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FOREST REVIEW

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INTERNATIONAL SCIENTIFIC JOURNAL

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80 YEARS OF RADOSLAV RIZOVSKI'S BIRTH

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FLORISTIC AND VEGETATION DIVERSITY IN KONGURA RESERVE (SOUTH-WEST BULGARIA)

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ABSTRACT: Kongura reserve is situated in the Bulgarian part of Belasitsa mountain. It occupies an area of 1310.80 ha on slopes with northern, north-eastern and north-western exposition from 430 to 1740 m alt. The reserve was established in 1988 mainly to protect the well preserved *Castanea sativa* and *Fagus sylvatica* forests. A total of 300 vascular plant species were identified, more than a quarter of which belong to the families *Asteraceae*, *Rosaceae* and *Fabaceae*. Among the richest genera are *Galium*, *Campanula*, *Acer*, *Hieracium*, *Lathyrus*, *Trifolium* and *Viola*, which comprise more than 12% of the total flora of the study area. Five species are of conservation concern and are included in the *Red Data Book of the Republic of Bulgaria*. Three taxa of these are legally protected by the national Biodiversity Act. Endemism is relatively low (3.3%) since only 10 Balkan endemics have been recorded. Almost the entire territory of the reserve is covered by various forest types. The most widespread vegetation type belongs to *Querco-Fagetea* class, which is represented by alliance *Fagion sylvaticae*. The rest of the forest vegetation was classified to alliances *Quercion petraeo-cerridis* and *Carpinion orientalis* of *Quercetea pubescentis* class. Wet woodlands of *Salici purpureae-Populetea nigrae* class (alliance *Platanion orientalis*) have only limited distribution in the area. Areas covered by shrubs were classified to *Loiseleurio-Vaccinietea* and *Rhamno-Prunetea* classes. Although areas dominated by herbs or grasses cover only less than two percent of the reserve's territory their diversity was classified into four classes: *Festuco-Brometea*, *Juncetea trifidi*, *Mulgedio-Aconitetea* and *Galio-Urticetea*.
Keywords: Belasitsa Mt., endemics, flora, habitats, conservation.

1 INTRODUCTION

Kongura reserve was declared as a protected area in 1988, covering the area of the former "Skoshnik" reserve, established in 1954 to preserve the most characteristic for Belasitsa mountain primary sweet chestnut forests. Apart from them slopes of the mountain are covered by variety of mesic and xeric woodlands, creating a rich diversity of habitats and niches. The top of the main ridge of Belasitsa mountain consists of vast mountain pastures.

Despite the high number of researches from Belasitsa Mt. there was no complete study of the reserve's flora and vegetation until now. Studies on the vegetation and habitat diversity of Belasitsa Mt. are clearly unequal. On one hand, there are a considerable number of scientific publications that deal with syntaxonomy [73, 53, 58], ecology [79, 49, 33, 70, 55, 60, 52], resources [81, 72, 71, 47, 45, 46] and ecosystem health of sweet chestnut forests [48, 64, 59], whereas on the other hand, shrub and grassland vegetation and resources were highly neglected [54, 27].

Floristic data were provided by [54, 61, 5, 41], as well as in the above mentioned vegetation studies. However, these publications do not deal with the area of Kongura reserve.

The aim of this study is to reveal the floristic and syntaxonomic diversity of Kongura reserve and to assess their current condition.

2 MATERIAL AND METHODS

2.1 Study area

The study was conducted in Kongura reserve, situated in the northeast part of Belasitsa Mountain. It covers 1310.8 ha in the valley of Petrichka river at altitude from 430 m to 1740 m a.s.l. (Fig. 1). The average annual air temperature is 9-11°C with average gradient of decline 0.26°C/100m. The highest average monthly temperature is in July (18-23°C) and the lowest in January (0-2°C) [6]. The monthly maximum precipitation rates are in November – December, and the minimum in July – August [21]. Annual precipitation rates are between 600 and 1100 mm, depending on the altitude. The snow cover is shallow and short lasting (about 20–80 days/year) between November and April. The bedrock type is silicate [30]. Soils are Litosols up to 1000 m a.s.l. and Regosols above [67].

The potential natural vegetation is mostly comprised of south and east Balkan, as well as Crimean-west Caucasian colline Oriental hornbeam-downy oak forests (Mapping unit G57) and Species-rich, eutrophic and eu-mesotrophic beech and mixed beech forests with two subtypes 1. Colline-submontane, partly with hornbeam, sessile oak (Mapping unit F124) and 2. Montane-altimontane mostly with fir, partly with spruce and other mixed tree species (Mapping unit F154) [69].

The territory of the reserve is part of the Belasitsa Natural Park as well as Site of Community Importance (NATURA 2000 site BG0000167 Belasitsa). Recently, Belasitsa Mt. was declared as Important Plant Area [26].

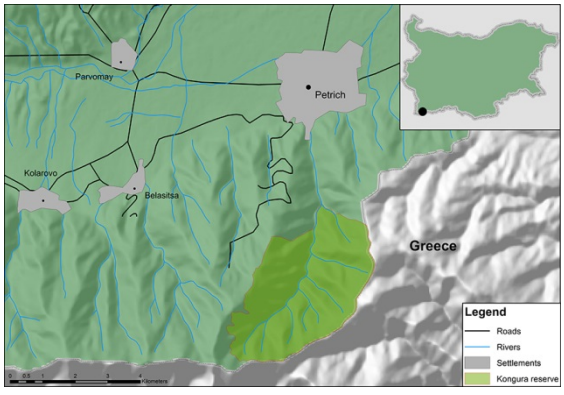

Figure 1: Map of the study area

2.2 Sampling of the flora

Field studies were conducted in summer and autumn of 2014 using transect sampling method. For compilation of the list of vascular plant species in the reserve phytosociological relevés from the syntaxonomic studies

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as well as some critical editions on the Bulgarian flora were used [18, 76, 77, 62, 19, 78]. The taxonomic scheme adopted follows mostly [13]. Biological types and life-forms are based on field observations and checked with relevant literature sources, e.g. [18, 77, 76, 62, 19, 50, 22]. Conservation significance of the species was determined according to [10] and [2]. Floristic elements follow [7].

2.3 Vegetation sampling

The field sampling was carried out during the period July – August 2014 following the Braun-Blanquet approach [35, 83]. We covered the whole range of different vegetation types as well as all grassland fragments on the territory of the reserve. We used 16 m^2, 64 m^2 and 100 m^2 plots (n = 28) square-shaped and placed in stands that were visually homogeneous in terms of topography, vegetation structure and floristic composition. All relevés were stored in TURBOVEG database [63] and in the Balkan Vegetation Database [38].

2.4 Data analysis of relevés

Numerical classification was performed by PC-ORD [9] incorporated in JUICE 7.0 software package [40]. Relative Sörensen was used as distance measure and species similarity was calculated using flexible betta (-0.25).

2.5 Habitat classification and mapping

Habitat types were determined according to the Interpretation Manual of European Union Habitats [34, 74]. Assignment of each vegetation unit at association level to a certain Habitat Directive Code (HDC) was given in the text. Mapping was done using ArcGIS 10.0 software [23]. Spatial data was collected in the field using GPS devise Juno BS by Trimble and was later overlaid over the most recent orthophoto images available. Outlining the polygons was done manually by using features collected in the field as well as the orthophoto images. Mapping was done in scale 1:5000.

3 RESULTS

3.1 Flora

The flora of Kongura reserve comprises 64 families, 184 genera and 300 species. The taxonomic structure of the flora is presented in table I. *Polypodiophyta* comprises 7.81% of the families, 3.80% of the genera and 2.67% of the species from the total flora, *Pinophyta* – 3.13% of families, 1.09% of genera, 0.67 of species, and *Magnoliophyta* – 89,06%, 95.11% and 96.67% respectively. The list of taxa is provided in Annex I.

Table I: Taxonomic structure of the flora

Taxon	no. of species	no. of genera	no. of families
Polypodiophyta	8	7	5
Pinophyta	2	2	2
Magnoliophyta	290	175	57
Magnoliopsida	*255*	*151*	*50*
Liliopsida	*35*	*24*	*7*
Total numbers	300	184	64

The richest in species 12 families are: *Asteraceae* – 29 species (9.67% of the total flora), *Rosaceae* – 25 (8.33%), *Fabaceae* – 25 (8.33%), *Lamiaceae* – 23 (7.67%), *Poaceae* – 18 (6.00%), *Caryophyllaceae* – 15 (5.00%), *Scrophulariaceae* – 13 (4.33%), *Rubiaceae* – 9 (3.00%), *Ranunculaceae* – 8 (2.72%), and *Apiaceae*, *Boraginaceae*, *Liliaceae* – each with 6 (2.33%). Altogether these families comprise 57.33% of the species and 52.72% of the genera in the total flora. The largest genera are *Galium* – 7 species, *Campanula* – 6, *Acer*, *Hieracium*, *Lathyrus*, *Trifolium*, *Viola* – each with 5 species, *Genista*, *Ranunculus*, *Rosa*, *Rubus*, *Veronica* – each with 4 species.

The biological spectrum of the flora of Kongura reserve is presented in table II.

Table II: Biological spectrum of the flora

Biological type	no. of species	Share (%)
Perennials	198	66.00
Shrubs, incl. semishrubs and lianes	31	10.33
Trees	23	7.67
Biennials and Annuals to Biennials	19	6.33
Annuals	12	4.00
Annuals to perennials and biennials to perennial	11	3.67
Shrub/Tree	6	2.00
total	**300**	100

The life-form spectrum of the flora of Kongura reserve is presented in table III.

Table III: Life-form spectrum of the flora

Life form	no. of species	Share (%)
Hemicryptophytes	172	57.33
Phanerophytes	43	14.33
Geophytes	33	11.00
Chamaephytes	19	6.33
Therophytes	13	4.33
Therophytes/ Hemicryptophytes	9	3.00
Chamaephytes/ Phanerophytes	7	2.33
Geophytes/ Hemicryptophytes	3	1.00
Chamaephytes/ Hemicryptophytes	1	0.33
total	300	100

The phytogeographic composition of the flora of Kongura reserve is presented in Table IV.

Table IV: Floristic elements in the flora of Kongura reserve

Floristic element	no. of species	Share (%)
subMed	38	12.67
Eur-As	37	12.33
Eur-Sib	34	11.33
Eur-Med	31	10.33
Eur	30	10.00
Boreal	27	9.00
subBoreal	22	7.33
Bal	10	3.33
Kos	9	3.00
Med	9	3.00

Eur-subMed	8	2.67
Bal-Anat	5	1.67
Carp-Bal	5	1.67
Eur-OT	4	1.33
Pont-Med	4	1.33
Alp-Carp	3	1.00
Spont	3	1.00
Ap-Bal	2	0.67
Other – each with 1 species (Adv (SAm), Alp-Carp-Bal, Arct-Alp, Bal-Carp, Bal-Dac, Bul-Dac, Eur-Med-CAs, Eur-Pont, Eur-WAs, Med-CAs, Med-OT, Med-subMed, Pann-Bal, Pont-OT, Pont-Sib, Pont-subMed, SSib, subMed-As, subMed-CAs)	19	6.34
total	**300**	**100**

The endemic taxa in the flora are 10 – *Acer heldreichii*, *Armeria rumelica*, *Chamaecytisus absinthioides*, *Digitalis viridiflora*, *Festuca hirtovaginata*, *F. valida*, *Peucedanum olygophyllum*, *Scabiosa triniifolia*, *Scrophularia aestivalis* and *Viola speciosa*, all Balkan endemics [3].

The species of conservation concern are five. With a national IUCN category are *Viola speciosa* (CR), *Castanea sativa* (EN), *Ilex aquifolium* (EN), *Medicago carstiensis* (EN), *Acer heldreichii* (VU), all included in the *Red Data Book of the Republic of Bulgaria* [15, 14, 12,11, 17, 16, 64, 65]. Legally protected by the national Biodiversity Act are three species – *Acer heldreichii*, *Ilex aquifolium* and *Viola speciosa*.

3.2 Vegetation

Classification of relevés showed a great diversity of communities on the territory of Kongura reserve. The list of established syntaxa consists of 10 classes, 10 orders, 12 alliances, 8 associations and 5 communities at association level. Beech forests are the most widespread vegetation type and cover more than 85% of the reserve's territory. Despite their prevalence they are relatively uniform and were classified into two associations of *Querco-Fagetea* class (clusters 1-12 Fig. 2).

3.2.1 Ass. *Asperulo odoratae-Fagetum sylvaticae* (HDC: 9130; 1101.0 ha)

This is the most widespread association on the territory of the reserve. Its communities occur at 700-1600 m a.s.l. on moderately steep slopes (20^o-30^o) with varying aspects. Soils are shallow to moderately deep regosols. The dominant species is *Fagus sylvatica* but at lower altitude other species like *Castanea sativa*, *Quercus dalechampii* and *Carpinus betulus* are found as subdominant with covers between 10% and 30%. The shrub layer is usually missing but undergrowth has cover between 0% and 40%, mainly by *Calamagrostis arundinacea*, *Luzula sylvatica*, *Melica uniflora*, *Euphorbia amygdaloides*, *Festuca heterophylla*, *Geranium robertianum*, *Lapsana communis*.

3.2.2 Ass. *Aremonio agrimonoidis-Fagetum sylvaticae* (HDC: 91W0; 28.4 ha)

This vegetation type was found at 900-1000 m a.s.l. on south facing slopes with inclination of 30^o-35^o. *Fagus sylvatica* subsp. *moesiaca* is dominant species and subdominants are *Castanea sativa* and *Quercus dalechampii*. Shrub layer is presented by young trees of above mentioned species as well as *Carpinus betulus*, *Tilia tomentosa*, *Fraxinus ornus*, *Acer platanoides* and *Crataegus monogyna*. Undergrowth is well developed mainly by *Dactylis glomerata*, *Melica uniflora*, *Poa nemoralis*, and *Festuca heterophylla*.

Quercetea pubescentis class covers only 11% of the study area but its communities were classified into three different alliances (clusters 13-17 and 24 Fig. 2).

3.2.3 Ass. *Tilio tomentosae-Castanetum sativae* (HDC: 9260; 113.7 ha)

Sweet chestnut forests are distributed from 550-800 m a.s.l. on north facing slopes with inclination of 25^o-35^o. Soils are moderately deep litosols. *Castanea sativa* is dominating in the tree layer (50%-70%) together with *Fagus sylvatica* subsp. *moesiaca* (20%-40%). Participation of *Quercus dalechampii* and *Carpinus orientalis* is low (up to 10%). Accept for the species from the tree layer the shrub layer is also formed by *Chamaecytisus austriacus*, *Corylus avellana*, *Rubus caesius*, *Rosa* sp. *Brachypodium sylvaticum*, *Melica uniflora*, *Galium pseudoaristatum* and *Festuca heterophylla* are forming the undergrowth.

3.2.4 *Quercus dalechampii* communities (HDC: 9170; 20.5 ha)

Communities of *Quercus dalechampii* have a limited distribution on the territory of the reserve. They cover areas between 750 and 800 m a.s.l. on north facing slopes with inclination between 25^o-35^o. Soils are moderately deep litosols. Balkan durmast oak is covering between 50%-60% whereas its subdominants (*Castanea sativa* and *Fagus sylvatica*) between 10%-20%. Single trees of *Carpinus orientalis* and *Ostrya carpinifolia* are also typical for the communities. The shrub layer is formed by *Corylus avellana*, *Chamaecytisus austriacus* and *Crataegus monogyna*. Undergrowth is formed mainly by *Poa nemoralis*, *Dactylis glomerata*, *Brachypodium sylvaticum*, *Galium pseudoaristatum*.

3.2.5 *Ostrya carpinifolia* community (HDC: – ; 4.8 ha)

Hop hornbeam communities are locally distributed in the area at 500 m a.s.l. on northern slopes with prevailing inclination of 10^o-35^o. Soils are shallow, moderately dry litosols. The dominant species in the tree layer is *Ostrya carpinifolia*, but *Quercus dalechampii* is also forming substantial cover. Single trees of *Fagus sylvatica*, *Castanea sativa* and *Carpinus orientalis* are also common. Shrub layer is mainly formed by the same species like in the tree layer together with *Chamaecytisus austriacus*, *Corylus avellana*, *Crataegus monogyna* and *Rosa* sp. The composition of the undergrowth is uniform, with higher abundance of *Dactylis glomerata*, *Galium pseudoaristatum*, *Festuca heterophylla* and *Poa nemoralis*.

Platanus orientalis woods (cluster 25 Fig. 2) are only distributed along the Petrichka River at the lower part of the territory and were classified to *Salici-Populetea* class.

3.2.6 Ass. *Petasito hybridi-Platanetum orientalis* (HDC: 92C0; 3.4 ha)

The association is locally distributed at 600-650 m a.s.l. on slightly inclined north facing slopes. Soils are rich, moderately deep, alluvial. *Platanus orientalis* is forming mono-dominant communities with low cover

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(less than 10%) of other tree species like *Fagus sylvatica* and *Ostrya carpinifolia*. Shrub layer is formed by young individuals of the above mentioned trees as well as *Rubus caesius*, *Acer platanoides* and *Sambucus nigra*. Species with high cover in the undergrowth are *Dryopteris* spp., *Aegopodium podagraria*, *Geranium robertianum*, *Physospermum cornubiense* and *Lunaria rediviva*.

Shrublands and grasslands are covering very small areas (2% and 0.2% of the total area respectively) due to the intentional selection of the boundaries of the reserve to protect the well preserved *Castanea sativa* and *Fagus sylvatica* forests. Shrubby vegetation (clusters 18-20 Fig. 2) is classified to *Loiseleurio-Vaccinietea* and *Rhamno-Prunetea* classes.

3.2.7 Ass. *Festuco-Juniperetum sibiricae* (HDC: 4060; 24.4 ha)

The association is present at the beech forests belt, just above the timberline at 950-1150 m a.s.l. Soils are shallow to moderately deep, regosols. *Juniperus sibirica* is forming the highest cover but species like *Chamaecytisus absinthioides*, *Vaccinium myrtilus*, and *Rubus caesius* are also well presented (10%-35%). The herb layer is dominated by *Calamagrostis arundinacea*, *Festuca valida*, *Thymus jankae* and *Luzula luzuloides*.

3.2.8 *Rosa*, *Crataegus*, *Prunus* community (HDC: – ; 1.0 ha)

This community is very locally distributed at the beech forests belt in forest openings at the place of abandoned secondary grasslands at 1300-1700 m a.s.l. Soils are shallow to moderately deep, regosols. Dominant species are *Rosa* sp., *Crataegus monogyna* and *Prunus spinosa*. Other species with higher values are *Chamaecytisus absinthioides*, *Rubus caesius*, *Festuca hirtovaginata*, *Thymus jankae*, *Brachypodium pinnatum*, *B. sylvaticum*, *Dactylis glomerata*. At certain places stands are showing a transition to ass. *Festuco-Juniperetum sibiricae*.

Herb communities (clusters 21-23 and 26-27 Fig. 2) showed greater diversity than other vegetation types and were assigned to five phytosociological classes: *Trifolio-Geranietea*, *Festuco-Brometea*, *Juncetea trifidi*, *Mulgedio-Aconitetea* and *Galio-Urticetea*.

3.2.9 Ass. *Festucetum validae* (HDC: 62D0; 0.9 ha)

Communities of this association are locally distributed in the sub-alpine and beech forests zones on western slopes with inclination 5°-15°. Soils are shallow to moderately deep, regosols. Species with high cover values are: *Festuca valida*, *Thymus jankae*, *Calamagrostis arundinacea*, *Juniperus sibirica*, *Vaccinium myrtilus*, *Luzula luzoloides*.

3.2.10 *Calamagrostis arundinacea* community (HDC: – ; 0.4 ha)

These communities are locally distributed in the sub-alpine zone of the reserve above the timber line on north and northwestern slopes with inclination of 10°-25°. *Calamagrostis arundinacea* is a dominant species and subdominants are *Rubus caesius*, *Epilobium angistifolium* and *Festuca valida*. Individuals of shrubs like *Fagus sylvatica*, *Juniperus sibirica* and *Vaccinium myrtilus* are also present in the community.

3.2.11 *Festuca hirtovaginata* community (HDC: 6210; 0.06 ha)

These communities are locally distributed in the beech forests zone on southern slopes with inclination 3°-8°. Soils are shallow, dry litosols. Communities have semi-open horizontal structure with no single species dominating. The group of species with high cover values contain *Festuca hirtovaginata*, *Carex caryophyllea*, *Phleum phleoides*, *Agrostis castellana*, *Thymus jankae*.

3.2.12 Ass. *Pteridietum aquiline* (HDC: – ; 0.8 ha)

The association is present at the beech forests belt on flat or slightly inclined terrains. Soils are regosols. Horizontal structure is closed with high cover of *Pteridium aquilinum* (90%-100%).

3.2.13 Ass. *Urtico-Sambucetum ebuli* (HDC: – ; 0.3 ha)

The association was found in a single locality in the beech zone at 1300 m a.s.l. on flat or slightly inclined terrains. Soils are moderately deep regosols. Communities have a specific species composition, rich in ruderal species. *Sambucus ebulus* is dominating with cover of 80%-90%.

Proposed syntaxonomical scheme:

Cl. *Salici purpureae-Populetea nigrae* Rivas-Martinez et Cantó ex Rivas-Martinez et al. 2001
- **Ord.** *Populetalia albae* Br.-Bl. ex Tchou 1948
  - **All.** *Platanion orientalis* Kárpáti et Kárpáti 1961
    - **Ass.** *Petasito hybridi-Platanetum orientalis* Kárpáti et Kárpáti 1961

Cl. *Querco-Fagetea* Braun-Blanq. et Vlieger in Vlieger 1937
- **Ord.** *Fagetalia sylvaticae* Pawł. et al. 1928
  - **All.** *Fagion sylvaticae* Luquet 1926
    - **Ass.** *Asperulo odoratae-Fagetum sylvaticae* Sougnez et Thill 1959
    - **Ass.** *Aremonio agrimonoidis-Fagetum sylvaticae* Boşcaiu in Resmeriță 1972

Cl. *Quercetea pubescentis* (Oberd. 1948) Doing Kraft 1955
- **Ord.** *Quercetalia pubescenti-petreae* Klika 1933
  - **All.** *Carpinion orientalis* Horvat 1958
    - *Ostrya carpinifolia* community
  - **All.** *Quercion confertae Horvat 1954*
    - **Ass.** *Tilio tomentosae-Castanetum sativae* Dafis 1973
  - **All.** *Quercion petraeo-cerridis* (Lakušić et Jovanović 1980) Čarni et al. 2009
    - *Quercus dalechampii* community

Cl. *Loiseleurio-Vaccinietea* Eggl. 1952 ex Schub. 1960
- **Ord.** *Rhododendro-Vaccinietalia* Braun-Blanq. in Braun-Blanq. et Jenny 1926
  - **All.** *Juniperion nanae* Br.-Bl. et al. 1939
    - **Ass.** *Festuco-Juniperetum sibiricae* Roussakova in Tzonev et al. 2009
      - **facies** of *Chamaecytisus absinthioides*

Cl. *Rhamno-Prunetea* Rivas Goday et Borja Carbonell, 1961
- **Ord.** *Prunetalia spinosae* Tüxen 1952
  - **All.** *Berberidion vulgaris* Br.-Bl. 1950
    - *Rosa*, *Crataegus*, *Prunus* community

Cl. *Trifolio-Geranietea sanguinei* T. Müller 1962
- **Ord.** *Melampyro pratensis-Holcetalia mollis* Passarge 1979
  - **All.** *Holco mollis-Pteridion aquilini* Passarge (1994) 2002
    - **Ass.** *Pteridietum aquilini* Jouanne & Chouard 1929

Cl. *Festuco-Brometea* Braun-Blanq. et Tüxen ex Soó 1947
Ord. *Astragalo-Potenilletalia* Micevski 1971
All. *Armerio-Potentillion* Mic. 1978
Festuca hirtovaginata community
Cl. *Juncetea trifidi* Hadač in Klika et Hadač 1944
Ord. *Seslerietalia comosae* Simon 1958
All. *Poion violaceae* Horvat 1937
Ass. *Festucetum validae* Horvat et al. 1937

Cl. *Mulgedio-Aconitetea* Hadač et Klika in Klika et Hadač 1944
Ord. *Calamagrostietalia vilosae* Pawlowski et al. 1928
All. *Calamagrostion arundinaceae* Oberd. 1950
Calamagrostis arundinacea community
Cl. *Galio-Urticetea* Passarge ex Kopecky 1969
Ord. *Lamio albi-Chenopodietalia boni-henrici* Kopeckỳ 1969
All. *Geo-Alliarion* Lohm et Oberd. in Görs et Müler 1969
Ass. *Urtico-Sambucetum ebuli* Braun-Blanq. et al. 1952

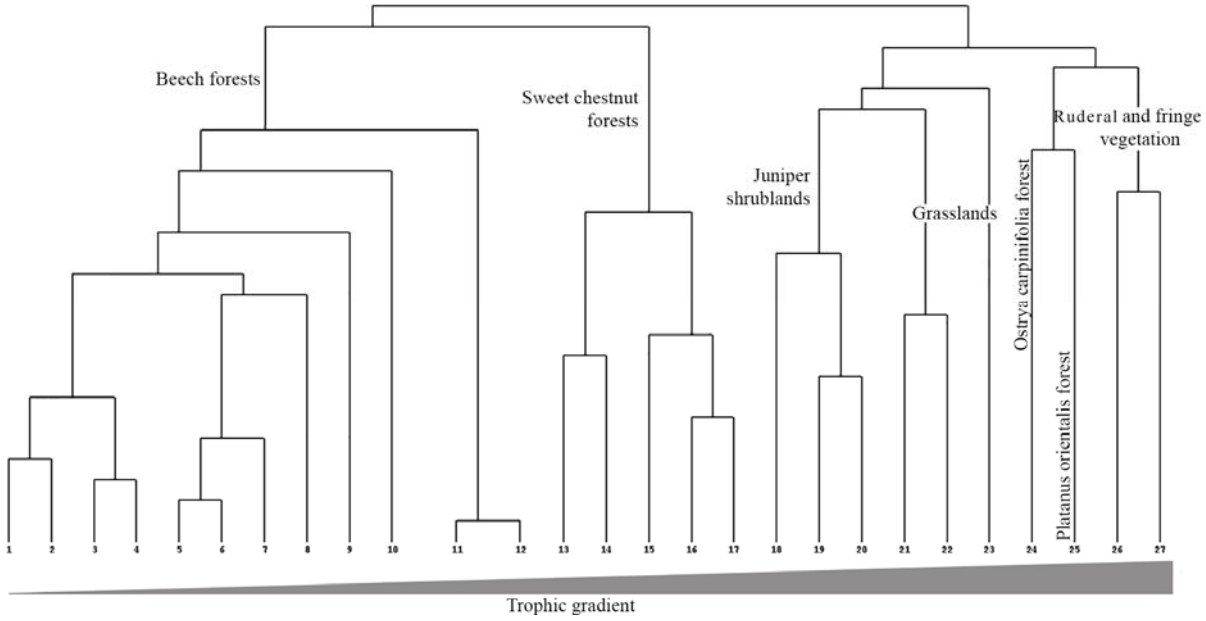

Figure 2: Dendrogram of phytosociological relevés (Relative Sorensen clustering method; flexible betta (-0.25) used for similatiry). Legend: *Asperulo odoratae-Fagetum sylvaticae* (clusters 1-10), *Aremonio agrimonoidis-Fagetum sylvaticae* (clusters 11 and 12), *Tilio tomentosae-Castanetum sativae* (clusters 13-15), *Quercus dalechampii* community (clusters 16 and 17), *Festuco-Juniperetum sibiricae* (clusters 18-20), *Festucetum validae* (cluster 21), *Calamagrostis arundinacea* community (cluster 22), *Festuca hirtovaginata* community (cluster 23), *Ostrya carpinifolia* community (cluster 24), *Petasito hybridi-Platanetum orientalis* (cluster 25), *Urtico-Sambucetum ebuli* (cluster 26), *Pteridietum aquilini* (cluster 27).

4 DISCUSSION

4.1 Flora

Kongura reserve comprises 7.3% of the species in the Bulgarian flora. Vascular plant diversity is relatively low compared to some other areas with similar size, e.g. Vitanovo Reserve in Strandzha Mts [36] has smaller size but the number of vascular plant species is higher by ca. 54%. This can be explained by the fact that almost the entire territory of Kongura reserve is covered by beech and sweet chestnut forests, by the siliceous bedrock and by the lack of diversity of substrate and expositions. The share of *Polypodiophyta* in the flora of Kongura reserve – 2.67% of all species – is slightly higher than in some other studied sites, e.g. Vrashka Chuka protected site (0.8%, [82]), Mt Golo Bardo (0.6%, [51]) as well as for the whole country (1.1%, cf. [4]). This fact was noted first by [54] and can be explained with the presence of suitable habitats and environmental conditions, e.g. prevalence of forested habitats, northern expositions, relatively high soil and air humidity.

Regarding the presentation of the different families, the relatively high share of *Rosaceae* and relatively low share of *Asteraceae* and *Poaceae* in the flora of Kongura reserve are notable if compared with the data for the total Bulgarian flora ([4]). Again, this can be explained with the availability of suitable habitats for *Rosaceae* (especially for shrubs and trees), and lack of such for *Asteracea*e and *Poaceae* (e.g. large open areas). For similar reasons the higher representation of the genera *Campanula, Galium* and *Viola* is obvious if compared with data for the whole country [4].

The analysis of the biological types and life forms in the flora of Kongura reserve shows an overall pattern characteristic for the temperate mountainous floras in the Balkans – strong prevalence of herbaceous perennial species, respectively hemicryptophytes [20]. However, it is noteworthy the relatively high representation of shrubs and trees, respectively phanerophytes, and the low presentation of annuals and therophytes which relates to the habitat availability. For example, the phanerophytes in the flora of Mt Golo Bardo are 10% (ca. two times lower than in Kongura) and therophytes are 18% (four times higher than in Kongura) [51].

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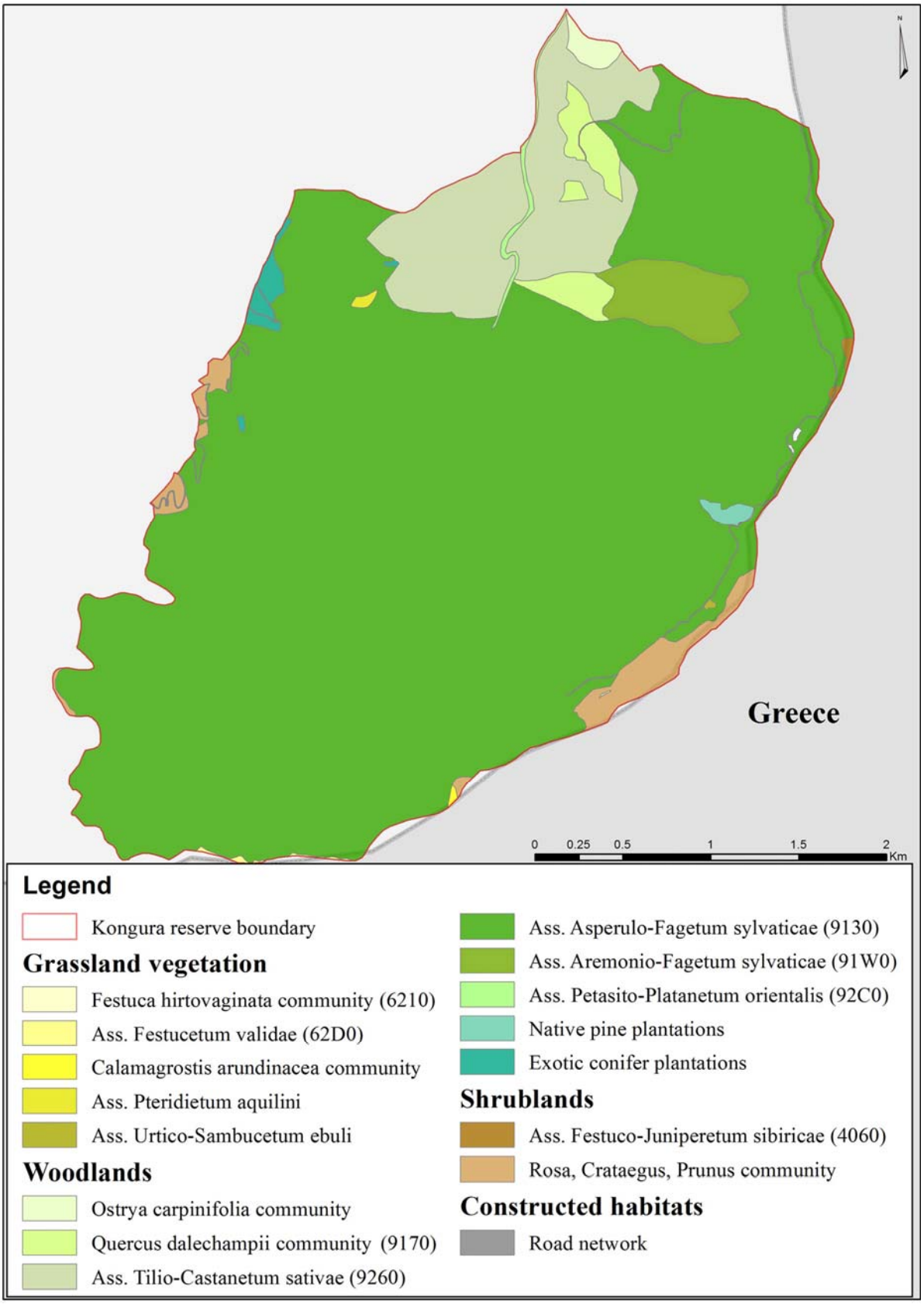

Figure 3: Map of vegetation units on Kongura reserve. Codes in brackets represent the codes of habitats in the Habitat directive: 6210 – Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*), 62D0 – Oro-Moesian acidophilous grasslands, 9170 – *Galio-Carpinetum* oak-hornbeam forests, 9260 – *Castanea sativa* woods, 9130 – *Asperulo-Fagetum* beech forests, 91W0 – Moesian beech forests, 92C0 – *Platanus orientalis* and *Liquidambar orientalis* woods (*Platanion orientalis*), 4060 – Alpine and Boreal heaths.

The phytogeographical analysis shows that in the flora of Konura reserve prevail the following floristic elements – subMediterranean, Euro-Asiatic, Euro-Siberian, Euro-Mediterranean, European, Boreal and subBoreal, which altogether comprise nearly 73% of the total flora. This pattern is similar to the pattern in other studied areas, e.g. Mt Golo Bardo [51]. However, the representation of the Mediterranean and subMediterranean chorotypes is obviously lower (21.4% in Golo Bardo) and corresponds better to the share in the mountain regions – 11.9% [20]. This intermediate position of Kongura reserve can be explained with the higher elevation and position further to the south.

The endemism in the flora of Kongura reserve is low – only about 3.33% if compared with the data for the whole country – ca. 11% of the total Bulgarian flora [3]. This corresponds well with the low number of endemic species for the whole mountain and floristic region of Belasitsa as well as with the ecological structure of endemism in Bulgaria. As [80] state, with a few exceptions the Bulgarian endemics grow in open places, and are heliophytes and xerophytes, but this is true also for the Balkan endemics.

Although the number of the species of conservation concern is rather low, the reserve is of crucial importance for the preservation of these species. It harbours some of the best subpopulations at national level, e.g. of *Castanea sativa*, *Medicago carstiensis*, and *Viola speciosa*.

4.2 Vegetation

4.2.1 Syntaxonony

This investigation is one of the few comprehensive studies about vegetation diversity in SW part of Bulgaria [25, 68]. In addition this is one of the few studies about fringe [29, 75, 42, 37], ruderal [31, 32, 39, 56, 42, 43, 37, 24] and shrubland vegetation belonging to *Rhamno-Prunetea* class [41] in the country. Due to the small size of the study area as well as the limited distribution of some vegetation types we were unable to classify them to already described associations, so they were classified as communities. Beech and sweet chestnut forests are among the best studied communities of all vegetation types present on the mountain [57, 58]. Further studies should be conducted for analyzing communities of *Festuca hirtovaginata*, *Calamagrostis arundinaceae* and shrublands dominated by *Rosa sp.*, *Crataegus monogyna* and *Prunus spinosa*.

Despite the wide distribution of *Quercus dalechampii* forests in Bulgaria their syntaxonomical position according to Braun-Blanquet approach is still uncertain. According to the variety of described formations and associations following the dominant approach, its communities will be probably classified to more than one class. Problem for classification of Balkan durmast oak forests is also the fact that *Quercus dalechampii* is often recorded as *Quercus petraea* agg., including *Quercus petraeae*, *Q. dalechampii* and *Q. polycarpa*, [8] or even misidentified as any of the species of the group. Mesophitic woodlands of *Quercus dalechampii* with *Fagus sylvatica*, *Carpinus betulus*, *Poa nemoralis* and *Luzula luzuloides* might be separated as "mesophytic type" and should be classified to *Querco-Fagetea* class. This vegetation type is known from other parts of the country such as Balkan Range (unpublished data), Rila Mt, Pirin Mt, Sredna Gora Mts (unpublished data) and Western Frontier Mts [25]. On the other hand xerophytic communities of *Quercus dalechampii* are found together with *Pinus nigra*, *Fraxinus ornus*, *Carpinus orientalis*, *Brachypodium pinnatum* and *Dactilis glomerata*. They should be assigned to *Carpinion orientalis* alliance of *Quercietea pubescenti* class. This "xerophytic type" is known up to now from Balkan Range (Chamdzha reserve, Vassilev & Gavrilova in preparation), Western Frontier Mts (Gabra reserve, [28]) *Quercus dalechampii* communities from Kongura reserve show an intermediate position determined by their mountainous distribution on one hand and the Mediterranean influence on the other. These ecological characteristics as well as the species composition convinced us to consider *Quercion petraeo-cerridis* alliance (*Quercietea pubescenti* class) as suitable for our communities. [1]) report communities of the same alliance only 50 km west from the Kongura reserve, on the territory of Macedonia. Future analysis with supranational dataset from the areal of *Quercus dalechampii* in S and SE Europe will give the real syntaxonomical position of its communities.

4.2.2 Ecology

Agglomerative classification of the data resulted in sorting of relevés along the gradient of soil trophic status (Fig. 2), which appeared to be the most important environmental factor responsible for their separation. The oligotrophic beech forests of *Asperulo-Fagetum* were positioned at the left edge of the dendrogram whereas eutrophic ruderal communities of *Urtico-Sambucetum ebuli* appeared on the right-most part.

Vegetation belts in Kongura reserve as well as on the whole Belasitsa Mt. are well preserved like in most high Bulgarian mountains (Stara Planina, Rila, Pirin, the Rhodopes). Xero-mesophytic forests of *Quercetea pubescenti* class (*Castanea sativa*, *Quercus dalechampii* and *Ostrya carpinifolia* stands) are distributed at the bottom of the altitudinal gradient up to 800 m a.s.l. Higher parts of the slopes are covered by mesophytic beech forests belonging to *Querco-Fagetea* class, which form the timberline in the reserve at about 1500-1700 m a.s.l. Grasslands of *Juncetea trifidi* class are distributed above the beech woodlands up to the top of the mountain. They are very weakly presented in the reserve because beech and sweet chestnut forests were the target communities subject to protection. They usually grow in a complex with shrublands of *Loiseleurio-Vaccinietea* class outside the reserve's territory. The other herb communities do not form a separate belt but grow on forest openings in the forest zone. *Platanus orientalis* communities are also zonally distributed, intersecting the beech and sweet chestnut belts along the small streams.

Within the reserve's territory we encountered the tendency of shrub encroachment in grasslands. At higher altitude *Festuca valida* grasslands were overgrown by *Juniperus sibirica* whereas at lower places *Festuca hirtovaginata* communities were almost completely replaced by *Rosa* sp., *Crataegus monogyna* and *Prunus spinosa*.

4.2.3 Importance for conservation

Looking from conservational point of view, among all 13 communities at association level, there are 8 habitat types (Fig. 3) protected by Appendix 1 of the Bulgarian Biological Diversity Act (2007) and Directive 92/43/EEC. Most habitat types (6210, 62D0, 9170, 9130, 91W0 and 4060) are widespread on the territory of the country, whereas 92C0 *Platanus orientalis* and *Liquidambar orientalis* woods (*Platanion orientalis*) is

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distributed only in Macedono-Rhodope mountains and neighboring lowlands but its largest areas are on the territory of Belasitsa Mt. Similar example is habitat type 9260 – *Castanea sativa* woods, 80% of the national cover of which is also on northern slopes of Belasitsa Mt.

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Annex I: List of taxa

POLYPODIOPHYTA

***Aspidaceae*:** *Dryopteris filix-mas* (L.) Schott, *Gymnocarpium dryopteris* (L.) Newman; ***Aspleniaceae*:** *Asplenium adiantum-nigrum* L., *A.trichomanes* L.; ***Athyriaceae*:** *Athyrium filix-femina* (L.) Roth, *Cystopteris fragilis* (L.)Bernh.; ***Hypolepidaceae*:** *Pteridium aquilinum* (L.) Kuhn.; ***Polypodiaceae*:** *Polypodium vulgare* L.

PINOPHYTA

***Cupressaceae*:** *Juniperus sibirica* Burgsd.; ***Pinaceae*:** *Pinus sylvestris* L.

MAGNOLIOPHYTA

Magnoliopsida

***Aceraceae*:** *Acer campestre* L., *A. heldreichii* Orph.; *A. hyrcanum* Fisch. & C.A. Mey; *A. platanoides* L.; *A. pseudoplatanus* L.; ***Apiaceae*:** *Aegopodium podagraria* L., *Ferulago sylvatica* (Besser) Rchb., *Huetia cynapioides* (Guss.) P. W. Ball, *Peucedanum oligophyllum* (Griseb.) Vandas, *Physospermum cornubiense* (L.) DC., *Sanicula europaea* L., *Seseli libanotis* (L.) Koch; ***Aquifoliaceae*:** *Ilex aquifolium* L.; ***Araliaceae*:** *Hedera helix* L.; ***Aristolochiaceae*:** *Asarum europaeum* L.; ***Asteraceae*:** *Achillea grandifolia* Friv., *A. millefolium* L., *Anthemis tinctoria* L., *Arctium lappa* L., *Artemisia vulgaris* L., *Centaurea biebersteinii* DC., *C. stenolepis* A. Kern., *C. stoebe* L., *Cichorium inthybus* L., *Cirsium candelabrum* Griseb., *C. ligulare* Boiss., *C. vulgare* (Savi) Ten., *Doronicum columnae* Ten., *Erigeron acris* L., *Galinsoga parviflora* Cav., *Hieracium hoppeanum* Schult., *H. murrorum* L., *H. pilosella* L., *H. racemosum*Waldst. &Kit., *H. sparsum* Friv., *Inula conyza* DC., *Lapsana communis* L., *Leucanthemum vulgare* Lam., *Mycelis muralis* (L.) Dum., *Omalotheca sylvatica* (L.) Sch. Bip. & F.W. Schultz, *Senecio papposus* (Reichenb.) Less., *Tanacetum corymbosum* (L.) Schultz-Bip., *T. macrophyllum* (Waldst. & Kit.) Sch. Bip., *T. vulgare* L.; ***Balsaminaceae*:** *Impatiens noli-tangere* L.; ***Betulaceae*:** *Betula pendula* Roth, *Carpinus betulus* L., *C.orientalis* Mill.,*Corylus avellana* L., *Ostrya carpinifolia* Scop.; ***Boraginaceae*:** *Buglossoides purpurocaerulea* (L.) I.M. Johnst., *Echium vulgare* L., *Myosotis nemorosa* Besser, *Pulmonaria mollis* Hornem., *P. officinalis* L., *P.rubra* Schott, *Symphytum ottomanum* L.; ***Brassicaceae*:** *Alliaria petiolata* (M.Bieb.) Cavara & Grande, *Arabis glabra* (L.) Bernh., *A.sagittata* (Bertol.) DC., *A.turrita* L., *Cardamine bulbifera* (L.) Crantz, *Lunaria rediviva* L.; ***Campanulaceae*:** *Campanula glomerata* L., *C. patula* L., *C. persicifolia* L., *C. rapunculoides* L., *C. sparsa* Friv., *C. trachelium* L.; ***Caprifoliaceae*:** *Sambucus ebulus* L., *S. nigra* L.; ***Caryophyllaceae*:** *Cerastium alpinum* L., *C. dubium* (Bastard) Guépin, *Dianthus armeria* L., *D. petraeus* Waldst. & Kit., *Lychnis coronaria* (L.) Desr., *L. flos-cuculi* L., *Moehringia trinervia* (L.) Clairv., *Saponaria officinalis* L., *Silene italica* (L.) Pers., *S. latifolia* Poir., *S. vulgaris* (Moench) Garcke, *Stellaria graminea* L., *S. holostea* L., *S. media* (L.) Vill.,*Viscaria vulgaris*Röhl.; ***Celastraceae*:** *Euonymus europaeus* L., *E. latifolius* (L.) Mill.; ***Cornaceae*:** *Cornus mas* L., *C. sanguinea* L.; ***Crassulaceae*:** *Sedum cepaea* L., *Umbilicus erectus* DC.; ***Cuscutaceae*:** *Cuscuta epithymum* (L.) L.; ***Dioscoreaceae*:** *Tamus communis* L.; ***Dipsacaceae*:** *Knautia drymeia* Heuff., *Scabiosa columbaria* L., *S. ochroleuca* L., *S. triniifolia* Friv.; ***Ericaceae*:** *Bruckenthalia spiculifolia* (Salisb.) Rchb.,*Vaccinium myrtillus* L., *V.uliginosum* L., *V.vitis-idaea* L.; ***Euphorbiaceae*:** *Euphorbia amygdaloides* L., *E. polychroma* A. Kern., *Mercurialis perennis* L.; ***Fabaceae*:** *Astragalus glycyphyllos* L., *Chamaecytisus absinthioides* (Janka) Kuzm., *Ch. austriacus* (L.) Link, *Ch. hirsutus* (L.) Link., *Ch. supinus* (L.) Link, *Coronilla emerus* L. subsp. *emeroides* (Boiss. &Spruner) Holmboe, *C.varia* L., *Genista carinalis* Griseb., *G. depressa* M. Bieb., *G. lydia* Boiss., *G. ovata* Waldst. et Kit., *Lathyrus laxiflorus* (Desf.) Kuntze, *L. niger* (L.) Bernh., *L. pratensis* L., *L.venetus* (Mill.) Wohlf., *L.vernus* (L.) Bernh., *Lotus aegaeus* (Griseb.) Boiss., *L.corniculatus* L., *Medicago carstiensis* Wulf., *Trifolium alpestre* L., *T. arvense* L., *T. aureum* Poll., *T. pratense* L., *T. repens* L., *Vicia cracca* L.; ***Fagaceae*:** *Castanea sativa* Mill., *Fagus sylvatica* L., *Quercus dalechampii* Ten.; ***Geraniaceae*:** *Geranium robertianum* L., *G. sylvaticum* L.; ***Hypericaceae*:** *Hypericum maculatum* Crantz, *H. olympicum* L., *H. perforatum* L.; ***Lamiaceae*:** *Acinos alpinus* (L.) Moench, *A. arvensis* (Lam.) Dandy, *Ajuga genevensis* L., *Calamintha grandiflora* (L.)Moench, *Clinopodium vulgare* L., *Galeopsis tetrahit* L., *Glehoma hederacea* L., *Lamium galeobdolon* (L.) Crantz, *L. garganicum* L., *L. maculatum* L., *L. purpureum* L., *Melittis melissophyllum* L., *Mentha longifolia* (L.) Huds., *M. spicata* L., *Nepeta nuda* L., *Origanum vulgare* L., *Prunella vulgaris* L., *Salvia glutinosa* L., *Stachys alpina* L., *S. germanica* L., *S. sylvatica* L., *Teucrium chamaedrys* L., *Thymus jankae* Čelak.; ***Malvaceae*:** *Althaea officinalis* L. , *Lavatera thuringiaca* L.; ***Oleaceae*:** *Fraxinus ornus* L.; ***Onagraceae*:** *Circaea luteciana* L., *Epilobium angustifolium* L., *E. montanum* L.; ***Orobanchaceae*:** *Orobanche gracilis* Sm., *O. reticulata* Wallr.; ***Oxalidaceae*:** *Oxalis acetosella* L.; ***Papaveraceae*:** *Chelidonium majus* L., *Corydalis solida* (L.) Clairville; ***Plantaginaceae*:** *Plantago major* L., *P. subulata* Roth; ***Platanaceae*:** *Platanus orientalis* L.; ***Plumbaginaceae*:** *Armeria rumelica* Boiss.; ***Polygonaceae*:** *Bilderdykia convolvulus* (L.) Dumort., *Rumex acetosa* L., *R. acetosella* L., *R. pulcher* L.; ***Primulaceae*:** *Cyclamen hederifolium* Aiton, *Lysimachia punctata* L., *Primula acaulis* (L.) L., *P. veris* L.; ***Pyrolaceae*:** *Orthilia secunda* (L.) House; ***Ranunculaceae*:** *Anemone ranunculoides* L., *Clematis vitalba* L., *Helleborus odorus*Waldst. &Kit., *Isopyrum thalictroides* L., *Ranunculus acris* L., *R. ficaria* L., *R. nemorosus* DC., *R. repens* L.; ***Rosaceae*:** *Agrimonia eupatoria* L., *Aremonia agrimonoides* (L.) DC., *Cotoneaster nebrodensis* (Guss.) K. Koch, *Crataegus monogyna* Jacq., *Fragaria moschata* Weston, *F. vesca* L., *F. viridis* Duchesne, *Geum urbanum* L., *Malus sylvestris* Mill., *Potentilla inclinata* Vill., *P. micrantha* DC., *Prunus avium* (L.) L., *P. spinosa* L., *Rosa arvensis* Huds., *R. canina* L., *R. dumalis* Bechst., *R. pendulina* L., *Rubus caesius* L., *R. canescens* DC., *R. idaeus* L., *R. sanguineus* Friv.,

Sanguisorba minor Scop., *Sorbus aria* (L.) Crantz, *S. borbasii* Jav., *S. torminalis* (L.) Crantz; ***Rubiaceae*: *Asperula aristata*** L., *Cruciata glabra* (L.) Opiz, *Galium album* Mill.,*G. anisophyllon* Vill., *G. aparine* L., *G. odoratum* (L.) Scop., *G. pseudaristatum* Schur, *G. schultesii* Vest, *G.verum* L.; ***Salicaceae*: *Populus tremula*** L., *Salix caprea* L.; ***Santalaceae*: *Thesium linophyllon*** L.; ***Saxifragaceae*: *Saxifraga rotundifolia*** L.; ***Scrophulariaceae*: *Digitalis grandiflora*** Mill., *D.viridiflora*Lindl., *Euphrasia liburnica* Wettst., *Lathraea squamaria* L., *Odontites serotina* (Lam.) Dum., *Scrophularia aestivalis*Griseb., *S.scopolii* Hoppe ex Pers., *Verbascum abietinum* Borbas, *V. longifolium* Ten. subsp. *pannosum* (Vis. & Pančić) Murb., *Veronica chamaedrys* L., *V. officinalis* L., *V. verna* L., *V. vindobonensis* (M. Fisch.) M. Fisch.; ***Solanaceae*: *Atropabella-donna*** L., *Solanum dulcamara* L.; ***Tiliaceae*: *Tilia cordata*** Mill.,*T. tomentosa* Moench; ***Urticaceae*: *Urtica dioica*** L.; ***Valerianaceae*: *Valeriana officinalis*** L.; ***Violaceae*: *Viola canina*** L., *V. odorata* L., *V. riviniana* Rchb., *V. speciosa* Pant., *V. tricolor* L.

Liliopsida

Araceae*: *Arum maculatum L.; ***Cyperaceae*: *Carex caryophyllea*** Latour.,*Carex hirta* L.; ***Iridaceae*: *Crocus chrysanthus*** (Herb.) Herb.; ***Juncaceae*: *Luzula campestris*** (L.) DC., *L. luzuloides* (Lam.) Dandy, *L. sylvatica* (Huds.) Gaudin; ***Liliaceae*: *Lilium martagon*** L., *Ornithogalum nutans* L., *Paris quadrifolia* L., *Polygonatum latifolium* (Jacq.) Desf.,*P. odoratum* (Mill.) Druce, *Scilla bifolia* L., *Veratrum lobelianum* Bernh.;***Orchidaceae*: *Cephalanthera longifolia*** (L.) Fritsch, *Epipactis helleborine* (L.) Crantz, *Neottia nidus-avis* (L.) Rich.; ***Poaceae*: *Agrostis capillaris*** L., *A. castellana* Boiss. & Reut., *Alopecurus pratensis* L., *Brachypodium sylvaticum* (Huds.) Beauv., *B. pinnatum* (L.) P. Beauv., *Calamagrostis arundinacea* (L.) Roth, *Dactylis glomerata* L., *Deschampsia flexuosa* (L.)Trin., *Festuca heterophylla* Lam., *F. hirtovaginata* (Acht.) Markgr.-Dann., *F. rubra* L., *F.* (Uechtr.) Pénzes, *Melica uniflora* Retz., *Milium effusum* L., *Phleum phleoides* (L.) H. Karst., *Ph.pratense* L., *Poa annua* L., *P. nemoralis* L.

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