Flora, vegetation and natural habitat types in Kutelka Reserve (Eastern Stara Planina, Bulgaria)

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Abstract. The main aim of this study is to reveal plant diversity (flora, medicinal plants, vegetation), as well as natural habitats on the territory of Kutelka Reserve. Bryophyte flora in the Reserve comprises of 28 species, referred to two divisions (liverworts and mosses), three classes and 18 families. A list of 483 species of vascular plants altogether has been compiled. Ferns are represented by seven species, there are three conifer species and the others (473 species) are flowering plants, including 104 monocots and 369 dicots. Twenty-five plant taxa are endemics and/or of conservation importance. Medicinal plants constitute 167 species. Vegetation is classified into five phytosociological classes. Ten types of natural habitats included in the Habitat Directive (Council Directive 92/43/EEC) and, respectively, Annex 1 of the Bulgarian Biological Diversity Act are represented in the reserve. Our findings show high plant diversity and confirm the reserve's importance for conservation of biodiversity and nature of Bulgaria.

Key words: bryophytes, conservation, medicinal plants, plant communities, vascular plants

Introduction

Kutelka Reserve was declared as a restricted territory in 1983 (Order №1253/22.12.1983 of the Committee for Environment Protection), with an area of 645.1 ha, for protection of its characteristic rocky habitats of rare birds of prey. The Reserve's territory is surrounded by another protected area – Sinite Kamani Nature Park – and both are part of the Bulgarian Natura 2000 Network (Special Protection Area BG0000164 Sinite Kamani) and the Bulgarian Important Plant Area Network (BGIPA101 Sinite Kamani). The mapping out of species and natural habitats under the Habitats Directive (Council Directive 92/43/ EEC) shows that two plant species and six habitat types are distributed on the reserve's territory (http://natura2000.moew.government.bg/Home/ProtectedSite?code=BG0000164&siteType=HabitatDirective).

In spite of the fact that Mt Slivenska divide has attracted botanists since the first floristic studies in Bulgaria (Velenovsky 1891, 1898), so far there have been no detailed investigations, nor any published data on the flora and vegetation of Kutelka Reserve. Botanical studies on the Sinite Kamani Nature Park (Andreev 1986; Grozeva & al. 2004, 2014 a, b, 2015; Stoeva 2004; Stoeva-Hristova 2004; Georgieva & Dohchev 2008; Tashev & Alexandrova 2009, 2010, 2012 a, b, c; Grozeva & Budakov 2010; Petrova & al. 2012) have not been focused on the reserve's territory and even exclude it. There are some recent floristic findings (Sopotlieva & Petrova 2002; Petrova 2004; Grozeva & Georgieva

2005; Petrova & al. 2009, 2011; Tashev & al. 2010) considering some new localities of plant species distributed very close to the Reserve's boundary, but data on vascular plants occurring in the reserve's territory could only be found sporadically (Brizicky 1940; Sopotlieva & Petrova 2001).

The main aim of this study is to reveal the plant diversity – flora, medicinal, rare and endangered plants – as well as vegetation and natural habitats diversity on the territory of Kutelka Reserve.

Material and methods

The study area is located in the Eastern Stara Planina (Balkan Range), on the southern slopes of Mt Slivenska divide. It is part of the Sinite Kamani (Blue Stones) rocky ridge and includes the region between peaks Kutelka and Golyama Chatalka. The landscape is strongly varied. The main ridge of the mountain, formed by the area of peaks Kutelka, Golyama Chatalka, Malka Chatalka, and Karandila, consists of metamorphic rocks – quartz porphyry – with the characteristic blue-violet tinge giving the name to the area. The reserve's territory falls within the range of transitional continental climate with a mild winter and hot summer, low yearly air temperature, maximum precipitation in July and November and minimum precipitation in August and February (Velev 2002). The vegetation is presented by deciduous forests, as well as open scrublands, grasslands and sparsely vegetated rocks (Stoeva 2004).

The study has been conducted during the vegetation period of 2014. The route method has been used to describe the biodiversity of bryophytes, vascular plants, vegetation and natural habitats. During the field work, the found taxa have been recorded in lists or were gathered for further determination. Identification of taxa and nomenclature for vascular plants and bryophytes followed the main taxonomic sources for Bulgaria (Jordanov 1963–1979; Petrov 1975; Velčev 1982, 1989; Kozhuharov 1992; Kožuharov 1995; Delipavlov & Chesmedzhiev 2003; Natcheva & Ganeva 2005; Peev 2012). The list of medicinal plants followed Appendix 1 of Medicinal Plants Act (2000). To evaluate the conservation status, the lists of established taxa were checked for endemics – Bulgarian and Balkan (Petrova & Vladimirov 2010), protected species (Appendix 3 of Bulgarian Biological Diversity Act 2002), rare and endangered species according to the Bulgarian Red Lists and Red Data Book (Natcheva & al. 2006; Petrova & Vladimirov 2009; Peev & al. 2015), as well as European and international documents (e.g. Bern convention, Directive 92/43/EEC, IUCN Red List, CITES).

Data were collected about the population characteristics of some medicinal plants and plants with conservation status. Population density and vegetative/generative individuals' ratio were counted by random plotted square-shaped plots, with an area of 0.25 m^2.

The study of vegetation follows the methodology of the Braun-Blanquet school. We placed subjectively minimum one plot per each visually homogeneous stand in terms of vegetation structure and floristic composition. Material from a total of 50 phytosociological plots (relevés) was collected. All plots were square-shaped with an area of 16 m^2 for grasslands and 100 m^2 for shrubs and forests (Chytrý & Otýpková 2003). The abundance and cover of species as well as the total cover of vegetation was estimated in percentage. Altitude and coordinates were measured by GPS. Slope was estimated by visual deviation from an imaginary vertical surface. The data set was included in the Bulgarian National Vegetation Database (Apostolova & al. 2012, GIVD ID EU-BG-001) stored in TURBOVEG software (Hennekens & Schaminée 2001). All relevés were imported into JUICE 7.0 (Tichý 2002) for further data preparation and analysis. Collected material from the relevés was analysed by modified TWINSPAN (Roleček & al. 2009). Cut levels of pseudospecies were set at 0, 2, 5 and 25 % cover, respectively, and minimum group size for division was two plots. During the first step, the data set was split into two groups, representing forest and shrub and grassland vegetation, respectively. Next, we applied TWINSPAN algorithm to identify the patterns of floristic variation within each of these two groups. The final number of groups was subjectively chosen when they represented homogenous vegetation type and/or should be recognized as vegetation classes, orders and alliances after referring to appropriate literature. The diagnostic species per group were calculated by the species' fidelity phi coefficient of association (Chytrý & al. 2002; Tichý & Chytrý 2006) calculated on the assumption of equal group size, and positive phi-values were only accepted, if the differences in species constancy between

the target group and the rest of the data set were significant, according to Fisher's exact test at $p \leq 0.5$.

Habitats were defined according to EUNIS classification, the Habitats Directive (Council Directive 92/43/EEC) and, respectively, Annex 1 of the Bulgarian Biological Diversity Act (2002) and the Bulgarian Red Data Book, vol. 3 (Biserkov & al. 2015).

Mapping out was done with ArcGIS 10.0 software (ESRI 2011). Spatial data was collected in the field by GPS device Juno SB by Trimble and was later overlaid on the most recent available ortophoto images. Outlining of polygons was done manually by using features collected in the field, as well as ortophoto images.

Results and discussion

Bryophytes

Bryophyte flora in the reserve comprises 28 species, referred to two divisions (liverworts and mosses), three classes and 18 families (Appendix 1). Species like *Platyhypnidium riparioides*, *Conocephalum conicum* and *Cratoneuron filicinum* occur in wet places, but *Grimmia* spp. are typical for rocky habitats. *Ceratodon purpureus*, *Tortella tortuosa* and *Pleurochaete squarrosa* are frequent species in the grasslands. Widely distributed are cosmopolitans *Ceratodon purpureus* and *Bryum argenteum*.

Bryophyte species of conservation concern have not been recorded.

During the studies in the Sinite Kamani Nature Park, Stoeva-Hristova (2004) reported 67 bryophyte species, seven of which were also found in Kutelka Reserve (*Polytrichum formosum*, *P. piliferum*, *Grimmia pulvinata*, *Hypnum cupressiforme*, *Bryum alpinum*, *Dicranum scoparium*, and *Plagiomnium affine*), being widespread species in the mountain areas.

Vascular flora

As a result of the study, a total of 483 species of vascular plants have been determined on the territory of the reserve (Appendix 1). According to the most recent inventory study of the flora of Sinite Kamani Nature Park (Grozeva & al. 2004), its diversity consists of 958 taxa. Thus we could claim that the territory of Kutelka Reserve accommodates about 50 % of the vascular plant diversity of the Nature Park. However, 125 taxa (marked by number sign (#) in Appendix 1), or 26 % of all vascular plants found in Kutelka Reserve during this study, are missing from the latest Sinite Kamani plant species list (Grozeva & al. 2004).

Ferns (*Polypodiophyta*) are represented by seven species, three species are conifers (*Pinophyta*) and the remaining 473 species are flowering plants (*Magnoliophyta*), including 104 monocots and 369 dicots. The most species-rich families are *Asteraceae* (55), *Poaceae* (50), *Fabaceae* (39), *Lamiaceae* (35), *Rosaceae*, and *Caryophyllaceae* (each with 28 species), *Apiaceae* (23), *Brassicaceae* (17), *Scrophulariaceae* (16), *Orchidaceae* (15), and *Liliaceae* (14). These families are among the most species-rich families in the Bulgarian flora (Petrova & al. 2005). The most species-rich genera are *Trifolium* – 12 species, *Veronica*, *Viola* and *Festuca* – with 8 species each, *Lathyrus* – 7 species, and *Galium*, *Potentilla*, *Minuartia*, and *Sedum* – with 6 species each. Numerous genera are presented by five species: *Allium*, *Carex*, *Luzula*, *Poa*, *Achillea*, *Alyssum*, *Campanula*, *Dianthus*, *Silene*, and *Euphorbia*.

A total of 25 endemic vascular plants and/or species of conservation concern were found in the reserve's territory (Table 1). There are seven species of conservation concern and they all are important at national level. Six species are protected by the Bulgarian law. Two species are included in the Bulgarian Red Data Book, vol. 1 (Peev & al. 2015), while seven species are listed in the Bulgarian Red List (Petrova & Vladimirov 2009). There are no species included in the international conservation documents (Bern Convention, Habitat Directive). According to the IUCN list (IUCN 2015), there are 15 threatened species at global level (not shown in Table 1), they all are assessed as Least Concern and are trivial species for the Bulgarian flora (for example *Carpinus orientalis*, *Colchicum autumnale*, *Coryllus avellana*, *Juniperus communis* etc.). Furthermore, 16 species are listed in the CITES appendices (Table 1).

Endemics are represented by seven Balkan endemics (Table 1). Some of them (e.g. *Achillea clypeolata* and *Sesleria latifolia*) are widely distributed across the country. Two species (*Campanula jordanovii* and *Minuartia bulgarica*) are rare for Bulgaria and are included in the national red list (Petrova & Vladimirov 2009) as Vulnerable (VU). All endemic species have numerous populations in the reserve's territory.

Medicinal plants

Of the recorded vascular plants, 167 species are considered medicinal (marked by asterix (*) in Appendix 1). Their total number exceeds one-third (34.5 %) of all vascular plants identified during this study. The richest families are *Lamiaceae* (23 species), *Asteraceae* (19 species) and *Rosaceae* (15 species).

Of the medicinal plants in Kutelka Reserve, 150 species (e.g. *Hedera helix*, *Achillea millefolium*, *Achillea clypeolata*, *Coryllus avellana*, *Campanula persicifolia*, *Lathyrus vernus*, *Colchicum autumnale*, etc) are common for the reserve's territory. Two species – *Anacamptis pyramidalis* and *Galanthus elwesii*, are protected by law, but the first one has a very limited distribution, while the latter forms numerous populations in the grasslands (Table 1). Some species like *Ruscus aculeatus*, *Orchis* spp., *Paeonia peregrina*, *Primula veris*, and *Scilla bifolia* are often collected from the adjacent territories to the reserve by tourists not only as medicinal but also as ornamental plants (Sopotlieva 2000).

Several regions with high concentration of medicinal plants (more than 12 species per 16 m^2) could be outlined in the territory of the reserve. Such areas are: the northern slopes of peak Golyama Chatalka, grasslands between peak Golyama Chatalka and Mochurite locality, northern slopes of peak Kutelka, and rocky grasslands at the southern boundary of the Reserve (Fig. 1).

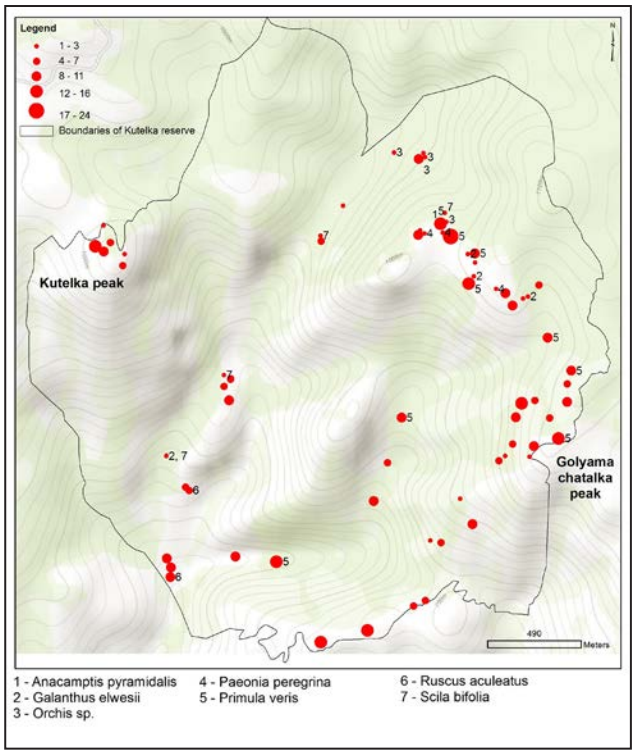

Fig. 1. Map of distribution of medicinal plants in Kutelka Reserve. Red dots represent localities where medicinal plant are found. The size of the dots corresponds to the number of species in the respective locality (1–3 species, 4–7 species, etc.). Arabic numbers represent localities of the following protected and/or highly collected from surrounding territories species: **1** – *Anacamptis pyramidalis*; **2** – *Galanthus elwesii*; **3** – *Orchis* spp.; **4** – *Paeonia peregrina*; **5** – *Primula veris*; **6** – *Ruscus aculeatus*; **7** – *Scilla bifolia*.

Table 1. Endemic vascular plants and species of conservation concern in the Kutelka Reserve.

№	Species	Protected (Biodiversity Act-Annex 3)	Red Data Book of Bulgaria (Peev & al. 2015)	Red List (Petrova & Vladimirov 2009)	Endemic	CITES	Distribution in the Kutelka Reserve; abundance/density of population
1	*Achillea clypeolata*	–	–	–	Balkan	–	Occurs in dry and stony grasslands with calcareous rock outcrops. Numerous population, high density.
2	*Anacamptis pyramidalis*	yes	–	Vulnerable (VU)	–	yes	Found in grassland community westwards from peak Golyama Chatalka to the Mochurite locality. Only one individual with flowers was observed.
3	*Campanula jordanovii*	yes	Vulnerable (VU)	Vulnerable (VU)	Balkan	–	Observed localities: ➢ region of peak Kutelka; ➢ rocks at the foot of peak Kuminite; ➢ region of peak Golyama Chatalka. Abundance: 30–40 tussocks in each locality
4	*Cephalanthera damasonium*	–	–	–	–	yes	Occurs in beach forests. Population consists of sparsely distributed individuals. Total numbers per reserve area reach 20–30 individuals.
5	*Cephalantera longifolia*	–	–	–	–	yes	Occurs in beach forests. Population consists of sparsely distributed individuals. Only 7 individuals with flowers were observed.
6	*Cephalantera rubra*	–	–	–	–	yes	Occurs in beach forests. Population consists of sparsely distributed individuals. This *Cephalantera* species is most common in the reserve among the other species of the same genera, but the total numbers do not exceed 50–60 individuals.

Table 1. Continuation.

№	Species	Protected (Biodiversity Act-Annex 3)	Red Data Book of Bulgaria (Peev & al. 2015)	Red List (Petrova & Vladimirov 2009)	Endemic	CITES	Distribution in the Kutelka Reserve; abundance/density of population
7	*Dacthylorhyza sambucina*	–	–	–	–	yes	Distributed in a grassland community westwards from peak Golyama Chatalka. This is the most numerous orchid species on the reserve territory. Population consists of hundreds individuals.
8	*Dianthus carthusianorum*	yes	–	Vulnerable (VU)	–	–	Occurs in open, pioneer communities on silicate rocks. Sparse structure, total population numbers about 50 tussocks.
9	*Epipactis atrorubens*	–	–	–	–	yes	Found in grasslands and fringe communities. Total population number reaches 50 individuals.
10	*Epipactis helleborine*	–	–	–	–	yes	Found in grasslands and fringe communities. Total population number reaches 50–70 individuals.
11	*Epipactis microphylla*	–	–	–	–	yes	Found in grasslands and fringe communities. Total population number reaches 20–30 individuals.
12	*Galanthus elwesii*	yes	Endangered (EN)	Endangered (EN)	–	yes	Observed localities: ➢ river Novoselska northwards from Omaynikovoto locality; vegetative – 2.44 ind./m^2, generative – 1 ind./m^2, total – 3.44 ind./m^2; ➢ grasslands westwards from peak Golyama Chatalka; hundreds to thousands individuals.
13	*Limodorum abortivum*	yes	–	–	–	yes	Single sparse individuals at the edge of beach forests along the trail to peak Golyma Chatalka – Mochurite locality.
14	*Listera ovata*	–	–	–	–	yes	Only one individual with flowers was observed.
15	*Minuartia bulgarica*	–	–	Vulnerable (VU)	Balkan	–	In rocky places. Numerous population.
16	*Neotia nidus-avis*	–	–	–	–	yes	In beach forests. Single, sparse individuals. Total numbers reach up to 30–40 individuals.
17	*Orchis pinetorum*	–	–	–	–	yes	In grasslands and at forest edges. The numbers vary from single to groups of 30–50 flowering individuals. This is the most common *Orchis* species in the reserve.
18	*Orchis morio*	–	–	–	–	yes	In grasslands and at forest edges. The total number for the reserve area is below 20 individuals.
19	*Orchis purpurea*	–	–	–	–	yes	Occurs in a thermophile beach forest, with calcareous outcrops, along the trail Mochurite locality – Karandila locality. Population structure varies from single individuals to groups of about 10 individuals.
20	*Platantera bifolia*	–	–	–	–	yes	Occurs in a thermophile beach forest with calcareous outcrops, along the trail Mochurite locality – Karandila locality. Only one flowering individual was observed.
21	*Sesleria latifolia*	–	–	–	Balkan	–	This species forms plant communities in places on calcareous bedrock.
22	*Sempervivum leucanthum*	–	–	–	Balkan	–	In rocky places. Numerous population.
23	*Tulipa australis*	yes	–	Near treatened (NT)	–	–	Observed localities: ➢ region of peak Kutelka– sparse, single individuals; ➢ grasslands westwards of peak Golyama Chatalka – thousands of flowering indiwiduals; ➢ rocky grasslands at the foot of peak Kuminite – good regeneration potential of the population (12.2 vegetative individuals/m^2).
24	*Verbascum humile*	–	–	Least concern (LC)	Balkan	–	Observed localities: ➢ region of peak Kutelka; ➢ grasslands westwards of peak Golyama Chatalka; ➢ rocky grasslands at the foot of peak Golyama Chatalka. The numbers vary from single to 80–100 rosettes
25	*Viola aetolica*	–	–	–	Balkan	–	Found in the region of peak Kutelka. Forms numerous groups.

Vegetation and habitats

Vegetation diversity established in Kutelka Reserve could be summarized in the following syntaxonomical scheme:

Class *Querco-Fagetea* Braun-Blanq. et Vlieger in Vlieger 1937
- Order *Fagetalia sylvaticae* Pawł. et al. 1928
  - Alliance *Cephalanthero-Fagion* Tuxen 1955
  - Alliance *Fagion sylvaticae* Luquet 1926

Class *Quercetea pubescentis* (Oberd. 1948) Doing Kraft 1955
- Order *Quercetalia pubescentis* Klika 1933
  - Alliance *Quercion petraeae-cerris* (Lakušić et Jovanović 1980) Čarni et al. 2009
  - Alliance *Syringo-Carpinion orientalis* Jakucs 1959
- Order *Fraxino orni-Cotinetalia* Jakucs 1961
  - Alliance *Pruno tenellae-Syringion* (Jovanović 1979) Čarni et al. 2009

Class *Koelerio-Corynephoretea* Klika in Klika & Novák 1941
- Order *Sedo-Scleranthetalia* Br.-Bl. 1955
- Order *Trifolio arvensis-Festucetalia ovinae* Moravec 1967

Class *Trifolio-Geranietea* T. Müller 1962

Order *Origanetalia vulgaris* T. Müller 1962

Class *Festuco-Brometea* Br.-Bl. et Tx. ex Klika et Hadač 1944
- Order *Stipo pulcherrimae-Festucetalia pallentis* Pop 1968
  - Alliance *Saturejion montanae* Horvat et al. 1974

Community of birch (*Betula pendula)*

Pinus nigra-plantations

Communities of cryptogams on rocks (not studied in this research)

The study area is mostly covered by natural and seminatural communities. Vegetation of anthropogenic origin is only represented by *Pinus nigra* plantations and occurs in small patches in the southern parts of the reserve. The origin and syntaxonomical affiliation of birch communities are uncertain. On the one hand, they might have anthropogenic origin as a result of erosion control measures taken in the past. On the other hand, as birches are competitively weak, light-demanding but stress-tolerant trees, *Betula pendula* is considered as an early successional species in deforested sites (Chytrý 2012).

Shrub communities of *Pruno tenellae-Syringion* are varied in terms of physiognomy and species composition. Pioneer vegetation of *Koelerio-Corynephoretea* and fringe vegetation of *Trifolio-Geranietea* is still insufficiently studied in Bulgaria. For correct classification of such communities at alliance or association level, more relevés are needed. Cryptogam communities (of lichens and mosses) on rocks are considered as a separate vegetation unit, despite the fact that we did not collect material from own relevés. A map of vegetation diversity of Kutelka Reserve is presented in Fig. 2.

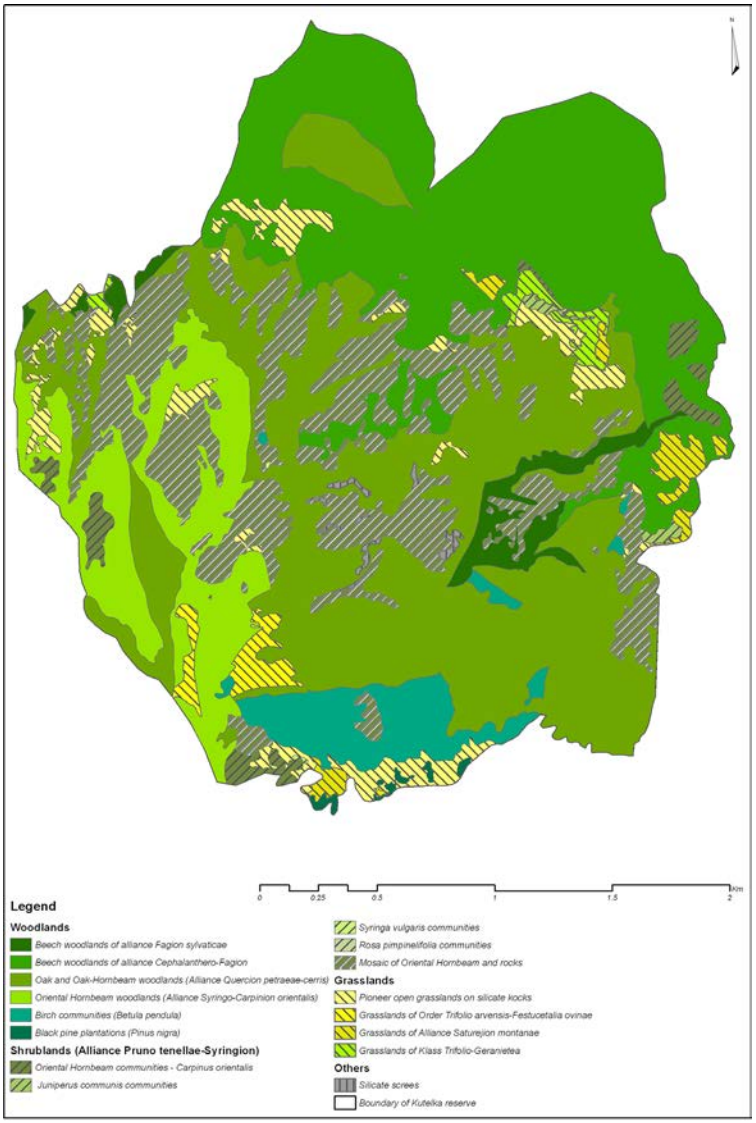

Fig. 2. Map of vegetation diversity of Kutelka Reserve.

Most of the identifed syntaxa are known for Bulgarian vegetation diversity, but the occurrence of *Quercion petraeae-cerris* and *Pruno tenellae-Syringion* communities is announced for the first time.

1. Forest vegetation

1.1. Beech forests of *Fagion sylvaticae* alliance (Table 2, column 1)

This vegetation unit includes beech or mixed beech-hornbeam forests on moderately deep to deep and moist soils. Its communities occur on silicate bedrock, or on carbonate terrains, but in such cases the deep soil neutralizes the carbonate rock influence, so the floral composition consists of neutral to slightly acidophilus species. Due to the high canopy values of tree layer, the herb layer is sparse. The undergrowth is formed by meso- and eutrophilous forest species (*Dryopteris filix-mas*, *Cardamine bulbifera*, *Lamiastrum galeobdolon*, and *Mycelis muralis*), as well as by typical plants for nemoral flora (*Melica uniflora*, *Luzula luzuloides*, *Poa nemoralis*). The unit covers an area of 16.7 ha.

Affiliation to habitat types:

- EUNIS – G1.63 Medio-European neutrophile *Fagus* forests;
- Dir. 92/43/EEA/Biological Diversity Act – 9130 *Asperulo-Fagetum* beech forests;
- *Red Data Book of R. Bulgaria* – 09.G1. Neutrophilic common beech forests: Near threatened [NT].

1.2. Beech forests of *Cephalanthero-Fagion* alliance (Table 2, column 2)

These are thermophilous beech forests on carbonate bedrock, with shallow to moderately deep soil cover with many outcrops. The canopy of tree layer is dense, predominantly composed of beech trees, but occasionally other thermophilous trees might occur (*Sorbus torminalis*, *Acer pseudoplatanus*, *A. campestre*). The most specific characteristic of this vegetation is the presence of *Orchidaceae* species: four species, of which *Cephalanthera rubra* and *C. damasonium* are diagnostic and were never recorded in other forests in the reserve. The unit covers an area of 176.5 ha.

Affiliation to habitat types:

- EUNIS – G1.661 Middle European dry-slope limestone beech forests;
- Dir. 92/43/EEA/Biological Diversity Act – 9150 Medio-European limestone beech forests of the *Cephalanthero-Fagion*;
- *Red Data Book of R. Bulgaria* – 11G1 Limestome common beech (*Fagus sylvatica*) forests: Near Threatened [NT].

Table 2. Abridged combined synoptic table of forest vegetation in Kutelka Reserve.

Class	*Querco-Fagetea*		*Quercetea pubescentis*	
Alliance	*Fagion*	*Cephalanthero-Fagion*	*Syringo-Carpinion orientalis*	*Quercion petraeae-cerris*
No. of column	**1**	**2**	**3**	**4**
number of relevés	3	4	3	9
altitude [m a.s.l.]	851	987	657	785
inclination [°]	30	20	26	26
total vegetation cover [%]	90	91	90	86
cover tree layer [%]	90	91	68	70
cover shrub layer [%]	2	1	26	2
cover herb layer [%]	10	9	20	39
cover of mosses [%]	0	0	1	3
species richness	12	19	22	23
Species diagnostic for current group				
Fagus sylvatica	100	100	.	33
Acer platanoides	67**	.	.	.
Dryopteris filix-mas	33	.	.	.
Sambucus nigra	33	.	.	.
Cephalanthera rubra	.	75 **	.	.
Cephalanthera damasonium	.	75 **	.	.
Acer pseudoplatanus	.	75**	.	11
Campanula rapunculoides	.	75**	.	11
Physospermum cornubiense	.	75**	.	22
Sorbus torminalis	.	75	67	22
Lathyrus laxiflorus	.	75	33	33
Rosa species	.	50	.	11
Carpinus orientalis	.	.	100	67
Fraxinus ornus	33	25	100	78
Arabis turrita	.	.	100**	33
Ruscus aculeatus	.	.	67**	.
Galium aparine	.	.	67	11
Myrrhoides nodosa	.	.	67**	.
Cephalorrynchus tuberosus	33	.	67	.
Tamus communis	.	.	67	22
Carex divulsa	.	.	67**	.
Cystopteris fragilis	.	.	67	11
Muscari botryoides	.	.	67	11
Arrhenatherum palaestinum	.	.	33	.
Achillea grandifolia	.	.	33	.

Table 2. Continuation.

Class	*Querco-Fagetea*		*Quercetea pubescentis*	
Alliance	*Fagion*	*Cephalanthero-Fagion*	*Syringo-Carpinion orientalis*	*Quercion petraeae-cerris*
No. of column	**1**	**2**	**3**	**4**
number of relevés	3	4	3	9
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total vegetation cover [%]	90	91	90	86
cover tree layer [%]	90	91	68	70
cover shrub layer [%]	2	1	26	2
cover herb layer [%]	10	9	20	39
cover of mosses [%]	0	0	1	3
species richness	12	19	22	23
Trifolium scabrum	.	.	33	.
Clinopodium vulgare	.	.	33	.
Tragopogon pratensis	.	.	33	.
Luzula forsteri	.	.	33	.
Geranium divaricatum	.	.	33	.
Syringa vulgaris	.	.	33	.
Alyssum desertorum	.	.	33	.
Digitalis lanata	.	.	33	.
Luzula luzuloides	67	.	.	89 **
Quercus dalechampii	.	.	67*	78**
Hieracium species	33	.	.	67**
Viscaria vulgaris	.	.	.	56**
Festuca heterophylla	.	25	.	56**
Quercus frainetto	.	.	67	44
Carpinus betulus	67*	50	.	44
Hieracium pilosella	.	.	.	44**
Lerchenfeldia flexuosa	.	.	.	44**
Hypericum perforatum	.	.	.	33
Chamaecytisus ciliatus	.	.	.	33
Linaria genistifolia	.	.	.	22
Polygonatum odoratum	.	.	.	22
Galium pseudaristatum	.	.	.	22
Veronica chamaedrys	.	.	.	22
Melica uniflora	67	25	33	56
Other species				
Poa nemoralis	67	25	100	100
Acer campestre	.	75	67	44
Campanula persicifolia	67	25	.	44
Mycelis muralis	67	50	.	44
Hieracium murrorum	67	25	.	33
Viola species	33	.	33	11
Prunella vulgaris	.	.	.	11
Corylus avellana	33	.	.	11
Glechoma hederacea	33	.	.	11
Moehringia trinervia	67	25	.	11
Aegopodium podagraria	.	.	.	11
Cardamine bulbifera	33	25	.	11
Brachypodium sylvaticum	.	.	.	11
Silene italica	33	.	.	11
Silene viridiflora	.	.	.	33
etc.				

Percentage constancies are given, the phi-values are represented with the superscript symbols (** Phi>0.5, * Phi>0.3), for each column the means of header data for belonging relevés are calculated.

1.3. Oak and oak-hornbeam forests (alliance *Quercion petraeae-cerris*); (Table 2, column 4)

This group is relatively heterogeneous in floristic composition and at association level could be classified to more than one association. Dominant in the tree layer is *Quercus dalechampii*, which belongs to *Quercus petraea* agg. Co-dominants in different places are *Carpinus betulus* and/or *Q. frainetto.* The constant species *Luzula luzuloides*, *Lerchenfeldia flexuosa*, *Festuca heterophylla*, and *Polygonatum odoratum* reveal the mesophytic conditions at higher altitudes on which these communities occur, as opposed to the thermophilous oak forests which are lacking them. Furthermore, due to their distribution on sunny slopes (southern and western), *Q. dalechampii* communities include a great variety of thermophilous species too. These communities have some floristic similarities with Central European forests of *Quercion petraeae*, but they contain species of Southeast European/Balkan origin (such as *Q. frainetto*). On the other hand, these forests do not fit into any of the known types of oak forests in Bulgaria (Roussakova & Tzonev 2003; Lyubenova & al. 2011). Floristically and ecologically, these communities better correspond with the proposed by Čarni & al. (2009)

alliance *Quercion petraeae-cerris*. The unit covers an area of 196.5 ha.

Affiliation to habitat types:

- EUNIS – G1.A16 Sub-continental *Quercus – Carpinus betulus* forests;
- Dir. 92/43/EEA/Biological Diversity Act – 9170 *Galio-Carpinetum* oak-hornbeam forests; 91M0 Pannonian-Balkanic Turkey oak – sessile oak forests;
- *Red Data Book of R. Bulgaria* – 15G1. Moesian mixed thermophilic oak forests: Endangered [EN]; 27G1 Mountain forests of *Carpinus betulus* and *Quercus dalechampii*: Near threatened [NT].

1.4. Forests of *Carpinus orientalis* (*Syringo-Carpinion orientalis* alliance) (Table 2, column 3)

These communities are dominated by *Carpinus orientalis*, but its canopy varies greatly in the different plots. In some stands, was registered a high presence of *Fraxinus ornus* and/or *Acer campestre*, *Quercus dalechampii* and *Q. frainetto*. Presence of some southern elements, such as *Ruscus aculeatus* is very typical. Undergrowth consists of heliophitic and thermophitic elements. This vegetation is the most thermophilous forest vegetation presented in the Kutelka Reserve. Probably, it belongs to *Arabido turritae-Carpinetum orientalis* Tzonev 2009 association described from North Bulgaria (Tzonev 2009), but for final decision more relevés are needed. The unit covers an area of 96.5 ha.

Affiliation to habitat types:

- EUNIS – G1.7 Thermophilous deciduous woodland;
- Dir. 92/43/EEA/Biological Diversity Act – 91M0 Pannonian-Balkanic Turkey oak – sessile oak forests; 91AA* Eastern White oak woods;
- *Red Data Book of R. Bulgaria* – 16G1. Thracian mixed thermophilic oak forests: Endangered [EN].

1.5. *Pinus nigra* plantantions

Some small patches of plantations of *Pinus nigra* are found in the southern parts of the reserve's territory and surrounding areas. They have very sparse shrub and herb layers despite the encroachment of some thermophilous species from the neighbouring grassland communities. The unit covers an area of 1.6 ha.

Affiliation to habitat types:

- EUNIS – G3.F12 Native pine plantations;
- Dir. 92/43/EEA/Biological Diversity Act – N/A;
- *Red Data Book of R. Bulgaria* – N/A.

2. Shrub vegetation

2.6. Community of *Rosa pimpinelifolia* (*Pruno tenellae-Syringion* alliance) (Table 3, column 2)

Very seldom found in the reserve's vegetation type, located only in the region of peak Kutelka. *Rosa pimpinelifolia* dominates, while other species are present only by single individuals. The unit covers an area of 0.02 ha.

Affiliation to habitat types:

- EUNIS – F3.2412 Subcontinental peri-Pannonic scrub;
- Dir. 92/43/EEA/Biological Diversity Act – 40A0* Subcontinental peri-Pannonic shrub;
- *Red Data Book of R. Bulgaria* – 18F3 Subcontinental steppe shrub: Endangered [EN].

2.7. Shrubs of *Carpinus orientalis* (*Pruno tenellae-Syringion* alliance) (Table 3, column 3)

This vegetation type is probably a degraded stage of xero-thermopile forest vegetation subjected to strong anthropogenic impact. Such communities are typical for the lower parts of the southern slopes of the mountain, just above Sliven town, mostly outside the reserve's territory. Along the boundaries of the reserve this vegetation type is probably a pioneer stage of the vegetation succession on rocky terrains, with such accompanying species like *Jasione heldreichii*, *Verbascum humile*, *Anthemis tenuiloba*, and *Rumex acetosella*, characteristic for hasmophytic communities. The unit covers an area of 10.5 ha.

Affiliation to habitat types:

- EUNIS – F3.2431 Moesian oriental hornbeam thickets;
- Dir. 92/43/EEA/Biological Diversity Act – N/A;
- *Red Data Book of R. Bulgaria* – N/A.

Table 3. Abridged combined synoptic table of shrub and grasslands vegetation in Kutelka Reserve.

class	**Betula pendula community**	***Quercetea pubescentis***				***Koelerio-Corynephoretea***		***Trifolio-Geranietea***	***Festuco-Brometea***
alliance		***Pruno tenellae-Syringion***							***Saturejion montanae***
No. of column	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
No. of releves	2	1	1	3	2	9	4	2	7
altitude [m a.s.l.]	823	1058	731	745	1041	896	522	1011	984
inclination [°]	30	15	15	16	6	6	15	7	8
total vegetation cover [%]	78	95	30	92	53	61	66	83	61
cover shrub layer [%]	45	95	15	68	28	0	0	0	0
cover herb layer [%]	33	0	20	42	35	50	60	83	58
cover of mosses [%]	28	0	0	2	6	15	12	0	7
species richness	21	14	12	27	19	23	31	38	31
Species diagnostic for current group									
Betula pendula	100**	.	.	.	.	.	.	.	.
Hieracium species	100**	.	.	.	.	.	.	.	14
Jasione heldreichii	100**	.	100	.	.	11	25	.	.
Lerchenfeldia flexuosa	100**	100	.	.	50	11	.	.	.
Rosa pimpinellifolia	.	100**	.	.	.	.	.	.	.
Quercus petraea juv.	.	100**	.	.	.	.	.	.	.
Glechoma hederacea	.	100**	.	.	.	.	.	.	.
Lamium species	.	100**	.	.	.	.	.	.	.
Stellaria alsine	.	100**	.	.	.	.	.	.	.
Geranium macrorrhizum	.	100**	.	.	.	.	.	.	.
Poa nemoralis	.	100**	.	.	.	.	.	.	.
Carpinus orientalis	100**	.	100	.	.	.	.	.	14
Prunus cerasifera	.	.	100**	.	.	.	.	.	.
Verbascum humile	.	.	100	33	.	56	50	.	.
Hypericum umbellatum	50	.	100	.	.	.	25	.	.
Anthemis tenuiloba	50	.	100	.	.	33	.	.	.
Syringa vulgaris	.	.	.	100**	.	.	50	.	.
Juniperus communis	50	.	.	.	100	11	.	.	71*
Plantago subulata	.	.	.	.	50	89**	.	.	14
Sedum caespitosum	.	.	.	.	.	44**	.	.	.
Viola tricolor	.	.	.	.	.	33**	.	.	.
Festuca rupicola	.	.	.	33	50	89**	.	.	43
Sempervivum marmoreum	.	.	.	.	50	56*	25	.	.
Thymus striatus	50	.	.	67	.	78*	75*	.	14
Rumex acetosella	50	.	100	.	50	89*	25	50	14
Scleranthus annuus	.	100	.	33	.	67	25	.	14
Euphorbia myrsinites	.	.	.	.	.	22	100**	.	.
Orlaya daucoides	.	.	.	33	.	.	100**	.	.
Thesium dollineri	.	.	.	.	.	.	50**	.	.
Linaria pelisseriana	.	.	.	.	.	.	50**	.	.
Micropyrum tenellum	.	.	.	.	.	.	50**	.	.
Viola kitaibeliana	.	.	.	.	.	.	50**	.	.
Rorippa lippizensis	.	.	.	.	.	.	50**	.	.
Crepis biennis	.	.	.	.	.	.	50**	.	.
Tragopogon pratensis	.	.	.	33	.	.	75**	.	.
Crupina vulgaris	.	.	.	33	.	.	75**	.	14
Convolvulus cantabrica	.	.	.	33	.	.	75**	.	14
Allium flavum	.	.	.	.	.	11	75**	.	43
Trifolium arvense	.	.	.	33	.	56	100**	50	14
Vicia hirsuta	.	.	.	33	.	.	50*	.	.
Trifolium campestre	.	.	.	67	.	44	100*	100*	14
Vicia grandiflora	.	.	.	.	.	.	50*	50*	.

Table 3. Continuation.

class	Betula pendula community	*Quercetea pubescentis*				*Koelerio-Corynephoretea*		*Trifolio-Geranietea*	*Festuco-Brometea*
alliance		*Pruno tenellae-Syringion*							*Saturejion montanae*
No. of column	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
No. of releves	2	1	1	3	2	9	4	2	7
altitude [m a.s.l.]	823	1058	731	745	1041	896	522	1011	984
inclination [°]	30	15	15	16	6	6	15	7	8
total vegetation cover [%]	78	95	30	92	53	61	66	83	61
cover shrub layer [%]	45	95	15	68	28	0	0	0	0
cover herb layer [%]	33	0	20	42	35	50	60	83	58
cover of mosses [%]	28	0	0	2	6	15	12	0	7
species richness	21	14	12	27	19	23	31	38	31
Thymus pulegioides	.	.	.	.	.	.	.	100**	.
Trifolium alpestre	.	.	.	.	.	11	.	100**	.
Fragaria viridis	.	.	.	.	50	.	.	100**	.
Geranium sanguineum	.	.	.	67	.	.	.	100**	14
Alyssum desertorum	.	.	.	.	.	.	.	50	29
Carex humilis	.	.	.	.	100	11	.	.	86**
Rhodax canus	.	.	.	.	.	.	.	.	71**
Anthericum ramosum	.	.	.	.	.	.	.	.	71**
Teucrium montanum	.	.	.	.	.	.	.	.	57**
Inula ensifolia	.	.	.	.	.	.	.	.	57**
Thymus zygioides	.	.	.	.	50	.	.	.	86**
Genista januensis	.	.	.	.	.	.	.	.	43**
Campanula glomerata	.	.	.	.	.	.	.	.	43**
Anthyllis vulneraria	.	.	.	33	50	.	.	.	86**
Asperula cynanchica	.	.	.	33	50	.	.	50	100**
Satureja montana	.	.	.	.	.	.	.	.	29**
Bromus barcensis	.	.	.	.	.	.	.	.	29**
Sideritis montana	.	.	.	.	.	.	.	.	29**
Anthylis montana	.	.	.	.	.	.	.	.	29**
Poa badensis	.	.	.	.	.	.	.	.	29**
Stipa epilosa	.	.	.	.	.	.	.	.	29**
Bupleurum tenuissimum	.	.	.	.	.	.	.	.	29**
Tragopogon balcanicum	.	.	.	.	.	.	.	.	29**
Pimpinella tragium	.	.	.	.	.	.	.	.	29**
Cephalaria uralensis	.	.	.	.	.	.	.	.	29**
Linum tenuifolium	.	.	.	33	.	.	.	.	43*
Teucrium chamaedrys	.	.	.	33	50	.	.	50	71*
Sanguisorba minor	.	.	.	33	50	.	.	.	57*
Euphorbia cyparissias	.	.	.	67	.	22	50	100	86*
Leontodon crispus	.	.	.	33	50	11	25	50	71*
Centaurea rhenana	.	.	100	33	.	22	.	50	71*
Other species									
Achillea clypeolata	.	.	.	.	.	11	25	.	29
Sesleria latifolia	100	.	.	33	50	11	.	.	57
Acinos alpinus	.	.	.	67	.	.	25	.	43
Fraxinus ornus	50	.	.	33	.	22	.	.	.
Anthemis carpatica	50	.	.	.	50	33	.	.	.
Thlaspi kovatsii	.	.	.	33	.	.	.	50	.
Stachys recta	.	.	.	.	.	22	50	.	14
Koeleria nitidula	.	.	.	67	.	11	75	50	29
Muscari botryoides	.	.	.	67	.	56	75	.	29
etc.									

Percentage constancies are given, the phi-values are represented with the superscript symbols (** Phi>0.5, * Phi>0.3), for each column the means of header data for belonging relevés are calculated.

2.8. Community of *Syringa vulgaris* (*Pruno tenellae-Syringion* alliance) (Table 3, column 4)

Syringa vulgaris shrubs are typical for the "shibljak"-type vegetation of the xero-thermophile forest vegetation zone in Southeast Europe and the Balkans. On the reserve's territory, we have registered a rich species composition (32 and 37 species), with a typical thermophile (*Jasminum fruticans*, *Fraxinus ornus*) and calcicolous (*Sesleria latifolia*, *Convolvulus cantabrica*, *Euphorbia myrsinites* etc.) species. In one relevé, we have found only 13 species, because of the great canopy values of codominant species (*Pyrus pyraster*) that limit the development of the herb layer. The unit covers an area of 0.2 ha.

Affiliation to habitat types:

- EUNIS – F3.2432 Moesian lilac thickets;
- Dir. 92/43/EEA/Biological Diversity Act – N/A;
- *Red Data Book of R. Bulgaria* – 20F3 Moesian Lilac (*Syringa vulgaris*) thickets: Vulnerable [VU].

2.9. Shrubs of *Juniperus communis* (*Pruno tenellae-Syringion* alliance); (Table 3, column 5)

Juniperus communis shrubs form two types of communities in the Kutelka Reserve. Most often juniper grows on calcareous bedrock, colonizing grasslands of *Sesleria latifolia* and *Carex humilis*. Such communities are rich in calcicolous species. On the opposite, single juniper shrubs or small groups grow in rocky crevices. The unit covers an area of 1.8 ha.

Affiliation to habitat types:

- EUNIS – F3.164 Sub-Mediterranean Common Juniper thickets;
- Dir. 92/43/EEA/Biological Diversity Act – 5130 *Juniperus communis* formations on heaths or calcareous grassland;
- *Red Data Book of R. Bulgaria* –17F3 Common juniper (*Juniperus communis*) scrub: Near threatened [NT].

2.10. Community of *Betula pendula* (Table 3, column 1)

The birch communities are found on dry screes and boulder-falls, at altitudes between 700 and 900 m a.s.l. Accompanying species are: *Lerchenfeldia flexuosa*, *Hieracium pilosella*, *Sesleria latifolia*, *Minuartia viscosa*, and *Dianthus petraeus.*

In Central Europe, *Betula pendula* is known as the first colonizer on cleared areas in the mountains, but it also grows in nutrient-poor, dry or wet habitats that are too stressful for broad-leaved species (Chytrý 2012). Willner & al. (2016) proposed new descriptions and validation of syntaxonomy of birch woodlands – for acidophilous Atlantic birch forests of West and South Europe and also for temperate deciduous birch-poplar woodlands on mineral soils, classically classified into one order (*Betulo pendulae-Populetalia tremulae* of class *Querco-Fagetea*). The material collected from limited relevés during our study and the lack of knowledge of birch woodlands in Bulgaria do not permit a more precise syntaxonomical affiliation.

The unit covers an area of 29.6 ha.

Affiliation to habitat types:

- EUNIS – G1.9135 Illyro-Moesian montane birch woods;
- Dir. 92/43/EEA/Biological Diversity Act – N/A;
- *Red Data Book of R. Bulgaria* – N/A.

3. Grassland vegetation

3.11. Pioneer open grasslands on silicate rocks (Table 3, column 6)

This vegetation type is typical for rocky terrains and belongs to order *Sedo-Scleranthetalia*. Herbaceous calcifuge species as *Plantago subulata*, *Rumex acetosella*, *Thymus striatus*, *Scleranthus annuus*, *S. perennis*, and *Sedum caespitosum*, as well as mosses and lichens prevail, while grasses and herbs are sparse. The unit covers an area of 25.3 ha.

Affiliation to habitat types:

- EUNIS – H3.62 Sparsely vegetated weathered rock and outcrop habitats;
- Dir. 92/43/EEA/Biological Diversity Act – 8230 Siliceous rock with pioneer vegetation of *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*;
- *Red Data Book of R. Bulgaria* – 09H3 Silicate rocks with pioneer herbaceous vegetation: Vulnerable [VU].

3.12. Grassland communities of the order *Trifolio arvensis-Festucetalia ovinae* (Table 3, column 7)

These grasslands are also considered pioneer vegetation, like the previous category. Despite their relatively similar floristic composition, this vegetation type

is characterized by a more closed horizontal structure, dominance of grasses (such as *Festuca rupicola*, *Poa bulbosa*, or in some places *Koeleria nitidula* and *Chrysopogon gryllus*), lower occurrence of mosses and lichens, and increased participation of calcicolous species. The unit covers an area of 7.7 ha.

Affiliation to habitat types:

- EUNIS – H3.62 Sparsely vegetated weathered rock and outcrop habitats;
- Dir. 92/43/EEA/Biological Diversity Act – 8230 Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*;
- *Red Data Book of R. Bulgaria* – 09H3 Silicate rocks with pioneer herbaceous vegetation: Vulnerable [VU].

3.13. Grasslands of the *Saturejion montanae* alliance (Table 3, column 9)

This vegetation is dominated by *Sesleria latifolia* or *Carex humilis*, on calcareous terrains with rocky outcrops. It includes species-rich communities with prevalence of many calcicolous species: *Anthyllis vulneraria*, *A. montana*, *Rhodax canus*, *Allium flavum*, *Euphorbia cyparissias*, etc. The alliance has Balkan distribution and is known for Bulgaria from several recent studies (Tzonev 2002; Sopotlieva 2008, 2009; Pedashenko & al. 2009, 2013; Todorova & Tzonev 2010; Vassilev & al. 2011; Vassilev 2012), but the current record in Kutelka Reserve extends its area to the east. The unit covers an area of 9.1 ha.

Affiliation to habitat types:

- EUNIS – E1.55 Eastern sub-Mediterranean dry grassland;
- Dir. 92/43/EEA/Biological Diversity Act – 62A0 Eastern sub-Mediterranean dry grasslands (*Scorzoneretalia villosae*);
- *Red Data Book of R. Bulgaria* – 03E1Sub-Mediterranean petrophytic steppes: Vulnerable [VU].

3.14. Fringe vegetation (class *Trifolio-Geranietea)* (Table 3, column 8).

This vegetation includes (sub)thermophile, (sub)heliophitic and (sub)xeric to mesic communities at the forest edge. The most typical species for this class are found in the studied territory too (*Trifolium alpestre*, *Geranium sanguineum*, *Agrimonia eupatoria*, *Clinopodium vulgare*, *Origanum vulgare* etc.). The unit covers an area of 5.5 ha.

Affiliation to habitat types:

- EUNIS – E5.21 Xero-thermophile fringes;
- Dir. 92/43/EEA/Biological Diversity Act – N/A;
- *Red Data Book of R. Bulgaria* – N/A.

Appendix 1. List of recorded taxa in the Kutelka Reserve [species not included in the respective lists of Sinite Kamani Nature Park (Grozeva & al. 2004; Stoeva-Hristova 2004) are marked by number sign (#); medicinal plants (Appendix 1 of Medicinal Plants Act 2000) are marked by asterix (*)]

Bryophytes:

***Marchatiophyta* (Liverworts)**

***Marchatiopsida: Conocephalaceae*:** #*Conocephalum conicum* (L.) Dumort.

***Bryophyta* (Mosses)**

***Andreaeopsida: Andreaeaceae*:** #*Andreaea rupestris* Hedw.

***Polytrichopsida: Polytrichaceae*:** *Polytrichum piliferum* Hedw., *P. formosum* Hedw.

***Bryopsida: Grimmiaceae*:** #*Grimmia montana* Bruch & Schimp., *G. pulvinata* (Hedw.) Sm., #*G. laevigata* (Brid.) Brid.; ***Fissidentaceae*:** #*Fissidens dubius* P. Beauv.; ***Dicranaceae*:** *Dicranum scoparium* Hedw.; ***Ditrichaceae*:** *Ceratodon purpureus* (Hedw.) Brid., #*Ditrichum flexicaule* (Schwägr.) Hampe; ***Rhabdoweisiacae*:** *Cynodontium* sp.; ***Pottiaceae*:** *Weissia* sp., #*Tortella tortuosa* (Hedw.) Limpr., #*Pleurochaete squarrosa* (Brid.) Lindb.; ***Orthotrichaceae*:** #*Orthotrichum affine* Schrad. ex Brid., #*O. striatum* Hedw.; ***Hedwigiaceae*:** #*Hedwigia ciliata* (Hedw.) P. Beauv.; ***Bryaceae*:** #*Bryum argenteum* Hedw., *B. alpinum* Huds. ex With., #*B. pseudotriquetrum* (Hedw.) Gaertn. et al., #*B. moravicum* Podp.; ***Mniaceae*:** *Plagiomnium affine* (Blandow ex Funck) T.J. Kop.; ***Thuidiaceae*:** #*Abietinella abietina* (Hedw.) M. Fleisch.; ***Campyliaceae*:** #*Campyliadelphus chrysophyllus* (Brid.) R.S.Chopra; ***Cratoneuraceae*:** #*Cratoneuron filicinum* (Hedw.) Spruce; ***Brachytheciaceae*:** #*Platyhypnidium rtiparioides* (Hedw.) Dixon; ***Hypnaceae*:** *Hypnum cupressiforme* Hedw.

Appendix 1. Continuation.

Vascular plants:

Polypodiophyta

Polypodiopsida: Aspidiaceae: **Dryopteris filix –mas* (L.) Schott; ***Aspleniaceae:*** **Asplenium ruta-muraria* L., **A. trichomanes* L.; ***Athyriaceae:*** *Cystopteris fragilis* (L.) Bernh; ***Hypolepidaceae:*** *Pteridium aquilinum* (L.) Kuhn; ***Polypodiacea:*** *Polypodium vulgare* L.; ***Sinopteridaceae:*** *Cheilanthes maranthae* (L.) Domin;

Pinophyta

Cupressaceae: *Juniperus communis* L.; ***Pinaceae:*** *Pinus nigra* J.F. Arn., **P. sylvestris* L.

Magnoliophyta

Magnoliopsida: Aceraceae: *Acer campestre* L.; **A. platanoides* L.; *A. pseudoplatanus* L.; *A. tataricum* L.; ***Apiaceae:*** *Aegopodium podagraria* L., *Antriscus sylvestris* (L.) Hoffm., *#Apium graveolens* L., *Bupleurum praealtum* L., *B. sibthorpianum* Sm., *B. tenuissimum* L., *#*Carum graecum* Boiss. & Heldr., *Chaerophyllum byzantinum* Boiss., **Eryngium campestre* L., **Heracleum sibiricum* L., **Laser trilobium* (L.) Borkh., *Myrrhoides nodosa* (L.) Cann., *#Orlaya daucoides* (L.) Greuter, *O. grandiflora* (L.) Hoffm., *#*Peucedanum officinalis* L., *Physospermum cornubiense* (L.)DC., **Pimpinella saxifraga* L., *P. tragium* Vill., *#*Sanicula europaea* L., **Seseli rigidum* Waldst. & Kit., *#*S. tortuosum* L., *#Torilis japonica* (Houtt.) DC., *T. leptophylla* (L.) Rchb.; ***Apocynaceae:*** **Vinca herbaceae* Waldst. & Kit., *#*V. minor* L.; ***Araliaceae:*** **Hedera helix* L.; ***Asclepiadaceae:*** *Vincetoxicum hirundinaria* Medic.; ***Asteraceae:*** **Achillea clypeolata* Sibth. & Sm., *A. grandifolia* Friv., **A. millefolium* L., *A. setacea* Waldst. & Kit., *#A. tanacetifolia* All., *#Anthemis carpatica* Willd., *#A. ruthenica* M. Bieb., *#A. tenuiloba* (DC.) Fernand., **A. tinctoria* L., *Arctium lappa* L., **Artemisia vulgaris* L., **Carduus acanthoides* L., *#C. candicans* subsp. *globifer* (Velen.) Kazmi, *#Carlina acanthifolia* All., *#*C. vulgaris* L., *Centaurea rhenana* Boreau, *#C. rutifolia* Sibth. & Sm., *C. salonitana* Vis., *C. triumfetti* All., *Cephalorrhynchus tuberrosus* (Steven) Schchian, *#Chondrilla juncea* L., *#Cirsium oleraceum* (L.) Scop., *#Crepis biennis* L., *C. setosa* Hall.f., *Crupina vulgaris* Cass., **Doronicum columnae* Ten., *D. hungaricum* Rchb., **Filago vulgaris* Lam., *Hieracium hoppeanum* Schult., *#H. praealtum* Vill. subsp. *bauhinii* (Besser) Petun., *#*H. pilosella* L., *#Hypochaeris glabra* L., **H. radicata* L., **Inula aschersoniana* Janka, *#I. britanica* L., **I. ensifolia* L., *#Jurinea glicacantha* (Sibth. & Sm.) DC., *Lactuca quercina* L., *#*L. serriola* L., *Leontodon crispus* Vill., *#Logfia arvensis* (L.) J. Holub, *#L. minima* (Sm.) Dum., *Mycelis muralis* (L.) Dum., *#Senecio hercynicus* Herborg, *S. papposus* (Rchb.) Less., *#S. vernalis* Waldst. & Kit., *#*Solidago virgaurea* L., *#Tanacetum corymbosum* (L.) Schultz-Bip., *Taraxacum* sect. *Ruderalia*, *#*Telekia speciosa* (Schreb.) Baumg., *Tragopogon balcanicum* Velen., *T. dubius* Scop., **T. pratensis* L., **Tussilago farfara* L., **Xeranthemum annuum* L.; ***Betulaceae:*** **Betula pendula* Roth, **Carpinus betulus* L., *C. orientalis* Mill., **Coryllus avellana* L.; ***Boraginaceae:*** **Buglossoides purpurocaerulea* (L.) Johnst., *#Myosotis ramosissima* Roch., *#M. scorpioides* L., *M. sylvatica* Ehrh. ex Hoffm., *#Neathostema apulum* (L.) Johnst., *Symphytum tuberosum* L.; ***Brassicaceae:*** **Alliaria petiolata* (Bieb.) Cavara & Grande, *#Alyssum desertorum* Stapf; *A. murale* Waldst. & Kit., *#A. saxatile* L., *#A. strigosum* Banks & Soland., *#A. tortuosum* Willd., *Arabis turrita* L., *#Camelina sativa* (L.) Crantz, **Cardamine bulbifera* (L.) Crantz, *#Cardaria draba* (L.) Desv., *#Draba aizoides* L., *Erophylla verna* (L.) Chevall., *Erysimum diffusum* Ehrh., *#Neslia paniculata* (L.) Desv., *#Rorripa lippizensis* (Wulf.) Rchb., *#R. pyrenaica* (L.) Rchb., *#Thlaspi kovatsii* Heuff.; ***Campanulaceae:*** *#Campanula glomerata* L., *C. jordanovii* Ančev & Kovanda, *C. lingulata* Waldst. & Kit., **C. persicifolia* L., *C. rapunculoides* L., *Jasione heldreichii* Boiss. & Orph.; ***Caprifoliaceae:*** **Sambucus ebulus* L., *#*S. nigra* L., *Viburnum lantana* L.; ***Caryophyllaceae:*** *#Arenaria leptoclados* (Rchb.) Guss., *#Cerastium brachypetalum* Pers., *#C. velenovskyi* Hay., *#Dianthus carthusianorum* L., *D. giganteus* D'Urv., *D. moesiacus* Vis. & Panč., *D. petraeus* Waldst. & Kit., *D. pinifolius* Sibth. & Sm., **Lychnis coronaria* (L.) Desr., *Minuartia bulgarica* (Velen.) Grbn., *M. caespitosa* (Ehrh.) Deg., *M. garcкeana* (Asch. & Graebn.) Mattf., *#M. hybrida* (Vill.) Schischk., *M. recurva* (All.) Schinz. & Thell., *#M. viscosa* (Schreb.) Schinz. & Thell., *Moehringia trinervia* (L.) Clairv., *#Paronychia cephalotes* (M. Bieb.) Bess., *Petrorhagia prolifera* (L.) Ball & Heyw., *#*Scleranthus annuus* L., **S. perennis* L., *Silene compacta* Fisch., *S. italica* (L.) Pers., *S. saxifraga* L., *S. viridiflora* L., *S. vulgaris* (Moench) Garke, **Stellaria media* (L.) Vill., *S. holostea* L., **Viscaria vusgaris* subsp. *atropurpurea* (Griseb.) Stoj.; ***Celastraceae:*** *Euonymus latifolius* (L.) Mill.; ***Cistaceae:*** *Fumana procumbens* (Dunal) Gren. & Godr., *Helianthemum numularium* (L.) Mill., *#H. salicifolium* (L.) Mill., *Rhodax canus* (L.) Fuss.; ***Convolvulaceae:*** *Calystegia sylvatica* (Kit.) Grsb., *Convolvulus cantabrica* L.; ***Cornaceae:*** **Cornus mas* L.; ***Crassulaceae:*** *#*Sedum*

Appendix 1. Continuation.

acre L., **S. album* L., *#S. caespitosum* (Cav.) DC., *S. hispanicum* L., *S. maximum* (L.) Suter, *S. ochroleucum* Chaix, *Sempervivum leucanthum* Panč., *#S. marmoreum* Griseb.; ***Dipsacaceae:*** *#Cephalaria uralensis* (Murr.) Roem. & Schult., **Knautia arvensis* (L.) Coult., *Scabiosa triniifolia* Friv.; ***Euphorbiaceae:*** **Euphorbia amygdaloides* L., **E. cyparissias* L., *E. helioscopia* L., **E. myrsinites* L., *E. polychroma* Kern., **Mercurialis perrenis* L., ***Fabaceae:*** *Anthyllis montana* subsp. jacquinii (A. Kern.) Hay., **A. vulneraria* L., **Astragalus glycyphyllus* L., **Bituminaria bituminosa* (L.) Stirt., *#Chamaecytisus albus* (Jacq.) Rothm., *Ch. ciliatus* (Wahlb.) Rothm., *Ch. polytrichus* (M. Bieb.) Rothm., **Coronilla varia* L., *Dorycnium herbaceum* Vill., *Genista januensis* Viv., *G. rumelica* Velen., *#Hippocrepis comosa* L., *Lathyrus laxiflorus* (Desf.) O. Kuntze, *L. niger* (L.) Bernh., *L. nissolia* L., *L. pratensis* L., *L. sphaericus* Retz., *L. venetus* (Mill.) Wohlf., **L. vernus* (L.) Bernh., *Lembotropis nigricans* (L.) Griseb., *#Lotus angustissimus* L., *#Medicago arabica* (L.) Huds., *M. lupulina* L., *Robinia pseudoacacia* L., **Trifolium alpestre* L., *#T. angustifolium* L., **T. arvense* L., *T. campestre* Schreb., *T. hirtum* All., *T. medium* L., *T. ochroleucon* Huds., *T. pallidum* Waldst. & Kit., *#T. purpureum* Loisel., *T. scabrum* L., *T. striatum* L., *#T. strictum* L., **Vicia grandiflora* Scop., *V.hirsuta* (L.) S. Gary, *#V. lathyroides* L., ***Fagaceae:*** **Fagus sylvatica* L., *Quercus dalechampii* Ten., **Q. frainetto* Ten., *Q. pubescens* Willd., ***Fumariaceae:*** *Corydalis slivenensis* Velen., **C. solida* (L.) Swartz, ***Gentianaceae:*** **Centaurium erythraea* Rafn, **Gentiana crutiata* L.; ***Geraniaceae:*** **Erodium cicutarium* (L.) L'Hér., *#Geranium divaricatum* Ehrh., **G. macrorrhizum*, **G. robertianum* L., **G. sanguineum* L.; ***Globulariaceae:*** **Globularia aphyllanthes* Crantz; ***Hypericaceae:*** *Hypericum montbretii* Spach, **H. perforatum* L., *H. rumeliacum* Boiss., *H. umbellatum* Kern.; ***Juglandaceae:*** *Juglans regia* L.; ***Lamiaceae:*** *#Acinos alpinus* (L.) Moench, *Ajuga genevensis* L., **A. laxmanii* (L.) Benth., *A. reptans* L., **Clinopodium vulgare* L., **Galeopsis tetrahit* L., **Glechoma hederacea* L., *Lamiastrum galeobdolon* (L.) Ehrend., *Lamium amplexicaule* L., **L. purpureum* L., **Marrubium perregrinum* L., *#*Mentha aquatica* L., *#*M. longifolia* (L.) Huds., **M. spicata* L., *Nepeta nuda* L., **Origanum vulgare* L., **Phlomis tuberosa* L., *Prunella laciniata* (L.) L., **P. vulgaris* L., **Salvia glutinosa* L., *S. ringens* Sibth. & Sm., **Satureja montana* subsp. *kitaibelii* (Wierzb.) Ball, *#Scutellaria albida* L., *Sideritis montana* L., **Stachys germanica* L., *#*S. officinalis* (L.) Trev.,* *S. recta* L., **S. sylvatica* L., **Teucrium chamaedrys* L., **T. montanum* L., **T. polium* L., **Thymus jankae* Čelak., **T. pulegioides* L., **T. striatus* Vahl., *#*T. zygioides* Griseb.; ***Linaceae:*** *Linum tenuifolium* L.; ***Monotropaceae:*** *#Monotropa hypopitys* L; ***Oleaceae:*** **Fraxinus exelsior* L., **F. ornus* L., *Jasminum fruticans* L., **Ligustrum vulgare* L., **Syringa vulgaris* L.; ***Paeoniaceae:*** **Paeonia peregrina* Mill.; ***Papaveraceae:*** **Chelidonium majus* L.; ***Plantaginaceae:*** *#Plantago coronopus* L., **P. major* L., **P. media* L., **P. subulata* L.; ***Polygalaceae:*** **Polygala major* Jacq.; ***Polygonaceae:*** **Rumex acetosella* L.; ***Primulaceae:*** **Anagalis arvensis* subsp. *foemina* (Mill.) Schintz & Thell., **Lysimachia vulgaris* L., **Primula veris* L.; ***Pyrolaceae:*** **Orthilia secunda* (L.) House; ***Ranunculaceae:*****Anemone ranunculoides* L., *Delphinium fissum* Waldst. & Kit., *Pulsatilla montana* (Hoppe) Rchb., **Ranunculus ficaria* L., *R. illyricus* L., *R. milefoliatus* Vahl., **R. polyanthemos* L., **Thalictrum aquilegifolium* L., **T. minus* L.; ***Rosaceae:*** **Agrimonia eupatoria* L., *Amelanchier ovalis* Medic., *Aremonia agrimonioides* (L.) DC., **Crataegus monogyna* Jacq., **Filipendula vulgaris* Moench, *#Fragaria viridis* Duch., **Geum urbanum* L., **Malus sylvestris* Mill., *#Mespilus germanica* L., **Potentilla argentea* L., *#P. laciniosa* Nestler, *P. micrantha* DC., *P. neglecta* Baumg., *P. pedata* Willd., **P. rupestris* L., *Prunus avium* L., *P. cerasifera* Ehrh., **P. mahaleb* L., **P. spinosa* L., *Pyrus pyraster* Burgsd., **Rosa canina* L., *#R. pimpinelifolia* L., *#*Rubus caesius* L., *#*R. idaeus* L., **Sanguisorba minor* Scop., **Sorbus aucuparia* L., **S. torminalis* (L.) Crantz, *#S. umbellata* (Desf.) Fritsch; ***Rubiaceae:*** *Asperula cynanchica* L., *Crucianella angustifolia* L., *Cruciata glabra* (L.) Ehrend., **C. laevipes* Opiz, **Galium aparine* L., *#G. divaricatum* Lam., *G. heldreichii* Hal., *G. pseudoaristatum* Schur., *#G. tenuissimum* M. Bieb., **G. verum* L.; ***Salicaceae:*** **Popolus tremula* L., *#*Salix alba* L.; ***Santalaceae:*** *Comandra elegans* (Roch. ex Rchb.) Rchb.f., *#Thesium dollineri* Murb.; ***Scrophulariaceae:*** **Digitalis lanata* Ehrh.; *Euphrasia pectinata* Ten., **Lathraea squamaria* L., *Linaria genistifolia* (L.) Mill., *L. pelisseriana* (L.) Mill., *Pedicularis comosa* L., *Scrophularia umbrosa* Dum., *Verbascum humile* Janka, *#Veronica acinifolia* L., *V. austriaca* L., **V. chamaedrys* L., *#V. cymbalaria* Bod., *#V. hederifolia* L., *#V. jacquinii* Baumg., **V. officinalis* L., *#V. verna* L.; ***Thymeleaceae:*** *Thymelaea passerina* (L.) Coss & Germ.; ***Tiliaceae:*** **Tilia cordata* Mill., *#*T. platyphyllos* Scop.; ***Ulmaceae:*** *Ulmus laevipes* Pall; ***Urticaceae:*** **Urtica dioica* L.; ***Valerianaceae:*** *#Valerianella costata* Stev.; ***Violaceae:*** *#Viola aetolica* Boiss. & Heldr., *V. dacica* Borb., *#*V. hirta* L., *#V. kitaibeliana* Schult., *#V. mirabilis* L., **V. odorata* L., *#V. riviniana* Rchb., **V. tricolor* L.; ***Vitaceae:*** *#Vitis sylvestris* L.

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Liliopsida: Alliaceae: *Allium flavum* L., #*A. guttatum* Stev., *A. paniculatum* L., **A. sphaerocephalon* L., #*A. vineale* L.; ***Amaryllidaceae:*** **Galanthus elwesii* Hook fill.; ***Araceae:*** **Arum maculatum* L.; ***Asparagaceae:*** *Ruscus aculeatus* L.; ***Cyperaceae:*** #*Carex divulsa* Stokes, *C. humilis* Leyss., *C. pendula* Huds., #*C. praecox*Schreb., #*C. otrubae* Podp.; ***Dioscoreaceae:*** **Thammus communis* L.; ***Iridaceae:*** *Crocus biflorus* Mill., *C. flavus* West., **Gladiolus imbricatus* L., **Iris graminea* L., *I. reichenbachii* Heuff.; ***Juncaceae:*** *Luzula forsteri* (Sm.) DC., #*L. italica* Parl., *L. luzuloides* (Lam.) Dandy, #*L. multiflora* (Retz.) Lej., #*L. sylvatica* (Huds.) Gand.; ***Liliaceae:*** *Anthericum ramosum* L., *Asphodeline lutea* (L.) Rchb., **Colchicum autumnale* L., **Lilium martagon* L., *Muscari botryoides* (L.) Mill., *M. comosum* (L.) Mill., *M. neglectum* Guss. ex Ten., *M. tenuiflorum* Tausch, *Ornithogalum kochii* Parl., *O. umbelatum* L., **Polygonatum odoratum* (Mill.) Druce, *Scilla autumnalis* L., **S. bifolia* L., *Tulipa australis* Link; ***Orchidaceae:*** **Anacamptys pyramidalis* (L.) L.C. Rich., *Cephalanthera damasonium* (Mill.) Druce, *C. longifolia* (L.) Fritsch, *C. rubra* (L.) L.C. Rich., **Dacthylorhyza sambucina* (L.) Soó, #*Epipactis atrorubens* (Hoffm.) Besser, *E. helleborine* (L.) Crantz, #*E. microphylla* (Ehrh.) Swartz, *Limodorum abortivum* (L.) Schwartz, *Listera ovata* (L.) R.Br., *Neotia nidus-avis* (L.) L.C. Rich., **Orchis morio* L., #**O. pinetorum* Boiss. & Kotschy, **O. purpurea* Huds., **Platantera bifolia* (L.) L.C.Rich.; ***Poaceae:*** #*Agrostis stolonifera* L., *Aira elegantissima* Schur, *Anthoxanthum odoratum* L., *Arrhenatherum palestinum* Boiss., #*Avenula pubescens* (Huds.) Dum., *Bellardiochloa variegata* (Lam.) Kerguélen, *Botriochloa ischaemum* (L.) Keng, *Brachypodium sylvaticum* (Huds.) Beauv., #*Briza humilis* M. Bieb., *B. media* L., #*Bromus barcensis* Simk., *B. mollis* L., *B. squarrosus* L., *B. sterilis* L., *B. tectorum* L., *Calamagrostis arundinacea* (L.) Roth, *Chrysopogon gryllus* (L.) Trin., *Cynosurus echinatus* L., *Cleistogenes serotina* (L.) Keng, *Dactylis glomerata* L., #*Festuca arundinacea* Schreb., *F. dalmatica* (Hack.) K. Richt., *F. gigantea* (L.) Vill., *F. heterophylla* Lam., *F. nigrescens* Lam., *F. rubra* L., *F. rupicola* Heuff., *F. valesiaca* Schleich. ex Gaud., *Koeleria macrantha* (Ledeb.) Schult. & Schult. f., *K. nitidula* Velen., #*Lerchenfeldia flexuosa* (L.) Schur., *Melica ciliata* L., *M. uniflora* Retz., *Micropyrum tenellum* (L.) Link, *Milium effusum* L., #*M. vernale* M. Bieb., *Phleum montanum* C. Koch, *P. phleoides* (L.) Karst., #*Poa alpina* L., *P. badensis* Haenke ex Willd., *P. bulbosa* L., *P. compressa* L., *P. nemoralis* L., #*Psilurus incurvus* (Gouan) Schinz & Thell., *Sesleria latifolia* (Adam.) Deg., *Stipa capillata* L., *S. pennata* L., #*S. pulcherima* subsp. *epilosa*, #*S. pulcherima* C. Koch subsp. *pulcherima*, #*Vulpia myuros* (L.) C.C. Gmel; ***Smilacaceae:*** *Smilax exelsa* L.

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