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Scrub vegetation in the Slivenska Planina Mt, Bulgaria

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Abstract

This study deals with the diversity of scrub vegetation in Slivenska Planina Mt (Eastern Stara planina Mts). On the basis of analisys of 29 relevés, the scrub phytocoenoses were classifyied into 1 association, 2 variants and 4 plant communities. They have been identified and characterized in the article. The studied communities belong to the the class *Crataego-Prunetea*, order *Paliuretalia* with alliance *Buxo-Syringion* and in order *Prunetalia spinosae* with the alliances *Berberidion vulgaris* and *Brachypodio pinnati-Juniperion communis*. The phytocoenoses belong to 4 habitat types of EUNIS, 2 habitat types of Annex I of the Habitat Directive and 3 habitat types of Red Data Book of Bulgaria, v. 3, Natural habitats.

Key words: Braun-Blanquet approach, scrub habitats, southeastern Bulgaria, syntaxonomy.

Introduction

Slivenska Planina Mt is a part of Eastern Stara Planina Mts. Any detailed study of the scrub vegetation of Slivenska Planina Mt as a separate geographical unit, have not been carried out until now. The gathering of detailed information about the characteristic and successional trends in the scrub vegetation would contribute for their more sustainable management, as well as for some prerequisite for their conservation and sustainable use. It is a part of the study on the biodiversity in the region, which is an important part of these activities related also to their environmental protection. However, the regional vegetation studies are relevant in the context of the observed climatic changes, sustainable developement and nature conservation (Alexandrova et al. 2020).

The earliest studies of the vegetation of Slivenska Planina Mt had a generally descriptive nature or followed the method of the Russian phytocoenological school. They were part of national (Stoyanov 1941, Bondev 1991, Apostolova and Slavova 1997) or regional studies on the territory of the ‘Sinite Kamani’ Natural Park (Andreev 1981, Stoeva 2004).

The studied territory is located in the eastern part of the Balkan Range phytoclimatic region (Stoyanov 1941), where the specific patterns of the vegetation is expressed in the presence of Mediterranean species and also presence of some Euxinian floristic elements. The

former studies of this region have been mainly focused on the forest vegetation (Andreev 1981, Bondev 1991, Sopotlieva et al. 2016, Alexandrova et al. 2020). There is some information for the scrub vegetation but only from small areas (Stoeva 2004) or for certain communities/ habitat types (Tashev 2013). For a first time, the communities which belong to the habitat 5130 of *Juniperus communis* on limestone, have been found in the protected area by Tashev (2013). Kunev and Tzonev (2019) published data for habitat F3.1d Balkan-Anatolian submontane genistoid scrub included in the European Red List of Habitats (Janssen et al. 2016), which includes the communities dominated by *Genista lydia* also from the studied region. Also, Kunev et al. (2020) have studied the scrub communities of *Genista lydia* in the Southeast Balkans and published 4 new associations. One of them *Galio flavescentis-Genistetum lydiae* Kunev et al. 2020 is found from the area of 'Sinite Kamani' Nature Park.

The aim of present study was to investigate the scrub vegetation on the territory of Slivenska Planina Mt according to the approach of Braun-Blanquet's phytocoenological school (Braun-Blanquet 1964).

Object and Methods

The studied area – Slivenska Planina Mt is located in southeastern Bulgaria, at the most western part of the Eastern Stara planina Mts (Balkan range) (Steffanov 2002). The borders of the mountain are: on the north – the valley of Luda Kamchia river which separates it from Kotlenska Mt, on the south – the valley of Assenovska river and the Slivenska Plain, on the west the border goes along the Vratnik Pass which divides it from the Eleno-Tvardishka Mt, and on the east – Icherenski Pass between Slivenska Planina Mt and Stidovska Planina Mt. The southeastern part of the Slivenska Planina Mt belongs to the Grebenets Ridge, whose borders on north and east, are along the valleys of the Ovcharitsa and Marash rivers, while on the south it's borders with the Slivenska Plain (Fig. 1). The total area of the Slivenska Planina Mt is 212.267 km^2. The physico-geographical division of Bulgaria assignes the Slivenska Planina Mt to the Southern low-mountainous sub-region of the Forebalkan-Eastern Balkan Mountains. The bedrocks of the study area are predominantly lower Cretaceous sandstones and marls, which pass into upper Cretaceous and Paleogene flysch formations (Yordanova et al. 2002). According to the climatic division of Bulgaria (Velev 2002), the study area falls into the transitional-continental climatic region and the Eastern Balkan Range climatic region.

This climate is characterized by warm and slightly arid summer and mild winter, with small annual temperature amplitudes, two maximums (July and November) and two minimums (August and February) of the annual rainfalls, with an average of 600 mm. According to the hydrological division of Bulgaria (Yordanova 2002), the study area falls into the zone with Mediterranean climate influence on the outflow and in the Eastern Balkan region. It is characterized by increased aquifer, poorly regulated groundwater runoff and relatively deep and shallow water, which corresponds to a relatively large tide of waters. The soils in the lower parts of the studied area (below 500 m a.s.l.) are included in the Eastern Balkan province of the Carpathian-Danube soil region, while in the higher part are in the Balkan Mountains

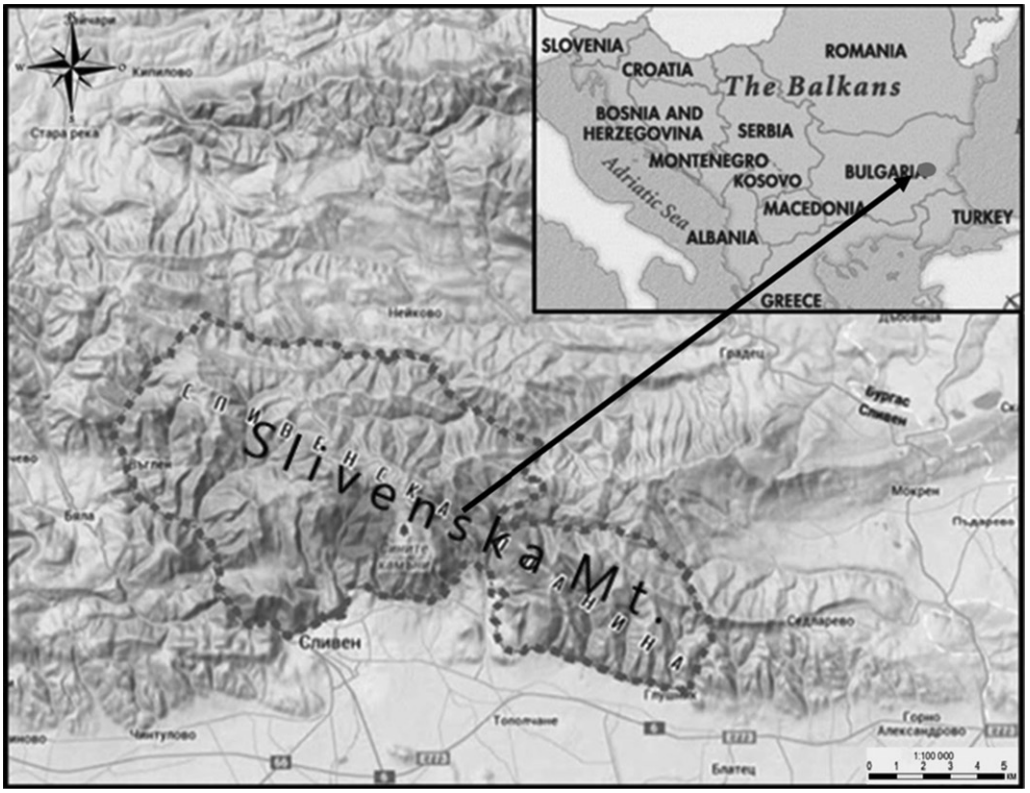

Fig. 1. Slivenska Planina Mt's map.

of the Mediterranean soil region (Ninov 2002). According to the geobotanical division of Bulgaria (Bondev 2002), the Slivenska Mt belongs to the European Broadleaved Forest Area, Illyrian (Balkan) Province and Kotlensko-Preslavski District.

Seven protected areas are located in Slivenska Planina Mt: part of 'Sinite Kamani' Nature Park and 'Kutelka' Reserve; protected areas of 'Lale Bair', 'Orlite', and 'Trakiiski kiln'; natural monuments of 'Halkata' and 'Zmeevi dupki'. Three NATURA 2000 sites party or completely are overlaped with the studied area: BG000016 Sinite Kamani and BG0000420 Grebenets (declared under the Habitat Directive) and BG0002058 Sinite Kamani – Grebenets (declared under the Bird Directive). One Important Plant Area (IPA) site (BGIPA101 Sinite Kamani), covering an area of 122.80 km^2 within the object of study (Alexandrova et al. 2020).

The field studies were conducted during the vegetation seasons of 2014–2016. A total of 29 relevés were collected from scrub vegetation, following the Braun-Blanquet approach (Braun-Blanquet 1964). The relevés were taken in homogeneous parts of scrub stands. Size of the relevés was in the range 100 m^2 (Chytrý and Otýpková 2003). For each relevé, complete floristic composition of vascular flora was recorded. Total vegetation cover, as well as the cover of scrub and herbaceous layers were also recorded. The abundance of each species was estimat-

ed by its cover in percents, which was later transformed into 7-grade Braun-Blanquet scale (Braun-Blanquet 1964). If one species is found in several layers in the relevé, it was recorded in each of them. The data for topographic and ecological peculiarities field (e.g. elevation, aspect, slope) were also collected, in the, whereas basic soil data (e.g. soil type and some soil characteristics as a soil reaction, soil depth and humidity) was exctracted from the Forest Management Plans of State Forestry Units Sliven and Kotel (Agrolesproject 2012, 2014). All relevés were digitalized in Excel format and stored in the Balkan Vegetation database using in TURBOVEG format (Vassilev et al. 2016).

The taxonomic position of vascular plants is standardized according to the Euro+Med PlantBase (Euro+Med 2006–2020). Taxa identified with different taxonomic precision were merged to species 'sensu lato' or species aggregates.

All relevés were exported in JUICE 7.0 software (Tichý 2002). Agglomerative method for numerical analysis (PC-ORD, McCune and Mefford 1999) was used. Square root transformation of species cover/abundance and minimum number of 2 relevés by cluster were applied. Relative Sorensen index was used as distance measure and the similarity was calculated by Flexible beta (ß = -0.25). The phi-coefficient of established groups was applied as a measure of fidelity (Sokal and Rohlf 1995, Chytrý et al. 2002), and all clusters were standardized to equal size (Chytrý et al. 2006). Only the statistically significant phi-coefficient values evaluated by Fisher's exact test ($p < 0.05$) were considered. For each differentiated group the diagnostic, constant and dominant species were determined by 'Analysis of constancy columns in synoptic table' function in the JUICE software. The threshold value for a species to be considered as diagnostic was set up at phi-coefficient ≥ 0.3. The list of constant species includes species with presence at least 40 % in relevés in a cluster, whereas the species with cover more tham 20 % were considered as dominants. Finally, in the 'Results and discussion' section, the value of phi-coefficient for each species per group was presented in parentheses multiplied by 100. Respectively, the values in parentheses for a constant species signify their percentages constancy per group, while for the dominant species the parentheses present the percentage ratios of relevés of the target group where the dominant species cover was above the defined threshold. The final synoptic table presents both species percentage frequency and fidelity (Appendix A).

The syntaxonomic nomenclature on the alliance level followed the concept of Mucina et al. (2016). The classification of established vegetation units is determined after a comparative analysis of the diagnostic, constant and dominant species groups with those indicated in the cited referance (Kojić et al. 1998, Borhidi et al. 2012, Chytrý 2013, Biondi et al. 2014, Coldea et al. 2015). Some of phytocoenoses were not detrmined as belonging to any association and were assigned as 'community types' because of their local occurrence or limited data for their presence in other regions of Bulgaria.

The assignment of communities to some natural habitats is done according to the EUNIS classification scheme (EEA 2019), Red Data Book of the Republic of Bulgaria, v. 3, Natural Habitats (Biserkov et al. 2015) (RB) and Directive 92/43/EEC.

Results and Discussion

The scrub communities on the territory of Slivenska Planina Mt after the cluster analysis (Fig. 2) were separated into 6 groups, presented in the synoptic Table A1 (Appendix A). They belong to 1 class, 2 orders, 2 alliances, 1 association, 2 variants and 4 plant communities.

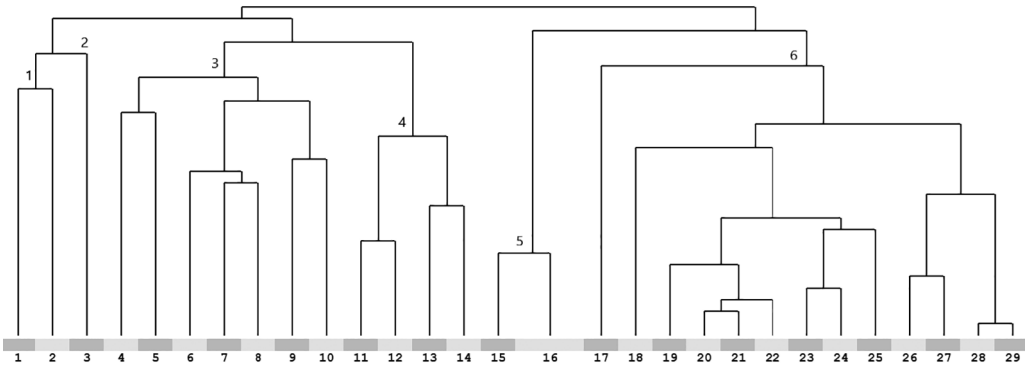

Fig. 2. Classification dendrogram of scrub vegetation on Slivenska Planina Mt.
Note: The identified scrub vegetation groups' number was showen on respective dendrogram separation, while the numbers on the botton of dendrogram corresponded to relevé number.

Syntaxonomical scheme of recorded phytocoenoses

Class *Crataego-Prunetea* Tx. 1962
Order *Prunetalia spinosae* Tx. 1952
Alliance *Brachypodio pinnati-Juniperion communis* Mucina in Mucina et al. 2016
Juniperus communis comm.
Alliance *Berberidion vulgaris* Br.-Bl. ex Tx. 1952
Association *Crataego-Prunetum spinosae* Hueck 1931
variant *Lamium maculatum*
variant *Thymus pulegioides*
Order *Paliuretalia* Trinajstić 1978
Alliance *Buxo-Syringion* P. Fukarek ex Diklić 1965
Rosa spinosissima comm.
Syringa vulgaris comm.
Syringa vulgaris and *Quercus pubescens* comm.

Class *Crataego-Prunetea* Tx. 1962

The scrub vegetation of Slivenska Mt belongs to the class *Crataego-Prunetea*, which includes scrub and mantle vegetation, among or on the margins of broad-leaved forests in the temperate zone and sub-Mediterranean regions of Europe (Mucina et al. 2016). These communities have an intrazonal distribution. The described scrub phycoenoses belong to two orders and three alliances.

Order *Prunetalia spinosae* Tx. 1952

The order *Prunetalia spinosae* includes scrubs on the margins of deciduous forests or serial scrub communities formed in abandoned fields or pastures. Their species composition is very similar to those of forest phytocoenoses from *Carpino-Fagetea* class. Alliance *Brachypodio pinnati-Juniperion communis* Mucina et al. 2016 includes lowland thermophilous and calciphilous Common juniper scrubs in Europe, but the alliance *Berberidion vulg*aris – southern temperate and sub-Mediterranean thermophilous broad-

leaved scrubs in southern and central Europe (Mucina et al. 2016). These communities are of secondary origin, as a result of human activities and have not yet been described in detail both on the territory of Slivenska Planina Mt and also on the territory of Bulgaria.

***Juniperus communis* comm. (figure 2, relevés 1-2; annex A, group 1)**

Diagnostic species: *Juniperus communis* (92.2).

Consant Species: *Viola mirabilis* (50), *Thymus zygioides* (50), *Teucrium chamaedrys* (50), *Tephroseris papposa* (50), *Stachys officinalis* (50), *Sesleria latifolia* (50), *Scabiosa triniifolia* (50), *Sanguisorba minor* (50), *Rubus caesius* (50), *Rosa canina* (50), *Primula veris* (50), *Potentilla erecta* (50), *Polygala major* (50), *Poa pratensis* (50), *Poa compressa* (50), *Piptatherum virescens* (50), *Pilosella officinarum* agg. (50), *Nardus stricta* (50), *Luzula luzuloides* (50), *Leontodon crispus* (50), *Holcus lanatus* (50), *Helianthemum nummularium* (50), *Galium pseudaristatum* (50), *Fragaria viridis* (50), *Filipendula vulgaris* (50), *Filago germanica* (50), *Dianthus pinifolius* (50), *Cytisus hirsutus* (50), *Carlina acanthifolia* (50), *Carex humilis* (50), *Campanula persicifolia* (50), *Avenella flexuosa* (50), *Asperula cynanchica* (50), *Anthyllis vulneraria* (50), *Agrostis capillaris* (50), *Achillea millefolium* agg. (50), *Achillea grandifolia* (50).

Dominant species: *Juniperus communis* (100), *Sesleria latifolia* (50), *Nardus stricta* (50).

In a cluster 2, the relevés are separated with the dominant participation of *Juniperus communis*. They occur in the range of 920–1020 m a.s.l., on the not steep slopes (about 5 degrees), with north and south-west aspect. The soils are *Dystric Cambisols*, nutrient-poor, dry, compacted, medium stony. The rocks are most commonly quartz porphyries and sandstones and less limestones. The scrub layer is dominated by the scrubs or groups of *Juniperus communis*, with fragments in between dominated by herbaceous species such as *Carex humilis, Agrostis capillaris, Nardus stricta, Anthyllis vulneraria, Carlina acanthifolia, Avenella flexuosa*, etc. In the past, these areas were occupied by forests that were cut down to provide territories for grazing. Their formation is secondary, and after abandonment of grazing, the juniper begans to increase in the the area.

Until now, no detailed studies of this type of phytocoenoses have been done and the literature sources are limited. Bondev (1991) determined them as Juniper Scrubs (*Juniperus communis*) mainly on the place of former forests of *Quercus petraea, Fagys sylvatica, Pinus nigra, P. sylvestris*, etc. Redžić (2007) has described the association *Juniperetum communis* Fukarek 1969 from Vranica Mts in Bosnia, and refered it to the alliance *Juniperion communis* Fukarek 1969, order *Pteridio-Juniperetalia* Lakušić 1978, class *Rhamno-Prunetea* Rivas Goday et Borja Carbonell 1961. The specified order is now accepted as a synonym of *Vaccinio-Juniperetalia communis* Passarge 1972 which includes the juniper communities of the class *Calluno-Ulicetea* distributed in the temperate Atlantic regions of Europe. Firstly, only the juniper calciphilous scrubs in Western and Central Europe were referred to the allance *Brachypodio pinnati-Juniperion communis* (Mucina et al. 2016). In the current list of habitats and plant communities in Europe (FloraVeg. EU 2022–2023), the range of the alliance includes also the territory of Bulgaria, and in its ecological characteristics the accent is not on the calciphilous preferences of communities. This is the reason to accept

that the communities of *Juniperus communis* on the territory of Slivenska Planina Mt belong to this alliance. Moreover, the habitat 5130, which includes communities of *Juniperus communis* on limestone areas already has been found on this territory (Tashev 2013).

This community belongs to the following types of natural habitats – EUNIS: S314 Sub-Mediterranean common juniper thickets; RB (2015): 17F3 Common juniper (*Juniperus communis*) scrub; Directive 92/43: 5130 *Juniperus communis* formations on heaths or calcareous grasslands.

Association *Crataego-Prunetum spinosae* Hueck 1931 (figure 2, relevés 15-30; annex A, groups 5-6)

Diagnostic species: *Agrimonia eupatoria* (79.9), *Lychnis coronaria* (71.2), *Crataegus monogyna* (66.8), *Prunus spinosa* (66.7), *Prunus cerasifera* (66.7), *Dorycnium pentaphyllum* s.l. (66.7), *Brachypodium pinnatum* (66.7), *Rosa canina* (63.4), *Vicia tenuifolia* s.l. (61.9), *Veronica chamaedrys* (61.9), *Salvia pratensis* (61.9), *Festuca dalmatica* (60.5), *Clinopodium vulgare* (59.2), *Pyrus communis* s.l. (57.4), *Thymus pulegioides* (56.9), *Rubus canescens* (56.9), *Galium verum* (55.5), *Fragaria vesca* (54.2), *Stachys germanica* (51.6), *Pteridium aquilinum* (51.6), *Cota tinctoria* (51.6), *Hypericum perforatum* (47.1), *Eryngium campestre* (42.0).

Constant species: *Euphorbia cyparissias* (62), *Dactylis glomerata* (62), *Teucrium chamaedrys* (44), *Achillea millefolium* agg. (44).

Dominant species: *Prunus spinosa* (31), *Crataegus monogyna* (31), *Rosa canina* (25), *Pteridium aquilinum* (6), *Prunus cerasifera* (6).

The phytocoenoses of this association are found in the altitudinal range 500–1000 m. The bedrocks are varied – marls, sandstones, shales, quartz porphyries and limestones, and the soils are *Dystric Cambisols*, *Chromic Luvisols* and *Rendzic Leptosols*, medium nutrient-rich, dry to fresh, with exposed rocks. The aspects are diverse, predominatly with eastern and southern components. The slopes are between 5 and 20 degrees. Dominants in the scrub layer are *Crataegus monogyna, Prunus spinosa*, *Rosa canina*, *Prunus cerasifera* and also *Pyrus communis* participates. The herbaceous layer is well developed and a great diversity of species is observed. It includes *Brachypodium pinnatum, Clinopodium vulgare, Dactylis glomerata, Dorycnium herbaceum, Eryngium campestre, Euphorbia cyparissias, Filipendula vulgaris, Hypericum perforatum, Lychnis coronaria, Teucrium chamaedrys, Thymus pulegioides, Vicia dalmatica,* etc. The territories occupied by these communities were used for grazing in the past, but they were subsequently abandoned, which led to the increase of scrubs in them.

The association is published from Romania in the alliance *Berberidion*, order *Prunetalia spinosae*, class *Crataego-Prunetea* (Coldea et al. 2015) and also from Vranica Mt in Bosnia (Redžić 2007). In Czech Republic, the association *Pruno spinosae-Ligustretum vulgaris* Tüxen 1952 is determined as belonging to the alliance *Berberidion vulgaris* Br.-Bl. ex Tüxen 1952 (Chytrý 2013). The same association is reported for Slovenia as well under *Prunus spinosa* community (Šilc and Čarni 2012). The association *Pruno spinosae-Crataegetum* (Soo 1927) Hueck 1931 has been published for Serbia in the alliance *Prunion spinosae* Soo 1940, order *Prunetalia spinosae*, class *Quercо-Fagetea* Br.-Bl. et Vlieg. 1937 (Kojić et al. 1998). In Hungary, the same association is classified to the alliance *Berberid-*

ion, order *Prunetalia spinosae* and class *Crataego-Prunetea* (Borhidi et al. 2012). All names of the mentioned associations are asscepted as synonyms by Chytrý (2013) and Coldea et al. (2015).

The recent studies of the class *Crataego-Prunetea* in Bulgaria were performed by Vassilev et al. (2020). They have published the distribution of 2 associations (*Corno-Ligustretum* Horvat ex Trinajstić & Z. Pavletić 1991, *Pruno spinosae-Ligustretum vulgaris* Tüxen 1952) and 1 community (*Elytrigia repens-Crataegus monogyna* community) belonging to the allance *Berberidion vulgaris*. Sopotlieva et al. (2016) has found the association from the 'Kutelka' Reserve.

The association belongs to the following natural habitat – EUNIS: S357 Subcontinental and continental deciduous thickets.

Two variants are differentiated floristically and ecologically within the association.

Variant *Lamium maculatum* (figure 2, relevés 15-17; annex A, group 5)

Diagnostic species: *Bromus arvensis* (95.6), *Prunus spinosa* (81.6), *Lamium maculatum* (79.1), *Galium aparine* (73.7).

Constant species: *Rosa canina* (67), *Cynosurus echinatus* (67).

Dominant species: *Prunus spinosa* (100).

The communities of this variant are the most xerophytic ones. The soils are dry and with exposed rocks. A typical characteristic is the layer of *Prunus spinosa* in all relevés.

Variant *Thymus pulegioides* (figure 2, relevés 18-30; annex A, group 6)

Diagnostic species: *Agrimonia eupatoria* (90.6), *Crataegus monogyna* (81.3), *Lychnis coronaria* (80.8), *Dorycnium pentaphyllum* s.l. (75.6), *Brachypodium pinnatum* (75.6), *Festuca dalmatica* (71.5), *Clinopodium vulgare* (71.4), *Vicia tenuifolia* s.l. (70.2), *Veronica chamaedrys* (70.2), *Pyrus communis* s.l. (69.7), *Galium verum* (65.8), *Fragaria vesca* (65.8), *Thymus pulegioides* (64.5), *Rubus canescens* (64.5), *Euphorbia cyparissias* (58.6), *Stachys germanica* (58.5), *Pteridium aquilinum* (58.5), *Cota tinctoria* (58.5), *Hypericum perforatum* (58.2), *Rosa canina* (54.5), *Eryngium campestre* (53.5), *Potentilla argentea* (52.0), *Galium album* (52.0), *Prunus cerasifera* (49.9), *Potentilla pedata* (46.9), *Origanum vulgare* (46.9), *Anthoxanthum odoratum* (46.9), *Dactylis glomerata* (46.5), *Salvia pratensis* (43.4), *Filipendula vulgaris* (36.7).

Constant species: *Teucrium chamaedrys* (54), *Achillea millefolium* agg. (54).

Dominant species: *Crataegus monogyna* (38), *Rosa canina* (31), *Prunus spinosa* (15), *Pteridium aquilinum* (8), *Prunus cerasifera* (8).

The communities of this variant are more mesophytic and represent the main characteristics of the association.

Order *Paliuretalia* Trinajstić 1978

The order is represented by thermophilous scrubs in the periphery of the oak forests of the sub-Mediterranean region of southeastern Europe. The sub-Mediterranean alliance *Buxo-Syringion* includes thermophilous scrubs in the continental part of the Northern and Central Balkans (Mucina et al. 2016).

***Rosa spinosissima* comm. (figure 2, relevé 3; annex A, group 2)**

Diagnostic species: *Viscaria vulgaris* (100), *Viola dacica* (100), *Stellaria alsine* (100), *Rosa spinosissima* (100), *Quercus petraea* agg. (100), *Poa nemoralis* (100), *Glechoma hederacea* (100), *Geranium macrorrhizum* (100), *Festuca nigrescens* (100).

Constant species: *Scleranthus annuus* (100), *Avenella flexuosa* (100).

Dominant species: *Rosa spinosissima* (100).

One relevé is separared in this cluster, where *Rosa spinosissima* (90%) has a dominant role in the first layer, but the herbaceous layer is poorly developed. The community is located in the 'Kutelka' reserve, at 1058 m a.s.l. The soils are *Dystric Cambisols*, medium nutrient-rich, fresh, loose and medium rocky. The slope is 15 degrees, with north aspect. On the basis on only one relevé, it is not possible to attribute it to a certain association. Čarni et al. (2009) and Čarni and Mucina (2015) have refered *Rosa pimpinellifolia* (syn. *Rosa spinosissima*) as the diagnostic species for the alliance *Buxo-Syringion* P. Fukarek ex Diklić 1965.

The community belongs to the following types of natural habitats – EUNIS: S2573 Balkano-Hellenic deciduous thickets; Directive 92/43: 40A0* Subcontinental peri-Pannonian scrub.

***Syringa vulgaris* comm. (figure 2, relevés 4-10; annex A, group 3)**

Diagnostic species: *Muscari botryoides* (62.0), *Syringa vulgaris* (61.3), *Vicia hirsuta* (50.0), *Verbascum humile* (50.0), *Sedum acre* (50.0), *Ranunculus illyricus* (50.0), *Melica ciliata* (50.0), *Lathyrus sphaericus* (50.0), *Colchicum autumnale* (50.0), *Clinopodium alpinum* (50.0), *Arenaria serpillifolia* agg. (50.0), *Allium guttatum* (50.0), *Achillea clypeolata* (50.0), *Crupina vulgaris* (44.5).

Constant species: *Koeleria nitidula* (57), *Euphorbia cyparissias* (57), *Achillea millefolium* agg. (57), *Thymus striatus* (43), *Poa bulbosa* (43), *Orlaya grandiflora* (43), *Jasminum fruticans* (43), *Festuca valesiaca* (43).

Dominant species: *Syringa vulgaris* (86), *Pyrus communis* s.l., (14), *Jasminum fruticans* (14), *Festuca valesiaca* (14).

The communities of this group occupy terrains at an altitude between 500 and 1000 m a.s.l., on sunny aspects – with a predominance of eastern and southern components. The soils are *Chromic Cambisols* and *Chromic Luvisols*, medium rich in nutrient, dry to fresh, compacted, medium to highly skeletal. The vertical structure comprises two layers, the first one is dominated by *Syringa vulgaris* (cover between 30 and 90 %). In the herbaceous layer, the floristic composition is a diverse and includes species such as *Euphorbia cyparissias, Jasminum fruticans, Koeleria nitidula, Muscari botryoides, Orlaya grandiflora, Thymus striatus*.

Syringa vulgaris communities are represented on the territory of Serbia by 4 associations – *Syringetum vulgaris* Knapp 1994, *Eryngio-Syringetum vulgaris* Diklić 1965, *Syringetum vulgaris serpentinicum* Vukić. et Jov. 1979 and *Syringetum vulgaris silicicolum* Jov. et Vukić. 1982 (Kojić et al. 1998), which are similiar to the communities in Slivenska Planina Mt. However, the small number of relevés and the various ecological characteristics do not provide enough reasons to refer them to any of the already described associations.

These communities belong to the following types of natural habitats – EUNIS: S35732 Moesian lilac thickets; RB (2015): 20F3 Moesian lilac (*Syringa vulgaris*) thickets.

***Syringa vulgaris* and *Quercus pubescens* comm. (figure 2, relevés 11-14; annex A, group 4)**

Diagnostic species: *Quercus pubescens* (100.0), *Hypericum aucheri* (84.5), *Cyanus thirkei* (84.5), *Carpinus orientalis* (84.5), *Sideritis montana* (75.5), *Ajuga chamaepitys* s.l. (75.5), *Dactylis glomerata* (69.2), *Fraxinus ornus* (68.3), *Securigera varia* (67.4), *Linum austriacum* (67.4),

Geranium purpureum (67.4), *Astragalus spruneri* (67.4), *Arum maculatum* (67.4), *Paliurus spina-christi* (66.2), *Festuca valesiaca* (62.3), *Tanacetum vulgare* (61.3), *Paeonia peregrina* (56.8).

Constant species: *Syringa vulgaris* (75), *Orlaya grandiflora* (75), *Achillea millefolium* agg. (75), *Thymus striatus* (50), *Poa pratensis* (50), *Poa bulbosa* (50), *Jasminum fruticans* (50), *Erysimum diffusum* (50), *Centaurea stoebe* (50), *Ajuga laxmannii* (50).

Dominant species: *Syringa vulgaris* (25), *Carpinus orientalis* (25).

The communities are distributed in the range of 400–500 m a.s.l., on eastern aspects. The slopes are steep – between 15 and 30 degrees. The rocks are marls, and the soils are *Chromic Luvisols*, nutrient-poor, dry, skeletal, with erosion processes observed in places. Typical to this group is the domination of *Syringa vulgaris*, and in some releves *Carpinus orientalis* and *Quercus pubescens* have also found. The herbaceous layer is well developed, with species characteristic to the group 3 and the alliance *Buxo-Syringion* (*Ajuga chamaepytis* s.l., *Centaurea thirkei, Festuca valesiaca, Hypericum aucheri, Jasminum fruticans, Orlaya grandiflora, Sideritis montana, Thymus striatus*). However, the species characteristic of the alliance *Syringo-Carpinion orientalis* Jakucs (1959) 1960 and the association *Syringo-Carpinetum orientalis* Jakucs 1959 (Coldea et al. 2015) (*Dactylis glomerata, Carpinus orientalis, Fraxinus ornus, Quercus pubescens*) also appear, which emphasized the transitional position of this group between these two alliances. Additional researches are needed in the area and also in other parts of Bulgaria to clarify the group‘s affiliation to some specific association.

The communities belong to the following types of natural habitats – EUNIS: S35732 Moesian lilac thickets; RB (2015): 20F3 Moesian lilac (*Syringa vulgaris*) thickets.

Conclusions

The scrub vegetation occupies a small part of the studied area (about 5%). Its distribution is fragmentary, mainly in the ridge of the mountain. However, the scrub vegetation has increased in the area in the recent years, probably due to the abandonment of grazing in the meadows. This is again the result of anthropogenic activity and subsequent successional processes. Probable successional series, part of which are established scrub communities, occur in several variants, most likely of which are: on carbonate soils – associations *Galio pseudaristati-Fagetum sylvaticae* Tzonev et al. 2006 or *Genisto januensis-Quercetum pubescentis* (Jackus 1961) Tzonev et al. 2019 → *Syringa vulgaris* and *Quercus pubescens* comm. → *Syringa vulgaris* comm. → *Rosa spinosissima* comm.; on silicate soils – association *Plantagini subulatae-Agrostietum capillaris* Pedashenko et al. 2013 → *Juniperus communis* comm.; associations *Quercetum frainetto-cerris* (Rudski 1949) Trinajstić et al. 1996 or *Carpino-Fagetum* Paucă 1941 → association *Crataego-Prunetum spinosae* Hueck 1931 → association *Galio flavescentis-Genistetum lydiae* Kunev et al. 2020 → community of *Koeleria nitidula.* Depending on the directions of antropogenic and zoogenic activity, they can proceed in the opposite order.

Some more detailed studies on the scrub communities are necessary also to make more precise analisys of the associations and successional processes. It will be also with practical needs, be-

cause of right management of seminatural ecosystems.

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Appendix A

Table A1. Synoptic table of scrub vegetation on Slivenska Mt

Group number	1	2	3	4	5	6
Group name	*Juniperus communis* comm.	*Rosa spinosissima* comm.	*Syringa vulgaris* comm.	*Syringa vulgaris* and *Quercus pubescens* comm.	Ass. *Crataego-Prunetum spinosae* variant *Lamium maculatum*	Ass. *Crataego-Prunetum spinosae* variant *Thymus pulegioides*
Number of relevés	**2**	**1**	**7**	**4**	**3**	**13**
Diagnostic taxa of groups						
Juniperus communis	100$^{92.2}$	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Quercus petraea agg.	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Viscaria vulgaris	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Stellaria alsine	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Poa nemoralis	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Geranium macrorrhizum	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Viola dacica	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Glechoma hederacea	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Rosa spinosissima	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Festuca nigrescens	0^{---}	100$^{100.0}$	0^{---}	0^{---}	0^{---}	0^{---}
Muscari botryoides	0^{---}	0^{---}	43$^{62.0}$	0^{---}	0^{---}	0^{---}
Syringa vulgaris	0^{---}	0^{---}	100$^{61.3}$	75^{---}	33^{---}	0^{---}
Vicia hirsuta	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Ranunculus illyricus	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Colchicum autumnale	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Lathyrus sphaericus	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Verbascum humile	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Melica ciliata	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Sedum acre	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Clinopodium alpinum	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Arenaria serpyllifolia agg.	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Allium guttatum	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Achillea clypeolata	0^{---}	0^{---}	29$^{50.0}$	0^{---}	0^{---}	0^{---}
Crupina vulgaris	0^{---}	0^{---}	43$^{44.5}$	25^{---}	0^{---}	0^{---}
Quercus pubescens	0^{---}	0^{---}	0^{---}	100$^{100.0}$	0^{---}	0^{---}
Hypericum aucheri	0^{---}	0^{---}	0^{---}	75$^{84.5}$	0^{---}	0^{---}
Cyanus thirkei	0^{---}	0^{---}	0^{---}	75$^{84.5}$	0^{---}	0^{---}
Carpinus orientalis	0^{---}	0^{---}	0^{---}	75$^{84.5}$	0^{---}	0^{---}

Group number	1	2	3	4	5	6
Sideritis montana	0---	0---	14---	75$^{75.5}$	0---	0---
Ajuga chamaepitys s.l.	0---	0---	14---	75$^{75.5}$	0---	0---
Dactylis glomerata	0---	0---	0---	100$^{69.2}$	0---	77$^{46.5}$
Fraxinus ornus	0---	0---	29---	75$^{68.3}$	0---	0---
Arum maculatum	0---	0---	0---	50$^{67.4}$	0---	0---
Sherardia arvensis	0---	0---	0---	50$^{67.4}$	0---	0---
Astragalus spruneri	0---	0---	0---	50$^{67.4}$	0---	0---
Linum austriacum	0---	0---	0---	50$^{67.4}$	0---	0---
Geranium purpureum	0---	0---	0---	50$^{67.4}$	0---	0---
Securigera varia	0---	0---	0---	50$^{67.4}$	0---	0---
Paliurus spina-christi	0---	0---	0---	75$^{66.2}$	33---	0---
Festuca valesiaca	0---	0---	43---	75$^{62.3}$	0---	0---
Tanacetum vulgare	0---	0---	0---	50$^{61.3}$	0---	8---
Convolvulus cantabrica	0---	0---	14---	75$^{60.5}$	33---	0---
Satureja montana	0---	0---	14---	50$^{56.8}$	0---	0---
Paeonia peregrina	0---	0---	14---	50$^{56.8}$	0---	0---
Stipa pulcherrima s.l.	0---	0---	14---	50$^{56.8}$	0---	0---
Bromus arvensis	0---	0---	0---	0---	100$^{95.6}$	8---
Prunus spinosa	0---	0---	0---	0---	100$^{81.6}$	38---
Lamium maculatum	0---	0---	0---	0---	67$^{79.1}$	0---
Galium aparine	0---	0---	0---	0---	67$^{73.7}$	8---
Agrimonia eupatoria	0---	0---	0---	0---	0---	85$^{90.6}$
Crataegus monogyna	0---	0---	14---	25---	0---	100$^{81.3}$
Lychnis coronaria	0---	0---	0---	0---	0---	69$^{80.8}$
Dorycnium pentaphyllum s.l.	0---	0---	0---	0---	0---	62$^{75.6}$
Brachypodium pinnatum	0---	0---	0---	0---	0---	62$^{75.6}$
Festuca dalmatica	0---	0---	14---	0---	0---	69$^{71.5}$
Clinopodium vulgare	0---	0---	0---	25---	0---	77$^{71.4}$
Vicia tenuifolia s.l.	0---	0---	0---	0---	0---	54$^{70.2}$
Veronica chamaedrys	0---	0---	0---	0---	0---	54$^{70.2}$
Pyrus communis s.l.	0---	0---	29---	0---	0---	77$^{69.7}$
Galium verum	0---	0---	14---	0---	0---	62$^{65.8}$
Fragaria vesca	0---	0---	0---	25---	0---	69$^{65.8}$
Thymus pulegioides	0---	0---	0---	0---	0---	46$^{64.5}$
Rubus canescens	0---	0---	0---	0---	0---	46$^{64.5}$
Euphorbia cyparissias	0---	0---	57---	0---	0---	77$^{58.6}$
Stachys germanica	0---	0---	0---	0---	0---	38$^{58.5}$
Cota tinctoria	0---	0---	0---	0---	0---	38$^{58.5}$
Pteridium aquilinum	0---	0---	0---	0---	0---	38$^{58.5}$
Hypericum perforatum	0---	0---	29---	0---	0---	62$^{58.2}$
Rosa canina	50---	0---	0---	25---	67---	100$^{54.5}$
Eryngium campestre	0---	0---	14---	25---	0---	62$^{53.5}$
Potentilla argentea	0---	0---	0---	0---	0---	31$^{52.0}$

Group number	1	2	3	4	5	6
Galium album	0---	0---	0---	0---	0---	31$^{52.0}$
Prunus cerasifera	0---	0---	0---	0---	33---	54$^{49.9}$
Potentilla pedata	0---	0---	14---	0---	0---	38$^{46.9}$
Anthoxanthum odoratum	0---	0---	14---	0---	0---	38$^{46.9}$
Origanum vulgare	0---	0---	14---	0---	0---	38$^{46.9}$
Salvia pratensis	0---	0---	0---	0---	33---	46$^{43.4}$
Filipendula vulgaris	50---	0---	0---	0---	0---	46$^{36.7}$
Other taxa						
Geum urbanum	0---	0---	0---	0---	0---	15---
Clematis vitalba	0---	0---	0---	0---	0---	15---
Rumex tuberosus	0---	0---	0---	0---	33---	0---
Sesleria latifolia	50---	0---	29---	0---	0---	8---
Centaurea scabiosa	0---	0---	0---	0---	0---	8---
Trifolium campestre	0---	0---	29---	0---	0---	23---
Achillea millefolium agg.	50---	0---	57---	75--	0---	54---
Inula oculus-christi	0---	0---	14---	0---	0---	8---
Thymus zygioides	50---	0---	0---	0---	0---	0---
Dianthus pinifolius	50---	0---	14---	0---	0---	0---
Cynosurus echinatus	0---	0---	14---	0---	67---	15---
Geranium sanguineum	0---	0---	29---	0---	33---	38---
Digitalis lanata	0---	0---	0---	0---	0---	15---
Carex humilis	50---	0---	0---	0---	0---	0---
Anthyllis vulneraria	50---	0---	14---	0---	0---	0---
Euphorbia myrsinites	0---	0---	29---	25---	0---	0---
Festuca rupicola	0---	0---	14---	0---	0---	0---
Centaurea stoebe	0---	0---	29---	50---	0---	31---
Carex spicata	0---	0---	0---	0---	33---	0---
Orlaya daucoides	0---	0---	14---	0---	0---	0---
Luzula luzuloides	50---	0---	0---	0---	0---	0---
Agrostis capillaris	50---	0---	0---	0---	0---	23---
Poa bulbosa	0---	0---	43---	50---	33---	8---
Thymelaea passerina	0---	0---	14---	0---	0---	0---
Poa compressa	50---	0---	14---	0---	0---	15---
Sorbus torminalis	0---	0---	0---	0---	0---	15---
Briza media	0---	0---	0---	0---	0---	23---
Linum tenuifolium	0---	0---	14---	0---	0---	0---
Minuartia verna	0---	0---	14---	0---	0---	0---
Scleranthus annuus	0---	100---	14---	0---	0---	0---
Petrorhagia prolifera	0---	0---	14---	0---	0---	8---
Ballota nigra s.l.	0---	0---	0---	0---	33---	0---
Orlaya grandiflora	0---	0---	43---	75--	33---	23---
Seseli rigidum	0---	0---	14---	0---	0---	0---
Odontarrhena muralis	0---	0---	14---	0---	0---	0---

Group number	1	2	3	4	5	6
Plantago lanceolata	0---	0---	14---	0---	0---	15---
Rubus caesius	50---	0---	0---	0---	0---	23---
Stachys officinalis	50---	0---	0---	0---	0---	23---
Teucrium polium	0---	0---	14---	0---	0---	0---
Vicia tetrasperma	0---	0---	0---	0---	0---	8---
Sambucus ebulus	0---	0---	0---	0---	0---	8---
Leontodon crispus	50---	0---	14---	25---	0---	0---
Asperula cynanchica	50---	0---	29---	0---	0---	8---
Brachypodium sylvaticum	0---	0---	0---	0---	0---	8---
Aremonia agrimonoides	0---	0---	0---	0---	0---	8---
Quercus frainetto	0---	0---	0---	0---	0---	8---
Alliaria petiolata	0---	0---	0---	0---	33---	0---
Arabis turrita	0---	0---	0---	0---	33---	0---
Geranium pyrenaicum	0---	0---	0---	0---	0---	15---
Daucus carota	0---	0---	0---	0---	0---	8---
Vicia narbonensis	0---	0---	14---	0---	0---	0---
Trifolium ochroleucon	0---	0---	0---	0---	0---	8---
Avenella flexuosa	50---	100---	0---	0---	0---	0---
Geranium robertianum	0---	0---	0---	0---	0---	15---
Heracleum sphondylium s.l.	0---	0---	0---	0---	0---	8---
Nepeta cataria	0---	0---	14---	0---	0---	0---
Clinopodium acinos	0---	0---	29---	0---	0---	8---
Knautia macedonica	0---	0---	0---	0---	0---	23---
Lathyrus laxiflorus	0---	0---	0---	0---	0---	15---
Poa pratensis	50---	0---	14---	50---	0---	31---
Inula hirta	0---	0---	0---	0---	0---	8---
Astragalus glycyphyllos	0---	0---	0---	0---	0---	23---
Campanula persicifolia	50---	0---	0---	0---	0---	0---
Quercus cerris	0---	0---	0---	0---	0---	8---
Lapsana communis	0---	0---	0---	0---	0---	23---
Seseli peucedanoides	0---	0---	0---	0---	0---	23---
Trifolium pannonicum	0---	0---	0---	0---	0---	8---
Viola hirta	0---	0---	0---	25---	33---	8---
Xeranthemum cylindraceum	0---	0---	0---	0---	0---	8---
Torilis japonica	0---	0---	14---	25---	33---	8---
Geranium dissectum	0---	0---	0---	0---	0---	8---
Trifolium pratense	0---	0---	0---	0---	0---	8---
Geranium molle	0---	0---	14---	0---	0---	0---
Cruciata glabra	0---	0---	0---	0---	0---	15---
Euphorbia amygdaloides	0---	0---	0---	0---	0---	8---
Jasminum fruticans	0---	0---	43---	50---	0---	0---
Nardus stricta	50---	0---	0---	0---	0---	0---
Thymus striatus	0---	0---	43---	50---	0---	0---

Group number	1	2	3	4	5	6
Dianthus giganteus	0---	0---	0---	0---	0---	23---
Anagallis foemina	0---	0---	14---	0---	0---	0---
Cornus mas	0---	0---	0---	25---	0---	23---
Sanguisorba minor	50---	0---	29---	25---	0---	31---
Tragopogon pratensis	0---	0---	14---	0---	0---	0---
Rorippa lippizensis	0---	0---	0---	0---	0---	8---
Nepeta nuda	0---	0---	0---	0---	0---	15---
Salvia verticillata	0---	0---	0---	0---	0---	8---
Piptatherum virescens	50---	0---	0---	25---	0---	0---
Calamagrostis arundinacea	0---	0---	0---	0---	0---	15---
Poa trivialis s.l.	0---	0---	0---	0---	0---	15---
Medicago falcata	0---	0---	14---	0---	0---	0---
Hylotelephium maximum	0---	0---	14---	0---	0---	0---
Sedum ochroleucum	0---	0---	14---	0---	0---	0---
Fragaria viridis	50---	0---	0---	0---	0---	0---
Odontites vernus	0---	0---	0---	0---	0---	8---
Agrostis stolonifera	0---	0---	0---	0---	0---	8---
Teucrium chamaedrys	50---	0---	29---	25---	0---	54---
Lotus corniculatus	0---	0---	0---	0---	0---	23---
Trifolium arvense	0---	0---	14---	0---	33---	15---
Centaurium erythraea	0---	0---	14---	0---	0---	15---
Cirsium vulgare	0---	0---	14---	0---	33---	0---
Ochlopoa annua	0---	0---	14---	0---	0---	0---
Lathyrus aphaca	0---	0---	14---	0---	0---	0---
Trifolium pallidum	0---	0---	14---	0---	0---	0---
Achillea grandifolia	50---	0---	0---	0---	0---	0---
Poa alpina	0---	0---	14---	0---	0---	0---
Arrhenatherum palaestinum	0---	0---	14---	0---	0---	0---
Conium maculatum	0---	0---	0---	0---	0---	8---
Galium pseudaristatum	50---	0---	14---	0---	0---	0---
Scabiosa triniifolia	50---	0---	14---	0---	0---	31---
Viola mirabilis	50---	0---	0---	0---	0---	0---
Marrubium peregrinum	0---	0---	14---	0---	0---	0---
Tulipa hungarica	0---	0---	0---	25---	0---	0---
Saponaria glutinosa	0---	0---	0---	25---	0---	0---
Potentilla recta s.l.	0---	0---	14---	0---	33---	8---
Torilis arvensis	0---	0---	0---	25---	0---	0---
Lathyrus pratensis	0---	0---	0---	0---	0---	8---
Melampyrum arvense	0---	0---	0---	0---	0---	8---
Holcus lanatus	50---	0---	0---	0---	0---	15---
Cruciata laevipes	0---	0---	0---	0---	0---	8---
Carlina vulgaris	0---	0---	14---	25---	0---	8---
Campanula bononiensis	0---	0---	0---	0---	0---	8---

Group number	1	2	3	4	5	6
Noccaea kovatsii	0---	0---	14---	0---	0---	0---
Ranunculus acris	0---	0---	0---	0---	0---	8---
Cuscuta europaea	0---	0---	0---	0---	0---	8---
Myosotis sylvatica	0---	0---	0---	0---	0---	8---
Xeranthemum annuum	0---	0---	14---	0---	0---	8---
Veronica officinalis	0---	0---	0---	0---	0---	8---
Crucianella angustifolia	0---	0---	0---	0---	0---	15---
Vicia grandiflora	0---	0---	14---	0---	0---	0---
Cytisus hirsutus	50---	0---	0---	0---	0---	0---
Mentha longifolia	0---	0---	0---	0---	0---	8---
Anisantha sterilis	0---	0---	14---	0---	0---	0---
Ferulago campestris	0---	0---	0---	0---	0---	8---
Carlina acanthifolia	50---	0---	0---	0---	0---	8---
Allium flavum	0---	0---	14---	0---	0---	0---
Pilosella officinarum agg.	50---	0---	0---	0---	0---	0---
Viola tricolor	0---	0---	0---	25---	33---	23---
Anisantha tectorum	0---	0---	14---	25---	0---	0---
Carduus candicans s.l.	0---	0---	14---	0---	0---	0---
Bromus squarrosus	0---	0---	29---	25---	0---	8---
Ajuga laxmannii	0---	0---	14---	50---	0---	15---
Potentilla erecta	50---	0---	0---	0---	0---	8---
Veronica austriaca s.l.	0---	0---	29---	25---	0---	0---
Linaria genistifolia	0---	0---	0---	25---	0---	15---
Ficaria verna	0---	0---	0---	25---	0---	0---
Dipsacus laciniatus	0---	0---	0---	0---	0---	8---
Tephroseris papposa	50---	0---	0---	0---	0---	0---
Buglossoides arvensis	0---	0---	14---	0---	0---	0---
Verbena officinalis	0---	0---	0---	0---	0---	8---
Primula veris	50---	0---	0---	0---	0---	15---
Lactuca quercina	0---	0---	14---	0---	0---	0---
Elytrigia repens	0---	0---	0---	0---	33---	15---
Cotinus coggygria	0---	0---	0---	25---	0---	0---
Euphorbia nicaeensis	0---	0---	14---	0---	0---	0---
Phleum phleoides	0---	0---	14---	0---	0---	0---
Arrhenatherum elatius	0---	0---	0---	0---	0---	15---
Fumana procumbens	0---	0---	0---	25---	0---	0---
Polygala major	50---	0---	0---	0---	0---	0---
Carex leporina	0---	0---	0---	0---	0---	8---
Buglossoides purpurocaerulea	0---	0---	0---	25---	0---	0---
Schedonorus giganteus	0---	0---	0---	25---	0---	0---
Milium effusum	0---	0---	14---	0---	0---	0---
Prunus tenella	0---	0---	0---	25---	0---	0---
Euphorbia esula	0---	0---	0---	0---	0---	15---

Group number	1	2	3	4	5	6
Vicia sepium	0---	0---	0---	0---	0---	8---
Muscari comosum	0---	0---	14---	0---	0---	0---
Digitalis viridiflora	0---	0---	0---	0---	0---	8---
Ranunculus millefoliatus	0---	0---	14---	0---	0---	0---
Torilis leptophylla	0---	0---	14---	0---	0---	0---
Chrysopogon gryllus	0---	0---	0---	0---	0---	8---
Calamagrostis epigejos	0---	0---	0---	0---	0---	15---
Chaerophyllum byzantinum	0---	0---	0---	0---	0---	8---
Scorzonera hispanica	0---	0---	29---	25---	0---	8---
Erysimum diffusum	0---	0---	14---	50---	0---	8---
Luzula forsteri	0---	0---	0---	0---	0---	23---
Vicia cassubica	0---	0---	0---	0---	0---	8---
Trifolium alpestre	0---	0---	0---	0---	0---	23---
Filago germanica	50---	0---	14---	0---	0---	0---
Helianthemum nummularium	50---	0---	0---	0---	0---	0---
Drymocallis rupestris	0---	0---	14---	0---	0---	0---
Phleum montanum	0---	0---	14---	0---	0---	0---
Koeleria nitidula	0---	0---	57---	0---	0---	38---
Milium vernale	0---	0---	14---	0---	0---	0---
Apera spica-venti	0---	0---	0---	0---	0---	8---
Trifolium hybridum	0---	0---	0---	0---	0---	15---
Dioscorea communis	0---	0---	0---	25---	0---	0---
Lactuca muralis	0---	0---	0---	25---	0---	0---
Alyssum alyssoides	0---	0---	14---	0---	0---	0---
Euphorbia agraria	0---	0---	14---	0---	0---	0---
Allium paniculatum	0---	0---	14---	0---	0---	0---
Cerastium glomeratum	0---	0---	14---	0---	0---	0---
Avenula pubescens	0---	0---	14---	0---	0---	0---
Scilla bifolia	0---	0---	14---	0---	0---	0---
Astragalus angustifolius	0---	0---	0---	25---	0---	0---
Crepis sancta	0---	0---	0---	25---	0---	0---
Alyssum hirsutum	0---	0---	0---	25---	0---	0---
Ononis pusilla	0---	0---	0---	25---	0---	0---
Dasypyrum villosum	0---	0---	0---	25---	0---	0---
Scutellaria orientalis	0---	0---	0---	25---	0---	0---
Odontarrhena tortuosa	0---	0---	14---	0---	0---	0---
Reseda lutea	0---	0---	0---	25---	0---	0---
Acer platanoides	0---	0---	0---	0---	0---	8---
Mentha spicata	0---	0---	0---	0---	0---	8---
Silene dichotoma	0---	0---	14---	0---	0---	0---
Acer pseudoplatanus	0---	0---	0---	0---	0---	15---
Cerastium gracile	0---	0---	14---	0---	0---	0---

Group number	1	2	3	4	5	6
Jacobaea vulgaris	0^{---}	0^{---}	0^{---}	0^{---}	0^{---}	8^{---}
Agrostis castellana	0^{---}	0^{---}	0^{---}	0^{---}	0^{---}	8^{---}
Agrostis gigantea	0^{---}	0^{---}	0^{---}	0^{---}	0^{---}	8^{---}
Potentilla astracanica	0^{---}	0^{---}	0^{---}	25^{---}	0^{---}	0^{---}
Iris reichenbachii	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Viola kitaibeliana	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Carex liparocarpos	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Scleranthus perennis	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Astragalus depressus	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Calystegia sepium	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}
Hypericum umbellatum	0^{---}	0^{---}	14^{---}	0^{---}	0^{---}	0^{---}

Note: The frequency of each species is presented by percentage. The fidelity was presented by their phi-coefficient per group multiplied by 100 (in superscript). The group numbers correspond to the syntaxa numbers described in the text. The frequency and fidelity of diagnostic taxa for the groups are colored in gray.