Vegetation of alpine screes on Bjelašnica Mt. — syntaxonomy and ecology

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Abstract
We analysed vegetation of calcareous screes in the alpine belt of Bjelašnica Mt. (Western Balkan) by the Central European phytosociological method. In total, 69 relevés were submitted to numerical analysis in R ver. 3.5.2. (UPGMA clustering with chord distance). The obtained cluster dendrogram showed differentiation in nine associations, of which Festuco xanthinae—Valerianetum montanae Trakić et al. ass. nov. and Drypido spinosae—Seslerietum wettsteinii Trakić et al. ass. nov. are new ones. In lower section of the alpine belt we described new subassociation Pseudofumarietum leiospermae helictochloetosum Trakić et al. subass. nov. which raises questions about ecological preferences of the alliance Corydalion ochroleucae. We also neotypified the association Drypidi—Heracleetum orsinii Redžić et al. ex Trakić et al. and made correction for Pseudofumarietum leiospermae Lakušić et Redžić 1991 nom. corr. The observed high diversification of the alpine screes on Bjelašnica Mt. is based upon its ecological heterogeneity and tranzitional position in the Dinarides.

Key words: New syntaxa, alpine screes, distribution pattern, Dinarides.

Introduction

The vegetation of screes in the Dinarides occurs azonally, mainly in the alpine and subalpine belt, between 1800 and 2000 m a.s.l. (Strid et al., 2003). Due to extreme temperature fluctuation, the weathering of rocks, which gives rise to rockslides, is more intense at high altitudes. On the other hand, development of screes in the past was favoured by the Periglacial climate (Ružička and Klimeš, 2005), as well as by the occurrence of the Pleistocene glaciers which covered numerous mountain tops across the Balkan Peninsula (Cvijić, 1924), and exist even today in the central Dinarides (Gachev et al., 2016; Gachev, 2017). Generally, the glaciation events have played major role when it comes to the evolution of dinaric relief (Roglić, 1959) and local flora (Mucina et al., 1990; Stevanović et al., 2009). The regional orogenesis gave rise to isolated habitats in the alpine belt, because of which the screes represent an island-like ecosystems that support species missing in the surrounding areas (Möseker and Molenda, 1999; Kubát, 2000). The proportion of glacial or Tertiary relics within the vegetation of alpine screes is high (Lakušić, 1975; Redžić et al., 2011a). Because of conservative thermic character, screes are largely independent of the above-ground temperature fluctuations (Ružička and
Klimeš, 2005), creating the ecoclimatic which is suitable for the psychrophilous vegetation. Due to the harsh ecoclimatic and conditions related to them, the syntaxa of scree vegetation are clearly distinguished from each other (Redžić, 2011b).

However, since at the bottom of screes in the alpine belt frequently occur snow-beds, vegetation of screes and snow-beds show syngenetic continuity which raises controversy about their syntaxonomy (Mucina et al. 1990, 2016; Šilić, 1969; Modrić Surina et Surina, 2010). By some authors, the vegetation around snow-beds is classified in the class Thlaspietea rotundifolii Br.-Bl. 1948 (Lakušić et al., 1969; Englisch et al. 1993; Theurillat et al., 1995; Englisch, 1999; Modrić Surina et Surina, 2010; Škvorc et al. 2017), whereas others included it in the class Salicetum herbaceae Br.-Bl. et al. 1947 (Lakušić, 1968; Horvat et al., 1974). After Mucina et al. (2016), the class Thlaspietea rotundifolii Br.-Bl. 1948 encompasses screes of temperate, boreal and oromediterranean Europe, of which the order Thlaspietealia rotundifolii Br. encompasses calcareous screes in the alpine and subalpine belt of Europe and Greenland. From the above mentioned order, in the Balkan occur alliances Saxifragion prenjae Lakušić 1968, Bunion alpini Lakušić 1968 and Veronic—Papaverion degenii Mucina et al. 1990. On the other hand, the montane submediterranean and oromediterranean screes of the Balkan, Crete and Crimea are encompassed by the class Drypidetea spinosae Quézel 1964 (order Drypidetalia spinosae Quézel 1964), of which in the Western Balkan occur alliances Peltarion alliaceae Horvatić in Domac 1957, Corydalion ochroleucae Lakušić 1975 and Silenion marginatae Lakušić 1968 (Mucina et al., 2016).

Inspite of the proximity to the capital of Bosnia and Herzegovina (B&H), Bjelašnica Mt. is poorly investigated in respect of vegetation diversity in general. Previous studies have been conducted either as a part of broader vegetation research, such as the vegetation map project for the B&H (Bjelčić et al., 1975), or as the assessment study of its natural values with the purpose to define conservation measures for the area (Redžić et al., 1999). In addition, the vegetation of alpine screes in the B&H has been anaalised only within ecological research of the entire alpine belt (Lakušić et al, 1969; Lakušić et al. 1982; Redžić et al., 1984), but it was missing in some of them (Bjelčić, 1966; Lakušić et al., 1982; Redžić et al., 1984).

The aim of our study was to define the syntaxonomic pattern for vegetation on screes in the alpine belt of Bjelašnica Mt.

Materials and methods

Study Area

Bjelašnica Mt. is located 21 km southwest from Sarajevo (between 43° 41’ 33.0 and 43° 45’ 22.9”N; 18° 09’ 59.4” and 18° 10’ 27.9”E) (Figures 1).

It is placed in the transitional zone of Dinarides and stretches in the direction from NW to SE (Mojičević, 1984). Its geographic position in Bosnia and Herzegovina is very specific, for major part of it belongs to Northern Dinarides, while small proportion belongs to SE Dinarides. The area belongs to the High-Dinaric Province of High-Alpine-Nordic region (Lakušić, 1969; 1975). Southern slopes of Bjelašnica are in High-Zelengora’s sector, while norther slopes are placed in High-Treskavica’s sector (Redžić, 2011). The highest peaks are Observatory (2067 m), Kravac (2062 m), Velika Vlahinja (2057 m) and Velika Hranisava (1965 m). The NE section is mainly built up of limestone with megalodones, whereas SW and S sections are made of grey dolomite with small proportion of limestone (Mojičević, 1977). Its morphostructure is sharply carved by canyons of river Neretva, Rakitnica and Trešanica during Pliocene (Milojević, 1937; Lepirica, 2013). The upper surface of Bjelašnica Mt. is karstified upland, with countless sinkholes and steep slopes around the edges of massif (Milojević, 1937). Hence, screes are being formed mainly around the Bjelašnica's plateau. Due to its geomorphology and phystoco-geographical position, on Bjelašnica Mt. occur submediterranean and continental pluviometric regimes.

Data collection and analysis

Field survey was conducted during vegetation optima in the period from 2006 to 2008. The vegetation was sampled according to the phytosociological method of the Zürich-Montpellier School (Braun-Blanquet, 1964). The analised relevés are part of the larger database, whose numbering of relevés was applied herein.
For the statistics we used R ver. 3.5.2. (R Core Team, 2018). The cluster analysis was performed on matrix 101 species x 69 relevés, after the Braun-Blanquet cover-abundance values were transformed into nine-degree-ordinal scale (van der Maarel, 1979). According to cophenetic correlation (Borcard et al., 2011), average linkage (UPGMA) with chord distance was employed as the most adequate clustering method. In the synoptic table relevés were re-arranged according to cluster-dendrogram, whereby the outliers were omitted, and vegetation units of similar floristic composition identified. In the synoptic table (Table 1) species abundances were given as a percentage frequencies which were rounded to integer. New phytocoenoses were described according to the Code of Phytosociological Nomenclature (Theurillat et al., 2021). The syntaxonomy follows Mucina et al. (2016). The nomenclature of vascular plants is given after Euro+Med PlantBase (Euro+Med 2006-2021) and for the bryophytes it follows Sabovljević et al. (2008). The endemic taxa were comprehended after relevant literature for the area (Bjelčić et al., 1969; Bjelčić & Šilić, 1971; Lakušić & Redžić, 1989, 1991; Lakušić et al., 1982; Redžić, 1990, 2007; Redžić et al., 1984, 1992-1995, 2003).
Results

The vegetation on calcareous screes in the alpine belt of Bjelašnica Mt. encompasses 101 species, of which only few occur in 50% relevés. The most frequent are species which are characteristic for the classes Thlaspietea rotundifolii and Drypidetea spinosae: Drypis spinosa L., Rumex scutatus L., Heracleum sphondylium subsp. orsinii (Guss.) H. Neumayer, Valeriana montana L., Sedum magellense Ten., Silene marginata (Kit.) Kit. and Scrophularia bosniaca Beck.

The cluster dendrogram (Figure 2) showed grouping into nine floristical similar groups of relevés (for legend see Figure 3). From further analysis in the dendrogram were omitted relevés 190-192 for they represented syndinamic stages from screes to tall-herb and forest communities. Omitted was also relevé 23 which in the floristic respect (Androsace lactea, Saxifraga prenja, Viola zoysii, Arabis alpina subsp. caucasica or Heracleum sphondylium subsp. orsinii, whereby the most frequent are Valeriana montana and Festuca xanthina. We described new association of alpine screes and named it after diagnostic taxa Festuco xanthinae—Valerianetum montanae ass. nov.
Table 1. Synoptic table for the alpine screes on Bjelašnica Mt. Dry.Sil. Drypidi—Silenion; Dry.Hera. Drypidi—Heracleetum orsinii; Pseudo.leio. Pseudofumarietum leiospermae; Pseudo.leio.heli. P.l. helictochloetosum; Dry.Sesl. Drypidio spinosae—Seslerietum wettsteinii; Dry.lin. Drypetum linneanae; Dry.vil. Dryopteridetum villarii; Fest.Val. Festuco xanthinae—Valerianetum montanae; Cer.din. Cerastietum dinaricae.

| Association                     | Dry.Sil. | Dry.Hera. | Dry.Sesl. | Dry.lin. | Pseudo.leio. | Pseudo.leio.heli. | Dry.vil. | Fest.Val. | Cer.din. |
|---------------------------------|----------|-----------|-----------|----------|--------------|-------------------|----------|-----------|----------|
| Number of relevés               | 8        | 9         | 8         | 4        | 9            | 5                 | 5        | 27        | 9        |
| Number of species               | 34       | 45        | 35        | 20       | 44           | 51                | 51       | 27        | 9        |
| **Drypidetea spinosae**         |          |           |           |          |              |                   |          |           |          |
| **Drypidetalia spinosae**       |          |           |           |          |              |                   |          |           |          |
| Silenion marginatae             | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| **Drypis spinosa L.**           | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| *Rumex scutatus* L.             | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| *Heracleum sphondylium* subsp. | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| orsinii (Guss.) H. Neumayer     | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| Silene marginata (Kit.) Kit.    | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| Cardamine glauca DC.            | 100      | 100       | 100       | 100      | 89           | 100               | 100      | 11        | 33       |
| *Grafia golaka* (Hacq.) Rchb.   | 78       | 13        | 33        | 40       |              |                   |          |           |          |
| *Cruciata pedemontana* (Bellard) Ehrend. | 78 | 13 | 33 | 40 | | | | | |
| *Pimpinella alpina* Host        | 38       | 78        | 13        | 20       |              |                   |          |           |          |
| *Achillea abrotanoides* (Vis.) | 38       | 78        | 13        | 20       |              |                   |          |           |          |
| *Vis.* Host                     | 38       | 78        | 13        | 20       |              |                   |          |           |          |
| *Sesleria wettsteinii* Dörfl. & Hayek | 25 | 100 | | | | | | | | |
| *Sedum magellense* Ten.         | 88       | 78        | 13        | 20       |              |                   |          |           |          |
| *Iberis sempervirens* L.        | 22       | 50        | 40        |          |              |                   |          |           |          |
| *Euphorbia epithymoides* L.     | 13       | 50        |           |          |              |                   |          |           |          |
| **Corydalion ochroleucae**      |          |           |           |          |              |                   |          |           |          |
| *Pseudofumarietum leiospermae*  |          |           |           |          |              |                   |          |           |          |
| *Pseudofumaria alba* subsp. leiosperma* (P. Conrath) Lidén | 100 | 100 | | | | | | | |
| *Senecio squalidus* subsp. rupestris* (Waldts. & K.) Greuter | 25 | 89 | 40 | | | | | | |
| *Geranium robertianum* L.       | 22       | 78        | 40        | 20       |              |                   |          |           |          |
| *Rhamnus alpina* subsp. fallax* (Boiss.) Maire & Petitm. | 13 | 25 | 78 | 40 | | | | | |
| *Lamium garganicum* L.          | 56       |           |           |          |              |                   |          |           |          |
| *Helictochloa blau* (Asch. & Janka) Romero Zarco | 11 | 100 | 60 | 33 | | | | | |
| *Poa caenisia* All.             | 13       | 11        | 80        | 20       |              |                   |          |           |          |
| **Thlaspietea rotundifolii**    |          |           |           |          |              |                   |          |           |          |
### TABLE 1

**Bunio alpini**

| Species                                | 13 | 25 | 25 | 67 | 100 |
|----------------------------------------|----|----|----|----|-----|
| *Arabia alpina subsp. caucasica* (Willd.) Briq. |    |    |    |    |     |
| *Cerastium dinaricum* Beck & Szyszyl.   |    |    |    |    | 100 |
| *Galium anisophyllum* Vill.             |    |    | 25 |    | 67  |
| *Poa alpina* L.                         | 13 | 13 |    |    | 100 |
| *Festuca xanthina* Roem. & Schult.      | 13 | 11 | 25 | 50 | 89  |
| *Valeriana montana* L.                  | 13 | 67 | 50 | 25 | 44  |
| *Cystopteris fragilis* (L.) Bernh.      |    |    | 22 |    | 67  |
| *Scrophularia bosniaca* Beck             | 38 | 44 | 56 |    | 67  |
| *Dryopteris villarii* (Bellardi) Schinz & Thell. |    |    |    |    |     |
| *Cystopteris fragilis* (L.) Bernh.      |    |    | 22 |    | 67  |
| *Scrophularia bosniaca* Beck             | 38 | 44 | 56 |    | 67  |

**Characteristic species Salicetia herbacea**

| Species                                | 13 | 25 | 25 | 11 | 20 |
|----------------------------------------|----|----|----|----|----|
| *Viola biflora* L.                     |    |    |    |    |    |
| *Ranunculus thora* L.                  | 13 | 22 | 13 |    |    |
| *Silene saxifraga* L.                   |    |    |    |    | 44 |
| *Ranunculus montanus* Wild.             | 13 | 38 | 11 |    |    |

**Characteristic species Asplenietea trichomanis**

| Species                                | 13 | 25 | 22 | 11 | 20 |
|----------------------------------------|----|----|----|----|----|
| *Silene pusilla* Waldst. & Kit.        |    |    |    |    |    |
| *Moehringia muscosa* L.                 |    |    | 40 |    | 56 |
| *Erysimum linariifolium* Tausch         | 25 | 78 |    |    |    |
| *Asplenium viride* Huds.                |    |    |    |    | 44 |
| *Achillea clavennae* L.                 | 38 | 50 |    |    |    |
| *Asperula longiflora* Waldst. & Kit.    | 13 | 25 | 20 |    |    |
| *Ctenidium molluscum* (Hedw.) Mitt.     | 13 | 11 | 44 |    |    |
| *Poa minor* Gaudin                     | 25 |    |    |    |    |
| *Minuartia graminifolia* (Ard.) Jav.    | 13 |    |    |    | 20 |
| *Hieracium villosum* Jacq.              |    | 25 |    |    | 11 |
| *Senecio thapsoides* DC.                | 13 | 13 |    |    | 11 |
| *Sedum hispanicum* L.                   |    |    |    | 33 |    |
| *Leucanthemum graminifolium* (L.) Lam.  | 25 | 56 | 38 | 11 | 80 |

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**TABLE 1**

**Characteristic species of Festuco-Brometea**

| Species                                           | 44 | 13 | 50 | 11 | 60 | 100 | 44 |
|---------------------------------------------------|----|----|----|----|----|-----|----|
| Bromopsis erecta (Huds.) Fourr.                   |    |    |    |    |    |     |    |
| Koeleria splendens C.Presl                        | 20 | 80 | 67 |
| Scabiosa cinerea Lam. subsp. cinerea               | 25 | 44 | 13 | 25 | 20 | 40  | 11 |
| Thymus serpyllum L.                                | 20 | 56 | 33 |
| Galium corradifolium Vill.                         | 13 | 67 |    | 11 | 60 | 40  |
| Stachys recta L.                                   | 33 | 13 | 25 | 22 | 20 |     |
| Cirsium acaulon (L.) Scop.                         |    |    |    |    |    |     | 44 |
| Sedum ochroleacum Chaix                            |    |    |    |    |    | 50  |    |
| Helianthemum nummularium subsp. obscurum (Čelák) Holub |    |    |    |    |    |     | 44 |
| Leontodon hispidus L.                              | 11 |    |    |    |    |     | 11 |
| Rhinanthus minor L.                                | 63 | 89 | 38 |    | 22 |     | 40 |

**Characteristic species of Elyno-Seslerietea**

| Species                                           | 80 | 80 | 11 |
|---------------------------------------------------|----|----|----|
| Campanula scheuchzeri Vill.                       |    |    |    |
| Hypericum richeri subsp. grisebachii (Boiss.) Nym | 100 | 33 |
| Festuca bosniaca Kumm. & Sendtn.                  | 13 | 40 | 100 |
| Myosotis suaveolens Wildl.                         | 13 | 11 | 67 |
| Gentianella crispata (Vis.) Holub.                 | 13 | 11 |    |
| Phyteuma orbiculare L.                             | 50 |    | 20 |
| Linum capitatum Schult.                            | 13 |    | 20 |
| Hypericum richeri Vill.                            | 25 | 67 | 13 | 40 |
| Alyssum montanum L.                                |    | 60 | 56 |
| Alchemilla hoppeana (Rchb.) Dalla Torre            | 38 |    | 20 |
| Carex kitaibeliana Bech                            | 13 |    | 20 |
| Euphrasia dinarica (Beck) Murb.                    | 11 | 60 | 20 |
| Polygala chamaebuxu L.                             | 11 | 22 |
| Cerastium arvense L.                               |    | 67 |
| Festuca panciciana (Hack.) K.Richt.                | 11 | 20 | 33 |
| Sesleria nitida Ten.                               | 11 |    | 33 |
| Linum catharticum L.                               | 20 | 33 |    |

**Characteristic species of Mulgedio-Aconitetea**
| TABLE 1 |
|---------------------------------------------|
| **Solidago virgaurea** subsp. *minuta* (L.) Arcang. | 44 | 33 | 40 |
| *Scrophularia alpestris* Benth. | 11 | 33 | 40 |
| *Laserpitium latfolium* L. | 11 | 40 |
| *Paeonolirium cervaria* (L.) Lapeyr. | 22 | 60 |
| *Adenostyles alliariae* (Gouan) A. Kern. | 13 | 11 | 13 | 11 |
| *Lactuca alpina* (L.) A. Gray | 11 |
| *Astrantia major* L. | 22 |
| *Thalictrum minus* L. | 56 | 22 | 20 |
| **Characteristic species of Querco-Fagetea** |
| *Cyclamen purpurascens* Mill. | 11 | 40 |
| *Melica nutans* L. | 11 | 40 | 11 |
| *Veronica arctunifolia* Jacq. | 13 | 11 | 11 |
| *Euphorbia amygdaloides* L. | 22 | 20 | 60 |
| *Polygonatum verticillatum* (L.) All. | 11 |
| *Epilobium montanum* L. | 22 |
| *Anemone nemorosa* L. | 33 |
| *Dryopteris filix-mas* (L.) Schott. | 13 | 22 | 25 | 22 | 40 | 33 |
| *Senecio nemorensis* L. | 89 | 20 |
| *Convallaria majalis* L. | 22 | 60 |
| *Saxifraga rotundifolia* L. | 11 |
| **Characteristic species of Vaccinio-Piceetae** |
| *Lonicera alpigena* L. | 40 |
| *Pinus mugo* Turra | 22 |
| *Rosa pendulina* L. | 22 | 13 |
| *Asarum europaeum* L. | 40 | 78 |
| *Polystichum lonchitis* (L.) Roth | 20 | 56 |
| *Daphne mezereum* L. | 11 | 20 |
| **Others** |
| *Urtica dioica* L. | 33 | 78 | 33 |
| *Galium mollugo* L. | 33 | 63 | 11 | 22 |
**TABLE 1**

| Plant Name                        | Value |
|----------------------------------|-------|
| *Achnatherum calamagrostis* (L.) P. Beauv. | 22    |
| *Sedum album* L.                 | 22    |
**Thlaspietalia rotundifolii Br. & Bl. in Br. & Bl. et Jenny 1926**

**Bunion alpini** Lakušić 1968

**Festuco xanthinae—Valerianetum montanae** Trakić et al. ass. nov. hoc loco

**Holotypus:** Table 2, rel. 184

### Table 2. Festuco xanthinae—Valerianetum montanae ass. nov. Trakić et al.

| Relevé number | 61 | 62 | 63 | 183 | 184** | 185 | 186 | 187 | 188 |
|---------------|----|----|----|-----|-------|-----|-----|-----|-----|
| Valeriana montana L. | 1.2 | 2.2 | 2.2 | 2.3 | 3.3 | 3.3 | 3.3 | 2.3 |
| Festuca xanthina Roem. & Schult. | +.2 | +2-1.2 | 1.2 | 1.2 | 2.2 | 1.2-2.2 | +2 | +2-1.2 |
| Asarum europaeum L. | +2 | 1.2 | +2 | 1.2 | 1.3 | +3 | +2 |
| Scrophularia bosniaca Beck | +.1 | +2 | | | | | |
| Galium anisophyllon Vill. | +.2 | +2 | +2 | +2 | +2 | +2 |
| Cystopteris fragilis (L.) Bernh. | 2.2 | +2 | +2 | 1.2-2.2 | 1.2 | 1.2 |
| Koeleria splendens C. Presl | +2 | 1.2 | +2 | +2 | +2 | +2 |
| Cerastium arvense L. | +.2 | +2-1.2 | +2 | 2.3 | +2 | 1.2 |
| Urtica dioica L. | +.1 | +2 | +1 | +1 | 1.1 | +2 | +2 |
| Alyssum montanum L. | +.2 | 1.2 | +2 | 1.2 | +2 |
| Thymus serpyllum L. | +.2 | 1.2 | 1.2 | 1.3 | 1.3 |
| Moehringia muscosa L. | +.2-1.2 | 1.2 | 1.1 | +1-1.1 | +1 |
| Polystichum lonchitis (L.) Roth | +.2 | +2-1.2 | +2 | +2 | 1.2 |
| Bromopsis erecta (Huds.) Fourr. | 1.2 | +.2 | +2 | 1.2 | 1.2 |
| Asplenium viride Huds. | +.2 | +2 | +2 | +2 |
| Linum catharticum L. | +.1 | +.1 | +.1 | +.1 |
| Cirsiuim acaulon (L.) Scop. | +.1 | +.1 | +.1 | +.1 |
| Helianthemum nummularium subsp. obscurum (Čelak) Holub | +.2 | 1.2-2.2 | +.2 | +2-1.2 |
| Silene saxifraga L. | +.2-1.2 | 1.2 | 1.1 | +1-1.1 | +1 |
| Achillea abrotanoides (Vis.) Vis. | +.2 | 2.2 | +2 |
| Helictochloa blauoi (Asch. & Janka) Romero Zarco | 2.2 | +.2 | +2 | +2-1.2 |
| Hypericum richeri subsp. grisebachii (Boiss.) Nyman | 1.2 | +.2 | 1.2 |
| Linum capitatum Schult. | +.1 | +.1 | +.1 |
| Anemone nemorosa L. | +.1 | +.2 | +.1 | 1.1 |
| Galium mollugo L. | 1.2 | +.2 | +2 | +2 |
| Poa caenisia All. | +.2-1.2 | +.2 |
| Phyteuma orbiculare L. | +.1 | +.1 |
| Silene pusilla Waldst. & Kit. | +.1 | +2-1.2 |
| Carex kitaibeliana Bech | +.1 | +2-1.2 |
| Pinus mugo Turra | 1.2 | +.1 |
| Polygala chamaebuxus L. | +.1 | +1 |
| Drypis spinosa L. | 3.4 |
| Cardamine glauca DC. | +.1 |
| Geranium robertianum L. | +.1 |
| Scabiosa cinerea Lam. subsp. cinerea | +.1 |
| Campanula scheuchzeri Vill. | +.1 |
| Sedum ochroleucum Chaix | +.1 |
| Hieracium villosum Jacq. | +.1 |

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TABLE 2.

| Species                  | Value |
|--------------------------|-------|
| Leontodon hispidus L.    | +1    |
| Melica nutans L.         | +2    |
| Senecio thapsoides DC.   | 1.2   |

Characteristic species: Festuca xanthina, Valeriana montana, Scrophularia bosniaca, Cystopteris fragilis, Cerastium arvense.

Diagnosis: Festuco xanthinae—Valerianetum montanae is a true alpine association, occurring at altitudes from 1800 to 1920 m. It shows ecological continuity with alpine grassland, on one side, which is indicated by the occurrence of Alyssum montanum, Hypericum richeri subsp. grisebachii and Linum capitatum. But also with xeric grassland, on the other side, which is indicated by Koeleria splendens, Bromopsis erecta, Cirsium acaulon, Thymus serpyllum, Helianthemum nummularium subsp. obscurum and Scabiosa cinerea subsp. cinerea. The wind is the main factor for its syngenes, because the association prefers open habitats which are exposed to the collision of the air from the south with the cold, continental air. The substrate is made of large carbonate rocks, dolomite or limestone, with sirozem type of soil. This is highly endemic association with large proportion of balkan and dinaric taxa. However, due to its open character, the association Festuco xanthinae—Valerianetum montanae is disturbed by grazing which is indicated by high frequency of Urtica dioica.

The association Cerastietum dinaricae (cluster I) is completely different from the entire data set by its chinophilous character.

Cerastietum dinaricae Horvat 1931

The association takes the highest positions (1955 to 2017 m a.s.l.) on Bjelašnica Mt. The distribution range of the association is therefore very limited. We have made only three relevés, for it is rare in the area. This is chinophilous community, which in its ecological preferences corresponds with the alliance Saxifragion prenjae. However, the alliance Saxifragion prenjae was not identified during our research. From the characteristic species we have identified: Cerastium dinaricum, Poa alpina, Galium anisophyllon, Arabis alpina subsp. caucasica and Rumex scutatus. Other species indicate the syngenetic continuity with alpine grassland: Myosotis suaveolens, Linum capitatum and Sesleria nitida. Due to extreme ecoclimate, the association characterizes low species diversity, with 14 identified taxa.

According to the dendrogram of association in the synoptic table (Figure 3), association Dryopteridetum villarii (cluster G) shows close relationship with the association Festuco xanthinae—Valerianetum montanae (cluster H) which confirms its syntaxonomic position within the order Thlaspietalia rotundifolii. This is the result of syngenetic tendencies for these associations, for both of them include taxa from the adjacent alpine grassland and lack of dinaric species, such as: Silene marginata, Grafia golaka, Heracleum sphondylium subsp. orsinii.

Dryopteridetum villarii Jenny-Lips 1930

The association Dryopteridetum villarii on Bjelašnica Mt. develops in places of humid ecoclimate, in the zone of mountain-pine woods, close to the Lokvanjsko lake. It is characterized by high proportion of tall herbs: Senecio nemorensis, Lactuca alpina, Solidago virgaurea subsp. minuta. High constancy and diagnostic value show: Dryopteris villarii, Bromopsis erecta, Rumex scutatus, Festuca bosniaca, Hypericum richeri subsp. grisebachii, Campanula scheuchzeri.

In the dendrogram (Figure 2) closely related are A—C group of relevés which are all characterized by high abundance of Drypis spinosa that places them in the alliance Silenion marginatae. The alliance occurs in the northern part of Bjelašnica Mt., which is characterized by less precipitation comparing to the south, with three closely related combination of scree-characteristic species. The diagnosed phytocoenoses differ in terrain inclination (the drainage rate), for Drypido—Heracleetum orsinii (C) occurs in the upper part of cirques, on steep slopes and very mobile substrate, Drypido—Silenetum marginatae (A) takes middle section of cirques and less steep ground, whereas Drypido spinosae—Seslerietum wettsteinii (B) occurs on the bottom of cirques.
Drypidetea spinosae Quézel 1964
Drypidetalia spinosae Quézel 1964
Silenion marginatae Lakušić 1968

Drypidi—Heracleetum orsinii Redžić et al. ex Trakić et al.
Validated name Drypidi—Heracleetum orsinii Redžić et al. 2011 Acta Carsologica 4 (3) nom. inval. (Arts. 2b, 5).
Neotypus: Table 5, rel. 85
The association was originaly identified in the endemic center Prenj-Čvrsnica-Čabulja Mts. which is the mountain complex continuing southwards of Bjelašnica Mt. However, the orginal diagnosis of a name didn't include all necessary elements, hence, we neotypify it herein. The characteristic species for the association Drypidi—Heracleetum orsinii are: Drypis spinosa, Heracleum sphondylum subsp. orsinii, Grafia golaka, Crucia pedemontana, Achillea abrotanoides and Pimpinella alpina. High constancy in the association also have: Rumex scutatus, Erysimum linariifolium, Thalictrum minus, Rhinanthus minor and Silene marginata. Average cover for the association is 37%. In total, we recorded 45 species with average number per relevé of 18. From the floristical standpoint, the association shows similarity with Geranio—Heracleetum balcanicum (Lakušić 1968) 1970 of the Durmitor Mt. sector of the High-dinaric province.

Drypidi—Silenetum marginatae Lakušić (1968) 1970
This is the community of dry (sub)alpine screes, which is the result of its position on spacious screes, far from the humid ecoclimate evolving around snow-beds at the screes bottom, or under high cliffs with prevalence of tall-herb species. The association on Bjelašnica Mt. is characterized by the occurrence of species: Drypis spinosa, Silene marginata and Rumex scutatus. Small coverage, but high constancy and diagnostic value have Sedum magellense and Cardamine glauca, while other species occur only sporadically. Heracleum sphondylum subsp. orsinii covers large areas within stands. In total, we recorded 34 species. Average number of species per relevé is 12.

Drypido spinosae—Seslerietum wettsteinii Trakić et al. ass. nov. hoc loco
Holotypus: Table 3, rel. 25

Table 3. Drypido spinosae—Seslerietum wettsteinii ass. nov. Trakić et al.

| Relevé number | 21 | 22 | 24 | 25* | 35 | 37 | 38 | 42 |
|---------------|----|----|----|-----|----|----|----|----|
| Drypis spinosa L. | 1.2 | 1.2 | +2-1.2 | 1.2 | 1.2-2.2 | 1.2 | 2.2 |
| Heracleum sphondylum subsp. orsinii (Guss.) H. Neumayer | 1.2 | +.1 | +.1 | 1.1 | 2.2 | 1.1 | +.1 | 1.1 |
| Sesleria wettsteinii Dörfl. & Hayek | 1.2-2.2 | 2.3 | 1.2 | 2.3 | +.2 | +.2 | 1.2-2.2 | +.2 |
| Rumex scutatus L. | +.2 | +2-1.2 | +.1 | +.2 | +.2 | +.2 | +.2 | +.2 |
| Cardamine glauca DC. | +2-1.2 | 1.2 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 |
| Silene marginata (Kit.) Kit. | +.2 | 1.1 | +.1 | 1.2 | 1.2 | +.1 | +.1 | +.1 |
| Galium mollugo L. | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 |
| Valeriana montana L. | 1.2-2.2 | 1.2 | 1.2-2.2 | 2.3 | +.2 | +.2 | +.2 | +.2 |
| Phyteuma orbiculare L. | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 |
| Sedum magellense Ten. | +.1 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 |
| Rhinanthus minor L. | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 |
| Leucanthemum graminifolium (L.) Lam. | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 | +.1 |
| Alchemilla hoppeana (Rchb.) Dalla Torre | +.2 | +2-1.2 | +.2 | +.2 | +.2 | +.2 | +.2 | +.2 |

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Characteristic species: *Sesleria wettsteinii*, *Drypis spinosa*, *Valeriana montana*, *Galium mollugo*, *Cardamine glauca*.

Diagnosis: The community occurs in the lower part of alpine belt (1730 to 1870 m a.s.l.), on less inclined slopes with less mobile parent material. Due to favourable ecoclimatic, the average vegetation coverage is relatively high (40%). The substrate is mainly composed of large carbonate blocks with rock debris in between. The soil type is colluvium. This is the most hygric association within the alliance, for it occurs around the snow-beds and on the bottom of northern exposed cirque. Here accumulates water drained from the upper positioned screes, which is being preserved by thick deposits of colluvium. According to the cluster dendrograms (Figure 2 and 3), the association shows high floristic similarity with *Drypidi—Silenetum marginatae*.

The group D encompasses relevés of the *Drypetum linneanae* community which is the most xeric association within the alliance. According to the cluster dendrogram (Figure 3) it is clearly separated from the rest of the set within the alliance *Silenion marginatae*. 

### TABLE 3.

| Species / Genus, Species | Coverage |
|--------------------------|----------|
| Ranunculus montanus Willd. | +.1 +.1 +.1 |
| Achillea clavennae L. | +.1 1.2 +.2 |
| Achillea abrotanoides (Vis.) | 2.3 +.2 |
| Arabis alpina subsp. caucasica (Willd.) Briq. | +.2 +.1 |
| Festuca xanthina Roem. & Schult. | +.2-1.2 |
| Galium anisophyllum Vill. | +.2 |
| Silene pusilla Waldst. & Kst. | 1.2 +.1 |
| Bromopsis erecta (Huds.) Fourr. | +.2 |
| Pimpinella alpina Host | |
| Grafia golaka (Hacq.) Rchb. | +.1 |
| Hypericum richeri Vill. | |
| Scabiosa cinerea Lam. subsp. cinerea | +.1 |
| Stachys recta L. | 2.2-2.3 |
| Adenostyles alliariae (Gouan.) A. Kern. | +.1 |
| Linum capitatum Schult. | +.1 |
| Myosotis suaveolens Willd. | +.1 |
| Poa alpina L. | +.2 |
| Ranunculus thora L. | +.2 |
| Carex kitaibeliana Bech | +.2 |
| Rosa pendulina L. | 1.2 |
| Minuartia graminifolia (Ard.) Jav. | +.1 |
| Senecio thapsoides DC. | +.1 |
Drypetum linneanae Horvat 1931

This is the most frequent association in the montane belt extending from the SE Alps to the Olimp Mt. On Bjelašnica Mt. it is characterized by high level of endemicity (30%). The association Drypetum linneanae occurs on extremely mobile substrate which is mainly caused by inclined slopes (40-70°). The highest coverage have Drypis spinosa and Rumex scutatus, whereas high constancy show Heracleum sphondylium subsp. orsinii. Diagnostic species of the association are Sedum magellese, Euphorbia epithymoides and Iberis sempervirens. Mean vegetation coverage per relevé is 22%. It should be stressed that in the floristic composition lacks Silene marginata, which is characteristic species of the alliance. In the ecoton area, under cliffs with locally high humidity and shadow conditions, occurs subassociation Drypetum linneanae adenostyletosum Horvat 1931. On the other hand, in the ecoton toward alpine grasslands occur subassociation Drypetum linneanae senecietosum Horvat 1931 with dominance of Senecio doronicum. The most important biotic factor for the syngenesis and occurrence of stands of the Drypetum linneanae on Bjelašnica Mt. are populations of the chamois which keep the substrate mobile and fertilized.

Cluster Dendrogram

Figure 3. Cluster dendrogram of columns (associations) in the synoptic table. A. Drypidi—Silenetum; B. Drypido spinosae—Seslerietum wettsteinii; C. Drypidi—Heracleetum orsinii; D. Drypetum linneanae; E. Pseudofumarietum leiospermae; F. Pseudofumarietum leiospermae helictochloetosum; G. Dryopteridetum villarii; H. Festuco xanthinae—Valerianetum montanae; I. Cerastietum dinaricae.

Cluster E encompasses the Pseudofumarietum leiospermae community with floristically close group of relevés (F) which are characterized by the occurrence of Helictochloa blau and described as a new subassociation Pseudofumarietum leiospermae helictochloetosum. The dendrogram confirms the syntaxonomic position of Pseudofumarietum leiospermae and P.I. helictochloetosum, for they are classified within the group of associations belonging to the order Drypidetalia spinosae. However, they are separated from the rest of the set on the alliance level and placed within the alliance Corydalion ochroleucae.

All. Corydalion ochroleucae Lakušić 1975
**Pseudofumarietum leiospermae** Lakušić et Redžić 1991 nom. corr.
The alpine habitat of the association *Pseudofumarietum leiospermae* is sheltered by the relict woods of white-barked pine (*Pinus heldreichii*) and shrubs of *Rhamnus alpina* subsp. *fallax* (*Rhamnetum fallacis*). The ecoclimatic therefore is humid which is indicated by the occurrence of hygrophyllous taxa, such as *Phyllitis scolopendrium* and *Ctenidium molluscum*. Due to the western aspect of the habitat, there are many sciophytic species also: *Moehringia muscosa*, *Convallaria majalis*, *Euphorbia amygdaloides*, *Cyclamen purpurascens*, *Knautia drymeia*, *Laser trilobum*. The alpine association *Pseudofumarietum leiospermae* on Bjelašnica Mt. is characterized by the occurrence of: *Pseudofumaria alba* subspp. *leiosperma*, *Geranium robertianum*, *Lamium garganicum*, *Rumex scutatus* and *Heracleum sphondylium* subsp. *orsinii*. Other species of high frequency and abundance are: *Drypis spinosa*, *Senecio nemorensis*, *S. squalidus* subsp. *rupestris*, *Sedum magellense*, *Rhamnus alpina* subsp. *fallax* and *Arabis alpina* subsp. *caucasica*. Because of favourable ecoclimatic, the vegetation coverage of the association is high (around 60%). In total, we recorded 44 species with average number of 17 species per relevé.

**Pseudofumarietum leiospermae helictochloetosum** Trakić et al. subass. nov. hoc loco
Holotypus: Table 4, rel. 97

Table 4. *Pseudofumarietum leiospermae helictochloetosum* subass. nov. Trakić et al.

| Relevé number | 96  | 97* | 98  | 110 | 130 |
|---------------|-----|-----|-----|-----|-----|
| *Drypis spinosa* L. | +2  | 2.2 | 2.2 | 2.2  | 2.2 |
| *Rumex scutatus* L. | +2.1-2 | 2.2 | 2.2 | +2.2-1.2 | 1.2 |
| *Pseudofumaria alba* subsp. *leiosperma* (P. Conrath) Lidén | 2.3 | 2.3 | 1.2 | +2  | 2.3 |
| *Helictochloa blaui* (Asch. & Janka) Romero Zarco | 1.2 | 1.2 | 1.2 | +2  | +2 |
| *Valeriana montana* L. | +2  | +2  | 2.2 | 1.2-2.2 | +2 |
| *Lescanthusum graminifolium* (L.) Lam. | +2  | 2.2 | 2.2 | +2.1-2 | +2 |
| *Poa caenisia* All. | +2  | +2  | +2  | 1.2  | +2.1-2 |
| *Campanula scheuchzeri* Vill. | +1  | +1  | +1  | 1.2  | +1 |
| *Helacrynum sphenodylum* subsp. *orsinii* (Guss.) H. Neumayer | +1  | 1.2 | +1  | 1.2  | +1 |
| *Bromopsis erecta* (Huds.) Fourr. | +2  | +2  | +2-1.2 | 1.2 |
| *Galium corrudifolium* Vill. | +2  | +2  | +2  | +2  | +2 |
| *Rhamnus alpina* subsp. *fallax* (Boiss.) Maire & Petitm. | +2  | +2  | +2.1-2 | 2.2 |
| *Cystopteris fragilis* (L.) Bernh. | +2-1.2 | +2  | +2  | 1.3  | +2.1-2 |
| *Dryopteris villarii* (Bellardi) Schinz & Thell. | +2  | +2  | +2  | 1.2  | +2.1-2 |
| *Peucedanum cervaria* (L.) Lapeyr. | +1  | +1  | +1  | 1.2  | +1 |
| *Convallaria majalis* L. | +1  | +1  | +1  | 1.2  | +1 |
| *Euphrasia dinarica* (Beck) Murb. | +2  | +2  | +2  | +2  | +2 |
| *Scrophularia bosniaca* Beck | +1  | +1  | +1  | +1  | +1 |
| *Rhinanthus minor* L. | +1  | +1  | +1  | +1  | +1 |
| *Geranium robertianum* L. | +1  | +1  | +1  | +1  | +1 |
| *Grafia golaka* (Hacq.) Rechb. | +1  | +1  | +1  | +1  | +1 |
| *Hypericum richeri* Vill. | +1  | +1  | +1  | +1  | +1 |
| *Dryopteris filix-mas* (L.) Schott. | +2  | +2  | +2  | +2  | +2 |
| *Solidago virgaurea* subsp. *minuta* (L.) Arcang. | +1  | +1  | +1  | +1  | +1 |
| *Festuca bosniaca* Kumm. & Sendtn. | +2  | +2  | +2  | +2  | +2.1-2 |
| *Scrophularia alpestris* Benth. | +2  | +2  | +2  | +2  | +2 |
| *Moehringia muscosa* L. | +2  | +2  | +2  | +2  | +2 |
| *Cyclamen purpurascens* Mill. | +2  | +2  | +2  | +2  | +2 |
| *Lonicera alpigena* L. | +2  | +2  | +2  | +2  | +2 |
TABLE 4.

| Species | Code |
|---------|------|
| Laserpitium latifolium L. | +.1 |
| Melica nutans L. | +.1 |
| Sedum magellense Ten. | +.2 |
| Achillea abrotanoides (Vis.) Vis. | 1.2 |
| Pimpinella alpina Host. | +.2 |
| Crucia pedemontana (Bellardi) Ehrend. | +.2 |
| Scabiosa cinerea Lam. subsp. cinerea | +.1 |
| Senecio nemoirensis L. | +.1 |
| Koeleria splendens C.Presl | +.2 |
| Stachys recta L. | +.2 |
| Alchemilla hoppeana (Rehb.) Dalla Torre | +.1 |
| Thalictrum minus L. | 1.2 |
| Euphorbia amygdaloides L. | +.1 |
| Carex kitaibeliana Bech | +.2 |
| Linum catharticum L. | +.1 |
| Asperula longiflora Waldst. & Kit. | +.2 |
| Gentianella crispata (Vis.) Holub. | +.1 |
| Daphne mezereum L. | +.1 |
| Festuca panciciiana (Hack.) K.Richt. | +.2 |
| Hieracium villosum Jacq. | +.1 |
| Minuartia graminifolia (Ard.) Jav. | +.2 |
| Viola biflora L. | +.1 |

Characteristic species: *Pseudofumaria alba* subsp. *leiosperma*, *Helictochloa blaui*, *Poa caenisia*.

Diagnosis: The sub-association occurs in the lower part of alpine belt (1700-1770 m a.s.l.), on very steep slopes (35-60°), which results in small vegetation coverage (30%). The substrate is made of limestone or dolomite, of small granulometric fractions, which makes the main ecological difference in comparison with the association *Pseudofumarietum leiospermae*. Because of that, in the sub-association *P. l. helictochloetosum* shrubs of *Rhamnus alpina* subsp. *fallax* have smaller abundance, for they prefer large carbonate blocks. Instead, sporadically occurs *Lonicera alpigena*. From the physiognomic point of view, for the sub-association is significant species *Peucedanum cervaria* which is equivalent to *Heracleum sphondylium* subsp. *orsinii* in the association *Pseudofumarietum leiospermae*.

The syntaxonomical scheme for the alpine screes on Bjelašnica Mt.

Cl. Drypidetea spinosae Quèzel 1964
Or. Drypidetalia spinosae Quèzel 1964
All. Silenion marginatae Lakušić 1968
Ass. Drypidi—Silenetum marginatae Lakušić (1968) 1970
Ass. Drypidi—Heracleetum orsinii Redžić et al. ex Trakić et al.
Ass. Drypido spinosae—Seslerietum wettsteinii ass. nov. Trakić et al.
Ass. Drypetum linneanae Horvat 1931
All. Corydalion ochroleucos Lakušić 1975
Ass. Pseudofumarietum leiospermae Lakušić et Redžić 1991 nom. corr.
Subass. Pseudofumarietum leiospermae helictochloetosum subass. nov. Trakić et al.
Cl. Thlaspietalia rotundifolii Br.-Bl. 1948
Or. Thlaspietalia rotundifolii Br.-Bl. in Br.-Bl. et Jenny 1926
All. Bunion alpini Lakušić 1968
Ass. Festuco xanthinae—Valerianetum montanae ass. nov. Trakić et al.
Ass. Cerastietum dinaricae Horvat 1931
Ass. Dryopteridetum villarii Jenny-Lips 1930

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**Table 5. Drypīdi—Heracleetum orsinii Redžić et al. ex Trakić et al.**

| Relevé number | 64 | 65 | 67 | 68 | 69 | 70 | 74 | 78 | 85* |
|---------------|----|----|----|----|----|----|----|----|-----|
| *Drypis spinosa* L. | 1.2 | 1.2-2.2 | 1.2 | +2 | 1.2 | +2 | +2-1.2 | +2 | 1.2 |
| *Rumex scutatus* L. | +2 | +1-1.2 | 1.2 | 1.2 | +2 | +2 | +2 | +2 | +2 |
| *Heracleum spondylium* subsp. *orsinii* (Guss.) H. Neumayer | 2.2 | +1 | 1.2 | 2.2 | 2.2 | 2.2 | 1.1 | 1.2 | 2.2 |
| *Rhianthus minor* L. | +1 | +1-1.1 | 1.1 | +1 | +1 | +1 | +1 | +1 | +1 |
| *Silene marginata* (Kit.) Kit. | 1.2 | 1.2 | +1 | +2-1.2 | +2 | 1.2 | +2-1.2 | +2 | 1.2 |
| *Achillea abrotanoides* (Vis.) Vis. | +1-2.2 | 1.2 | +2 | +1 | +2 | 1.2 | +2 | 1.2 |
| *Pimpinella alpina* Host | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 |
| *Grafia golaka* (Hacq.) Rchb. | +1 | +1 | +1 | 1.2 | +2-1.2 | 1.2 | 2.2-2.3 | +2-1.2 | +2 |
| *Crucia pedemontana* (Bellardi) Ehrend. | +2-1.2 | 1.2 | +2 | +2 | 1.2 | +2 | 2.2 | +2-1.2 | +2 |
| *Erysimum linariifolium* Tausch | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 |
| *Valeriana montana* L. | +2-1.2 | 1.2 | +2 | +2 | +2 | +2 | +2-1.2 | +2 | 1.2 |
| *Hypericum richeri* Vill. | +1 | +1 | 1.1 | +1 | 1.2 | +1 | +1 | +1 | +1 |
| *Galium corrulifolium* Vill. | +2 | 1.2 | +2 | +2-1.2 | +2 | +2 |
| *Leucanthemum graminifolium* (L.) Lam. | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 |
| *Thalictrum minus* L. | 1.2 | +1 | 1.2-2.2 | 2.2 | 1.2-2.2 | +2 |
| *Scrophularia bosniaca* Beck | +2 | 1.2 | +2 | +2-1.2 | +2 | +2 |
| *Bromopsis erecta* (Huds.) Fourr. | +2 | +2 | +2 | +2 |
| *Scabiosa cinerea* Lam. subsp. *cinerea* | +1 | +1 | +1 | +1 | +1 | +1 |
| *Solidago virgaurea* subsp. *minuta* (L.) Arcang. | +1 | +1 | +1 | +1 | +1 | +1 |
| *Galium mollugo* L. | +1 | +2 | +2 |
| *Stachys recta* L. | +2 | +2 | +2-1.2 | +2-1.2 | +2-1.2 | +2-1.2 | +2 |
| *Euphorbia amygdaloides* L. | +2 | 1.2 | +2 |
| *Ranunculus thora* L. | +2 | 1.2 | +2 |
| *Sedum magellense* Ten. | +2 | +2 |
| *Geranium robertianum* L. | +2 | +2 |
| *Cystopteris fragilis* (L.) Bernh. | +2 | +2 |
| *Dryopteris filix-mas* (L.) Schott. | +2 | 1.2 |
| *Convallaria majalis* L. | +2 | +2 |
| *Iberis sempervirens* L. | 2.2 | 1.2-2.2 |
| Species                                              | Value | Value |
|------------------------------------------------------|-------|-------|
| Rosa pendulina L.                                     | +.2   | 1.2   |
| Astrantia major L.                                    | +.1   | +.1-1.1 |
| Achnatherum calamagrostis (L.) P. Beauv.              | +.2   | 1.2   |
| Arabis alpina subsp. caucasica (Willd.) Briq.        | +.2   |       |
| Cardamine glauca DC.                                  | +.1   |       |
| Ctenidium molluscum (Hedw.) Mitt.                    | 1.2   |       |
| Scrophularia alpestris Benth.                         | +.2   |       |
| Adenostyles alliariae (Gouan) A. Kern.               | +.2   |       |
| Veronica urticifolia Jacq.                           | +.2   |       |
| Euphrasia dinarica (Beck) Murb.                       | +.1   |       |
| Gentianella crispata (Vis.) Holub.                   | +.1   |       |
| Festuca panciciana (Hack.) K.Richt.                  | 1.2   |       |
| Laserpitium latifolium L.                            | 1.2   |       |
| Leontodon hispidus L.                                 | +.1   |       |
| Sesleria nitida Ten.                                  | +.2   |       |
Discussion

Comparing to the SE Dinarides, which are continuing southwards, Bjelašnica Mt. is characterized by much milder geomorphology and limited distribution of screes in the (sub)alpine belt. The relief of the adjacent mountains characterize sharp peaks with steep slopes and widely distributed screes, resulting in their high syntaxonomic diversity e.g. for Prenj Mt. were described four orders, seven alliances and even thirty associations (Redžić et al., 2011).

However, the highest area of Bjelašnica Mt. is composed of rounded tops and deep sinkholes which are covered by the alpine calcareous grasslands (Elyno—Seslerietea) and the mountain-pine shrubs (Pinetum mughi calcicolum). Nevertheless, the distribution of screes around the Bjelašnica's plateau led to their distinct syntaxonomic differentiation when it comes to the eoclimate. Thus, the alliance Corydalion ochroleucae occurs in the supra-mediterranean eoclimate which protrudes deep into the inland through the valley of rivers Neretva, Trešnica and Rakitnica. The alliance Silenion marginatae prefers dry, continental climate, whereas the alliance Bunion alpini occurs around the peak Krvavac which was the glaciation centre during Pleistocene (Kanaet, 1954) indicating the most psychrophilous eoclimate with the association Cerastetum dinaricae. Horvat (1962) described the association Cerastietum dinaricae on Dinara and Velebit Mts. in Croatia quoting as constant species: Cerastium dinaricum, Euphorbia capitulata, Thlaspi dinaricum, Rumex scutatus, Valeriana montana, Achillea clavennae and Arabis scopolina. On Bjelašnica Mt. we have diagnosed different combination of characteristic species: Cerastium dinaricum, Poa alpina, Galium anisophyllum, Arabis alpina subsp. caucasia, Rumex scutatus, Myosotis suaveolens, Linum capitatum and Sesleria nitida. However, in both cases common is low species diversity.

Along with the alliance Saxifragion prenjae, Bunio alpini is geographic vicariant to the Veronica—Papaverion degeni firstly described on the Pirin Mt. (Mucina et al., 1990).

Previously, researcher of Bjelašnica Mt. were able to identify the alliance Saxifragion prenjae (Horvat, 1941; Bjelčić et al., 1975; Šilić, 1990; Redžić et al., 1999). However, we have recognized only one stand with Saxifraga prenja (and other species occurring around the snow-beds) at the bottom of the glacial cirque Veliki Kotoa, which wasn't enough to included it into the syntaxonomic scheme. The distribution of the alliance Saxifragion prenjae on Bjelašnica Mt. shrank over the last 50 years probably as a consequence of the global climate changes. The snow-beds in the glacial cirques of northern slopes used to exist over entire summer (Milojević, 1937), while nowadays they disappear early in June.

According to Redžić et al. (1999), the vegetation of screes on Bjelašnica Mt. differentiates into associations: Saxifragetum prenjae, Bunio—Iberetum carnosae, Geranio—Heracleetum orsinii, Drypetum lineanae, Poetum caenisiae, Asperulo hercegovinae—Arabidetum flavescentis and Pseudofumarietum leiospermae which coincide with our results by 37.5%. On the other hand, for the entire mountain complex Visočica-Treskavica-Bjelašnica, Lakusič et al. (1980) have identified only one alliance with five associations. This kind of literature discordance is probably caused by different author's approaches, for only Horvat (1941) was focused exclusively on vegetation of screes, whereas other researchers analysed the alpine screes within the complex vegetation studies. It was the same with other mountains in the area: Kamešnica (Kušan, 1956), Jahorina (Bjelčić, 1966), Durmitor (Lakusič, 1968), Vlašić (Lakusič et al., 1982), Cincar and Vitorog (Redžić et al., 1984), Maglić-Volujak-Zelengora (Lakusič et al., 1987), Vranica (Redžić, 2007), Crvanj (Redžić et al., 1995), Prenj-Čvrsnica-Čabulja (Redžić et al., 2011a), where the alpine screes were only a component of the researches or missing completely. In the Dinarides, there is a positive correlation between the contemporary occurrences of screes in the alpine belt and the Pleistocene glaciation. For instance, on Jahorina and Vlašić Mts., which lacked glaciers, don't occur screes in the alpine belt and the relief is less dynamic.

The alliance Silenion marginatae on Bjelašnica Mt. shows floristical similarity with the same alliance described by Šilić (1969) on Maglić Mt. (SE Dinarides). Moreover, we have identified Drypido spinosae—Seslerietum wettsteinii ass. nov. in previously published relevés initially described as Drypido—Silenetum marginatae (Šilić, 1969). On the other hand, there is a synecological continuity between Bjelašnica and the southwards located endemic centre Prenj-Čvrsnica-Čabulja Mts., for they have several associations in common: Drypido—Silenetum marginatae, Drypetum lineanae and Drypido—Heracleetum orsinii (Redžić et al., 2011a). The latter one was invalidly published for the nomenclature type wasn't indicated in the paper. Herein, we have validated the association providing the neotypus from the Bjelašnica Mt. which is in the same geographic region as the originally identified association.
After Mucina et al. (1990), the alliance *Silenion marginatae* is geographic vicariant syntaxon to the *Peltarion alliaceae* which is characteristic for the northern Dinarides. Later on Mucina et al. (2016) have pointed out distinction between thermophilous calcareous screes of the alliance *Peltarion alliaceae* (syn. *Corydalion ochroleucae*) and oligothermic alliance *Silenion marginatae*. The ambiguity regarding ecology and altitudinal distribution for the alliance *Corydalion ochroleucae* became obvious through our research, for we have identified the association *Pseudofumarietum leiospermae* between 1587 and 1790 m a.s.l. which is way above its tolerance range (Figure 4). The additional research in 2020 (relevés weren't taken into account for this study) have shown that the alliance occurs also in eastern section of Bjelašnica Mt. at 1600 m a.s.l.

![Figure 4](image.png)

*Figure 4.* Association *Pseudofumarietum leiospermae* on western slopes of Bjelašnica Mt. (Photo: D. Kulijer).

These findings indicate that the most significant ecological variable for *Pseudofumaria alba* subsp. *leiosperma* to occur is humidity, regardless of temperature range. However, Lakušić et al. (1969) did mention it as a characteristic species of the alliance *Silenion marginatae* in the Durmitor sector, which additionally underlines our concern about the syntaxonomic position of the alliance *Corydalion ochroleucae*. The syntaxonomic diversification of screes on Bjelašnica Mt. is promoted by its transitional position between two climates, calcareous bedrock and its geological past that was marked by the interchange of glacial and interglacial periods as stated by Horvat (1962) for the entire Balkan Peninsula. Due to absence of human-induced disturbances, the vegetation in the alpine belt of Balkan is well preserved (Mucina et al., 1990) and the most diversified syntaxa are to be found in rock crevices and screes (Redžić, 2007; Lakušić et al., 1987). In general, the lack of full ice cover at any time led to high species richness and uniqueness of the Balkan flora (Strid et al, 2003), which is being reflected in the syntaxonomic diversity. Moreover, as a result of calcareous bedrock, relict character of habitats, long-lasting isolation and high species richness, in the Dinarides occur many vicariant syntaxa (Mucina et al., 1990).
When it comes to the alpine screes, the silicate bedrock is characterized by low syntaxonomic diversification, as it was shown by Redžić (2007) for Vranica Mt. where the class Thlaspietea rotundifolii differentiates in only three associations, as follows: Arabidetalia flavescentis (Silenion marginatae; Cardamino—Arabidetum flavescentis, Heliospermo pusillae—Ranunculetum scutati) and Androsacetalia alpinae (Poion laxae; Poetum laxae).

From the geographic standpoint, Bjelašnica Mt. is a section of the Northern Dinarides. However, our phytosociological study pointed out that in respect of vegetation differentiation it belongs to the SE Dinarides. This is a result of inclined position of Bjelašnica's plateau southwards. Hence, in its southern section the alpine belt is missing and synecological connection with the SE Dinarides is being established and preserved.

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