Article

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# Contribution to the knowledge of habitat and vascular plant diversity of Alibotush Reserve, Slavyanka Mountain (Bulgaria)

**Abstract**

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Alibotush Reserve is located in Slavyanka Mountain, Southwestern Bulgaria, near the state border with Greece. It was established as protected area in 1951 and currently covers 1638.12 ha, which is about 25% of the Bulgarian territory of the mountain. It has the strictest protection regime according to Bulgaria's national legislation and corresponds to IUCN category Ia. The article aims to present and analyse the floristic and habitat diversity of the reserve. Altogether 611 species, 287 genera and 72 families of vascular plants are reported for the area. The most species-rich families are *Asteraceae*, *Caryophyllaceae*, *Poaceae*, *Fabaceae*, *Rosaceae*. The biological spectrum of the flora, both in respect to biological types and life forms, shows strong prevalence of herbaceous perennials, respectively, hemicryptophytes. The endemism is relatively high – ca. 11.5%. The species of conservation concern are 54 (8.8%) and most of them are xerophytes and heliophytes. List of the vascular plant species recorded in the field or from earlier literature sources is provided. The habitat diversity is represented by 13 habitat types. Woodland vegetation dominates and covers 1330.5 ha in total, whereas grasslands are represented by 4 habitat types and cover 110.7 ha. A map of the habitats is provided.

*Key words*: Bulgarian flora, floristic diversity, habitats, protected areas, vegetation.

## Introduction

Alibotush Reserve is located in Southwestern Bulgaria, near the state border with Greece, in the Slavyanka Mountain, which until 1955 was called Alibotush as well. The reserve was declared by Decree of the Council of Ministers No. 1171 of 24.09.1951, in order to preserve the unique relict forests of *Pinus heldreichii*, *P. nigra*, *Abies borisii-regis* and the rich flora and fauna. On March 1, 1977 the reserve was included in the World Network of Biosphere Reserves under UNESCO's Program 'Man and the Biosphere'. Initially, the area of the reserve was 523.9 ha, but after several extensions the current territory reaches a total of 1638.12 ha (Order № RD-206 / 04.03.2013 of the Minister of Environment and Water) which is about 25% of the Bulgarian territory of the mountain. During the period 1944–1989, Alibotush Reserve fell into the so-called "border zone"

which, combined with the difficult accessibility, is the main reason for the preserved natural biodiversity of the mountain. Therefore, the reserve remained poorly studied until nowadays, and there is no published scientific article dealing particularly with the flora and vegetation of the area.

The flora of the mountain was most intensively studied in 1920s and 1930s, when several works were published by N. Stojanov (1921, 1924) and A. Drenovski (1933a, b, 1934a, b, 1936). Later, mainly in connection with the preparation of the multi-volume edition "Flora of Republic of Bulgaria" (since 1963 until now) and of the Red Data Book of the Republic of Bulgaria (Velchev 1984; Peev & al. 2015), a number of botanists visited the mountain and published data on different plant species. Among them, it is worth mentioning the publications of Kitanov & al. (1983), Pashaliev & Dimitrov (1995), Dimitrov (2010), Aneva & al. (2015). However, a study particularly into the flora of the reserve has not been carried out yet. In most cases, the publications are on the flora of the entire mountain or on even the larger Slavyanka floristic region.

The territory of the reserve is included in the NATURA 2000 network in Bulgaria, especially in BG0001028 Sreden Pirin – Alibotush site.

The article aims to present and analyse the floristic and habitat diversity of Alibotush Reserve with an emphasis on the species of conservation concern.

## Materials and methods

Several field trips were carried out along several transects in the reserve between July 2014 and October 2018. Major habitat types have been studied so as to fully cover the floristic composition. Plant identification and preparation of the species list was done according to Delipavlov & Cheshmedzhiev (2011), Flora of Bulgaria (Jordanov 1963, 1964, 1966, 1970, 1973, 1976, 1979; Velčev 1982, 1989; Kožuharov 1995; Peev 2012). Species of conservation concern and endemic taxa were determined according to Petrova (2006), Petrova & Vladimirov (2009, 2010), Peev & al. (2015), Bulgarian Biological Diversity Act (2002, 2007), Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES, https://www.cites.org/eng), Directive 92/43/EEC (1992) and Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1979). The chorological elements follow Assyov & Petrova (2012). Life forms follow Raunkiaer (1934) and were determined by the authors and verified with relevant literature sources, e.g. Dimopoulos & al. (2013) and Fischer & al. (2008). The floristic diversity of the region is compared to that for the entire country: 4064 species, 921 genera and 159 families (Petrova & Vladimirov 2018).

Habitat types were determined according to EUNIS habitat classification (EUNIS 2012) and Directive 92/43/EEC (Interpretation Manual of European Union Habitats 2007, Kavrakova & al. 2009). 'Habitat directive code' is abbreviated as 'HDC' throughout the text below. Mapping was done using ArcGIS 10.0 software (ESRI 2011). Spatial data was collected in the field using GPS devise Juno BS by Trimble and was later laid over the most recent orthophoto images available. Polygons were outlined manually by using features collected in the field as well as the orthophoto images. Mapping was done in scale 1:5000.

*Geographical position of the study area* – Alibotush Reserve is situated on the northern slopes of Slavyanka Mt., which is part of the Rila-Pirin Mountain Range and is located to the south of the main ridge of the Pirin Mts (Fig. 1). In morphographic and morphometric traits, Slavyanka Mt. belongs to the high non-glacial mountains. The reserve territory covers the altitude range of between 900 and 2200 m a.s.l., which determines the typical mountain climate. The average altitude is about 1500 m. According to the administrative division of the Republic of Bulgaria, the area of Alibotush Reserve falls entirely in the Blagoevgrad district, in the land of Goleshovo (Sandanski mun.), Paril and Nova Lovcha villages (Hadzhidimovo mun.).

*Climate of the area* – According to the climatic zoning of Bulgaria, Slavyanka falls in the Continental-Mediterranean climate, the Pirin region (Velev 2002). The average annual temperature decreases from 9.0°C in the lowest point of the reserve to 2.2°C at an altitude of 2200 m. The warmest months of the year are July and August. Average July temperatures are 18.5°C at 1000 m above sea level to 10.5°C at 2200 m (Management plan 2016). The coldest month is January, with temperatures between –1.1°C and –5.7°C. The maximum rainfall is in the winter (November-December) and is in the range of 100–150 mm. The minimum rainfall occurs in August-September and is 30 mm at the mountain's foot, and up to 50–60 mm in the high mountain parts.

*Bedrock and soils* – The bedrock of almost the entire territory of Alibotush Reserve is formed of marbles of the Dobrostan Marble Branch (Kozhuharov & Marinova 1989). Humus-carbonate soils (randzines) predominate in the reserve, covering 79% of its territory. Brown soils (cambisols) and alluvial-diluvial soils are also spread (WRB, FAO 2015).

## Results and discussion

*Floristic diversity* – The flora of Alibotush Reserve comprises 72 families, 287 genera and 611 species and subspecies. List of the taxa is provided as Electronic Supplementary File 1 (ESF1). The taxonomic structure of the flora is presented in Table 1. Altogether *Lycopodiophyta*, *Equisetophyta* and *Polypodiophyta* comprise 9.7% of the families, 3.8% of the genera, and 2.5% of the species from the flora, *Pinophyta* – 4.2% of the families, 1.8% of the genera, 1.8% of the species, and *Magnoliophyta* – 86.1%, 94.4% and 95.7% respectively.

Table 1. Taxonomic structure of the flora.

| Taxon | No. of species and subspecies | No. of genera | No. of families |
|---|---|---|---|
| *Lycopodiophyta* | 1 | 1 | 1 |
| *Equisetophyta* | 1 | 1 | 1 |
| *Polypodiophyta* | 13 | 9 | 5 |
| *Pinophyta* | 11 | 5 | 3 |
| *Magnoliophyta* | 585 | 271 | 62 |
| *Magnoliopsida* | *500* | *227* | *55* |
| *Liliopsida* | *85* | *44* | *7* |
| **Total** | **611** | **287** | **72** |

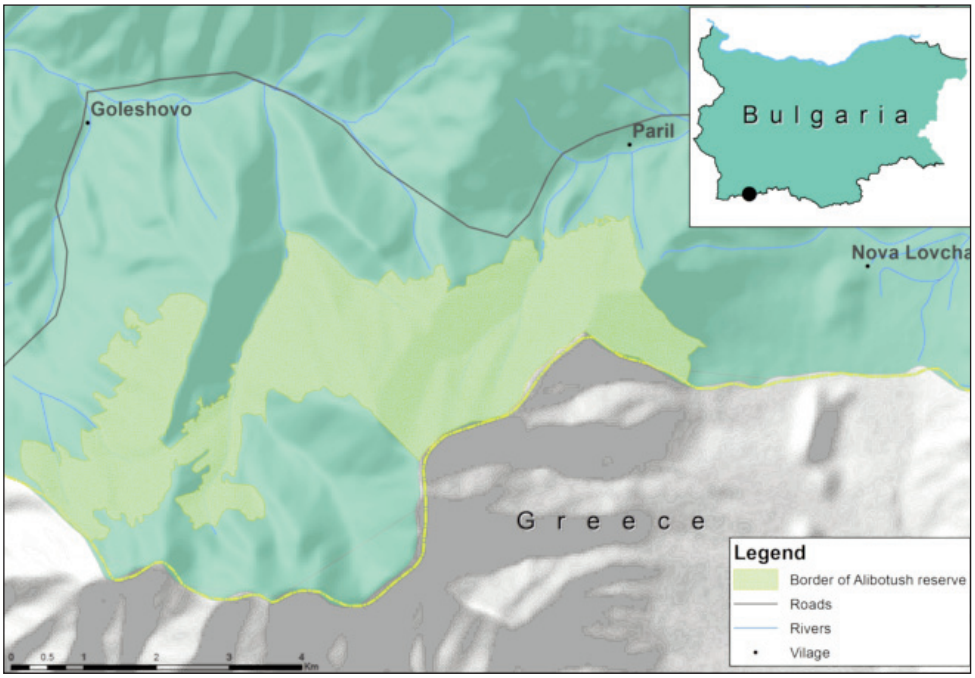


Fig. 1. Geographic position of Alibotush reserve.

The richest 10 families in specific and subspecific taxa are: *Asteraceae* (82, 13.4% of the total flora), *Caryophyllaceae* (44, 7.2%), *Poaceae* (43, 7.0%), *Fabaceae* (39, 6.4%), *Rosaceae* (38, 6.2%), *Lamiaceae* (31, 5.1%), *Scrophulariaceae* (25, 4.1%), *Brassicaceae* (22, 3.6%), *Apiaceae* (21, 3.4%), *Rubiaceae* (16, 2.6%). Altogether these families comprise 59% of the species in the reserve's flora. These data are somewhat similar to that for the entire Bulgarian flora, in which the richest families are: *Asteraceae*, *Poaceae*, *Fabaceae*, *Caryophyllaceae* and *Brassicaceae* (Petrova & al. 2005).

The biological spectrum of the flora of Alibotush Reserve is presented in Table 2.

The life-form spectrum of the flora of Alibotush Reserve is presented in Table 3.

The phytogeographic composition of the flora of Alibotush Reserve is presented in Table 4. The number of species in a reproductive phase of development by months is presented on Fig. 2. The highest number is registered in June and July which is typical for the mountainous regions in temperate Europe.

A total of 54 species of conservation concern (8.8% of the entire flora of the reserve) has been identified on the territory of the reserve. There are 47 species with a national IUCN category according to the national Red List of Bulgarian vascular plants (Petrova & Vladimirov 2009). Of these, 8 species are Critically Endangered (CR), 21 are Endangered (EN), 12 are Vulnerable (VU), and 6 are Near Threatened (NT). In the Red Book of the Republic of Bulgaria, vol. 1. Plants and Fungi (Peev & al. 2015) are included 33 species –

Table 2. Biological spectrum of the flora.

| Biological type | No. of taxa | Share (%) |
|---|---|---|
| Perennial | 425 | 69.5 |
| Annual | 47 | 7.7 |
| Shrub | 35 | 5.7 |
| Biennial | 24 | 3.9 |
| Tree | 20 | 3.3 |
| Biennial – perennial | 17 | 2.8 |
| Annual – biennial | 12 | 2.0 |
| Shrub – tree | 10 | 1.6 |
| Tree – Shrub | 8 | 1.3 |
| Annual – perennial | 7 | 1.1 |
| Semishrub | 4 | 0.7 |
| Perennial – shrub | 1 | 0.2 |
| Semishrub – perennial | 1 | 0.2 |
| **Total** | **611** | **100.0** |

Table 3. Life-form spectrum of the flora.

| Life form | No. of taxa | Share (%) |
|---|---|---|
| Hemicryptophytes | 369 | 60.4 |
| Geophytes | 63 | 10.3 |
| Phanerophytes | 63 | 10.3 |
| Therophytes | 48 | 7.8 |
| Chamaephytes | 42 | 6.9 |
| Hemicryptophytes – Chamaephytes | 9 | 1.5 |
| Therophytes – Hemicryptophytes | 7 | 1.1 |
| Chamaephytes – Phanerophytes | 4 | 0.6 |
| Chamaephytes – Hemicryptophytes | 2 | 0.3 |
| Geophytes – Hemicryptophytes | 1 | 0.2 |
| Hemicryptophytes – Geophytes | 1 | 0.2 |
| Hemicryptophytes – Therophytes | 1 | 0.2 |
| Therophytes – Geophytes | 1 | 0.2 |
| **Total** | **611** | **100.0** |

all taxa with 'Critically Endangered' and 'Endangered' category, as well as 4 'Vulnerable' species. Two species are listed in Annex II to Directive 92/43 / EEC (Habitats Directive) – *Himantoglossum jankae* and *Viola delphinantha*.

Balkan endemics are 61 species (ca. 10.0% of the total flora of the reserve), whereas the Bulgarian endemics are 9 species (1.5%).

The flora of the reserve comprises ca. 15% of the species diversity of the entire Bulgarian flora. Compared to other territories of a similar size, e.g. with Kongura reserve in the neighbouring Belasitsa Mt., the species diversity is high (300 species in Kongura reserve, Pedashenko & al. 2015). This can be explained by the higher habitat diversity of Alibotush Reserve, the larger altitudinal range, and the calcareous bedrock. The share of

Table 4. Floristic elements in the flora of Alibotush Reserve.

| Floristic element | No. of taxa | Share (%) |
|---|---|---|
| subMed | 81 | 13.5 |
| Bal | 61 | 10.2 |
| Eur-Med | 60 | 10.0 |
| Boreal | 49 | 8.2 |
| Eur-As | 47 | 7.8 |
| Eur-Sib | 45 | 7.5 |
| Eur | 41 | 6.8 |
| subBoreal | 30 | 5.0 |
| Med | 28 | 4.7 |
| Pont-Med | 23 | 3.8 |
| Kos | 14 | 2.3 |
| Alp-Med | 13 | 2.2 |
| Carp-Bal | 12 | 2.0 |
| Bal-Anat | 11 | 1.8 |
| Bul | 9 | 1.5 |
| Eur-subMed | 9 | 1.5 |
| Ap-Bal | 6 | 1.0 |
| Pont | 6 | 1.0 |
| Other 30 geoelements | 66 | 9.2 |
| **Total** | **611** | **100.0** |

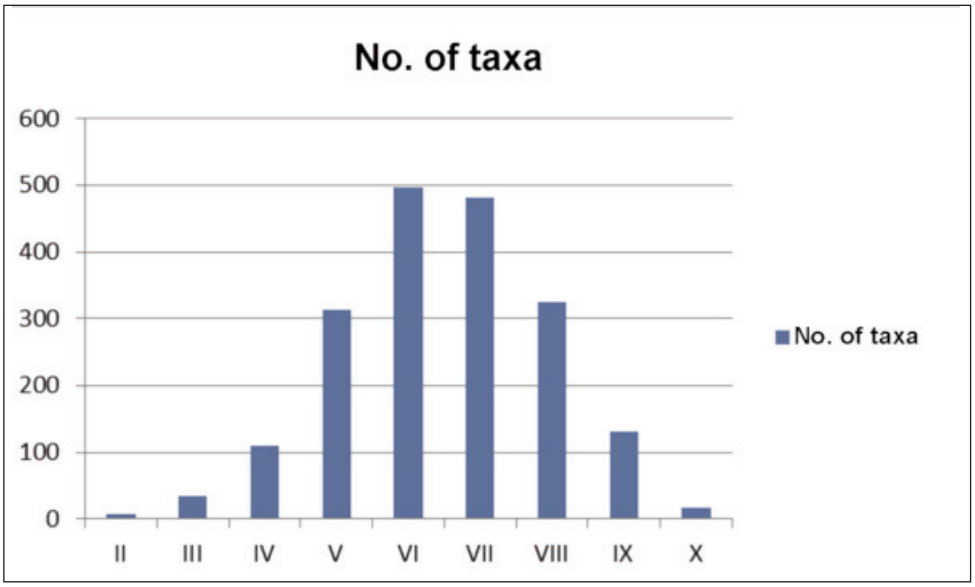


Fig. 2. Reproductive phenophase spectrum of the flora of Alibotush Reserve.

the species of *Polypodiophyta* is slightly higher than that in some other areas, e.g. Vrashka Chuka protected site (0.8%, Vladimirov 2012), Mt Golo Bardo (0.6%, Apostolova-Stoyanova & Stoyanov 2009), as well as in the whole country (1.1%, Petrova & al. 2005) which is due to the availability of suitable habitats.

The biological spectrum of the flora of Alibotush Reserve, both with respect to biological types and life forms, is similar to this of the entire Bulgarian flora, and demonstrates a pattern characteristic for the temperate mountainous floras, i.e. the strong prevalence of herbaceous perennials, respectively, the hemicryptophytes (Uzunov & Gussev 2003). However, it is worth pointing the relatively high representation of geophytes and therophytes which can be explained with the relatively strong influence of the Mediterranean climate despite the northern exposition and high elevation.

The phytogeographical analysis shows that in the flora of Alibotush Reserve prevail the following floristic elements – subMediterranean, Balkan endemics, Euro-Mediterranean, Boreal, Euro-Asiatic, Euro-Siberian and European, which altogether comprise nearly 64% of the total flora. Especially noteworthy is the presentation of both Balkan and Bulgarian endemic species – ca. 11.5% (ca. 11% for the total Bulgarian flora), which characterises the reserve as an area with high endemism in Bulgaria and of high conservation concern. This statement is supported also by the fact that Kongura reserve in the neighbouring Belasitsa Mt. shelters only about 3.3% of endemic species (Pedashenko & al. 2015) and this of the entire Mt Golo Bardo – 4.3% (Apostolova-Stoyanova & Stoyanov 2009). The high share of endemic species can be explained by the calcareous substrate, relatively high influence of the Mediterranean climate and the high habitat diversity, especially in open places, since most endemics in the Bulgarian flora are heliophytes and xerophytes (Velchev & Kozhuharov 2006). The high presentation of endemic species (11.5%) and species of conservation concern (8.8%) determines the high value of the reserve for the conservation of the vascular plant diversity. Moreover, the reserve is of crucial importance for the preservation of some species, e.g. *Centaurea parilica*, *Crepis schachtii*, *Erysimum drenowskii*, *E. slavjankae*, *Fritillaria drenovskii*, *Hieracium marotii*, *Peridictyon sanctum*, *Pinus heldreichii*, *Pulsatilla slaviankae*, *Viola delphinantha* etc., which in Bulgaria have their only or largest populations within the territory of the reserve.

According to the national legislation Alibotush is a strict reserve which has the strongest regime of protection (IUCN category Ia). Any human activities on the territory of the reserve are forbidden except for guarding of the reserve, scientific research and monitoring, visits by tourists only on marked trails and regulated (by the Ministry of Environment and Water) collection of seeds and wild species for scientific research or for reintroduction of the species to other territories. Although the strict protection regime ensures high naturalness of the area, some of the species of conservation concern may experience slight decline of their populations. The major threat is the change of the habitats mainly due to lack of any grazing and natural afforestation of some of the open places on lower altitudes. Most obvious are the changes in the Parilski Dol locality (Hambar-Dere) which is a deep natural gorge and is famous for the high plant diversity and concentration of endemic species. In the past, the area was grazed mainly by sheep from closest Paril village and provided suitable open habitats for many species of high conservation concern. After the establishment of the reserve, grazing by the sheep was stopped completely which allowed for natural afforestation of the whole gorge mainly by *Fagus sylvatica*, and the open spaces

were gradually replaced by forests. This deteriorated the conditions for most of the endemic plants which are mainly heliophyte and xerophyte species and their populations declined locally in the gorge and in some open places nearby, e.g. the populations of *Bromus parilicus*, *Centaurea parilica*, *Chondrilla urumoffii*, *Crepis schachtii*, *Pulsatilla slaviankae*, *Onosma rhodopea*, *Saxifraga* spp., *Sideritis scardica*, *Viola delphinantha*, etc. Also, the lack of any grazing may affect negatively the population of the symbolic for the area *Sideritis scardica* (popular for making herbal tea) since it enables the growth of the perennial grasses which are more competitive and gradually replace *Sideritis scardica* (usually not grazed by the sheep).

## Habitat diversity

Habitat diversity on the territory of Alibotush Reserve is presented by 13 habitat types (Electronic Supplementary File 2). Woodland vegetation dominates and covers 1330.5 ha in total. Grasslands are represented by 4 habitat types (110.7 ha).

***Grassland vegetation***

**E1.55. Eastern sub-Mediterranean dry grassland** (HDC: 62A0 Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*); 12.2 ha)

*Abiotic characteristics* – This habitat has limited distribution on the territory of the reserve forming rocky grassland within *Pinus nigra*, *P. heldreichii* and *Fagus sylvatica* forests. Ecologically it is similar to E4.438. Oro-Moesian calciphile stripped grasslands but is found at lower altitude between 900 and 1450 m a.s.l. Stands cover south- or southeast-facing slopes with rough microrelief and calcareous outcrops. Terrains are flat or slightly inclined. Soils are shallow to moderately deep.

*Vegetation structure* – Very species-rich phytocoenosis (number of species is between 39 and 52 species per 16 $m^2$) with semi-closed to closed horizontal structure and total cover of vegetation 75–100%. Species composition is rich of calcareous species such as *Stipa eriocaulis*, *Euphorbia myrsinites*, *Leontodon crispus*, *Teucrium polium*, *Artemisia alba*, *Melica ciliata*, *Anthyllis vulneraria*, etc. Species with higher cover and abundance are *Artemisia alba*, *Stipa eriocaulis* and *Tortella tortuosa* (*Bryophyta*). Cover of cryptogams is higher than in the other habitat types, e.g. between 10–35% for bryophytes and 5–60% for lichens. This habitat is also rich of species with conservation concern such as *Himantoglossum jankae*, *Hypericum rumeliacum*, *Fritillaria drenovskii*, *Anthemis macedonica*, etc.

**E2.11. Unbroken pastures** (HDC: -; 1.1 ha)

*Abiotic characteristics* – It is locally found under Gotsev peak and presents intensively used pasture. The ground is trampled. Terrain is flat to slightly or moderately-inclined with varying exposition. Soils are moderately-deep.

*Vegetation structure* – Xero-mesophytic community with semi-closed to closed horizontal structure and total cover of vegetation 85–100%. Species with higher abundance are *Agrostis capillaris*, *Dactylis glomerata*, *Cynosurus cristatus*, *Trifolium repens* and *Festuca* sp. Some shrubs are also found such as *Chamaecytisus absinthioides*, *Rubus idaeus* and *Juniperus sibirica*. Cover of cryptogams is only 5–8%.

**E4.438. Oro-Moesian calciphile stripped grasslands** (HDC: 6170 Alpine and subalpine calcareous grasslands; 97 ha)

*Abiotic characteristics* – This is widest distributed grassland habitat on the territory of the reserve. It occurs from 1500 to 2200 m a.s.l. predominantly on steep slopes with inclination of 30–40º and north-facing slopes. Soils are shallow to moderately deep, rich of skeletons. Bedrock type is marbled limestone.

*Vegetation structure* – Moderately species-rich community with semi-closed horizontal structure and total cover of vegetation 70–90%. Species with higher abundance are *Festuca valida*, *F. hirtovaginata*, *F. panciciana*, *Sesleria latifolia*, *S. coerulans*, *Peridictyon sanctum*, *Astragalus angustifolius*, *Anthyllis aurea*, *Sideritis scardica*, *Thymus jankae*, *Saxifraga ferdinandi-coburgi* and *Poa badensis*. This habitat type is rich of species with conservation concern such as *Festuca hirtovaginata*, *F. panciciana*, *Anthyllis aurea*, *Sideritis scardica*, *Centaurea parilica*, etc. On the territory of Slavyanka Mt and Alibotush reserve this vegetation has been also studied by Karakiev & Tzonev (2011).

**E5.52. Alpic tall-grass communities** (HDC: 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels; 0.4 ha)

*Abiotic characteristics* – It has limited distribution in subalpine zone within *Pinus heldreichii* forests along streams. Soils are wet and moderately-deep. Terrains are slightly inclined to steep with varying aspects. Phytocoenosis are characterized by dense litter cover, which prevent the formation of cryptogam layer.

*Vegetation structure* – Moderately species-poor community, dominated by *Calamagrostis arundinacea* (cover 40–50%). Phytocoenosis have closed horizontal structure and total vegetation cover is 100%. Other species with higher abundance (cover 10–20%) are *Geranium sylvaticum*, *Hypericum maculatum*, *Ranunculus nemorosus*, *Luzula luzuloides*, *Senecio macedonicus* and *Alchemilla* sp.

***Shrubland vegetation***

**F2.2917. Rhodopide mountain avens mats** (HDC: 4060 Alpine and Boreal heaths; 0.5 ha)

*Abiotic characteristics* – This habitat is locally distributed in subalpine zone of Alibotush Reserve around Tsarev vrah peak. It occurs on flat to slightly inclined terrains with varying exposition. Soils are shallow with a high proportion of skeleton and rocky outcrops. Bedrock type is marbled limestone.

*Vegetation structure* – Communities have semi-closed horizontal structure with total cover of vegetation 80–90%. The dominated species is *Dryas octopetala* (cover 40–65%) and subdominants are *Juniperus sibirica* and *Thymus jankae*. Other shrubby species are *Vaccinium myrtillus* and *Daphne oleoides*. The herb layer is dominated by *Sesleria coerulans*, *Festuca valida*, *Achnatherum bromoides*, *Carex kitaibeliana* and *Hieracium petrovae*. The cover of cryptogam layer is about 10–15%.

**F2.231. Mountain Juniperus nana scrub** (HDC: 4060 Alpine and Boreal heaths; 28 ha)

*Abiotic characteristics* – This habitat is distributed in subalpine zone of Slavyanka Mt. and Alibotush Reserve from 1600 to 2000 m a.s.l. It occurs on moderately-steep terrains with inclinaton of 25–30º and north-facing or derivate slopes. Soils are shallow to moderately-deep with a high proportion of skeleton and rocky outcrops. Bedrock type is marbled limestone.

*Vegetation structure* – Its communities have closed horizontal structure with total cover of vegetation 100%. The dominated species is *Juniperus sibirica* (cover 90–95%). Other

shrubby species are *Chamaecytisus absinthioides*, *Rosa myriacantha*, *Rubus caesius* and *Daphne oleoides*. At the edge of the stands, close to woodlands, in phytocoenosis are also found some woody species such as *Pinus heldreichii*, *P. peuce*, *P. sylvestris* and *Fagus sylvatica*. The undergrowth layer is rich of species widespread in neighbouring grassland habitats. Species with higher abundance are *Carex kitaibeliana*, *Thymus jankae*, *Rhodax alpestris*, *Anthyllis aurea*, *Festuca valida* and *Luzula luzuloides*. The cover of cryptogams is about 2–5%.

***Woodland vegetation***

**G1.661. Middle European dry-slope limestone beech forests** (HDC: 9150 Medio-European limestone beech forests of the *Cephalanthero-Fagion*; 65 ha)

*Abiotic characteristics* – This habitat has limited distribution on the territory of the reserve. It occurs between 1100 and 1400 m a.s.l. on steep terrains with inclinaton of 25–40º and varying expositions. Soils are moderately-deep and bedrock type is marbled limestone.

*Vegetation structure* – Moderately species-rich community with closed horizontal structure with total cover of vegetation 90–100%. The dominated species in tree layer is *Fagus sylvatica*. Other woody species found in tree layer are *Populus tremula*, *Ostrya carpinifolia*, *Pinus nigra* and *P. heldreichii*. Shrubland layer has cover between 10–20% and is formed by the same species like in the tree layer. Herb layer is rich of species and has cover 40–50%. Species with higher abundance are *Euphorbia amygdaloides*, *Physospermum cornubiense* and *Brachypodium sylvaticum*. Cover of cryptogam layer is about 10% composed of *Pseudovernia furfuracea*, *Hypogymnia tubulosa*, *Hypnum cupressiforme*, *Homalothecium lutescens*, *Dicranum scoparium*, etc.

**G1.6924. Southeastern Moesian Ostrya-beech forests** (HDC: 91W0 Moesian beech forests; 179 ha)

*Abiotic characteristics* – This forests are distributed between 1100 and 1400 m a.s.l. along valleys, predominantly on northern slopes with inclinaton of 25–30º. Soils are moderately-deep and bedrock type is marbled limestone.

*Vegetation structure* – This vegetation has closed horizontal structure with total cover of vegetation 85–100%. Dominant species in tree layer are *Fagus sylvatica* and *Ostrya carpinifolia*. Single trees of *Pinus nigra*, *P. heldreichii* and *Carpinus orientalis* are also common. Shrubland layer has cover between 20–40% and is formed by the same species like in the tree layer together with *Rosa* sp., *Fraxinus ornus*, *Crataegus monogyna*, *Rubus* spp. Species with higher abundance in the herb layer are *Euphorbia amygdaloides*, *Physospermum cornubiense*, *Calamagrostis arundinacea* and *Brachypodium sylvaticum*. Cover of cryptogam layer is about 10–15%.

**G1.737. Eastern sub-Mediterranean white oak woods** (HDC: 91AA *Eastern white oak woods; 0.3 ha)

*Abiotic characteristics* – It is locally found on the territory of the reserve close to Nova Lovcha village. It occurs on moderately-steep and slightly inclined terrains with varying expositions. Soils are shallow to moderately-deep and rich of skeleton material. Bedrock type is marbled limestone.

*Vegetation structure* – It includes species-rich phytocoenosis with semi-closed horizontal structure. Total cover is 90–95%. In tree layer dominant species are *Quercus pubescens* and *Carpinus orientalis*. Shrub layer is well-developed and has cover 40–65%. It is formed

by the same species like in the tree layer together with *Fraxinus ornus*, *Prunus spinosa*, *Cotoneaster nebrodensis*, *Juniperus oxycedrus*, *Ligustrum vulgare*, *Acer campestre* and *Cornus mas*. The species composition of undergrowth is about 60–80%. Species with higher abundance are *Fragaria vesca*, *Dactylis glomerata*, *Trifolium alpestre*. Cover of cryptogams is 10–15% and is formed by species such as *Evernia prunastri*, *Hypnum cupressiforme*, *Orthotrichum affine*, etc.

**G3.52. Western Balkanic *Pinus nigra* forests** (HDC: 9530 *(Sub-) Mediterranean pine forests with endemic black pines; 294 ha)

*Abiotic characteristics* – It occurs between 1200 and 1600 m a.s.l. both on steep and slightly inclined terrains with varying expositions. Soils are shallow to moderately-deep and bedrock type is marbled limestone.

*Vegetation structure* – Moderately species-rich community with semi-closed horizontal structure, dominated by *Pinus nigra*. It forms monodominant communities or mixed woodlands with *Ostrya carpinifolia*, *Fagus sylvatica*, *Pinus heldreichii* and *Abies borisii-regis*. Shrub layer (cover between 20–45%) is mainly formed by the same species like in the tree layer together with *Fraxinus ornus*, *Carpinus orientalis*, *Juniperus oxycedrus*, *Genista carinalis*, *Crataegus monogyna*, *Daphne oleoides*, *Chamaecytisus absinthioides*, *Rubus caesius*. Herb layer is rich of species and cover 40–95%. Species with higher abundance are *Sesleria latifolia*, *Brachypodium sylvaticum*, *Physospermum cornubiense*, *Carex humilis*. Cover of cryptogams is 10–20%.

**G3.616. Rhodopide white-barked pine forests** (HDC: 95A0 High oro-Mediterranean pine forests; 759 ha)

*Abiotic characteristics* – It occurs at 700–1600 m a.s.l. on moderately steep slopes (20–30º) with varying expositions. Soils are shallow to moderately-deep with high proportion of skeleton materials. Bedrock type is marbled limestone.

*Vegetation structure* – This habitat type includes woodlands dominated by *Pinus heldreichii*. This tertiary relict species forms monodominant forests. Other woodland species found in tree layer as single trees are *Pinus nigra*, *P. sylvestris*, *Fagus sylvatica*, *Abies alba*, *A. borisii-regis* and *Ostrya carpinifolia*. Shrub layer is mainly formed by the same species like in the tree layer together with *Acer campestre*, *A. pseudoplatanus*, *Rosa canina*, *Fraxinus ornus* and *Crataegus monogyna*. The composition of the undergrowth is uniform. Species with higher abundance are *Calamagrostis arundinacea*, *Festuca hirtovaginata*, *Mycelis muralis*, *Hieracium petrovae*, *Luzula luzuloides*.

**G3.171. King Boris's fir forests** (HDC: 9170 Hellenic beech forests with *Abies borisii-regis*; 33.2 ha)

*Abiotic characteristics* – This habitat type is distributed around 1500 m a.s.l. on north-facing slopes with prevailing inclination 25–30º. The soils are moderately-deep with high proportion of skeleton. Bedrock type is marbled limestone

*Vegetation structure* – Communities have semi-closed to closed horizontal structure and are dominated by *Abies borisii-regis*. Other woodland species present in communities are *Pinus nigra*, *P. heldreichii*, *P. sylvestris* and *Fagus sylvatica*. Shrubland layer is mainly formed by the same species like in the tree layer together with *Juniperus sibirica*, *Crataegus monogyna*, *Rosa* sp. and *Chamaecytisus absinthioides*. Species with higher abundance in herb layer are *Oxalis acetosella*, *Luzula luzuloides* and *Physospermum cornubiense*.

***Chasmophytic vegetation***

**H3.25. Alpine and sub-Mediterranean chasmophyte communities** (HDC: 8210 Calcareous rocky slopes with chasmophytic vegetation; 2.4 ha)

*Abiotic characteristics* **–** It is found in subalpine and alpine zones within the belt formed by *Fagus sylvatica*, *Pinus nigra* and *P. heldreichii*, on fissures of calcareous cliffs. They cover an area from several square metres to several hundred square meters. Terrains are steep with varying aspects. Soils are shallow, rich of skeleton or are missing. Bedrock type is marbled limestone.

*Vegetation structure* **–** Phytocoenoses have open-horizontal structure with total cover 40–70%. Species with higher abundance (cover 10–15%) are *Festuca valida*, *Sedum album*, *Thymus jankae* and *Poa badensis*. Some typical chasmophytic species are also found such as *Asplenium ruta-muraria*, *A. trichomanes*, *Ceterach officinarum*, *Sempervivum leucanthum*, *Dianthus pinifolius*. Cover of cryptogams is 15–20%.

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