, 1968, 1964); [8]Lauber & Wagner (1998); [9]Wraber & Seliškar (1986); [10]Wraber (1990); [11]Grey-Wilson (1998)
References for classis formation in matrix:
[*] Kahmen *et al.* (2002)
[**] Cornelissen *et al.* (2003)
[***] Hodgson *et al.* (1999)

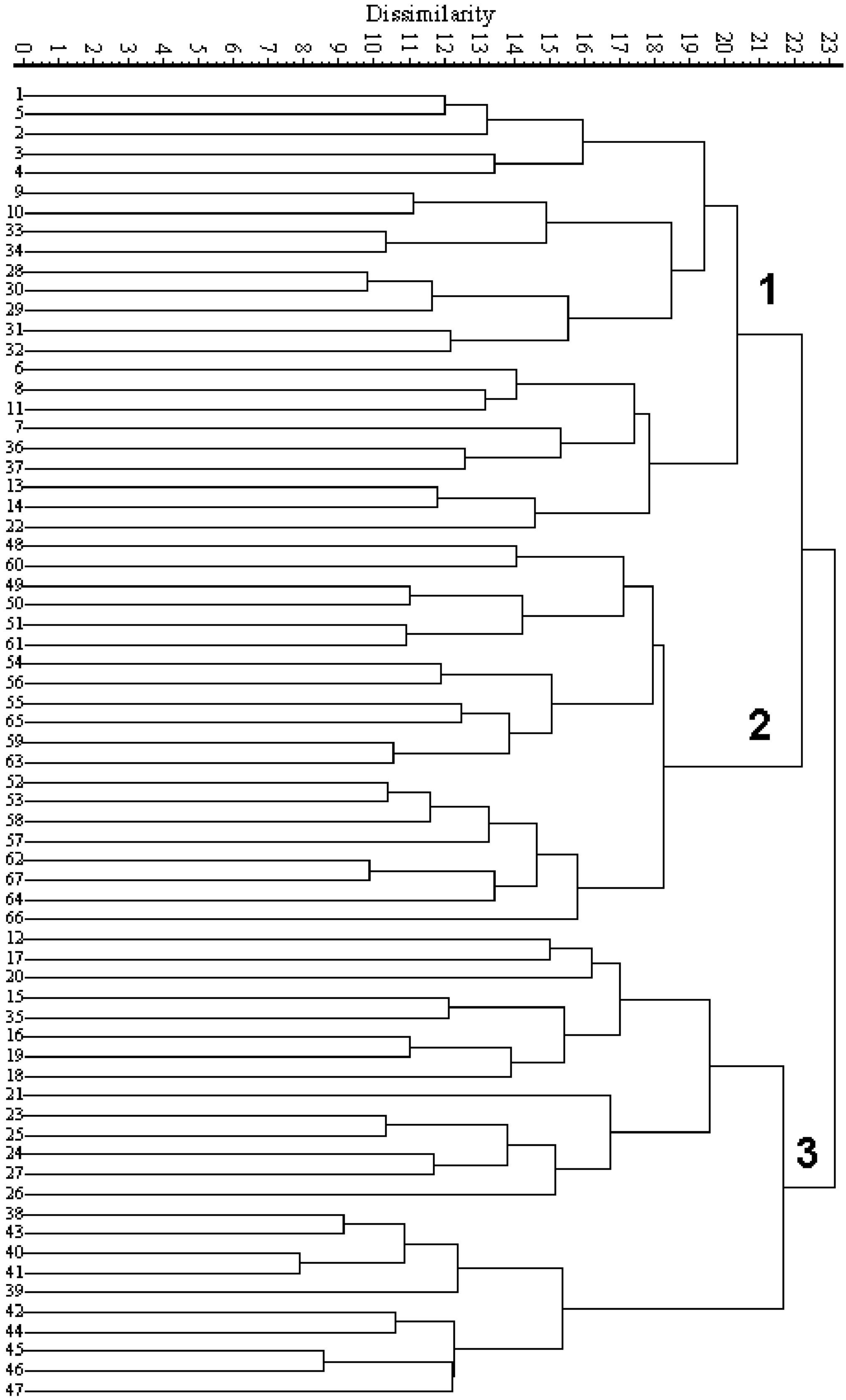
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Fig. 1: Dendrogram: the result of the hierarchical clustering of 67 relevés of *Mesobromion erecti* ***dry grasslands, collected in the territory of Central, Eastern, South- and North-eastern Slovenia. Numbers on dendrogram represent the following relevés from the original tables:***
No. 1-27: ***Škornik (2000): Tab. 11, relevés No. 3, 4, 6, 7, 8, 15, 30, 33, 37, 40, 43, 46, 47, 49, 51, 52, 53, 55, 59, 64, 75, 77, 80, 81, 84, 85 and 86;*** *No. 28-37:* ***Škornik (2000): Tab. 6, relevés No. 6, 10, 12, 14, 15, 16, 17, 20, 25 and 26;*** *No. 38-47:* ***Škornik (2003): Tab. 2, relevés No. 7, 8, 9, 10, 11, 12, 13, 23, 24 and 25;*** *No. 48-67:* ***Škornik (2000): Tab. 1, relevés No. 13, 21, 22, 24, 39, 40, 43, 54, 55, 56, 63, 64, 72, 73, 83, 84, 90, 96, 102 and 103. Cluster numbers are indicated on the dendrogram.***
Sl. 1: Dendrogram: rezultat hierarhične klasifikacije 67 popisov suhih travišč iz zveze *Mesobromion erecti****, zbranih na območju osrednje, vzhodne, južne in severovzhodne Slovenije. Številke v dendrogramu predstavljajo naslednje popise v originalnih tabelah:***
Št. 1-27: ***Škornik (2000): Tab. 11, popisi št. 3, 4, 6, 7, 8, 15, 30, 33, 37, 40, 43, 46, 47, 49, 51, 52, 53, 55, 59, 64, 75, 77, 80, 81, 84, 85 in 86;*** *Št. 28-37:* ***Škornik (2000): Tab. 6, popisi št. 6, 10, 12, 14, 15, 16, 17, 20, 25 in 26;*** *Št. 38-47:* ***Škornik (2003): Tab. 2, popisi št. 7, 8, 9, 10, 11, 12, 13, 23, 24 in 25;*** *Št. 48-67:* ***Škornik (2000): Tab. 1, popisi št. 13, 21, 22, 24, 39, 40, 43, 54, 55, 56, 63, 64, 72, 73, 83, 84, 90, 96, 102 in 103. Številke klastrov so označene na dendrogramu.***

of variables, in which data are cantered and standardized by standard deviation, which is considered appropriate for mixed data (Jongman *et al.*, 1987). The species cluster was assumed to represent PFTs at the species level (Keddy, 1992; Garcia Mora *et al.*, 1999).

In order to identify the predominant plant traits for Slovenian semi-dry grassland vegetation, the matrix of 11 traits by 155 species was multiplied by the matrix of 155 species x 67 relevés. The result was a matrix of 11 traits x 67 relevés that was analysed by means of PCA.

Nomenclature

Taxonomic nomenclature follows Martinčič *et al.* (1999), while syntaxonomic nomenclature follows Mucina & Kolbek (1993).

RESULTS AND DISCUSSION

Floristic analysis

Figure 1 shows the results of the hierarchical clustering of 67 relevés of dry and semi-dry grasslands. Through the analysis of the species x sites matrix, the main types of dry and semi-dry grasslands could be distinguished.

Cluster 1: 23 relevés of grasslands collected on very shallow Rendzinas and Chromic Cambisols on Limestone mainly from Dinaric, Predinaric and pre-Alpine regions at higher altitudes. These grasslands occur on very shallow and warm soils with basic pH. Characteristic species of the cluster are *Carex humilis, Plantago holosteum, Polygala chamaebuxus, Gentiana verna* subsp. *tergestina, Knautia illyrica, Tragopogon tommasinii, Pseudolysimachion barrelieri* subsp. *barrelieri, Anthericum ramosum*, etc.

Cluster 2: 20 relevés of semi-dry grasslands on Eutric Cambisols on tertiary bedrock (limestone or flysch). These soils represent eutrophic (mesic) sites, rich with nutrients due to the deeper profile, containing more humidity and having basic to slightly acid pH. Favourable conditions result high and dense grassland stands with some dominant grass species *(e.g. Bromus erectus* agg., *Briza media, Dactylis glomerata, Koeleria pyramidata*, ...). Other indicator species are *Onobrychis viciifolia, Arrhenatherum elatius, Daucus acrota, Galium mollugo, Trisetum flavescens, Poa angustifolia, Medicago lupulina, Viccia cracca, Lathyrus pratensis* and many other species of more fertile and moist grasslands are frequent.

Cluster 3: 24 relevés of grassland stands on acid soils. First 14 relevés present stands on acid and leached soils on calcareous substrate (limestone, dolomite) from the central part of Dolenjska region and from Bela krajina. Last 10 relevés were collected on sandstone hilly area of Goričko (NE Slovenia), where they occur on acid soils (mainly Ranker and Pseudogleys) developed on non-carbonate substrate. Species, which are characteristic for these relevés, are typical acidophilus species like *Agrostis tenuis, Festuca filiformis, Carex pallescens, Luzula campestris, Hieracium pilosella, Cynosurus cristatus, Potentilla erecta* and *Danthonia decumbens*.

In the PCA ordination, the three clusters appeared well separated (Fig. 2). Dispersion of relevés along the first axis of the PCA (PCA1) suggested a gradient of soil pH, while the second floristically based gradient along PCA2 axis was interpreted as soil humidity. Most clearly separated group of relevés is located at the left extreme of the first gradient (diamonds) and represents dry grasslands from the Goričko region, which occupies very acid and dry sites. Above the middle of the PCA-ordination there are grassland stands from the second cluster (squares), which are characteristic of moderately humid and mainly neutral soils. The third group of relevés could represent the mixture of relevés from clusters 1 and 3 (circles, diamonds). At the right extreme of the first PCA axis, we found stands with the most basic and moderately humid conditions.

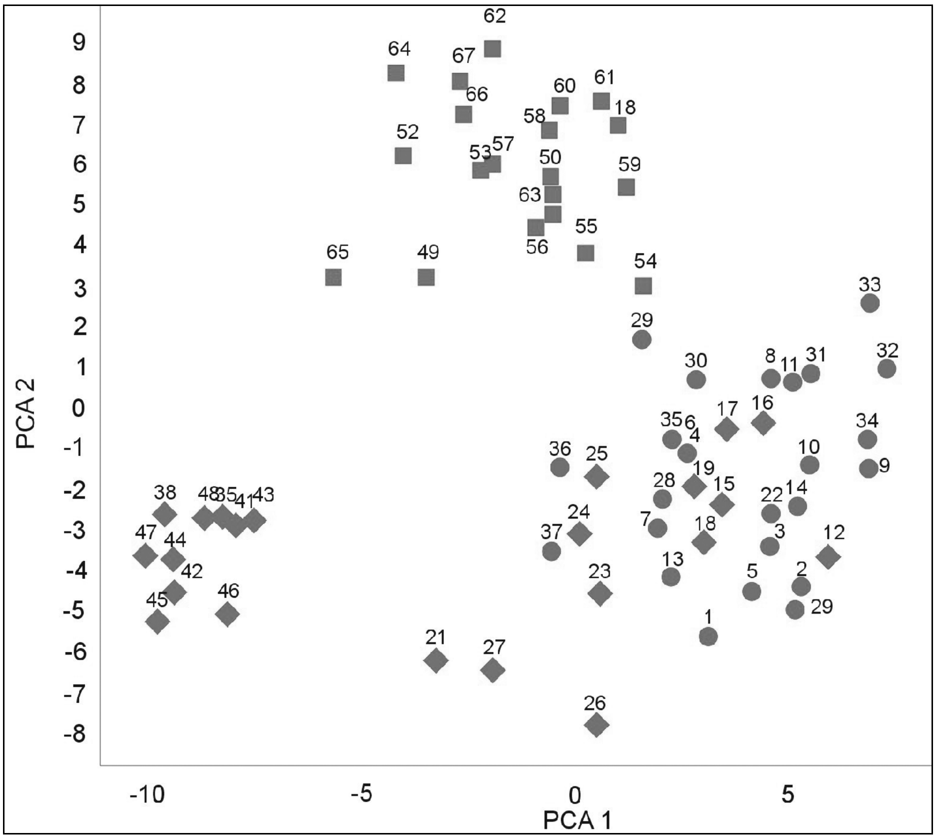

Fig. 2: PCA: ordination of 155 species x 67 sites matrix. Numbers correspond to the relevé numbers in figure1. Legend: circles = 1st cluster, squares = 2nd cluster, diamonds = 3rd cluster.
Sl. 2: PCA: ordinacija matrike 155 vrst x 67 popisov. Številke se ujemajo s številkami popisov na sliki 1. Legenda: krogec = klaster št. 1, kvadrat = klaster št. 2, karo = klaster št. 3.

It could be concluded that the studied dry grasslands differ according to their floristic composition as the consequence of different environmental parameters (climate, geographical position, altitude, soil conditions...) and disturbance of land use.

Plant functional types

We distinguished three groups (clusters) of plant species on the basis of the hierarchical classification of the traits x species. Detailed analysis of clusters is presented in Table 2. First group included 100 species. They were mostly perennial species (91%) and hemicryptophytes (74%). In comparison with the other two groups, there was the highest percentage of chamaephytes (14%). More than half of the plants had leafy stem and almost a quarter (24%) were tussock-forming species, which indicates that this group was rich in grasses *(e.g. Anthoxanthum odoratum, Arrhenatherum elatius, Avenula pubescens, Briza media, Danthonia decumbens, Festuca pratensis…*). Half of them were of medium height, namely 25-75 cm (52%). 75% of the species had no stolons and no rhizomes (82%). They were mostly without storage organs (88%), spineless (95%) and started to flower in early summer (May, June).

The second group (16 species) had the highest portion of therophytes and consequently the main part of annuals. In the second group, the major part of biennials (31.3%) were also classified. Species had mainly leafy stem, they were all without stolons and more than half of them had rhizomes (*e.g. Campanula patula, Cirsium pannonicum, Crepis biennis, Daucus carota, Leucanthemum vulgare…).* All the species from the second group started to flower in May or June. They often contained potential allelochemical compounds (62.5%). All the species from the third group (39) were hemicryptophytes, perennial and without stolons. In comparison with the 1st and 2nd groups, this group had the highest proportion of species with rosette (61.5%), species with rhizomes (79.5%), and species with high hairiness (66.7%).The traits *storage organs* and *spinescence* exhibited no evident differences between clusters of species. Therefore we could summarize our PFTs analysis with conclusion that there are no clear PFTs distinguished on the basis of the classification of the traits x species matrix. This indicates that for the species occur-

Tab. 2: PFT analysis for three groups (clusters) of plant species, defined by the hierarchical classification of the traits x species matrix. Values represent the proportion (in %) of species within the cluster.
Tab. 2: Analiza po znakih za 3 skupine (klastre) rastlinskih vrst, dobljenih na podlagi hierarhične klasifikacije matrike znaki x vrste. Številke predstavljajo deleže (v %) vrst v posameznem klastru.

Trait		**Cluster 1**	**Cluster 2**	**Cluster 3**
Life form	Chamaephytes	14	12.5	0
	Geophytes	7	12.5	0
	Hemicryptophytes	74	56.3	100
	Phanerophytes	0	0	0
	Therophytes	5	18.8	0
Life cycle	Annual	5	18.8	0
	Biennial	4	31.3	0
	Perennial	91	50	100
Growth form	Tussocks	24	0	15.4
	Rosette	5	0	35.9
	Leafy stem	51	75	23.1
	Rosette and leafy stem	20	25	25.6
Plant height	< 5 cm	0	0	2.6
	5 – 25 cm	46	31.3	28.2
	25 – 75 cm	52	43.8	59
	75 – 125 cm	2	25	10.3
	125 – 150 cm	0	0	0
	> 150 cm	0	0	0
Stolons	Absent	75	100	100
	Present	25	0	0
Rhizomes	Absent	18	68.8	79.5
	Present	82	31.3	20.5
Storage organs	Absent	88	87.5	82.1
	Tubers	7	0	0
	Bulbs	2	0	0
	Rhizomes	3	12.5	18
Spinescence	None	95	93.8	97.4
	Present	5	6.3	2.6
Hairiness	No	45	31.3	20.5
	Low	21	43.8	12.8
	High	34	25	66.7
Flowering Start	in March or earlier	5	0	10.3
	in April	13	0	12.8
	in May	39	50	35.9
	in June	36	50	23.1
	in July	6	0	15.4
	in August or later or before leaves in spring	1	0	2.6
Potential allelochemicals	Absent	55	37.5	35.9
	Present	45	62.5	64.1
No. of species in cluster		**100**	**16**	**39**

ring on the studied semi-dry grasslands no easy-interpreting groupings of species on the basis of selected traits could be noted. PCA ordination of 11 traits x 67 relevés matrix (Fig. 3) is confirming the conclusion given above. Floristically well separated relevés (marked with different colours on figure 1) are scattered irregularly in this PCA ordination. Groups of morphologically (functionally) similar relevés could not be recognized. Since there was no discernible difference in vegetation structure in terms of measured plant traits, it could be concluded that secondary dry grasslands share rather uniform functional types. This may be due to the lack of strong species turnover (Diaz *et al.*, 1999), which may mask structural differences.

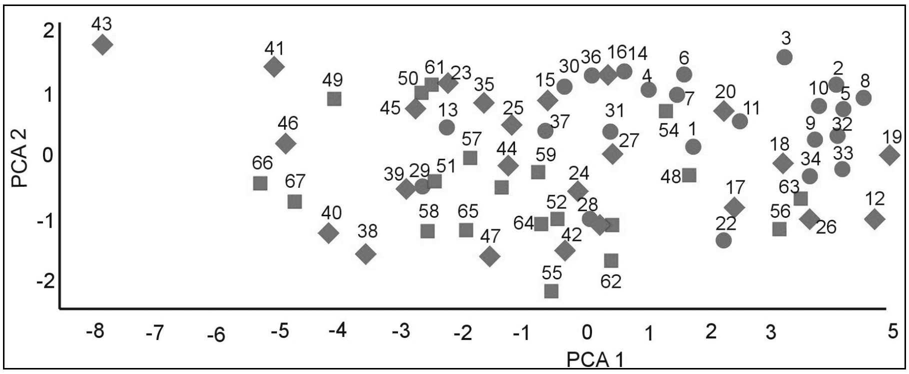

Fig. 3: PCA: ordination of 11 traits x 67 relevés matrix. Numbers correspond to the relevé numbers in figure1. Legend: circles = 1st cluster, squares = 2nd cluster, diamond = 3rd cluster.
Sl. 3: PCA: ordinacija matrike 11 znakov x 67 popisov. Številke se ujemajo s številkami popisov na sliki 1. Legenda: krogec = klaster št. 1, kvadrat = klaster št. 2, karo = klaster št. 3.

ALI JE RAZNOLIKOST POLSUHIH VRSTNO BOGATIH TRAVIŠČ ZVEZE *MESOBROMION* MOGOČE ZAZNATI S FUNKCIONALNIM PRISTOPOM?

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POVZETEK

Cilj avtorjev tega članka je bil ugotoviti osnovne tipe slovenskih sekundarnih polsuhih travišč iz zveze Mesobromion erecti *(razred* Festuco-Brometea*) na osnovi floristične sestave in 11 rastlinskih funkcionalnih potez (znakov). Analizirane podatke predstavljata matrika s 67 objavljenimi in neobjavljenimi fitocenološkimi popisi polsuhih travišč iz območij osrednje in vzhodne Slovenije ter matrika z 11 funkcionalnimi potezami, ki smo jih zbrali za 155 rastlinskih vrst teh polsuhih travišč. Podatke smo obdelali s standardnimi multivariatnimi metodami – metodo hierarhične klasifikacije ter ordinacijsko metodo glavnih komponent (PCA).*

Na osnovi floristične strukture in vrednosti za pokrovnost so se popisi klasificirali v tri dobro ločene skupine (klastre). Tudi v PCA ordinacijskem diagramu so bile te tri skupine lepo prepoznavne. Sklepali smo, da predstavlja prva ordinacijska os (x os) gradient pH tal, druga PCA os (y os) pa gradient vlažnosti.

Za določitev značilnih rastlinskih znakov vrst polsuhih travišč smo matriko znaki x vrste pomnožili z matriko vrste x popisi. Kot rezultat smo dobili matriko znaki x popisi, ki smo jo nato analizirali z ordinacijsko metodo glavnih komponent (PCA analiza). Na osnovi zbranih znakov so se rastlinske vrste klasificirale v tri skupine, ki pa jih je bilo težko interpretirati v smislu funkcionalnih tipov. Tako smo ugotovili, da kljub razlikam v okoljskih parametrih (podnebje, geografska lega, nadmorska višina, tip tal, inp.) in njihovi različni rabi na podlagi izbranih rastlinskih znakov ter s pomočjo ordinacijske metode ni bilo mogoče zaznati razločnih razlik v strukturi vegetacije. Zaključili smo, da se na preučevanih polsuhih traviščih pojavljajo precej enotni funkcionalni tipi s težko določljivimi razlikovalnimi znaki.

Ključne besede: suha travišča, rastlinski funkcionalni znaki, rastlinski funkcionalni tipi, *Festuco-Brometea*, raba tal, Slovenija, PCA, vegetacija

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