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THE ASSOCIATION *ERYSIMO - TRIFOLIETUM* MICEV. 1977 IN BULGARIA AND SOME REMARKS ON ITS MEDITERRANEAN CHARACTER

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Abstract

We endeavor to enlarge the knowledge about Bulgarian vegetation diversity. Data on seminatural grasslands containing 344 relevés, collected in Southeast Bulgaria were analyzed by the combine method, using TWINSPAN and the Cocktail method. The *Erysimo diffusii-Trifolietum angustifolii* association and the alliance *Trifolion cherleri* were established for the first time in Bulgaria. So far the presence of this association was known for Macedonia. The aims of our study are to present more data about the *Erysimo-Trifolietum* in Bulgaria and to make some comments about its affiliation to *Helianthemetea guttati*. The association is characterized ecologically and floristically. Analysis of the floristic elements shows that the most numerous are sub-Mediterranean species. Analysis of the life forms shows that these communities are hemicryptophyte-therophytic. A review of syntaxonomical systems and association assignment to higher syntaxa were made. According to current European vegetation surveys the association should be related to class *Helianthemetea guttati*. Our results reveal an intermediate character of the studied vegetation – closed dry grasslands, with distinct presence of *Festuco-Brometea* species with a high percent of therophytes and Mediterranean floristic elements related to *Helianthemetea guttati* as well.
Key words: dry grasslands, syntaxonomy, *Helianthemetea guttati*.

Izvleček

Članek je prispevek k poznavanju raznovrstnosti vegetacije Bolgarije. Podatke, ki obsegajo 344 popisov, narejenih v jugovzhodni Bolgariji, smo analizirali s kombinacijo metod TWINSPAN in Cocktail. Asociacija *Erysimo diffusii-Trifolietum angustifolii* in zveza *Trifolion cherleri* sta prvič omenjeni v vegetaciji Bolgarije. Do sedaj je bila prisotnost te asociacije poznana le v Makedoniji. Namen raziskave je predstaviti dodatne podatke o asociaciji *Erysimo-Trifolietum* v Bolgariji in podati nekaj komentarjev o njeni uvrstitvi v razred *Helianthemetea guttati*. Asociacija je označena ekološko in floristično. Analiza flornih elementov je pokazala, da so submediteranske vrste najštevilnejše. Analiza življenjskih oblik pa, da je to hemikriptofitsko-terofitska združba. Opravljen je pregled sinataksonomskega sistema in uvrstitev v višje sintaksone. Po trenutnem pregledu evropske vegetacije jo uvrščamo v razred *Helianthemetea guttati*. Naši rezultati pa razkrivajo vmesni značaj obravnavane vegetacije – sorodnost s suhimi travniki s prisotnostjo vrst *Festuco-Brometea* in visokim odstotkom terofitov in z razredom *Helianthemetea guttati*, ki ga označujejo mediteranski elementi.
Ključne besede: suhi travniki, sintaksonomija, *Helianthemetea guttati*.

1. INTRODUCTION

The Bulgarian phytogeographic position predetermines conditions for the presence of Central European as well as Mediterranean floristic elements, i.e. respective vegetation types (cf. Bohn et al. 2003). Unlike the vegetation of most European countries, Bulgarian vegetation is still poorly studied following the floristic criteria. Up to the recent several years in the phytosociological investigations the dominance approach was applied (Apostolova & Slavova 1997). This results in questions so far unanswered, as for example "what is the diversity of alliances and associations within the class *Festuco-Brometea* in the country", or "does *Helianthemetea guttati* reach the country territory"? During the Bulgarian grassland inventory (Meshinev et al. 2005) Mediterranean floristic elements in the her-

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baceous vegetation of southern Bulgarian regions, were distinguished, and the *Thero-Brachypodietea* class was reported for the country.

The *Erysimo-Trifolietum* association, which is the subject of the current study, is described by Micevski (1977). This association belongs to the *Trifolion cherleri* Micev. 1970 alliance. It is widely distributed in the central north and northeastern parts of the Republic of Macedonia (Micevski 1977).

The presence of similar communities in the territories surrounding Bulgaria poses a question about the existence of the same vegetation in the country. The aims of this study are to present more data about the *Erysimo-Trifolietum* association and to make some comments about its affiliation to *Helianthemetea guttati*.

2. MATERIAL AND METHODS

The study region is situated, between 42–43° N and 26–27° E, in Southeast Bulgaria (Fig. 1). It is assigned to the Straldzha-Aitos phytogeographic region (Bondev 2002). The region is characterized by mild climate with mean annual temperatures 12.2 °C for the Aitos and Yambol, 12.4 °C for Sliven and mean annual precipitation 490.6 mm for Aitos, 567 mm for Sliven and 535.9 mm for Yambol (unpublished data provided by Bulgarian National Institute of Meteorology and Hydrology, Bulgarian Academy of Sciences). Field investigations were carried out throughout the years 2004 and 2005, according to the methods of the Braun-Blanquet School (Braun-Blanquet 1964, Westhoff & van der Maarel 1980). The data about natural and semi-natural grassland vegetation were sampled. The total number of collected relevés was 344. The standard relevé area was 16 m^2 (Chytrý & Otýpková 2003). The cover of vascular plant and bryophyte was estimated using the nine-grade Braun-Blanquet scale (Barkman et al. 1964). Altitude and coordinates were measured by GPS Garmin Etrex Summit (WGS 84 system) with altimeter calibrated by current atmospheric pressure. Slope, soil depth and soil moisture were estimated.

The nomenclature of vascular plants follows Kozhuharov (1992) and the bryophyte nomenclature follows Natcheva & Ganeva (2005). The floristic elements were established according to Assyov & Petrova (2006) for the vascular plants and according to Ganeva & Düll (1999) for the bryophytes. Life forms are estimated using the data about biological types in Kozhuharov (1992).

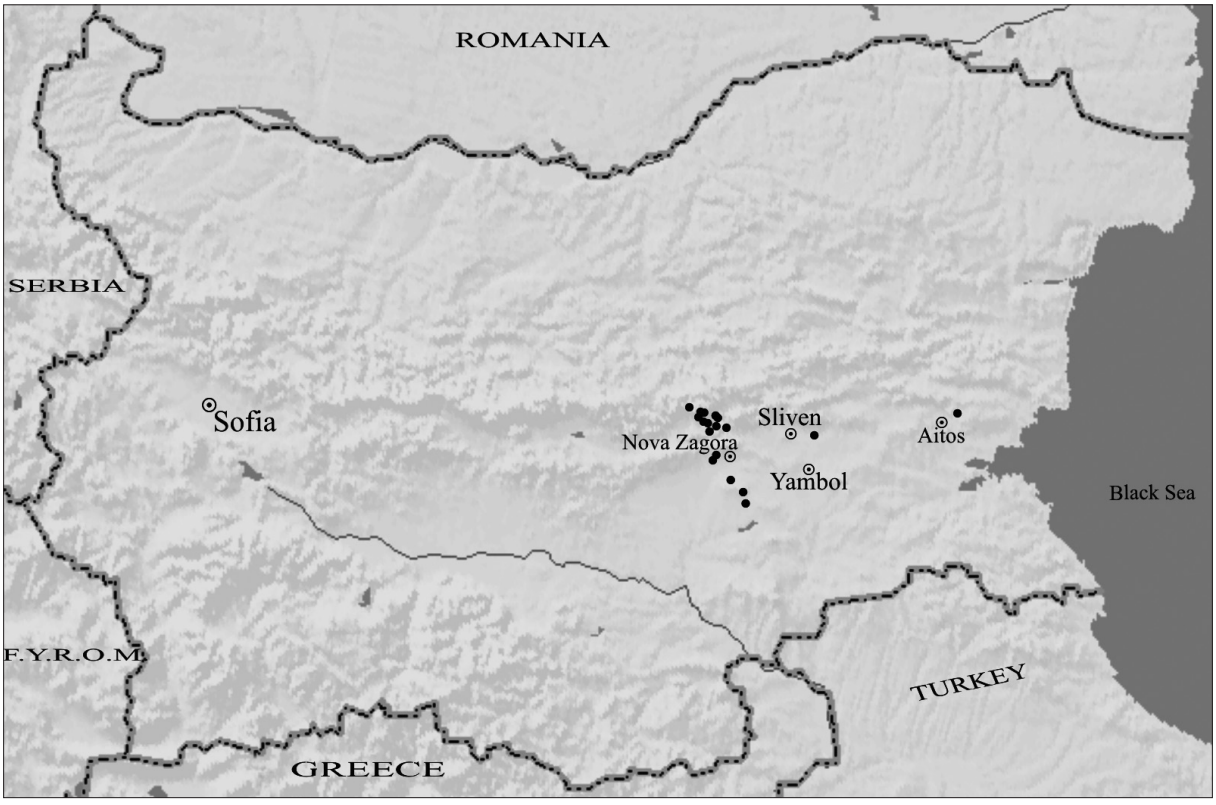

Figure 1: Points of the studied localities. / **Slika 1:** Lokacije proučevanih sestojev.

The data set was entered and stored in the TURBOVEG database (Hennekens & Schaminée 2001) and then exported into JUICE software (Tichý 2002). A polythetic, divisive classification that uses two-way indicator species analysis (TWINSPAN, Hill 1979) was applied. The resulting vegetation types roughly corresponded with the phytosociological alliances. These vegetation types were then checked by the statistical tendency of species to have a joint occurrence in vegetation by the Cocktail method (Bruelheide 1995), using the phi-coefficient (Chytrý et al. 2002). The Cocktail method and phi-coefficient were used to find the diagnostic species. Based on results of the Cocktail method, several relevés were manually moved within the groups for better representation of the diagnostic species groups. All undetermined groups were removed from the subsequent analysis. As a result the amount of 175 phytosociological relevés was classified into six alliances, and in the synoptic tables species were ranked according to their fidelity value for individual clusters (Sopotlieva in press). Fidelity was calculated by the phi-coefficient of association, applied to the classified data set with equalised sizes of clusters according to Tichý & Chytrý (2006). Within the alliances, the associations were recognized after referring to the appropriate literature.

Soil samples were collected in the studied area at 5–10 cm depth and basic soil properties (pH, electrical conductivity, humus content, concentration of $CaCO_3$) were analysed. The samples were air-dried. The pre-treatment of samples for chemical analyses follows ISO 11464:1994 (E). Electrical conductivity (EC) and pH were measured in water solution using a 1:5 soil:water ratio and using pH-meter Jenway3310 (ISO 10390:1994 (E)). $CaCO_3$ concentration was measured in 1:10 water solution using Photometer PC 22, the results are presented as mg/l. Humus was determined according to the modified Turin method (Kononova 1966). All the analyses were performed in the Analytical Laboratory, Department of Phytocoenology and Ecology in the Institute of Botany, Bulgarian Academy of Sciences.

3. RESULTS AND DISCUSSION

Detailed sampling of grassland diversity in the Straldzha – Aitos phytogeographic region revealed the presence of *Trifolion cherleri* alliance. All relevés confined to this cluster were homogenous and obviously belong to one association. So far several different associations are described within this alliance (Micevski 1972, 1973, 1977, Micevski & Matevski 1984, Matevski & Kostadinovski 1998). Based on the diagnostic species group, in the studied region appears the association *Erysimo-Trifolietum* Micev. 1977. It is documented by 18 phytosociological relevés and is reported for the first time for Bulgaria.

Characteristics of the association in Bulgaria

Our investigation shows that its communities predominantly cover terrains with sunny expositions and slopes up to 15°. Soils are shallow or with medium depth and dry. So, the terrains are similar to those in Macedonia, as compared with the data published by Micevski (1977). The altitude ranges between 200 and 350 m, while in Macedonia it reaches up to 900 m above sea level. From the mean values of the examined soil parameters it appears that in Bulgaria the association *Erysimo-Trifolietum* grows on slightly acidic to neutral soils (average pH 6.22) with average electrical conductivity 37.3 $\mu S.cm^{-1}$. The organic matter varies, but most often it is between 2–3 %, which corresponds with the considerably low nutritient availability. $CaCO_3$ has an average content of 51.3 $mg.l^{-1}$ (Table 2).

The floristic composition of the association is shown in Table 1. The plants diversity includes 161 taxa. The average number of species per relevé is 31.4. As compared with the relevés published by Micevski (1977) species diversity in Macedonia is higher.

The association character species, in our data (*Trifolium angustifolium, Vulpia myurus, Erysimum diffusum, Trifolium striatum*) (Table1) includes species with highest constancy among the character species for the association, as described by Micevski (1977). In Bulgaria these species grow in dry grasslands communities in lowlands and hilly regions (Kozhuharov 1992), and thus they correspond well to the ecological conditions, occupied by the communities of the association.

The *Trifolion cherleri* alliance is represented by 11 species (Table 1). The relatively low constancy (II) of most of the species, which belong to alliance *Trifolion cherleri*, including the clover *Trifolium cherleri*, could be explained by the fact that our data were sampled from the region situated further north than the still known areal of the association. Micevski (1977) mentions that northward the com-

munities start to lose some diagnostic species. According to him, among the other *Trifolion cherleri* associations (*Tunico-Trisetum myrianthi* Micev. 1972, *Helianthemo-Euphorbietum thessalae* Micev. 1973, *Diantho-Cistetum incani* Micevski & Matevski 1984, *Biserrulo-Scleranthetum dichotomae* Matevski & Kostadinovski 1998), *Erysimo-Trifolietum* association has the most continental character. The author states also that this is obvious by the decreasing number, abundance and constancy of the Mediterranean species. The clover *Trifolium cherleri*, the most character species to the alliance, has a V degree of constancy in the associations *Tunico-Trisetum myrianthi* and *Helianthemo-Euphorbietum thessalae*, but in the *Erysimo-Trifolietum* it has different constancy in the different areas or does not occur in all the localities of association in Macedonia.

The analysis of the floristic elements shows that the most numerous are sub-Mediterranean species (28), followed by Euro-Asiatic (25); Euro-Mediterranean and Euro-sub-Mediterranean (24); Mediterranean (16); boreal and sub-boreal (10); Pontic-Mediterranean (9); Pontic and Pontic-Siberian (9); Balkan, Balkan-Dacian, Pannonian-Balkan and Apenninian-Balkan (9). The other types contain 7 or less than 7 species (Table 1). Thus the Mediterranean floristic element (including Mediterranean, sub-Mediterranean, Euro-Mediterranean and Euro-sub-Mediterranean) has a convincing presence in the studied vegetation (42 %).

Analysis of the types of life forms shows that these communities are hemicryptophyte-therophytic, which also emphasizes their southern affiliation (Table 1). The therophytes are 68 species (42 %). The other approximately one half of the species are hemicriptophytes.

Association assignment to the higher syntaxonomical level

As proposed by the Braun-Blanquet School, assignment of an association to an alliance (and other higher units) is primarily based on comparison of floristic relationships (Westhoff & van der Maarel 1980). In this respect, in the original data (Micevski 1977), as well as in our data, the *Erysimo-Trifolietum* association contains a well-defined group of diagnostic species of alliance *Trifolion cherleri* and undoubtedly belongs to this alliance.

The *Trifolion cherleri* alliance is described as "silicicolous therophyte swards of submediterranean character in Macedonia and northern Greece" (Rodwell et al. 2002). This alliance has not been established in Bulgaria so far. Thus our results prove its enlargement to the North-East.

The position of the alliance *Trifolion cherleri* in the syntaxonomical system and its relation to higher syntaxa is problematic. When it was described, it was assigned to the order *Astragalo-Potentilletalia* Micev. 1970 without any decision about the affiliation to a class (Micevski 1970). In the later publications (Micevski 1978; Micevski & Matevski 1984) the alliance as well as the order was assigned to the class *Festuco-Brometea*. This class includes grasslands of the temperate and sub-boreal regions (Mucina 1997). Such position presumes a more continental character of the communities of the alliance.

According to the current syntaxonomical vision about European vegetation (Rodwell et al. 2002), *Trifolion cherleri* belongs to *Helianthemetalia guttati* Br.-Bl. in Br.-Bl., Molinier & Wagner 1940 and *Helianthemetea guttati* (Br.-Bl. in Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas-Martínez 1963 em. Rivas-Martínez 1978, which perceives its Mediterranean character.

Analysis of the floristic composition of the *Erysimo-Trifolietum* association in Straldzha-Aitos phytogeographic region shows that order *Astragalo-Potentilletalia* is represented by 15 diagnostic species and class *Festuco-Brometea* is represented by 30 diagnostic species (Table 1), while to the *Helianthemetalia guttati* belong 7 such species. Class *Helianthemetea guttati* is represented by 7 species, but four of them occur only in one relevé. These results reveal an intermediate character of studied vegetation – closed dry grasslands, with distinct presence of *Festuco-Brometea* species as well with a high percent of therophytes and Mediterranean floristic elements. In the monograph about the class *Festuco-Brometea* Royer (1991) comments on the existence of heterogenic groups in Bulgaria, Macedonia, Serbia and probably in Greece, which belong to the class *Thero-Brachypodietea* with penetrating *Festuco-Brometea* species. Royer (1991) states that the border between these two classes probably lies in Southern Bulgaria. The studied vegetation type the author assigns to *Astragalo-Potentilletalia* and *Thero-Brachypodietea*, i.e. to the vegetation with Mediterranean character.

In some overviews of the Balkan Peninsula vegetation (Horvat et al. 1974; Wendelberger 1965) *Trifolion cherleri* is not mentioned. Recently, critical revision of *Helianthemetalia guttati* (Pérez Prieto & Font 2005) considers only West Mediterranean and does not include this Balkan alliance.

Even at the broad level of classes, different syntaxonomical schemes were proposed without universal acceptance. During the development of syntaxonomy, within the sandy dry grasslands and related vegetation types of Europe, different vegetation classes were described (Dierschke 1986). Among them, according to Mucina (1997), classes *Helianthemetea guttati* and *Poetea bulbosae* are syntaxonomical synonyms of class *Thero-Brachypodietea*. Rodwell et al. (2002) published the more finely divided scheme and accepted *Helianthemetea guttati* and *Thero-Brachypodietea ramosi* as distinct classes within Mediterranean vegetation. This reveals the need of critical revision for dry grassland vegetation in South-East Europe.

4. CONCLUSIONS

The *Erysimo-Trifolietum* association as well as the *Trifolion cherleri* alliance is distributed in Bulgaria. Despite the fact that these syntaxa are documented only by 18 relevés, the intermediate character of the studied vegetation between the continental and Mediterranean dry grasslands is obvious. This is witnessed by the statements (Royer 1991) that the border between *Festuco-Brometea* and *Helianthemetea guttati* lies in Southern Bulgaria.

Further investigations in Bulgaria would be very useful not only to reveal Bulgarian vegetation diversity, but also to help outlining the border between continental and Mediterranean vegetation in the South-East, as well to support the better understanding of European vegetation diversity.

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Table 1: *Erysimo-Trifolietum* association.
Tabela 1: Asociacija *Erysimo-Trifolietum.*

Number of relevé			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	
Altitude [m]			318	316	246	268	300	340	269	355	268	200	325	300	345	281	285	322	283	264	
Exposition	**Life forms**	**Floristic elements**		W	E	W	S	SW	N	S	NW			W	N	SW	S		S	W	**Constancy**
Cover [%]			80	95	90	70	90	95	85	90	100	85	85	75	95	90	85	85	85	85	
Number of species			26	34	28	30	31	32	27	46	38	19	30	30	28	33	37	34	32	31	
Char. for Association																					
Trifolium angustifolium	Th	med	+	+	+	+	+	1	.	+	.	.	.	+	+	+	+	.	.	.	IV
Vulpia myurus	Th	subboreal	.	2m	2b	2a	+	.	.	.	+	2b	.	.	.	.	.	.	.	+	II
Erysimum diffusum	H	eur	+	.	.	.	.	.	+	.	.	.	1	.	.	.	.	+	+	.	II
Trifolium striatum	Th	eur-med	1	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	II
Trifolion cherleri																					
Trifolium arvense	Th	eur-sib	1	+	+	1	+	.	+	.	1	.	.	+	+	+	+	+	+	+	IV
Rumex acetosella	H	eur-submed	1	.	1	+	.	1	.	.	+	.	.	.	+	+	1	1	1	+	IV
Logfia minima	Th	eur-sib	.	+	.	.	.	.	+	+	.	.	.	.	.	+	+	.	.	+	II
Petrorhagia prolifera	Th	pont-med	.	.	.	+	1	.	.	+	+	+	.	+	.	.	r	.	.	.	II
Trifolium cherleri	H	med	1	.	.	.	2m	.	.	.	.	.	.	+	.	+	+	.	.	.	II
Vulpia ciliata	Th	med-as	.	.	.	.	.	.	+	.	.	.	2b	.	.	.	1	2b	2a	.	II
Taeniatherum caput-medusae	Th	eur-as	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	+	.	.	II
Aira elegantissima	Th	med	.	2m	.	.	.	.	.	.	.	.	.	.	2a	+	+	.	.	+	II
Linaria pelisseriana	Th	med	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+	II
Silene subconica	Th	submed	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Sedum caespitosum	H	med	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Helianthemetalia guttati																					
Psilurus incurvus	Th	submed	+	+	.	+	+	.	1	.	.	1	.	+	+	+	1	.	1	.	IV
Trifolium strictum	Th	eur-sib	.	+	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	II
Filago lutescens	Th	boreal	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Helianthemetea guttati																					
Trifolium campestre	Th	eur-med	1	+	+	+	+	+	1	+	+	+	+	.	+	+	+	.	2a	+	V
Arenaria leptoclados	Th	eur-as	.	.	+	.	+	+	.	.	.	.	+	.	.	.	+	+	.	.	II
Medicago minima	Th	eur-as	.	.	.	.	.	1	.	+	.	.	2b	.	.	.	.	2b	.	.	II
Cerastium pumilum	Th	eur-med	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	I
Scleranthus polycarpos	Th	submed	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Arenaria serpyllifolia	Th	eur-as	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Acinos arvensis	Th	eur-med	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Festuco-Brometea																					
Eryngium campestre	H	pont-med	+	+	+	1	+	.	1	+	+	+	1	+	+	+	+	1	+	.	V
Poa bulbosa	H	eur-as	.	.	2m	1	3	+	+	+	+	.	.	3	+	+	2a	1	1	1	IV
Sanguisorba minor	H	subboreal	+	1	+	.	.	1	+	+	.	.	+	1	+	+	+	+	1	1	IV
Thymus striatus	H	submed	.	+	.	.	2a	1	1	2b	+	.	.	+	+	+	1	.	+	+	IV
Festuca valesiaca	H	pont	.	2b	2b	.	2a	4	2b	2a	+	.	.	1	.	2a	.	.	.	.	III
Chondrilla juncea	H	eur-sib	+	.	.	+	.	+	.	+	.	+	+	r	.	.	+	.	+	.	III
Euphorbia cyparissias	H	eur	+	r	.	.	.	1	+	.	.	.	+	.	r	.	1	.	+	.	III
Koeleria nitidula	H	pont	.	+	.	.	.	+	+	.	+	.	.	.	r	4	2a	.	+	+	III
Chrysopogon gryllus	H	pont-med	.	2b	.	.	r	.	.	.	4	.	.	.	.	r	2a	.	.	3	II
Galium verum	H	eur-as	.	.	2a	.	.	.	.	+	+	.	.	.	.	.	.	+	+	+	II

Number of relevé			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Dichantium ishaemum	H	med-as	.	.	.	+	1	+	.	3	+	.	.	2a	.	.	.	.	+	.	II
Teucrium polium	H	pont-med	.	+	.	.	.	.	.	+	.	.	.	+	.	+	+	.	+	.	II
Achillea crithmifolia	H	pann-bal	+	.	.	.	.	+	+	.	.	.	+	.	.	.	.	1	1	.	II
Hieracium praealtum	H		.	+	.	.	.	.	+	.	.	.	.	.	+	+	.	.	+	.	II
Trifolium scabrum	Th	med-as	.	.	.	.	+	.	.	+	+	.	.	+	.	.	.	.	.	.	II
Convolvulus cantabrica	H	pont	.	.	.	+	.	.	.	+	+	.	.	.	.	.	1	.	.	.	II
Centaurea rhenana	H	submed	.	.	.	.	+	+	.	.	.	.	+	+	.	.	.	.	.	.	II
Asperula cynanchica	H	eur-med	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	r	+	II
Hypericum perforatum	H	cosm	.	+	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	I
Euphrasia stricta	Th	eur-med	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	I
Linaria genistifolia	H	pont-sib	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	I
Hieracium hoppeanum	H	eur-med	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	I
Dasypyrum villosum	H	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	I
Helianthemum nummularium	Ch	alp-med	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Carthamus lanatus	Th	submed	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Stipa capillata	H	pont-med	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	I
Achillea nobilis	H	eur-as	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Allium flavum	K	med	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Teucrium chamaedrys	H	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Astragalus onobrychis	H	eur-as	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Other species																					
Anthemis ruthenica	Th	submed	+	+	.	.	+	r	3	.	.	+	+	.	.	1	r	+	+	.	IV
Plantago lanceolata	H	cosm	+	+	1	1	.	+	1	+	.	2a	2a	.	.	.	.	+	+	.	IV
Crepis setosa	Th	eur-med	.	+	+	+	1	+	.	.	+	.	1	.	.	.	+	r	.	.	III
Scleranthus perennis	H	eur-med	3	+	.	.	1	.	+	.	.	.	.	.	+	+	+	.	+	.	III
Bromus squarrosus	Th	submed	.	+	.	.	1	+	+	.	.	.	2m	.	.	.	.	r	+	.	II
Lotus angustissimus	Th	med	.	+	+	+	.	.	.	.	+	.	.	.	+	+	r	.	.	.	II
Galium tenuissimum	Th	pont-as	.	.	+	+	.	.	.	1	+	.	.	.	.	.	+	.	.	.	II
Stachys angustifolia	H	pont-med	+	r	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	II
Potentilla inclinata	H	eur-as	.	+	+	+	.	.	r	.	.	.	.	.	.	.	.	.	+	.	II
Ceratodon purpureus	H	cosm;temp	+	.	1	+	+	.	.	.	.	.	.	+	.	.	1	.	.	1	II
Ornithogalum umbellatum	K	pont-submed	.	+	+	.	.	.	.	.	+	.	.	.	.	+	+	.	.	+	II
Potentilla argentea	H	pont	.	.	.	.	.	+	+	.	.	.	+	.	+	+	.	.	+	.	II
Cichorium intybus	H	eur-sib	+	.	+	+	.	r	.	.	+	+	.	.	.	.	.	.	.	.	II
Syntrichia ruralis	H	cosm;temp	1	.	1	.	.	+	.	.	.	.	.	+	.	.	1	.	.	.	II
Brachythecium albicans	H	subboreal	.	2a	.	.	.	.	1	.	.	.	.	.	2a	2a	.	.	2a	.	II
Bombycilaena erecta	Th	eur-med	.	.	.	.	+	.	.	.	.	+	+	r	.	.	.	+	.	.	II
Hypochaeris radicata	H	eur-med	.	.	+	+	.	r	.	.	.	.	.	.	r	.	.	.	r	.	II
Erodium cicutarium	Th	subboreal	+	.	.	.	.	.	.	.	.	1	1	.	.	.	.	+	.	.	II
Echium vulgare	H	eur-as	.	.	.	.	+	.	.	.	r	.	r	+	.	.	.	+	.	.	II
Herniaria hirsuta	Th	eur-as	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	+	.	.	II
Jasione heldreichii	H	eur-med	.	.	.	.	.	.	r	.	.	.	.	.	r	+	.	.	+	.	II
Vicia grandiflora	H	submed	.	.	.	.	.	.	.	+	+	.	r	.	.	.	.	+	.	.	II
Cynodon dactylon	H	cosm	+	.	.	+	.	.	.	.	.	1	+	.	.	.	.	+	.	.	II
Filago vulgaris	Th	eur-as	.	.	.	+	.	.	.	.	+	+	.	.	.	.	+	.	.	.	II
Hypericum rumeliacum	H	bal	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	+	I
Euphorbia myrsinites	H	submed	.	.	.	.	r	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Xeranthemum annuum	Th	submed	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Aegilops triuncialis	Th	eur-as	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I

Number of relevé			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	
Ziziphora capitata	Th	med	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Velezia rigida	Th	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Plantago subulata	H	med	.	+	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	I
Veronica arvensis	Th	eur-sib	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	+	.	.	I
Trifolium retusum	Th	med	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	I
Leontodon crispus	H	pont-med	.	.	.	.	.	r	.	.	.	.	.	.	.	r	.	.	.	+	I
Centaurium erythraea	H	submed	.	+	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	I
Verbascum adrianopolitanum	H	bal	.	.	.	.	.	.	r	.	.	.	.	.	.	r	.	.	.	.	I
Dianthus pinifolius	H	bal-dac	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+	I
Sedum acre	H	eur-med	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Achillea coarctata	H	pont-med	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Dactylis glomerata	H	eur-as	.	.	.	2a	.	.	.	.	+	.	.	.	.	.	.	.	.	+	I
Agrostis canina	H	eur-sib	.	.	.	.	.	.	r	.	.	.	.	.	4	.	.	.	.	+	I
Cynosurus echinatus	H	submed	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Viola arvensis	Th	eur	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Bromus tectorum	Th	boreal	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	+	.	.	I
Hypericum thasium	H	bal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	I
Dianthus armeria	Th	eur	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Alyssum desertorum	Th	eur-med	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	I
Rorippa thracica	H	submed	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Sideritis montana	Th	submed	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	I
Potentilla neglecta	H	subboreal	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	I
Echinops ritro	H	eur-sib	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	+	.	.	I
Centaurea diffusa	H	pont-med	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	I
Anthoxanthum odoratum	H	eur-as	.	.	.	.	.	.	.	.	.	.	.	.	2b	+	.	.	.	.	I
Gypsophila muralis	H	eur-as	.	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Trifolium diffusum	Th	submed	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Orlaya kochii	Th	eur-as	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Geranium rotundifolium	Th	eur-as	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	I
Verbascum thapsiforme	H	submed	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2a	.	I
Koeleria macrantha	H	eur	.	.	.	.	+	.	.	.	.	.	.	3	.	.	.	.	.	.	I
Orlaya grandiflora	Th	ap-bal	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	I
Filipendula vulgaris	H	eur-med	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	I
Chamomilla recutita	Th	eur-as	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Dorycnium herbaceum	H	eur-med	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Reseda lutea	H	subboreal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	I
Dianthus moesiacus	H	bal	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Trifolium setiferum	Th	med	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Phleum phleoides	H	eur-as	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	I
Erysimum repandum	Th	eur-as	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Sherardia arvensis	Th	med	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Astragalus hamosus	H	eur-as	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Trifolium incarnatum	Th	submed	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Carduus nutans	H	eur-med	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	I
Medicago lupulina	Th	eur-as	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Allium vineale	K	eur-NAm	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	I
Convolvulus arvensis	H	cosm	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Trifolium repens	H	eur-sib	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Tragopogon dubius	H	eur-med	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I

Number of relevé			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Marrubium peregrinum	H	submed	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	I
Muscari sp.	K		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Lotus corniculatus	H	eur-med	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Dianthus pallens	H	bal-dac	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	I
Bromus arvensis	Th	eur-as	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Chenopodium botrys	Th	boreal	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	I
Ferulago sylvatica	H	submed	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Racomitrium canescens	H	boreal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I
Verbascum floccosum	H	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Trifolium purpureum	Th	med	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Centaurea cyanus	Th	eur-med	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	I
Lathyrus nissolia	Th	eur-med	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Scabiosa triniifolia	Th	bal	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Valerianella coronata	Th	eur-med	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	I
Ornithopus compressus	Th	submed	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Trifolium echinatum	Th	med	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Pterygoneurum ovatum	H	temp	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Euphorbia chamaesyce	Th	eur-as	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	I
Salvia argentea	H	med	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	I
Bryum caespiticium	H	temp	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	I
Barbula unguiculata	H		.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Xeranthemum cylindraceum	Th	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Poa angustifolia	H	cosm	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	I
Coronilla scorpioides	Th	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Anthemis tinctoria	H	eur-sib	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Alyssum hirsutum	Th	submed	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Crucianella angustifolia	Th	med	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	I
Melica ciliata	H	eur-submed	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	I
Viscaria vulgaris ssp. atropurpurea	H	eur-sib	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	I

Localities: **1.**-E of the Tvarditzha town, 42.67839° N, 25.95018° E, 10.06.2005; **2.**-North slopes of Sredna Gora mountains, S of the Tvarditzha town, 42.64797° N, 25.92345° E, 14.06.2005; **3.**-Svetiilijski vazvishenia hill, N of Sokol village, 42.41123° N, 26.10004° E, 11.06.2005; **4.**-E of Zlatari village, 42.3847° N, 26.2315° E, 29.06.2004; **5.**-W of Nautchen village, 42.56536° N, 26.08056° E, 20.07.2004; **6.**-the Golina hill near Tvarditzha town, 42.68123° N, 25.92186° E, 09.06.2005; **7.**- North slopes of Sredna Gora mountains, S of Tvarditzha town, 42.65615° N, 25.92084° E, 14.06.2005; **8.**-NW of Peshtersko village, 42.75153° N, 27.33362° E, 22.07.2005; **9.**-E of Zlatari village, 42.38478° N, 26.23153° E, 29.06.2004; **10.**-E of the Sliven town, 42.6686° N, 26.4010° E, 25.07.2004; **11.**-S of Kozharevo village, 42.68975° N, 25.87724° E, 06.06.2005; **12.**-W of Nautchen village, 42.5653° N, 26.0805° E, 20.07.2004; **13.**-North slopes of Sredna Gora mountains, S of the Tvarditzha town, 42.64839° N, 25.92273° E, 14.06.2005; **14.**-Sredna Gora mountains, near the Zhrebtchevo dam, 42.60160° N, 25.91573° E, 14.06.2005; **15.**-E of Banja village, 42.61227° N, 26.00080° E, 10.06.2005; **16.**-S of Kozharevo village, 42.68935° N, 25.87649° E, 06.06.2005; **17.**-near the Zhrebtchevo dam, 42.63688° N, 25.89264° E, 14.06.2005; **18.**-the Marashka Mogila hill, N of mezhda village, 42.36735° N, 26.25332° E, 29.06.2004.

Table 2: Ecological characteristics of the sampled relevés.
Tabela 2: Ekološke značilnosti vzorčenih popisov.

relevé	slope [°]	soil depth	soil moisture	pH	EC [µS. cm^{-1}]	humus [%]	$CaCO_3$ [mg. l^{-1}]
1	0	medium	dry	6,12	24	7.98	78
2	5–10	medium	dry	6,2	30	3,7	35
3	1–5	medium	dry	5,95	29	2,13	36
4	10–15	medium	dry	-	-	-	-
5	5–10	shallow	dry	-	-	-	-
6	10–15	medium	dry	6,45	63	13,88	96
7	1–5	shallow	dry	-	-	-	-
8	10–15	shallow	dry	-	-	-	-
9	1–5	medium	dry	7,06	79	1,79	96
10	0	shallow	dry	-	-	-	-
11	0	shallow	dry	-	-	-	-
12	1–5	shallow	dry	-	-	-	-
13	5–10	medium	moderatly moist	6,41	23	3,1	33
14	10–15	shallow	dry	6,03	22	2,33	32
15	10–15	shallow	dry	6,41	40	3,46	43
16	0	shallow	dry	-	-	-	-
17	1–5	medium	dry	6,11	20	3,4	28
18	10–15	shallow	dry	5,44	43	1,04	36