Festuco-Brometea vegetation in Central Ukraine (figure above left) with the detail of stand with Salvia nutans (above right), Stipa pulcherrima on the terrace slope of a small river (Molinio-Arrhenatheretea grassland in background, down left) and Galietalia veri grassland in the Psjol River floodplain (Central Ukraine, down right). All photos: S. Rūsiņa.

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Transylvania

EDGG cooperation on syntaxonomy and biodiversity of *Festuco-Brometea* communities in Transylvania (Romania): report and preliminary results

Introduction

In the Transylvanian Lowland (Romania), extensive dry grasslands still exist that are outstanding in diversity and conservation status compared to European standards. However, this treasure is not well documented so far. Despite a variety of local phytosociological studies by Romanian colleagues (see Sanda et al. 2008), three major issues have hardly been addressed before: (i) arrangement of the vegetation types within a consistent national or supranational classification based on modern methodological approaches; (ii) consideration of the bryophytes and lichens in these dry grassland stands; (iii) description and analysis of the scale-dependent diversity patterns in these communities.

In a Romanian-British-German-Turkish-Bulgarian cooperation within the EDGG, we aimed at collecting and analysing baseline data for all three aspects mentioned. The idea for the present cooperation had

Fig. 1: Location of the study area (rectangle) in the north-central part of Romania.

emerged from a presentation of Eszter Ruprecht at the 5th Dry Grassland Meeting 2008 in Kiel, which then was published in the Special Feature of the conference (Ruprecht et al. 2009). Originally, the study was planned by Jürgen Dengler, Eszter Ruprecht, and Anna Szabó. Later, also Emin Uğurlu (Turkey) joined the team for the 10 days of field work in the region of Cluj. Dan Turtureanu, Monica Beldean and Andrew Jones became involved through ADEPT, a British-Romanian NGO, active in Southern Transylvania. Hristo Pedashenko (Bulgaria) helped with the data preparation and Christian Dolnik (Germany) is responsible for the determination of most of the non-vascular plants.

Study area

The Transylvanian Lowland in central Romania is a hilly region, about 300–700 m a.s.l. (Fig. 1). The substrates are mostly marly and the climate is subcontinental, with an annual precipitation of 520–650 mm.

Sampling methods

We sampled the whole range of *Festuco-Brometea* communities occurring in different places (many of them within Natura 2000 sites) in the Transylvanian Lowland, mainly in the counties of Cluj and Mureş (see Fig. 1). We applied two sampling designs, nested-plot sampling with plot sizes ranging from 1 cm² to 100 m² (Dengler 2009; n = 20) and phytosociological relevés with a standardised plot size of 10 m² (see Dengler et al. 2009; approximately n = 70). In both cases, we sampled vascular plants as well as terricolous bryophytes, lichens, and macroscopic cyanobacteria, recorded major environmental data (altitude, aspect, inclination, microrelief, land use, structural data), and measured fundamental soil parameters.

Composition and classification

The studied communities were mostly dominated by grasses, such as *Stipa capillata*, *S. lessingiana*, *S. pulcherrima*, *S. tirsa*, *Bothriochloa ischaemum*, *Brachypodium pinnatum*, *Briza media*, *Bromus erectus*, *Festuca rupicola*, *F. pallens*, *Helictotrichon decorum*, *Sesleria heuflerana*, as well as *Carex humilis* and *C. tomentosa*. The stands were also rich in perennial forbs, with genera such as *Campanula*, *Centaurea*, *Euphorbia*, *Inula*, *Iris*, *Linum*, *Potentilla*, *Salvia*, *Trifolium* and *Veronica* represented by particularly many taxa. By contrast, therophytes, succulents as well as bryophytes and lichens were much less represented than in other European dry grasslands.

The classification of the 70 10-m² relevés that are presently available with modified TWINSPAN (see Roleček et al. 2009) resulted in three major clusters (Table 1). These correspond well to established phytosociological orders. They reflect different ecological situations: *Stipo pulcherrimae-Festucetalia pallentis* Pop 1968: rocky grasslands; *Festucetalia valesiacae* Br.-Bl. & Tx. ex Br.-Bl. 1950: xerophytic grasslands on soft substrates; *Brachypodietalia pinnati* Korneck 1974 (= *Brometalia erecti* W. Koch 1926 nom. amb. propos.): meso-xerophytic grasslands.

Table 1: Phytosociological table of the studied communities. S-F: Stipo pulcherrimae-Festucetalia pallentis, Fv: Festucetalia valesiacae, Bp: Brachypodietalia pinnati.

	All	S-F	Fv	Bp
Number of relevés	70	7	32	31
Mean altitude [m a.s.l.]	480	606	467	465
Mean inclination [°]	25	32	33	15
Mean heat index	0.34	0.48	0.61	0.02
Mean microrelief [cm]	8	17	9	4
Mean total vegetation cover [%]	77	61	67	92
Mean cover herb layer [%]	74	50	65	89
Mean cover moss layer [%]	10	24	1	15
Mean cover litter [%]	22	24	23	21
Mean cover stones and rocks [%]	3	32	0	0
Mean cover open soil [%]	14	6	24	5
Mean species richness (all plants)	**51.4**	**42.0**	**40.0**	**65.3**
Mean species richness (vascular plants)	49.1	37.9	38.6	62.5
Mean species richness (non-vascular plants)	2.2	4.1	1.3	2.8
Joint diagnostic species of the two xerophytic orders (O1 and O2)				
Stipa capillata	43	71	72	6
Vinca herbacea	39	71	63	6
Stipa pulcherrima	43	71	69	10
Artemisia campestris ssp. campestris	21	43	38	.
Dichantium ischaemum	60	86	75	39
Cleistogenes serotina ssp. serotina	23	29	44	.
O1. *Stipo pulcherrimae-Festucetalia pallentis Pop 1968*				
Helianthemum nummularium ssp. obscurum	14	100	3	6
Allium flavum ssp. flavum	11	86	6	.
Linaria angustissima	7	71	.	.
Minuartia verna	7	71	.	.
Sedum hispanicum	7	71	.	.
Acinos arvensis	16	86	6	10
Cf. Tortella sp.	9	71	3	.
Genista januensis	9	71	3	.
Poa badensis	6	57	.	.
Syntrichia ruralis agg.	6	57	.	.
Melica ciliata ssp. ciliata	14	71	13	3
Anthericum ramosum	19	71	6	19
Carduus candicans ssp. candicans	4	43	.	.
Centaurea atropurpurea ssp. atropurpurea	4	43	.	.
Helictotrichon decorum	4	43	.	.
Sempervivum marmoreum	4	43	.	.
Allium albidum ssp. albidum	13	57	16	.
Medicago minima	6	43	3	.
Verbascum lychnitis	6	43	3	.
Amaranthus retroflexus	6	43	.	3

O2. *Festucetalia valesiacae Br.-Bl. & Tx. ex Br.-Bl. 1950*				
Cephalaria uralensis	30	.	63	3
Stipa lessingiana ssp. lessingiana	21	.	47	.
Tragopogon dubius	20	.	44	.
Galium glaucum	44	14	75	19
Aster linosyris	20	.	41	3
Inula ensifolia	36	29	66	6
Astragalus monspessulanus ssp. monspessulanus	26	.	44	13
Veronica spicata ssp. orchidea	50	43	78	23
Prunus tenella	33	43	63	.
Euphorbia seguierana ssp. seguierana	10	.	22	.
O3. *Brachypodietalia pinnati Korneck 1974*				
Lotus corniculatus	37	.	.	84
Brachypodium pinnatum ssp. pinnatum	43	.	6	90
Ranunculus polyanthemos agg.	34	.	.	77
Leontodon hispidus	33	.	.	74
Trifolium montanum	31	.	.	71
Plantago lanceolata	43	.	13	84
Dactylis glomerata ssp. glomerata	30	.	.	68
Homalothecium lutescens	40	.	13	77
Carex michelii	36	14	.	77
Briza media	27	.	.	61
Knautia arvensis	27	.	.	61
Linum catharticum	26	.	.	58
Filipendula vulgaris	50	.	28	84
Plantago media	66	.	50	97
Achillea millefolium agg.	64	29	38	100
Scabiosa ochroleuca	36	14	6	71
Leucanthemum vulgare	21	.	.	48
Carex tomentosa	27	.	6	55
Centaurea jacea agg.	27	.	6	55
Festuca pratensis	20	.	.	45
Companions (mostly widespread *Festuco-Brometea species)*				
Asperula cynanchica	84	100	75	90
Festuca ser. Valesiacae	81	71	66	100
Teucrium chamaedrys	79	57	84	77
Thymus pannonicus agg.	77	86	84	68
Euphorbia cyparissias	76	86	91	58
Elymus hispidus	74	57	72	81
Koeleria macrantha	73	29	72	84
Stachys recta	64	86	75	48
Medicago sativa ssp. falcata	63	86	53	68
Potentilla cinerea agg.	57	71	75	35
Carex humilis	56	43	78	35
Convovulus arvensis	53	.	59	58
Salvia pratensis agg.	50	14	41	68

Diversity

We found very high species richness values at all spatial scales, compared to dry grassland types in most other European regions (Table 2; compare Dengler 2005). They are similar to values previously recorded from semi-dry grasslands in the White Carpathians (compare Klimeš et al. 2001) or from alvar grasslands in the hemiboreal zone (e.g. Dengler & Boch 2008, Löbel & Dengler 2008). In Transylvania, the highest richness values occurred in meso-xeric hay meadows (*Brachypodietalia pinnati*). It appears that our maximum values at 0.1 m² (45 species, including 43 vascular plants) and at 10 m² (102/99 species) are possibly the highest ever recorded in any plant community worldwide.

The heat index (a composite measure of aspect and inclination, see Olsson et al. 2009) was the strongest (negative) predictor of species richness at the 10-m² scale (Fig. 2), with the soil parameters not being available so far. In a multiple regression, additionally litter cover had significant negative effects, while microrelief and altitude had slight and insignificant positive effects.

Table 2: Species richness at different spatial scales.

		Richness (all plants)		
Area [m²]	***n***	**Min**	**Max**	**Mean**
0.0001	40	0	5	2.6
0.001	40	0	9	4.6
0.01	40	3	20	10.2
0.1	40	8	45	22.7
1	40	18	82	40.0
10	70	9	102	52.3
100	20	58	131	87.9

Conclusions

We conclude that studying Transylvanian dry grasslands in more detail would be a high priority in order to understand the causes underlying the described biodiversity patterns and to place the community types encountered within a consistent, continent-wide classification scheme. At the same time, these communities represent an outstanding and highly valuable part of Europe's natural heritage that needs stronger conservation efforts, particularly as many of the stands are threatened by land use changes.

Outlook

These first, preliminary results have been presented at the 6th European Dry Grassland Meeting in Halle, only one month after the field work. Presently, we are adding some further relevés, determining the bryophytes and lichens as well as some critical vascular plants, analysing the soil samples, and continuing the statistical analyses. In total, we plan three publications in international journals based on the data sampled, one on phytosociology, one on diversity patterns and finally a contribution to a comprehensive study on species-area relationships in dry grasslands throughout Europe.

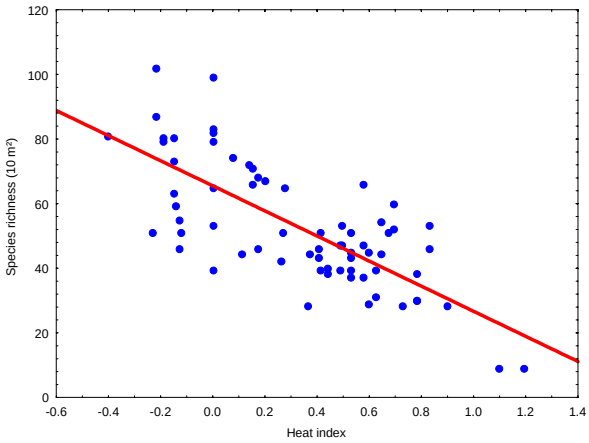

Table 2: Relation between species richness and head load.

Based on the stimulating experience of this cooperation, we are now planning several similar or consecutive international EDGG projects in SE Europe. (1) In 2010, we intend to carry out such a joint field work (with similar questions and sampling designs) in central Podolia (Ukraine), organised by Anna Kuzemko in collaboration with Solvita Rusina and Jürgen Dengler. (2) We plan to establish a comprehensive vegetation database of dry grassland relevés from SE Europe (i.e. Romania, Bulgaria, Ukraine, Moldova, and perhaps Hungary, ex-Yugoslavia, and Albania). More information on these planned projects will be provided under „Miscellaneous" in one of the next Bulletin issues.

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In many Transylvanian landscapes there are dry grasslands to the horizon. Photo: J. Dengler.

Order Stipo pulcherrimae-Festucetalia pallentis. Photo: J. Dengler.

Anna Szabó, Eszter Ruprecht, and Emin Uğurlu during the field work. Photo: J. Dengler.

Inula ensifolia. Photo: J. Dengler.

Slumping hill, a typical feature of the Transylvanian landscape. Photo: J. Dengler.

A plot of our nested biodiversity sampling according to Dengler (2009). Photo: J. Dengler.