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New vegetation data of dry grasslands in the Western Carpathians and the northern Pannonian Basin

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Abstract

The paper presents new vegetation data from dry grassland sites in the biogeographical regions of the Western Carpathians and the northern Pannonian Basin, mainly belonging to the alliances *Bromo pannonici-Festucion pallentis* and *Festucion valesiacae* (*Festuco-Brometea*). The 124 phytosociological relevés were sampled between 2005 and 2009 in Slovakia, the SE Czech Republic, NE Austria, and N Hungary. They are classified into 16 associations and four transitional vegetation types. The paper also brings new information on the distribution of grassland associations in the study area. A new locality of the rare association *Teucrio botryos-Andropogonetum ischaemi* was confirmed. During our recent investigation of historical sites of the *Alopecuro pratensis-Festucetum pseudovinae* (*Cynosurion cristati*, *Molinio-Arrhenatheretea*) in the Slaná river floodplain, only one occurrence could be confirmed. Geographical principles in distribution of dry grassland associations and classification of the *Stipa pulcherrima*-dominated stands are also discussed.

Zusammenfassung: Neue Vegetationsdaten von Trockenrasen aus den Westkarpaten und aus dem nördlichen Pannonischen Becken

Der Beitrag präsentiert neue Vegetationsdaten von Trockenrasen der Naturräume Westkarpaten und nördliches Pannonisches Becken, die überwiegend zu den Verbänden *Bromo pannonici-Festucion pallentis* und *Festucion valesiacae* (*Festuco-Brometea*) gehören. Die 124 Vegetationsaufnahmen wurden zwischen 2005 und 2009 in der Slowakei, in Südost-Tschechien, Nordost-Österreich und Nord-Ungarn angefertigt. Sie werden 17 verschiedenen Assoziationen und vier Übergangsstadien zugeordnet. Ferner enthält die Publikation neue Angaben zur Verbreitung der Trockenrasenassoziationen im Untersuchungsgebiet. Wir publizieren einen neuen Standort der seltenen Assoziation *Teucrio botryos-Andropogonetum ischaemi*, während von den historischen Standorten des *Alopecuro pratensis-Festucetum pseudovinae* (*Cynosurion cristati*, *Molinio-Arrhenatheretea*) nur ein einziger bestätigt werden konnte. Schließlich werden geografische Muster in der Verbreitung von Trockenrasenassoziationen sowie die Klassifikation der von *Stipa pulcherrima* dominierten Bestände diskutiert.

Keywords: Austria, *Bromo pannonici-Festucion pallentis*, *Festucion valesiacae*, *Festuco-Brometea*, *Cynosurion cristati*, Czech Republic, Hungary, *Molinio-Arrhenatheretea*, phytosociological relevé, Slovakia, syntaxonomy.

Abbreviations: Art. – Article, AT – Austria, CZ – Czech Republic, E_2 – shrub layer, E_1 – herb layer, E_0 – layer of bryophytes and lichens, FPFI – Frequency-Positive Fidelity Index, ICPN – International Code of Phytosociological Nomenclature (Weber et al. 2000), HU – Hungary, ÖK – site code in "Österreichischer Trockenrasen-Katalog" (Holzner 1986), rel. – relevé, SK – Slovakia

1. Introduction

Pannonian dry grassland vegetation on shallow soils over calcareous bedrock (*Bromo pannonici-Festucion pallentis* Zólyomi 1966) and narrow-leaved continental dry grasslands on calcareous or acidic soils (*Festucion valesiacae* Klika 1931, *Koelerio-Phleion phleoidis* Korneck 1974) belong to the priority habitats of the Habitats Directive and the most endangered vegetation types in central Europe (European Commission 2007, Molnár et al. 2008). However, the management of these types of xerophilous vegetation underwent some dramatic changes in the last decades. Among these, the cessation of traditional low-intensity grazing has had particularly adverse effects. Alteration in management of dry grasslands resulted in changes of species composition or abundance of some species at the sites. There are some very good records of the species composition of dry grassland vegetation in the

Western Carpathians and the northern Pannonian Basin in older literature sources (e.g. SILLINGER 1930, KLIKA 1931, DOMIN 1932, BOJKO 1934, FUTÁK 1947, ZÓLYOMI 1958, MÉSZÁROS-DRASKOVITS 1967, EJSINK et al. 1978). There are also some more recent papers that publish relevés from individual regions (e.g. DOBOLYI et al. 1991, CSIKY 2003, WILLNER et al. 2004, MICHÁLKOVÁ et al. 2006, DÚBRAVKOVÁ-MICHÁLKOVÁ et al. 2008). However, there is still a lack of new vegetation data documenting the current species composition of many dry grassland sites.

The present paper aims to present new vegetation data that have not been published yet. Besides relevés from dry grassland sites protected by nature conservation, it also includes data recorded in non-protected areas. Here, the dry grassland vegetation might have been sampled and/or published for the first time, so these relevés represent unique vegetation data. We recorded the current species composition of dry grassland communities including bryophytes and lichens and assigned the relevés to phytosociological associations. Most of these relevés were used in the large-scale synthesis of dry grassland vegetation of the *Festucion valesiacae* and *Bromo pannonici-Festucion pallentis* (DÚBRAVKOVÁ et al. 2010). Thus, we attempted to classify the presented relevés in accordance with that recent synthesis.

2. Material and methods

2.1. Study area and vegetation data

The paper presents phytosociological relevés recorded in a large geographical region including Slovakia, the south-eastern Czech Republic (southern Moravia), north-eastern Austria (federal states of Burgenland, Lower Austria and Vienna), and northern Hungary. The study area includes the biogeographical region of the Western Carpathians and adjacent lowland and hilly landscapes of the northern Pannonian Basin (Fig. 1). Here, the dry grassland vegetation is mostly restricted to smaller extrazonal stands, although is shows some attributes similar to the zonal steppes in central Eurasia (WALTER 1974).

The 124 relevés presented were sampled in 2005–2009 according to the standard Braun-Blanquet approach (Zürich-Montpellier school, BRAUN-BLANQUET 1964, WESTHOFF & VAN DER MAAREL 1973, DENGLER et al. 2008). For sampling, we selected sites homogenous in species composition and environmental conditions. The relevé plot size was 16–25 m^2 in most relevés. We used a smaller plot size in three relevés (Table 1, rel. 26, 65, and 84), when the vegetation type sampled covered less than 16 m^2. At the sites, we also documented the cover of litter layer (which may indicate abandonment of the sites) and cover of rocks not covered by vegetation.

We stored all the relevés in a TURBOVEG database (HENNEKENS & SCHAMINÉE 2001). For cover values of species in all relevés, we used the extended nine-degree Braun-Blanquet scale (VAN DER MAAREL 1979). Vegetation data were processed using JUICE 6.5 software (TICHÝ 2002).

For matching of relevés to existing clusters created by numerical analysis published in DÚBRAVKOVÁ et al. (2010), we excluded taxa determined only on the level of genus as well as all species of lichens and bryophytes. We also merged some difficult species or subspecies, which were not determined in all relevés, as it was done in DÚBRAVKOVÁ et al. (2010: Appendix 1). However, for the presentation of our data, we included taxa determined on the level of genus, as well as lichens and bryophytes, and we merged only the following species into aggregates: *Cerastium pumilum* agg. (incl. *C. glutinosum*), *Dorycnium pentaphyllum* agg. (incl. *D. herbaceum*) and *Galium mollugo* agg. (incl. *G. album*), *Lotus corniculatus* agg. (incl. *L. borbasii*), *Poa pratensis* agg. (incl. *P. angustifolia*). Nomenclature of vascular plants and lichens is in accordance with MARHOLD & HINDÁK (1998). For taxa not listed in this handbook, nomenclature is according to other handbooks on national flora (SIMON 2000, FISCHER et al. 2005). Nomenclature of bryophytes follows KUBINSKÁ & JANOVICOVÁ (1996).

2.2. Syntaxonomical assignment of relevés

For assignment of relevés to syntaxonomical associations, we used the clusters revealed in the syntaxonomical study published by DÚBRAVKOVÁ et al. (2010). The major part of relevés presented in the current paper (83) was directly included in the data set used in that study. The rest of the relevés (41) were excluded from that data set due to the geographical stratification performed prior to the classification analysis. The assignment of relevés included in the data set of the former study follows the results of that synthesis. The relevés that were not included in the data set used in DÚBRAVKOVÁ et al. (2010) were compared to the clusters found in that study using the Frequency-Positive Fidelity Index (FPFI;

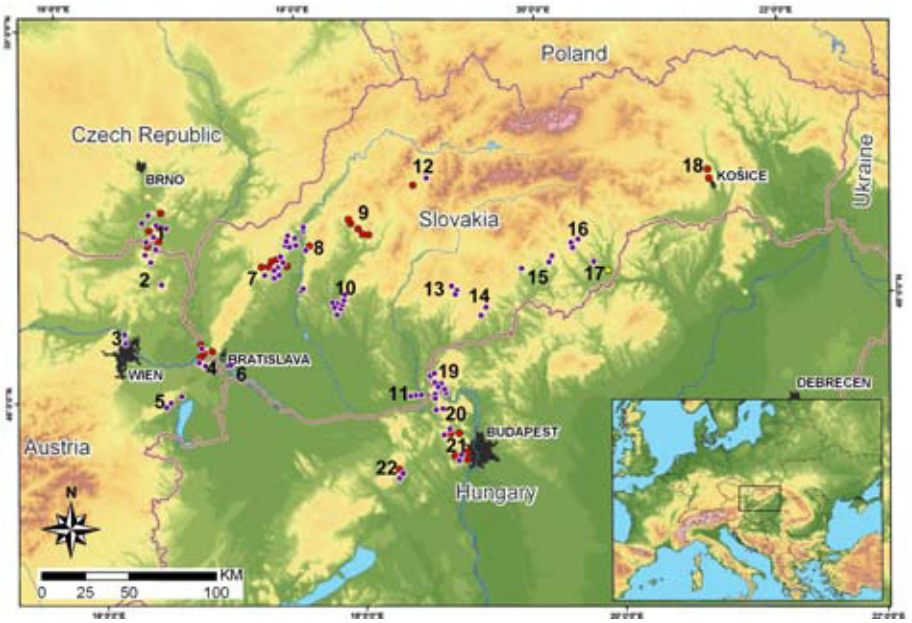

Fig. 1: Distribution of the analysed plots in the study area. Red circles indicate relevés of the *Bromo-pannonici-Festucion pallentis*, violet circles of the *Festucion valesiacae*, and the yellow circle the single relevé of the *Cynosurion cristati*. The numbers denote the geographic units in which the relevés were sampled. They are arranged in west-east and north-south directions. Czech Republic: Pavlovské vrchy Mts. (1); Austria: Weinviertel (2), Bisamberg (3), Hainburger Berge (4), Leitha-Gebirge (5); Slovakia: Podunajská rovina lowland (6), Malé Karpaty Mts. (7), Považský Inovec Mts. (8), Strážovské vrchy Mts. (9), Tríbeč Mts. – Zoborské vrchy Mts. (10), Hronská pahorkatina hills – Belianské kopce (11), Turčianska kotlina basin (12), Štiavnické vrchy Mts. (13), Krupinská planina hills (14), Lučenecká kotlina basin (15), Revúcka vrchovina hills – Drienčanský kras (16), Rimavská kotlina basin (17), Čierna hora Mts. (18); Hungary: Börzsöny Mts. (19), Visegrági-hegység Mts and Pilis Mts. (20), Budai-hegysek Mts. (21), Vértes Mts. (22).

Abb. 1: Räumliche Verteilung der Aufnahmen im Untersuchungsgebiet. Rote Kreise stehen für das *Bromo-pannonici-Festucion pallentis*, violette Kreise für das *Festucion valesiacae* und der gelbe Kreis für die einzige Aufnahme des *Cynosurion cristati*. Die Nummern bezeichnen die Herkunftsregionen und sind in der englischen Legende erklärt.

Tichý 2005), which expresses the similarity of species composition of a relevé and a cluster. The highest index values do not always mean that the relevé should undoubtedly be assigned to the cluster at the first position, but a decision has to be made among several proposed clusters with the highest similarity indices regarding the information about their environmental and chorological conditions (Janišová 2007a). For this reason, we looked at the three highest values of the FPFI and assigned the relevés to the clusters according our field experience, taking into consideration the species composition, environmental conditions, and geographical location of each relevé. Since the large-scale survey of Dúbravková et al. (2010) does not characterise the individual associations, but merely rankless vegetation types, some of which include more than one association, we classified relevés to particular associations or transitional vegetation types according to our expertise.

The assignment of diagnostic values to species in Table 1 (in the Supplement) follows Borhidi (2003), Chytrý et al. (2007), Janišová (2007a), and Dúbravková et al. (2010). The character species of associations are only of local validity. The assignment of species to higher vegetation units (alliances, classes) in Table 1 follows Janišová (2007a) and Chytrý et al. (2007). If some species are characteristic of more than one syntaxon, we assigned them to one of them and label the species name with the abbreviation of the other higher syntaxa. Table 2 lists the syntaxa names used in this paper with full author citations.

Table 2: Syntaxonomical assignment of relevés to associations and transitional vegetation types. Formal applications for the listed *nomina proposita* will be submitted to the Committee on Nomina Conservanda (CNC) of the Nomenclature Commission by the first author in the near future, according to the regulations of the ICPN (WEBER et al. 2000).

Tab. 2: Syntaxonomische Zuordnung der Aufnahmen zu Assoziationen und Übergangsbeständen. Formelle Anträge auf die genannten nomina proposita beim Committee on Nomina Conservanda (CNC) der Nomenklaturkommission gemäß den Regeln des ICPN (WEBER et al. 2000) sind seitens der Erstautorin in Arbeit.

Association/ transitional stage No.	Relevé No.	Syntaxonomical affiliation	Cluster No. (DÚBRAVKOVÁ et al. 2010)
		***Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947**	
		***Bromo pannonici-Festucion pallentis* Zólyomi 1966**	
1	1–3	*Poo badensis-Caricetum humilis* (Dostál 1933) Soó ex Michálková in Janišová et al. 2007	3
2	4	*Orthantho luteae-Caricetum humilis* Kliment et Bernátová 2000	4
3	5–10	*Seselio leucospermi-Festucetum pallentis* Zólyomi 1936 corr. 1966 nom. invers. propos.	5
4	11–25	*Festuco pallentis-Caricetum humilis* Sillinger 1930 corr. Gutermann et Mucina 1993	6
5	26–31	*Poo badensis-Festucetum pallentis* Klika 1931 corr. Zólyomi 1966 nom. invers. propos.	6
		***Festucion valesiacae* Klika 1931**	
6	32	*Teucrio botryos-Andropogonetum ischaemi* Sauberer et Wagner in Sauberer 1942	7
7	33–37	*Inulo oculi-christi-Festucetum pseudodalmaticae* Májovský et Jurko 1956	8
8	38–40	*Festucetum pseudodalmaticae* Mikyška 1933	9
9	41–42	*Alysso heterophylli-Festucetum valesiacae* (Dostál 1933) Kliment in Kliment et al. 2000	11
10	43–102	*Festuco valesiacae-Stipetum capillatae* Sillinger 1930	12, 13
11	103	*Astragalo exscapi-Crambetum tatariae* Klika 1939 nom. invers. propos.	14
12	104	*Avenastro besseri-Stipetum joannis* Klika 1951 corr. Kolbek in Moravec et al. 1983	14
13	105–111	Dry grasslands on acidophilous and base-poor volcanic bedrock – transitions between *Festucion valesiacae* and *Koelerio-Phleion phleoidis* Korneck 1974	16
14	112	*Koelerio macranthae-Stipetum joannis* Kolbek 1978	14
15	113	*Stipetum tirsae* Meusel 1938	21
16	114–115	Successionally advanced stands of the *Festuco valesiacae-Stipetum capillatae*	22
17	116–118	Early stages of succession from *Festucion valesiacae* towards *Cirsio-Brachypodion pinnati* Hadač et Klika ex Klika 1951 (*Polygalo majoris-Brachypodietum pinnati* Wagner 1941)	23
18	119–120	Transitions from the *Festucion valesiacae* grasslands to the *Bromion erecti* Koch 1926 (*Brachypodio pinnati-Molinietum arundinaceae* Klika 1939) and other types of broad-leaved meadow steppes	24
19	121–123	*Festuco rupicolae-Caricetum humilis* Klika 1939	25
		***Molinio-Arrhenatheretea* Tx. 1937**	
		***Cynosurion cristati* Tx. 1947 nom. cons. propos.**	
–	A (sect. 3.3)	*Alopecuro pratensis-Festucetum pseudovinae* Juhász-Nagy 1957	18

3. Results

The relevés from Table 1 (in the Supplement) were assigned to five associations of the alliance *Bromo pannonici-Festucion pallentis* and 10 associations and four transitional stages within the alliance *Festucion valesiacae* (Table 2). Regarding the high number of associations distinguished in this paper, we only present a brief description of each (distinctive features and distribution). The detailed characteristics of the associations including the diagnostic species are available in the national surveys of the grassland vegetation in the study region (MUCINA & KOLBEK 1993, BORHIDI 2003, CHYTRÝ et al. 2007, JANIŠOVÁ 2007a) and partly also in DÚBRAVKOVÁ et al. (2010).

3.1. Description of associations of the *Bromo pannonici-Festucion pallentis*

The ***Poo badensis-Caricetum humilis*** (Table 1, rel. 1–3) represents open dry grasslands. It occurs on shallow soils in rocky fields in karst regions of the Slovak-Hungarian border area and in adjacent regions of the northeastern border of the Pannonian Basin. The stands are dominated by *Carex humilis*. Other caespitose grasses (*Botriochloa ischaemum*, *Festuca valesiaca*) occur in places with slightly deeper soil.

Submontane grasslands with *Carex humilis* and *Bromus monocladus* (***Orthantho luteae-Caricetum humilis***, Table 1, rel. 4) represent the most mesic grassland type within the *Bromo pannonici-Festucion pallentis*. This community occurs on limestone in the inner-Carpathian basins of northwest and central Slovakia.

The ***Seselio leucospermi-Festucetum pallentis*** (Table 1, rel. 5–10) comprises rocky grasslands on dolomite in the Hungarian Transdanubian Mountain Range. They contain endemic (*Seseli leucospermum*) and sub-endemic taxa (*Dianthus plumarius* subsp. *regis-stephani*) of the Pannonian region and several sub-mediterranean species (e.g. *Chrysopogon gryllus*, *Fumana procumbens*, *Paronychia cephalotes*, and *Stipa eriocaulis*).

The ***Festuco pallentis-Caricetum humilis*** (Table 1, rel. 11–25) includes calcareous rocky grasslands with *Carex humilis* at the western periphery of the Western Carpathians. The occurrence of chamaephytes (e.g. *Fumana procumbens*, *Rhodax canus*, *Thymus praecox*), hemicryphophytic forbs (e.g. *Leontodon incanus*, *Scorzonera austriaca*), and ephemeral annuals is characteristic. It also includes the sub-endemic *Dianthus praecox* subsp. *lumnitzeri* and the rare xerophilous moss *Pleurochaete squarrosa*.

The ***Poo badensis-Festucetum pallentis*** (Table 1, rel. 26–31) occurs in similar geographical regions as the previous association. It forms species-poor, open stands. It grows on steep scree slopes with limestone and dolomite bedrock. The dominating grass species is *Festuca pallens*, while chamaephytes, succulents, therophytes, and mosses are constantly present as well.

3.2. Description of associations and transitional vegetation types of the *Festucion valesiacae*

The ***Teucrio botryos-Andropogonetum ischaemi*** (Table 1, rel. 32) includes open grasslands on alluvial soils along large water bodies. Its species composition comprises species typical of sandy soils (e.g. *Arenaria serpyllifolia*, *Bothriochloa ischaemum*, *Petrorhagia saxifraga*, *Poa bulbosa*) and vernal ephemeral annuals.

The ***Inulo oculi-christi-Festucetum pseudodalmaticae*** (Table 1, rel. 33–37) represents semi-closed grasslands on sun-exposed slopes on volcanic bedrock in warm areas of the Inner Western Carpathians. It is dominated by *Festuca pseudodalmatica* and hosts thermophilous species and species of sub-mediterranean distribution (e.g. *Cleistogenes serotina*, *Cruciata pedemontana*, *Melica transsilvanica*).

The ***Festucetum pseudodalmaticae*** (Table 1, rel. 38–40) includes *Festuca pseudodalmatica*-dominated open rocky grasslands on volcanic bedrock with abundance of succulents, lichens, and mosses. It is a species-poorer and less thermophilous community than the *Inulo oculi-christi-Festucetum pseudodalmaticae*.

The ***Alysso heterophylli-Festucetum valesiacae*** (Table 1, rel. 41–42) includes steppe grasslands dominated by *Festuca valesiaca* or *F. pseudodalmatica*. It usually occurs in karst regions located at the north-eastern periphery of the Pannonian Basin. Accordingly, some particular species of this area are present in the stands (e.g. *Achillea nobilis*, *Silene donetzica*).

The ***Festuco valesiacae-Stipetum capillatae*** (Table 1, rel. 43–102) is the most frequent association of the *Festucion valesiacae* alliance. It is dominated by *Festuca valesiaca*, *F. rupicola*, or *Stipa capillata*. The association includes many common generalist species of central European dry grasslands (e.g. *Asperula cynanchica*, *Eryngium campestre*, *Koeleria macrantha*, *Sanguisorba minor*, *Teucrium chamaedrys*, and *Tithymalus cyparissias*), but only very few specialists of narrower amplitude. Most of the stands are abandoned at present, as shown by the presence of the competitive grasses *Arrhenatherum elatius* and *Bromus erectus* in many relevés.

The ***Astragalo exscapi-Crambetum tatariae*** (Table 1, rel. 103) includes dry grasslands on deep soils over loess or sands in southern Moravia (CZ). A typical feature is the presence of competitively weak continental steppe species (e.g. *Crambe tataria*, *Oxytropis pilosa*).

A rare relict continental grass, *Helictotrichon desertorum* subsp. *basalticum*, occurs in the Šibeničník Nature Reserve in the Pavlovské vrchy Mts. (Table 1, rel. 104, Fig. 2). We classify this relevé as ***Avenastro besseri-Stipetum joannis*** within the *Festucion valesiacae*. The relevé includes species of sub-xerophilous character (e.g. *Festuca rupicola*, *Filipendula vulgaris*, *Plantago media* and *Salvia pratensis*), although there are also species of the *Bromo pannonici-Festucion pallentis* (e.g. *Anthericum ramosum*, *Carex humilis*, *Globularia punctata*, *Scorzonera austriaca*, and *Thymus praecox*). The stand shows some relationship to the *Festuco pallentis-Caricetum humilis* (cf. KOLBEK & BOUBLÍK 2006), which also occurs in this locality. Similar stands with *Helictotrichon desertorum* subsp. *basalticum* in the Hainburger Berge Mts. (AT) were studied by GAUCKLER (1969).

Dry grasslands on acidic (quartzite) and base-poor volcanic bedrock (Table 1, rel. 105–111) represent transitions between the *Festucion valesiacae* and the *Koelerio-Phleion*

Fig. 2: *Astragalo exscapi-Crambetum tatariae* (Table 1, rel. 101). Pavlovské vrchy Mts., Šibeničník Nature Reserve (Photo: D. Dúbravková, 11.06.2006).

Abb. 2: *Astragalo exscapi-Crambetum tatariae* (Tab. 1, Aufn. 101). Pavlovské vrchy Mts., Naturschutzgebiet Šibeničník (Foto: D. Dúbravková, 11.06.2006).

phleoidis, which is reflected in the presence of dry grassland species along with some low pH tolerant herbs (e.g. *Acetosella vulgaris*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Potentilla argentea*, *Steris viscaria*, and *Trifolium arvense*). In spite of some attempts (e.g. MICHÁLKOVÁ 2007: 38), the classification and nomenclature of such stands has not been sufficiently solved yet.

Relevé 112 (Table 1) was sampled in a well-known site in southern Moravia, the Pouzdřany steppe. It is dominated by *Stipa pulcherrima* and includes some species of Pannonian and sub-continental distribution (*Astragalus exscapus*, *Jurinea mollis*). We classified this relevé as ***Koelerio macranthae-Stipetum joannis***.

Relevé 113 (Table 1, Fig. 3) represents a closed grassland dominated by the rare grass *Stipa tirsa*. Besides widespread species of central European dry grasslands, the ***Stipetum tirsae*** also contains continental and sub-mediterranean species (*Chamaecytisus austriacus*, *Scorzonera hispanica*) as well as species of meadow steppes (e.g. *Filipendula vulgaris*, *Salvia pratensis*, *Securigera varia*, and *Plantago media*).

Table 1 includes three transitional vegetation types (No. 16, 17, and 18, rel. 114–120) that represent proceeding phases of succession from xerophilous grassland of the *Festucion valesiacae* to sub-xerophilous meadow steppes (*Cirsio-Brachypodion pinnati*, *Bromion erecti*).

We suppose that relevés 114–115 (Table 1) are successionally advanced stands of the *Festuco valesiacae-Stipetum capillatae*. The presence of species of dry grasslands resembles the floristic composition of the *Festuco valesiacae-Stipetum capillatae*, however the dominants are changed (*Carex humilis* and *Festuca rupicola* in great measure). The xerophilous character of the stands are less extreme compared to typically developed stands, which is indicated by the higher cover of *Avenula pubescens* and presence of fringe species of the *Geranion sanguinei* Tx. in Müller 1962 (e.g. *Geranium sanguineum*, *Vincetoxicum hirundinaria* etc.).

Early stages of succession from the *Festucion valesiacae* towards the *Cirsio-Brachypodion pinnati* are documented by the relevés 116–118 (Table 1, Fig. 4). Relevés 116 and 117 are dominated by *Stipa pulcherrima* and most probably represent successionally shifted stands

Fig. 3: *Stipetum tirsae* (Table 1, rel. 112). Börzsöny Mts., Ruzsás-hegy Mt. (Photo: D. Dúbravková, 26.05.2006).

Abb. 3: *Stipetum tirsae* (Tab. 1, Aufn. 112). Börzsöny Mts., Ruzsás-hegy Mt. (Foto: D. Dúbravková, 26.05.2006).

Fig. 4: Dry grassland dominated by *Stipa pulcherrima* (Table 1, rel. 116). Malé Karpaty Mts., Pod Holým vrchom Nature Reserve. In the background, there are scree slopes with stands of the *Poo badensis-Festucetum pallentis* (Table 1, rel. 19 and 30) (Photo: D. Dúbravková, 23.6.2006).

Abb. 4: Von *Stipa pulcherrima* dominierter Trockenrasen (Tabelle 1, Aufn. 116). Malé Karpaty Mts., Naturschutzgebiet Pod Holým vrchom. Im Hintergrund erkennt man Schutthalden mit Beständen des *Poo badensis-Festucetum pallentis* (Tab. 1, Aufn. 19 and 30) (Foto: D. Dúbravková, 23.6.2006).

of the *Koelerio macranthae-Stipetum joannis*. *Inula ensifolia* took over a stand at the Bissamberg near Vienna (rel. 118). Besides widespread species of the *Festucion valesiacae*, these relevés contain many species of forest fringes (e.g. *Geranium sanguineum*, *Inula ensifolia*, and *Peucedanum cervaria*) and meadow steppes (e.g. *Bromus erectus*, *Polygala major*). A common feature is the relatively high cover of *Peucedanum cervaria* and the presence of *Geranium sanguineum.* This indicates cessation of management activities due to which the sites became more mesic (ŠKODOVÁ 2007).

Brachypodium pinnatum and *Bromus erectus* together with *Festuca rupicola* dominate the abandoned pastures documented by relevés 119–120 (Table 1). They represent the most advanced phase of succession towards the broad-leaved meadow steppe, and they contain many species of dry grassland habitats in combination with species typical for sub-xeric meadows.

The ***Festuco rupicolae-Caricetum humilis*** is the least xerophilous association of the *Festucion valesiacae*. Relevés 121–123 (Table 1) represent closed grasslands with *Festuca rupicola*, generalists of dry grasslands, and some common sub-xerophilous and mesophilous species.

3.3. *Alopecuro pratensis-Festucetum pseudovinae*

Additionally, we present a new relevé of the association *Alopecuro pratensis-Festucetum pseudovinae* (Rel. A, see below; Fig. 5), which was classified in the *Cynosurion cristati* (*Molinio-Arrhenatheretea*) by JANIŠOVÁ (2007a), although it shows relationship to the continental dry grasslands of the *Festucion valesiacae*. This species-poor vegetation includes both species of hay meadows and dry grasslands. It occupies the edges or the mounds in river floodplains not directly affected by ground water. Relevé A was sampled in the alluvium of the Slaná river, South Slovakia. In 2009, we visited sites in the Slaná river floodplain that had

been sampled by ŘEHOŘEK (1969: Table 7; under the association name "*Festucetum sulcatae-pseudovinae* Řehořek 1969 ms.", Art. 1 ICPN). The site of relevé A was the only one where vegetation of the *Alopecuro pratensis-Festucetum pseudovinae* had maintained until recent times. All the other sites were ploughed or successionally changed into shrubbery. The association also occurs in the lowlands of eastern Slovakia (RUŽIČKOVÁ 1971) and the northern part of the Great Hungarian Plain (JUHÁSZ-NAGY 1957), but the recent state of these localities also needs a revision. Given the insufficient knowledge of the actual distribution of the *Alopecuro pratensis-Festucetum pseudovinae*, this relevé is important as a unique record of this association in Slovakia.

Relevé A:
SK, Rimavská kotlina basin, Chanava, Slaná river floodplain, NE of the village, a cattle pasture just behind the river embankment, 48° 20' 46" N, 20° 19' 01" E, 165 m a.s.l.; 25 m^2, cover total 85%, cover herb layer 85%, cover bryophyte and lichen layer 0%, cover of litter 45%, field number IŠ02/09, 2009/06/15, IŠ, DD, KH & MJ.
E_1: *Festuca pseudovina* 3, *F. rupicola* 2b, *Convolvulus arvensis* 2b, *Elytrigia repens* 2a, *Acetosa thyrsiflora* 2a, *Potentilla reptans* 2m, *Carex hirta* 1, *C. praecox* 1, *Galium verum* 1, *Glechoma hederacea* agg. 1, *Holcus lanatus* 1, *Lotus corniculatus* agg. 1, *Plantago lanceolata* 1, *Poa pratensis* agg. 1, *Tithymalus esula* 1, *Achillea millefolium* agg. +, *Dactylis glomerata* +, *Geranium pusillum* +, *Plantago media* +, *Potentilla argentea* +, *Silene dioica* +, *Taraxacum* sect. *Ruderalia* +, *Astragalus glycyphyllos* r, *Capsella bursa-pastoris* r.

4. Discussion

4.1. The syntaxonomical system applied

Our data were sampled in four central European countries (Austria, Czech Republic, Hungary, Slovakia) within a large geographical area. The recently used systems of syntaxonomical classification of dry grasslands differ significantly in these countries (cf. MUCINA & KOLBEK 1993, BORHIDI 2003, CHYTRÝ et al. 2007, JANIŠOVÁ 2007a). Some of them present various association names with similar or identical content. For this reason, neither applica-

Fig. 5: *Alopecuro pratensis-Festucetum pseudovinae* (section 3.3, rel. A). Rimavská kotlina basin, Chanava, Slaná river floodplain (Photo: D. Dúbravková, 15.6.2009).

Abb. 5: *Alopecuro pratensis-Festucetum pseudovinae* (Kap. 3.3, Aufn. A). Rimavská kotlina Becken, Chanava, Slaná-Aue (Foto: D. Dúbravková, 15.6.2009).

tion of a single classification nor application of a combination of these classification systems to our data would lead to an unambiguous result. An internationally compatible classification of dry grasslands is missing; a call for such a consistent international survey in SE Europe was also expressed by RUPRECHT et al. (2009). The situation is different in case of describing the variability of semi-dry grassland vegetation: a large-scale study was undertaken recently by ILLYÉS et al. (2007). We lack an international syntaxonomical typology of European dry grasslands, in which all associations would be defined by unequivocal assignment criteria created by a supervised classification (e.g. the Cocktail method; BRUELHEIDE 1995, 2000, BRUELHEIDE & CHYTRÝ 2000). However, a study that describes patterns in species composition of dry grasslands in the Carpatho-Pannonian region using an unsupervised classification method (modified TWINSPAN algorithm; ROLEČEK et al. 2009) was published by DÚBRAVKOVÁ et al. (2010). A part of our unpublished relevés was included directly in the data set used in the previous study. For this reason, we took advantage of having the possibility to compare all our unpublished data to this geographically stratified dataset consisting of a great number of relevés (nearly 2700) from the same region. Thus, we additionally documented clusters revealed from that large-scale study by individual relevés. We believe to have classified our relevés as accurately as possible in a sense of comprising the complete large-scale variability of dry grasslands in central Europe.

4.2. Relevés difficult to assign

The gradient of environmental conditions of dry grassland sites is continuous. Therefore, the species composition of a few relevés was in transition to ecologically similar vegetation types. Some relevés classified with the FPFI showed a high affinity to more than one related cluster. In these cases, we also took into consideration the assignment of similar relevés sampled in the same area, which influenced the final classification of these specific relevés. This concerns the following relevés from Table 1 (in the Supplement):

- Relevé 32 sampled in a Danube river terrace (Ostrov Kopáč) was assigned to a rare association, *Teucrio botryos-Andropogonetum ischaemi*; however, it shows some relationship to the *Festuco valesiacae-Stipetum capillatae*.
- Relevé 41 assigned to *Alysso heterophylli-Festucetum valesiacae* is related to *Festuco rupicolae-Caricetum humilis*.
- Relevés 46 and 47 from the Belianske kopce hills and relevé 74 from the Leitha-Gebirge were assigned to the *Festuco valesiacae-Stipetum capillatae*, the central association of central European *Festucion valesiacae*; however, they show some relationship to the *Salvio nemorosae-Festucetum rupicolae* Zólyomi ex Soó 1959, representing the continental steppe grasslands with *Festuca rupicola* on loess in northern Hungary (HORVÁTH 2002, ILLYÉS & BÖLÖNI 2007).
- Relevés 78 and 102 classified within *Festuco valesiacae-Stipetum capillatae* and relevé 104 assigned to *Avenastro besseri-Stipetum joannis* include many species of the *Bromo pannonici-Festucion pallentis* and may represent a transition to the *Festuco pallentis-Caricetum humilis*.
- Relevé 121 assigned to *Festuco rupicolae-Caricetum humilis* is transitional between this association and the *Festuco valesiacae-Stipetum capillatae*.

4.3. Geographical principles in distribution of dry grassland associations

The geographical distribution of some associations included in this paper is restricted to certain parts of the study area. The site conditions and the regional species pool seem to be the most important factors influencing the distribution of the individual types of dry grassland vegetation.

Very narrow restrictions of individual associations to certain regions of the study area are obvious especially for associations of the *Bromo pannonici-Festucion pallentis* alliance. Some associations developing in environmentally similar conditions are vicarious in their geographical distribution (JANIŠOVÁ & DÚBRAVKOVÁ in press). The *Poo badensis-Caricetum humilis* (NE periphery of the Pannonian Basin), the *Festuco pallentis-Caricetum humilis* (W border of the Western Carpathians), and the *Seselio leucospermi-Festucetum pallentis* (Transdanubian Mountain Range in Hungary) represent geographical vicariads of dry grass-

lands dominated by *Carex humilis* on shallow soils over limestone or dolomite bedrock. Each of these associations is characterised by a set of species that reflects the regional species pool.

The species composition of dry grasslands of the *Festucion valesiacae* at supra-regional scale, however, seems to be more homogeneous. We suppose that one of the most important factors decreasing the beta-diversity of *Festucion valesiacae* grasslands is their overgrazing in the last centuries (ELLENBERG 1996). Some of the associations are specific in their species composition (e.g. *Alysso heterophylli-Festucetum valesiacae* and *Inulo oculi-christi-Festucetum pseudodalmaticae*). However, there are associations (*Festuco valesiacae-Stipetum capillatae, Festuco rupicolae-Caricetum humilis*) that include mainly species of wide ecological amplitude (generalists) and lack species of narrow amplitude (specialists), so that it is very difficult to define diagnostic species for them. These "central" associations in the sense of DENGLER et al. (2008) do not show any strong preference to a certain geographical region and are widely distributed over the study area.

Some of the studied associations (*Astragalo exscapi-Crambetum tatariae, Avenastro besseri-Stipetum joannis, Stipetum tirsae*) are characterised by the occurrence of rare taxa (e.g. *Astragalus excapus*, *Crambe tataria*, *Helictotrichon desertorum* subsp. *basalticum* and *Stipa tirsa*), and their distribution is thus conditioned by the distribution of these species. The occurrence of some rare associations (e.g. *Alopecuro pratensis-Festucetum pseudovinae*, *Teucrio botryos-Andropogonetum ischaemi*, and also *Astragalo exscapi-Crambetum tatariae*) is limited due to a lack of suitable sites. Many of these sites have been destroyed by human activities, such as ploughing and afforestation, in the past.

4.4. *Stipa pulcherrima*-dominated stands

An interesting point to discuss is the syntaxonomical status of *Stipa pulcherrima*-dominated stands in the Carpatho-Pannonian region. Their classification was rather inconsistent in older phytosociological literature. In some papers, such stands were classified as separate newly described syntaxa (e.g. SILLINGER 1930, Považský Inovec Mts., SK: *Stipetum pulcherrimae*; JAKUCS 1954, Aggteleki-karszt Mts., HU: *Caricetum humilis* társulás *Stipa pulcherrima* szubasszociációja [Art. 3, 31 ICPN]; HÁBEROVÁ et al. 1988, Slovenský kras Mts., SK: *Poo badensis-Caricetum humilis stipetosum pulcherrimae* [Art. 2b ICPN]; TICHÝ et al. 1997, Dyje river valley, CZ: *Inulo oculi-christi-Stipetum pulcherrimae*). Besides the high cover of *Stipa pulcherrima* and a low species richness of these communities, these syntaxa lacked common features and were thus never included in national vegetation overviews.

Summing up the information from the most recent surveys of dry grasslands (CHYTRÝ et al. 2007, ILLYÉS & BÖLÖNI 2007, JANIŠOVÁ 2007a, DÚBRAVKOVÁ et al. 2010), there are two main types of grasslands dominated or co-dominated by *Stipa pulcherrima* in the study area. Dry grasslands on relatively steep slopes with shallow calcareous rocky soils with presence of species of the *Bromo pannonici-Festucion pallentis* belong to the first type. *Stipa pulcherrima*, as a competitive grass, expands into the sites disturbed by soil erosion, which were originally dominated by *Carex humilis* and *Festuca pallens*, and forms succesionally advanced vegetation (JAKUCS 1955). Such vegetation should be classified within the associations of *Bromo pannonici-Festucion pallentis*, from which it was successionally derived (cf. JANIŠOVÁ 2007b, DÚBRAVKOVÁ-MICHÁLKOVÁ et al. 2008).

Another type of vegetation dominated by *Stipa pulcherrima* is represented by (semi-) closed grasslands at sites with deeper soils over loess, calcareous flysch sandstones, and conglomerates located on gentle slopes of hilly landscapes. These grasslands include common dry grassland species (e.g. *Colymbada scabiosa, Crinitina lynosyris, Galium glaucum*, and *Teucrium chamaedrys*) and some species present in continental steppes (e.g. *Adonis vernalis, Astragalus* spp., *Festuca valesiaca, Jurinea mollis*, and *Pseudolysimachion spicatum*), which indicates a syntaxonomical affiliation with the *Festucion valesiacae* alliance (ILLYÉS & BÖLÖNI 2007, KUZEMKO 2009). Such stands represent either natural steppe vegetation or secondary communities developed after deforestation. CHYTRÝ et al. (2007) proposed their classification within a broadly defined association *Koelerio macranthae-Stipetum joannis*,

which also includes grasslands dominated by other penniform *Stipa* species. Relevé 112 (Table 1) is a good example of this association. Relevés 116 and 117, however, represent successionally altered stands of *Koelerio macranthae-Stipetum joannis*. The steppic grasslands with *Stipa pulcherrima* occuring at large flat sites are quite rare in Slovakia, while they are more abundant in other parts of the study area. One of the few localities is the Pod Holým vrchom Nature Reserve (NE foothills of the Malé Karpaty Mts., SK; Table 1, rel. 116, Fig. 4). The site became more mesic, which is indicated by the presence of species of forest fringes and meadow steppe. The real reason for such a succesional shift is not clear. The relevé plot was selected in a large homogeneous site, which was not in direct contact with a forest edge. Mowing or grazing, which might have disturbed these grasslands according to CHYTRÝ et al. (2007), has not been practised here since the 1970s (D. Válková pers. comm.). We assume that some extensive management activities are also needed in this type of dry grasslands.

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Appendix A: Origin of the relevés in Table 1

Anhang A: Herkunft der Aufnahmen in Tabelle 1

The entries are structured as follows: relevé number, ISO country code, detailed description of the locality, longitude, latitude, field number, soil and bedrock type, date (year/month/day), relevé author(s) (DD – D. Dúbravková, KH – K. Hegedüšová, MJ – M. Janišová, IŠ – I. Škodová).

Die Einträge sind folgendermaßen aufgebaut: Aufnahmenummer, ISO-Ländercode, Fundort, geografische Länge und Breite, Geländenummer, Boden- und Gesteinstyp, Datum (Jahr/Monat/Tag), Urheber der Aufnahme (DD – D. Dúbravková, KH – K. Hegedüšová, MJ – M. Janišová, IŠ – I. Škodová).

1. SK, Čierna hora Mts, Košice – Podhradová, dry grassland below elevation point Hradová, 21°14′23″ E, 48°45′23″ N, 63/05, brown loamy and rocky soil, limestone, 2005/07/11, DD, KH, IŠ & MJ; 2. SK, Čierna hora Mts, Družstevná pri Hornáde, Malá Vieska, N part of village, W of elevation point Vápenná, a hillside above the road, 21°14′25″ E, 48°48′25″ N, 64/05, limestone, 2005/07/11, DD, KH, IŠ & MJ; 3. SK, Čierna hora Mts, Družstevná pri Hornáde, Malá Vieska, N part of village, W of elevation point Vápenná, a hillside above the road, 21°14′22″ E, 48°48′24″ N, 25 m^2, 65/05, limestone, 2005/07/11, DD, KH, IŠ & MJ; 4. SK, Turčianska kotlina basin, Moškovec, Príboje, a hillside above a road NE of the village, 18°49′55″ E, 48°56′46″ N, 53/06, a fluvial gravel terrace, 2006/06/06, DD & MJ; 5. HU, Pilis Mts, Solymár (NW of Budapest), Szénások, Felso Zsíros-hegy hill, by a tourist trail, 18°52′46″ E, 47°35′25″ N, 14/06, rendzina over dolomite, 2006/05/23, DD & E. Illyés; 6. HU, Pilis Mts, Solymár (NW of Budapest), Szénások, a foothill, near a mobile phone antenna post, 18°52′54″ E, 47°35′19″ N, 17/06, rendzina over dolomite, 2006/05/23, DD & E. Illyés; 7. HU, Budai-hegysek Mts, Budaőrs, Odvas-hegy Mt. Nature Reserve, above a tourist trail, WSW of the hilltop, 18°56′20″ E, 47°27′55″ N, 18/06, rocky soil, dolomite, 2006/05/24, DD; 8. HU, Budai-hegysek Mts, Budaőrs, Odvas-hegy Mt. Nature Reserve, 18°56′33″ E, 47°27′59″ N, 20/06, dolomite, 2006/05/24, DD; 9. HU, Budai-hegysek Mts, Budaőrs, Odvas-hegy Mt. Nature Reserve, elevation point 258, near a calvary hill, 18°57′06″ E, 47°28′09″ N, 22/06, crumbly dolomite rendzina, dolomite, 2006/05/24, DD; 10. HU, Vértes Mts, Csákvár, Haraszt-hegy, about 5 m below a plateau edge near an interpretive trail, 18°26′29″ E, 47°23′51″ N, 32/06, very shallow soil on dolomite crumbly gravel, 2006/05/28, DD; 11. SK, Malé Karpaty Mts, Lančár, Chríb Nature Reserve, near the bell tower, 17°38′57″ E, 48°36′00″ N, 76/06, dolomite, 2006/06/21, DD; 12. AT, Burgenland, Leitha-Gebirge Mts, Purbach, Purbacher Heide (ÖK 78/19), 16°41′00″ E, 48°55′19″ N, 04/07, shallow soil, limestone (Leithakalk), 2007/06/20, DD & W. Willner; 13. SK, Strážovské vrchy Mts, a

hillside above the road between Látkovce and Dolné Vestenice, 18°22′22″ E, 48°42′55″ N, 68/06, limestone, 2006/06/13, DD, MJ & J. Smatanová; 14. SK, Malé Karpaty Mts, Bratislava, Devínska Kobyla National Nature Reserve, a grassland below an interpretive trail between Sandberg and the Weitov lom quarry, 16°58′45″ E, 48°11′50″ N, 01/05, sandstone, 2005/05/12, DD & J. Miškovic; 15. SK, Malé Karpaty Mts, Bratislava, Devínska Kobyla National Nature Reserve, a hillside between Sandberg and the Weitov lom quarry, closer to the quarry, 16°58′49″ E, 48°11′44″ N, 02/05, sandy soil, sandstone, 2005/05/12, DD & J. Miškovic; 16. CZ, Pavlovské vrchy Mts, Mikulov, Svatý kopeček hill, a hillside of the forested hilltop with the Sepulchre of Christ, 16°38′59″ E, 48°48′26″ N, 56/06, 2006/06/09, DD; 17. SK, Strážovské vrchy Mts, Ľutov, N of the village, Bradlo National Nature Reserve, E ridge, 18°17′09″ E, 48°47′48″ N, 65/06, limestone, 2006/06/12, DD & J. Smatanová; 18. CZ, Pavlovské vrchy Mts, Perná, Pálava Mt., about 80 m to the right of ruins of St. Antonín chapel, 16°38′17″ E, 48°51′28″ N, 59/06, shallow rocky soil, limestone, 2006/06/10 DD; 19. SK, Malé Karpaty Mts, Dolný Lopašov, middle part of an abandoned quarry NNW of the village, 17°38′07″ E, 48°35′16″ N, 80/06, dolomite, 2006/06/23, DD; 20. CZ, Pavlovské vrchy Mts, Mikulov, Šibeničník Nature Reserve, 16°37′48″ E, 48°47′22″ N, 62/06, 2006/06/11, DD; 21. SK, Malé Karpaty Mts, Dobrá Voda, dry grassland above a road to an open-air swimming pool, 17°31′15″ E, 48°36′05″ N, 69/05, shallow soil (15 cm) with humus, dolomite, 2005/08/21, DD; 22. SK, Malé Karpaty Mts, Dolný Lopašov, Pod Holým vrchom Nature Reserve, N part of reserve, 17°37′20″ E, 48°35′14″ N, 77/06, rocky soil (rendzina) under a shallow humus layer (10 cm), dolomite, 2006/06/23, DD; 23. AT, Lower Austria, Hundsheim, Hundsheimer Berg Mt. Nature Reserve (ÖK 61/11), near the plateau above the village, 16°56′20″ E, 48°07′30″ N, 14/07, shallow soil, limestone, 2007/06/27, DD & KH; 24. AT, Lower Austria, Hainburg, Braunsberg Mt. (ÖK 61/14), a hillside below the wooden replica of a Celtic fort, 16°57′07″ E, 48°09′11″ N, 16/07, limestone, 2007/06/27, DD & KH; 25. SK, Malé Karpaty Mts, Hrachovište, Veľký Plešivec Nature Reserve, SE hillside, 17°44′12″ E, 48°42′05″ N, 100/06, rocky crumbly soil, dolomite, 2006/08/17, DD; 26. SK, Malé Karpaty Mts, Bratislava, Devínska Kobyla National Nature Reserve, Weitov lom quarry, grassland on an overhanging rock on the upper terrace, 16°58′54″ E, 48°11′41″ N, 03/05, friable sandy soil with rocks, sandstone, 2005/05/12, DD & J. Miškovic; 27. SK, Považský Inovec Mts, Lúka, Bôrovište, SW of the hilltop, 17°54′21″ E, 48°40′20″ N, 97/06, shallow rocky soil, dolomite, 2006/08/15, DD & Š. Maglocký; 28. SK, Strážovské vrchy Mts, Mitické vrchy, Dolné Vestenice, dry grassland on a hillside above a road to an open-air cinema, 18°23′18″ E, 48°42′28″ N, 25 m^2, 69/06, limestone, 2006/06/13, DD, KH, MJ & IŠ; 29. SK, Strážovské vrchy Mts, Uhrovec, top of a rock above a road to the Striebornica valley, 18°20′33″ E, 48°44′53″ N, 67/06, limestone, 2006/06/13, DD & J. Smatanová; 30. SK, Malé Karpaty Mts, Dolný Lopašov, hillside of an abandoned quarry NNW of the village, 50 m from the road, 17°38′10″ E, 48°35′15″ N, 81/06, shallow rocky soil, dolomite, 2006/06/23, DD; 31. SK, Strážovské vrchy Mts, Podlužany, Ľutovský Drieňovec National Nature Reserve, Vysoká, dry grassland on a tourist trail, 18°16′22″ E, 48°48′17″ N, 2 m, 66/06, shallow rocky soil, 2006/06/12, DD, MJ & J. Smatanová; 32. SK, Podunajská rovina lowland, Bratislava, Ostrov Kopáč National Nature Reserve, 17°09′38″ E, 48°05′42″ N, 68/05, gravelly soil, 2005/08/03, DD & K. Vidékyová; 33. SK, Krupinská planina hills, Príbelce, Holice National Nature Reserve, grassland in a sand quarry, 19°14′47″ E, 48°11′50″ N, 86/06, sandy soil, 2006/06/27, DD & MJ; 34. HU, Börzsöny Mts, Ipolytólgyes, Bánya-hegy Mt., a foothill above a little quarry, 18°47′44″ E, 47°55′07″ N, 25 m^2, 23/06, ranker, andesite, 2006/05/25, DD & J. Nagy; 35. HU, Börzsöny Mts, Letkősz, Galla tisztás, Nagy-Galla hilltop, 18°49′38″ E, 47°52′24″ N, 26/06, shallow soil (3–5 cm), andesite, 2006/05/26, DD & J. Nagy; 36. HU, Börzsöny Mts, Ipolydamazd, Jama, 312 m a.s.l., 18°50′04″ E, 47°51′07″ N, 27/06, 2006/05/26, DD & J. Nagy; 37. HU, Börzsöny Mts, Szob, Ruzsás-hegy Mt., 18°52′49″ E, 47°49′53″ N, 25 m^2, 30/06, 2006/05/26, DD & J. Nagy; 38. SK, Krupinská planina hills, Horné Plachtince, Skala Mt. (elevation point 493.6), 19°17′44″ E, 48°14′17″ N, 85/06, volcanic bedrock, 2006/06/27, DD & MJ; 39. SK, Štiavnické vrchy Mts, left of the road between Krupina and Žibritov, Ficberg Mt., a steep scree hillside in a quarry, 19°02′22″ E, 48°22′35″ N, 87/06, relatively deep soil-filled gaps among boulders, volcanic bedrock, 2006/06/28, DD & MJ; 40. SK, Štiavnické vrchy Mts, left of the road between Krupina and Žibritov, Ficberg Mt., a foothill of a quarry above a road, 19°02′24″ E, 48°22′36″ N, 88/06, volcanic bedrock, 2006/06/28, DD & MJ; 41. SK, Revúcka vrchovina hills (Drienčanský kras), Hrušovo, a large pasture N of the village (Závoz), below an elevation point 362, 20°03′05″ E, 48°31′22″ N, 90/06, 2006/07/05, DD & J. Kliment; 42. SK, Revúcka vrchovina hills (Drienčanský kras), by a bridge between Drienčany and Hrušov, SW foothill of Holý vrch Mt., 20°03′26″ E, 48°29′40″ N, 91/06, 2006/07/05, DD, J. Kliment, J. Smatanová, K. Vidékyová & T. Mihálíková; 43. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Dank hill (elevation point 220.9), above the vineyards; the site was in fire a few years ago, 18°38′39″ E, 47°49′06″ N, 04/05, friable soil with rocks, andesite covered with loess, 2005/05/16, DD; 44. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Dank hill (elevation point 220.9), above the vineyards, 18°38′40″ E, 47°49′07″ N, 05/05, andesite covered with loess, 2005/05/16, DD; 45. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Dank hill (elevation point 220.9), about 200 m W of the hilltop, 18°38′37″ E, 47°49′07″ N, 06/05,

andesite covered with loess, 2005/05/16, DD; 46. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Dank hill (elevation point 220.9), SE hillside, above the vineyards, 18°38′49″ E, 47°49′05″ N, 07/05, andesite covered with loess, 2005/05/17, DD; 47. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Starý vrch hill, about 100 m below the hill ridge, 18°38′01″ E, 47°49′02″ N, 08/05, rocky soil, andesite covered with loess, 2005/05/17, DD; 48. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Starý vrch hill, N of an abandoned quarry in a valley between Dank and Starý vrch, 18°38′02″ E, 47°49′06″ N, 10/05, rocky soil, andesite covered with loess, 2005/05/17, DD; 49. SK, Malé Karpaty Mts, Višňové, left of a tourist trail on the ridge of Čachtice castle Mt., 17°45′42″ E, 48°43′27″ N, 47/05, dolomite, 2005/06/27, DD, KH & IŠ; 50. SK, Malé Karpaty Mts, Čachtice, Drapliak Mt., W of a quarry, 17°47′20″ E, 48°43′35″ N, 49/05, limestone, 2005/06/27, DD, KH & IŠ; 51. SK, Tríbeč Mts (Zoborské vrchy), Nitra, Zoborská lesostep National Nature Reserve, 18°05′41″ E, 48°20′51″ N, 50/05, limestone, 2005/06/28, DD, KH & IŠ; 52. SK, Tríbeč Mts (Zoborské vrchy), Nitra, Zoborská lesostep National Nature Reserve, in top part, 18°05′47″ E, 48°20′57″ N, 51/05, relatively deep soil, limestone, 2005/06/28, DD & KH; 53. SK, Tríbeč Mts (Zoborské vrchy), Dražovce, Plieška hill, 18°05′06″ E, 48°21′12″ N, 52/05, limestone, 2005/06/28, DD, KH, IŠ & H. Rosinová; 54. SK, Tríbeč Mts (Zoborské vrchy), Nitra, Lupka hill, 18°04′35″ E, 48°20′18″ N, 53/05, limestone, 2005/06/28, DD, KH, IŠ & H. Rosinová; 55. SK, Tríbeč Mts (Zoborské vrchy), Štitáre, Haranč Mt., in top part near an open fireplace, 18°08′28″ E, 48°21′26″ N, 54/05, limestone, 2005/06/29, DD & KH; 56. SK, Tríbeč Mts (Zoborské vrchy), Štitáre, Žibrica National Nature Reserve, Žibrické lúky meadows, right of a tourist trail, 18°08′47″ E, 48°21′50″ N, 55/05, shallow soil, limestone, the bedrock uncovered in some parts, 2005/06/29, DD, KH, IŠ & H. Rosinová; 57. SK, Tríbeč Mts (Zoborské vrchy), Štitáre, Žibrica National Nature Reserve, Žibrické lúky meadows, below a hilltop, 18°08′58″ E, 48°22′00″ N, 56/05, rocky soil, limestone, 2005/06/29, DD, KH, IŠ & H. Rosinová; 58. SK, Tríbeč Mts (Zoborské vrchy), Nitra, Kalvária (Calvary hill), near the hilltop, 18°05′25″ E, 48°17′50″ N, 57/05, rocky soil, limestone, 2005/06/29, DD, KH, IŠ & H. Rosinová; 59. SK, Malé Karpaty Mts, Bratislava, Sandberg Mt., a hill with a small water company building above the road to Devín, 16°58′20″ E, 48°12′03″ N, 01/06, sandy soil, sandstone, 2006/05/15, DD & KH; 60. SK, Považský Inovec Mts, Beckov, Skalka pri Beckove Nature Reserve, a rocky hill in an arable field near the road to Rakoľuby, 17°53′34″ E, 48°46′19″ N, 71/06, limestone, 2006/06/14, DD; 61. SK, Malé Karpaty Mts, Prašník, Tlstá hora Mt., Čerenec Nature Reserve, in top part of the reserve, 17°41′15″ E, 48°38′41″ N, 72/06, conglomerates and sandstones, 2006/06/21, DD; 62. SK, Malé Karpaty Mts, Prašník, Tlstá hora Mt., Čerenec Nature Reserve, dry grassland on W hillside, 17°41′12″ E, 48°38′43″ N, 73/06, conglomerates and sandstone, 2006/06/21, DD; 63. SK, Považský Inovec Mts, Hlohovec, Sedliská Nature Reserve, below a hilltop, 17°49′23″ E, 48°26′53″ N, 98/06, limestone covered with loess, 2006/08/17, DD; 64. SK, Malé Karpaty Mts, Hrachovište, Veľký Plešivec Nature Reserve, SE hillside, 17°44′13″ E, 48°42′05″ N, 101/06, loamy soil, dolomite, 2006/08/17, DD; 65. HU, Visegrági-hegység Mts, Ostrihom, Búbánat valley, Szamár-hegy Mt., a mound next to the hilltop, 18°47′56″ E, 47°48′15″ N, 09/06, andesite, 2006/05/22, DD & E. Illyés; 66. HU, Budai-hegysek Mts, Budaőrs, Odvas-hegy Mt. Nature Reserve, near the hilltop, 18°56′48″ E, 47°28′04″ N, 21/06, dark rendzina, dolomite, 2006/05/24, DD; 67. HU, Visegrági-hegység Mts, Ostrihom, Búbánat valley, Szamár-hegy Mt., hilltop, 18°47′50″ E, 47°48′23″ N, 10/06, andesite, 2006/05/22, DD & E. Illyés; 68. HU, Pilis Mts, Kestölc, Kétágú-hegy Mt., 18°47′36″ E, 47°43′36″ N, 11/06, limestone, 2006/05/22, DD & E. Illyés; 69. HU, Budai-hegysek Mts, Budaőrs, Odvas-hegy Mt. Nature Reserve, 18°56′24″ E, 47°27′56″ N, 19/06, dolomite, 2006/05/24, DD; 70. HU, Vértes Mts, Csákvár, foothill of Őreg-hegy Mt., S of an interpretive trail, 18°26′05″ E, 47°23′00″ N, 33/06, 2006/05/28, DD; 71. CZ, Pavlovské vrchy Mts, Milovice, Milovická stráň Nature Reserve, part of the hillside located further from village and sports ground, 16°41′36″ E, 48°50′53″ N, 55/06, 2006/06/09, DD; 72. CZ, Pavlovské vrchy Mts, Klentnice, Stolová hora Mt., E hillside, just opposite Pension Blanka, 16°38′23″ E, 48°50′30″ N, 58/06, 2006/06/10, DD; 73. CZ, Pavlovské vrchy Mts, Pavlov, Děvín Mt., 16°38′55″ E, 48°51′54″ N, 60/06, 2006/06/10, DD; 74. AT, Burgenland, Leitha-Gebirge Mts, Donnerskirchen, Kirchberg Mt. (ÖK 78/21), 16°38′24″ E, 47°54′05″ N, 03/07, relatively deep soil, limestone (Leithakalk), 2007/06/20, DD & W. Willner; 75. SK, Podunajská rovina lowland, Bratislava, Ostrov Kopáč National Nature Reserve, 17°09′32″ E, 48°05′44″ N, 67/05, sandy soil without rocks, 2005/08/03, DD & K. Vidékyová; 76. SK, Malé Karpaty Mts, Višňové, foothill of the Čachtice castle hill, left of a tourist trail, 17°45′28″ E, 48°43′26″ N, 45/05, dolomite, 2005/06/27, DD, KH & IŠ; 77. SK, Malé Karpaty Mts, Čachtice, SSE foothill of Drapliak Mt., above a chalet village, left of a quarry, 17°47′22″ E, 48°43′29″ N, 48/05, rocky soil, limestone, 2005/06/27, DD, KH & IŠ; 78. SK, Malé Karpaty Mts, Višňové, below a tourist trail on the ridge of Čachtice castle hill, 17°45′45″ E, 48°43′21″ N, 46/05, dolomite, 2005/06/27, DD, KH & IŠ; 79. SK, Malé Karpaty Mts, Dechtice, Katarína Nature Reserve, dry grassland next to the church altar ruins, 17°32′25″ E, 48°33′15″ N, 58/05, conglomerates, 2005/07/03, DD; 80. SK, Malé Karpaty Mts, Lančár, Lančársky Dubník Nature Reserve, a hilltop above a quarry, 17°38′38″ E, 48°35′32″ N, 74/06, shallow soil (15 cm), dolomite, 2006/06/21, DD & J. Májeková; 81. SK, Malé Karpaty Mts, Lančár,

below the Lančár bell tower, on the left side of the road, 17°38′55″ E, 48°35′58″ N, 75/06, dolomite, 2006/06/21, DD & J. Májeková; 82. SK, Malé Karpaty Mts, Dolný Lopašov, Pod Holým vrchom Nature Reserve, 17°37′30″ E, 48°35′07″ N, 2 m, 78/06, relatively deep soil (rendzina), dolomite, 2006/06/23, DD; 83. SK, Malé Karpaty Mts, Dolný Lopašov, top of an abandoned quarry NNW of the village, 17°38′09″ E, 48°35′17″ N, 82/06, dolomite, 2006/06/23, DD; 84. SK, Malé Karpaty Mts, Bratislava, Štokeravská vápenka Nature Reserve, lower grassland above a garden village, 17°00′22″ E, 48°12′11″ N, 93/06, relatively shallow soil, dolomites, 2006/07/13, DD & K. Vidékyová; 85. SK, Malé Karpaty Mts, Bratislava, Štokeravská vápenka Nature Reserve, lower grassland just above Technické sklo factory, 17°00′21″ E, 48°12′10″ N, 95/06, dolomites, 2006/07/13, DD & K. Vidékyová; 86. SK, Považský Inovec Mts, Lúka, Lúčanská dolina valley, a hillside above a tourist trail, 17°53′50″ E, 48°39′56″ N, 96/06, dolomite, 2006/08/15, DD & Š. Maglocký; 87. SK, Považský Inovec Mts, Hlohovec, Sedliská Nature Reserve, about 100 m below an information panel, 17°49′24″ E, 48°26′52″ N, 2 m, 99/06, limestone covered by loess, 2006/08/17, DD; 88. HU, Pilis Mts, Kestölc, Kétágú-hegy, a foothill, 18°47′29″ E, 47°43′36″ N, 12/06, limestone, 2006/05/22, DD & E. Illyés; 89. HU, Pilis Mts, Kestölc, Kétágú-hegy, a foothill, 18°47′28″ E, 47°43′35″ N, 13/06, rendzina over limestone, 2006/05/22, DD & E. Illyés; 90. HU, Pilis Mts, Solymár (NW of Budapest), Szénások, Felso Zsíros-hegy Mt., in direction towards Nagy-Szenás-hegy Mt., N of the hilltop, 18°52′30″ E, 47°35′36″ N, 15/06, rendzina over dolomite, 2006/05/23, DD & E. Illyés; 91. HU, Pilis Mts, Solymár (NW of Budapest), Szénások, Nagy-Szenás-hegy Mt., E of the hilltop, 18°52′18″ E, 47°35′25″ N, 16/06, rendzina over dolomite, 2006/05/23, DD & E. Illyés; 92. HU, Börzsöny Mts, Ipolydamazd, Jama, lower part of the hill, 18°49′55″ E, 47°50′56″ N, 28/06, relatively deep soil, 2006/05/26, DD & J. Nagy; 93. HU, Vértes Mts, Csákvár, Haraszt-hegy Mt., edge of a plateau near an interpretive trail, 18°26′29″ E, 47°23′41″ N, 31/06, 2006/05/28, DD; 94. CZ, Pavlovské vrchy Mts, Mikulov, Svatý kopeček hill, a plateau behind a chapel near the Sepulchre of Christ next to a tourist trail, 16°38′52″ E, 48°48′25″ N, 57/06, 2006/06/09, DD; 95. AT, Burgenland, Leitha-Gebirge Mts, Donnerskirchen, Kirchberg Mt. (ÖK 78/21), 16°38′27″ E, 47°54′02″ N, 02/07, shallow soil, limestone (Leithakalk), 2007/06/20, DD & W. Willner; 96. AT, Burgenland, Leitha-Gebirge Mts, Purbach, Purbacher Heide (ÖK 78/19), 16°40′52″ E, 47°55′18″ N, 05/07, limestone (Leithakalk), 2007/06/20, DD & W. Willner; 97. AT, Burgenland, Jois, Hackelsberg Nature Reserve (ÖK 78/15), 16°46′16″ E, 47°57′10″ N, 06/07, 2007/06/20, DD & W. Willner; 98. AT, Lower Austria, Weinviertel, Maustrenk (ÖK 25/13), N of a gravel quarry, 16°41′50″ E, 48°33′39″ N, 07/07, tertiary gravel and conglomerate, 2007/06/21, DD & W. Willner; 99. AT, Lower Austria, Weinviertel, Falkenstein, above an abandoned quarry (ÖK 25/3), 16°35′18″ E, 48°43′41″ N, 09/07, 2007/06/21, DD & W. Willner; 100. AT, Lower Austria, Hundsheim, Hundsheimer Berg Mt. Nature Reserve (ÖK 61/11), top plateau, 474 m a.s.l., 16°56′20″ E, 48°07′30″ N, 15/07, limestone, 2007/06/27, DD & KH; 101. AT, Lower Austria, Weinviertel, Falkenstein, Höllenstein Nature Reserve (ÖK 25/2), 16°35′11″ E, 48°43′49″ N, 08/07, 2007/06/21, DD & W. Willner; 102. AT, Lower Austria, Hundsheim, Hundsheimer Berg Mt. Nature Reserve (ÖK 61/11), above the village, 16°56′28″ E, 48°07′28″ N, 12/07, limestone, 2007/06/27, DD & KH; 103 CZ, southern Moravia, Pouzdřany, Pouzdřanská step-Kolby National Nature Reserve, plateau about 10 m from a wayside cross, 16°38′32″ E, 48°56′34″ N, 64/06, loess, 2006/06/11, DD; 104. CZ, Pavlovské vrchy Mts, Mikulov, Šibeničník Nature Reserve, 16°37′48″ E, 48°47′23″ N, 25 m^2, 61/06, relatively deep rocky soil, 2006/06/11, DD; 105. SK, Lučenecká kotlina basin, Hrnčiarska Ves, a grassland in an orchard on a hill, 19°51′02″ E, 48°26′06″ N, 21 m^2, KH38/09, quartzite, 2009/06/18, KH & MJ; 106. SK, Lučenecká kotlina basin, Hrnčiarska Ves, a hillside over field tracks, 19°51′02″ E, 48°26′05″ N, KH39/09, quartzite, 2009/06/18, KH, DD, IŠ & MJ; 107. SK, Revúcka vrchovina hills, Selce, NNE of the village, xeric edge of a grassland, 19°52′54″ E, 48°27′57″ N, 01/09, quartzite, 2009/06/18, DD & KH; 108. SK, Revúcka vrchovina hills, Uderiná, E of the village, behind a farm area, 19°37′24″ E, 48°25′16″ N, 02/09, quartzite, 2009/06/19, DD & MJ; 109. SK, Krupinská planina hills, Krupina, Vartovka hill, 30 m N from an observation tower located on the hilltop, 19°04′44″ E, 48°20′59″ N, 83/06, 2006/06/26, DD; 110. SK, Krupinská planina hills, Krupina, above a quarry E of the town and SW of Vartovka hill, 19°04′38″ E, 48°20′45″ N, 84/06, 2006/06/26, DD; 111. HU, Börzsöny Mts, Ipolytólgyes, Bánya-hegy Mt., a hill plateau behind an abandoned quarry, 18°48′49″ E, 47°55′27″ N, 24/06, ranker, andesite, 20060525, DD & J. Nagy; 112. CZ, southern Moravia, Pouzdřany, Pouzdřanská step-Kolby National Nature Reserve, 16°38′35″ E, 48°56′28″ N, 63/06, loess, 2006/06/11, DD; 113. HU, Börzsöny Mts, Szob, Ruzsás-hegy Mt., 18°52′46″ E, 47°49′58″ N, 29/06, 2006/05/26, DD & J. Nagy; 114. SK, Hronská pahorkatina hills (Belianske kopce), Mužla, Starý vrch hill, above an abandoned quarry in a valley between Dank and Starý vrch, 18°38′03″ E, 47°49′07″ N, 09/05, andesite covered with loess, 20050517, DD; 115. AT, Lower Austria, Hundsheim, Hundsheimer Berg Mt. Nature Reserve (ÖK 61/11), plateau above the village, 16°56′19″ E, 48°07′31″ N, 13/07, relatively deep soil, limestone, 2007/06/27, DD & KH; 116. SK, Malé Karpaty Mts, Dolný Lopašov, Pod Holým vrchom Nature Reserve, 17°37′36″ E, 48°35′06″ N, 79/06, rendzina, dolomite, 2006/06/23, DD; 117. AT, Lower Austria, Bisamberg Mt. (ÖK 41/20), 332 m a.s.l., 16°21′33″ E, 48°19′04″ N, 10/07, flysch, 2007/06/25, DD & W.

Willner; 118. AT, Lower Austria, Bisamberg Mt. (ÖK 41/20), 16°21′43″ E, 48°16′05″ N, 11/07, flysch, 2007/06/25, DD & W. Willner; 119. SK, Turčianska kotlina basin, Folkušová, Pálčin diel (elevation point 543.1), N of the village, 18°56′54″ E, 48°58′31″ N, 54/06, 2006/06/06, DD & MJ; 120. SK, Rimavská kotlina basin, Čilík (between Rimavská Sobota and Tornaľa), N of the village, 20°12′46″ E, 48°24′12″ N, 89/06, 2006/07/03, KH & IŠ; 121. SK, Považský Inovec Mts, Beckov castle hill, near the entrance to the castle, 17°53′54″ E, 48°47′25″ N, 2 m, 70/06, limestone, 2006/06/14, DD; 122. SK, Revúcka vrchovina hills (Drienčanský kras), Slizké, dry grassland hill NW of the village, near the transmission line, 20°04′30″ E, 48°31′26″ N, 92/06, 2006/07/05, DD, KH & MJ; 123. SK, Malé Karpaty Mts, Bratislava, Štokeravská vápenka Nature Reserve, upper grassland above the climbing rocks, 17°00′09″ E, 48°12′06″ N, 94/06, quartzite, 2006/07/13, DD & K. Vidékyová.

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Table 1: Relevé table of the studied dry grasslands of *Bromo pannonici-Festucion pallentis* and *Festucion valesiacae*
Abbreviations used: Ae – *Arrhenatherion elatioris*, Be – *Bromion erecti*, B-F – *Bromo pannonici-Festucion pallentis*, Const. – constancy, E2 – shrub layer, E1 – herb layer, E0 – layer of bryophytes and lichens, FB – *Festuco-Brometea*, Fv – *Festucion valesiacae*, Gs – *Geranion sanguinei*, K-P – *Koelerio-Phleion phleoidis*, cover values of species: a = 2a, b = 2b, m = 2m.

Tabelle 1: Vegetationstabelle der untersuchten Trockenrasen aus den Verbänden *Bromo pannonici-Festucion pallentis* und *Festucion valesiacae*
Für die Bedeutung der Abkürzungen siehe die englische Tabellenüberschrift.

Alliance	Association No. / Transitional stage No.	Association / Transitional stage	Relevé numbers
Bromo pannonici-Festucion pallentis	1	*Poo badensis-Caricetum humilis*	1–3
	2	*Orthantho luteae-Caricetum humilis*	4
	3	*Seselio leucospermi-Festucetum pallentis*	5–10
	4	*Festuco pallentis-Caricetum humilis*	11–25
	5	*Poo badensis-Festucetum pallentis*	26–31
Festucion valesiacae	6	*Teucrio-Andropogonetum ischaemi*	32
	7	*Inulo oculi-christi-Festucetum pseudodalmaticae*	33–37
	8	*Festucetum pseudodalmaticae*	38–40
	9	*Alysso heterophylli-Festucetum valesiacae*	41–42
	10	*Festuco valesiacae-Stipetum capillatae*	43–102
	11	*Astragalo exscapi-Crambetum tatariae*	103
	12	*Avenastro besseri-Stipetum joannis*	104
	13	Dry grasslands on acidophilous and base-poor volcanic bedrock (transitions between *Festucion valesiacae* and *Koelerio-Phleion phleoidis*)	105–111
	14	*Koelerio macranthae-Stipetum joannis*	112
	15	*Stipetum tirsae*	113
	16	Successionally advanced stands of *Festuco valesiacae-Stipetum capillatae*	114–115
	17	Early stages of succession towards *Cirsio-Brachypodion pinnati*	116–118
	18	Transitions to meadow steppes	119–120
	19	*Festuco rupicolae-Caricetum humilis*	121–123

Species / parameter	Syntaxon	*Bromo pannonici-Festucion pallentis* (Mean or % constancy) n=31	*Festucion valesiacae* (Mean or % constancy) n=92
Altitude (m a.s.l.)		325	300
Relevé plot size (m²)		23.5	24.0
Aspect			
Aspect - angle deflection from N (°)			
Slope (°)		28	16
Cover total (%)		74	87
Cover shrub layer (%)		0.3	0.5
Cover herb layer (%)		65.0	83.0
Cover moss layer (%)		17.0	13.5
Cover litter layer (%)		1.6	5.5
Cover bare rock (%)		4.6	1.3
No. of species (vascular plants, bryophytes and lichens)		41.6	44.7
E2			
Crataegus monogyna		.	3
Rosa canina agg.		.	5
E1			
Galium glaucum		23	34
Artemisia campestris	Fv	29	21
Poa badensis	B-F	65	12
Carex humilis	B-F, FB	84	26
Bromus monocladus		3	.
Hippocrepis comosa		16	4
Seseli leucospermum		16	2
Dianthus plumarius subsp. *regis-stephani*		10	.
Paronychia cephalotes		6	.
Grimmia pulvinata (E0)		16	11
Weissia condensa (E0)		19	7
Stipa eriocaulis		23	2
Minuartia verna agg.		29	8
Chrysopogon gryllus		10	7
Jurinea mollis		26	14
Festuca pallens	B-F, FB	77	11
Globularia punctata	B-F, FB	61	12
Alyssum montanum	B-F, FB	58	23
Rhodax canus	B-F	35	2
Fumana procumbens	B-F, FB	45	1
Scorzonera austriaca	B-F, FB	48	3
Jovibarba hirta subsp. *glabrescens*	B-F	39	7
Thymus praecox	B-F, FB	71	25
Leontodon incanus	B-F, FB	23	1
Sedum album		42	16
Tortella inclinata (E0)		26	2
Dianthus praecox subsp. *lumnitzeri*		13	5
Stipa joannis	Fv	29	8
Campanula sibirica	FB	19	7
Pleurochaete squarrosa (E0)		19	5
Petrorhagia saxifraga		3	5
Poa bulbosa		3	14
Cota tinctoria		.	12
Bryum argenteum (E0)		10	8
Bupleurum affine		.	2
Achillea crithmifolia		.	2
Veronica arvensis		3	20
Bromus japonicus		3	7
Linaria genistifolia		32	34
Melica transsilvanica		3	8
Cleistogenes serotina		.	4
Cruciata pedemontana		.	15
Carex praecox		.	9
Vicia hirsuta		.	11
Festuca pseudodalmatica		3	17
Trifolium arvense	Fv, K-P	.	17
Cerastium brachypetalum		3	18
Hylotelephium maximum		.	5
Cladonia subulata (E0)		.	4
Parmelia conspersa (E0)		.	2
Epilobium collinum		.	2
Verbascum chaixii subsp. *austriacum*		3	16
Achillea nobilis	Fv	.	10
Orobanche alba		6	11
Silene donetzica		.	1
Geranium columbinum		.	5
Prunella laciniata		.	5
Vicia angustifolia		.	5
Ajuga genevensis		3	3
Thymus pannonicus	Fv, FB	16	54
Festuca valesiaca	Fv, FB	13	65
Festuca rupicola	C-B, FB	29	49
Arrhenatherum elatius	FB	10	37
Stipa capillata	Fv	19	32
Viola arvensis		3	25
Stachys recta	B-F, FB	23	39
Sedum sexangulare	Fv, FB	16	38
Medicago minima	Fv	3	26
Thlaspi perfoliatum	FB	13	34
Alyssum alyssoides	Fv	6	21
Melica ciliata	B-F, FB	29	21
Cerastium semidecandrum		3	9
Bromus squarrosus		.	8
Erysimum odoratum		10	18
Astragalus onobrychis	C-B	10	20
Achillea pannonica	Fv	10	27
Oxytropis pilosa		.	1
Crambe tataria		.	1
Helictotrichon desertorum subsp. *barbatum*		.	1
Avenula pratensis			
Plantago lanceolata		26	27
Potentilla argentea		.	13
Anthoxanthum odoratum		.	5
Luzula campestris		.	7
Agrostis capillaris		.	3
Trifolium dubium		.	3
Hypochaeris radicata		.	3
Dianthus armeria		.	3
Jacea pratensis		.	4
Trifolium repens	Cc	.	5
Acetosella vulgaris	K-P	.	4
Vicia tetrasperma		.	12
Steris viscaria	K-P	.	2
Astragalus exscapus	Fv	.	1
Stipa pulcherrima	B-F, Fv	13	16
Stipa tirsa		.	2
Chamaecytisus austriacus		.	4
Filipendula vulgaris		.	12
Scorzonera hispanica		.	7
Trifolium alpestre		.	3
Vincetoxicum hirundinaria		19	12
Avenula pubescens		3	10
Peucedanum cervaria	Gs	3	8
Onobrychis arenaria	C-B	.	3
Chamaecytisus ratisbonensis	C-B	19	5
Geranium sanguineum	Gs	6	8
Inula ensifolia	B-F, FB	23	12
Briza media		3	4
Bromus erectus	C-B, FB	13	16
Polygala major	FB	.	2
Plantago media	C-B, FB	16	18
Brachypodium pinnatum	C-B, Gs, FB	10	4
Orchis militaris		3	2
Carlina vulgaris	C-B	10	9
Carlina acaulis	Be	13	1
Trifolium montanum	Be	.	7
Koeleria pyramidata agg.	Be	.	1
Carex michelii		.	8
Potentilla heptaphylla	FB	10	14
Homalothecium lutescens (E0)	C-B	3	7
Salvia verticillata	FB	3	4
Melampyrum arvense		10	12
Festuco-Brometea	**FB**		
Sanguisorba minor	B-F, C-B	97	72
Tithymalus cyparissias	B-F, Fv, C-B	74	76
Teucrium chamaedrys	B-F, Fv, C-B	58	73
Asperula cynanchica	B-F, Fv, C-B	71	50
Potentilla arenaria	B-F, Fv, K-P	77	55
Acinos arvensis	Fv	52	40
Pimpinella saxifraga agg.	C-B	35	42
Salvia pratensis		39	37
Hypericum perforatum		23	51
Medicago falcata	C-B	29	36
Anthyllis vulneraria	C-B	65	23
Dorycnium pentaphyllum agg.		45	29
Thesium linophyllon		26	30
Colymbada scabiosa	C-B	26	28
Pilosella bauhinii	C-B	32	24
Securigera varia	C-B	10	30
Carex caryophyllea		26	17
Seseli hippomarathrum		23	15
Arabis hirsuta		23	11
Dianthus carthusianorum		16	20
Crinitina linosyris		13	20
Chamaecytisus supinus		3	4
Primula veris		3	2
Bromo pannonici-Festucion pallentis	**B-F**		
Teucrium montanum	FB	77	9
Linum tenuifolium	C-B, FB	65	14
Seseli osseum	FB	52	39
Silene otites	Fv	52	20
Anthericum ramosum	FB	52	18
Helianthemum ovatum	FB	48	23
Allium flavum	FB	19	35
Verbascum lychnitis		3	9
Festucion valesiacae	**Fv**		
Koeleria macrantha	FB	48	77
Eryngium campestre	FB	23	73
Arenaria serpyllifolia	FB	48	53
Acosta rhenana	FB	45	48
Scabiosa ochroleuca	C-B, FB	42	45
Bothriochloa ischaemum	B-F, FB	42	37
Echium vulgare	FB	26	40
Fragaria viridis	FB	13	40
Galium verum	FB	10	61
Elytrigia intermedia		13	46
Poa pratensis agg.		3	55
Adonis vernalis		10	16
Sedum acre		16	10
Veronica prostrata		6	16
Verbascum phoeniceum		.	13
Thymus glabrescens		3	8
Carex supina		3	7
Salvia nemorosa		3	4
Cirsio-Brachypodion pinnati	**C-B**		
Viola hirta	FB	16	12
Bupleurum falcatum		16	12
Agrimonia eupatoria	FB	.	8
Linum catharticum	FB	6	2
Ononis spinosa	FB	.	5
Aster amellus		3	2
Veronica teucrium		.	3
Linum flavum		.	3
Koelerio-Phleion phleoidis	**K-P**		
Pseudolysimachion spicatum		26	20
Pilosella officinarum		23	20
Phleum phleoides		6	26
Trifolium campestre		.	22
Euphrasia stricta		6	2
Cladonia rangiformis (E0)		6	4
Orthantha lutea		.	3
Arrhenatherion elatioris	**Ae**		
Dactylis glomerata		.	7
Knautia arvensis		.	7
Leontodon hispidus		.	4
Leucanthemum vulgare		.	4
Galium mollugo agg.		.	4
Other taxa			
Lotus corniculatus agg.		16	35
Dianthus pontederae		16	26
Erysimum diffusum agg.		19	15
Odontites vulgaris		19	12
Crataegus monogyna juv.		10	14
Cerastium pumilum agg.		13	12
Seseli annuum		10	12
Rosa canina agg. juv.		10	22
Reseda lutea		26	7
Iris pumila		16	10
Saxifraga tridactylites		10	10
Chondrilla juncea		10	10
Trinia glauca		10	9
Senecio jacobaea		6	8
Cuscuta sp.		6	8
Achillea collina		6	29
Leopoldia comosa		6	13
Acosta biebersteinii		6	12
Falcaria vulgaris		3	27
Convolvulus arvensis		3	20
Petrorhagia prolifera		3	16
Ornithogalum kochii		3	15
Poa compressa		3	12
Veronica austriaca		3	12
Cuscuta epithymum		3	10
Allium senescens subsp. *montanum*		19	4
Genista pilosa		19	1
Pulsatilla grandis		10	5
Tithymalus seguierianus		10	4
Orobanche sp.		10	3
Polygala comosa		10	2
Polygonatum odoratum		10	1
Asplenium ruta-muraria		10	.
Avenula praeusta		6	7
Thalictrum minus		6	5
Lappula squarrosa		6	5
Holosteum umbellatum		6	5
Orobanche caryophyllacea		6	4
Orlaya grandiflora		6	4
Myosotis arvensis		6	4
Carduus nutans		6	4
Camelina microcarpa		6	3
Peucedanum oreoselinum		6	3
Quercus pubescens agg.		6	2
Asperula tinctoria		6	2
Bromus pannonicus		6	2
Arabis auriculata		6	2
Galium pumilum agg.		6	2
Minuartia rubra		6	1
Dictamnus albus		6	1
Silene vulgaris		6	1
Viola rupestris		6	1
Prunus spinosa		3	8
Cyanus triumfettii		3	7
Taraxacum sect. *Erythrosperma*		3	5
Hesperis tristis		3	5
Muscari tenuiflorum		3	5
Scorzonera purpurea		3	4
Fragaria vesca		3	3
Sesleria albicans		3	2
Fraxinus ornus juv.		3	2
Myosotis ramosissima		.	15
Bromus hordeaceus subsp. *hordeaceus*		.	14
Picris hieracioides		.	13
Cota tinctoria		.	12
Medicago lupulina		.	10
Tragopogon dubius		.	9
Erodium cicutarium		.	9
Arabidopsis thaliana		.	9
Hesiodia montana		.	8
Valerianella locusta		.	8
Asparagus officinalis		.	8
Rhinanthus minor		.	7
Campanula bononiensis		.	7
Allium sphaerocephalon		.	7
Arabis glabra		.	7
Lepidium campestre		.	7
Daucus carota		.	7
Inula oculus-christi		.	5
Veronica chamaedrys		.	5
Calamagrostis epigejos		.	5
Hieracium sabaudum		.	5
Potentilla neglecta		.	5
Lembotropis nigricans		.	5
Stenactis annua		.	5
Ranunculus illyricus		.	5
Genista tinctoria		.	5
Taraxacum sect. *Ruderalia*		.	4
Achillea millefolium agg.		.	4
Elytrigia repens		.	4
Silene nutans		.	4
Potentilla recta		.	4
Peucedanum alsaticum		.	4
Myosotis stricta		.	4
Verbascum sp.		.	4
Berteroa incana		.	4
Cerastium sp.		.	4
Lactuca serriola		.	4
Linum austriacum		.	4
Lactuca viminea		.	4
Orchis sp.		.	3
Ornithogalum umbellatum		.	3
Orobanche teucrii		.	3
Potentilla reptans		.	2
Ranunculus polyanthemos		.	3
Verbascum speciosum		.	3
Viola tricolor		.	3
Robinia pseudacacia juv.		.	3
Trifolium pratense		.	3
Cerastium holosteoides		.	3
Artemisia absinthium		.	3
Allium vineale		.	3
Inula hirta		.	3
Galium spurium		.	3
Inula salicina		.	3
Erophila verna		.	3
E0			
Hypnum cupressiforme		26	37
Tortula ruralis		35	12
Thuidium abietinum		19	25
Bryum caespiticium		23	14
Cladonia furcata		6	12
Didymodon acutus		6	9
Tortella tortuosa		23	4
Ditrichum flexicaule		19	3
Peltigera rufescens		13	4
Aspicilia contorta		16	2
Cladonia sp.		13	2
Cladonia pocillum		10	3
Encalypta streptocarpa		10	2
Toninia sedifolia		10	1
Protoblastenia rupestris		10	.
Verrucaria sp.		6	3
Cladonia symphycarpa		9	2
Ceratodon purpureus		3	9
Cladonia pyxidata		3	4
Parmelia pulla		3	3
Weissia controversa		3	3
Caloplaca holocarpa		3	2
Campylium chrysophyllum		3	2
Rhytidium rugosum		3	2
Tortula intermedia		.	7
Eurhynchium schleicheri		.	5
Brachythecium glareosum		.	5
Bryum capillare		.	5
Brachythecium albicans		.	5
Homalothecium sericeum		.	4
Cladonia fimbriata		.	4
Lecanora muralis		.	4
Toninia sp.		.	3
Racomitrium canescens		.	3

Species that occur in only one or two relevés:
E2: *Berberis vulgaris* 118: +; *Crataegus laevigata* 14: +; *Fraxinus ornus* 36: +, 65: +; *Juniperus communis* 38: 1; *Pinus nigra* 82: +; *Pinus sylvestris* 82: +; *Prunus fruticosa* 76: +; *Prunus mahaleb* 65: +; *Prunus spinosa* 111: +; *Quercus pubescens* agg. 38: +; *Rhamnus cathartica* 116: +; *Swida sanguinea* 46: +; *Ulmus minor* 46: 1;
E1: *Acer platanoides* 29: r; *Acetosa pratensis* 40: r, 105: +; *Achillea ochroleuca* 65: 1, 67: +; *A. setacea* 70: 1, 93: a; *Agrostis vinealis* 98: +; *Ajuga chamaepitys* 47: +; *A. reptans* 60: r; *Alliaria petiolata* 60: r; *Allium carinatum* 3: +; *A. ochroleucum* 42: r; *A. oleraceum* 79: 1; *A. scorodoprasum* 27: +, 75: 1; *Allium* sp. 108: +; *Alopecurus pratensis* 105: +; *Alyssum* sp. 21: +; *Anagallis arvensis* 75: r; *Anchusa officinalis* 76: +; *Anthemis austriaca* 34: +; *Arabis turrita* 121: r; *Arenaria procera* 67: +; *Artemisia pontica* 67: +; *Astragalus austriacus* 18: +, 20: +; *A. vesicarius* subsp. *albidus* 66: +; *Avenula compressa* 113: +; *A. pratensis* 12: +, 95: r; *Barbarea vulgaris* 111: r; *Betonica officinalis* 122: +; *Biscutella laevigata* 76: 1, 78: +; *Botrychium lunaria* 22: +; *Brachypodium sylvaticum* 13: r, 29: +; *Bromus commutatus* 98: +; *B. inermis* 75: 1; *Bromus* sp. 32: r; *B. sterilis* 93: +; *B. tectorum* 39: +, 54: +; *Bupleurum praealtum* 65: +, 67: r; *Campanula glomerata* 68: +; *C. moravica* 76: 1; *C. patula* 105: +; *C. rotundifolia* 31: r; *Carduus acanthoides* 74: 1, 91: r; *C. collinus* 42: r, 89: r; *C. hamulosus* 69: +; *Carex digitata* 29: r; *C. flacca* 4: +, 119: 1; *C. hirta* 107: +; *C. liparocarpos* 7: +, 67: +; *C. montana* 42: +; *C. muricata* agg. 107: r; *C. pallescens* 107: r; *Carex* sp. 4: +, 110: +; *C. stenophylla* 65: r; *C. tomentosa* 120: b; *Carpinus betulus* 120: r; *Caucalis platycarpos* 65: r, 67: +; *Centaurea* sp. 46: +; *Centaurium erythraea* 107: r; *Cerastium arvense* 29: +, 101: +; *C. glomeratum* 56: m; *Cerinthe minor* 41: +, 47: +; *Chamaecytisus albus* 122: 3; *C. hirsutus* 63: 1, 87: +; *C. virescens* 77: +; *Cichorium intybus* 107: r, 108: +; *Cirsium arvense* 107: r; *C. vulgare* 43: +, 121: +; *Clematis vitalba* 21: r; *Clinopodium vulgare* 46: +, 123: +; *Convolvulus cantabrica* 65: r, 69: 1; *Conyza canadensis* 75: +; *Cotinus coggygria* 10: r; *Crataegus laevigata* 77: +, 105: r; *Crepis pulchra* 65: r; *Crupina vulgaris* 67: +, 69: +; *Cynoglossum officinale* 34: r; *Danthonia alpina* 110: +; *Dianthus deltoides* 108: +; *Draba lasiocarpa* 5: +, 27: +; *Dryopteris filix-mas* 39: r; *Erigeron acris* 40: +, 107: r; *Erucastrum nasturtiifolium* 32: +; *Euphrasia tatarica* 40: +; *Fallopia convolvulus* 38: r, 65: +; *Festuca pratensis* 107: r; *F. pseudovina* 47: 3; *F. stricta* 12: a; *Filago vulgaris* 39: +; *Fumaria* sp. 47: r; *Galium aparine* 34: r, 65: r; *Geranium divaricatum* 65: +; *Gymnadenia conopsea* 116: +; *Helichrysum arenarium* 83: +; *Hornungia petraea* 76: +, 77: +; *Inula conyza* 30: r; *Jacea pannonica* 37: r, 111: r; *J. stenolepis* 32: 1, 108: a; *Juniperus communis* 120: r; *Knautia kitaibelii* 55: +; *Lactuca perennis* 65: +, 67: r; *Lamium amplexicaule* 88: r; *Lappula heteracantha* 65: b; *Lathyrus nissolia* 37: +; *Lavatera thuringiaca* 112: +; *Libanotis pyrenaica* 101: +, 118: +; *Ligustrum vulgare* 41: +, 60: +; *Linaria vulgaris* 93: +; *Lithospermum arvense* 65: r, 103: +; *Lychnis coronaria* 108: 1; *Melampyrum* sp. 111: r; *Melilotus officinalis* 1: +, 60: r; *Melilotus* sp. 47: +; *Minuartia setacea* 50: +, 77: 1; *Minuartia* sp. 32: +; *Muscari neglectum* 90: +, 91: +; *Nonea pulla* 59: r, 103: +; *Odontites* sp. 108: +; *Ononis arvensis* 12: r, 95: +; *O. pusilla* 90: +; *Onosma visianii* 9: r; *Ophrys insectifera* 29: r; *Orchis morio* 111: r; *O. purpurea* 17: +, 48: +; *Origanum vulgare* 103: +, 123: +; *Ornithogalum pannonicum* 8: r; *Ornithogalum* sp. 32: 1, 66: +; *Orobanche lutea* 85: +; *Papaver dubium* subsp. *austromoravicum* 51: +, 59: +; *Phlomis tuberosa* 35: r; *Pilosella auriculoides* 35: +; *P. densiflora* 103: +; *P. echioides* 94: +, 101: +; *Pinus sylvestris* 4: r, 40: r; *Poa nemoralis* 39: b, 67: +; *Poa pannonica* subsp. *scabra* 38: b; *Polygonum arenarium* 38: +; *Potentilla rupestris* 106: r; *Prunella grandiflora* 4: 1; *Prunus domestica* 105: r; *Prunus* sp. 102: r; *Pseudolysimachion orchideum* 105: b; *Pulmonaria mollis* 41: +; *Pulsatilla pratensis* subsp. *bohemica* 14: +, 15: +; *Pyrus communis* 120: r; *P. pyraster* 35: +, 92: +; *Quercus cerris* 42: r; *Quercus* sp. 3: +; *Ranunculus acris* 107: r; *R. bulbosus* 29: r; *R. pedatus* 113: r; *Reseda phyteuma* 9: r; *Rhamnus cathartica* 24: +, 118: +; *R. saxatilis* 14: +, 15: +; *Rhinanthus* sp. 53: +, 75: +; *Rosa gallica* 37: +, 113: +; *R. pimpinellifolia* 67: 1, 105: +; *Saxifraga bulbifera* 111: +; *Scabiosa canescens* 4: a; *Scleranthus annuus* 39: m; *Seseli pallasii* 91: +; *Sesleria sadleriana* 24: +; *Setaria viridis* 32: 1, 75: 1; *Silene dioica* 114: +; *S. latifolia* 81: +; *Sorbus aria* agg. 17: r, 31: r; *Stellaria graminea* 107: r; *S. media* 35: r; *Swida sanguinea* 47: +, 118: +; *Symphytum tuberosum* 62: r; *Tanacetum corymbosum* 62: +, 84: r; *Tephroseris integrifolia* 90: +; *Thalictrum foetidum* 72: a; *T. minus* subsp. *pseudominus* 10: +; *Thlaspi jankae* 52: +; *Thlaspi* sp. 59: +; *Thymus pulcherrimus* subsp. *sudeticus* 21: 1; *T. pulegioides* 123: +; *Thymus* sp. 94: 1; *Tithymalus epithymoides* 44: +; *T. esula* 45: +; *T. glareosus* 48: +; *T. tommasinianus* 47: +, 114: +; *Tragopogon* sp. 58: +; *Trifolium ochroleucon* 37: r; *Trisetum alpestre* 111: 1; *Triticum* sp. 116: r; *Ulmus minor* 65: 1, 76: +; *Valerianella carinata* 46: +, 47: +; *Valerianella* sp. 68: +; *Ventenata dubia* 111: r; *Veronica dillenii* 51: +; *V. hederifolia* agg. 60: r; *V. praecox* 100: r; *V. serpyllifolia* 107: r; *Vicia cracca* 107: +, 108: +; *V. lathyroides* 35: r, 42: +; *V. tenuifolia* 44: +; *Vinca herbacea* 66: +; *Viola* sp. 43: +; *Xeranthemum annuum* 34: r, 65: 1;
E0: *Aspicilia* sp. 24: +; *Bacidia bagliettoana* 10: +; *Barbula unguiculata* 62: +, 121: +; *Brachythecium starkei* 105: 1; *Caloplaca aurantia* 84: +; *C. lactea* 7: +, 87: +; *Cladonia pyxidata* subsp. *chlorophaea* 42: +; *C. coniocraea* 42: +, 72: +; *C. convoluta* 8: +, 55: +; *C. polycarpoides* 57: +, 79: +; *Collema tenax* 31: +; *Didymodon cordatus* 7: +; *D. fallax* 102: +; *Ditrichum heteromallum* 50: 1; *Encalypta vulgaris* 24: +; *Eurhynchium hians* 46: 1; *Fissidens taxifolius* 4: +; *Grimmia anodon* 38: +, 65: +; *Hypnum vaucheri* 8: +; *Lecanora argopholis* 34: +; *L. polytropa* 110: +; *Lecidella carpathica* 38: +; *Leucodon sciuroides* 72: +; *Mannia fragrans* 25: +; *Nostoc* sp. 22: +; *Orthotrichum cupulatum* 20: +, 84: +; *Peltigera collina* 50: +; *Peltigera* sp. 106: +; *Phascum cuspidatum* 80: +, 111: +; *Physcia adscendens* 73: +; *Physcia* sp. 65: +; *P. wainioi* 38: +; *Placynthiella* sp. 58: +; *Plagiomnium affine* 105: +, 111: +; *Pogonatum urnigerum* 39: +; *Polytrichum juniperinum* 40: +; *Pottia lanceolata* 39: +, 89: +; *Pseudoscleropodium purum* 98: +; *Psora decipiens* 19: +, 25: +; *Pterygoneurum subsessile* 89: +; *Pleuroscleropodium purum* 111: +; *Rhynchostegium megapolitanum* 100: +, 102: +; *Schistidium apocarpum* 25: +; *Staurothele hymenogonia* 9: +; *Staurothele rufa* 6: +; *Thuidium philibertii* 29: +; *Trichostomum crispulum* 29: +, 84: +; *Verrucaria muralis* 5: +, 19: +; *V. nigrescens* 24: +, 84: +; *Weissia longifolia* 87: +; *Xanthoparmelia somloensis* 12: +;