

Phytosociological study of submontane genistoid scrub communities from the Southeastern Balkans

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Abstract – *Genista lydia* Boiss. is an endemic Balkan-Anatolian species which forms rare communities in the territory of south Bulgaria and northeast Greece. They are spread exclusively on acidic, siliceous substrates. This study presents new data on their distribution, floristic and ecological structure and phytosociological affinities. The research is based on 156 phytosociological relevés. Unweighted pair-group method with arithmetic averages (UPGMA) was employed and a detrended correspondence analysis (DCA) was performed prior to the syntaxonomical decision. Three new associations and the new alliance *Genistion lydiae* have been described and classified within the order *Lavandulo stoechadis-Hypericetalia olympici* Mucina in Mucina et al. 2016 of the class *Cisto-Lavanduletea stoechadis* Br.-Bl. in Br.-Bl. et al. 1940. The study has also emphasized the potential threats concerning a decline of the habitat area and proposed some conservation measures.

Keywords: *Cisto-Lavanduletea stoechadis*, *Genistion lydiae*, grazing impact, shrub vegetation, vulnerable habitat types

Introduction

The communities of *Genista lydia* Boiss. and *G. rumelica* Velen. represent indigenous and rare vegetation described from the Southern Balkans and mostly south Bulgaria (Bondev 1991). The dominant species are low shrubs, with erect or ascending branches, which lose their leaves during the summer drought (Kuzmanov 1976, Strid 1986). According to the Bulgarian floristic literature *G. lydia* is clearly distinguished from *G. rumelica* at species level (Kuzmanov 1976, Evstatieva et al. 2004, Delipavlov and Chesmedzhiev 2011). However, for the purpose of the study, a broader description of *G. lydia* (incl. *G. rumelica*) has been adopted, one that seems more widely accepted at present (Strid 1986, Zieliński et al. 2004, Roskov et al. 2006, Dimopoulos et al. 2013, The Plant List 2013).

Those communities are floristically rich and occur in the transitional (sub-Mediterranean) zone, influenced by Mediterranean and Continental (Temperate) climate. Because of the rarity and vulnerability of this vegetation type, it was assessed for the national (Tzonev and Gussev 2015) and European (Janssen et al. 2016) Red Data Books of Habitat Types.

The communities dominated by *G. lydia* have been presented (Velčev and Bondev 1984a) as an original and typi-

cal part of the Balkan vegetation. These communities are strongly influenced by anthropogenic activities and have a very limited range and for these reasons, they have been determined as "Endangered" (Velčev and Bondev 1984b). More data on their distribution in Bulgaria have been published in the vegetation map of Bulgaria (1:600 000) (Bondev 1991). Bondev (1991) has also concluded that those communities are of secondary origin, because they often replace destroyed xerothermic oak or black pine forests.

The most detailed studies on the *G. lydia* communities, have been focused on their habitat types, their floristic and ecological structure and their range (Tzonev and Gussev 2015, Janssen et al. 2016, Kunev and Tzonev 2019). In those studies, this habitat type is described as mosaic vegetation composed of shrub, herbaceous and chasmophytic plants, typical of the Balkan regions, influenced by the transitional continental-Mediterranean climate.

Despite comparatively detailed information at the habitat level, the syntaxonomic position of this vegetation type is still indefinite. In general, different plant communities dominated by or with a high abundance of *Genista* species are widespread in the Mediterranean regions of Europe. Most of

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these communities occupying siliceous substrates were classified within the *Calluno-Ulicetea*, *Cytisetea scopario-striati* and *Cisto-Lavanduletea* classes (Rivas-Martínez et al. 2002; Gianguzzi et al. 2015). For example, some associations have been recorded from the Balkans, such as the association *Genisto-Ericetum manipuliflorae* Horvatić 1958 from the Croatian coastal region (Horvatić 1958) or the shrub communities of the association *Genisto acanthocladae-Ouercetum cocciferae* Dimopoulos et al. 1996 from Peloponnisos, Southern Greece (Dimopoulos et al. 1996). The species *Genista januensis* Viv. demonstrates great morphological similarity and is also closely related to *G. lydia*. *Genista januensis* typically inhabits forest fringes and open woodlands dominated by *Quercus pubescens* and *Carpinus orientalis* in some regions of west Bulgaria (Tzonev et al. 2019). It is also diagnostic species to the basophilic *Pinus sylvestris* and *P. nigra* forests of the Southeastern and Dinaric Alps (*Genista januensis-Pinetum* Tomažič 1940) (Chiappella and Longo 1987, Dakskobler 1999).

However, after the first assessment for the Red List of European habitat types (Janssen et al. 2016), Bulgaria and Greece were the only countries that provided information on the scrub vegetation dominated by *G. lydia*. Therefore, its occurrence in other Balkan countries or Western Anatolia continues to be unclear.

The aim of this study is to propose a new syntaxonomic framework for *G. lydia* communities, based on abundant phytosociological material collected from south Bulgaria and northeastern Greece.

Material and methods

The principles and methods of the study follow the Braun-Blanquet phytosociological approach (Braun-Blanquet 1964). The plant communities of *Genista lydia* were sampled between March and October of the years 2016 to 2018. All localities of the dominant species in Bulgaria known from the literature data and herbaria collections have been visited. The localities of the studied communities in Greece were provided by one of the authors. In these areas, relevés were set in places where the coverage of the species exceeded 30%. In total, 156 unpublished phytosociological relevés were used in the present study. Their plot sizes vary between 16 and 25 m². At each sampling plot, a complete list of vascular plants, mosses and lichens taxa was made together with their cover-abundance values according to the 9-degree modified Br-Bl scale. The Braun-Blanquet categories were transformed to ordinal numbers from 1 to 9 for further statistical analysis (van der Maarel 1979). The data set was subjected to hierarchical classification by the SYN-TAX program (Podani 2001). The unweighted pair-group method with arithmetic averages (UPGMA) as an average-linkage type of clustering algorithm was used as clustering method. The floristic similarity between relevés in the dissimilarity matrix was calculated by using Horn's index (see Podani 2001). Five relevés from the dendrogram of the cluster analysis were not considered in further analysis since they repre-

sented strongly ruderalized stands. Some of these plots were set within the built-up area of the town of Plovdiv, while others were placed in abandoned vineyards. Diagnostic species of each cluster were determined on the basis of their fidelity (ϕ) measures using the ϕ coefficient of association between groups (Chytrý et al. 2002) in the JUICE 7.0 program (Tichý 2002). The size of target groups was fixed at 25% of the total data set. The threshold ϕ value for the diagnostic species was set at 0.30 and Fisher's exact test was calculated to exclude those species from diagnostic ones when their fidelity was not statistically significant ($P < 0.001$). The results of the classification are summarized in Tab. 1, in which the diagnostic species are ranked according to decreasing fidelity. Species are considered as constant if their frequency exceeded 50% for a given group, and species with cover higher than 50% in a minimum of 5% of relevés were considered to be dominant. New syntaxa are named according to the rules of the 3rd edition of the International Code of Phytosociological Nomenclature (Weber et al. 2000). Syntaxonomic nomenclature follows Mucina et al. (2016).

Vegetation groups are described on the basis of their diagnostic, constant and dominant species in the "Results" section. The values of fidelity, relative frequency and number of relevés for dominants with at least 50% cover are given in brackets for diagnostic, constant and dominant species respectively. In addition to the syntaxa names of the groups, their geographical names are also included according to the proposal on the subdivision of the habitat S3-4 Balkan-Anatolian submontane genistoid scrub from the EUNIS habitat classification into three subhabitat types: S3-41 Balkan-Range submontane genistoid scrub, S3-42 Thracian submontane genistoid scrub and S3-43 Rilo-Rhodopean submontane genistoid scrub (Schaminée et al. 2019; Kunev and Tzonev 2019).

For the visualization and interpretation of the relevé groups, a detrended correspondence analysis (DCA) was performed using the vegan 2.5–3 package for R (<https://cran.r-project.org/web/packages/vegan/index.html>). All 151 relevés, together with the diagnostic species given in the synoptic table and selected ecological variables, were projected onto two-dimensional ordination space of DCA, with centroids calculated for each of the four clusters. Species ecological indicator values (EIVs) for temperature, light, moisture, continentality, soil reaction and nutrients (Pignatti et al. 2005) and selected bioclimatic variables from the WorldClim database (Fick and Hijmans 2017) were used as explanatory ecological variables. EIVs were calculated as unweighted average indicator values of taxa for each relevé. All bioclimatic variables available in the WorldClim database were extracted for each relevé on the basis of their geographical coordinates and with the use of the finest spatial resolution provided (30 seconds; ~1 km²). The possible effect of climatic variables on the vegetation composition was tested by using canonical correspondence analysis (CCA) in CANOCO 5.0 software (Ter Braak and Šmilauer 2012) using the global Monte-Carlo permutation test with 999 permutations. Forward selection together with Monte-Carlo permutation test was used to indicate the

Tab. 1. Frequency–fidelity synoptic table of the communities of *Genista lydia*. Frequencies of species are presented as percentages with *phi* values multiplied by 100 in superscript (group sizes were equalized before the calculation of phi values). Diagnostic species of each cluster are shaded and ranked by decreasing fidelity. Only species with *phi* values higher than 0.30 are considered to be diagnostic. Species with less than 20% frequency in the whole data set have been omitted.

Group No.	1	2	3	4
No. of relevés	79	54	14	4
No. of species with less than 20% occurrence	329	272	108	61
<i>Diantho pinifolii-Genistetum lydiae</i>				
<i>Centaurea rhenana</i> ssp. <i>rhenana</i>	82	82.2	. ---	14 ---
<i>Sedum grisebachii</i>	24	43.8	. ---	. ---
<i>Asperula aristata</i> ssp. <i>scabra</i>	70	40.2	31 ---	. --- 25 ---
<i>Anthemis tenuiloba</i>	23	37	. ---	7 --- . ---
<i>Thymus longicaulis</i>	49	32.8	11 ---	43 --- . ---
<i>Dianthus pinifolius</i> ssp. <i>pinifolius</i>	39	31.6	11 ---	14 --- . ---
<i>Romuleo graecae-Genistetum lydiae</i>				
<i>Romulea linaresii</i> ssp. <i>graeca</i>	. ---	70	80	. --- . ---
<i>Tuberaria guttata</i>	. ---	50	65.5	. --- . ---
<i>Cerastium gracile</i>	. ---	50	65.5	. --- . ---
<i>Trifolium tenuifolium</i>	. ---	41	58.3	. --- . ---
<i>Erodium botrys</i>	. ---	37	55.3	. --- . ---
<i>Dianthus corymbosus</i>	. ---	26	45.6	. --- . ---
<i>Galio flavescens-Genistetum lydiae</i>				
<i>Anthemis cretica</i>	. ---	. ---	71	80.8 . ---
<i>Sempervivum erythraeum</i>	4 ---	. ---	57	65 . ---
<i>Hypericum montbretii</i>	. ---	4 ---	50	61.3 . ---
<i>Galium flavescens</i>	. ---	. ---	43	60 . ---
<i>Verbascum humile</i>	9 ---	. ---	50	52.6 . ---
<i>Plantago subulata</i>	41	26.6	2 ---	71 42.7 . ---
<i>Lembotropis nigricans</i>	. ---	. ---	21	41.2 . ---
<i>Genista lydia and Satureja pilosa community</i>				
<i>Satureja pilosa</i>	. ---	. ---	7 ---	75 81.6
<i>Crucianella angustifolia</i>	3 ---	. ---	7 ---	75 78.6
<i>Linaria simplex</i>	. ---	. ---	. ---	50 65.5
<i>Cionura erecta</i>	. ---	. ---	. ---	50 65.5
<i>Geranium purpureum</i>	. ---	. ---	. ---	50 65.5
<i>Genistion lydiae</i>				
<i>Genista lydia</i>	100	---	100	--- 100 ---
<i>Minuartia hirsuta</i> ssp. <i>falcata</i>	35	30.3	6 ---	29 --- . ---
<i>Centaurea cuneifolia</i>	8	---	48	44.8 7 --- 25 ---
<i>Viola tricolor</i> ssp. <i>macedonica</i>	20	---	26	--- . --- 25 ---
<i>Rorippa thracica</i>	25	---	11	--- 21 --- . ---
<i>Lavandulo stoechadis-Hypericetalia olympici Mucina et 2016 and Cisto-Lavanduletea stoechadis Br.-Bl. in Br.-Bl. et al. 1940</i>				
<i>Hypericum olympicum</i>	32	---	24	--- 21 --- . ---
<i>Genista carinalis</i>	22	---	11	--- . --- . ---
<i>Vicia lathyroides</i>	16	---	13	--- . --- . ---
<i>Stachys angustifolia</i>	19	---	4	--- 7 --- . ---
<i>Campanula lingulata</i>	18	---	4	--- . --- . ---
<i>Cistus creticus</i>	. ---	19	38.2	. --- . ---
<i>Thymus sibthorpii</i>	10	---	2	--- . --- . ---
<i>Festuco-Brometea Br.-Bl. et Tx. ex Soó 1947</i>				
<i>Eryngium campestre</i>	58	---	87	31.4 . --- 100 ---
<i>Festuca valesiaca</i>	81	42.8	41	--- 7 --- . ---
<i>Sanguisorba minor</i>	48	---	70	25.2 . --- 50 ---
<i>Teucrium chamaedrys</i>	58	24.8	41	--- . --- . ---
<i>Cruciata pedemontana</i>	56	---	41	--- . --- . ---
<i>Hieracium hoppeanum</i>	49	---	28	--- 43 --- . ---
<i>Chrysopogon gryllus</i>	23	---	76	51.6 7 --- . ---
<i>Euphorbia cyparissias</i>	43	---	24	--- 21 --- 100 ---
<i>Scabiosa triniifolia</i>	39	---	24	--- 29 --- . ---

Tab. 1. Continued

Group No.	1	2	3	4
<i>Achillea coarctata</i>	48 ^{44.6}	2	36	.
<i>Hypericum perforatum</i>	39	7	64	.
<i>Dichanthium ischaemum</i>	32	33	.	.
<i>Thymus glabrescens</i>	29	35	.	.
<i>Koeleria macrantha</i>	53 ^{67.8}	.	.	.
<i>Luzula campestris</i>	20	31	.	.
<i>Phleum montanum</i>	38 ^{44.1}	.	21	.
<i>Helianthemetea guttati</i> Rivas Goday et Rivas-Mart. 1963				
<i>Aira elegantissima</i>	33	69 ^{36.3}	7	.
<i>Trifolium arvense</i>	41	31	14	75
<i>Cerastium brachypetalum</i>	27	46	.	.
<i>Cynosurus echinatus</i>	29	39	14	.
<i>Galium divaricatum</i>	35	31	.	25
<i>Linaria pelisseriana</i>	14	41 ^{32.7}	.	.
<i>Teesdalia coronopifolia</i>	16	35	7	.
<i>Hypochaeris glabra</i>	8	37 ^{36.5}	7	.
<i>Vulpia myuros</i>	13	31	.	.
<i>Crupina vulgaris</i>	18	20	14	.
<i>Trifolium strictum</i>	8	30 ^{31.2}	.	.
<i>Ornithopus compressus</i>	.	39 ^{56.8}	.	.
<i>Myosotis stricta</i>	8	26 ^{27.2}	.	.
<i>Vulpia ciliata</i>	.	35 ^{53.8}	.	.
<i>Trifolium cherleri</i>	1	26 ^{41.6}	.	.
<i>Trifolium striatum</i> ssp. <i>striatum</i>	16	4	.	.
<i>Alyssum minutum</i>	13	4	.	50
<i>Sedum rubens</i>	5	13	.	75
<i>Koelerio-Corynephoretea Klika in Klika et Novák 1941 and Sedo-Scleranthetea Br.-Bl. 1955</i>				
<i>Cladonia foliacea</i>	65	52	100 ^{39.4}	.
<i>Rumex acetosella</i>	34	59	64	.
<i>Trifolium campestre</i>	57 ^{35.9}	24	7	.
<i>Potentilla argentea</i>	44	30	.	.
<i>Bromus squarrosus</i>	46 ^{27.5}	20	.	50
<i>Potentilla neglecta</i>	46 ^{39.8}	11	7	.
<i>Myosotis ramosissima</i>	32	26	14	.
<i>Moenchia mantica</i>	11	50 ^{41.1}	14	.
<i>Scleranthus perennis</i>	29	15	43	.
<i>Petrorhagia prolifera</i>	14	35	7	50
<i>Filago vulgaris</i>	22	26	.	.
<i>Chondrilla juncea</i>	24	15	.	100
<i>Cerastium pumilum</i>	34 ^{48.2}	2	.	.
<i>Racomitrium canescens</i>	24	9	14	.
<i>Veronica praecox</i>	16	19	.	.
<i>Scabiosa argentea</i>	16	15	.	.
Other species with high frequency				
<i>Poa bulbosa</i>	51	83 ^{30.5}	36	50
<i>Plantago lanceolata</i>	51	52	7	.
<i>Anthoxanthum odoratum</i>	30	69 ^{35.2}	29	.
<i>Galium verum</i>	33	41	.	.
<i>Agrostis capillaris</i>	54 ^{58.3}	.	21	.
<i>Euphorbia niciciana</i>	16	44 ^{27.2}	.	100
<i>Geranium columbinum</i>	22	39	7	.
<i>Leontodon crispus</i>	32 ²⁹	11	.	.
<i>Poa compressa</i>	28	15	.	.
<i>Sherardia arvensis</i>	4	50 ^{57.2}	.	.
<i>Hieracium bauhinii</i>	23	19	14	.
<i>Dianthus giganteus</i> ssp. <i>giganteus</i>	33 ^{35.9}	4	14	.

bioclimatic variables most effective on species composition. Rare species were down-weighted in CCA. In both ordination techniques the digital cover–abundance values (numbers from 1 to 9) were used without any further transformation. The three bioclimatic variables with the highest explanatory value calculated in CCA were selected and together with the EIVs according to Pignatti et al. (2005) were passively projected onto the DCA-ordination diagram.

The taxonomic nomenclature of the vascular plants follows Delipavlov and Chesmedzhiev (2011), except for the genera *Juniperus* L., *Genista* L., *Cistus* L., *Anthemis* L., *Tolpis* Adans. and *Tripleurospermum* Sch. Bip., for which some additional sources were used, mostly from other Bulgarian floras (Jordanov et al. 1963-2012; Assyov and Petrova 2012) or occasionally, on-line databases (Roskov et al. 2006, The Plant List 2013, Euro+Med 2006-2018). Nomenclature of mosses follows Hill et al. (2006); lichens are given after Mayrhofer et al. (2005). Chorological and life-form spectra were calculated for each vegetation unit and are presented as percentages on the basis of presence of a species (On-line Suppl. Tab. 1). The chorotypes were initially indicated in accordance with Assyov and Petrova (2012) and then grouped in 10 larger categories for better representation of the general trends in the phytogeographical relationships. The chorotypes of lichens and mosses have not been included in these calculations due to insignificant species richness of these taxa in the communities of *Genista lydia*. The biological spectrum is presented following the classification of Raunkiaer (1934). The endemic taxa are given after Petrova and Vladimirov (2010), Assyov and Petrova (2012) and Euro+Med PlantBase (2006-2018). The soil types and composition of the bedrock outcrops are presented in accordance with the soil (Ninov 2002) and the geological map of Bulgaria (Cheshitev and Kánčev 1989). Analysis of representative soil samples taken from selected relevés were performed in an authorized laboratory – NIK Agro Service Ltd. The samples were analyzed (see Teoharov et al. 2009) in accordance with ISO standards

as follows: pH (ISO 10390), specific electrical conductivity (ISO 11265), total organic carbon (ISO 10694) and carbonate content (ISO 10693).

Results

The floristic composition of the communities of *Genista lydia* is very rich and includes 580 taxa. The average number of species per plot is 46. The mean vegetation cover is 80.14%. The elevation is significantly variable, ranging between 150 and 1500 m a.s.l. The slope inclination varies between 1°–60° (mean 10°), while the exposure is most frequently southern. The soil sample analysis (Tab. 2) demonstrates that in most localities the soils have a sandy texture. They are slightly to moderately acidic (pH 5.02 – 7.13), with conductivity ranges between 0.02 and 0.13 dS m⁻¹, while the carbonate content is represented only as traces. The amount of soil organic carbon varies significantly (0.24 to 10.03%), although it rarely exceeds (3%), which is an indicator for their low nutrition content.

The cluster analysis resulted in the distinction of four groups (Fig. 1). Two of them are found only in the territory of Bulgaria, while the rest are also found in Northern Greece. These four units are geographically, ecologically and floristically well defined. The differences between them are also supported by the DCA-ordination diagram (Fig. 2). The interpretation of the DCA-diagram is assisted by the passively projected EIVs and the three bioclimatic variables with the highest explanatory value. Analysis with forward selection in CCA provided a ranking of the relative importance of the tested bioclimatic variables (On-line Suppl. Tab. 2). All 19 bioclimatic variables were statistically significant ($P < 0.001$) and explained 31.19% of the total variance of the data set. The three with strongest effect on vegetation composition are precipitation of warmest quarter (Bio 18), precipitation seasonality (Bio 15) and mean temperature of coldest quarter (Bio 11).

Tab. 2. Soil properties of representative plots occupied by the communities of *Genista lydia*. EC – specific electrical conductivity (dS m⁻¹), and C org – total organic carbon content (%). Group 1 – *Diantho pinifolii-Genistetum lydiae*, Group 2 – *Romuleo graecae-Genistetum lydiae*, Group 3 – *Galio flavescentis-Genistetum lydiae*.

	Relevé no.	Soil depth (cm)	pH	EC (dS m ⁻¹)	C org (%)	CaCO ₃ (%)
Group 1	59	15–30	6.66	0.02	0.45	0.41
	65	15–30	6.48	0.02	0.4	Traces
	70	0–5	5.08	0.09	9.22	Traces
	71	0–5	6.09	0.03	1.85	0.03
	100	5–15	6.65	0.02	0.44	0.08
	102	5–15	6.22	0.02	0.7	Traces
	111	0–5	6.8	0.02	0.46	Traces
	112	15–30	5.38	0.02	1.79	Traces
Group 2	119	5–15	7.13	0.02	0.24	Traces
	13	15–30	5.39	0.02	1.65	Traces
	114	0–5	6.52	0.04	0.51	Traces
Group 3	133	5–15	5.62	0.02	2.61	Traces
	128	0–5	5.34	0.13	8.9	9.57
	135	0–5	5.02	0.07	10.03	Traces

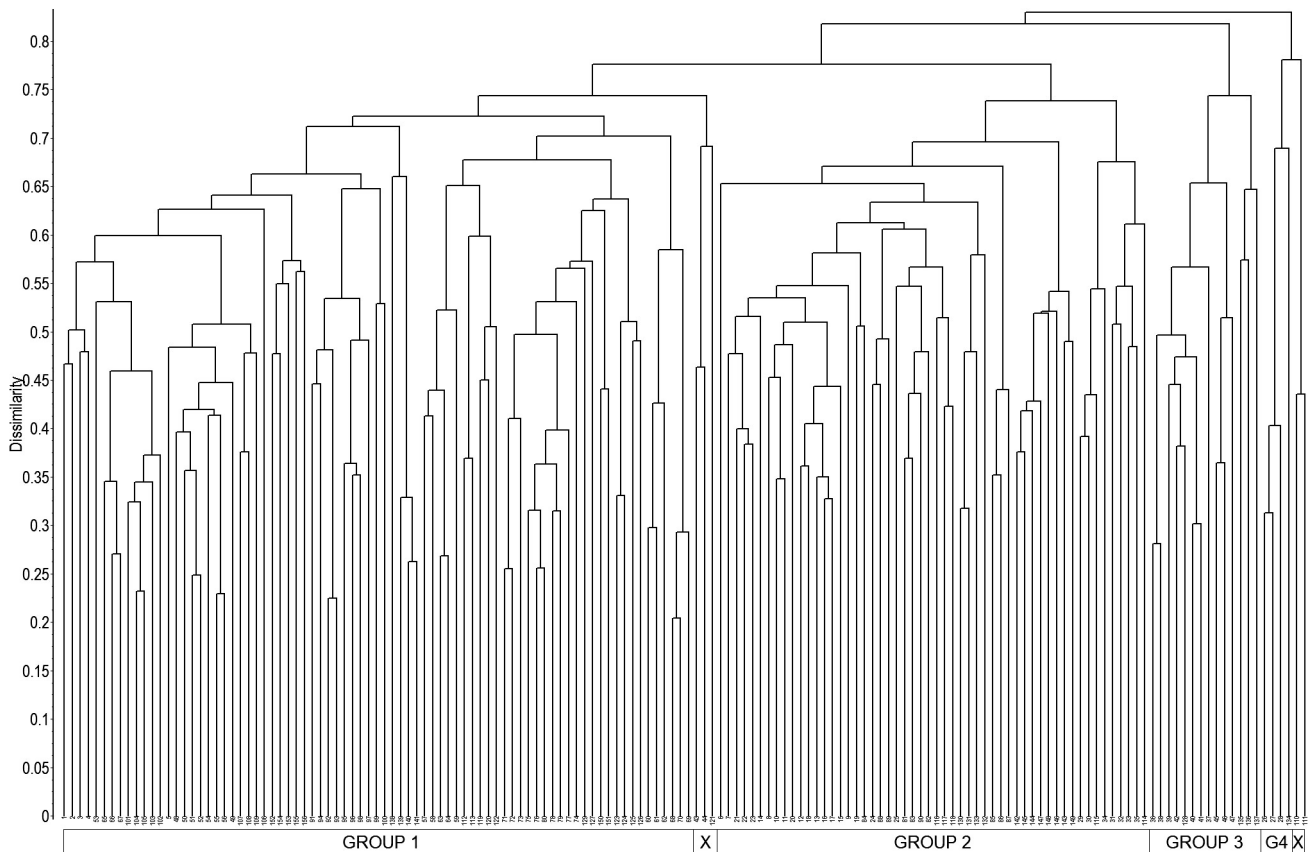


Fig. 1. Cluster dendrogram of *Genista lydia* communities. Group 1 – *Diantho pinifolii-Genistetum lydiae*, Group 2 – *Romuleo graecae-Genistetum lydiae*, Group 3 – *Galio flavescens-Genistetum lydiae*, Group 4 (G4) – *Genista lydia-Satureja pilosa* communities, X – excluded plots.

The first axis on Fig. 2 can be interpreted as an altitudinal gradient, positively correlated also with continentality and precipitation, the latter being represented by the precipitation of the warmest quarter. The other two bioclimatic variables plotted in the ordination space are more or less negatively correlated with the first DCA axis. These are the temperature of the coldest quarter and precipitation seasonality. The second DCA axis is probably related to soil moisture as revealed by the corresponding environmental parameter used in the DCA-diagram, as well as from the discrimination at the top of this axis of the *Genista lydia-Satureja pilosa* community (group 4) which grows on well drained substrates of sandy gravel bars.

Description of the communities

Group 1: Association *Diantho pinifolii-Genistetum lydiae* ass. nova hoc loco (On-line Suppl. Tab 1), *holotypus* rel. 55 (Appendix, Fig. 3a) (Rilo-Rhodopean submontane genistoid scrub)

Diagnostic species: *Centaurea rhenana* ssp. *rhenana* (82.2), *Sedum grisebachii* (43.8), *Asperula aristata* ssp. *scabra* (40.2), *Anthemis tenuiloba* (37), *Thymus longicaulis* (32.8), *Dianthus pinifolium* ssp. *pinifolius* (31.6)

Constant species: *Genista lydia* (100), *Centaurea rhenana* ssp. *rhenana* (82), *Festuca valesiaca* (81), *Asperula aristata* ssp. *scabra* (70), *Cladonia foliacea* (65), *Teucrium chamae-*

drys (58), *Eryngium campestre* (58), *Trifolium campestre* (57), *Cruciata pedemontana* (56), *Agrostis capillaris* (54), *Koeleria macrantha* (53), *Poa bulbosa* (51), *Plantago lanceolata* (51)

Dominant species: *Genista lydia* (20)

Distribution: Mesta (Nestos) River valley in Bulgaria and Greece, Central Rhodope Mts., 600 – 1500 m a.s.l.

This association is distributed on volcanic rocks and soils with a sandy structure. Its altitudinal range corresponds to submontane and montane belt on slopes with more pronounced inclinations (mean 14.5°). The soils are Umbric Leptosols and less often Dystric Cambisols (especially in the Central Rhodope Mts.). This group is characterized by its more frequent occurrence at higher altitudes and in sites with higher annual precipitation, lower annual temperatures and less pronounced summer drought, as compared to all other groups (On-line Suppl. Tab. 3). The influence of colder and more humid mountain climate is a reason for more significant participation of some European and Boreal species as well as more xeromesophytes or mesophytes, such as *Agrostis capillaris*, *Brachypodium sylvaticum*, *Arrhenatherum elatius*, *Vicia incana* and *Trifolium medium*. The herbaceous layer is dominated by hemicryptophytes (46.8%), although therophytes are still well represented (34.5%) (Figs. 4, 5). There is also high number of Balkan endemics and subendemics (13.04%), such as *Viola aetolica*, *Sedum grisebachii*, *S. stefčo*, *Silene velenovskiana* and *Anthemis macedonica*.

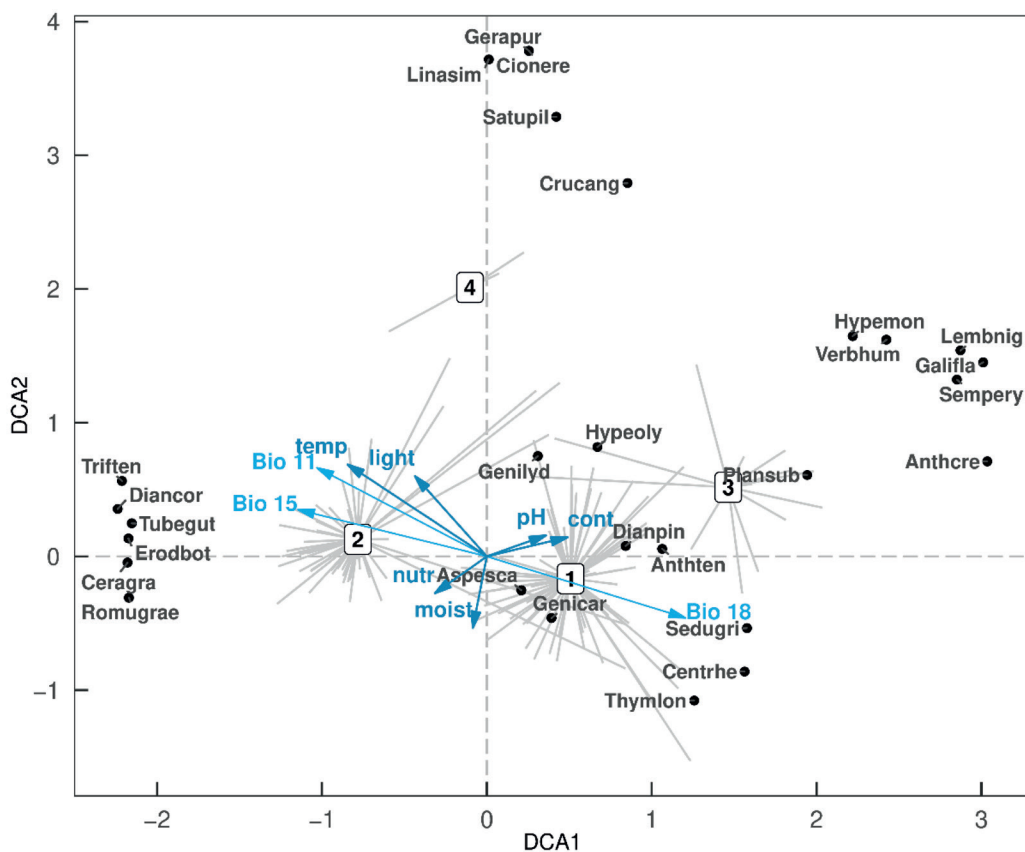


Fig. 2. Detrended correspondence analysis (DCA) spider-plot of the 151 relevés classified in the four groups distinguished. The length of the first DCA axis is 3.31 SD units, while of the second axis 3.80 SD units. Numbers refer to the centroids of vegetation groups corresponding to: 1 – *Diantho pinifolii*-*Genistetum lydiae*, 2 – *Romuleo graecae*-*Genistetum lydiae*, 3 – *Galio flavescens*-*Genistetum lydiae*, 4 – *Genista lydia*-*Satureja pilosa* communities. Ecological indicator values and bioclimatic variables are represented by arrows (temp – temperature, light – light, pH – soil reaction, cont – continentality, moist – moisture, nutr – nutrients, Bio 15 – precipitation seasonality, Bio 11 – mean temperature of coldest quarter, Bio 18 – precipitation of warmest quarter). Diagnostic species for the relevant groups are represented by dots and abbreviated names as follows: *Anthcre* – *Anthemis cretica*, *Anthten* – *Anthemis tenuiloba*, *Aspesca* – *Asperula aristata* ssp. *scabra*, *Centrhe* – *Centaurea rhenana* ssp. *rhenana*, *Ceragra* – *Cerastium gracile*, *Cionere* – *Cionura erecta*, *Crucang* – *Crucianella angustifolia*, *Diancor* – *Dianthus corymbosus*, *Dianpin* – *Dianthus pinifolius* ssp. *pinifolius*, *Erodbot* – *Erodium botrys*, *Galifla* – *Galium flavescens*, *Genicar* – *Genista carinalis*, *Genilyd* – *Genista lydia* agg., *Gerapur* – *Geranium purpureum*, *Hypeoly* – *Hypericum olympicum*, *Lembnig* – *Lembotropis nigricans*, *Linasim* – *Linaria simplex*, *Plansub* – *Plantago subulata*, *Romugrae* – *Romulea linaresii* ssp. *graeca*, *Satupil* – *Satureja pilosa*, *Sedugri* – *Sedum grisebachii*, *Sempere* – *Sempervivum erythraeum*, *Thymlon* – *Thymus longicaulis*, *Triften* – *Trifolium tenuifolium*, *Tubegut* – *Tuberaria guttata*, *Verbhum* – *Verbascum humile*.

Group 2: Association *Romuleo graecae*-*Genistetum lydiae* ass. nova hoc loco (On-line Suppl. Tab 1), *holotypus* rel. 131 (Appendix, Fig. 3b) (Thracian submontane genistoid scrub)

Diagnostic species: *Romulea linaresii* ssp. *graeca* (80), *Tuberaria guttata* (65.5), *Cerastium gracile* (65.5), *Trifolium tenuifolium* (58.3), *Erodium botrys* (55.3) and *Dianthus corymbosus* (45.6)

Constant species: *Genista lydia* (100), *Eryngium campstre* (87), *Poa bulbosa* (83), *Chrysopogon gryllus* (76), *Romulea linaresii* ssp. *graeca* (72), *Sanguisorba minor* (70), *Anthoxanthum odoratum* (69), *Aira elegantissima* (69), *Rumex acetosella* (59), *Plantago lanceolata* (52) and *Cladonia foliacea* (52)

Dominant species: *Genista lydia* (15)

Distribution: Eastern Rhodope Mts., both in Bulgaria and Greece, on schist, sandstones, tuffs, 150 – 600 m a.s.l.

The association occupies sandy soils, sandstones or mining deposits composed of white zeolites. The soil types are mostly Lithic and Umbric Leptosols. The precipitation regime has a winter maximum in November and a well pronounced summer drought between July and September (On-line Suppl. Tab. 3). The Mediterranean climate influence is significant in this association, and possibly is one of the reasons for it having the highest species richness amongst all groups. This is justified by the high frequency of therophytes (47.18%), and Mediterranean and sub-Mediterranean species (38%) (Figs. 4, 5). In early spring, the herbaceous layer is dominated by geophytes like *Romulea linaresii* ssp. *graeca*, *Ornithogalum* spp. and *Crocus chrysanthus*. Therophytes with a typical Mediterranean origin dominate from the late April till the end of May, such as many annual clovers, *Vulpia ciliata*, *Tuberaria guttata*, *Molineriella minuta*, *Aira elegantissima* and *Aegilops neglecta*. In the summer period, the flowering aspect is influenced by yellow flower-

ing *Compositae* species like *Hypochaeris glabra*, *H. cretensis*, *H. radicata* and *Crepis setosa*. The endemics are not so frequent/abundant, as compared to the other groups. Balkan endemics recorded in the association are *Armeria rumelica*, *Chamaecytisus jankae*, *Daucus guttatus* ssp. *zahariadii*, *Dianthus corymbosus*, *Anthemis virescens* and *Romulea linarensis* ssp. *graeca*.

Group 3: *Galio flavescens*-*Genistetum lydiae* ass. nova hoc loco (On-line Suppl. Tab 1), *holotypus* rel. 41 (Appendix, Fig. 3c) (Balkan-Range submontane genistoid scrub)

Diagnostic species: *Anthemis cretica* (80.8), *Sempervivum erythraeum* (65), *Hypericum montbretii* (61.3), *Galium flavescens* (60.0), *Verbascum humile* (52.6), *Plantago subulata* (42.7) and *Lembotropis nigricans* (41.2)

Constant species: *Genista lydia* (100), *Cladonia foliacea* (100), *Polytrichum piliferum* (71), *Plantago subulata* (71), *Anthemis cretica* (71), *Rumex acetosella* (64), *Hypericum perforatum* (64), *Festuca dalmatica* (64) and *Viola arvensis* (57)

Dominant species: *Genista lydia* (7)

Distribution: Southern slopes of East Balkan Range (Sliven district) and East Rhodope Mts., 300 – 1000 m a.s.l.

The communities of this association mostly occur on acidic rocks such as andesites, diorites, conglomerates. They are found on rock cliffs and terraces with a predominantly southern exposure. The soils are shallow Umbric Leptosols.

Although this association demonstrates a more pronounced continental character, the number of Mediterranean species in their floristic composition continues to be significant (34.93%) (Fig. 4). On the other hand, the annual species (28.77%) are fewer in number than other groups. Another specific feature of the group is the higher frequency and abundance of shrub and juvenile tree species (Fig. 5) such as *Syringa vulgaris*, *Lembotropis nigricans* and *Fraxinus ornus*. This is due to the abandonment of grazing practices, since this association is mostly located in some protected areas such as Sinite Kamuni Nature Park. These communities are also rich in Balkan endemics and subendemics (17.81%), like *Sesleria latifolia*, *Sempervivum erythraeum*, *Verbascum humile*, *Chamaecytisus calcareus*, *Scabiosa triniifolia* and *Silene lerchenfeldiana*.

Group 4. *Genista lydia*-*Satureja pilosa* community (Fig. 3d)

Diagnostic species: *Satureja pilosa* (81.6), *Crucianella angustifolia* (78.6), *Linaria simplex* (65.5), *Geranium purpureum* (65.5) and *Cionura erecta* (65.5)

Constant species: *Genista lydia* (100), *Euphorbia niciciana* (100), *Euphorbia cyparissias* (100), *Eryngium campestre* (100), *Chondrilla juncea* (100), *Vicia cracca* (75), *Trifolium arvense* (75), *Senecio vulgaris* (75), *Sedum rubens* (75), *Satureja pilosa* (75), *Orlaya grandiflora* (75), *Melica ciliata* (75), *Medicago minima* (75), *Linaria genistifolia* ssp. *genistifolia*

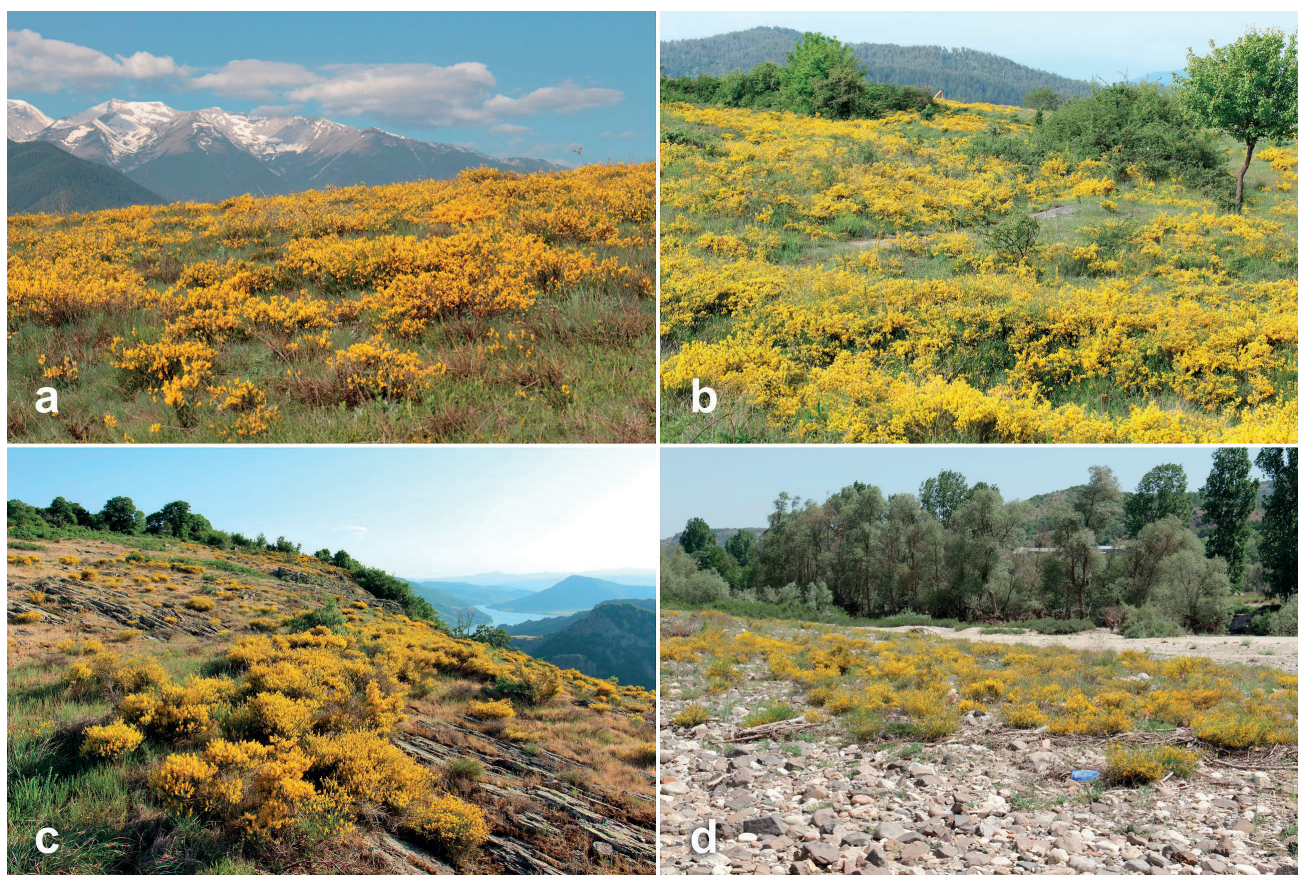


Fig. 3. Physiognomy of *Genista lydia* communities: a – *Diantho pinifolii*-*Genistetum lydiae*, b – *Romuleo graecae*-*Genistetum lydiae*, c – *Galio flavescens*-*Genistetum lydiae*, d – *Genista lydia*-*Satureja pilosa* community.

(75), *Koeleria nitidula* (75), *Geranium rotundifolium* (75), *Galium lucidum* (75), *Euphorbia myrsinites* (75), *Crucianella angustifolia* (75), *Buglossoides arvensis* (75) and *Asperula purpurea* (75)

Dominant species: *Genista lydia* (25)

Distribution: East Rhodopes Mts., 150 – 300 m a.s.l.

This community is distributed on the alluvial sandy terraces of Arda River and its tributaries. Typical species are many psamophytes as well as some species that inhabit the gravel bars like *Satureja pilosa*, *Cionura erecta*, *Euphorbia niciciana*, etc. The highest proportion of therophytes and the absence of geophytes in this community could be explained through its development on unstable (pioneer) substrates, influenced by river floods (Fig. 5). The floristic composition is also highly influenced by trampling by cattle and sheep that take water from the streams of the Arda River.

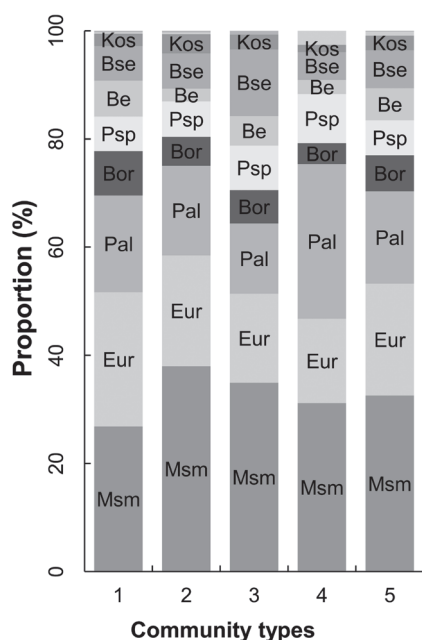


Fig. 4. Proportion of chorotypes within the different units of the *Genista lydia* communities: 1 – *Dianthus pinifolii-Genistetum lydiae*, 2 – *Romuleo graecae-Genistetum lydiae*, 3 – *Galio flavescens-Genistetum lydiae*, 4 – *Genista lydia-Satureja pilosa* community, 5 – The last column represents the proportion of chorotypes within all community types from the dataset. Chorotypes abbreviation: Msm – Mediterranean and sub-Mediterranean, Eur – European, Pal – Palearctic, Bor – Boreal, Psp – Pontic and sub-Pontic, Be – Balkan endemic, Bse – Balkan subendemic, Kos – Cosmopolitan. The Adventive and Holarctic elements are insignificant part of compared chorotypes, thus they are not marked in the figure.

Discussion

The largest areas occupied by *Genista lydia* communities are on the slopes of Pirin, Rila and the Rhodope Mountains. (in both Bulgarian and Greek parts). The northernmost localities are on the southern slopes of the Eastern Balkan Mountains. (Fig. 6).

The communities of *G. lydia* are known to have very limited distribution in Bulgaria covering a total area of 5.2 km²,

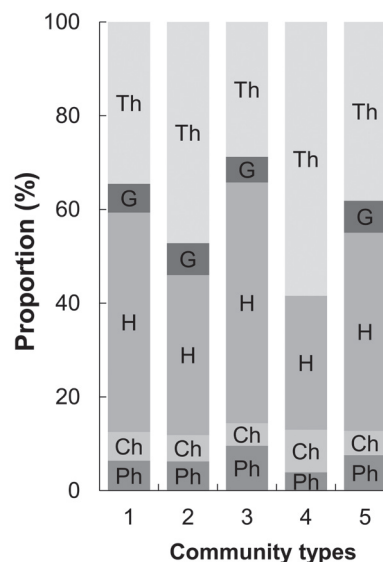


Fig. 5. Biological spectrum of the *Genista lydia* communities: 1 – *Dianthus pinifolii-Genistetum lydiae*, 2 – *Romuleo graecae-Genistetum lydiae*, 3 – *Galio flavescens-Genistetum lydiae*, 4 – *Genista lydia-Satureja pilosa* community, 5 – The last column represents the proportion of life-forms of community types 1, 2, 3 and 4. Life-form abbreviations: Ph – Phanerophytes, Ch – Chamaephytes, H – Hemicryptophytes, G – Geophytes, Th – Therophytes.

area of occupancy (AOO) – 26 (2600 km²) and extent of occurrence (EOO) – 9670 km² (Kunev and Tzonev 2019). Their distribution in Greece has not been completely investigated. However, the data presented in the habitat's description from the European Red List of Habitats (Janssen et al. 2016) shows a wider distribution area, which is 20 km² for the territory of Greece and 60 km² in Bulgaria. These data suggests that the occupied area in the Red List is probably overestimated.

The studied shrub communities could develop as primary vegetation on extreme sites, such as sheer rocks, rock crevices and terraces, where the soil is often absent or very shallow. However, secondary expansion of these communities has been also observed in some areas. It is initiated largely due to habitat degradation as a result of overgrazing, deforestation and following soil erosion. Those secondary communities are distributed mostly close to the settlements and in extensively grazed areas. The soil layer is more developed there, although it rarely reaches 30 cm in depth.

The present distribution of the studied vegetation has probably resulted also from some historical events. These communities occur mostly on the slopes of the Mesta (Nestos) and Arda River Valleys in Southern Bulgaria and Northern Greece and also penetrate into the valleys of their tributaries. Before the 1950s, these river valleys were used as transition route during the annual migration of the livestock from the winter grazing sites (in the lowlands) to the summer pasturelands (in the mountains). This type of grazing, known as “transhumance”, was widespread until 19th century in Bulgaria (Stoynov 2008). Therefore, probably the recent distribution and abundance of *G. lydia* communities in these areas is also related with the trampling and seed dispersal by the grazing animals. This fact is also supported by the abun-

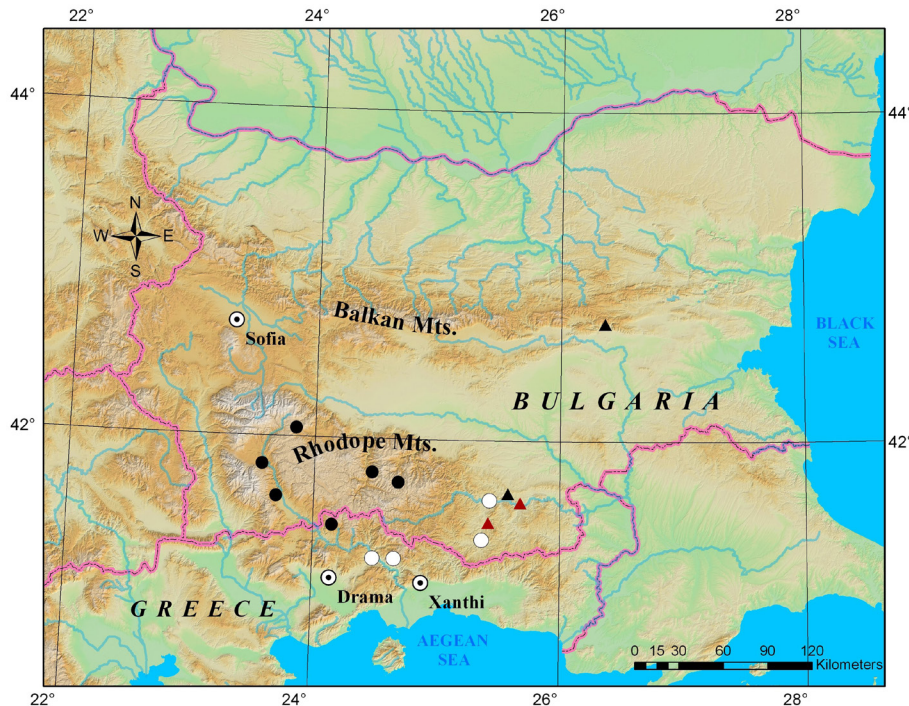


Fig. 6. Distribution map of *Genista lydia* communities: ● – *Diantho pinifolii*-*Genistetum lydiae*, ○ – *Romuleo graecae*-*Genistetum lydiae*, ▲ – *Galio flavescens*-*Genistetum lydiae*, ▲ – *Genista lydia*-*Satureja pilosa* community.

dance of *G. lydia* communities mostly close to the settlements where these grazing practices are still maintained. In the mountainous areas, these communities are often found near shieling sites. At the same time, in the sites with low or zero grazing intensity, the phytocoenoses have lower density and patchy distribution (Kunev and Tzonev 2019).

The information for the distribution of the studied communities on the territory of other Balkan countries and Turkey is very limited. *G. lydia* is reported mostly as an accompanying species in various vegetation types, but mostly forests and grasslands.

For example, this species in Serbia is distributed in the scrublands or forest fringes of the mountain regions (Diklić 1972). The species also has been reported to participate in the floristic composition of the association *Trifolio-Trisetum flavescens* N. Randelović 1975 (*Chrysopogono-Danthonion calycinae* Kojić 1957 of *Festuco-Brometea*) from Central Serbia (Ačić et al. 2014).

After revision of herbaria collections Teofilovski (2011) concluded, based on Zieliński et al. (2004), that part of the specimens previously cited by Micevski (2001) as *G. lydia*, actually belong to *G. januensis*. Therefore, the occurrence of *G. lydia* in North Macedonia should be accepted as uncertain.

Genista lydia in Greece is distributed mainly in the north-eastern parts of the country (Strid 1986, Zieliński et al. 2004). It has been reported as a common species in the forest clearings from the Rhodope Mountains, as well in the shrub layer of forests dominated by *Betula pendula* and *Pinus sylvestris* (Theodoropoulos et al. 2003, Eleftheriadou et al. 2009). It is

also reported as diagnostic species to the associations *Centaureo affinis-Festucetum koritnicensis* Karagiannakidou et al. 2001, especially in its high-altitudinal variant described from Pangeon Mt., where it occupies schistose substrates at altitudes of 1500–1800 m a.s.l. However, this association is classified in the alliance of oromediterranean dry grasslands and thorny-cushion dwarf shrub – *Astragalo angustifolii-Seslerion coeruleantis* Quézel 1964 from the class *Daphno-Festucetea* Quézel 1964 (Karagiannakidou et al. 2001).

The association *Minuartia hirsutae-Dianthetum pinifolii* (variant with *G. lydia*) has been described from Nomos of Chalkidiki, Greece (Bergmeier et al. 2009). As diagnostic species are referred *Centaurea diffusa*, *C. grisebachii*, *Dianthus pinifolius*, *Hypericum olympicum*, *Minuartia hirsuta* ssp. *falcata*, *Phleum phleoides*, *Psilurus incurvus*, *Rumex acetosella* and *Thymus sibthorpii*. Bergmeier et al. (2009) also noted that these communities inhabit slightly acidic, skeletal soils and classified them into the alliance *Diantho pinifolii-Jasionion heldreichii* Bergmeier et al. 2009 of *Sedo-Scleranthetea*. These communities differ from the studied vegetation by poorer species composition and lower abundance of therophytes.

The distribution range of *G. lydia* in Turkey includes its European parts as well as the western Asia Minor, and especially mountainous areas near the coastline (Gibbs 1970, Zieliński et al. 2004). The species occurs mostly on schistose substrates and participates in the floristic structure of macchia and phrygic vegetation, as understory of degraded mixed deciduous or coniferous forests and even in subalpine shrub communities (Quézel and Pamukçuoğlu 1970, Quézel 1986, Uğurlu and Senol 2005, Kaya and Aladağ 2009).

However, the community *Genista lydia*-*Hypericum linarioides* described from the Mount Uludağ (Quézel and Pamukçuoğlu 1970) is the only unit reported from Turkey with definitive dominance or codominance of *G. lydia*. These dwarf shrubs occur on schistose substrates, on 1800–2200 m a.s.l., at the fringes of *Abies bornmuelleriana* forests. From the pointed diagnostic species only *Juniperus nana* and *Thymus sibtorpii* are presented also in the Bulgarian and Greek communities of *G. lydia*, but with a low constancy. Quézel and Pamukçuoğlu (1970) have also noted the secondary origin of the community, which probably is related to the grazing in the subalpine zone. The proposed classification of the unit in the alliance *Bruckenthalion (Vaccinio-Piceetalia)* may be considered as provisional because it was based on four relevés only.

The diagnostic value of *G. lydia* communities for other, hierarchically higher, syntaxa is very poorly known. For example, according to Stefanov (1921), *G. lydia* (referred as *G. rumelica*) is an evergreen species from the pseudomaquis formations in the Western Thrace region and Northeastern Greece. The dominants in this type of vegetation are also *Pistacia terebinthus*, *Juniperus oxycedrus*, *J. excelsa*, *Cistus creticus*, *Calicotome villosa*, etc. Specific characteristic of these vegetation formations are also the abundance of annuals and geophytes, especially in more disturbed locations. Typical species mentioned by Stefanov (1921), such as *Teesdalia coronopifolia*, *Trifolium subterraneum*, *Ornithopus compressus*, *Crepis zacintha*, *Plantago bellardii*, *Orchis papilionacea*, *Ranunculus paludosus*, *Campanula phrygia*, are also found in the stands of *G. lydia* studied here.

The shrub communities, dominated by *Cistus incanus* from the southern parts of Bulgaria demonstrate also very similar ecological and floristic structure to those of *G. lydia*. Gussev (2015) suggested that they have some intermediate characteristics between the two plant associations described from neighbouring countries: *Diantho-Cistetum incani* Micevski et Matevski 1984 and *Calicotomo villosae-Cistetum cretici* Oberd. 1954. For example, the first association from the southern regions of North Macedonia was classified within the alliance *Trifolion cherleri* Micevski 1972 of *Festuco-Brometea* (Micevski and Matevski 1984, Čarni et al. 2010). Some of its diagnostic species such as *Cistus incanus*, *Dianthus pinifolius*, *Micropyrum tenellum*, *Anthemis macedonica*, *Briza maxima*, *Scabiosa triniifolia*, *Lupinus angustifolius* have been also found in the communities of *G. lydia*. A common feature to both vegetation types is the high constancy of leguminosae and especially *Trifolium* species.

On the other hand, the association *Calicotomo villosae-Cistetum cretici* Oberd. 1954 from Thessaloniki, Thrace and Thessaly, North Greece, dominated by the more thermophilous *C. incanus* ssp. *creticus*, could be a good example for communities synvicariant to *G. lydia*. The communities occur on silicate substrates and some of them are maintained by grazing. The association is characterized by the presence of widespread mesophilous species such as *Hypericum perforatum*, *Brachypodium sylvaticum*, *Plantago lanceolata* and *Teucrium chamaedrys*. Some early spring annuals like *Aira*

elegantissima, *Cerastium brachypetalum*, *Cynosurus echinatus* and *Vulpia ciliata* also participate in its floristic structure (Oberdorfer 1954, Čarni et al. 2010). Additionally, in the mosaics of these shrub communities, Oberdorfer (1954) sampled grassland fragments with high abundance of *Poa bulbosa* and other therophytes and geophytes - *Romulea linarioides* ssp. *graeca*, *R. bulbocodium*, *Ornithogalum* spp., *Gagea* spp. According to Oberdorfer (1954), these grasslands represent a regression stage of the shrub communities, such as *Calicotome villosa-Cistetum cretici* Oberd. 1954 caused by overgrazing and trampling. Although this association is dominated by some typical Mediterranean species not present in the *G. lydia* communities, both units have a similar appearance, floristic and ecological structure.

Different vegetation types, occurring in the transitional zone between the Temperate and Mediterranean climatic regions of the Southern Balkans were also reported to have such a complex floristic structure (Stoyanov and Achtarov 1951, Sopotlieva and Apostolova 2014, Čarni et al. 2018). From these data, it could be concluded that complexity and intermediate state (mixture of low shrubs, perennial and annual herbs with Continental-Temperate and Mediterranean origin) of the communities of *G. lydia* are common phenomenon in these regions. Their specific structure is determined by the transitional position between the two climatic types as well as the variability of their altitudinal range. Other important factors influencing the studied communities are grazing pressure, deforestation, construction and mining activities.

The complexity and the mixed structure of the open shrubland communities in these transitional areas make them difficult to be classified on the higher than the association level. For example, Oberdorfer (1954), who described the association *Calicotomo villosae-Cistetum cretici*, classified it in the alliance *Cistion orientale* Oberd. 1954 of the class of "eastern Mediterranean hedgehog heaths and low-grown broom phryganas" - *Cisto-Micromerietea julianae* Oberd. 1954 (see also Čarni et al. 2010). However, the name *Cistion orientale* was illegitimate and thus was replaced by *Hyperico olympici-Cistion cretici* (Oberd. 1954) R. Jahn et Bergmeier (Mucina et al. 2009). According to Mucina et al. (2016), this alliance belongs to the class *Cisto-Lavanduletea stoechadis* Br.-Bl. in Br.-Bl. et al. 1940. The similarities of the association *Calicotome villosa-Cistetum cretici* with the western mediterranean phryganic communities of *Cisto-Lavanduletea* have been also noted by Oberdorfer (1954). *Genista lydia* is also a low, evergreen to semi-evergreen shrub, which dominates communities developed mostly on siliceous substrates. This indicates the affiliation of such communities to the class *Cisto-Lavanduletea stoechadis* and its Eastern Mediterranean order *Lavandulo stoechadis-Hypericetalia olympici*. The diagnostic species of the order, found in the studied communities, are *Cistus creticus*, *Anthemis cretica*, *Dianthus pinifolius*, *Hypericum olympicum*, *Genista carinalis* and *Stachys angustifolia*. Moreover, it was recently reported from the southern regions of the Crimean peninsula (Ryff 2018), a fact that presents the order as not strictly Mediterranean. The order consists of three alliances, from which *Hyperico olympici-Cistion cretici* Mucina et al. (2009) was described as ther-

mo-meso-Mediterranean silicolous phrygana of Northern Hellas. This alliance is the most floristically, biogeographically and ecologically similar to the studied communities. From the characteristic species of the alliance, *Campanula lingulata*, *Vicia lathyroides* and *Thymus sibthorpii* (Čarni et al. 2010) have been also recorded in the *G. lydia* communities. However, the studied vegetation could be determined as submediterranean silicolous garigue distributed in southern parts of Central and Eastern Balkans, as well as locally in West Anatolia. Their floristic composition, structure and richness in Balkan endemics are sufficient to differentiate them from the already described syntaxa on the alliance level and to justify the establishment of a new independent alliance, which is described below.

Alliance: *Genistion lydiae* all. nov. hoc loco

Holotypus hoc loco: *Romuleo graecae-Genistetum lydiae* Kunev et al. nov. hoc loco

Diagnosis: Low-growing shrub communities dominated by the evergreen to semi-evergreen species *G. lydia* distributed in the south-eastern part of the Balkan Peninsula and probably Western Anatolia. These communities are acidophilous and occupy eroded places with shallow, poor soils or also rocky sites. The bedrock is of volcanic origin (andesites, rhyolites, volcanic schist, zeolites, gneisses), but also of sandstones. These communities occur as primary vegetation on rocky areas, but may also have a secondary origin replacing other communities on overgrazed grasslands. They are often open and with rich floristic composition which includes different plant life-forms. Many typical herbaceous species of the class of perennial grasslands *Festuco-Brometea* (in the foothill and mountain areas) and of the class of the therophytic pseudosteppes - *Helianthemetea guttati* (in the areas with a stronger Mediterranean climatic influence) participate in the stands of *G. lydia*. Such species are *Festuca valesiaca*, *F. dalmatica*, *Agrostis capillaris*, *A. castellana*, *Poa bulbosa*, *Chrysopogon gryllus*, *Koeleria macrantha*, *Aira elegantissima*, *Eryngium campestre*, *Sanguisorba minor*, *Trifolium cherleri* and *T. subterraneum*. In the canopy gaps of more open stands or on steep slopes of river valleys many ecologically flexible species, which generally belong to *Koelerio-Corynephoretea* and *Sedo-Scleranthetea* classes can be also found, such as *Rumex acetosella*, *Bromus squarrosus*, *Scabiosa argentea*, *Scleranthus perennis*, *Erysimum diffusum*, *Myosotis ramosissima*, *Sedum* spp., etc.

Characteristic species: *Genista lydia*, *Satureja pilosa*, *Thymus atticus*, *Hypericum montbretii*, *Anthemis tenuiloba*, *Galium flavescens*, *Minuartia hirsuta* ssp. *falcata*, *Centaurea cuneifolia*, *Viola tricolor* ssp. *macedonica* and *Rorippa thracica*.

Transgressive and differential species: *Asperula aristata* ssp. *scabra*, *Carlina corymbosa*, *Centaurea rhenana* ssp. *rhenana*, *Chamaecytisus absinthioides*, *Daucus guttatus*, *Dianthus pinifolium* ssp. *pinifolius*, *Erodium botrys*, *Romulea linnaesii* ssp. *graeca*, *Sedum grisebachii*, *Tuberaria guttata*, *Trifolium tenuifolium* and *T. strictum*.

This new alliance is similar and close to the alliance *Hyperico olympici-Cistion cretici*, but it is differentiated by its biogeographical range (Southeast Balkans and adjacent regions

of Asia Minor), its transitional position between Mediterranean and Continental (Temperate) climatic types and its floristic composition rich in Balkan endemics and subendemics.

Proposed syntaxonomic scheme

Class *Cisto-Lavanduletea stoechadis* Br.-Bl. in Br.-Bl. et al. 1940

Order *Lavandulo stoechadis-Hypericetalia olympici* Mucina in Mucina et al. 2016

Alliance *Genistion lydiae* Kunev, Tzonev, Tsiripidis et Pachedjieva all. nov. hoc loco

Association *Diantho pinifolii-Genistetum lydiae* Kunev, Tzonev, Tsiripidis et Pachedjieva ass. nova hoc loco

Association *Romuleo graecae-Genistetum lydiae* Kunev, Tzonev, Tsiripidis et Pachedjieva ass. nova hoc loco

Association *Galio flavescantis-Genistetum lydiae* Kunev, Tzonev, Tsiripidis et Pachedjieva ass. nova hoc loco

Genista lydia-Satureja pilosa community

Conclusion

The current study is the first attempt to describe appropriately the syntaxonomy of *Genista lydia* communities. The establishment of an endemic Southeast Balkan-West Anatolian alliance of sub-Mediterranean low evergreen to semi-evergreen scrub vegetation is proposed. The *G. lydia* communities have conservation significance on the European scale (Janssen et al. 2016). The major threat to the habitat is the abandonment of traditional grazing and pasture management as well as the changes in the land use. The latter threat concerns the transformation of pasturelands into crop fields or artificial forest plantations. If grazing is suspended, rapid successional changes will lead to the complete replacement of the shrub communities with hemicryptophytic grasslands or tall scrublands. Therefore, certain conservation measures, such as specific grazing maintenance, should be applied in order to prevent the decline of the communities. The inclusion of the "Balkan-Anatolian submontane genistoid scrub" habitat in the Annex I of the Habitat Directive is considered as a necessary policy measure that can ensure the conservation of this rare and vulnerable habitat type.

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Appendix

Nomenclatural type relevés of the newly described syntaxa:

1. *Diantho pinifolii*-*Genistetum lydiae* ass. nova hoc loco

Holotypus hoc loco: Bulgaria, Dobrinishte; Relevé no. 55 (On-line Suppl. Tab 1); relevé collector: G. Kunev, 23.06.2016; plot size 25 m²; alt. 739 m a.s.l.; slope: 20°, S; vegetation cover: 70%; latitude: 41.82577°, longitude: 23.62033°

Shrub species: *Genista lydia* 3; Herbaceous species: *Festuca valesiaca* 2a, *Sanguisorba minor* 2a, *Thymus longicaulis* 2a, *Dianthus pinifolius* ssp. *pinifolius* 1, *Agrostis capillaris* 1, *Bromus squarrosus* 1, *Centaurea rhenana* ssp. *rhenana* 1, *Chrysopogon gryllus* 1, *Crupina vulgaris* 1, *Cynosurus echinatus* 1, *Eryngium campestre* 1, *Euphorbia cyparissias* 1, *Euphrasia pectinata* 1, *Geranium columbinum* 1, *Hieracium bauhinii* 1, *Hypericum rumeliacum* 1, *Koeleria macrantha* 1, *Leontodon crispus* 1, *Melica ciliata* 1, *Orlaya daucoides* 1, *Phleum montanum* 1, *Plantago lanceolata* 1, *Plantago subulata* 1, *Potentilla neglecta* 1, *Stachys angustifolia* 1, *Stipa pulcherrima* 1, *Taeniatherum caput-medusae* 1, *Teucrium chamaedrys* 1, *Trifolium campestre* 1, *Trifolium hirtum* 1, *Trifolium striatum* ssp. *striatum* 1, *Xeranthemum annuum* 1, *Achillea coarctata* +, *Acinos rotundifolius* +, *Aegilops triuncialis* +, *Anagallis arvensis* +, *Anthemis tenuiloba* +, *Asperula aristata* ssp. *scabra* +, *Campanula lingulata* +, *Cerastium brachypetalum* +, *Cerastium pumilum* +, *Cuscuta approximata* +, *Hypericum olympicum* +, *Logfia arvensis* +, *Nigella arvensis* +, *Onobrychis gracilis* +, *Orlaya grandiflora* +, *Potentilla argentea* +, *Psilurus incurvus* +, *Scleranthus perennis* +, *Sedum caespitosum* +, *Sedum rubens* +, *Thesium arvense* +, *Trifolium arvense* +, *Valerianella coronata* +, *Valerianella dentata* +

2. *Romuleo graecae*-*Genistetum lydiae* ass. nova hoc loco

Holotypus hoc loco: Bulgaria, Dedets; Relevé no. 131 (On-line Suppl. Tab 1); relevé collector: G. Kunev, 22.04.2018; plot size 25 m²; alt. 382 m a.s.l.; slope: 3°, SW; vegetation cover: 80%; latitude: 41.38857°, longitude: 25.22668°

Shrub species: *Genista lydia* 3, *Cistus creticus* 2a, *Juniperus communis* ssp. *communis* 1, *Juniperus deltoides* 1, *Chamaecytisus albus* +, *Rosa turcica* +; Herbaceous species: *Chrysopogon gryllus* 2a, *Hieracium hoppeanum* 2a, *Poa bulbosa* 2a, *Aira elegantissima* 1, *Anthoxanthum odoratum* 1, *Carex*

caryophyllea 1, *Centaurea cuneifolia* 1, *Cerastium gracile* 1, *Chondrilla juncea* 1, *Crepis sancta* 1, *Daucus guttatus* 1, *Erodium botrys* 1, *Eryngium campestre* 1, *Hieracium bauhinii* 1, *Hypericum cerastoides* 1, *Hypericum olympicum* 1, *Hypochaeris glabra* 1, *Jasione heldreichii* 1, *Leontodon crispus* 1, *Moenchia mantica* 1, *Ornithopus compressus* 1, *Parentucellia latifolia* 1, *Petrorhagia illyrica* 1, *Potentilla recta* 1, *Romulea linaresii* ssp. *graeca* 1, *Rumex acetosella* 1, *Sanguisorba minor* 1, *Sherardia arvensis* 1, *Spergula pentandra* 1, *Teesdalia coronopifolia* 1, *Thymus atticus* 1, *Thymus longicaulis* 1, *Trifolium nigrescens* ssp. *petrisavii* 1, *Trifolium strictum* 1, *Trifolium tenuifolium* 1, *Tuberaria guttata* 1, *Anthemis arvensis* +, *Cirsium vulgare* +, *Cnicus benedictus* +, *Dianthus corymbosus* +, *Geranium molle* +, *Lupinus angustifolius* +, *Moenchia erecta* +, *Orchis morio* +, *Scabiosa argentea* +, *Scilla autumnalis* +, *Scleranthus verticillatus* +, *Thesium dollineri*; Cryptogams: *Cladonia foliacea* 1, *Cladonia furcata* agg. 1, *Polytrichum piliferum* 1, *Racomitrium canescens* 1, *Cetraria aculeata* agg. +

3. *Galio flavescens*-*Genistetum lydiae* ass. nova hoc loco

Holotypus hoc loco: Bulgaria, Sliven, NP "Sinite kamani"; Relevé no. 41 (On-line Suppl. Tab 1); relevé collector: G. Kunev, 19.06.2016; plot size 16 m²; alt. 612 m a.s.l.; slope: 7°, SW; vegetation cover: 60%; latitude: 42.70712°, longitude: 26.34363°

Shrub species: *Genista lydia* 3, *Amelanchier ovalis* +, *Lembotropis nigricans* +; Herbaceous species: *Plantago subulata* 2a, *Achillea coarctata* 1, *Anthemis cretica* 1, *Anthemis tinctoria* 1, *Festuca dalmatica* 1, *Galium flavescens* 1, *Hieracium hoppeanum* 1, *Hypericum perforatum* 1, *Koeleria nitidula* 1, *Logfia arvensis* 1, *Phleum montanum* 1, *Rumex acetosella* 1, *Scabiosa triniifolia* 1, *Scleranthus perennis* 1, *Sempervivum erythraeum* 1, *Stachys angustifolia* 1, *Thymus callieri* ssp. *urumovi* 1, *Verbascum humile* 1, *Veronica verna* 1, *Viola arvensis* 1, *Achillea millefolium* +, *Allium sphaerocephalon* +, *Alyssum alyssoides* +, *Avenula compressa* +, *Buglossoides arvensis* +, *Crucianella angustifolia* +, *Crupina vulgaris* +, *Cuscuta approximata* +, *Hypericum montbretii* +, *Linaria genistifolia* ssp. *genistifolia* +, *Micropyrum tenellum* +, *Orlaya grandiflora* +, *Ornithogalum kochii* +, *Psilurus incurvus* +, *Scandix pecten-veneris* ssp. *macrorhyncha* +, *Viscaria vulgaris* ssp. *atropurpurea* +; Cryptogams: *Cladonia foliacea* 1, *Cladonia rangiformis* 1, *Polytrichum piliferum* 1