Tuexenia 31: 235–269. Göttingen 2011.

Subxerophilous and mesophilous grasslands of the Biele Karpaty Mts. (White Carpathian Mts.) in Slovakia

– Iveta Škodová, Katarína Devánová and Dušan Senko –

Abstract

A long-term systematic survey of grassland communities was performed in the Biele Karpaty Mts. in Slovakia. The main aims of the research were i) syntaxonomical classification of meso- and subxerophilous grassland vegetation, ii) analysis of the main gradients in species composition, iii) evaluation of the effect of environmental factors on species composition of grasslands. The data set included 342 phytosociological relevés of grasslands recorded between 1991 and 1999. For the classification of relevés to associations, the expert system for identification of grassland vegetation of Slovakia was used. The main environmental gradients of species composition were analysed by detrended correspondence analysis (DCA). For the ecological interpretation of ordination axes Ellenberg indicator values were used. The relationship between species composition and environmental factors (geology, pedology, climate, topography, management) was analysed by canonical correspondence analysis (CCA). The expert system identified (according to association definitions) 220 phytosociological relevés (64% of the whole data set). Grassland communities were classified within seven associations belonging to four alliances and three classes: *Festuco-Brometea*: *Bromion erecti* and *Cirsio-Brachypodion pinnati*; *Molinio-Arrhenatheretea*: *Arrhenatherion*; *Nardetea strictae*: *Violion caninae*. The results of the DCA support our assumption that the main environmental gradient in species compositions of grasslands is related to moisture and soil reaction (content of $CaCO_3$ in the soil). The results of the direct gradient analysis (CCA) show that all 23 environmental variables explained 16.15% of the variability of the species data. The most important factors affecting the data variation were precipitation and geological bedrock.

Zusammenfassung: Subxerophile und mesophile Rasengesellschaften der Biele Karpaty (Weiße Karpaten) in der Slowakei

Im Zuge einer Langzeitstudie wurden sämtliche Rasengesellschaften im slowakischen Teil der Weißen Karpaten systematisch erfasst. Die vorrangigen Ziele dieser Studie waren 1) die syntaxonomische Klassifikation der meso- und subxerophilen Rasengesellschaften, 2) die Analyse der wesentlichen Gradienten der Artenzusammensetzung sowie 3) die Bewertung des Einflusses von Umweltfaktoren auf die Artenzusammensetzung der Rasen. Der Datensatz umfasste 342 pflanzensoziologische Aufnahmen aus dem Jahren 1991 bis 1999. Für die Zuordnung der Aufnahmen zu Assoziationen wurde das bestehende Expertensystem zur Identifikation von Rasengesellschaften der Slowakei benutzt. Die standörtlichen Gradienten der Artenzusammensetzung wurden mittels trendbereinigter Korrespondenzanalyse (DCA) analysiert. Für die ökologische Interpretation der Ordinationsachsen wurden Ellenberg-Zeigerwerte herangezogen. Die Beziehung zwischen Artenzusammensetzung und Umweltfaktoren (Geologie, Boden, Klima, Topographie, Bewirtschaftung) wurde mittels kanonischer Korrespondenzanalyse (CCA) analysiert. Das Expertensystem identifizierte (auf Basis der Assoziationsdefinitionen) 220 Vegetationsaufnahmen, was 64 % des Gesamtdatensatzes entspricht. Die Rasen wurden in sieben Assoziationen eingeordnet, welche zu vier Verbänden und drei Klassen gehören: *Festuco-Brometea*: *Bromion erecti* und *Cirsio-Brachypodion pinnati*; *Molinio-Arrhenatheretea*: *Arrhenatherion*; *Nardetea strictae*: *Violion caninae*. Das Ergebnis der DCA bestätigt unsere Annahme, dass der stärkste standörtliche Gradient der Artenzusammensetzung mit Feuchtigkeit und Bodenreaktion (Karbonatgehalt des Bodens) zusammenhängt. In der direkten Gradientenanalyse (CCA) erklären alle 23 untersuchten Umweltvariablen zusammen 16,15 % der floristischen Variabilität des Datensatzes. Den höchsten Erklärungswert besitzen die Faktoren Niederschlag und geologisches Substrat.

Keywords: CCA, DCA, formalised classification, GIS, environmental factor, expert system, ordination, *Festuco-Brometea*, *Molinio-Arrhenatheretea*, *Nardetea strictae.*
With 6 supplements.

1. Introduction

The Biele Karpaty Mts. are a Protected Landscape Area located at the border between the Slovak and the Czech Republic. The Czech part of the territory has also been a Biosphere Reserve since 1996. The main reason for its protection is its high biological diversity and the harmonic use of the country. The territory is a good example of a form of land use that preserves a high level of alpha phytodiversity. Here the special type of "lonely house" settlement called "kopanice" is typical (Fig. 1). In the 15th century, people from villages on the foothill colonised the outlying parts of the Biele Karpaty Mts. with the aim to acquire new land (POZDIŠOVSKÝ 1976). Thus a mosaic of little settlements, small fields, meadows, and orchards with deciduous forests around has developed. During the 20th century, many people left their land and found work in towns. Collectivisation in agriculture also had a negative impact on grasslands through increasing fertilisation and land reclamation. Some grasslands were preserved by being designated nature reserves, and some remained intact in inaccessible areas. Thanks to nature protection and the activities of people still living in secluded places and farming their land, the unique country has been preserved.

The vegetation of the meso- and subxerophilous grasslands of the Biele Karpaty Mts. is famous for its high species richness: up to 90 species of vascular plants may occur in a plot of just 20–24 m^2 (KLIMEŠ 1997, KUBÍKOVÁ & KUČERA 1999). This vast species diversity is a result of the long-term maintenance of grasslands (regular mowing and grazing), diverse microrelief conditions, and a history spanning to prehistoric times. HÁJKOVÁ et al. (2011) provide direct evidence for the existence of open human-influenced habitats before medieval times, based on the results of a multi-proxy analysis (macrofossils, molluscs, and pollen) of inorganic sediment dated back to the Roman Age.

Fig. 1: The typical "lonely houses" settlement called "kopanice" in the Drietoma valley (Photo: I. Škodová, 9.6.2010).

Abb. 1: Typische Siedlungsform mit abgelegenen Bauernhöfen, genannt "kopanice", im Tal Drietoma (Foto: I. Škodová, 9.6.2010).

Flora and vegetation of this territory have attracted a number of botanists since the 19th century (ROCHEL 1821, HOLUBY 1888, NEVOLE 1947, PODPĚRA 1948, 1951). The first complete vegetation study in the territory was made by SILLINGER (1929). In the second half of the 20th century, several botanists published results of their phytosociological research in the Biele Karpaty Mts. (FAJMONOVÁ 1972, TLUSTÁK 1972, TLUSTÁK 1975, RUŽIČKOVÁ 1997, HÁJEK 1998). JONGEPIEROVÁ et al. (1994), KLIMEŠ et al. (2000), and MLÁDEK et al. (2006) focused on the influence of management on meadow and pasture communities. Several theses dealing with the meadows in the Biele Karpaty Mts. have been written (POHORILJAKOVÁ 1992, PERNÝ 1999, ŠUŇALOVÁ 1999). JONGEPIEROVÁ (2008) published a monograph concerning the grasslands of the Biele Karpaty Mts., summarising all accessible information about botany, zoology, as well as applied research oriented towards optimal management.

In general, the grassland vegetation in the Czech part of the region has been studied much more intensively than that in the Slovak part. Only a few phytosociological relevés documenting grasslands in the Slovak part of the Biele Karpaty Mts. have been published up to now. In our contribution, we present 342 phytosociological relevés from this territory.
The main aims of our research were:
– Syntaxonomical classification of meso- and subxerophilous grassland vegetation,
– Analysis of the main gradients in species composition,
– Evaluation of the effects of environmental factors on species composition of grasslands.

2. Material and Methods

2.1. Study area

The studied grassland stands are situated in the Biele Karpaty Mts. in the west part of Slovakia, on the border between the Slovak and the Czech Republic (Fig. 2). The highest point is Mt. Veľká Javorina (970 m). Geologically, the Biele Karpaty Mts. belong to the Western Carpathians, which originated from orogenic processes in the Mesozoic Era and the Tertiary (STRÁNÍK & JANEČKOVÁ 1992). They are formed by the Flysch Zone and the Klippen Belt (Fig. 3). Most of the area is based on Magura flysch formed by Cretaceous and Paleogenic sea sediments. Flysch consists of alternating sandstone and rock clay layers of variable thickness (from several centimetres to metres). The Klippen Belt is situated on the south-eastern border of the mountain range. The bedrock of this area was deposited from the Late Triassic (Mesozoic Era) to the Palaeogene (Lower Tertiary). It consists of limestone and some marl (PECHANEC & JONGEPIEROVÁ 2008). Bizarre rock formations are characteristic for the Klippen Belt. The relief of the Biele Karpaty Mts. is determined mainly by flysch bedrock that created long gentle slopes and wide rounded ridges. They are divided by shallow valleys. A typical phenomenon occurring in flysch areas are landslides, which form the terrain, making the surface uneven and creating a mosaic of dry and moist sites.

The prevailing soil type in the territory of the Biele Karpaty Mts. is cambisol. The rendzinas are associated with the limestone rocks in the Klippen Belt. Pararendzinas occur very rarely. The valleys of streams are covered by fluvisols. Gley is the dominant soil type around the springs (KUNDRATA & KOĽAJOVÁ 1992).

The main part of the territory belongs to the moderately warm region (average temperature in July is 16–17 °C, precipitation in the vegetation season is 350–450 mm, the annual precipitation is 700–900 mm) with relatively short, dry summers and mild winters with short-term snow cover (LAPIN et al. 2002). Only parts at higher altitudes (above 800 m a.s.l.) belong to the cold region (average temperature in July is 15–16 °C, precipitation in the vegetation season is 500–600 mm, annual precipitation is 900–1000 mm). The southern part and the foothills belong to the warm region (average temperature in July is 18–19 °C, precipitation in the vegetation season is 350–450 mm, annual precipitation is 600–700 mm) (Fig. 4).

Forests cover more than 67% of the territory. Mixed hornbeam and oak forests (*Carpinion betuli*) occupy large areas in the middle altitude. In the higher altitude (above 500 m a.s.l.), beech forests (*Fagion sylvaticae*) are the climax community (JONGEPIEROVÁ & GRULICH 1992). In the northern part of the territory, in high altitude fir-beech forests are

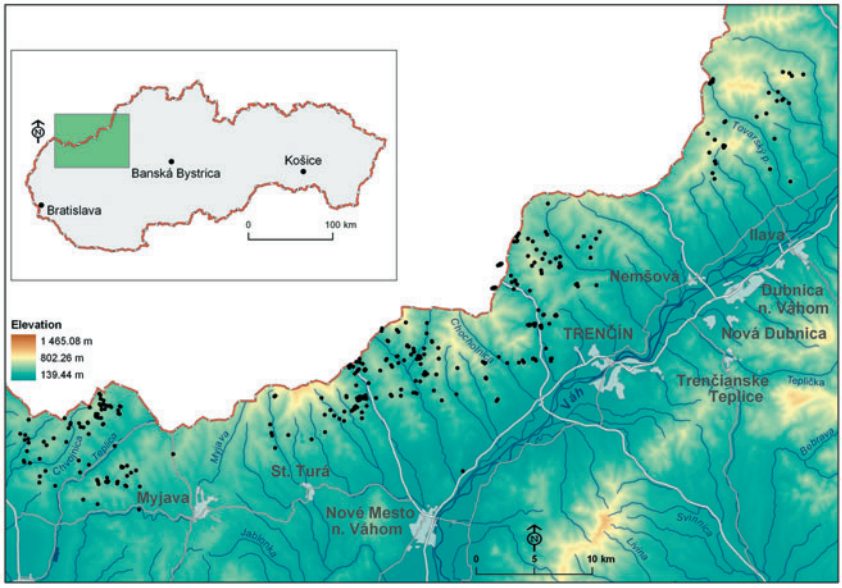

Fig. 2: Location of the study area on the border between the Slovak and the Czech Republic. Black points show the location of the analysed vegetation plots.

Abb. 2: Karte des Untersuchungsgebiets an der Grenze zwischen der Slowakei und Tschechien. Die schwarzen Punkte bezeichnen die Lage der Aufnahmeflächen.

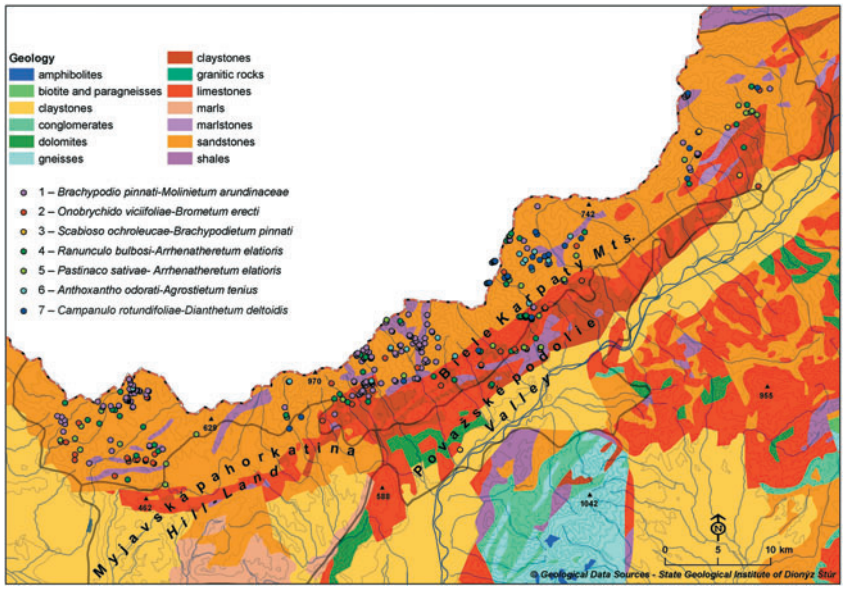

Fig. 3: Geological bedrock of the Biele Karpaty Mts. Coloured points show the distribution of individual grassland communities in this territory. The source data were acquired from the State Geological Institute of Dionýz Štúr.

Abb. 3: Karte der geologischen Einheiten der Weißen Karpaten. Die farbigen Punkte zeigen die Verteilung der einzelnen Rasengesellschaften im Untersuchungsgebiet. Die Daten stammen vom Staatlichen Geologischen Institut Dionýz Štúr.

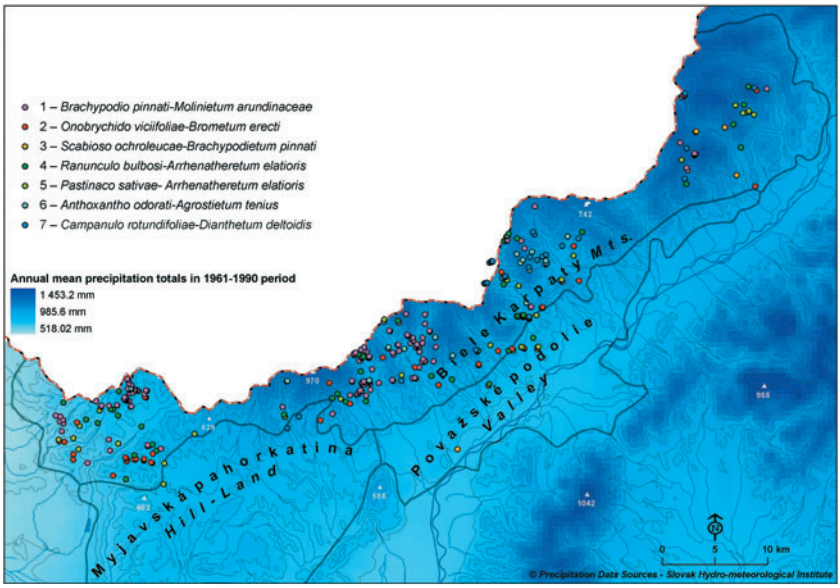

Fig. 4: Mean annual precipitation totals for the period 1961–1990. Coloured points show the distribution of individual grassland communities in this territory. The source data were provided by the Slovak Hydro-Meteorological Institute.

Abb. 4: Mittlere Jahresniederschläge im Zeitraum 1961–1990. Die farbigen Punkte zeigen die Verteilung der einzelnen Rasengesellschaften im Gebiet. Die Daten wurden vom Slowakischen Hydro-Meteorologischen Institut zur Verfügung gestellt.

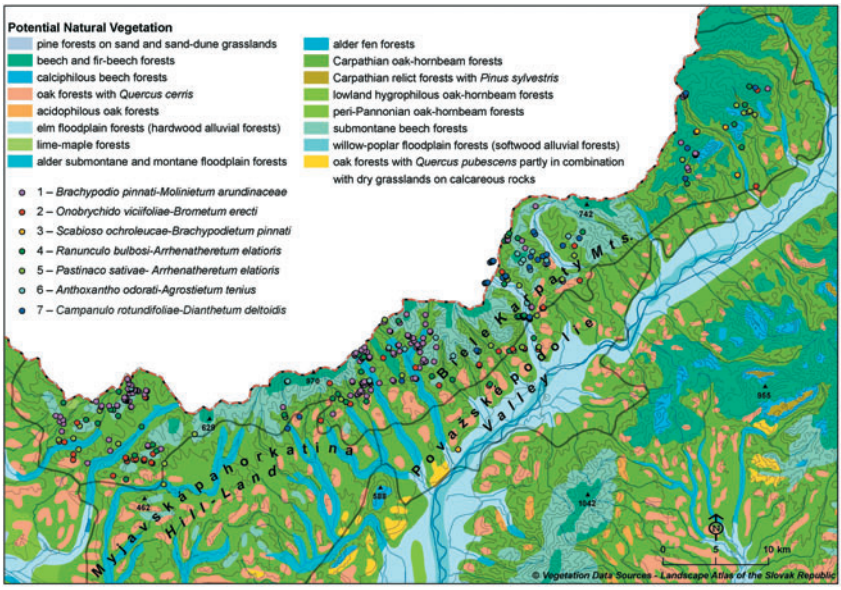

Fig. 5: Potential natural vegetation of the Biele Karpaty Mts. Coloured points show the distribution of individual grassland communities in this territory. The source data were acquired from the Landscape Atlas of the Slovak Republic.

Abb. 5: Karte der potentiellen natürlichen Vegetation in den Weißen Karpaten. Die farbigen Punkte zeigen die Verteilung der einzelnen Rasengesellschaften im Gebiet. Die Daten stammen aus dem Landschaftsatlas der Slowakei.

present. In the highest altitude and under the rocks of the Klippen Belt, scree and ravine forests of the alliance *Tilio-Acerion* occur. Hygrophilous forest communities along the streams belong to the alliance *Alno-Ulmion.* Oak forests with dominant *Quercus petraea* agg. and admixed *Quercus cerris* (*Quercion conferto-cerridis*) can be found in the southern part of the territory. Subxerophilous oak forests (*Quercion pubescenti-petraeae)* occur only fragmentarily in the warmest parts of the Biele Karpaty Mts. (CHYTRÝ 1994). Fig. 5 shows the distribution of the potential natural vegetation (MAGLOCKÝ 2002).

From the phytogeographic point of view, the area is divided into two regions: the White Carpathians (Biele Karpaty region) in the southwest (with occurrence of thermophilous species) and the West-Beskid Carpathians (Západobeskydské Karpaty region) in the northeast (with occurrence of several montane elements) (FUTÁK 1984).

2.2. Field sampling

During the years 1991–1999, we collected 342 phytosociological relevés (using 5 m × 5 m plots) of subxerophilous and mesophilous grasslands from the Slovak part of the Biele Karpaty Mts. The vegetation description was carried out according to the Braun-Blanquet method (BRAUN-BLANQUET 1964). The seven-degree scale of cover was used (WESTHOFF & van der MAAREL 1973). All relevés were marked on detailed maps with the scale 1:10,000 immediately after recording and the geographic coordinates read from the map. Detailed information on all relevés is provided in Appendix A.

2.3. Nomenclature

The names of vascular plants and bryophytes follow MARHOLD & HINDÁK (1998). The nomenclature of grasslands follows JANIŠOVÁ (2007), that of other plant communities MUCINA & MAGLOCKÝ (1985).

2.4. Data analysis

The phytosociological relevés were stored in the database program TURBOVEG (HENNEKENS & SCHAMINÉE 2001) and then analysed with the program JUICE 7.0.36 (TICHÝ 2002, TICHÝ & HOLT 2006). For the syntaxonomical analysis, we used the expert system for identification of grasslands in Slovakia (JANIŠOVÁ 2007, JANIŠOVÁ et al. 2010; see also http://ibot.sav.sk/ES_trav_veg_Sk.doc). It is based on formal definitions of associations using the presence of sociological species groups in combination with species dominance. The expert system was created for the territory of the Slovak Republic using a large stratified data set containing all vegetation types. The relevés not matching the definitions of associations were assigned to syntaxa according to their similarity index (Frequency-Positive Fidelity Index, FPFI, TICHÝ 2005). If a relevé was assigned by the expert system to an association not known from the territory, we classified it on the basis of similarity to one of the other clusters in our data set. In the program JUICE, the "matching" function and the FPFI – Frequency-positive fidelity index (TICHÝ 2005) were used.

Diagnostic species for the clusters in the data set were determined by the calculation of fidelity of each species to each cluster, using the phi coefficient of association based on presence/absence data (CHYTRÝ et al. 2002) in the program JUICE 7.0.36 (TICHÝ 2002). We standardised the relevé groups to equal size (the size of the target group was 15% of the total data set). Non-significant fidelity values were excluded using Fisher's exact test ($P < 0.001$). The threshold fidelity value for diagnostic species was set to phi = 0.20. Diagnostic species of associations are of local validity. The assignment of species to higher vegetation units (alliances, classes) follows JANIŠOVÁ (2007).

The variants of associations have been distinguished on the basis of a numerical classification (program PC-ORD, MCCUNE & MEFFORD 1999). Ward's method, Euclidean distance as a distance measure, and presence/absence data were used. Diagnostic species for variants were determined by the calculation of the phi coefficient. The threshold fidelity value was set to phi = 0.25.

2.5. Gradient analysis

The main environmental gradients of species composition were analysed by detrended correspondence analysis (DCA) in the CANOCO 4.5 package (TER BRAAK & ŠMILAUER 2002). For the ecological interpretation of ordination axes, the average non-weighted Ellenberg indicator values (ELLENBERG et al. 1992) for the relevés were plotted onto the DCA ordination diagram as supplementary environmen-

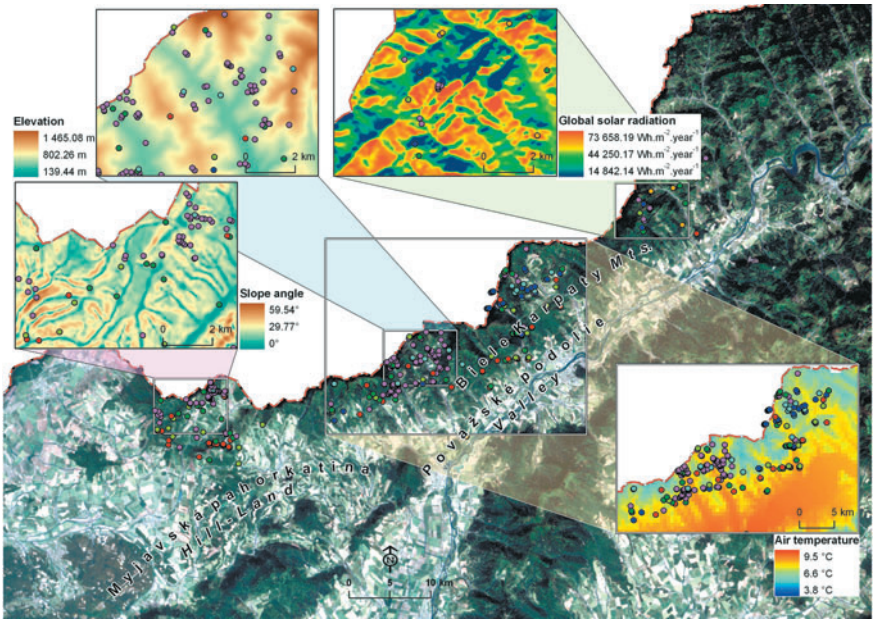

Fig. 6: Environmental factors derived from the digital elevation model and from raster maps.
Abb. 6: Überblick über die aus dem digitalen Höhenmodell und aus Rasterkarten abgeleiteten Umweltfaktoren.

tal data. Significant differences of Ellenberg indicator values among the studied associations were tested using the LSD test ($P < 0.05$) in the program Statistica 5.5 (MICROSOFT CORP. 1999). The relationship between species composition and selected environmental factors was analysed by canonical correspondence analysis (CCA) using the CANOCO 4.5 package (TER BRAAK & ŠMILAUER 2002). As the resulting gradient lengths in the DCA were long (4.191 for the first axis), the unimodal method of CCA was chosen for the evaluation of the independent (marginal), conditional, and pure effects of individual environmental variables. Species were not weighted by abundance, and no exclusion of rare species was applied. For each relevé, information on various ecological factors was gathered. A regular grid-based Digital Terrain Model (DTM) of appropriate resolution was generated from contour lines and elevation points vectorised from 1:50,000 raster maps. The DTM generation was carried out using the *usurf.rst* module in the non-commercial open source GRASS GIS v6.4 released under GNU/GPL license (GRASS Development Team 2010). The DTM was used to calculate first derivations of elevation, slope angle, and slope aspect (Fig. 6). Air temperature and vertical atmospheric precipitation were produced from rasters of mean annual precipitation for the years 1961–1990. The source data were provided by the Slovak Hydro-meteorological Institute. Information on geological settings in 1:50,000 scale were acquired from the State Geological Institute of Dionýz Štúr. The Landscape Atlas of the Slovak Republic was the information source on soil types (ŠÁLY & ŠURINA 2002). The surface solar radiation was calculated with the *r.sun* routine implemented in GRASS GIS. The model uses equations of solar energy transmission published in the European Solar Radiation Atlas (SCHARMER & GRIEF 2000). The grid-based digital elevation model and its slope angle and slope aspect were used as input. The significance of the correlation between vegetation formation and solar energy income was observed during a one-year cycle (8.760 hours) with a time increment of 15 min. The outputs encompass grids of beam, diffuse, and solar radiation reflected by the surface as well as their sum referred to as global radiation, all measured in Wh $m^{-2}year^{-1}$. The program uses the Linke atmosphere turbidity factor and a ground albedo coefficient and considers the shadowing effect of the local topography.

Forward selection was used for ranking environmental variables in order of importance (PALMER 1993). All studied environmental factors were tested by the Monte Carlo permutation test with unrestricted permutations (9999 permutations, $P \leq 0.01$). Finally, the pure effect (where the percentage variance is explained by the variable, while the remaining significant variables were used as co-variables) was calculated (TER BRAAK & PRENTICE 1988). Pure variance is expressed as percentage of total inertia.

Table 1: Abridged synoptic table of the meso- and subxerophilous grasslands occurring in the Biele Karpaty Mts.

Species are sorted according to the modified fidelity index and percentage frequency. Associations are numbered as follows: 1 *Brachypodio pinnati-Molinietum arundinaceae*, 2 *Onobrychido viciifoliae-Brometum erecti*, 3 *Scabioso ochroleucae-Brachypodietum pinnati*, 4 *Pastinaco sativae-Arrhenatheretum elatioris*, 5 *Ranunculo bulbosi-Arrhenatheretum elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis,* and 7 *Campanulo rotundifoliae-Dianthetum deltoidis*. Non-diagnostic species whose constancy is lower than 5% are not displayed. Diagnostic species with the highest phi coefficient are printed in bold (** for phi ≥ 0.35 and * for phi ≥ 0.20). ES = expert system.

Tabelle 1 (Beilage): Gekürzte Stetigkeitstabelle der meso- und subxerophilen Rasengesellschaften der Weißen Karpaten

Die Arten sind nach absteigender Treue bzw. Stetigkeit geordnet. Nicht-diagnostische Arten mit einer Stetigkeit von weniger als 5 % wurden weggelassen. Die diagnostischen Arten mit der höchsten Treue sind fett dargestellt (** – phi ≥ 0.35, * – phi ≥ 0.20). ES = Expertensystem.

Syntaxon	1	2	3	4	5	6	7
No. of relevés	152	40	4	54	38	22	32
No.of rel. matched by ES	151	33	2	12	8	7	4
Brachypodio pinnati-Molinietum arundinacae							
Cirsium pannonicum	**77** **	18	.	9	8	5	9
Trommsdorfia maculata	**61** **	2	.	4	.	5	12
Lathyrus latifolius	**62** **	8	.	6	8	9	3
Carex montana	**89** **	12	.	17	16	32	34
Betonica officinalis	**69** **	10	.	19	16	18	12
Filipendula vulgaris	**93** **	45	.	39	34	50	31
Trifolium rubens	**35** **	2	.	4	.	9	.
Pyrethrum corymbosum	**31** **	5	.	2	.	5	3
Traunsteinera globosa	**19** **	2	.	.	.	.	.
Melampyrum cristatum	**22** **	.	.	2	.	5	.
Campanula glomerata	**84** **	50	25	41	47	36	6
Campanula persicifolia	**31** **	5	.	2	8	5	3
Chamaecytisus supinus	**42** **	5	25	2	3	14	3
Thesium linophyllon	**25** *	10	.	2	3	.	.
Potentilla alba	**23** *	.	.	9	3	.	.
Trifolium montanum	**84** *	62	.	31	55	50	25
Brachypodium pinnatum	**82** *	35	100	26	21	23	9
Prunella grandiflora	**11** *	.	.	.	.	.	.
Inula salicina	**19** *	5	.	4	5	.	.
Trifolium alpestre	**38** *	5	25	4	3	14	12
Viola canina	**53** *	2	.	15	11	55	41
Tragopogon orientalis	**80** *	50	.	76	68	36	25
Helianthemum ovatum	**54** *	30	25	2	11	27	34
Carlina acaulis	**69** *	28	25	17	29	45	59
Ranunculus polyanthemos	**83** *	48	25	57	58	55	44
Peucedanum cervaria	**11** *	2	.	.	.	.	.
Serratula tinctoria	**7** *	.	.	.	.	.	.
Primula veris	**88** *	65	50	65	71	64	22
Genista tinctoria	**28** *	2	.	2	11	18	12
Jacea pratensis	**79** *	68	25	35	42	55	59
Cruciata glabra	**82** *	22	25	52	50	77	81
Gymnadenia conopsea	**30** *	.	25	4	8	5	16
Anthericum ramosum	**26** *	8	25	.	3	9	3
Onobrychido viciifoliae-Brometum erecti							
Onobrychis viciifolia agg.	20	**45** *	.	24	16	.	.
Bromus erectus	76	**100** *	50	61	84	41	25
Salvia pratensis	88	**98** *	75	63	79	41	12
Salvia verticillata	7	**30** *	25	6	11	.	.
Scabioso ochroleucae-Brachypodietum pinnati							
Dorycnium herbaceum	10	8	**75** **	2	.	.	.
Prunella laciniata	3	8	**75** **	2	5	.	3
Origanum vulgare	2	12	**75** **	6	5	.	3
Erysimum odoratum	.	.	**50** **	.	.	.	.

Eryngium campestre	.	5	**50** **	.	.	.	.
Agrimonia eupatoria	7	35	**100** **	19	34	9	6
Pastinaco sativae-Arrhenatheretum elatioris							
Glechoma hederacea	7	12	.	**46** **	18	9	.
Anthriscus sylvestris	6	2	.	**35** **	11	5	.
Crepis biennis	29	22	.	**67** **	39	41	3
Lysimachia nummularia	14	10	.	**54** **	24	27	16
Taraxacum sect. *Ruderalia*	58	38	.	**83** *	63	50	16
Alopecurus pratensis	1	2	.	**19** *	5	.	.
Medicago sativa	1	12	.	**24** *	8	5	.
Arrhenatherum elatius	72	80	75	**100** *	92	59	34
Campanula rapunculoides	5	22	.	**43** *	34	14	12
Galium mollugo	3	28	.	**43** *	34	14	12
Pastinaca sativa	2	2	.	**13** *	3	.	.
Poa trivialis	1	.	.	**15** *	5	5	.
Cirsium arvense	5	2	.	**24** *	5	9	9
Veronica arvensis	3	10	.	**26** *	18	5	3
Bellis perennis	.	10	.	**20** *	8	5	3
Geranium pratense	.	5	.	**15** *	8	.	.
Convolvulus arvensis	13	22	.	**37** *	37	.	9
Heracleum sphondylium	20	12	.	**43** *	16	36	25
Ranunculo bulbosi-Arrhenatheretum elatioris							
Daucus carota	24	55	50	52	**74** *	36	34
Polygala comosa	27	38	25	30	**53** *	23	3
Anthoxantho odorati-Agrostietum tenuis							
Carex pallescens	29	28	.	31	29	**68** *	59
Campanulo rotundifoliae-Dianthetum deltoidis							
Nardus stricta	3	2	.	.	.	14	**62** *
Veronica officinalis	17	15	.	2	18	23	**72** *
Betula pendula	.	.	.	.	3	5	**34** *
Hypochaeris radicata	3	.	.	2	.	18	**41** *
Luzula luzuloides	5	.	.	2	.	5	**31** *
Hypericum maculatum	21	5	.	19	11	36	**62** *
Danthonia decumbens	25	8	.	2	11	23	**53** *
Hieracium murorum	3	.	.	.	.	.	**19** *
Agrostis capillaris	64	12	.	22	39	64	**84** *
Pilosella officinarum	5	10	25	2	5	23	**50** *
Ranunculus acris	33	30	.	59	55	59	**84** *
Holcus lanatus	24	15	.	33	21	45	**62** *
Luzula campestris	70	52	.	63	79	68	**97** *
Stellaria graminea	24	12	.	37	26	45	**62** *
Viola riviniana	1	8	.	6	8	9	**28** *
Calluna vulgaris	.	.	.	.	.	.	**9** *
Ranunculus repens	.	.	.	2	3	.	**12** *
Acetosa pratensis	66	45	.	85	74	91	**94** *
Trifolium medium	27	35	.	24	32	50	**59** *
Species diagnostic for more than one association							
Ranunculus bulbosus	5	**38** *	.	20	**42** *	9	9
Veronica chamaedrys	51	62	25	**93** *	**92** *	91	66
Trifolium repens	26	42	25	**78** *	**79** *	50	72
Polygala vulgaris	23	.	.	4	.	**68** *	**97** *
Potentilla erecta	44	12	25	13	16	**77** *	**75** *
Festuco-Brometea							
Pimpinella saxifraga	63	90	50	67	84	91	97
Plantago media	66	85	75	50	84	59	19
Galium verum	66	54	75	30	61	32	12
Festuca rupicola	53	76	100	28	68	23	41
Potentilla heptaphylla	57	56	75	20	47	36	28
Thymus pulegioides	38	41	50	4	50	55	62
Sanguisorba minor	28	63	75	26	42	36	19
Knautia kitaibelii	36	22	75	26	37	36	41
Tithymalus cyparissias	47	29	100	11	13	41	19
Medicago falcata	42	44	50	20	34	5	.
Carex caryophyllea	39	27	75	9	26	32	22

Syntaxon	1	2	3	4	5	6	7
No. of relevés	152	40	4	54	38	22	32
No.of rel. matched by ES	151	33	2	12	8	7	4
Anthyllis vulneraria	30	34	.	22	29	32	31
Koeleria pyramidata	44	29	50	2	8	18	22
Colymbada scabiosa	38	20	50	15	16	18	6
Fragaria viridis	24	41	50	20	45	14	3
Dianthus carthusianorum	30	29	75	6	37	14	3
Viola hirta	70	61	100	46	47	23	12
Linum catharticum	55	61	75	33	58	45	25
Medicago lupulina	8	37	50	48	45	9	.
Carex flacca	21	29	50	9	21	14	16
Ononis spinosa	38	20	75	9	26	9	6
Securigera varia	13	34	75	19	24	18	6
Arabis hirsuta	22	20	50	9	13	.	.
Asperula cynanchica	15	24	75	4	8	14	12
Teucrium chamaedrys	12	32	50	.	13	.	.
Pilosella bauhinii	11	22	.	6	13	9	9
Sedum sexangulare	7	15	25	2	13	5	9
Polygala major	15	17	.	4	.	.	.
Silene nutans	8	10	.	2	11	14	6
Veronica teucrium	13	2	.	4	8	5	.
Crepis praemorsa	9	.	.	.	.	14	6
Avenula pubescens	22	7	.	13	18	9	.
Molinio-Arrhenatheretea							
Achillea millefolium agg.	91	85	100	93	95	82	100
Plantago lanceolata	87	80	75	94	97	95	97
Anthoxanthum odoratum	85	68	25	85	95	86	97
Dactylis glomerata	93	68	100	94	84	95	44
Leontodon hispidus	83	66	75	87	92	91	88
Lotus corniculatus	81	76	75	80	84	86	94
Briza media	86	76	25	67	87	95	84
Leucanthemum vulgare	76	78	75	85	87	73	84
Trisetum flavescens	72	73	75	72	76	77	50
Trifolium pratense	53	63	25	85	87	86	59
Campanula patula	53	56	25	87	71	82	81
Festuca rubra	68	27	25	52	68	82	62
Festuca pratensis	62	41	25	74	63	64	31
Prunella vulgaris	61	49	25	59	55	55	75
Alchemilla vulgaris s.lat.	56	32	.	56	58	82	78
Vicia cracca	55	54	25	59	66	59	25
Cerastium holosteoides	40	44	25	70	63	45	53
Rhinanthus minor	49	29	25	37	58	27	47
Poa pratensis agg.	38	56	100	70	55	27	9
Knautia arvensis	50	44	25	39	45	18	9
Ajuga reptans	48	24	.	39	29	41	25
Cynosurus cristatus	29	20	.	41	18	45	47
Carum carvi	21	24	.	28	29	14	3
Lathyrus pratensis	20	2	.	17	34	23	3
Avenula pubescens	22	7	.	13	18	9	.
Ranunculus auricomus agg.	18	2	.	13	11	5	3
Euphrasia rostkoviana	10	2	25	9	8	18	31
Sanguisorba officinalis	14	2	.	11	5	.	3
Trifolium dubium	5	10	.	7	21	18	12
Trifolium campestre	4	15	.	7	11	5	19
Ficaria bulbifera	.	.	.	2	.	.	9
Other species							
Colchicum autumnale	47	29	.	37	37	36	22
Hypericum perforatum	31	46	50	19	32	32	19
Listera ovata	24	12	.	15	11	36	9
Fragaria vesca	22	15	25	22	13	14	6
Carex tomentosa	25	12	25	6	13	9	19
Aquilegia vulgaris	24	5	.	13	11	9	16

Carex panicea	17	12	25	2	8	23	16
Allium scorodoprasum	15	10	.	20	5	5	.
Equisetum arvense	16	5	25	6	3	14	9
Myosotis arvensis	7	12	.	17	24	.	.
Tithymalus esula	9	12	25	19	8	.	.
Ranunculus nemorosus	3	15	25	6	13	18	22
Vicia tenuifolia	13	2	25	4	.	9	3
Galium album	11	2	25	13	8	.	.
Symphytum tuberosum	10	7	.	7	8	9	3
Astrantia major	11	2	.	4	3	14	6
Carex hirta	9	5	.	4	3	14	9
Ophioglossum vulgatum	5	5	.	7	11	5	.
Pulmonaria mollis	9	5	.	4	8	.	.
Tussilago farfara	4	.	.	13	3	5	12
Potentilla reptans	3	17	25	11	11	.	.
Dactylorhiza sambucina	7	2	.	2	.	9	6
Lathyrus tuberosus	3	17	.	4	8	.	.
Lathyrus niger	9	.	.	2	.	9	3
Trees and shrubs							
Prunus domestica	38	32	.	31	39	32	25
Crataegus monogyna	29	20	.	24	24	14	.
Quercus petraea agg.	22	22	.	9	13	23	22
Carpinus betulus	14	20	.	2	3	18	31
Prunus spinosa	7	5	.	2	3	5	6
Bryophytes							
Rhytidiadelphus squarrosus	3	5	.	17	16	14	47
Pseudoscleropodium purum	5	8	.	4	.	5	31
Atrichum undulatum	3	2	.	7	3	5	16
Rhytidiadelphus triquetrus	8	12	.	7	5	5	12
Calliergonella cuspidata	5	15	.	15	16	5	9
Cirriphyllum piliferum	10	10	.	20	26	5	9
Plagiomnium rostratum	11	12	.	11	21	5	9
Plagiomnium affine	5	15	.	6	8	5	9
Thuidium philibertii	14	12	.	11	21	5	9
Fissidens taxifolius	9	5	.	.	13	.	.
Thuidium abietinum	4	15	.	2	16	10	.
Eurhynchium hians	13	5	.	13	16	5	.
Brachythecium salebrosum	5	15	.	9	11	5	.

To evaluate the independent (marginal) effects of individual variables, the variance explained by the variable when used as the only constraining variable was calculated. The conditional effect of a variable is given by the additional variance explained by the variable at the time it was included in the forward selection. Measured environmental variables that passed the forward selection in the CCA were supplementarily added to the DCA and correlated with ordination axes (HERBEN & MÜNZBERGOVÁ 2003).

The following environmental variables were used in the CCA: (a) management: mowing (0 – non-mown, 1 – irregularly mown, 2 – regularly mown), grazing (1 – grazed, 0 – non-grazed); (b) topographical factors: global solar radiation (developed from DTM), slope inclination (in °) (obtained from DTM), altitude (in m a.s.l) (obtained from DTM); (c) biological variables: litter (cover of dead plant biomass in %); (d) climatic factors: average annual precipitation, average annual temperature, average temperature in July, average temperature in January, average number of days with snow cover; (e) geology and soil factors: soil type (fluvisol, cambisol, pararendzina, rendzina), soil texture (loam, loamy sand, clay loam, sandy loam), geological bedrock (limestone, sandstone, claystone, shale).

3. Results

3.1. Classification of relevés

The expert system identified 220 phytosociological relevés (64% of the whole data set containing 342 relevés). 151 relevés were assigned to the association *Brachypodio pinnati-Molinietum arundinaceae*, 33 relevés were classified as *Onobrychido viciifoliae-Brometum erecti*, 2 relevés as *Scabioso ochroleucae-Brachypodietum pinnati*, 8 relevés as *Ranunculo*

bulbosi-Arrhenatheretum, 12 relevés as *Pastinaco sativae-Arrhenatheretum elatioris*, 2 relevés as *Poo-Trisetetum flavescentis*, 1 relevé as *Lilio bulbiferi-Arrhenatheretum elatioris*, 7 relevés as *Anthoxantho-Agrostietum tenuis*, 4 relevés as *Campanulo rotundifoliae-Dianthetum deltoidis*. The relevés that were not matched by the expert system (122) were classified to associations by means of similarity indices. Finally, seven grassland associations were distinguished in the data set (Table 1; for *Lilio bulbiferi-Arrhenatheretum elatioris*, see Discussion):

Festuco-Brometea **Br.-Bl. et Tüxen ex Soó 1947**
Bromion erecti **W. Koch 1926**
Brachypodio pinnati-Molinietum arundinaceae Klika 1939
Onobrychido viciifoliae-Brometum erecti T. Müller 1966
Cirsio-Brachypodion pinnati **Hadač et Klika ex Klika 1951**
Scabioso ochroleucae-Brachypodietum pinnati Klika 1933
Molinio-Arrhenatheretea **Tüxen 1937**
Arrhenatherion **Koch 1926**
Ranunculo bulbosi-Arrhenatheretum Ellmauer 1993
Pastinaco sativae-Arrhenatheretum elatioris Passarge 1964
Anthoxantho-Agrostietum tenuis Sillinger 1933
Nardetea strictae **Rivas Goday et Borja Carbonell 1961**
Violion caninae **Schwickerath 1944**
Campanulo rotundifoliae-Dianthetum deltoidis Balátová-Tuláčková 1980

A detailed description of all grassland communities occurring in the Biele Karpaty Mts. was published by ŠKODOVÁ et al. (2008). In the present paper, only a short characterisation is presented.

3.2. Description of the syntaxa

Brachypodio pinnati-Molinietum arundinaceae **Klika 1939** (152 relevés, Table 2 in the Supplement, Figs. 7 and 8)

Meadows belonging to this association are the most typical grassland community in the Biele Karpaty Mts. (SILLINGER 1929, TLUSTÁK 1975). They are famous for their high species richness, which is the consequence of the common influence of abiotic factors, the long-term traditional use of grasslands, and the special phytogeographical position on the boundary between the Thermophyticum and the Mesophyticum (ŠKODOVÁ et al. 2008). SILLINGER (1929) called this grassland type "meadows with *Carex montana*". These swards consist of two layers: tall grasses (*Bromus erectus*, *Arrhenatherum elatius*, *Avenula pubescens*, *Molinia arundinacea*, and *Brachypodium pinnatum*), short caespitose grasses and graminoids (*Carex montana*, *Carex caryophyllea*, *Festuca rupicola*), and numerous dicots (*Cirsium pannonicum*, *Trifolium rubens*, *Trifolium montanum*, *Geranium sanguineum*, *Potentilla alba, Serratula tinctoria*, *Betonica officinalis*, *Lathyrus latifolius*). In regularly mown grasslands, no species becomes dominant. There are usually several subdominants, which cover about 25%. Notable is the coexistence of species with different environmental requirements. Due to the varied microrelief, xerophilous species (e.g. *Helianthemum grandiflorum* subsp. *obscurum*, *Polygala major*, *Astragalus danicus*, *Scorzonera purpurea*) can grow together with mesophilous species (e.g. *Galium boreale*, *Sanguisorba officinalis*, *Serratula tinctoria*, *Betonica officinalis*) and fringe species (*Geranium sanguineum*, *Trifolium medium*, *Astrantia major*) within small areas. Numerous rare and vulnerable species, especially orchids, occur in grasslands of this association (*Gymnadenia conopsea*, *Ophrys holosericea* subsp. *holubyana*, *Platanthera bifolia*, *Traunsteinera globosa*, *Scorzonera purpurea*, *Danthonia alpina*, *Gladiolus imbricatus*, *Iris graminea*).

The community is rather variable in dependency of soil characteristics. In Slovakia three variants of the association *Brachypodio pinnati-Molinietum arundinaceae* have been distinguished (ŠKODOVÁ 2007). On deep, moist soils on flysch bedrock, the variant with mesophilous species like *Lathyrus latifolius*, *Betonica officinalis, Sanguisorba officinalis*, and

Fig. 7: The *Brachypodio pinnati-Molinietum arundinaceae* with the typical species *Cirsium pannonicum* and *Pyrethrum corymbosum* in the Moravské Lieskové valley (Photo: I. Škodová, 17.6.2010).

Abb. 7: Das *Brachypodio pinnati-Molinietum arundinaceae* mit den typischen Arten *Cirsium pannonicum* und *Pyrethrum corymbosum* im Tal Moravské Lieskové (Foto: I. Škodová, 17.6.2010).

Fig. 8: The *Brachypodio pinnati-Molinietum arundinaceae* near the village Vrbovce. Mesophilous species like *Betonica officinalis* and *Sanguisorba officinalis* grow together with the xerophilous *Helianthemum grandiflorum* subsp. *obscurum* (Photo: I. Škodová, 14.8.2009).

Abb. 8: Das *Brachypodio pinnati-Molinietum arundinaceae* nahe dem Dorf Vrbovce. Mesophile Arten wie *Betonica officinalis* und *Sanguisorba officinalis* wachsen neben dem xerophilen *Helianthemum grandiflorum* subsp. *obscurum* (Foto: I. Škodová, 14.8.2009).

Galium boreale is common. Meadows of this variant occur in the southern part of the Biele Karpaty Mts. On moderately acid soils, the variant with higher frequencies of species like *Potentilla erecta*, *Viola canina*, *Polygala vulgaris*, *Veronica officinalis*, and *Nardus stricta* occurs. These grasslands can be found especially in the northern part of the territory. TLUSTÁK (1975) described similar communities as subassociation *typicum*, variant with *Nardus stricta* from the sites in higher altitudes with colder and wetter climate. The third variant includes grasslands on sites with shallower, dryer soils. We can find them in the whole territory, notably near the Klippen Belt. These grasslands are characterised by the presence of *Sanguisorba minor*, *Polygala major*, *Dorycnium herbaceum*, and *Festuca rupicola*. These meadows are rather similar to the first variant, but species preferring moist soils are missing here.

Grasslands belonging to the association *Brachypodio pinnati-Molinietum arundinaceae* have been utilised as meadows by regular mowing or occasional grazing. They occur mostly over calcareous flysch bedrock on neutral or alkaline soils at altitudes ranging from 300 to 750 m a.s.l.

***Onobrychido viciifoliae-Brometum erecti* T. Müller 1966** (40 relevés, Table 3 in the Supplement, Fig. 9)

These grasslands are usually strongly dominated by *Bromus erectus*, and some other grasses are subdominant (e.g. *Arrhenatherum elatius*, *Dactylis glomerata*, *Festuca rupicola*). Xerophilous species of the *Festuco-Brometea* (*Campanula glomerata*, *Dianthus carthusianorum*, *Teucrium chamaedrys*, *Ranunculus bulbosus*) grow together with mesophilous species of the *Molinio-Arrhenatheretea* (*Trifolium pratense*, *Leucanthemum vulgare*, *Campanula patula*, *Tragopogon orientalis*). Orchids (e.g. *Dactylorhiza sambucina*, *Gymnadenia conop-*

Fig. 9: The *Onobrychido viciifoliae-Brometum erecti* in the Bošáca valley. In the time of flowering, it belongs to the most colourful grasslands (Photo: I. Škodová, 8.6.2010).

Abb. 9: Das *Onobrychido viciifoliae-Brometum erecti* im Tal Bošáca. Zur Blütezeit gehört dieses zu den farbenprächtigsten Rasengesellschaften (Foto: I. Škodová, 8.6.2010).

saea, *Platanthera bifolia*, *Traunsteinera globosa*) often occur here. These meadows are mostly found on dry to mesic sites with a high content of $CaCO_3$, especially on the base of limestone rocks of the Klippen Belt, but also on calcareous flysch. Often they occur in orchards near rural settlements. In the past, these sites were mown once or twice a year and locally grazed at the end of summer. Today the traditional way of management continues only on sites where the villagers still use their land.

***Scabioso ochroleucae-Brachypodietum pinnati* Klika 1933** (4 relevés, Table 4)

Grasslands dominated by *Brachypodium pinnatum* belong to the most thermophilous grassland communities in the Biele Karpaty Mts. These swards are rather short. The upper layer consists mainly of *Brachypodium pinnatum* and also of herbs: *Anthericum ramosum*, *Scabiosa ochroleuca*, *Salvia verticillata*, *Securigera varia.* In the lower layer, some perennial grasses and dicots occur (e.g. *Festuca rupicola*, *Carex caryophyllea*, *Teucrium chamaedrys*, *Thymus pulegioides*, *Dorycnium herbaceum*, *Prunella laciniata*). Several typical pasture species are present (*Carlina vulgaris*, *C. acaulis*, *Ononis spinosa*, *Eryngium campestre*).

This vegetation type occurs only fragmentarily on warm sites on shallow soils formed on dry tufa sediments and on calcareous rocks in the Klippen Belt. Grasslands on steeper slopes were frequently used as pastures in the past. Some sites were mown once a year.

In the Biele Karpaty Mts., the association *Polygalo majoris-Brachypodietum pinnati* Wagner 1941 from the alliance *Cirsio-Brachypodion pinnati* was also found (ŠKODOVÁ et al. 2008). It occurs on the warmest sites on limestones in the Klippen Belt. In our data set was no phytosociological relevé belonging to this association.

***Pastinaco sativae-Arrhenatheretum elatioris* Passarge 1964** (54 relevés, Table 5 in the Supplement)

Mesophilous meadows dominated by *Arrhenatherum elatius* are common especially in orchards, on moist sites along streams, and on moderate slopes with deeper soil. In many cases, they have developed from species-rich subxerophilous meadows due to fertilisation and intensive utilisation. This is why many species typical for "grasslands with *Carex montana*" are present here with low constancy (e.g. *Cirsium pannonicum*, *Carex montana*, *Betonica officinalis*, *Filipendula vulgaris*, *Trifolium montanum*). Due to a sufficiency of nutrients and moisture, the vegetation is tall and dense with prevailing grasses (*Arrhenatherum elatius*, *Dactylis glomerata*, *Trisetum flavescens*, *Festuca pratensis*, *Poa pratensis* agg.). The lower layer contains dicotyledon herbs like *Trifolium pratense*, *T. repens*, *Leontodon hispidus*, *Glechoma hederacea*, and *Acetosa pratensis*. Some ruderal species can occur as well (e.g. *Cirsium arvense*, *Tussilago farfara*, *Bellis perennis*, *Cichorium intybus*, *Potentilla reptans*).

The vegetation of these stands is closely related to the association *Poo-Trisetetum flavescentis* (e.g. rel. nos. 43, 46, 54). *Arrhenatherum* grasslands were mown once or twice a year (along the streams) in the past. At present many orchards and meadows are abandoned due to a lack of farmers.

***Ranunculo bulbosi-Arrhenatheretum* Ellmauer 1993** (38 relevés, Table 6 in the Supplement, Fig. 10)

Mesophilous to subxerophilous grasslands dominated mostly by *Bromus erectus* or *Arrhenatherum elatius* with abundant flowering herbs. The vegetation consists of two layers. In the upper layer, tall grasses are prevailing (*Arrhenatherum elatius*, *Dactylis glomerata*, *Bromus erectus*, *Trisetum flavescens*, *Poa pratensis* agg.). The lower layer consists of species like *Festuca rupicola*, *Luzula campestris* s.lat., *Anthoxanthum odoratum*, *Veronica chamaedrys*, *Leontodon hispidus*, and *Lotus corniculatus.* Numerous thermophilous species of the class *Festuco-Brometea* constantly occur there (*Ranunculus bulbosus*, *Polygala comosa*, *Plantago media*, *Salvia pratensis*, *Pimpinella saxifraga*).

This vegetation is mostly found on dry to mesic sites with a high $CaCO_3$ content, especially on limestone of the Klippen Belt. It is frequent in orchards and on warm slopes. Many of these formerly once-a-year mown meadows are unmanaged nowadays.

Table 4: Phytosociological table of the *Scabioso ochroleucae-Brachypodietum pinnati*
Used symbols: * – relevés matched by formal definition, o – relevés assigned to the association on the basis of the highest similarity indices, / – relevés assigned to the association using similarity to the clusters, D – diagnostic species of the association on national level.

Tabelle 4: Pflanzensoziologische Tabelle des *Scabioso ochroleucae-Brachypodietum pinnati*
Verwendete Symbole: * – Aufnahme erfüllt formale Definition der Assoziation, o – Aufnahme per Ähnlichkeitsmaß zugeordnet (erfüllt keine formale Definition einer Assoziation), / – Aufnahme per Ähnlichkeitsmaß zugeordnet (erfüllt formale Definition einer nicht aus dem Gebiet bekannten Assoziation), D – National gültige diagnostische Art der Assoziation.

Relevé number		1	2	3	4
Altitude (m)		536	456	433	157
Aspect (degrees)		180	158	135	135
Slope (degrees)		0	5	20	35
Cover herb layer (%)		98	90	100	70
Cover moss layer (%)		0	10	5	5
Relevé area (m²)		25	25	25	25
Number of vascular plants		43	66	56	45
Determination by expert system		*	*	o	/
Diagnostic species of *Scabioso ochroleucae-Brometum erecti*					
Agrimonia eupatoria	D	a	+	a	+
Dorycnium herbaceum		b	.	1	+
Prunella laciniata		1	+	1	.
Origanum vulgare		1	+	.	+
Erysimum odoratum		.	.	+	r
Eryngium campestre		.	.	1	+
Festuco-Brometea					
Festuca rupicola	D	b	b	a	b
Brachypodium pinnatum	D	3	b	4	3
Tithymalus cyparissias		+	a	1	+
Salvia pratensis		.	+	+	1
Ononis spinosa	D	+	r	+	.
Knautia kitaibelii		+	+	+	.
Carex caryophyllea		+	a	.	+
Securigera varia	D	1	+	a	.
Dianthus carthusianorum		.	+	+	1
Asperula cynanchica	D	.	a	a	+
Galium verum		+	+	.	a
Linum catharticum	D	1	+	1	.
Plantago media		1	.	1	+
Sanguisorba minor	D	+	a	a	.
Potentilla heptaphylla		+	1	+	.
Koeleria pyramidata		+	.	.	+
Medicago falcata		.	.	1	+
Medicago lupulina		+	1	.	.
Thymus pulegioides		.	b	a	.
Pimpinella saxifraga		+	.	.	+
Carex flacca		a	.	1	.
Fragaria viridis		1	.	a	.
Teucrium chamaedrys	D	.	.	3	1
Bromus erectus		.	.	b	a
Primula veris		.	+	+	.
Carex michelii		.	.	a	+

Arabis hirsuta		.	1	+	.
Carlina vulgaris	D	.	+	+	.
Colymbada scabiosa		.	1	+	.
Molinio-Arrhenatheretea					
Poa pratensis agg.		1	1	a	+
Dactylis glomerata		1	+	+	+
Achillea millefolium agg.		1	1	a	+
Lotus corniculatus		+	1	1	.
Trisetum flavescens		1	+	+	.
Leontodon hispidus		+	+	+	.
Plantago lanceolata		+	+	+	.
Arrhenatherum elatius		1	.	a	+
Leucanthemum vulgare		+	+	+	.
Hypericum perforatum		+	.	+	.
Daucus carota		+	.	1	.
Picris hieracioides		+	.	+	.
Silene vulgaris		.	+	.	+
Other species					
Viola hirta		+	+	3	+
Epipactis atrorubens		.	+	.	.
Torilis japonica		r	.	.	.
Tithymalus esula		.	r	.	.
Galium album		.	r	.	.
Trees and shrubs					
Rosa canina agg.		.	.	r	r

Species occurring in one relevé

Vascular plants: *Acinos arvensis* 3: +; *Acosta rhenana* 4: +; *Adonis vernalis* 4: a; *Agropyron intermedium* 4: b; *Agrostis stolonifera* 2: +; *Allium oleraceum* 3: +; *Anthericum ramosum* 2: +; *Anthoxanthum odoratum* 2: +; *Astragalus onobrychis* 4: 1; *Biscutella laevigata* 2: a; *Briza media* 3: +; *Bupleurum falcatum* 4: +; *Campanula glomerata* 2: r; *Campanula patula* 2: r; *Carduus acanthoides* 3: +; *Carex panicea* 2: +; *Carex tomentosa* 3: +; *Carlina acaulis* 2: 1; *Cerastium holosteoides* 2: +; *Clinopodium vulgare* 4: +; *Cruciata glabra* 2: +; *Cuscuta species* 2: +; *Elytrigia repens* 2: +; *Epipactis atrorubens* 2: +; *Equisetum arvense* 2: +; *Erigeron acris* 2: +; *Euphrasia rostkoviana* 2: +; *Fallopia convolvulus* 2: r; *Festuca pratensis* 1: 1; *Festuca rubra* 2: +; *Fragaria vesca* 4: 1; *Galium album* 2: r; *Gymnadenia conopsea* 2: r; *Helianthemum ovatum* 2: +; *Hippocrepis comosa* 2: 1; *Chamaecytisus supinus* 4: 1; *Inula britannica* 3: +; *Jacea pratensis* 3: +; *Knautia arvensis* 4: +; *Koeleria macrantha* 3: 1; *Leopoldia comosa* 4: +; *Myosotis scorpioides agg.* 2: +; *Orchis ustulata* 2: r; *Peucedanum alsaticum* 4: +; *Phleum phleoides* 3: +; *Pilosella officinarum* 2: +; *Poa compressa* 2: +; *Polygala amarella* 2: r; *Polygala comosa* 1: +; *Potentilla erecta* 2: 1; *Potentilla reptans* 4: +; *Prunella vulgaris* 1: +; *Pseudolysimachion orchideum* 4: +; *Pyrus communis* 1: r; *Ranunculus nemorosus* 1: +; *Ranunculus polyanthemos* 2: 1; *Rhinanthus minor* 2: +; *Salvia verticillata* 1: 1; *Scabiosa ochroleuca* 3: +; *Sedum sexangulare* 3: +; *Seseli annuum* 3: +; *Stachys recta* 4: +; *Thalictrum minus* 4: +; *Thymus pannonicus* 4: +; *Tithymalus esula* 2: r; *Tithymalus virgata* 3: +; *Torilis japonica* 1: r; *Trifolium alpestre* 4: r; *Trifolium pratense* 1: +; *Trifolium repens* 2: +; *Veronica chamaedrys* 1: +; *Vicia cracca* 2: +; *Vicia tenuifolia* 4: +.

Fig. 10: The *Ranunculo bulbosi-Arrhenatheretum elatioris* with flowering aspect of *Leucanthemum vulgare*, *Campanula patula*, and *Leontodon hispidus* near the village Vrbovce. In the southern part of the territory, the thermophilous species *Astragalus danicus* is also present in this community (Photo: K. Devánová, 28.8.2009).

Abb. 10: Das *Ranunculo bulbosi-Arrhenatheretum elatioris* mit Blühaspekt von *Leucanthemum vulgare*, *Campanula patula* und *Leontodon hispidus* nahe dem Dorf Vrbovce. Im südlichen Teil des Gebiets tritt auch die thermophile Art *Astragalus danicus* in dieser Gesellschaft auf (Foto: K. Devánová, 28.8.2009).

***Anthoxantho-Agrostietum tenuis* Sillinger 1933** (22 relevés, Table 7 in the Supplement)

This vegetation type represents moderately tall grasslands on neutral soils with a lower content of nutrients. The community is built by grasses such as *Dactylis glomerata*, *Briza media*, *Anthoxanthum odoratum, Festuca rubra*, *F. pratensis*, *Agrostis capillaris*, and *Arrhenatherum elatius*. In these swards, several species of the class *Nardetea strictae* (e.g. *Polygala vulgaris*, *Potentilla erecta*, *Viola canina*, *Carex pallescens*), thermophilous herbs (e.g. *Thymus pulegioides*, *Plantago media*, *Trifolium montanum*), and numerous species of the *Arrhenatherion* (*Leucanthemum vulgare*, *Acetosa pratensis*, *Campanula patula*, *Prunella vulgaris*, *Jacea pratensis*) constantly occur.

These grasslands are mostly mown once a year or extensively grazed. They are found on slopes especially in the central part of the Biele Karpaty Mts.

Campanulo rotundifoliae-Dianthetum deltoidis **Balátová-Tuláčková 1980** (32 relevés, Table 8 in the Supplement)

Meadow and pasture communities growing on nutrient-poor and acid soils. The vegetation is rather low and dense. These swards are dominated by various grasses (*Festuca rubra*, *Nardus stricta*, *Festuca rupicola*, *Carex montana*, *Festuca ovina*, *Danthonia decumbens*). In some cases, dicotyledonous herbs such as *Leontodon hispidus*, *Thymus pulegioides*, *Plantago lanceolata*, *Lotus corniculatus* can also reach high cover values. For this vegetation type, the presence of many species growing on acid and mineral-poor soils (*Nardus stricta*, *Danthonia decumbens*, *Veronica officinalis*, *Polygala vulgaris*, *Luzula luzuloides*, *Calluna vulgaris*, *Viola canina*) is characteristic. As these grasslands are mostly used as pastures, some common pasture species are found there (*Hypochaeris radicata*, *Trifolium repens*, *Cynosurus cristatus*, *Euphrasia rostkoviana*).

This community is found mostly on acid flysch layers in the northern part of the Biele Karpaty Mts. The association was formerly ranked as subassociation of the previous association (*Anthoxantho-Agrostietum tenuis nardetosum*; UJHÁZY 2007, ŠKODOVÁ et al. 2008).

3.2. Indirect gradient analysis DCA

The total inertia in the DCA was 8.56; eigenvalues were 0.322 (axis 1) and 0.264 (axis 2) (Fig. 11). As the resulting gradient lengths in the DCA were long (4.191 for the first axis), the unimodal method was chosen. The first axis explained 4.0% of the variance of species data, the second axis 3.3%.

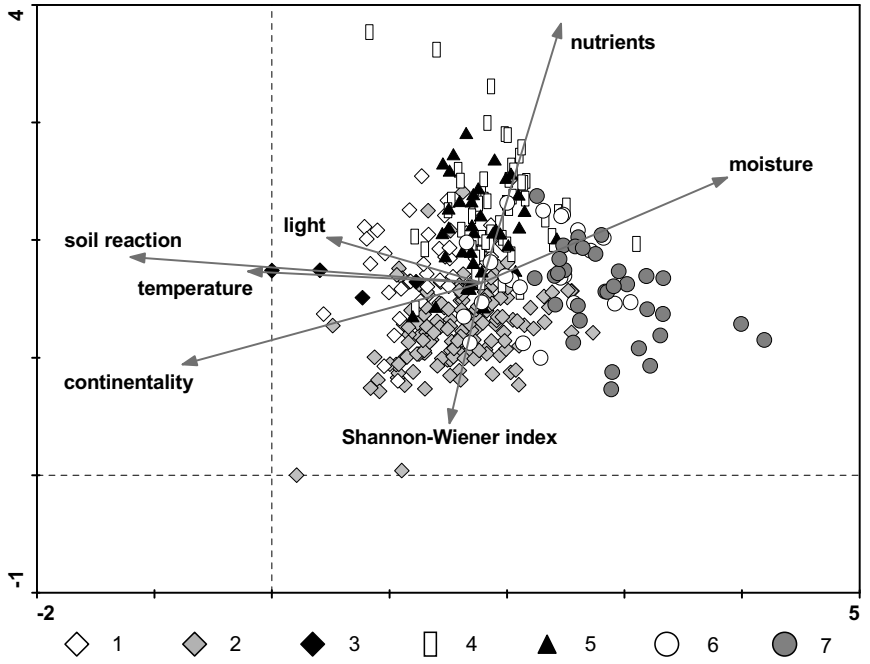

Fig. 11: Detrended correspondence analysis (DCA) of phytosociological relevés. The average non-weighted Ellenberg indicator values for the relevés were plotted onto the DCA ordination diagram as supplementary environmental data. Associations are marked as follows: 1 *Brachypodio pinnati-Molinietum arundinaceae*, 2 *Onobrychido viciifoliae-Brometum erecti*, 3 *Scabioso ochroleucae-Brachypodietum pinnati*, 4 *Pastinaco sativae-Arrhenatheretum elatioris*, 5 *Ranunculo bulbosi-Arrhenatheretum elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis*, 7 *Campanulo rotundifoliae-Dianthetum deltoidis*.

Abb. 11: Trendbereinigte Korrespondenzanalyse (DCA) der Vegetationsaufnahmen. Die mittleren ungewichteten Ellenberg-Zeigerwerte der Aufnahmen sind als passive Variablen in das Ordinationsdiagramm projiziert.

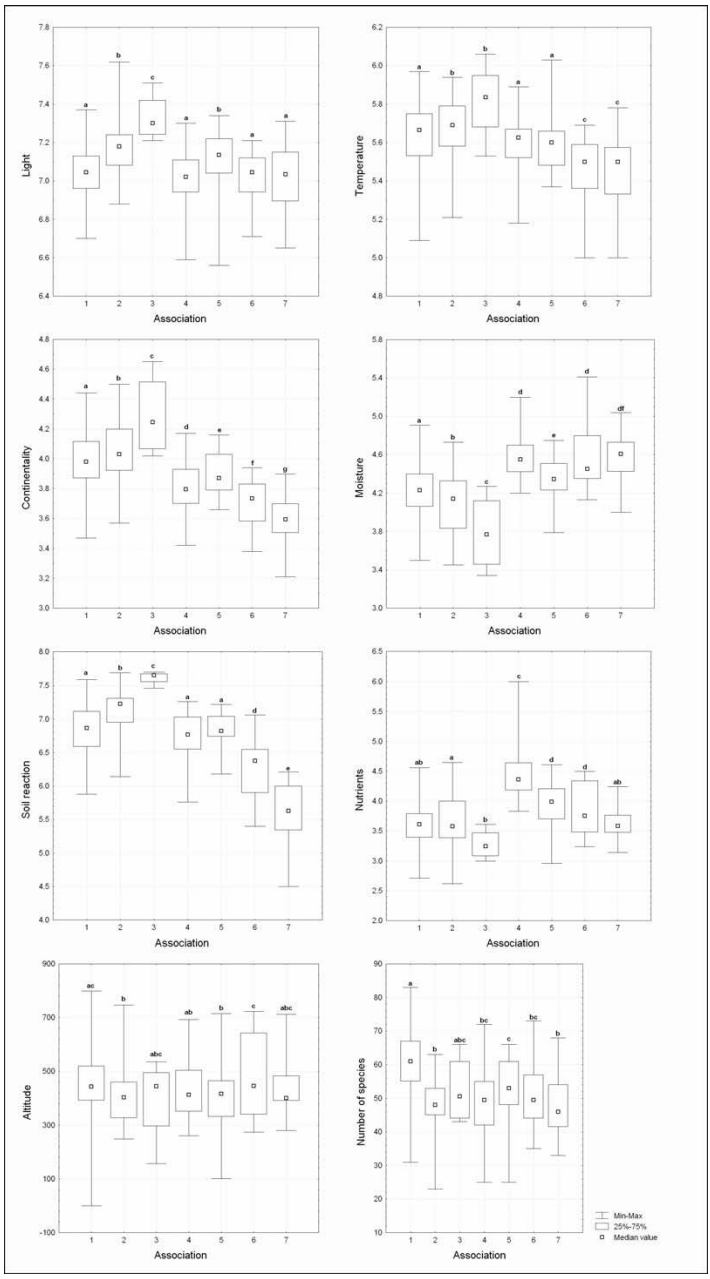

Fig. 12: Comparison of Ellenberg indicator values, altitude and species richness of vascular plants on 25 m² for the studied associations. Significant differences are marked with letters. Median values, quartiles, and ranges are shown. Associations are numbered as follows: 1 *Brachypodio pinnati-Molinietum arundinaceae*, 2 *Onobrychido viciifoliae-Brometum erecti*, 3 *Scabioso ochroleucae-Brachypodietum pinnati*, 4 *Pastinaco sativae-Arrhenatheretum elatioris*, 5 *Ranunculo bulbosi-Arrhenatheretum elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis*, 7 *Campanulo rotundifoliae-Dianthetum deltoidis*.

Abb. 12: Vergleich der untersuchten Assoziationen in Bezug auf mittlere Ellenberg-Zeigerwerte, Seehöhe und Zahl der Gefäßpflanzen je 25 m²-Aufnahme. Signifikante Unterschiede sind durch Buchstaben gekennzeichnet. Dargestellt sind Median, Quartile und Spannweite.

The first axis was positively correlated with moisture indicator values (correlation coefficient: 0.6298) and negatively correlated with temperature (–0.5821) and soil reaction indicator values (–0.8727). This supports our assumption that the main environmental gradient in our data set is related to moisture and soil reaction (content of $CaCO_3$ in soil). On the right side of the ordination chart, the relevés of mesophilous grasslands (*Anthoxantho odorati-Agrostietum tenuis*) and pastures on acid soils (*Campanulo rotundifoliae-Dianthetum deltoidis*) are separated. On the left side of the ordination chart, the relevés of subxerophilous vegetation are separated (*Brachypodio pinnati-Molinietum arundinaceae*, *Onobrychido viciifoliae-Brometum erecti*, *Scabioso ochroleucae-Brachypodietum pinnati*). The second axis was positively correlated with Ellenberg indicator values for nutrients (correlation coefficient: 0.6535). Communities occurring on nutrient-rich soils are located in the upper part of the chart (*Ranunculo bulbosi-Arrhenatheretum elatioris*, *Pastinaco sativae-Arrhenatheretum elatioris*).

The comparison of Ellenberg indicator values showed that there are significant differences between the associations, especially in requirements for moisture (Fig. 12). No significant differences were only found between *Ranunculo bulbosi- Arrhenatheretum elatioris*, *Anthoxantho odorati-Agrostietum tenuis* and *Campanulo rotundifoliae-Dianthetum deltoidis*. As for soil reaction, the association *Scabioso ochroleucae-Brachypodietum pinnati* reaches the highest values, significantly different from other communities. In the Biele Karpaty Mts., these grasslands often occur on sites with shallow soils rich in $CaCO_3$ formed on dry tufa sediments and on calcareous rocks in the Klippen Belt. The association *Campanulo rotundifoliae-Dianthetum deltoidis* has the lowest indicator values for soil reaction. It occurs on acid flysch layers.

The comparison of temperature indicator values showed that there are three significantly different groups of communities: the first group contains species occurring on the warmest sites (*Onobrychido viciifoliae-Brometum erecti*, *Scabioso ochroleucae-Brachypodietum pinnati*), the second group contains species with lower temperature requirements (*Brachypodio pinnati-Molinietum arundinaceae*, *Pastinaco sativae-Arrhenatheretum elatioris*, *Ranunculo bulbosi-Arrhenatheretum*), and the third group contains species with the lowest indicator values for temperature (*Anthoxantho odorati-Agrostietum tenuis*, *Campanulo rotundifoliae-Dianthetum deltoidis*).

Communities belonging to the alliance *Arrhenatherion* (*Pastinaco sativae-Arrhenatheretum elatioris*, *Ranunculo bulbosi-Arrhenatheretum*, *Anthoxantho odorati-Agrostietum tenuis*) have the highest nutrient demands.

3.3. Direct gradient analysis (CCA)

The relationship between species composition and selected environmental factors was analysed using canonical correspondence analysis. Total inertia was 7.932, and eigenvalues were 0.110 (axis 1) and 0.109 (axis 2). The first CCA axis explained 1.4% variance of the species data and 17.6% of the species-environment relationship, which means that 17.6% of the variability of our data set caused by the selected environmental factors was reflected by the first canonical axis.

As some climatic factors were correlated with altitude, two factors with the smallest effect on the species variability (average temperature in July and in January) were excluded from the analysis. All 23 environmental variables together explained 16.15% of the variability of the species composition. The 11 factors that were significant in the Monte Carlo permutation test explained 7.54% of the whole variability and 6.23% when other significant environmental variables were put into the CCA analysis as covariables. Of all significant environmental factors, precipitation had the strongest effect on the variability of our data set (1.07%), together with geological bedrock (shale 0.98%, all bedrock types together 2.77%) and mowing (0.88%) (Tab. 9). In forward selection, precipitation was included in the first step. Geological bedrock was the second most important factor affecting the data variation. Almost all variables passing the forward selection had a significant pure effect on the data set except of three types of geological bedrock (limestone, sandstone, claystone).

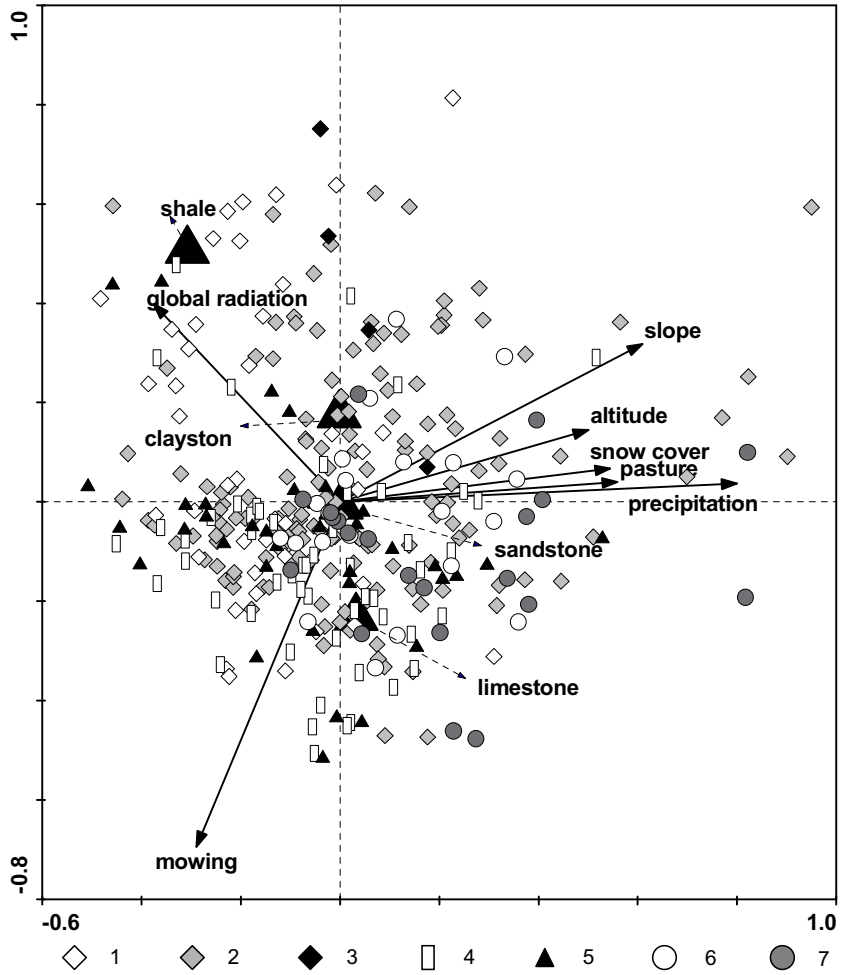

Fig. 13: Canonical correspondence analysis (CCA) of phytosociological relevés. Associations are marked as follows: 1 *Brachypodio pinnati-Molinietum arundinaceae*, 2 *Onobrychido viciifoliae-Brometum erecti*, 3 *Scabioso ochroleucae-Brachypodietum pinnati*, 4 *Pastinaco sativae-Arrhenatheretum elatioris*, 5 *Ranunculo bulbosi-Arrhenatheretum elatioris*, 6 *Anthoxantho odorati-Agrostietum tenuis*, 7 *Campanulo rotundifoliae-Dianthetum deltoidis*.

Fig. 13: Kanonische Korrespondenzanalyse (CCA) der Vegetationsaufnahmen.

The position of the grassland types in relation to the significant environmental factors is shown in Fig. 13. Subxerophilous grassland types (*Onobrychido viciifoliae-Brometum erecti*) are distributed on the left side of the chart, where the solar radiation increases and precipitation decreases. The pasture communities *Anthoxantho odorati-Agrostietum tenuis* and *Campanulo rotundifoliae-Dianthetum deltoidis* are concentrated on the sandstones on sites with higher precipitation; in the chart, these are distributed mainly on the right side. Mesophilous meadows (*Pastinaco sativae-Arrhenatheretum elatioris*, *Ranunculo bulbosi-Arrhenatheretum elatioris*) are related to mowing, concentrated in the lower left side of the ordination diagram. The relevés of the locally most typical grassland community *Brachypodio pinnati-Molinietum arundinaceae* are distributed almost over the whole chart area. It seems that this vegetation type is rather indifferent to the selected environmental factors.

Table 9: Canonical correspondence analysis (CCA):– variance explained by individual environmental variables. Legend: ns – not significant, *** – significant at $p \leq 0.001$, ** significant at $p \leq 0.01$
Tabelle 9: Kanonische Korrespondenzanalyse (CCA): durch die einzelnen Umweltfaktoren erklärte Varianz. Legende: ns. – nicht signifikant, *** – signifikant bei $p \leq 0.001$, ** signifikant bei $p \leq 0.01$

Environmental variable	Conditional effect (selection order)	%	Marginal effect	%	Pure effect	%
Precipitation	**0.085*** **	**1.07**	**0.085*** **	**1.07**	**0.049*** **	**0.62**
Shale	**0.078** **	**0.98**	**0.079** **	**1.00**	**0.071** **	**0.90**
Mowing	**0.070*** **	**0.88**	**0.078*** **	**0.98**	**0.071*** **	**0.90**
Slope	**0.055*** **	**0.69**	**0.073*** **	**0.92**	**0.050*** **	**0.63**
Limestone	**0.052*** **	**0.66**	**0.052*** **	**0.66**	0.030^{ns}	0.38
Sandstone	**0.052*** **	**0.66**	**0.041*** **	**0.52**	0.028^{ns}	0.35
Altitude	**0.044*** **	**0.55**	**0.061*** **	**0.77**	**0.042*** **	**0.53**
Snow cover	**0.043*** **	**0.54**	**0.067*** **	**0.84**	**0.043*** **	**0.54**
Global irradiation	**0.043*** **	**0.54**	**0.055*** **	**0.69**	**0.043*** **	**0.54**
Pasture	**0.039** **	**0.49**	**0.057*** **	**0.72**	**0.036** **	**0.45**
Claystone	**0.037** **	**0.47**	**0.038** **	**0.48**	0.031^{ns}	0.39
Sum		**7.54**		**7.58**		**6.23**

4. Discussion

4.1. The syntaxonomical classification

The expert system for the identification of grassland vegetation of Slovakia is a useful tool for the classification of phytosociological relevés based on formal definitions of individual associations, which were formulated at a national level. JANIŠOVÁ (2007) noted that the successfulness of the Slovak expert system is 46.3%, which means that 46.3% of relevés included in the training data set of the expert system fulfilled the criteria of the formal definitions of associations. As the expert system has identified 220 relevés of our data set (64% of the whole data set containing 342 relevés), the application of this method could be considered appropriate. DÚBRAVKOVÁ-MICHÁLKOVÁ et al. (2008) compared two classifications of the same data set, one based on the modified TWINSPAN algorithm and one using the electronic expert system. An important advantage of the expert system is that it uses external predefined criteria of what the individual vegetation units should look like. These criteria are independent from the classified data set. Using this method, the relevés with transitional features and the poorly developed stands with small numbers of diagnostic species remain unassigned by the definitions (JANIŠOVÁ et al. 2010).

There were relatively large differences among the associations in the percentage of relevés that were assigned by the expert system. From the 152 relevés finally classified as association *Brachypodio pinnati-Molinietum arundinaceae*, 99% (151) were determined by the expert system. This result can be explained by the fact that in Slovakia this association is mainly distributed in the Biele Karpaty Mts., and relevés from this region were included in the training data set used for creating the expert system (JANIŠOVÁ 2007). The formal definition of this association was therefore formed and tested using these relevés. As for *Onobrychido viciifoliae-Brometum erecti*, 80% (33 of 40) of the relevés were identified by the expert system. For the remaining associations, the expert system was not so successful. It identified 50% (2 of 4) of the relevés finally classified as *Scabioso ochroleucae-Brachypodietum pinnati*, 21% (8 of 38) of the relevés classified as *Ranunculo bulbosi-Arrhenatheretum*, 22% (12 of 54) of the relevés classified as *Pastinaco sativae-Arrhenatheretum elatioris*, 32% (7 of 22) of the relevés classified as *Anthoxantho-Agrostietum tenuis*, and 12% (4 of 32) of the relevés classified as *Campanulo rotundifoliae-Dianthetum deltoidis.* A possible reason for the low share of relevés assigned by the expert system could be the degradation and successional shifts in the species composition of grasslands and the transitional character of some analysed stands (JANIŠOVÁ 2007, DÚBRAVKOVÁ-MICHÁLKOVÁ et al. 2008). In the terri-

tory of the Biele Karpaty Mts., the grasslands of the *Ranunculo bulbosi-Arrhenatheretum*, the *Pastinaco sativae-Arrhenatheretum elatioris*, and the *Anthoxantho-Agrostietum tenuis* in many cases developed from grasslands of the *Brachypodio pinnati-Molinietum arundinaceae* due to changes in farming (pasture, fertilisation) (TLUSTÁK 1975).

Formal definitions of associations are able to identify relevés representing the community in optimal state. The expert system does not aspire to classify every existing stand of vegetation, but defines the cores of associations, which are usually characterised by the occurrence of ecologically specialised species (CHYTRÝ 2007). Since we tried to assign every relevé to some association, we used a similarity index (FPFI – Frequency-positive fidelity index). Relevés that remained unassigned do not belong to the core of the particular association and are not typical of it, but are close or similar to it (CHYTRÝ 2007).

The expert system classified two relevés of our data set as *Poo-Trisetetum flavescentis* (Table 5: no. 54, Table 6: no. 14). This association is not very common in the territory of the Biele Karpaty Mts. It represents species-poor grasslands that developed from semi-natural species-rich meadows after re-cultivation and fertilisation (UHLIAROVÁ et. al. 2007). As both relevés contain many species (41, 44) and were very similar to other *Arrhenatherion* communities in the territory, we decided to classify them on the base of similarity to other clusters in our data set (originated as results of the expert system). The relevé no. 152 (Table 2) was classified within the association *Lilio bulbiferi-Arrhenatheretum elatioris*. This community was not found yet in the Biele Karpaty Mts.; its distribution is restricted to Central Slovakia and calcareous bedrock (UHLIAROVÁ et al. 2007). As in the previous case, we matched the relevé to the other clusters using the similarity index.

After the analysis of phytosociological relevés, there were seven associations of meso- and subxerophilous grasslands determined in the Biele Karpaty Mts. These results indicate rather high beta diversity of the grassland vegetation in this territory. Several authors (SILLINGER 1929, TLUSTÁK 1975) declared that the vegetation diversity of the meadows is not very exceptional. In the past, some associations were not distinguished, for example the *Ranunculo bulbosi-Arrhenatheretum elatioris* and the *Campanulo rotundifoliae-Dianthetum deltoidis*. TLUSTÁK (1975) presents only the associations *Arrhenatheretum elatioris* with three subassociations and the *Anthoxantho-Agrostietum tenuis* with three subassociations. At present, some of these subassociations are considered separate associations. The first information about the occurrence of the *Scabioso ochroleucae-Brachypodietum pinnati* and the *Onobrychido viciifoliae-Brometum erecti* in the Biele Karpaty Mts. was published by ŠKODOVÁ et al. (2008).

4.2. Differences between grasslands in the Slovak and the Czech part of the Biele/Bílé Karpaty Mts.

There are some differences in species composition of the *Brachypodio pinnati-Molinietum arundinaceae* between the Slovak and the Czech Republic. In the meadows of the Slovak part of the Biele Karpaty Mts., species preferring intermittently wet soils (*Serratula tictoria*, *Galium boreale*, *Molinia arundinacea, Sanguisorba officinalis*) and some thermophilous species (*Astragalus danicus*, *Scorzonera purpurea*, *Melampyrum cristatum*, *Peucedanum cervaria*) are not so frequent. Only in the south-western part of the territory (mainly in the surroundings of the villages Nová Bošáca, Moravské Lieskové, and Vrbovce), the meadows of the *Brachypodio pinnati-Molinietum arundinaceae* are very similar to the grasslands occurring on the other side of the ridge. In the middle and north-eastern part, the community is mostly developed in a depauperate form. Such meadows also occur in the central part of the Czech side of the mountains – in the "kopanice" region, outside the area where heavy deep soils and prehistoric settlement coincide (HÁJKOVÁ et al. 2011).

SILLINGER (1929) mentioned that in the Slovak part of the Biele Karpaty Mts., the "meadows with *Carex montana*" are not as common as in the Czech part. He gave several reasons for this: differences in geological bedrock (limestone in the Klippen Belt in Slovakia), differences in settlement, smaller areas of grasslands in Slovakia, and a different way of

farming. JANŠÁK (1967) suggested that the former border between Hungary and Moravia also represents the sharp boundary of "kopanice" settlement. In the Czech part of the mountains, the "kopanice" has developed only in the central and the north-eastern part. This is connected with the fact that the land in this part was in the possession of an owner from Hungary, who enabled "kopanice" settlement and cultivation of new agricultural land (JANŠÁK 1967). The origin of the large meadow areas in the Czech part of the mountains is related to a different type of settlement. Villages there had strictly organised fields, meadows, and pastures (FUTÁK et al. 2008). This enabled an effective and practical use of the land by the whole village community. Meadows were mown in July, and this late cutting enabled most plants to flower and produce seeds. In the "kopanice" region in Slovakia, grasslands did not form such large areas and were usually cut earlier, namely in June.

4.3. Gradient analysis

In the CCA, precipitation had the strongest effect of all significant environmental factors. This is in accordance with many other studies suggesting that the main floristic gradient in grasslands is related to annual precipitation (EJRNÆS & BRUUN 2000, BRUELHEIDE & JANDT 2007).

The effect of the selected environmental factors was much smaller than we had expected. This is probably caused by the fact that the composition of vegetation depends on the complex influence of many environmental variables, and the studied variables explain only a small part of the variability of our data. Floristic composition in grasslands is shaped not only by current site conditions and management, but also by age, site history and traditional ancient management practices (PÄRTEL et al. 1996, COUSINS & ERIKSSON 2002, WELLSTEIN et al. 2007, HÁJKOVÁ et al. 2011). Another possible reason might be that our ecological data were obtained from raster maps scaled 1:50,000 and that such a coarse scale might not really be suitable for the purpose of our analysis. In grasslands the differences in micro-environmental factors are the most important ones (BRUELHEIDE & JANDT 2007). TER BRAAK & VERDONSCHOT (1995) mentioned that for ecological data the explained inertia is typically low (< 10%) and that this is an inherent feature of data with a strong presence/absence aspect. In species-rich grasslands with a high alpha and beta diversity, even a comprehensive set of environmental factors may explain only a small proportion of their variability (JANIŠOVÁ et al. 2010).

In the DCA, the first two axes explained 7.3% of the variability of the data set. In the CCA, the variability explained by the first two axes was much lower (only 2.8%). That means that the selected variables are probably not the most important factors affecting the grassland vegetation in our data set. Eleven environmental variables, which passed the forward selection in the CCA, were supplementarily added to the DCA and correlated with ordination axes (results not shown). However, none of the measured variables were significantly correlated with the ordination axes.

Acknowledgement

We are grateful to Sylva Mertanová, Monika Janišová, Janka Smatanová, Helena Ružičková, Janka Zlinská, Marián Perný, and Ján Hrbatý for field assistance and to Katharine Bhattacharyya and Mary Fülöpová for their correction of our English. We would like to thank Katarína Mišíková and Anna Kubínska for the identification of bryophytes and Wolfgang Willner, Michal Hájek, and an anonymous reviewer for valuable comments on the manuscript. We are very grateful to Aiko Huckauf for language editing and Jürgen Dengler for formal editing of the text and reference list.We are grateful to Daphne – Institute for Applied Ecology – for enabling us to use the program Statistica 5.5 for our statistical analysis. This contribution was supported by a grant through the EEA Financial Mechanism and the Norwegian Financial Mechanism, by the state budget of the Slovak Republic (SK0115, 40%), by the Science Grant Agency of the Ministry of Education of the Slovak Republic and the Slovak Academy of Sciences (VEGA 2/0181/09, 40%), and by the Slovak Research and Development Agency (APVT-51-015804, 10%). This contribution is also the result of the project implementation "The Centre of Excellency for biodiversity and land-use conservation" (ŠF OPVaV 26240120014) supported by the Research & Development Operational Programme funded by the ERDF (10%).

Appendix A: Origin of the relevés in Tables 2–8

Anhang A: Herkunftsnachweis der Vegetationsaufnahmen in den Tabellen 2–8

The entries are organised as follows: Number of relevé: Turboveg number, Locality, Longitude, Latitude, Date (year month day), Author code (IS – Iveta Škodová, KD – Katarína Devánová, HR – Helena Ružičková, JH – Ján Hrbatý, JS – Janka Smatanová, JZ – Janka Zlinská, MJ – Monika Janišová, MP – Marián Perný, SM – Sylva Mertanová).
Jeder Nachweis ist in der folgenden Reihenfolge organisiert: Aufnahmenummer: Turboveg-Nummer, Toponym, geografische Länge, geografische Breite, Datum (JJJJ MM TT), Autor/Autorin (IS – Iveta Škodová, KD – Katarína Devánová, HR – Helena Ružičková, JH – Ján Hrbatý, JS – Janka Smatanová, JZ – Janka Zlinská, MJ – Monika Janišová, MP – Marián Perný, SM – Sylva Mertanová).

Table 2:

1: 714074, Biele Karpaty, Moravské Lieskové, Komárech lúky, 17°44'23" E, 48°50'36" N, 1993 06 07, IS; **2:** 714032, Biele Karpaty, Moravské Lieskové, U Zlatých, 17°45'55" E, 48°51'22" N, 1998 06 26, KD; **3:** 714072, Biele Karpaty, Moravské Lieskové, Ligasová, 17°44'41" E, 48°51'02" N, 1993 06 07, IS; **4:** 714112, Biele Karpaty, Predpoloma, 17°47'55" E, 48°53'26" N, 1993 08 04, IS, KD; **5:** 714044, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43'50" E, 48°52'27" N, 1993 05 24, IS, KD; **6:** 714050, Biele Karpaty, Moravské Lieskové, Šance, 17°44'26" E, 48°51'57" N, 1993 05 25, IS; **7:** 714265, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'25" E, 48°49°'14" N, 1995 06 20, IS, HR; **8:** 714322, Biele Karpaty, Raková dolina, 17°21'09" E, 48°46'58" N, 1999 05 26, IS, JH; **9:** 714171, Biele Karpaty, Nová Bošáca, Grúň, 17°47'53" E, 48°53'42" N, 1998 06 13, IS; **10:** 714031, Biele Karpaty, Moravské Lieskové, U Zlatých, 17°45'50" E, 48°51'25" N, 1998 06 26, KD; **11:** 714286, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'18" E, 48°49°'14" N, 1999 06 10, IS; **12:** 714081, Biele Karpaty, Moravské Lieskové - border, Mikulci, 17°44'40" E, 48°52'44" N, 1993 06 08, IS; **13:** 714249, Biele Karpaty, Nová Bošáca, Predpoloma, parcel 7506, 17°48'26" E, 48°53'11" N, 1998 07 09, IS; **14:** 714250, Biele Karpaty, Nová Bošáca, Predpoloma, parcel 7551, 17°48'36" E, 48°53'12" N, 1998 07 09, IS; **15:** 714253, Biele Karpaty, Nová Bošáca, Predpoloma, Jastrabské, parcel 7274/1, 17°49'22" E, 48°54'05" N, 1998 07 09, IS; **16:** 714254, Biele Karpaty, Nová Bošáca, Predpoloma, Jastrabské, parcel 7274/1, 17°49'24" E, 48°54'02" N, 1998 07 09, IS; **17:** 714241, Biele Karpaty, Bošácka dolina, Predpoloma, Hajdarové, 17°48'58" E, 48°53'18" N, 1998 07 07, IS; **18:** 714090, Biele Karpaty, Vršatec, 18°07'28" E, 49°04'49" N, 1993 06 22, IS, KD; **19:** 714247, Biele Karpaty, Nová Bošáca Near Chabovec, 17°46'41" E, 48°52'48" N, 1998 07 08, IS, KD; **20:** 714248, Biele Karpaty, Nová Bošáca Near Chabovec, 17°46'45" E, 48°52'43" N, 1998 07 08, IS, KD; **21:** 714117, Biele Karpaty, Nová Bošáca, Kameničné, 17°47'10" E, 48°51'55" N, 1993 08 06, IS; **22:** 714278, Biele Karpaty, Vrbovce, Žalostiná, 17°25'52" E, 48°48°'47" N, 1997 07 11, IS; **23:** 714277, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'26" E, 48°49°'06" N, 1997 07 11, IS; **24:** 714266, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'18" E, 48°49°'09" N, 1995 06 20, IS, HR; **25:** 714268, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'20" E, 48°49°'06" N, 1995 06 20, IS, HR; **26:** 714267, Biele Karpaty, Vrbovce, Bučkova jama, 17°26'22" E, 48°49°'08" N, 1995 06 20, IS, HR; **27:** 714047, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43'49" E, 48°52'38" N, 1993 05 25, IS; **28:** 714042, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43'53" E, 48°52'30" N, 1993 05 24, IS, KD; **29:** 714043, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43'45" E, 48°52'30" N, 1993 05 24, IS, KD; **30:** 714052, Biele Karpaty, Moravské Lieskové, Švehlech kút, 17°45'06" E, 48°51'12" N, 1993 05 26, IS; **31:** 714080, Biele Karpaty, Moravské Lieskové - border, P22249, 17°44'27" E, 48°52'47" N, 1993 06 08, IS; **32:** 714045, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43'52" E, 48°52'25" N, 1993 05 24, IS, KD; **33:** 714069, Biele Karpaty, Moravské Lieskové, Ligasová, 17°44'34" E, 48°51'09" N, 1993 06 07, IS; **34:** 714070, Biele Karpaty, Moravské Lieskové, Ligasová, 17°44'30" E, 48°51'07" N, 1993 06 07, IS; **35:** 714260, Biele Karpaty, Moravské Lieskové, Kohútová, 17°43'45" E, 48°51'07" N, 1993 06 11, KD; **36:** 714257, Biele Karpaty, Krivoklát, Krivoklátske lúky, 18°08'08" E, 49°03'34" N, 1993 06 09, KD; **37:** 714053, Biele Karpaty, Moravské Lieskové, Švehlech kút, 17°45'13" E, 48°50'52" N, 1993 05 26, IS; **38:** 714054, Biele Karpaty, Moravské Lieskové, Švehlech kút, 17°45'13" E, 48°50'48°" N, 1993 05 26, IS; **39:** 714176, Biele Karpaty, Nová Bošáca, Grúň, 17°48'08" E, 48°53'39" N, 1998 06 14, IS; **40:** 714262, Biele Karpaty, Nová Bošáca, Grúň, 17°47'41" E, 48°53'47" N, 1993 05 29, KD; **41:** 714273, Biele Karpaty, Vrbovce, Štefanová, 17°26'49" E, 48°49'42" N, 1997 07 10, IS; **42:** 714264, Biele Karpaty, Vrbovce, U Chalupú, 17°25'54" E, 48°49°'30" N, 1995 06 20, IS, HR; **43:** 714274, Biele Karpaty, Vrbovce, Štefanová, 17°26'37" E, 48°49°'38" N, 1997 07 10, IS; **44:** 714039, Biele Karpaty, Štefanová, 17°27'05" E, 48°49°'40" N, 1998 07

17, KD; **45:** 714038, Biele Karpaty, Vrbovce, Štefanová, 17°26’30” E, 48°49°’42” N, 1998 07 16, KD; **46:** 714183, Biele Karpaty, Vrbovce, Štefanová, in the direction of Paseka, 17°26’59” E, 48°49°’41” N, 1998 06 22, IS; **47:** 714182, Biele Karpaty, Vrbovce, Štefanová, in the direction of Paseka, 17°26’55” E, 48°49°’42” N, 1998 06 22, IS; **48:** 714185, Biele Karpaty, Vrbovce, Štefanová, parcel 25653, 17°26’40” E, 48°49°’28” N, 1998 06 22, IS; **49:** 714037, Biele Karpaty, Vrbovce, Štefanová, 17°27’00” E, 48°49°’40” N, 1998 07 16, KD; **50:** 714275, Biele Karpaty, Vrbovce, Štefanová, 17°26’38” E, 48°49°’41” N, 1997 07 10, IS; **51:** 714215, Biele Karpaty, Vrbovce, Rúbanice, 17°26’29” E, 48°50’08” N, 1998 06 27, IS; **52:** 714216, Biele Karpaty, Vrbovce, Rúbanice, 17°26’24” E, 48°50’11” N, 1998 06 27, IS; **53:** 714111, Biele Karpaty, Predpoloma, parcel 9443, 17°47’58” E, 48°54’25” N, 1993 08 04, IS, KD; **54:** 714279, Biele Karpaty, Vrbovce, Žalostiná, 17°25’54” E, 48°48°’48°” N, 1997 07 11, IS; **55:** 714270, Biele Karpaty, Vrbovce, under Bučkova jama, U Mitáka, 17°26’32” E, 48°48’58” N, 1995 06 20, IS, HR; **56:** 714269, Biele Karpaty, Vrbovce, under Bučkova jama, 17°26’30” E, 48°49°’04” N, 1995 06 20, IS, HR; **57:** 714180, Biele Karpaty, Vrbovce, Bučkova jama, U Chlapečkov, 17°26’42” E, 48°49°’04” N, 1998 06 21, IS; **58:** 714290, Biele Karpaty, Vrbovce, Štefanová, Paseky, 17°27’15” E, 48°49°’40” N, 1999 06 17, IS; **59:** 714192, Biele Karpaty, Vrbovce, Kožíkov vrch Mt., 17°28’27” E, 48°45’55” N, 1998 06 23, IS; **60:** 714204, Biele Karpaty, Vrbovce, Chvojnica, U Šiflov, 17°24’09” E, 48°47’54” N, 1998 06 25, IS; **61:** 714326, Biele Karpaty, častkov, Častkovský Havran, Mičovci, 17°22’57” E, 48°45’43” N, 1999 05 28, IS; **62:** 714186, Biele Karpaty, Vrbovce, U Sukupov, parcel 13072, 17°29’30” E, 48°46’48°” N, 1998 06 22, IS; **63:** 714331, Biele Karpaty, Chvojnica, under Kuchavec, 17°21’44” E, 48°47’12” N, 1999 06 02, IS; **64:** 714289, Biele Karpaty, Vrbovce, opposite Medzný mlyn, 17°25’35” E, 48°46’27” N, 1999 06 16, IS; **65:** 714040, Biele Karpaty, Vrbovce, Žalostiná, 17°25’47” E, 48°48°’48°” N, 1998 07 17, KD; **66:** 714280, Biele Karpaty, Vrbovce, Žalostiná, 17°25’48” E, 48°48°’47” N, 1997 07 11, IS; **67:** 714184, Biele Karpaty, Vrbovce, Štefanová, Paseka, 17°27’20” E, 48°49°’37” N, 1998 06 22, IS; **68:** 714295, Biele Karpaty, Lednica, the hill opposite Lednické skalky, 18°12’50” E, 49°06’57” N, 1999 07 09, IS; **69:** 714049, Biele Karpaty, Moravské Lieskové, Šance, 17°44’11” E, 48°52’14” N, 1993 05 25, IS; **70:** 714097, Biele Karpaty, Hrubá strana, in the direction of Moravské Lieskové, 17°43’42” E, 48°50’26” N, 1993 06 24, IS; **71:** 714098, Biele Karpaty, Hrubá strana, in the direction of Moravské Lieskové, 17°43’56” E, 48°50’29” N, 1993 06 24, KD; **72:** 714101, Biele Karpaty, Moravské Lieskové, Komárech lúky, 17°44’22” E, 48°50’40” N, 1993 06 24, IS, KD; **73:** 714100, Biele Karpaty, Hrubá strana, in the direction of Kohútová, 17°44’15” E, 48°50’32” N, 1993 06 24, IS; **74:** 714099, Biele Karpaty, Hrubá strana, in the direction of Kohútová, 17°44’12” E, 48°50’30” N, 1993 06 24, KD; **75:** 714102, Biele Karpaty, Moravské Lieskové, Komárech lúky, 17°44’27” E, 48°50’44” N, 1993 06 24, IS, KD; **76:** 714076, Biele Karpaty, Moravské Lieskové, Šance, parcel 21017, 17°44’22” E, 48°52’25” N, 1993 06 08, IS; **77:** 714110, Biele Karpaty, Predpoloma, Ozefákovec, 17°48’00” E, 48°53’22” N, 1993 08 04, IS, KD; **78:** 714168, Biele Karpaty, Nová Bošáca, Dúbravy, 17°48’44” E, 48°51’58” N, 1998 06 07, IS; **79:** 714055, Biele Karpaty, Moravské Lieskové, Ligasová, 17°45’09” E, 48°51’07” N, 1993 05 26, IS; **80:** 714169, Biele Karpaty, Nová Bošáca, Dúbravy, 17°48’49” E, 48°52’10” N, 1998 06 07, IS; **81:** 714068, Biele Karpaty, Moravské Lieskové, Ligasová, 17°44’40” E, 48°51’12” N, 1993 06 07, IS; **82:** 714095, Biele Karpaty, Podkozince, opposite the house of Pospíšilová, 17°42’28” E, 48°49°’24” N, 1993 06 24, IS, KD; **83:** 714122, Biele Karpaty, Červený Kameň, Brezovská dolina, 18°08’34” E, 49°05’25” N, 1996 07 12, IS, JZ; **84:** 714157, Biele Karpaty, Nová Bošáca, Španie, Blažejová, 17°49’15” E, 48°52’32” N, 1998 06 06, IS; **85:** 714162, Biele Karpaty, Nová Bošáca, Španie, Blažejová, 17°49’14” E, 48°52’32” N, 1998 06 06, KD; **86:** 714258, Biele Karpaty, Krivoklát, Krivoklátske lúky, 18°08’13” E, 49°03’27” N, 19 930 609, KD; **87:** 714067, Biele Karpaty, Moravské Lieskové, Plevovec, 17°44’50” E, 48°51’12” N, 1993 06 07, IS; **88:** 714177, Biele Karpaty, Nová Bošáca, Predpoloma, 17°48’10” E, 48°53’30” N, 1998 06 14, IS; **89:** 714174, Biele Karpaty, Nová Bošáca, Grúň, 17°47’40” E, 48°53’45” N, 1998 06 14, IS; **90:** 714172, Biele Karpaty, Nová Bošáca, Grúň, 17°47’48” E, 48°53’43” N, 1998 06 13, IS; **91:** 714263, Biele Karpaty, Nová Bošáca, Grúň, 17°47’54” E, 48°53’54” N, 1993 05 29, KD; **92:** 714173, Biele Karpaty, Nová Bošáca, Grúň, 17°47’43” E, 48°53’44” N, 1998 06 14, IS; **93:** 714175, Biele Karpaty, Nová Bošáca, Grúň, 17°47’26” E, 48°53’50” N, 1998 06 14, IS; **94:** 714178, Biele Karpaty, Nová Bošáca, Predpoloma, 17°48’12” E, 48°53’31” N, 1998 06 14, IS; **95:** 714120, Biele Karpaty, Červený Kameň Nebrová, 18°07’22” E, 49°07’15” N, 1996 07 12, IS, JZ; **96:** 714118, Biele Karpaty, Červený Kameň Nebrová, 18°07’29” E, 49°07’14” N, 1996 07 10, IS, JZ, MJ; **97:** 714103, Biele Karpaty, Červený Kameň Nebrová, 18°07’18” E, 49°07’09” N, 1993 07 05, IS; **98:** 714259, Biele Karpaty, Moravské Lieskové, Kohútová, 17°43’52” E, 48°51’08” N, 1993 06 11, KD; **99:** 714242, Biele Karpaty, Bošácka dolina, Predpoloma, under Hajdarové, 17°48’35” E, 48°53’14” N, 1998 07 07, IS; **100:** 714240, Biele Karpaty, Bošácka dolina, Predpoloma, parcel 7403, 17°48’38” E, 48°53’20” N, 1998 07 07, IS; **101:** 714035, Biele Karpaty, Moravské Lieskové, Kohútová, 17°43’50” E, 48°51’12” N, 1998 06 23, KD; **102:** 714036, Biele Karpaty, Moravské Lieskové, Kohútová, 17°43’58” E, 48°51’08” N, 1998 06 23, KD; **103:** 714261,

Biele Karpaty, Moravské Lieskové, Kohútová, 17°43’44” E, 48°51’10” N, 1993 06 11, KD; **104:** 714226, Biele Karpaty, Horná Súča, Vlčí vrch Mt., parcel 7812, 17°56’08” E, 48°58’44” N, 1998 07 01, IS; **105:** 714104, Biele Karpaty, Červený Kameň Nebrová, 18°07’30” E, 49°07’17” N, 1993 07 09, IS; **106:** 714163, Biele Karpaty, Nová Bošáca, Španie, Blažejová, 17°48’54” E, 48°52’33” N, 1998 06 06, KD; **107:** 714131, Biele Karpaty, Horná Súča, Vlčí vrch Mt., od Stehlíkov, parcel 9154, 17°54’50” E, 48°59’06” N, 1998 05 23, IS, KD; **108:** 714130, Biele Karpaty, Horná Súča, Vlčí vrch Mt., U Stehlíkov, parcel 9154, 17°54’45” E, 48°59’04” N, 1998 05 23, IS, KD; **109:** 714145, Biele Karpaty, Horná Súča, Závrská, Včelíny, parcel 7071/2, 17°56’50” E, 48°58’02” N, 1998 05 30, KD; **110:** 714114, Biele Karpaty, Nová Bošáca, Valentová, 17°46’17” E, 48°53’00” N, 1993 08 06, IS, MJ; **111:** 714307, Biele Karpaty, Stará Turá, Topolecká, 17°38’35” E, 48°49°’31” N, 1999 07 15, IS; **112:** 714222, Biele Karpaty, Horná Súča, Trnávka, Doliny, parcel 10335, 17°56’39” E, 48°59’55” N, 1998 07 01, IS; **113:** 714210, Biele Karpaty, Vrbovce, Hate, 17°25’11” E, 48°48°’44” N, 1998 06 26, IS; **114:** 714243, Biele Karpaty, Nová Bošáca, Balážová, 17°47’04” E, 48°53’14” N, 1998 07 08, IS; **115:** 714239, Biele Karpaty, Bošácka dolina, parcel 7433, under Hajdarové, 17°48’30” E, 48°53’20” N, 1998 07 07, IS; **116:** 714244, Biele Karpaty, Nová Bošáca, Balážová, 17°47’00” E, 48°53’13” N, 1998 07 08, IS, KD; **117:** 714246, Biele Karpaty, Nová Bošáca, above Valentová, 17°46’19” E, 48°52’53” N, 1998 07 08, IS; **118:** 714245, Biele Karpaty, Nová Bošáca, above Valentová, 17°46’15” E, 48°52’55” N, 1998 07 08, IS; **119:** 714251, Biele Karpaty, Nová Bošáca, Predpoloma, Hajdarové, 17°48’42” E, 48°53’15” N, 1998 07 09, IS; **120:** 714155, Biele Karpaty, Nová Bošáca, Mravcové, 17°45’46” E, 48°54’20” N, 1998 06 06, IS; **121:** 714156, Biele Karpaty, Nová Bošáca, Španie, Blažejová, 17°49’05” E, 48°52’37” N, 1998 06 06, IS, KD; **122:** 714236, Biele Karpaty, Horná Súča, U Čechov, 17°59’11” E, 48°57’16” N, 1998 07 05, IS; **123:** 714235, Biele Karpaty, Horná Súča, U Čechov, 17°59’08” E, 48°57’17” N, 1998 07 04, IS; **124:** 714139, Biele Karpaty, Horná Súča, Vlčí vrch Mt., parcel 8794, horná čas , 17°54’42” E, 48°59’02” N, 1998 05 30, IS; **125:** 714237, Biele Karpaty, Horná Súča, U Čechov, 17°59’17” E, 48°57’12” N, 1998 07 05, IS; **126:** 714288, Biele Karpaty, Vrbovce, Homolovci, 17°25’25” E, 48°47’00” N, 1999 06 15, IS; **127:** 714211, Biele Karpaty, Vrbovce, Hate, U Kubičku, 17°24’35” E, 48°48°’38” N, 1998 06 26, IS; **128:** 714212, Biele Karpaty, Vrbovce, Hate, U Kubičku, 17°24’36” E, 48°48°’42” N, 1998 06 26, IS; **129:** 714256, Biele Karpaty, Vršatecké podhradie, Lysá, 18°08’39” E, 49°04’16” N, 1993 06 08, KD; **130:** 714086, Biele Karpaty, Vršatec, Lysá, 18°08’40” E, 49°04’14” N, 1993 06 22, KD; **131:** 714089, Biele Karpaty, Vršatec, Lysá, 18°08’39” E, 49°04’20” N, 1993 06 22, KD; **132:** 714088, Biele Karpaty, Vršatec, Lysá, 18°08’45” E, 49°04’19” N, 1993 06 22, IS; **133:** 714087, Biele Karpaty, Vršatec, Lysá, 18°08’39” E, 49°04’17” N, 1993 06 22, IS; **134:** 714075, Biele Karpaty, Moravské Lieskové, Šance, parcel 21017, 17°44’20” E, 48°52’22” N, 1993 06 08, IS; **135:** 714073, Biele Karpaty, Moravské Lieskové, Komárech lúky, 17°44’34” E, 48°50’41” N, 1993 06 07, IS; **136:** 714320, Biele Karpaty, Koválovské lúky, 17°21’30” E, 48°47’42” N, 1999 05 26, IS, JH; **137:** 714041, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43’55” E, 48°52’28” N, 1993 05 24, IS, KD; **138:** 612703, Biele Karpaty, Drietoma, U Mrázikov, parcel 2595, 17°57”04” E, 48°55’47” N, 1991 06 21, IS; **139:** 714079, Biele Karpaty, Moravské Lieskové - border, parcel 22249, 17°44’13” E, 48°52’48°” N, 1993 06 08, IS; **140:** 714046, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43’45” E, 48°52’29” N, 1993 05 24, IS, KD; **141:** 714048, Biele Karpaty, Moravské Lieskové, Barinech lúky, 17°43’42” E, 48°52’34” N, 1993 05 25, IS; **142:** 714158, Biele Karpaty, Nová Bošáca, Španie, 17°49’01” E, 48°52’30” N, 1998 06 06, IS; **143:** 714164, Biele Karpaty, Nová Bošáca, Lojková, 17°48’39” E, 48°51’35” N, 1998 06 07, IS; **144:** 714165, Biele Karpaty, Nová Bošáca, Lojková, 17°48’34” E, 48°51’37” N, 1998 06 07, IS; **145:** 714166, Biele Karpaty, Nová Bošáca, Lojková, 17°48’24” E, 48°51’36” N, 1998 06 07, IS; **146:** 714128, Biele Karpaty, Horná Súča, Vlčí vrch Mt., U Stehlíkov, parcel 9014, 17°54’40” E, 48°59’15” N, 1998 05 23, IS, KD; **147:** 714179, Biele Karpaty, Vrbovce, Bučkova jama, under Chlapečkovci, 17°26’45” E, 48°48°’54” N, 1998 06 21, IS; **148:** 714154, Biele Karpaty, Nová Bošáca, Mravcové, 17°45’58” E, 48°54’22” N, 1998 06 06, IS; **149:** 714333, Biele Karpaty, Chvojnica, Salaše, orchard, 17°21’30” E, 48°46’56” N, 1999 06 02, IS; **150:** 714329, Biele Karpaty, Chvojnica, under Kuchavec, 17°21’48” E, 48°47’36” N, 1999 06 02, IS; **151:** 714330, Biele Karpaty, Chvojnica, under Kuchavec, 17°21’44” E, 48°47’47” N, 1999 06 02, IS; **152:** 714181, Biele Karpaty, Vrbovce, Štefanová, U Gajdošov, 17°26’50” E, 48°49°’30” N, 1998 06 22, IS.

Table 3:

1: 714272, Biele Karpaty, Vrbovce, Štefanová, 17°26’53” E, 48°49°’21” N, 1995 06 20, IS, HR; **2:** 714199, Biele Karpaty, Vrbovce, Vápenník, 17°27’51” E, 48°46’03” N, 1998 06 24, IS; **3:** 612713, Biele Karpaty, Drietoma, Brúsne, parcel 1179, 17°55’59” E, 48°55’09” N, 1991 06 30, IS; **4:** 612715, Biele Karpaty, Drietoma, parcel 3186, 17°56’50” E, 48°53’46” N, 1991 07 05, IS; **5:** 714283, Biele Karpaty, Vrbovce, Pecková, U Mravúchov, 17°25’58” E, 48°46’00” N, 1999 06 09, IS; **6:** 714306, Biele Karpaty, Melčice, under Zabudišová, 17°50’27” E, 48°51’22” N, 1999 07 14, IS, KD; **7:** 714187, Biele Karpaty, Vrbovce Na Kúte,

17°28’17” E, 48°46’12” N, 1998 06 23, IS; **8:** 612716, Biele Karpaty, Drietoma, parcel 3179, 3281, 17°56’45” E, 48°53’40” N, 1991 07 05, IS; **9:** 612705, Biele Karpaty, Drietoma, U Mrázikov, parcel 2614, 17°56’58” E, 48°55’47” N, 1991 06 21, IS; **10:** 714313, Biele Karpaty, Lubina, Ličkovci, 17°42’00” E, 48°49°’58” N, 1999 07 16, IS; **11:** 714170, Biele Karpaty Nová Bošáca, Dúbravy, 17°48’30” E, 48°52’10” N, 1998 06 07, IS; **12:** 612712, Biele Karpaty, Drietoma, Brúsne, parcel 1179, 17°55’57” E, 48°55’11” N, 1991 06 30, IS; **13:** 714323, Biele Karpaty, Častkov, Častkovský Havran, 17°22’49” E, 48°45’48°” N, 1999 05 28, IS; **14:** 714082, Biele Karpaty, Moravské Lieskové, Žabčíkovci, 17°44’57” E, 48°52’30” N, 1993 06 08, IS; **15:** 714133, Biele Karpaty, Adamovské Kochanovce, parcel 761, 17°54’18” E, 48°51’35” N, 1998 05 24, IS; **16:** 714294, Biele Karpaty, Lednica Near Lednické skalky, 18°13’02” E, 49°06’50” N, 1999 07 08, IS; **17:** 714123, Biele Karpaty, Pruské, in the direction of Púchov, 18°13’35” E, 49°01’56” N, 1996 07 12, IS, JZ; **18:** 714197, Biele Karpaty, Vrbovce, Vápenník, 17°27’38” E, 48°46’10” N, 1998 06 24, IS; **19:** 714325, Biele Karpaty, Častkov, Častkovský Havran, 17°22’48” E, 48°46’05” N, 1999 05 28, IS; **20:** 714094, Biele Karpaty, Cetuna, in the direction of Hrubá strana, 17°43’44” E, 48°50’00” N, 1993 06 23, IS; **21:** 714328, Biele Karpaty, Chvojnica, under Kuchavec, 17°21’51” E, 48°47’43” N, 1999 06 02, IS; **22:** 612708, Biele Karpaty, Drietoma, parcel 3197, 17°56’34” E, 48°53’41” N, 1991 06 21, IS; **23:** 612700, Biele Karpaty, Drietoma, U Mrázikov parcel 2614, 17°56’56” E, 48°55’49°” N, 1991 06 16, IS; **24:** 612714, Biele Karpaty, Drietoma, Liešna, 17°54’31” E, 48°57’25” N, 1991 06 30, IS; **25:** 714315, Biele Karpaty, Chvojnica, Salaše, 17°21’37” E, 48°46’40” N, 1999 05 15, IS, KD, JS; **26:** 612702, Biele Karpaty, Drietoma, U Mrázikov, parcel 2595, 17°57’01” E, 48°55’45” N, 1991 06 16, IS; **27:** 714189, Biele Karpaty, Vrbovce, Malejov, 17°28’33” E, 48°45’53” N, 1998 06 23, IS; **28:** 714281, Biele Karpaty, Vrbovce, in the direction of Sobotište, Polákovci, 17°26’00” E, 48°45’12” N, 1999 06 08, IS; **29:** 714152, Biele Karpaty, Chocholná, Kamenná, parcel 1774, 17°54’52” E, 48°53’34” N, 1998 05 31, IS; **30:** 714285, Biele Karpaty, Vrbovce, Medzný mlyn, 17°25’50” E, 48°46’11” N, 1999 06 09, IS; **31:** 714220, Biele Karpaty, Horná Súča, under Jurci, 17°58’56” E, 48°59’04” N, 1998 06 30, IS, JS; **32:** 714150, Biele Karpaty, Chocholná, Olšovo, parcel 1773, 17°54’48” E, 48°53’23” N, 1998 05 31, IS; **33:** 714287, Biele Karpaty, Vrbovce, Sokolovci, 17°27’55” E, 48°46’30” N, 1999 06 15, IS; **34:** 714136, Biele Karpaty, Adamovské Kochanovce, Kurínov vrch Mt., 17°53’24” E, 48°52’37” N, 1998 05 24, IS, MP; **35:** 714135, Biele Karpaty, Adamovské Kochanovce, Kurínov vrch Mt., 17°53’23” E, 48°52’36” N, 1998 05 24, IS, MP; **36:** 714332, Biele Karpaty, Chvojnica, in the direction of Salaše, 17°22’01” E, 48°46’40” N, 1999 06 02, IS; **37:** 612718, Biele Karpaty, Drietoma, parcel 3178/1, 17°56’51” E, 48°53’39” N, 1991 07 05, IS; **38:** 714134, Biele Karpaty, Adamovské Kochanovce, Kurínov vrch Mt., 17°53’25” E, 48°52’34” N, 1998 05 24, IS, MP; **39:** 714195, Biele Karpaty, Vrbovce, Pecková, 17°27’28” E, 48°46’08” N, 1998 06 24, IS; **40:** 714314, Biele Karpaty, Lubina, Podkozince, 17°41’35” E, 48°49°’01” N, 1999 07 16, IS.

Table 4:
1: 714301, Biele Karpaty, Červený kameň, 18°10’49” E, 49°05’48°” N, 1999 07 13, IS; **1:** 714107, Biele Karpaty, Červený Kameň, Brezovská dolina, 18°08’38” E, 49°05’28” N, 1993 07 14, IS, JZ, MJ; **3:** 714126, Biele Karpaty, Mikušovce, 18°12’04” E, 49°03’25” N, 1996 07 13, IS, JZ; **4:** 714109, Biele Karpaty, Trenčianske Bohuslavice, Hájnica, 17°52’23” E, 48°48°’11” N, 1993 07 16, IS, JZ, MJ;

Table 5:
1: 612679, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1172, 17°56’00” E, 48°55’14” N, 1990 06 14, IS; **2:** 714096, Biele Karpaty Mts, Hrubá strana, 17°43’58” E, 48°50’12” N, 1993 06 24, IS, KD; **3:** 612678, Biele Karpaty Mts, Drietoma, Liešna, 17°54’47” E, 48°56’48 N, 1990 06 14, IS; **4:** 714051, Biele Karpaty Mts, Moravské Lieskové, Ligasová, 17°44’21 E, 48°51’42” N, 1993 05 25, IS; **5:** 714129, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., U Stehlíkov, 17°54’48“ E, 48°59’24“ N, 1998 05 23, IS, KD; **6:** 612699, Biele Karpaty Mts, Drietoma, U Mrázikov, parcel 2614, 17°56’52“ E, 48°55’47“ N, 1991 06 16, IS; **7:** 714057, Biele Karpaty Mts, Moravské Lieskové, Ligasová, 17°45’02“ E, 48°51’14“ N, 1993 05 26, IS; **8:** 612672, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1040, 17°56’07“ E, 48°55’16“ N, 1990 06 10, IS; **9:** 714194, Biele Karpaty Mts, Vrbovce, Pecková, 17°27’02“ E, 48°45’04“ N, 1998 06 24, IS; **10:** 612667, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1067, 17°56’30“ E, 48°55’13“ N, 1990 06 04, IS; **11:** 714071, Biele Karpaty Mts, Moravské Lieskové, Ligasová, 17°44’34“ E, 48°51’01“ N, 1993 06 07, IS; **12:** 612670, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1067, 17°56’30“ E, 48°55’17“ N, 1990 06 04, IS; **13:** 714196, Biele Karpaty Mts, Vrbovce, Vápenník, 17°27’35“ E, 48°46’07“ N, 1998 06 24, IS; **14:** 612685, Biele Karpaty Mts, Drietoma, parcel 2271, 17°53’52“ E, 48°57’12“ N, 1990 06 20, IS; **15:** 714271, Biele Karpaty Mts, Vrbovce, Štefanová, 17°26’58“ E, 48°49’20“ N, 1995 06 20, IS, HR; **16:** 714312, Biele Karpaty Mts, Lubina, between Cetuna and Podkozince, 17°42’21“ E, 48°50’12“ N, 1999 07 16, IS; **17:** 714308, Biele Karpaty Mts, Stará Turá, Topolecká, 17°38’44“ E, 48°49’08“ N, 1999 07 15, IS; **18:** 714125, Biele Karpaty

Mts, Červený Kameň, 18°11’28“ E, 49°04’59“ N, 19960712, IS, JZ; **19:** 714318, Biele Karpaty Mts, Vrbovce, U Chodurov, 17°26’50“ E, 48°46’50“ N, 1999 05 15, IS, KD, JS; **20:** 714093, Biele Karpaty Mts, Cetuna, 17°43’24“ E, 48°50’05“ N, 1993 06 23, IS; **21:** 612668, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1091, 17°56’24“ E, 48°55’18“ N, 1990 06 04, IS; **22:** 612677, Biele Karpaty Mts, Drietoma, Ostrá hôrka, 17°57’26“ E, 48°54’13“ N, 1990 06 14, IS; **23:** 714078, Biele Karpaty Mts, Moravské Lieskové, Šance, parcel 22679, 17°44’02“ E, 48°52’33“ N, 1993 06 08, IS; **24:** 714092, Biele Karpaty Mts, Cetuna, 17°42’43“ E, 48°50’27“ N, 1993 06 23, IS; **25:** 714297, Biele Karpaty Mts, Lednica, 18°12’10“ E, 49°07’02“ N, 1999 07 09, IS; **26:** 714205, Biele Karpaty Mts, Vrbovce, Chvojnica, 17°24’26“ E, 48°47’48“ N, 1998 06 25, IS; **27:** 612666, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1067, 17°56’31“ E, 48°55’20“ N, 1990 06 04, IS; **28:** 714214, Biele Karpaty Mts, Vrbovce, Chvojnica, 17°24’56“ E, 48°48’16“ N, 1998 06 26, IS; **29:** 714202, Biele Karpaty Mts, Vrbovce, Chvojnica, Jankovka, 17°23’31“ E, 48°46’55“ N, 1998 06 25, IS; **30:** 714296, Biele Karpaty Mts, Lednica, 18°12’23“ E, 49°06’59“ N, 1999 07 09, IS; **31:** 714077, Biele Karpaty Mts, Moravské Lieskové, Šance, parcel 21017, 17°44’27“ E, 48°52’28“ N, 1993 06 08, IS; **32:** 714198, Biele Karpaty Mts, Vrbovce, Vápenník, 17°27’31“ E, 48°46’20“ N, 1998 06 24, IS; **33:** 714083, Biele Karpaty Mts, Krivoklát, Richtárska meadow, parcel 486, 18°08’13“ E, 49°02’45“ N, 1993 06 21, IS, KD; **34:** 714217, Biele Karpaty Mts, Horná Súča, Repáci, 18°00’28“ E, 48°59’49“ N, 1998 06 30, IS, JS; **35:** 714201, Biele Karpaty Mts, Vrbovce, Pláňava, 17°27’50“ E, 48°45’58“ N, 1998 06 24, IS; **36:** 714206, Biele Karpaty Mts, Vrbovce, U Štefkov (near Sukupovci), 17°29’10“ E, 48°46’40“ N, 1998 06 25, IS; **37:** 612680, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1172, 17°55’59“ E, 48°55’12“ N, 1990 06 14, IS; **38:** 714209, Biele Karpaty Mts, Vrbovce, Hate, 17°25’19“ E, 48°48’34“ N, 1998 06 26, IS; **39:** 714167, Biele Karpaty Mts Nová Bošáca, Dúbravy, 17°48’50“ E, 48°51’48“ N, 1998 06 07, IS; **40:** 612701, Biele Karpaty Mts, Drietoma, U Mrázikov, parcel 2614, 17°56’54“ E, 48°55’46“ N, 1991 06 16, IS; **41:** 612673, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1040, 17°56’11“ E, 48°55’15“ N, 1990 06 10, IS; **42:** 714291, Biele Karpaty Mts, Vrbovce, U Chalupov, 17°25’49“ E, 48°49’31“ N, 1999 06 29, IS, KD; **43:** 714132, Biele Karpaty Mts, Adamovské Kochanovce, parcel 761, 17°54’22“ E, 48°51’40“ N, 1998 05 24, IS, MP; **44:** 714225, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., parcel 9418, 17°55’29“ E, 48°59’12“ N, 1998 07 01, IS; **45:** 714319, Biele Karpaty Mts, Koválovské meadows, 17°21’38“ E, 48°48’40“ N, 1999 05 26, IS, JH; **46:** 714304, Biele Karpaty Mts, Melčice, 17°51’26“ E, 48°51’43“ N, 1999 07 14, IS, KD; **47:** 714208, Biele Karpaty Mts, Vrbovce, Hate, orchard under Melicharek, 17°25’32“ E, 48°48’33“ N, 1998 06 26, IS; **48:** 714160, Biele Karpaty Mts, Mikušovce, 18°12’12 E, 49°03’51 N, 1998 06 03, KD; **49:** 714147, Biele Karpaty Mts, Chocholná, Tlstá Mt., parcel 694, 17°53’13“ E, 48°53’16“ N, 1998 05 31, IS, MP; **50:** 714143, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., parcel 8794, 17°54’30“ E, 48°59’00“ N, 1998 05 30, KD; **51:** 714153, Biele Karpaty Mts Nová Bošáca, Mravcové, 17°45’51“ E, 48°54’27“ N, 1998 06 06, IS; **52:** 714159, Biele Karpaty Mts Nová Bošáca, Španie, , 17°49’06“ E, 48°52’28“ N, 1998 06 06, IS, KD; **53:** 714148, Biele Karpaty Mts, Chocholná, Tlstá hora, parcel 1044a, 17°53’16“ E, 48°53’18“ N, 1998 05 31, IS, MP; **54:** 714138, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., parcel 7694, 17°55’37“ E, 48°53’27“ N, 1998 05 30, IS.

Table 6:

1: 714293, Biele Karpaty Mts, Lednica, 18°13’00“ E, 49°06’34“ N, 1999 07 08, IS; **2:** 714282, Biele Karpaty Mts, Vrbovce, Pecková, 17°26’10“ E, 48°45’51“ N, 1999 06 09, IS; **3:** 612674, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1040, 17°56’10“ E, 48°55’14“ N, 1990 06 10, IS; **4:** 612711, Biele Karpaty Mts, Drietoma, Liešna, 17°55’00“ E, 48°57’02“ N, 1991 06 30, IS; **5:** 612675, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1040, 17°56’05“ E, 48°55’13“ N, 1990 06 10, IS; **6:** 714190, Biele Karpaty Mts, Vrbovce, Krslica, 17°28’52“ E, 48°46’04“ N, 1998 06 23, IS; **7:** 714227, Biele Karpaty Mts, Horná Súča, orchard near cemetery, 17°58’59“ E, 48°58’35“ N, 1998 07 01, IS; **8:** 612681, Biele Karpaty Mts, Drietoma, Liešna, parcel 3419, 17°54’56“ E, 48°56’48“ N, 1990 06 14, IS; **9:** 714203, Biele Karpaty Mts, Vrbovce, Chvojnica, Tramka, 17°23’04“ E, 48°47’34“ N, 1998 06 25, IS; **10:** 714188, Biele Karpaty Mts, Vrbovce Na Kúte, 17°28’15“ E, 48°46’10“ N, 19980623, IS; **11:** 714161, Biele Karpaty Mts, Nová Bošáca, Mravcové, 17°45’48“ E, 48°54’27“ N, 1998 06 06, IS, KD; **12:** 714151, Biele Karpaty Mts, Chocholná, Olšovo, parcel 1773, 17°54’58“ E, 48°53’29“ N, 1998 05 31, IS; **13:** 714200, Biele Karpaty Mts, Vrbovce, Vápenník, 17°27’56“ E, 48°46’01“ N, 1998 06 24, IS; **14:** 714284, Biele Karpaty Mts, Vrbovce, Medzný mlyn, 17°25’54“ E, 48°46’07“ N, 1999 06 09, IS; **15:** 714191, Biele Karpaty Mts, Vrbovce, Krslica, parcel 14428, 17°28’58“ E, 48°45’00“ N, 1998 06 23, IS; **16:** 714193, Biele Karpaty Mts, Vrbovce, CHPV Kožíkov vrch Mt., 17°28’28“ E, 48°45’52“ N, 1998 06 23, IS; **17:** 714238, Biele Karpaty Mts, Horná Súča, U Čechov, 17°59’13“ E, 48°57’19“ N, 1998 07 05, IS; **18:** 714299, Biele Karpaty Mts, Lednica, 18°12’09“ E, 49°06’37“ N, 1999 07 12, IS; **19:** 612682, Biele Karpaty Mts, Drietoma, Kňažie hôlky, parcel 3188, 17°56’54“ E, 48°53’47“ N, 1990 06 20, IS; **20:** 612676, Biele Karpaty Mts, Drietoma, Kozí hrebeň, parcel

915, 17°57’31“ E, 48°55’23“ N, 1990 06 10, IS; **21:** 714091, Biele Karpaty Mts, Cetuna, 17°43’00“ E, 48°50’12“ N, 1993 06 23, IS; **22:** 714292, Biele Karpaty Mts, Vrbovce, Omastovci, 17°30’59“ E, 48°47’43“ N, 1999 06 29, IS; **23:** 714127, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., U Stehlíkov, parcel 9014, 17°54’43“ E, 48°59’18“ N, 1998 05 23, IS, KD; **24:** 612717, Biele Karpaty Mts, Drietoma, parcel 3178/1, 17°56’48“ E, 48°53’37“ N, 1991 07 05, IS; **25:** 714115, Biele Karpaty Mts Nová Bošáca, Kameničné, 17°47’32“ E, 48°51’42“ N, 1993 08 06, IS; **26:** 612669, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1091, 17°56’27“ E, 48°55’19“ N, 1990 06 04, IS; **27:** 714316, Biele Karpaty Mts, Chvojnica, Salaše, 17°21’34“ E, 48°46’45“ N, 1999 05 15, IS, KD, JS; **28:** 714327, Biele Karpaty Mts, Chvojnický Havran, 17°23’10“ E, 48°46’22“ N, 1999 05 28, IS; **29:** 612709, Biele Karpaty Mts, Drietoma, parcel 3197, 17°56’36“ E, 48°53’42“ N, 1991 06 30, IS; **30:** 714105, Biele Karpaty Mts, Lednica, 18°12’35“ E, 49°06’44“ N, 1993 07 13, IS, JZ; **31:** 714302, Biele Karpaty Mts, Červený kameň, 18°11’31“ E, 49°05’58“ N, 1999 07 13, IS; **32:** 714106, Biele Karpaty Mts, Lednica, 18°12’30“ E, 49°06’40“ N, 1993 07 13, IS, JZ; **33:** 714213, Biele Karpaty Mts, Vrbovce, Hate, U Bakošu, 17°24’29“ E, 48°48’27“ N, 1998 06 26, IS; **34:** 714085, Biele Karpaty Mts, Krivoklát, Chrastková, 18°07’42“ E, 49°02’57“ N, 1993 06 21, IS, KD; **35:** 714324, Biele Karpaty Mts, Častkov, Častkovský Havran, 17°22’40“ E, 48°45’54“ N, 1999 05 28, IS; **36:** 714137, Biele Karpaty Mts, Chocholná, Tlstá hora Mt., 17°54’10“ E, 48°53’38“ N, 1998 05 24, IS; **37:** 714309, Biele Karpaty Mts, Stará Turá, Topolecká, 17°38’48“ E, 48°49’01“ N, 1999 07 15, IS; **38:** 714207, Biele Karpaty Mts, Vrbovce, Kožíkov vrch Mt., parcel 15155, 17°28’16“ E, 48°46’06“ N, 1998 06 25, IS.

Table 7:
1: 714141, Biele Karpaty Mts, Horná Súča, Závrská, Včelíny, 17°56’05“ E, 48°58’08“ N, 19980530, IS; **2:** 714229, Biele Karpaty Mts, Horná Súča, Horná Závrská, 17°56’44“ E, 48°58’35“ N, 1998 07 03, IS; **3:** 714146, Biele Karpaty Mts, Horná Súča, Závrská, Včelíny, parcel 7615/12, 17°56’52“ E, 48°58’12“ N, 1998 05 30, KD; **4:** 714233, Biele Karpaty Mts, Horná Súča, Hutínovci, parcel 6320, 17°56’40“ E, 48°57’39“ N, 1998 07 04, IS; **5:** 714255, Biele Karpaty Mts, Nová Bošáca, Lopeníček, 17°47’33“ E, 48°53’04“ N, 1998 07 10, IS; **6:** 714303, Biele Karpaty Mts, Melčice, 17°51’20“ E, 48°51’56“ N, 1999 07 14, IS, KD; **7:** 714034, Biele Karpaty Mts, Borotová, 17°38’45“ E, 48°49’52“ N, 1998 06 23, KD; **8:** 714276, Biele Karpaty Mts, Vrbovce, Štefanová, 17°26’45“ E, 48°49’44“ N, 1997 07 10, IS; **9:** 612707, Biele Karpaty Mts, Drietoma, Brúsne, 17°55’54“ E, 48°55’15“ N, 1991 06 21, IS; **10:** 714056, Biele Karpaty Mts, Moravské Lieskové, Ligasová, 17°45’04“ E, 48°51’17“ N, 1993 05 26, IS; **11:** 714144, Biele Karpaty Mts, Horná Súča, Závrská, Včelíny, parcel 7071/2, 17°56’51“ E, 48°58’00“ N, 1998 05 30, IS, KD; **12:** 612706, Biele Karpaty Mts, Drietoma, Pod Techonovicou, parcel 1005, 17°56’40“ E, 48°54’58“ N, 1991 06 21, IS; **13:** 714033, Biele Karpaty Mts, Borotová, 17°38’42“ E, 48°49’50“ N, 1998 06 23, KD; **14:** 612704, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1172, 17°55’55“ E, 48°55’12“ N, 1991 06 21, IS; **15:** 714252, Biele Karpaty Mts Nová Bošáca, Predpoloma, Dzurákovec, parcel 7368/1, 17°48’52“ E, 48°53’47“ N, 1998 07 09, IS; **16:** 714470, Biele Karpaty Mts, Drietoma, parcel 2204/1, 17°53’43“ E, 48°56’53“ N, 1991 06 30, IS; **17:** 612683, Biele Karpaty Mts, Drietoma, Hranica, parcel 2271, 17°53’51“ E, 48°57’10“ N, 1990 06 20, IS; **18:** 714113, Biele Karpaty Mts Nová Bošáca, Valentová, 17°46’19“ E, 48°53’04“ N, 1993 08 05, IS, MJ; **19:** 612671, Biele Karpaty Mts, Drietoma, Brúsne, parcel 1067, 17°56’31“ E, 48°55’15“ N, 1990 06 10, IS; **20:** 612710, Biele Karpaty Mts, Drietoma, Liešne, 17°54’56“ E, 48°56’58“ N, 1991 06 30, IS; **21:** 714142, Biele Karpaty Mts, Horná Súča, Vlčí vrch Mt., 17°55’35“ E, 48°58’24“ N, 1998 05 30, KD; **22:** 714221, Biele Karpaty Mts, Horná Súča, Macharáci, 17°59’23“ E, 48°59’32“ N, 1998 06 30, IS, JS.

Table 8:
1: 714108, Biele Karpaty Mts, Vršatec, Biely vrch Mt., 18°08’00“ E, 49°04’34“ N, 1993 07 14, IS, JZ; **2:** 612693, Biele Karpaty Mts, Drietoma, Hranica, parcel 2204/1, 17°53’43“ E, 48°56’54“ N, 1991 06 08, IS; **3:** 612692, Biele Karpaty Mts, Drietoma, Hranica, parcel 2204/1, 17°53’41“ E, 48°56’55“ N, 1991 06 08, IS; **4:** 714084, Biele Karpaty Mts, Krivoklát, parcel 484, 18°08’03“ E, 49°03’00“ N, 1993 06 21, IS, KD; **5:** 612694, Biele Karpaty Mts, Drietoma, Hranica, parcel 2204/1, 17°53’40“ E, 48°56’55“ N, 1991 06 08, IS; **6:** 612691, Biele Karpaty Mts, Drietoma, Hranica, lúky na moravskej strane doliny, 17°53’17“ E, 48°56’45“ N, 1991 06 08, IS; **7:** 612698, Biele Karpaty Mts, Drietoma, Liešna, 17°54’36“ E, 48°57’07“ N, 1991 06 16, IS; **8:** 612686, Biele Karpaty Mts, Drietoma, Hranica, parcel 2271, 17°53’50“ E, 48°57’13“ N, 1990 06 20, IS; **9:** 612690, Biele Karpaty Mts, Drietoma, Hranica, 17°53’22“ E, 48°56’47“ N, 1990 06 28, IS; **10:** 612696, Biele Karpaty Mts, Drietoma, Hranica, parcel 2203/1, 17°53’38“ E, 48°56’53“ N, 1991 06 08, IS; **11:** 714218, Biele Karpaty Mts, Horná Súča, Repáci, 18°00’15“ E, 48°59’29“ N, 1998 06 30, IS; **12:** 612695, Biele Karpaty Mts, Drietoma, Hranica, 17°53’22“ E, 48°56’46“ N, 1991 06 08, IS; **13:** 612697, Biele Karpaty Mts, Drietoma, Brúsne, 17°55’57“ E, 48°55’16“ N, 1991 06 16, IS; **14:** 714223, Biele Kar-

paty Mts, Horná Súča, Trnávka, 17°56'40" E, 48°59'36" N, 1998 07 01, IS; **15:** 714234, Biele Karpaty Mts, Horná Súča, Seriška, 17°56'36" E, 48°57'47" N, 1998 07 04, IS; **16:** 714219, Biele Karpaty Mts, Horná Súča, Kučerákovci, parcel 14675, 17°59'02" E, 48°59'02" N, 1998 06 30, IS; **17:** 714232, Biele Karpaty Mts, Horná Súča, parcel 6961, 17°57'33" E, 48°58'24" N, 1998 07 03, IS; **18:** 714230, Biele Karpaty Mts, Horná Súča, Horná Závrská, parcel 7615/2, 17°56'37" E, 48°58'19" N, 1998 07 03, IS; **19:** 714116, Biele Karpaty Mts Nová Bošáca, Kameničné, 17°47'33" E, 48°51'25" N, 1993 08 06, IS; **20:** 714310, Biele Karpaty Mts, Stará Turá, Topolecká, 17°38'55" E, 48°49'06" N, 1999 07 15, IS; **21:** 714224, Biele Karpaty Mts, Horná Súča, Trnávka, parcel 10032, 17°56'48" E, 48°59'29" N, 1998 07 01, IS; **22:** 714140, Biele Karpaty Mts, Horná Súča, Závrská, Včelíny, parcel 7071/2, 17°56'58" E, 48°58'04" N, 1998 05 30, IS; **23:** 714121, Biele Karpaty Mts, Červený Kameň Nebrová, 18°07'30" E, 49°07'22" N, 1996 07 12, IS, JZ; **24:** 612687, Biele Karpaty Mts, Drietoma, Hranica, 17°53'29" E, 48°56'48" N, 1990 06 28, IS; **25:** 714311, Biele Karpaty Mts, Stará Turá, Topolecká, 17°39'05" E, 48°48'27" N, 1999 07 15, IS; **26:** 612688, Biele Karpaty Mts, Drietoma, Hranica, 17°53'46" E, 48°56'56" N, 1990 06 28, IS; **27:** 612689, Biele Karpaty Mts, Drietoma, Hranica, 17°53'25" E, 48°56'47" N, 1990 06 28, IS; **28:** 714149, Biele Karpaty Mts, Chocholná, Tlstá hora, parcel 1044d, 17°53'05" E, 48°53'20" N, 1998 05 31, IS, MP; **29:** 612684, Biele Karpaty Mts, Drietoma, Hranica, 17°53'32" E, 48°56'50" N, 1990 06 20, IS; **30:** 714298, Biele Karpaty Mts, Lednica, 18°11'51" E, 49°06'57" N, 1999 07 09, IS; **31:** 714231, Biele Karpaty Mts, Horná Súča, Včelíny, 17°57'11" E, 48°58'12" N, 1998 07 03, IS; **32:** 714228, Biele Karpaty Mts, Horná Súča, Horná Závrská, parcel 7615, 17°56'51" E, 48°58'30" N, 1998 07 03, IS.

References

Braun-Blanquet, J. (1964): Pflanzensoziologie. Grundzüge der Vegetationskunde. 3rd ed. – Springer, Wien, New York: 865 pp.

Bruelheide, H. & Jandt, U. (2007): The relationship between dry grassland vegetation and microclimate along a west-east gradient in Central Germany. – Hercynia N. F. 40: 153–176. Halle (Saale).

Chytrý, M. (1994): Xerothermic oak forests in the middle Váh basin and the southern part of the Strážovská hornatina upland, Slovakia. – Scr. Fac. Sci. Nat. Univ. Masaryk. Brun. 22–23: 121–134. Brno.

– (2007): Delimitation and interpretation of vegetation units. – In: Chytrý, M. (Ed.): Vegetation of the Czech Republic. 1. Grassland and Heathland Vegetation: 19–52. Academia, Praha.

–, Tichý, L., Holt, J. & Botta-Dukát, Z. (2002): Determination of diagnostic species with statistical fidelity measures. – J. Veg. Sci. 13: 79–90. Uppsala.

Cousins, S. A. O. & Eriksson, O. (2002): The influence of management history and habitat on plant species richness in a rural hemi-boreal landscape, Sweden. – Landsc. Ecol. 17: 517–529. Dordrecht.

Dúbravková-Michálková, D., Janišová, M., Kolbek, J., Šuvada, R., Virók, V. & Zaliberová, M. (2008): Dry grasslands in the Slovenský Kras Mts. (Slovakia) and the Aggteleki-Karsz. Mts. (Hungary) – A Comparison of two classification spproaches. – Hacquetia 7: 123–140. Ljubljana.

Ejrnæs, R. & Bruun, H. H. (2000): Gradient analysis of dry grassland vegetation in Denmark. – J. Veg. Sci. 11: 573–584. Uppsala.

Ellenberg, H., Weber, H. E., Düll, R., Wirth, V., Werner, W. & Paulißen, D. (1992): Zeigerwerte von Pflanzen in Mitteleuropa. – Scr. Geobot. 18: 1-258. Göttingen.

Fajmonová, E. (1972): Príspevok k fytocenológii vápencových bučín stredného Považia (*Carici albae-(Abieti-) Fagetum* Klika (1936) 1949) (The contribution to the vegetation of beech forests in the middle part of the Váh basin). – Biológia 1: 31–42. Bratislava.

Futák, J. (1984). Fytogeografické členenie Slovenska (Phytogeographic regions of Slovakia). – In: Bertová, L. (Ed.): Flóra Slovenska. IV/1 (Flora of Slovakia IV/1): 418–419. Veda, Bratislava.

Futák, P., Šimša, M., Piro, Z., Jongepierová, I. (2008): Historie obhospodařování (History of farming). – In: Jongepierová, I. (Ed.): Louky Bílých Karpat (Grasslands of the White Carpathian Mountains): 38–45. ZO ČSOP Bílé Karpaty, Veselí nad Moravou.

GRASS Development Team (2010): Geographic Resources Analysis Support System (GRASS) Software, Version 6.4.0. – Open Source Geospatial Foundation. URL: http://grass.osgeo.org.

Hájková, P., Roleček, J., Hájek, M., Horsák, M., Fajmon, K., Polák, M. & Jamrichová, E. (2011): Prehistoric origin of extremely species-rich semi-dry grasslands in the Bílé Karpaty Mts. – Preslia 83: 185–204. Praha.

Hennekens, S. M. & Schaminée, J. H. J. (2001): TURBOVEG, a comprehensive data base management system for vegetation data. – J. Veg. Sci. 12: 589–591. Uppsala.

HERBEN, T. & MÜNZBERGOVÁ, Z. (2003): Zpracování geobotanických dat v příkladech. I. Data o druhovém složení. (Analysis of geobotany data in examples. I. Species composition data). – Praha: 118 pp.

HOLUBY, J .L. (1888): Flora des Trencsiner Comitates. – František Xaver Skarnitzl, Trencsin: 146 pp.

JANIŠOVÁ, M. (2007) (Ed.): Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxónov (Grassland vegetation of Slovakia – electronic expert system for identification of syntaxa). – Botanický ústav SAV, Bratislava: 263 pp.

–, UHLIAROVÁ, E. & RUŽIČKOVÁ H. (2010): Expert system based classification of semi-natural grasslands in submontane and montane regions of central Slovakia. – Tuexenia 30: 375–422. Göttingen.

JANŠÁK, Š. (1967): O kopaničiarskom osídlení na Slovensku. (Study on "kopanice" settlement in Slovakia). –Vlastiv. Čas. 25: 18–24. Bratislava.

JONGEPIEROVÁ, I. (Ed.) 2008: Louky Bílých Karpat (Grasslands of the White Carpathian Mountains). – ZO ČSOP Bílé Karpaty, Veselí nad Moravou: 461 pp.

– & GRULICH, V. (1992): Prehľad typov vegetácie (Overwief of the vegetation types). – In: KUČA, P., MÁJSKY, J., KOPEČEK, F. & JONGEPIEROVÁ, I. (Eds.): Bílé-Biele Karpaty (White Carpathian Mts.). Ekológia: 83–99. Bratislava.

–, JONGEPIER, J.W. & KLIMEŠ, L. (1994): Obnova druhově bohatých luk v Bílých Karpatech (Restoration of species-rich meadows in the Bílé Karpaty Mountains). – Příroda 1: 185–189. Praha.

KLIMEŠ, L. (1997): Druhové bohatství luk v Bílých Karpatech (Species richness of meadows in Bílé Karpaty Mts.). – Sborn. Přír. Kl. 2: 31–42. Uherské Hradiště.

–, JONGEPIEROVÁ, I. & JONGEPIER, J. W. (2000). The effect of mowing on a previously abandoned meadow: a ten-year experiment. – Příroda 17: 7–24. Praha.

KONČEK, M. (1980). Klimatické oblasti (Climatic regions). – In: MAZÚR, E. et al. (Eds.): Atlas SSR: 64. Veda, Bratislava.

KUBÍKOVÁ, J. & KUČERA, T. (1999): Diverzita vegetace Bílých Karpat na příkladu Předních luk a okolí (Diversity of vegetation in Bílé Karpaty Mts. – example from the locality Přední louky and its surroundings). – Sborn. Přír. Kl. 4: 19–58. Uherské Hradiště.

KUNDRATA, M. & KOĽAJOVÁ, S. (1992): Pôdy (Soils). – In: KUČA, P., MÁJSKY, J., KOPEČEK, F. & JONGEPIEROVÁ, I. (Eds): Bílé-Biele Karpaty (White Carpathian Mts.). Ekológia: 68–69. Bratislava.

LAPIN, M., FAŠKO, P., MELO, M., ŠASTNÝ, P. & TOMLAIN, J. (2002): Klimatické oblasti (Climatic regions). – In: MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC (Ed.): Atlas krajiny Slovenskej republiky (Landscape Atlas of the Slovak Republic): 94. Slovak Agency of Environment, Banská Bystrica.

MAGLOCKÝ, Š. (2002): Potenciálna prirodzená vegetácia (Potential Natural Vegetation). – In: MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC (Ed.): Atlas krajiny Slovenskej republiky (Landscape Atlas of the Slovak Republic): 114. Slovak Agency of Environment, Banská Bystrica.

MARHOLD, K. & HINDÁK, F. (1998) (Eds.): Zoznam nižších a vyšších rastlín Slovenska (Checklist of Non-Vascular and Vascular Plants of Slovakia). – Veda, Bratislava: 688 pp.

MCCUNE B. & MEFFORD M. J. (1999): PC-ORD. Multivariate analysis of ecological data. Version 4. – MjM Software Design, Gleneden Beach: 237 pp.

MINÁR, J. (2009): Geografické polia a priestorová organizácia krajiny (pokus o vyjasňovanie základných konceptov) (Geographical field, landscape structure, tensor calculus, geographical theory, geographical synthesis). – Geogr. Čas. 61: 179–198. Bratislava.

MLÁDEK, J., PAVL , V., HEJCMAN, M. & GAISLER, J. (2006): Pastva jako prostředek údržby trvalých travních porost v chráněných územích (Pasture as the tool of maintenance of grasslands in protected areas). – Výzkumný ústav rostlinné výroby, Praha: 104 pp.

MUCINA, L. & MAGLOCKÝ, Š. (1985): A list of vegetation units of Slovakia. – Doc. Phytosociol. 9: 175–220. Camerino.

NEVOLE, J. (1947): Studie o lučních porostech Bílých Karpat (Study on meadow communities in Bílé Karpaty Mts.). – Sb. Klubu Přírodověd. Brně 28: 45–53. Brno.

PALMER, M. W. (1993). Putting things in even better order – the advantages of canonical correspondence-analysis. – Ecology 74: 2215–2230. Tempe.

PÄRTEL, M., ZOBEL, K. & VAN DER MAAREL, E. (1996): The species pool and its relation to species richness: evidence from Estonian plant communities. – Oikos 75: 111–117. Copenhagen.

PECHANEC, V. & JONGEPIEROVÁ, I. (2008): Popis území (Area description). – In: JONGEPIEROVÁ, I. (Ed.): Louky Bílých Karpat (Grasslands of the White Carpathian Mountains): 15–23. ZO ČSOP Bílé Karpaty, Veselí nad Moravou.

Perný, M. (1999): Vegetácia Chocholanskej, Melčickej a Kochanovskej doliny v Bielych Karpatoch (Vegetation of Chocholanská, Melčická a Kochanovská valley in Biele Karpaty Mts. – In: Škodová, I. (Ed.): Flóra a vegetácia Bielych Karpát. Zborník výsledkov z projektu MVTS 2000–2001 – Diverzita xerotermnej vegetácie pozd ž panónsko-karpatskej fytogeografickej hranice a z diplomových prác riešených na území Bielych Karpát. – Bull. Slov. Bot. Spoločn., Suppl. 29: 103–142. Bratislava.

Podpěra, J. (1948): Jak se rozvíjel floristický výzkum Bílých Karpat (Development of research of flora in Bílé Karpaty Mts.). – Pr. Morav.-Slez. Akad. Věd Přír. 19(7): 1–26. Brno.

– (1951): Rozbor květného komponentu Bílých Karpat (Analysis of floristic component of Bílé Karpaty Mts.). – Spisy Přírod. Fak. Masaryk. Univ., Ser. L5, 325: 1–62. Brno.

Pohoriljaková, I. (1992): Floristické a fytocenologické zhodnotenie lúčnych porastov v Drietomskej doline v Bielych Karpatoch (Floristic and phytosociological evaluation of grasslands in Drietoma valley in Biele Karpaty Mts.). – Thesis, Prírodovedecká fakulta UK, Bratislava: 84 pp.

Pozdišovský, Š. (1976): Bielokarpatské kopanice v Trenčianskom okrese (White Carpathian settlements in the district of Trenčín). – Západné Slovensko 3, Vlastivedný zborník múzeí západoslovenského kraja: 124–137. Obzor, Bratislava.

Rochel, A. (1821): Naturhistoriche Miscellen über den nordwestlichen Karpathen in Ober-Ungarn. – Pesth: 135 pp.

Ružičková, H. (1997): Sadové lúky myjavsko-bielokarpatských kopaníc a ich význam pre ochranu prírody na Slovensku (Orchard meadows of Biele Karpaty Mts. and their importance in nature protection in Slovakia). – Ochr. Prír. 15: 83–94. Banská Bystrica,

Senko, D., Mišković, J., Gallay, M. & Senková Baldaufová, K. (2008). Dynamika zmien vegetácie na Devínskej Kobyle a jej predikcia (Dynamics of vegetation changes and its prediction on the Devínska Kobyla Mt.). – Geogr. Čas. 60: 319–338. Bratislava.

Scharmer, K. & Greif, J. (2000) (Eds): The European solar radiation atlas. Vol. 2. Database and exploitation software. – Presses des Mines, Paris: 290 pp.

Sillinger, P. (1929): Bílé Karpaty. Nástin geobotanických poměr se zvláštním zřetelem ke společenstv m rostlinným. (White Carpathians Mts. Study of geobotanical conditions with special regard to plant communities). – Rozpr. Král. České Společn. Nauk, Tř. Mat.-Přír., Praha, 8(3): 1–73.

Šály, R. & Šurina, B. (2002): Soils. – In: Ministry of Environment of the Slovak Republic (Ed.): The Landscape Atlas of the Slovak Republic, 1:500 000: 344. Banská Bystrica: Slovak Environmental Agency.

Škodová, I. (2007): *Brachypodio pinnati-Molinietum arundinaceae* Klika 1939. – In: Janišová, M. (Ed.): Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxónov (Grassland vegetation of Slovakia – electronic expert system for identification of syntaxa): 73–75. Botanický ústav SAV, Bratislava.

–, Hájek, M., Chytrý M., Jongepierová, I. & Knollová, I. (2008): Vegetace (Vegetation). – In: Jongepierová, I. (Ed.): Louky Bílých Karpat (Grasslands of the White Carpathian Mountains). ZO ČSOP Bílé Karpaty, Veselí nad Moravou: 128-177.

Stráník, Z. & Janečková, H (1992): Geologická stavba a hydrogeologické pomery (Geology and hydrogeology conditions). – In: Kuča, P., Májsky, J., Kopeček, F. & Jongepierová, I. (Eds): Bílé-Biele Karpaty (White Carpathian Mts.). Ekológia, Bratislava: 14-23.

Šuňalová, K. (2007): Flóra a vegetácia lokalít Babiná a Krivoklátske lúky v Bielych Karpatoch (Flora and vegetation of localities Babiná and Krivoklátske meadows in Biele Karpaty Mts.). – In: Škodová, I. (Ed.): Flóra a vegetácia Bielych Karpát. Zborník výsledkov z projektu MVTS 2000–2001 – Diverzita xerotermnej vegetácie pozd ž panónsko-karpatskej fytogeografickej hranice a z diplomových prác riešených na území Bielych Karpát. – Bull. Slov. Bot. Spoločn., Suppl. 29: 71–101. Bratislava.

ter Braak, C. J. F. & Prentice, I. C. (1988): A theory of gradient analysis. – Adv. Ecol. Res. 18: 271–317. New York.

– & Šmilauer, P. (2002): CANOCO reference manual and CanoDraw for Windows user's guide: software for canonical community ordination (version 4.5). – Microcomputer Power, Ithaca, NY: 500 pp.

– & Verdonschot, P. F. M. (1995): Canonical correspondence analysis and related multivariate methods in aquatic ecology. – Aquat. Sci. 57: 153–187. Basel.

Tichý, L., (2002): JUICE, software for vegetation classification. – J. Veg. Sci. 13: 451–453. Uppsala.

– (2005): New similarity indices for the assignment of relevés to the vegetation units of an existing phytosociological classification. – Plant Ecol. 179: 67–72. Dordrecht.

– & Holt, J. (2006): JUICE program for management, analysis and classification of ecological data. Program manual. – Brno: 98 pp. URL: http://www.sci.muni.cz/botany/juice/jc06_man.htm.
Tlusták, V. (1972): Xerotermní travinná společenstva lesostepního obvodu Bílých Karpat (Thermophilous grassland vegetation of Bílé Karpaty Mts.). – Thesis, Přírodovědecká fakulta MU, Brno: 237 pp.
– (1975): Syntaxonomický přehled travinných společenstev Bílých Karpat (Syntaxonomical review of grassland communities of Bílé Karpaty Mts.). – Preslia 47: 129–144. Praha.
Uhliarová, E., Janišová & Ujházy, K., M (2007): *Arrhenatherion elatioris* Luquet 1926. – In: Janišová, M. (Ed.): Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxónov (Grassland vegetation of Slovakia – electronic expert system for identification of syntaxa): 91–109. Botanický ústav SAV, Bratislava.
Ujházy, K. (2007): *Violion caninae* Swickerath 1944. – In: Janišová, M. (Ed.): Travinnobylinná vegetácia Slovenska – elektronický expertný systém na identifikáciu syntaxónov (Grassland vegetation of Slovakia – electronic expert system for identification of syntaxa): 223–230. Botanický ústav SAV, Bratislava.
Wellstein, C., Otte, A. & Waldhart, R. (2007): Impact of site and management on the diversity of central European mesic grassland. – Agric. Ecosyst. Environ. 122: 203–210. Amsterdam.
Westhoff, V. & van der Maarel, E. (1973). The Braun-Blanquet approach. – In: Whittaker, R. H. (Ed.): Ordination and classification of communities: 617–726. Junk, The Hague.

Iveta Škodová and Dušan Senko
Institute of Botany, Slovak Academy of Sciences
Dúbravská cesta 9
845 23 Bratislava, SLOVAKIA
iveta.skodova@savba.sk, dusan.senko@savba.sk

Katarína Devánová
The Museum of Trenčín
Mierové námestie 46
912 50 Trenčín, SLOVAKIA
k.devanova@gmail.com

Co-ordinating editor: Wolfgang Willner
Manuscript received: 21.11.2010; accepted: 18.02.2011