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80 YEARS OF RADOSLAV RIZOVSKI'S BIRTH

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BOREO-MONTANE FOREST PHYTOCOENOSES IN CENTRAL STARA PLANINA MTS.

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ABSTRACT: This study deals with the subalpine conifers and related birch forests on the territory of National Park "Central Balkan"in Bulgaria. It is a part of a comprehensive study on the forest vegetation in the Park. 30 relevés were collected during the field research. JUICE, TWINSPAN and STATISTICA were applied for classification and statistical analysis. The studied forests are fragmented and do not form a continuous altitudinal belt within the park. The species composition, ecology and distribution determine their differentiation into four groups of phytocoenoses. Most widespread are the communities dominated by Norway spruce, which combine mesohygrophitic and eutrophic phytocoenoses, forming the timberline. Community of *Picea abies* and *Luzula sylvatica* includes woods, tied to acidophilous and relatively less humid and poor soil. Mesophytic and mesotrophic community of *Betula pendula* develops in areas where the timberline is composed of spruce forests, mostly southward from the main ridge of the mountain. The natural habitat of the Macedonian pine in the study area represents northernmost locality of its natural area of distribution and is the only one in Stara Planina Mts. Two associations were described: *Adenostylo alliariae-Pinetum peucis* and *Ranunculo carthusianae-Piceetum abietis*. They include hygromoesophytic and mesotrophic forests, forming some parts of the alpine timberline.
Keywords: subalpine forests, classification of vegetation, diagnostic species, environmental variables, *Pinus peuce*, phytocoenoses.

1 INTRODUCTION

Holarctic disjunctions are biogeographical phenomena formed after cooling of the climate during the Pliocene and are expressed in both distribution of plant species and communities in areas with different latitude and different altitude [1]. Boreal mountain disjunction includes coniferous forests growing north in the taiga and their vicariant phytocoenoses that develop in the high mountains in the central and southern parts of the continent. This is determined by the temperature gradient that changes analogously from south to north in the plains and from lower to higher altitudes in the mountains. According to the proposed altitudinal stratification of mountain systems depending on environmental, floristic and vegetation criteria, the coniferous forests grow in the lower subalpine belt [2]. According to the traditions concerning the zone differentiation of vegetation in Bulgaria [3, 4, 5] the boeral coniferous forests grow in the high mountain belt, which is equal to the lower subalpine belt, according to the traditional European stratification [2, 6].

Boreal forests include monodominant and polydominant coniferous and deciduous-coniferous forest phytocoenoses developing on diverse habitats. In southeastern Europe this vegetation is defined as a submediterranean and subcontinental mountain vegetation [7]. Besides typical boreal elements it is constituted of part european and endemic elements, which makes it somewhat different from the typical boreal vegetation. This research confines to the approach of boreal vegetation [8] and the visions for the hemiboreal vegetation in Southeast Europe [9, 10, 11, 12]. Similar mountain vegetation in Europe is found only on higher mountain ridges - the Pyrenees, the Alps, Jura, Black Forest, Hercynian hills, Thuringia, Carpathians, Dinaric Alps, Rhodope, Rila, Pirin, Stara Planina, and the Caucasus. Regional features are the main reason for the formation of a large number of regional plant associations.

Central Stara Planina is the northernmost mountain in Bulgaria with occurrence of vegetation types, common to the mountains in Central Europe [2] (between the boreal and mediterranean zone).

Forest communities in Central Stara Planina had been partly studied by different methodological approaches for collection, analysis and aggregation of phytocoenotic information [13, 14, 15, 16, 17, 18, 19, 20, 21, 22]. Currently there is not a comprehensive classification scheme providing an idea of the syntaxonomic diversity. The beech forests were relatively well studied out of the forest habitats and plant communities [23]. There is also some information about syntaxa in the forests in some of the reserves located within Central Stara Planina, differentiated using the Broun-Blanquet`s approach [17, 18, 22].

This research is part of a comprehensive study of the forest vegetation within the "Central Balkan" National Park, which covers the highest part of the Central Stara Planina. Main purpose is to study the boreo-montane forest phytocoenoses, which includes subalpine coniferous and related birch forests.

2 MATERIALS AND METHODS

Central Stara Planina is the highest part of the Stara planina Ridge, located between Zlatishki and Shipchenski passes (Fig. 1). Well shaped are Zlatishko-Tetevenski parts (Vejen peak – 2198 m.a.s.l., Troyanski (Kupena peak – 2169 m.a.s.l.) and Kaloferski (Botev peak – 2376 m.a.s.l.). The studied area falls within the Meridional zone, Submediterranean region, Balkan province [24]. The climatic conditions in this area are diverse and with dynamic changes in their values. This is due to the rough terrain, deep river valleys and hollows. The climate in the northern parts of the territory is temperate continental and

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in the southern parts is subcontinental. The thermal conditions are characterized by well-defined seasons, depending on the topography of the region [25]. This study covers the areas in the mountain belt (1500 - 2000 m.a.s.l.), characterized by a short vegetation period, an average annual temperature between 3,3°C and 5,1°C and annual rainfall sum from 860 to 1300 mm/m^2 [25]. Hydrographic system has a very high overall density – 3,03 km/km^2.

Figure 1: Location of Central Stara Planina Mts.

Soil variability is represented by zonal soils of the classes Cambisols – Dystric-Eutric Cambisols, Umbric Cambisols, Modic Cambisols [26].

Coniferous forests occupy a limited area primarily in the higher western and central parts of Central Stara Planina.

For purposes of this study in the period May 2011 – July 2013 30 relevés were established in the range of 1450-1850 m.a.s.l. The combined (cover-abundance) scale of Braun-Blanquet was used [27, 28].

When drawing up the environmental characteristics and while performing the gradient analysis the following factors and indicators were taken into account: exposition, slope, altitude, soil type, bedrock, stoniness, mechanical structure, morphological complexity, continentality, humidity, precipitation, light, and temperature. Environmental groups of plants were determined according Ellenberg [29].

The nomenclature of higher plants is according Delipavlov and Cheshmedjiev [30]. Floral elements were determined using the system of Walter [31].

Phytocoenological nomenclature is according ICPN [32] and the referenced literature. Sintaxa to alliance level are in accordance with the concepts of Rodwel et al. [33] and Mucina et al. [34]. Natural habitats are according Kavrakova et al. [35] and Biserkov et al. [36].

Phytocoenological analysis was conducted according to the Braun-Blanquet approach [27]. The classification analysis was perfomed by using the software product JUICE [37]. Cluster analysis was done using Modified TWINSPAN [38] and additional use of control clustering tools TWINSPAN 1979 and K-means [39]. Sorensen`s dissimilarity index was used.

Phi-coefficient (fidelity – association ratio between species and plant units) was used to determine the diagnostic species [40]. Preliminary thresholds for fidelityare Phi ≥20 Lower, ≥60 Higher [41, 42, 43]. The values of the constancy of species was taken into consideration [41]. The thresholds accepted for constant species are those with 'Frequency threshold' – ≥50 Lower, ≥60 Higher. Dominant species have cover higher than the upper limit provided in the methodology ≥ 20 Lower, ≥60 Higher. For the purpose of comprehensive treatment of the database the program STATISTICA [44] was used.

Classification of species was done using the scale of Ellenberg [29]. To assess the influence of several factors (variables) we used simultaneously the multidimensional variance analysis. Also, descriptive analysis of the environmental variables was performed (Descriptive statistics). 26 environmental variables were compared in the range of 30 relevés. A separate grouping of environmental factors equal to the grouping of the phyto-coenotic descriptions was achieved as a result. Principal Components Analysis (PCA) for ordinates of vegetation to environmental variables was put into practice [29].

3 RESULTS AND DISCUSSION

As a result of the implemented classification and coordination procedures 4 basic syntaxa were identified.

They are included in the following syntaxonomic scheme:

Class *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939
Order *Piceetalia excelsae* Pawłowski et al. 1928
Alliance *Piceion excelsae* Pawłowski et al. 1928
Eu-Vaccinio-Piceenion Oberdorfer 1957
Association *Ranunculo carthusianae-Piceetum abietis* ass. nova (holotypus hoc loco, Annex I, rel. 8)
Community of *Picea abies* and *Luzula sylvatica*
Community of *Betula pendula*
Alliance *Pinion peucis* Horvat 1950
Association *Adenostylo alliariae-Pinetum peucis* ass. nova (holotypus hoc loco, Annex I, rel. 28)

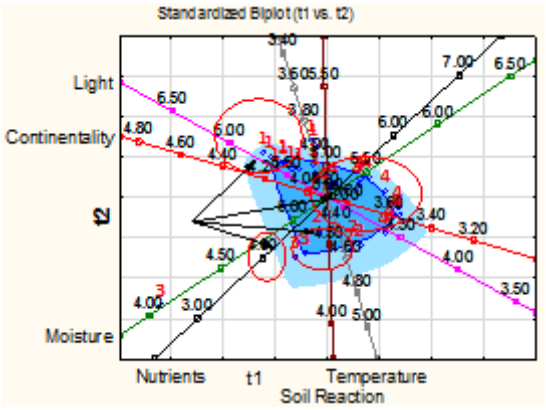

Figure 2: PCA of the boreal mountain forests on the territory of Central Stara Planina. 1 – Assoc. *Ranunculo carthusianae-Piceetum abietis*; 2 – Comm. of *Picea abies* and *Luzula sylvatica*; 3 – Comm. of *Betula pendula*; 4 – Assoc. *Adenostylo alliariae-Pinetum peucis*.

Fig. 2 illustrates the spatial arrangement of the isolated phytocoenoses in relation to the floristic similarity and the main environmental factors. Phytocoenoses from group № 1 develop on moderately

moist acidic soils at low temperatures and sufficient light. Group № 2 prefers less acidic substrates and relatively higher temperatures. Plant communities of Group № 3 develop at relatively low humidity and on poorer soils. Group № 4 combines hydrophilic and eutrophic communities.

3.1 Forests of *Picea abies*

Total 18 phytocoenotic relevés were done in this type of forest. Group №1 includes monodominant spruce forests. Group №2 unites forests with domination or high participation of *Picea abies*, in some places dominated by *Pinus peuce* and rarely (one time each) by *Abies alba* and *Fagus sylvatica*. The phytocoenoses dominated by or with participation of *Betula pendula* - group № 3 – possess high floristic and ecological similarity with forests of *Picea abies*. Species composition and location of these forests show that they are part of the succession line, developing on the site where coniferous forests were destroyed in the past. That is why they are referred to the alliance *Piceion excelsae* and are considered simultaneously as related to climax spruce forests.

High-mountain forests of *Picea abies*, monodominant or involving other conifers, form associations related to suballiance *Eu-Vaccinio-Piceenion* Oberd. 1957 and alliance *Piceion excelsae* Pawłowski et al. 1928. In Central Europe these communities often include *Larix europea*, *Pinus cembra* and *Pinus uncinata*, which sometimes form also monodominant phytocenoses. The spruce forests in Southeastern Europe are distinctive and with regional characteristics derived from both their history and the zonal location of mountains where they develop. Some authors accept the differentiation of regional suballiances, while others describe the regional associations. Based on some floristic characteristics in Romania the suballiance *Soldanello majori-Piceenion* Coldea 1991 is described [45, 46] as synvicariant of *Eu-Vaccinio-Piceenion* Oberd. 1957. The following associations are related to it: *Hieracio rotundati-Piceetum* Pawl. et Br.-Bl. 1939, *Luzulo sylvaticae-Piceetum* Wraber 1953, *Bruckenthalio-Piceetum* Borhidi 1969, *Vaccinio-Piceetum* Brez. et Had. 1962, *Sphagno-Piceetum* Brez. et Had. 1962, *Soldanello majori-Piceetum* Coldea et Wagner 1998 [45, 46, 47, 48, 49, 50, 51].

Phytosociologists in Serbia [52, 53, 54, 55, 56, 57, 58] point out a series of associations related to *Eu-Vaccinio-Piceenion – Junipero sibiricae-Piceetum* (Rudski 1947) Mišić et Popović 1980, *Oxali acetosellae-Piceetum abietis* (Rudski 1947) Mišić et Popović 1980, *Arctostaphyllo-Piceetum* (Jov. 1953) Mišić et Popović 1954.

The association *Piceetum subalpinum scardicum* Em (1962) 1986 was described in Macedonia (Jovanović et al. 1986). In Slovenia Zupančić (1980, 1999) includes spruce phytocoenoses in *Luzulo sylvaticae-Piceetum* Wraber 1963 em. Zupančić 1999 and *Luzulo albidae-Piceetum* Zupančić 1980. For Western Balkans the following associations were reported: Bosnia and Herzegovina - *Sorbo-Piceetum* Fukarek 1964; Croatia – *Piceetum croaticum subalpinum* Ht. (1950) 1967, *Helleboro nigrae-Piceetum* (Ht. 1958) Trinajstič et Pelcer 2005; Montenegro - *Piceetum abietis bertisceum subalpinum* Blečić (1961) 1964 [54]. In Greece the spruce forests have limited distribution. Dafis [59] refers them to the association *Piceetum abietis* s.l. and alliance *Piceion excelsae.*

In Bulgaria the spruce phytocoenoses are not enough studied. Most frequently mentioned in the phytocoenotic is the association *Piceetum myrtillosum*, distinguished by using the dominant method of Russian-Scandinavian phytocoenological school [6, 60]. Michalik [18] mentions the association *Piceetum excelsae balcanicum* (nom. illeg. – ICPN Art. 2b, 5, 34a) for the territory of the reserve "Boatin" (Central Stara Planina) [32]. An attempt to clarify the syntaxonomical status of spruce phytocoenoses in Rila was done by Rusakova & Valchev [61]. They relate the studied communities to alliance *Piceion excelsae* without any associations. Later, some of their relevés were included in the diagnosis of association *Moehringio pendulae-Piceetum* Roussakova et Dimitrov 2005, described for the territory of Rila and Western Rhodopes [62]. Pine species like *Pinus peuce* (as ecological vicariant of *Pinus cembra*) and *Pinus sylvestris*, and sometimes (in Rila and Pirin) *Pinus mugo* as undergrowth element, are common in the alpine spruce forests in Bulgaria [63]. Spruce forests in the Central Stara Planina occupy separate areas – Dobrila, Vezhen, Bashitite, Cartula, Boatin, Cherni vruh, Rozinska ravna and others. Most of these forests are older than 200 years. *Picea abies* forms mixed communities with *Pinus peuce* near Vezhen massif and partly with *Pinus sylvestris* north of Vezhen peak.

3.1.1 Ass. *Ranunculo carthusianae-Piceetum abietis* ass. nova hoc loco (Group № 1)

Diagnostic species: *Picea abies, Ranunculus carthusianus, Ribes alpinum, Rumex alpinus, Juniperus sibirica, Potentilla haynaldiana.* **Constant species**: *Picea abies, Juniperus sibirica, Ajuga reptans, Dryopteris filix-mas, Fagus sylvatica* ssp. *sylvatica, Myosotis sylvatica, Rubus idaeus, Scila bifolia, Senecio nemorensis, Sorbus aucuparia, Vaccinium myrtillus, Vaccinium vitis-idaea.* **Dominant species**: *Picea abies, Juniperus sibirica, Vaccinium myrtillus.* **Nomenclature type (holotypus):** Reléve 8, Annex I. The specific composition of species and environmental conditions are the reason for diagnosing the new association *Ranunculo carthusianae-Piceetum abietis*, which unites 11 phytocoenotic relevés.

The communities of the association *Ranunculo carthusianae-Piceetum abietis* are distributed in the range of 1600 – 1800 m.a.s.l. on slopes an average 8-10 degrees. (Fig. 3). The expositions vary, but those with western and northern components dominate, and there are also some with southernt component (below Karatepe peak). The rocks are silicate – south Bulgarian granite, slate, and diorite. The soils are Umbric, rarely Dystric or Modic Cambisols – moderately rich, medium deep, sandy and clay soils. The average temperature is about 3 °C.

The tree layer covers about 60% in average. Dominant species is *Picea abies* (Annex I). The cover of shrub layer ranges from 0 to 60%. *Picea abies, Juniperus sibirica, Ribes alpinum, Sorbus aucuparia, Fagus sylvatica* ssp. *sylvatica, Rubus idaeus, Rumex alpinus* are

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the most common species. The herbaceous layer has a cover of an average 40%. *Picea abies, Juniperus sibirica, Ranunculus carthusianus, Rumex alpinus, Vaccinium vitis-idaea, Veronica alpina* and others are with high constancy. Typical physiognomic feature for these communities is the low species diversity. These are light, subalpine forests, in certain areas changing into sparse early stage of forests involving *Juniperus sibirica*.

Figure 3: Ass. *Ranunculo carthusianae-Piceetum abietis*

Given the location of the forests at higher parts of the mountain and the climatic conditions, the boreal elements dominate (50%) in the phytogeographic spectrum, followed by the european (17%), arctic-alpine (13%), balkan, eurasian, euro-mediterranean, pontic and cosmopolitans (4% each).

Such types of forest are common in the Bashtite area, Karatepe, Dobrila, Gerdeka, Kumanitsa, and Harmana.

The combination of diagnostic species *Ranunculus carthusiana, Ribes alpinum, Rumex alpinus, Juniperus sibirica, Potentilla haynaldiana* reflects the highland character of the communities. These species are differential compared to other known associations of ordinary spruce on the Balkan Peninsula. The communities of the association *Ranunculo carthusianae-Piceetum abietis* are isolated from the similar forests, located in the western part of Stara Planina where the association *Junipero sibiricae-Piceetum* was established (Rudski 1947) Mišić et Popović 1980. The latter is distinguished by its open nature and the constant participation of species such as *Poa violacea, Potentilla ternata, Bruckenthalia spiculifoilia, Nardus stricta, Polygonum bistorta, Hypericum alpigenum, Agrostis capillaris, Thymus glabrescens, Alchemilla pubescens, Polygala comosa*, etc. [52, 58]. Furthermore *Ranunculus carthusianus, Ribes alpinum* and *Potentilla haynaldiana* are missing.

Association *Ranunculo carthusianae-Piceetum abietis* differentiates from the spruce forests described in Rila and Rhodope Mountains in Bulgaria, where participate species with high constancy as *Moehringia pendula, Melampyrum sylvaticum, Campanula sparsa, Lerchenfeldia flexuosa, Dicranum scoparium, Calamagrostis arundinacea, Orthilia secunda, Valeriana tripteris* [62]. This research confirms the findings of Roussakova and Dimitrov [62] that the spruce forests in Bulgaria differ from those located in neighboring countries which, although close as physiognomy and species composition, are characterized by the presence of species related to the specific historical development of the flora and vegetation. For example, the spruce communities in the Carpathian Mts are differentiated by a number of carpathian elements such as *Hieracium rotundatum, Syphythum cordatum, Dentaria glandulosa, Euphorbia carniolica, Soldanella major, Leucanthemum waldsteinii, Aconitum moldavicum*, etc. [48, 64]. The presence of species unusual for Central Stara Planina is typical in western Balkans - *Astrantia carniolica, Homogyne sylvestris, Adenostyles glabra, Lonicera alpigena, Sorbus mougeotii,* and *Helleborus niger* [6, 58].

3.1.2 Community of *Picea abies* and *Luzula sylvatica* (group №2)

Diagnostic species: *Picea abies, Pinus peuce, Dryopteris expansa, Laserpitium krapfii, Galium rotundifolium, Cardamine pectinata, Fragaria vesca, Geranium pyrenaicum, Galium odoratum.* **Constant species**: *Picea abies, Dryopteris filix-mas, Luzula luzuloides, Luzula sylvatica, Senecio nemorensis, Vaccinium myrtillus.* **Dominant species**: *Picea abies, Pinus peuce.*

The communities of this group are mainly located in the area between Kositsa peak and Yumruka peak (Fig. 4). They are distributed in the range of 1400 – 1600 m.a.s.l. The slopes are about 20 degrees. The exposures vary, but are dominated by those with northern and eastern components. The rocks are south Bulgarian granites, crystalline schists and others. Almost everywhere the soils are Umbric Cambisols, but in the lower parts are Dystric-Eutric Cambisols, medium deep, sandy and stony. The average temperature is above 4 °C. The environmental analysis shows that these are alpine forests, growing in places rich with nitrogen and water, shady and dark.

Figure 4: Community of *Picea abies* and *Luzula sylvatica*

These forests accomplish the transition from the mixed coniferous-deciduous forests to macedonian pine forests. The cover of the tree layer is 60-90%. Dominant and subdominant species is *Picea abies*, in certain communities *Pinus peuce* dominates, while in others

there is participation of *Fagus sylvatica* and *Abies alba*. In the shrub layer the coverage ranges from 0 to 20%, involving mainly undergrowth of *Picea abies* and *Fagus sylvatica*. The herbaceous layer has a cover an average of 30%. The most commonly found species are *Dryopteris filix-mas, Luzula luzuloides, Luzula sylvatica, Senecio nemorensis, Vaccinium myrtillus* (Annex I).

Boreal elements dominate in those communities too (40%) although their quantity is less compared to the monodominant spruce and macedonian pine forests that grow at high altitudes and in extreme ecological conditions. There is a relatively high participation of the sub-mediterranean elements (17%), followed by european (13%), mediterranean (9%) balkan (9%). Euro-mediterranean, euro-asian and cosmopolitan elements are involved with 4% each.

Typical physiognomic feature of these forests is the big cover of the tree layer, the lack of shrub layer at most places and poor grass layer with low coverage. The grass cover is formed only near small streams, bright open "windows" when the horizontal structure is disrupt, around springs. These phytocoenoses do not border the timberline zone, as the belt over them are common to the forests of *Pinus peuce*. The facies of *Luzula sylvatica* and *Senecio nemorensis* which develop in the lighter areas are typical.

3.1.3 Community of *Betula pendula* (group № 3)

Diagnostic species: *Betula pendula*. **Constant species**: *Fagus sylvatica* ssp. *sylvatica, Betula pendula, Luzula luzuloides, Vaccinium myrtillus.*

Dominant species: *Betula pendula, Juniperus sibirica, Vaccinium myrtillus.*

The communities of this group develop around the timberline in the areas where this line is composed of spruce forests, mostly south of the main ridge of the mountain. They are distributed in the range of 1400 – 1600 m.a.s.l. Sloppes are about 30-35 degrees. The expositions are diverse, but dominated by those with a southern component. The rocks are silicate – south Bulgarian granite, slate, diorite and some other less represented types. The soils are Umbric Cambisols, and in the lower parts Dystric Cambisols, moderately rich, medium deep, sandy, mostly stony. The average annual temperature is above 4 °C.

Figure 5: Community of *Betula pendula*

The cover of the tree layer is 50% on average. *Betula pendula* is the main dominant, but *Picea abies* dominates in some localities (Fig. 5). In the shrub layer *Fagus sylvatica* ssp. *sylvatica* and *Betula pendula* have sporadic occurrence. The grass layer has cover an average of 30%. Most commonly are found *Betula pendula, Luzula luzuloides* and *Vaccinium myrtillus* (Annex I).

The boreal floristic elements (36%) have the lowest relative participation in these forests. The higher temperatures and the open character of some of the communities are the major cause of strong presence of euro-mediterranean (25%) and mediterranean elements (7%), followed by euro-asian (14%), balkan (11%) and european (7%).

Characteristics of these forests are their fragmented distribution, their great lighting, the presence of *Betula pendula* in all layers, the acidophilous and oligotrophic character, and the low soil moisture. During the last 10–20 years there has been an expanding of their area and occupation of territories in the subalpine treeless zone in many places in the mountains, mainly in the high southern slopes – Ravnets massif over Vasil Levski, Karlovo and Sushitca villages, above Sopot, Anevo, Karnare, Iganovo and in several other places in the western part of the mountain.

3.2 Forests of *Pinus peuce*

12 relevés dominated by *Pinus peuce* which form a separate cluster of high floristic similarity were made during this research (group №4).

The forests of *Pinus peuce* in Europe belong in the mountainous and sub-alpine nemoral coniferous vegetation. These forests were much or less formed under the Mediterranean influence. Therefore, and due to historical reasons associated with the last icing, that vegetation can be considered endemic. The spread of the forests of macedonian pine is like insularity. They can be found in the highest mountain systems of Montenegro, Kosovo, Albania, Macedonia, and Bulgaria. The data on the natural habitat of macedonian pine in Bosnia and Herzegovina needs confirmation through genetic studies [65]. Vertically and environmentally the macedonian pine forests occupy mostly areas above beech and spruce forests and form the upper timberline, mainly on acid substrates, and less frequently on basic rocks.

The areal of macedonian pine forests include the Rila-Rhodope massif, Stara Planina, Voras, Shar Planina, Mokra gora and others. Their total area is about 96 000 ha [66], of which about 250 ha is territory of Central Stara Planina.

Various of authors have contributed in the sintaxonomy of the forests of *Pinus peuce* in the Balkans [6, 67, 68, 69, 70, 71, 72, 73, etc.]. The sintaxonomy of phytocoenoses of macedonian pine in Bulgaria is developed using only the dominant method of Russian-Scandinavian Phytocoenological School [14, 16, 74, 75]. The presence of the typical species *Gentiana lutea*, *Knautia midzorensis, Verbascum longifolium* ssp. *Pannosum* and the floristic composition of some phytocoenoses are a reason to assume their distribution in this country, at least partly in Rila and Pirin. The association *Gentiano luteae-Pinetum peucis* described by Pelister in Macedonia and the typical species of the endemic for the Balkan alliance *Pinion peucis* are found

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everywhere in phytocoenoses of *Pinus peuce* in Bulgaria [76].

Studies show that since 1970 there is a remarkable ascent of the macedonian pine in Rila and Stara Planina, which is mainly associated with climate changes and the increasing temperatures and weakened anthropogenic pressure [16, 77].

3.2.1 Ass. *Adenostylo alliariae-Pinetum peucis* ass. nova hoc loco (group № 4)

Diagnostic species: *Pinus peuce, Adenostyles alliariae, Calamagrostis arundinacea, Homogyne alpina.* **Constant species**: *Picea abies, Athyrium filix-femina, Dryopteris filix-mas, Hieracium murorum* gr., *Luzula luzuloides, Luzula sylvatica, Mycelis muralis, Prenanthes purpurea, Rubus idaeus, Senecio nemorensis, Sorbus aucuparia, Stellaria nemorum, Vaccinium myrtillus.* **Dominant species**: *Pinus peuce, Picea abies, Pinus sylvestris, Sorbus aucuparia, Festuca drymeja, Luzula sylvatica.* **Nomenclature type (holotypus)***:* Relévе 28, Annex I.

The comparative analysis of the total species composition, of the diagnostic species and of the environmental conditions in relation to the previously described syntaxons allows us to describe a new association - *Adenostylo alliariae-Pinetum peucis*.

The distribution of its communities is in the range of 1600-1900 m.a.s.l., but mostly at about 1700 m.a.s.l. The slopes are an average 35 degrees. The exposures are varied, but dominated by those with westerly and northerly component. South of Vezhen peak exposures are with southern components (Fig. 6). The rocks are acidic – south bulgarian granite, diorite and others. The soils are mainly Umbric Cambisols, medium rich to rich, medium deep, sandy, stony, wet. Compared with other boreal mountain forests in Central Stara Planina, the communities of *Pinus peuce* grow in the most humid and rich soils (Group № 4, Fig.2). The average annual temperature is about 3 degrees.

Figure 6: Ass. *Adenostylo alliariae-Pinetum peucis*

The tree layer cover is an average 60%. Dominants in various ratios, mostly prevailed by *Pinus peuce* are *Pinus peuce, Picea abies, Pinus sylvestris* and *Abies alba*. The cover of the shrub layer is generally low (below 10%). *Sorbus aucuparia* and *Rubus idaeus* are most common. The grass layer has a cover of on average 40%. Dominant and constant species most often are *Athyrium filix-femina, Adenostyles alliariae, Diphyscium foliosum, Gentiana asclepiadea, Gymnocarpium dryopteris, Homogine alpina, Lamium garganicum, Calamagrostis arundinacea, Stellaria nemorum* (Annex I).

Typical physiognomic feature of these forests are dense facies of *Adenostyles alliariae* in the grass layer, especially on a wet places and near streams.

In phytogeographical spectrum the boreal elements dominate (56%), which is determined by the environmental conditions, especially by the acidic substrates and the altitude. Follow by european and balkan (12%), mediterranean (8%), arctic-alpine, euro-mediterranean and cosmopolitans (4% each).

The association *Adenostyles alliariae-Pinetum peucis* has a relatively hygrophylous character and species that are not found in other known associations are present here - *Adenostyles alliariae, Cirsium appendiculatum, Heracleum verticillatum, Veronica beccabunga, Stellaria nemorum, Gymnocarpium dryopteris, Dryopteris dilatata, Senecio nemorensis, Diphyscium foliosum*. Moreover, other species, described in other associations for different areas, cannot be found here: *Gentiana lutea, Lilium carniolicum, Doronicum columnae, Bruckenthalia spiculifolia* and *Knautia midzoensis* for association *Gentiano luteae-Pinetum peucis* Em 1960; *Alyssum bertolonii, Dactylorhiza saccifera, Daphne blagayana, Minuartia baldaccii* and *Thymus boissieri* for association *Pinetum peucis* Janković 1959; *Digitalis viridiflora, Vaccinium uliginosum, Helleborus cyclophyllos* and *Astragalus glyciphyllos* for association *Digitali viridiflorae-Pinetum peucis* Em 1960; *Wulfenia carinthiaca, Potentilla ternata, Geum montanum* for association *Wulfenio carinthiacae-Pinetum peucis* Blečić et Tatić 1957; *Ajuga pyramidalis, Galium rotundifolium, Briza media, Platanthera bifolia* for Association *Ajugo pyramidalis-Pinetum peucis* Janković et R. Bogojević 1962, etc. [6, 58, 78].

The monodominant and mixed communities of macedonian pine in Central Stara Planina are located in separate mountain localities – north of Vezhen peak and Kamenitza peak. Scattered small groups are developing around Yumruka peak. In the recent past they had been developing into lower altitudes on inaccessible steep terrains [16]. In the recent years the lower limite had risen, where the macedonian pine is replaced primarily by beech. The upper limite has been higher as well and it corresponds to the upper timberline of the forest.

3.3 Conservation

Boreal mountain forests in Central Stara Planina are located within the National Park "Central Balkan". This is the second largest national park in Bulgaria and one of the most valuable park and one of the largest protected areas in Europe – second category according to the International Union for Conservation of Nature (IUCN). The territory of the park overlaps with the territory of the Special Protection Area – BG 0000494 Central Balkan (NATURA 2000), and about 45 000 ha of forest habitats are preserved there. The studied boreo-mountain forest communities belong to three habitat types listed in Annex I of the Habitats Directive 92/43/EEC and to 3 types of

habitats of the Red Book of Bulgaria – section 3 Natural habitats [36].

The spruce forests (ass. *Ranunculo carthusianae-Piceetum abietis*, comm. of *Picea abies* and *Luzula sylvatica*) are related to habitat 9410 Acidophillous *Picea* forests of the montane to alpine levels (*Vaccinio-Piceetea*) and habitat 34G3 Norway spruce (*Picea abies*) forests with conservation category Nearly threatened [63].

The forests dominated by common birch (comm. of *Betula pendula*) are related to habitat 25G1 Birch (*Betula pendula*) forests with conservation category Nearly threatened [79].

Macedonian forests (ass. *Adenostylo alliariae-Pinetum peucis*) are identified with habitat 95A0 High oro-Mediterranean pine forests and 38G3 Macedonian pine (*Pinus peuce*) forests – Endangered habitat [77].

4 CONCLUSION

The boreo-mountain forests on the territory of Central Stara Planina are fragmented, forming a separate belt only at the highest parts. The described new associations with specific species composition show their relict character, their geographical isolation and the specific environmental conditions.

Early stages of forest dominated by spruce, macedonian pine, silver birch and scots pine, which displace mainly heats and bushes of bilberries and siberian juniper are developing in the upper timberline. Particularly active in this process is the macedonian pine that is successfully spreading on mountain screes, rock landslips and steeper slopes, on places where spruce forests cannot grow.

The results obtained from this research will be a sound basis for making correct management decisions. They will be of great help at monitoring the forest succession in the highest part of the mountain.

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Annex I: Syntaxonomical table of boreo-montane forest phytocoenoses in Central Stara Planina Mts.

1 - Assoc. *Ranunculo carthusianae-Piceetum abietis* ass. nova, holotypus hoc loco, rel. 8; 2 - Comm. of *Picea abies* and *Luzula sylvatica*; 3 - Comm. of *Betula pendula*; 4 - Assoc. *Adenostylo alliariae-Pinetum peucis* ass. nova, holotypus hoc loco, rel. 28 (Fidelity >20)

Syntaxa	1												2					3				4													
Relève number	1	2	3	4	5	6	7	8	9	10	11		12	13	14	15		16	17	18		19	20	21	22	23	24	25	26	27	28	29	30		
Altitude (m a.s.l.) (x 10)	169	169	178	172	170	167	169	170	168	168	169		147	160	159	161		151	145	144		162	173	164	168	175	161	170	181	183	183	179	168		
Exposition	W	W	SE	N	S	SW	W	W	S	W	SW		N	NE	NE	NE		N	SE	S		NW	NE	N	N	NE	W	N	N	N	N	NE	N		
Slope (degree)	1	10	2	15	20	10	1	3	8	1	15		50	20	20	10		2	35	40		20	35	45	35	45	35	10	30	50	45	50	10		
Sample size (m^2)	400	400	400	400	400	400	400	400	400	400	400		400	400	400	400		225	225	225		400	400	400	400	400	400	400	400	400	400	400	400		
Cover of trees (%)	45	40	45	60	60	70	90	80	60	65	70		60	90	90	90		40	75	50		55	55	70	70	60	65	65	50	40	55	70	65		
Cover of bushes (%)	60	60	4	2	3	4	20	15	10	20	4		10	0	20	5		1	0	40		10	1	2	2	3	5	10	3	3	3	1	40		
Cover of grass (%)	20	20	50	45	60	40	30	35	45	35	45		50	30	30	20		55	30	20		40	60	40	40	55	40	40	40	75	45	40	30		
Soil richness	7	7	7	5	5	5	5	5	5	5	5		5	7	7	7		5	5	3		5	7	5	7	7	5	7	5	5	5	7	7		
Soil depth	4	4	4	3	3	3	3	3	3	3	3		3	4	4	4		3	3	2		3	4	3	4	4	3	4	3	3	3	4	4		
Soil stoniness	2	2	2	2	2	2	3	2	2	3	2		3	2	3	2		3	3	4		2	3	2	3	3	2	3	3	3	3	3	3		
Soil composition	4	4	4	4	4	4	4	4	4	4	4		4	4	4	2		3	4	4		4	4	4	4	4	4	4	4	4	4	4	4		
Soil reaction	4.5	4.7	4.9	5.1	5.2	4.9	5.2	5.8	5.6	5.1	5.2		4.4	4.2	4.9	4.6		3.5	6.1	4.4		4.4	5	4.7	4.7	5.1	4.5	4.3	4.6	4.6	4.7	4.9	4.2		
Nutrients	4.7	4.6	5	5.2	5.5	5.4	5.3	5.2	5.2	5.2	5.2		5	5	4.7	5.2		2.2	4.7	4.6		5.1	5.3	5.2	5.2	5.3	4.8	5	5.1	5.3	5.2	5.4	5.2		
Moisture	5.2	5.2	5.2	5.2	5.2	5.3	5.6	4.9	4.9	5.7	4.9		5.1	5	5.1	4.9		4.2	5.1	5		5.3	5.5	5.4	5.4	5.6	5.3	5.4	5.5	5.6	5.5	5.6	5.3		
Accessibility Q	500	500	500	500	500	500	500	500	500	500	500		650	650	650	650		700	600	700		700	700	700	700	700	700	700	700	700	700	700	700		
Air humidity Vv	83	83	83	83	83	83	83	83	83	83	83		82	83	82	83		82	82	82		83	83	83	83	83	83	83	83	83	83	83	83		
Light	5.4	5.4	5.6	5.4	5.2	5.2	5.5	5.6	5.7	5.6	5.4		4.9	4.3	4.7	5.2		5.9	4.9	5.1		4.5	4.6	4.6	4.5	4.8	4.6	5.4	5.3	5.3	5.3	5.2	5.3		
Temperature	3.6	3.8	4.1	4.3	4.3	4.5	3.9	4.2	4.2	4	4		4.5	4.3	4.4	4.6		4.3	5.4	4.4		4.5	4.6	4.6	4.5	4.4	4.6	3.8	3.9	3.8	3.9	4	4		
Continentality	3.8	4.2	4.1	4	4	3.9	3.9	4.4	4.2	3.9	4.1	***Fidelity***	3.4	3.9	3.6	4.1	***Fidelity***	4.5	3.9	3.7	***Fidelity***	3.5	3.6	3.6	3.5	3.8	3.5	4.2	3.8	3.8	3.8	3.9	4.5	***Fidelity***	
Ranunculus carthusianus	1	.	.	r	1	1	+	+	+	+	+	**88**	.	.	.	.	--*	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Rumex alpinus	.	.	+	+	1	1	+	+	1	+	1	**88**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Myosotis sylvatica	1	1	+	+	+	+	+	+	+	+	+	**86**	.	.	.	1	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Juniperus sibirica b	4	4	+	+	+	1	+	+	1	2	1	**82**	.	.	.	.	--	.	.	3	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Juniperus sibirica c	1	2	+	+	+	+	+	+	+	+	+	**82**	.	.	.	.	--	2	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Ribes alpinum b	.	.	+	+	1	.	+	1	1	+	+	**82**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Vaccinium vitis-idaea	1	.	2	1	2	1	1	2	2	1	1	**75**	.	.	.	.	--	2	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Fagus sylvatica c	1	1	+	+	+	+	.	+	+	+	1	**75**	.	.	.	.	--	.	.	1	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Potentilla haynaldiana	.	.	.	r	r	1	.	1	1	.	r	**69**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Scilla bifolia	.	1	2	+	+	+	+	2	+	1	.	**68**	.	.	.	.	--	.	2	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Veronica officinalis	.	.	1	+	+	+	+	.	1	+	+	**65**	.	.	.	.	--	.	.	.	--	1	.	.	+	.	+	.	.	.	.	.	.	--	
Ajuga reptans	1	.	+	+	+	1	+	.	2	+	1	**48**	1	.	1	.	--	.	1	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--	
Picea abies b	.	1	1	1	1	1	2	2	2	2	1	**48**	.	.	2	2	--	.	.	.	--	.	.	.	.	+	.	+	1	1	1	+	+	--	

continued

continuation of Annex I

Acer pseudoplatanus b	.	.	.	.	+	1	+	.	.	.	.	**47**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Veronica alpina	1	.	.	.	.	.	+	.	.	+	.	**47**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Veronica beccabunga	.	.	.	.	.	.	2	.	.	2	.	**38**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Juncus effusus	.	.	.	.	.	.	.	.	.	1	.	**26**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Geum coccineum	.	1	.	.	.	.	.	.	.	.	.	**26**	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Dryopteris expansa	.	.	.	.	.	.	.	.	.	.	.	--	.	.	1	1	**66**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Laserpitium krapfii	.	.	.	.	.	.	.	.	.	.	.	--	.	.	1	.	**45**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Galium rotundifolium	.	.	.	.	.	.	.	.	.	.	.	--	.	.	1	.	**45**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Cardamine pectinata	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	1	**45**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Fragaria vesca	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	1	**45**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Geranium pyrenaicum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	1	**45**	.	.	.	--	.	.	.	.	.	.	.	.	.	.	.	.	--
Galium odoratum	.	1	.	.	.	.	.	.	.	.	.	--	.	2	.	1	**41**	.	.	.	--	.	+	.	1	+	.	.	.	.	.	.	.	--
Abies albac	.	.	.	.	.	.	.	.	.	.	.	--	.	1	1	.	**23**	.	1	.	--	1	+	+	+	.	+	.	.	.	.	.	.	--
Betula pendula a	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	3	1	2	**78**	.	.	.	.	.	.	.	.	.	.	.	.	--
Betula pendula b	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	1	.	1	**78**	.	.	.	.	.	.	.	.	.	.	.	.	--
Chamaecytisus austriacus	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	1	1	.	**78**	.	.	.	.	.	.	.	.	.	.	.	.	--
Potentilla rupestris	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	2	.	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Poa nemoralis	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	1	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Crocus veluchensis	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	1	.	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Corylus avellana c	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	1	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Asarum europaeum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	1	.	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Acer pseudoplatanus a	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	+	.	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Acer pseudoplatanus c	1	.	.	+	+	+	.	.	.	+	.	--	.	.	.	.	--	.	1	1	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Acer heldreichii c	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	1	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Epilobium montanum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	1	.	**52**	.	.	.	.	.	.	.	.	.	.	.	.	--
Geranium macrorrhizum	.	.	.	.	.	.	.	.	.	.	.	--	2	.	.	.	--	.	1	.	**31**	.	.	.	.	.	.	.	.	.	.	.	.	--
Abies alba a	.	.	.	.	.	.	.	.	.	.	.	--	2	.	.	.	--	.	.	2	**21**	.	.	2	.	.	3	.	.	.	.	.	.	--
Luzula luzuloides	1	1	1	+	2	.	+	.	.	+	.	--	1	1	.	1	**1**	1	2	2	**52**	2	+	1	1	1	1	1	+	+	+	.	1	**23**
Calamagrostis arundinacea	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	1	--	.	.	.	--	1	+	r	+	+	+	+	+	r	+	r	1	**86**
Hieracium murorum gr.	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	1	--	+	+	1	+	+	+	+	+	+	+	+	1	**82**
Dryopteris dilatata	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	2	1	2	2	.	.	1	2	1	1	.	**78**
Gentiana asclepiadea	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	+	+	+	+	+	.	1	+	+	.	.	**78**
Adenostyles alliariae	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	2	.	2	+	.	1	1	2	2	2	.	**78**
Stellaria nemorum	.	.	.	2	+	2	+	.	.	+	.	--	.	.	.	.	--	.	.	.	--	1	+	+	+	+	+	1	+	1	+	2	1	**76**
Lamium garganicum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	1	+	+	+	r	+	.	.	.	.	r	.	**72**
Homogyne alpina	1	.	2	2	.	.	+	.	.	r	.	--	.	.	.	.	--	.	.	.	--	1	+	+	+	+	+	+	+	1	1	+	.	**70**
Pinus peuce a	.	.	.	.	.	.	.	.	.	.	.	--	.	5	.	3	--	.	.	.	--	2	3	2	2	4	2	2	2	3	3	3	2	**68**

continued

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continuation of Annex I

Festuca drymeja	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	1	+	1	+	+	3	.	.	.	.	.	.	**66**
*Abies alba*b	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	2	+	+	+	+	2	.	.	.	.	.	.	**66**
Pinus peuce b	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	+	.	.	1	1	1	+	.	**59**
*Pinus peuce*c	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	+	+	+	+	+	.	**59**
Gymnocarpium dryopteris	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	+	.	1	+	.	.	.	+	.	r	.	**59**
Mycelis muralis	.	.	+	+	+	1	+	.	.	+	.	--	.	.	1	1	--	.	.	.	--	1	+	+	+	+	+	+	+	+	+	+	1	**56**
Prenanthes purpurea	1	1	.	.	.	.	.	.	.	.	.	--	1	.	1	.	--	.	.	.	--	.	1	1	1	1	.	+	1	+	+	+	1	**54**
Lerchenfeldia flexuosa	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	r	+	r	.	1	.	.	.	.	.	.	**52**
Diphyscium foliosum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	+	.	.	+	.	.	.	.	.	+	.	**45**
Cirsium appendiculatum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	+	1	1	.	.	**45**
Geranium sylvaticum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	+	+	.	.	**36**
Dryopteris filix-mas	1	.	r	+	+	+	+	+	1	.	1	--	.	1	1	1	--	.	.	1	--	1	1	+	+	1	1	+	1	1	1	+	1	**36**
Pinus sylvestris a	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	3	.	.	.	.	3	**36**
Pinus sylvestris b	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	+	.	.	.	.	+	**36**
Pinus sylvestris c	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	+	.	.	.	.	1	**36**
*Lonicera xylosteum*b	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	+	.	.	.	.	.	.	.	**25**
Heracleum verticillatum	.	.	.	.	.	.	.	.	.	.	.	--	.	.	.	.	--	.	.	.	--	.	.	.	.	.	.	.	.	+	.	.	.	**25**
Luzula sylvatica	1	1	.	+	.	.	+	.	.	+	.	--	2	2	.	1	**23**	.	.	.	--	1	3	2	2	3	1	2	2	2	2	2	2	**52**
Senecio nemorensis	1	1	+	+	1	1	+	+	2	+	1	**35**	2	1	1	2	**35**	.	.	.	--	1	1	+	1	+	.	2	2	2	2	+	1	**24**
Picea abies a	3	3	3	4	4	4	5	5	4	4	4	**26**	3	2	5	3	**26**	.	4	+	--	4	2	3	3	2	+	2	2	2	2	2	2	**26**
Picea abies c	1	1	+	+	+	.	+	1	1	+	+	**50**	.	.	.	.	--	.	.	.	--	1	+	+	+	+	+	+	+	1	+	+	1	**60**
Rubus idaeus	1	1	1	1	1	1	+	+	+	r	1	**60**	.	.	.	.	--	.	.	1	--	.	+	+	+	1	+	+	+	+	+	+	1	**41**
Athyrium filix-femina	1	1	+	.	2	+	+	.	.	+	+	**40**	.	.	.	.	--	.	.	.	--	.	1	+	1	1	.	+	+	2	1	+	1	**52**
*Sorbus aucuparia*c	1	1	+	+	1	+	+	.	.	+	1	**35**	.	.	.	1	--	.	.	.	--	+	+	+	+	+	+	2	+	+	+	+	1	**56**
Sorbus aucuparia b	.	.	+	+	+	+	.	.	.	+	1	**28**	2	.	.	.	--	.	.	.	--	1	+	+	1	+	+	2	.	.	.	+	3	**53**
Oxalis acetosella	.	.	.	r	r	+	.	.	.	.	1	**25**	.	.	.	.	--	.	.	.	--	1	+	+	+	.	+	.	.	.	.	.	.	**32**
Vaccinium myrtillus	2	1	2	2	3	2	2	2	2	2	3	--	2	2	2	1	--	3	.	1	--	2	2	1	+	2	+	+	1	1	1	1	1	--
Fagus sylvatica a	.	.	.	.	.	.	.	.	.	.	.	--	2	.	.	.	--	+	+	2	--	+	.	2	+	.	2	.	.	.	.	.	.	--
Fagus sylvatica b	.	.	.	.	+	1	.	1	+	.	1	--	2	.	.	.	--	.	.	1	--	1	+	1	1	+	+	.	.	.	.	.	.	--

Locality of releves: Boryanin grob - **1, 4, 11**; Gerdektepe - **2**; Karatepe - **3, 7–10**; Dobrila - **5**; Nezabravka - **6**; Peshova maka - **12, 17**; Chernata mogila - **13**; Hristova dolchina - **14**; Dutkova polyana - **15**; Kelkaya - **16**; Dermenakaya - **18**; Murov dol - **19, 20, 25**; Borov dol – **21—24, 29, 30**; Kasadzhika –**26–28**.

Location: 1– 42° 42' 45.8964", 24°43' 48.6156"; **2** - 42°42' 58.0248", 24°42' 52.1100"; **3** - 42°42' 28.2960", 24°44' 22.6392"; **4** - 42°42' 47.3868", 24°43' 55.9704"; **5** - 42°42' 28.2960", 24° 44' 22.6392"; **6** - 42°42' 20.2932", 24° 44' 7.7856"; **7** - 42°42' 46.3320", 24°43' 53.2344"; **8** - 42°42' 46.1880", 24°43' 53.8608"; **9** - 42°42' 43.0308", 24°44' 0.4056"; **10** - 42°42' 46.5300", 24°43' 53.1876"; **11** - 42° 42' 38.7972", 24° 44' 4.0740"; **12** - 42°44' 3.7019", 24°39' 36.8192; **13** - 42°46' 29.4528", 24°23' 27.6432"; **14** - 42°46' 34.5072", 24°23' 25.0368"; **15** - 42°46' 34.5072", 24°23' 25.0368"; **16** - 42°43' 34.5108", 24°40' 28.0020"; **17** - 42°43' 56.2584", 24°39' 25.9992"; **18** - 42°43' 55.2828", 24°39' 42.2100"; **19** - 42°46' 15.3408", 24°23' 23.1036"; **20** - 42°45' 52.2036", 24°23' 17.0556"; **21** - 42°45' 59.0580", 24°23' 23.5176"; **22** - 42°45' 54.4716", 24°23' 19.5108"; **23** - 42°45' 52.4340", 42°45' 52.4340"; **24**- 42°46' 8.4432", 24°23' 25.4940"; **25** - 42°46' 12.4824", 24°23' 36.7368"; **26** - 42°45' 53.3196", 24°23' 37.2192"; **27** - 42°45' 46.4796", 24°23' 24.3276"; **28** - 42°45' 49.8672", 42°45' 49.8672"; **29** - 42°45' 46.0080", 24°23' 15.8496"; **30** - 42° 46' 13.3536", 24°23' 37.8708.

Date: 25.06.2013 -**1–11**; 12.06.2011 -**12**; 26.06.2012 - **17**; 09.07.2011 -**13–15**; 18.06.2013 - **16**; 07.06.2013 - **18**; 11.07.2013 -**19–30**.

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