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BETULA PUBESCENS EHRH. SUBSP. *CARPATICA* (WILLD.) ASCHERSON & GRAEBNER, A NEW TAXON IN THE FLORA OF THE JULIAN ALPS AND SLOVENIA AND ITS NEW ASSOCIATION *RHODODENDRO HIRSUTI-BETULETUM CARPATICAE* ASS. NOV.

BETULA PUBESCENS EHRH. SUBSP. *CARPATICA* (WILLD.) ASCHERSON & GRAEBNER, NOV TAKSON V FLORI JULIJSKIH ALP IN SLOVENIJE IN NJEGOVA NOVA ASOCIACIJA *RHODODENDRO HIRSUTI-BETULETUM CARPATICAE* ASS. NOV.

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ABSTRACT UDC 582.632.1(234.323.6:497.4)

***Betula pubescens* Ehrh. subsp. *carpatica* (Willd.) Ascherson & Graebner, a new taxon in the flora of the Julian Alps and Slovenia and its new association *Rhododendro hirsuti-Betuletum carpaticae* ass. nov.**

Based on most of its morphological characters the downy birch that grows in cold cirques in the altimontane-subalpine belt of the eastern Julian Alps (Pod Špikom, Za Akom, Beli potok and Smrajka) can be classified into the taxon *Betula pubescens* subsp. *carpatica*, which is new to the flora of Slovenia. The stands with *Pinus mugo*, *Rhododendron hirsutum* and *Alnus viridis* where it dominates in the tree layer were described as a new association *Rhododendro hirsuti-Betuletum carpaticae* ass. nov. (alliance *Pinion mugo*, class *Vaccinio-Piceetea*), which is a novelty among Alpine dwarf pine communities. Although they occupy small areas its stands have a significant protective and biotope role, also as the site of rare and protected species such as *Cypripedium calceolus* and *Listera cordata*.

Key words: *Betula pubescens* subsp. *carpatica, Rhododendro hirsuti-Betuletum carpaticae, Cypripedium calceolus*, Natura 2000, the Julian Alps, The Triglav National park, Slovenia

IZVLEČEK UDK 582.632.1(234.323.6:497.4)

***Betula pubescens* Ehrh. subsp. *carpatica* (Willd.) Ascherson & Graebner, nov takson v flori Julijskih Alp in Slovenije in njegova nova asociacija *Rhododendro hirsuti-Betuletum carpaticae* ass. nov.**

Puhasto brezo, ki uspeva v hladnih krnicah altimontansko-subalpinskega pasu v vzhodnih Julijskih Alpah (Pod Špikom, Za Akom, Beli potok in Smrajka), lahko po večini morfoloških znakov uvrstimo v takson *Betula pubescens* subsp. *carpatica*, ki je novost v flori Slovenije. Njene sestoji z rušjem, dlakavim slečem in zeleno jelšo, v katerih dominira v drevesni plasti, smo opisali kot novo asociacijo *Rhododendro hirsuti-Betuletum carpaticae* ass. nov. (zveza *Pinion mugo*, razred *Vaccinio-Piceetea*) in je novost med alpskimi ruševji. Kljub majhnim površinam imajo njeni sestoji pomembno varovalno in biotopsko vlogo, tudi kot rastišče redkih in zavarovanih vrst kot sta *Cypripedium calceolus* in *Listera cordata*.

Ključne besede: *Betula pubescens* subsp. *carpatica, Rhododendro hirsuti-Betuletum carpaticae, Cypripedium calceolus,* Natura 2000, Julijske Alpe, Triglavski narodni park, Slovenija

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1 INTRODUCTION

Betula pubescens subs. *carpatica* is a northern- and Central-European taxon, whose main distribution area is in (sub)Arctic regions, but is known also in the mountains of Central Europe, in the Pyrenees, the Alps and the Carpathians (Walters 1993: 69). It is characteristic of bog communities, birch swamp forests, subalpine scrub communities and acidophilous pine and spruce forests classified into different associations, e.g. *Empetro-Betuletum carpaticae* Van der Werf ex Westhoff et van Osten 1991, *Salici silesiacae-Betuletum carpaticae* Rejmánek, Sýkora et Štursa 1971, *Vaccinio uliginosi-Betuletum carpaticae* Lohmeyer et Bohn 1972, *Vaccinio myrtilli-Betuletum carpaticae* Stöcker 1967, *Betuletum carpaticae* Lohmeyer & Bohn 1972, *Betulo carpaticae-Piceetum* Stöcker 1967, *Betulo carpaticae-Pinetum* Mikyška 1970, *Betuletum pubescenti-carpaticae* Rivas-Martínez & Costa 1998. Higher syntaxonomic units are also named after the Carpathian birch, e.g. the alliance *Betulion carpaticae-pubescentis* Rivas-Martínez & Costa 2002 and class *Betulo carpaticae-Alnetea viridis* Rejmánek in Huml, Lepš, Prach et Rejmánek (comp. Jeník, Bureš & Burešová 1980, Oberdorfer 1983, Ellenberg 1996, Mertz 2000, Neuhäuslová 2001, Rivas-Martínez et al. 2002, Theurillat 2004). In the Alps, especially in Austria, the Carpathian birch thrives on stream banks, at the margins of bogs and in subalpine scrub communities, especially on moist rockfall blocks or on torrential or landslide debris cones (fans) overgrown with *Pinus mugo* and *Alnus viridis* (Franz 2000, Fischer, Adler & Oswald 2008: 470–471). In our research of forests on the upper forest limit we found *Betula pubescens* in the cirque Za Akom in the Martuljek mountains (the eastern Julian Alps), in a special form of subalpine beech forest, *Polysticho lonchitis-Fagetum* (I. Horvat 1938) Marinček in Poldini & Nardini 1993, on orographic timberline, which depends on annual snow avalanches. Initially, it was determined as a type subspecies *Betula pubescens* subsp. *pubescens* (Dakskobler & Rozman 2010). In 2010 and 2011 this birch was found on similar sites, on very cold, shady slopes, in hollows exposed to annual snow avalanches, in the subalpine beech forest or in dwarf pine stands, also in the spring area in the Beli potok valley, in the forest reserve Smrajka and in the cirque Pod Srcem (under Mt. Špik). Having been informed by the co-author W. R. Franz that it was likely a subspecies of *B. pubescens* subsp. *carpatica*, we re-examined our determination, taking into consideration as much as possible the distinguishing characters listed by Fischer, Adler & Oswald (2008: 470–471). It was established that in our specimens this year's shoots normally remain hairy (which is characteristic of *Betula pubescens* subsp. *pubescens*), but their leaf lamina is more or less rhomb-shaped, predominantly irregularly doubly serrate and mostly glabrescent underneath (the leaf lamina in *Betula pubescens* s. str. is ovate to orbicular-ovate, fairly evenly serrate, leaves remaining hairy at least in vein corners); the stems are often arched, twisted and have thick knobby nodes (in *Betula pubescens* s. str. they are upright, not twisted and without knobby nodes). The predominant coppice growth is partly a result of annual snowslides. Flowering plants were not noticed (in the specimens from Carinthia the female catkins are upright first, the stigma is pink). Bark is white, sometimes reddish – in Carinthia sometimes quite dark, almost black. Seed scales in *Betula pubescens* s. str. have semicircular lateral wings spreading horizontally or slightly drooping, rarely bent upwards. In the subspecies *B. pubescens* subsp. *carpatica* the lateral wings of seed scales are wider than long and protruding horizontally or upwards. The taxonomic status of the subspecies *B. pubescens* subsp. *carpatica* is slightly uncertain and some synoptic works do not discuss it at the level of an independent subspecies (e.g. Flora alpina – Aeschimann et al. 2004: 228). The size and shape of the leaves, the stem and the entire habitus of the downy birch specimens from the localities in the altimontane and subalpine belt in the eastern Julian Alps are very similar to the characters of the downy birch classified in Austria as the taxon *Betula pubescens* subsp. *carpatica*, so it makes sense to introduce this taxon also to the flora of Slovenia. The taxon remains absent from the latest synoptic work on the Slovenian flora (Martinčič et al. 2007), so this article will focus on its distribution, sites and phytosociology in Slovenia.

2. METHODS

The flora and vegetation on the sites of *Betula pubescens* s. lat. were studied according to the Central-European methods (Braun-Blanquet 1964, Ehrendorfer & Hamann 1965). The floristic records and phytosociological relevés were entered into the FloVegSi database (T. Seliškar, Vreš & A. Seliškar 2003). Combined

cover-abundance values were transformed into numerical values (1–9) according to van der Maarel (1979). Numerical comparisons were performed with the R programming environment (R Development Core Team 2011), using "vegan" package (Oksanen & al. 2011). The relevés were compared by means of "(unweighted) average linkage method" – UPGMA and principal coordinates analysis (PCoA). Bray-Curtis dissimilarity index was used in both of the methods. The nomenclature source for the names of vascular plants is the Mala flora Slovenije (Martinčič & al. 2007) – except for the taxon *Betula pubescens* Ehrh. subsp. *carpatica* (Willd.) Ascherson & Graebner. Martinčič (2003, 2011) is the nomenclature source for the names of mosses, and Suppan, Prügger & Mayrhofer (2000) for the names of lichens. The nomenclature source for the names of syntaxa of the rank higher than the association is Theurillat (2004). The sources for bedrock are Jurkovšek (1987 a, b) and Buser (2009), and the source for the names of soil types is Urbančič et al. (2005). The sources for climate data (precipitation volume, temperature) are J. Pristov, N. Pristov & Zupančič (1998). The specimens of *Betula carpatica* from the eastern Julian Alps are kept in the Herbarium of ZRC SAZU (LJS) – see http://sweetgum.nybg.org/ih/herbarium.php?irn=167779.

Ecological characteristics of the study area

The predominating geological bedrock in the study area of the eastern Julian Alps is Triassic thick-bedded Dachstein limestone with transition to dolomite and massive coarse-crystalline dolomite and limestone, on small areas also shale, siltstone and tuff. The climate is montane, humid (with mean annual precipitation of around 2500 mm), with a lot of snow remaining from autumn until late spring (150 to 200 days with snow cover), and cold due to a predominantly shady aspect, especially in Alpine cirques such as Za Akom, Pod Srcem (Pod Špikom), Smrajka and in the gable of Beli potok even slightly frosty (with mean annual temperature of 2 to 4 °C). Snow from the rockwalls accumulates in cirques and stays there long into the spring. Wherever the orographic factors allow, the upper timberline is at around 1800 m and is dominated by larch, whose stands are classified into the association *Rhodothamno-Laricetum* Willner & Zukrigl 1999. Spruce stands of the association *Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973 corr. Zupančič 1999 = *Homogyno sylvestris-Piceetum* Exner ex Poldini & Bressan 2007 occur locally on mixed bedrock and on rockfall blocks on several spots in Smrajka, above Beli potok and Za Akom. In some places, the beech stands reach the altitude of 1600 m, while individual beech trees can grow at altitudes of up to 1700 m a.s.l. In the main, these beech stands are classified into the association *Anemono-Fagetum* Tregubov 1962, but in the cirques Za Akom and Pod Špikom we determined also the association *Polysticho lonchitis-Fagetum* (I. Horvat 1938) Marinček and Poldini & Nardini 1993, including the subassociation *Polysticho lonchitis-Fagetum betuletosum pubescentis* Dakskobler & Rozman 2010 which we have now corrected to *Polysticho lonchitis-Fagetum betuletosum carpaticae* Dakskobler & Rozman 2010. In Smrajka and above the valley of Beli potok we found also the fir-beech stands of the association *Homogyno sylvestris-Fagetum* Marinček et al. 1993. Closed dwarf pine stands, *Rhododendro hirsuti-Pinetum prostratae* Zöttl 1951 = *Rhodothamno-Rhododendretum hirsuti* (Aichinger 1933) Br.-Bl. & Sissingh and Br.-Bl. & al. 1939, are distributed above the larch belt; in cirques and along torrential channels often also much lower, down to the altitude of 900 m. The researched stands with *Betula carpatica* are mainly limited to very cold, shady slopes in hollows exposed to annual snow avalanches, at between 1100 and 1400 m a. s.l.

3 RESULTS AND DISCUSSION

Description of the localities of *Betula pubescens* subsp. *carpatica* in Slovenia

9650/3 (UTM 33TVM22): Slovenia, the Julian Alps, Bohinj, Soteska, the foothills of Jelovica, local frost hollow on rockfall blocks, 520 m a.s.l., *Rhodothamno-Laricetum*. Downy birch (*Betula pubescens*) was first mentioned on this locality by Martinčič (1977: 294). Based on the specimens collected in spring 2010 (leg. I. Dakskobler & A. Rozman) and our photographs, this determination was revised by W. R. Franz, 2011, herbarium LJS.

9549/1 (UTM 33TVM14): Slovenia, the Julian Alps, the Martuljek mountains, cirque Za Akom, subalpine beech forest (*Polysticho lonchitis-Fagetum betuletosum carpaticae*) in the transitional zone to dwarf pine community, 1350 to 1360 m a.s.l. Leg. & det. I. Dakskobler & A. Rozman, 27. 7. 2009 and I. Dakskobler, 24. 8. 2009 sub. *Betula pubescens* subsp. *pubescens*, rev. W. R. Franz, 2010, LJS; Smrajka, glacial hollow and torrential debris

cone under the ridge Vrtaški vrh–Vrtaško Sleme, 1130 to 1270 m a.s.l., spruce forest (*Adenostylo glabrae-Piceetum*) and a community of Carpathian birch (*Rhododendro hirsuti-Betuletum carpaticae*). Leg. & det. I. Dakskobler & A. Rozman, 2. 7. 2010, rev. W. R. Franz, 2010, LJS; Beli potok, a gravelly cone at the foothills of Krničniki, 1180 m a.s.l., *Rhododendro hirsuti-Betuletum carpaticae*. Leg. & det. I. Dakskobler & A. Rozman, 2. 7. 2010 and 30. 8. 2011, rev. W. R. Franz, 2011, LJS; Beli potok, gravelly hollow under the pasture Robičeva planina, 1320 to 1450 m a.s.l., *Rhodothamno-Laricetum*, *Rhododendro hirsuti-Betuletum carpaticae, Rhododendro hirsuti-Pinetum mugo*. Leg. & det. I. Dakskobler, 10. 8. 2010, rev. W. R. Franz, 2011, LJS.

9548/2 (UTM 33T VM04): Slovenia, the Julian Alps, Pod Špikom, 1350 to 1370 m a.s.l., the lower part of a glacial cirque, subalpine beech (*Polysticho lonchitis-Fagetum*) and dwarf pine stands *(Rhododendro hirsuti-Pinetum mugo*). Leg. & det. I. Dakskobler & B. Zupan, 28. 9. 2011, rev. W. R. Franz, 2011, LJS.

9653/1 (UTM 33TVM63): Slovenia, the Kamnik Alps, Zgornje Jezersko, Ravenska Kočna, 1120 m a.s.l., torrential debris cone, coarse scree overgrown with dominant *Salix eleagnos* and *Petastes paradoxus*. Leg. & det. I. Dakskobler & A. Seliškar, 7. 7. 2010, rev. W. R. Franz, 2011, LJS.

In Zgornje Jezersko, in Ravenska Kočna, at Ancelj's, around 1000 m a.s.l., the taxon *Betula pubescens* was recorded also by B. Anderle, 3. 8. 2008. The same author (Anderle, in litt.) recorded *Betula pubescens* also in the Karawanken, on Ljubelj, at Jurij's (9551/4), at the altitude of 950 m (det. B. Anderle, 21. 7. 2004) and it is possible that this was also the subspecies *B. pubescens* subsp. *carpatica*. The distribution map of the Carpathian birch in Slovenia (Figure 1) is therefore still quite incomplete.

Description of the community with the dominant taxon *Betula pubescens* subsp. *carpatica* in the tree layer

The stands where *Betula pubescens* subsp. *carpatica* is dominant in the tree layer and where dwarf pine (*Pinus mugo*) and frequently admixed green alder (*Alnus viridis*) dominate in the shrub layer especially stand out among the described localities of Carpathian birch in Slovenia. Such stands were observed in Smrajka and in the Beli potok valley (Figure 2). A total of 8 relevés were made (Table 1) and compared with 50 relevés of dwarf

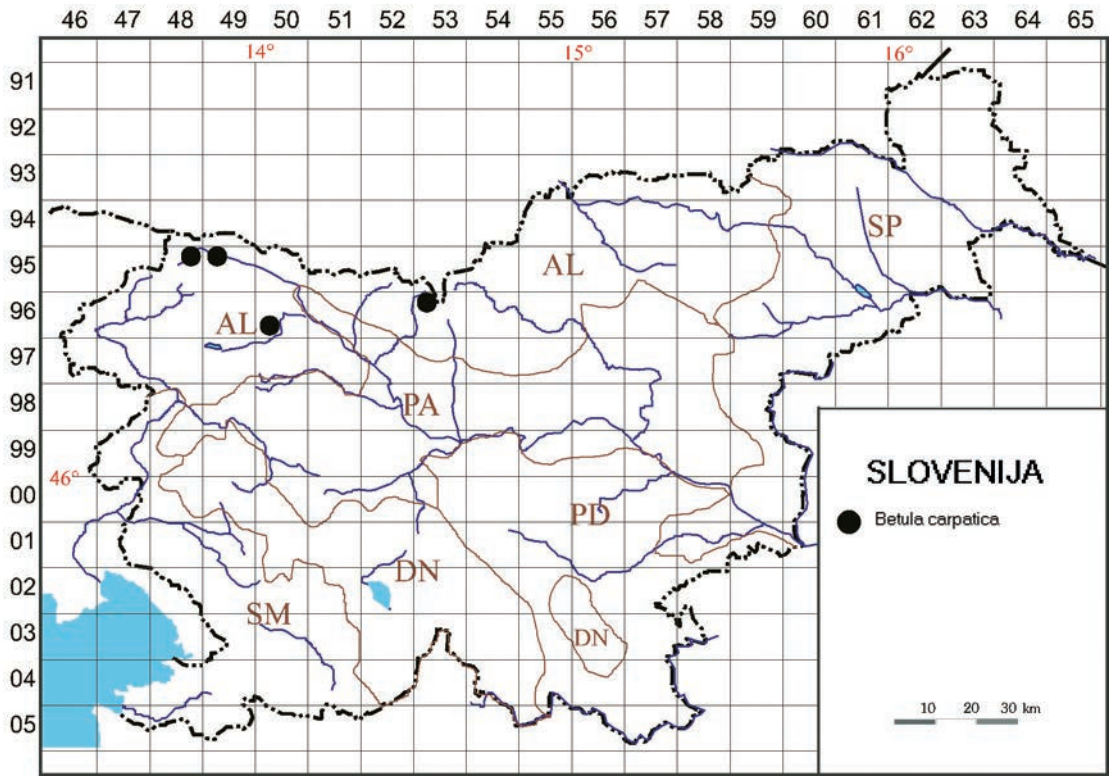

Figure 1: Distribution of Betula pubescens subsp. carpatica in Slovenia
Slika 1: Razširjenost podvrste Betula pubescens subsp. carpatica v Sloveniji

Figure 2: Approximate localities with recorded stands of Betula pubescens subsp. carpatica in northwestern Slovenia
Slika 2: Približna nahajališča sestojev s podvrsto Betula pubescens subsp. carpatica v severozahodni Sloveniji

pine stands from the Julian Alps (Figures 3 and 4). Our own relevés were used as comparative material instead of the relevés of *Pinus mugo* stands, published by Zupančič, Žagar & Culiberg (2006), which are more species-rich and less comparable to the studied form of dwarf pine community. The relevés of the stands with dominant Carpathian birch cluster separately from other dwarf pine relevés. Syntaxonomically, they can be treated as a special form of Alpine dwarf pine community, the subassociation *Rhododendro hirsuti-Pinetum mugo betuletosum carpaticae*.

According to the Code of phytosociological nomenclature (Weber, Moravec & Theurillat 2000: 753, Article 29 b), the strata that are considered to determine the vegetation structure must have the mean dominance degree of over 25 % (at least value 3 of the Braun-Blanquet cover-abundance scale). In our case, the dominant layer in most of the relevés (with exception of one) is the tree layer, which covers 30 % to 70 % of the recorded surface area. This means that at least one name-giving taxon of the association should belong to the dominant tree layer. Because the Carpathian birch dominates in the tree layer we find that classification into a new association *Rhododendro hirsuti-Betuletum carpaticae* is also appropriate. This association characterises a rather long-term successional stage in the belt of altimontane and subalpine beech and coniferous forests on ecologically specific sites – cold, shady, gravelly mountain hollows, where avalanches accumulate and snow stays long into the spring, on organogenic and (or) moder rendzina. Progressive development into spruce, larch or beech forest (their stands grow in the immediate vicinity, on less extreme sites) is substantially hindered or slowed down due to the natural conditions. In the synthetic overview of European dwarf pine communities published by Zupančič, Žagar & Culiberg (2006, synthetic Table 2) the taxon *Betula carpatica* occurs only within the syntaxon *Pinetum mughi carpaticum silicicolum* Pawłowski 1928 = *Pinetum mugo* var. geogr. *typicum* (Pawł. 1928) Zupančič & Žagar in

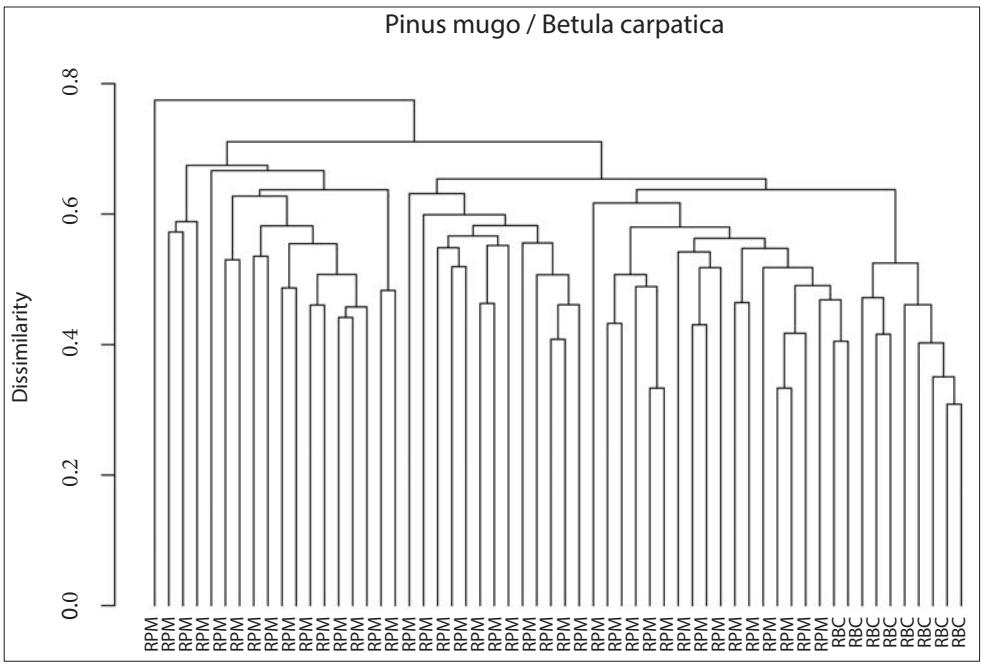

Figure 3: Dendrogram of Pinus mugo communities in the Julian Alps. UPGMA, Bray-Curtis index. RPM – Rhododendro hirsuti-Pinetum mugo, RBC – Rhododendro hirsuti-Betuletum carpaticae
Slika 3: Dendrogram združb rušja v Julijskih Alpah, UPGMA, Bray-Curtisov količnik različnosti. RPM – Rhododendro hirsuti-Pinetum mugo, RBC – Rhododendro hirsuti-Betuletum carpaticae

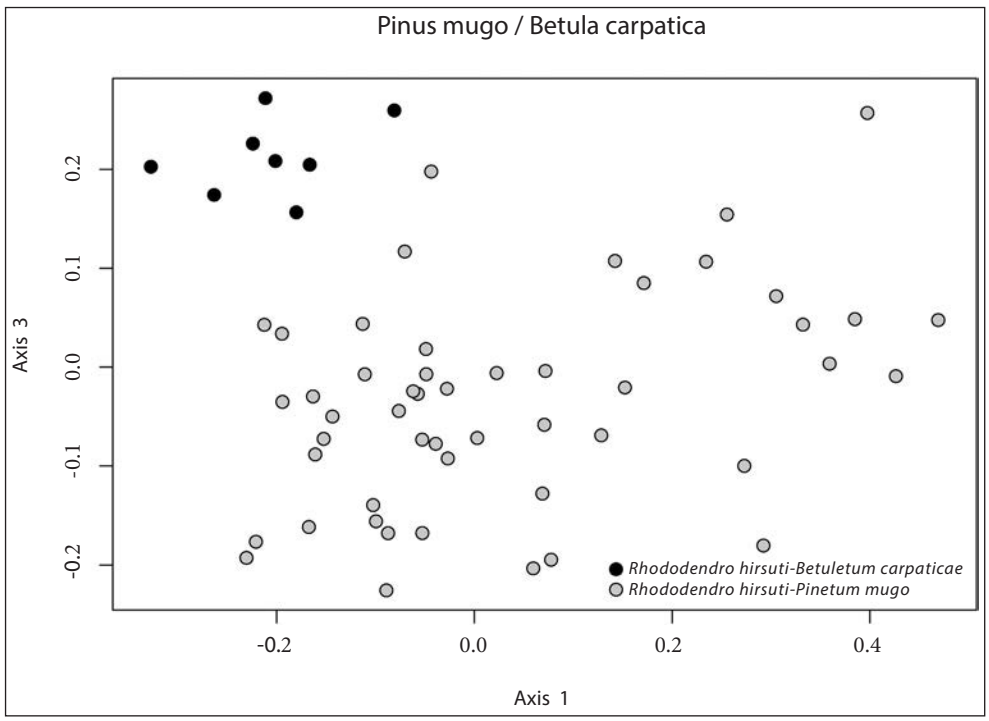

Figure 4: Two-dimensional scatter-diagram of Pinus mugo communities in the Julian Alps, PCoA, Bray-Curtis index
Slika 4: Dvorazsežni ordinacijski diagram združb rušja v Julijskih Alpah, PCoA, Bray-Curtisov količnik različnosti

Zupančič et al. 2006 and is featured in this table among other species, without any diagnostic value. This confirms that the Carpathian birch and dwarf pine community in our case is a previously phytosociologically undetermined form of Alpine *Pinus mugo* communities which deserves proper attention despite the small areas it covers. The taxon *Betula carpatica* was found in Carinthia on rather similar sites and in similar ecological conditions (also on the northern slopes of the Karavanke range), but relevés of one of the author's (Franz) have not been analysed as of yet. The nomenclatural type, *holotypus*, of the new association *Rhododendro hirsuti-Betuletum carpaticae* is relevé No. 4 in Table 1. It is temporarily classified into the alliance *Pinion mugo* Pawł. 1928 (*Erico-Pinion mugo* Leibundgut 1948), order *Junipero-Pinetalia* Boşcaiu 1971 and class *Vaccinio-Piceetea* Br.-Bl. et al. 1939 em. Zupančič (1976) 1980. In terms of ecology the stands of the new association could be compared also to the stands of the association *Betuletum pubescenti-carpaticae* from the Pyrenees, which is characteristically a community of channels, debris cones, slopes and ledges covered by large, frost-shattered blocks; its tree layer is dominated by *Betula carpatica* and *B. pubescens*, and the shrub layer by *Rhododendron ferrugineum* (Rivas-Martíinez et al. 2002). The Pyrenean stands do not include *Pinus mugo* and *Alnus viridis*, the species that are, like *Betula carpatica*, *Rhododendron hirsutum, Cystopteris montana, Saxifraga cuneifolia* and *Cypripedium calceolus,* diagnostic for the association *Rhododendro hirsuti-Betuletum carpaticae*.

4 CONCLUSIONS

Betula pubescens subsp. *carpatica* is a taxon which is most widely distributed in northern Europe, but grows also in western-, central- and eastern-European mountains (the Pyrenees, the Alps, the Carpathians). It is slightly different from the typical downy birch (*Betula pubescens* s. str.) in terms of morphology and ecology, so its classification at the level of subspecies is appropriate. So far, only marsh and swamp communities with dominant Carpathian birch have been described. In the Southeastern Alps it was first known in Austria (Franz 2000, Fischer, Adler & Oswald 2008), where it grows in subalpine scrub communities, on moist rockfall blocks and on torrential or avalanche debris cones. Very similar are its sites in the Julian Alps which caught our attention several years ago. Initially, it was determined as a type subspecies *Betula pubescens* subsp. *pubescens*; however, having revised our classification and based on a comparison with specimens of *Betula pubescens* in Carinthia, we established that our specimens from the Julian and Kamnik Alps can be determined as the subspecies *B. pubescens* subsp. *carpatica*. Its stands were phytosociologically studied and thus it was established that it can be classified into at least five syntaxa: *Adenostylo glabrae-Piceetum* sensu Zupančič = *Homogyno sylvestris-Piceetum* sensu Exner, *Rhodothamno-Laricetum*, *Rhododendro hirsuti-Pinetum mugo*, *Polysticho lonchitis-Fagetum betuletosum carpaticae* and *Rhododendro hirsuti-Betuletum carpaticae* ass. nov. hoc loco. It grows the most abundantly in the stands of the last two syntaxa where it is dominant or codominant also in the tree layer. Into the newly described association *Rhododendro hirsuti-Betuletum carpaticae* we classify the stands of *Betula pubescens* subsp. *carpatica*, *Pinus mugo*, *Alnus viridis* and *Rhododendron hirsutum* in cold, partly frosty and relatively moist hollows of the forest (altimontane-subalpine) belt, into which avalanches slide from the rockwalls and where the snow keeps long into the spring. The site conditions are therefore very unfavourable for the growth of forest and do not allow other tree species (beech, spruce, larch) to establish themselves and replace the Carpathian birch and dwarf pine in the succession. Despite the small areas it covers, this relatively long-term successional stage nevertheless has a significant protective role and is important also as a site of *Cypripedium calceolus*, a species of European conservation concern (comp. Jogan 2004), some other protected species (e.g. *Listera cordata, Lycopodium annotinum, Lilium martagon, Platanthera bifolia, Sphagnum* sp.) and rare species (*Cirsium helenioides* = *C. heterophyllum* – Beli potok is its first known locality in the Julian Alps). The community of *Betula carpatica*, *Pinus mugo*, *Alnus viridis* and *Rododendron hirsutum* is a special, new form of European dwarf pine communities (comp. Zupančič, Žagar & Culiberg 2006).

5 POVZETEK

5.1 Uvod

Betula pubescens subs. *carpatica* je severno- in srednjeevropski takson, najbolj razširjen v (sub)arktičnih deželah, a ga poznajo tudi v gorovjih srednje Evrope, v Pirenejih, Alpah in Karpatih (Walters 1993: 69). Značilen je za združbe visokih barij, močvirske brezove gozdove, subalpinska grmišča in kisloljubne borove in smrekove gozdove, ki jih uvrščajo v različne asociacije, npr. *Empetro-Betuletum carpaticae* Van der Werf ex Westhoff et van Osten 1991, *Salici silesiacae-Betuletum carpaticae* Rejmánek, Sýkora et Štursa 1971, *Vaccinio uliginosi-Betuletum carpaticae* Lohmeyer et Bohn 1972, *Vaccinio myrtilli-Betuletum carpaticae* Stöcker 1967, *Betuletum carpaticae* Lohmeyer & Bohn 1972, *Betulo carpaticae-Piceetum* Stöcker 1967, *Betulo carpaticae-Pinetum* Mikyška 1970, *Betuletum pubescenti-carpaticae* Rivas-Martínez & Costa 1998. Po karpatski brezi pa imenujejo tudi višje sintaksonomske enote, npr. zvezo *Betulion carpaticae-pubescentis* Rivas-Martínez & Costa 2002 in razred *Betulo carpaticae-Alnetea viridis* Rejmánek in Huml, Lepš, Prach et Rejmánek (prim. Jeník, Bureš & Burešová 1980, Oberdorfer 1983, Ellenberg 1996, Mertz 2000, Neuhäuslová 2001, Rivas-Martínez et al. 2002, Theurillat 2004). V Alpah, predvsem v Avstriji, karpatska breza uspeva na bregovih potokov, na robovih visokih barij in v subalpinskih grmiščih, še posebej na vlažnem podornem skalovju, na hudourniških in plazovnih vršajih, poraslih z vrstama *Pinus mugo* in *Alnus viridis* (Franz 2000, Fischer, Adler & Oswald 2008: 470–471). Pri naših raziskavah gozdov na zgornji gozdni meji smo vrsto *Betula pubescens* našli v krnici Za Akom v Martuljških gorah (vzhodne Julijske Alpe), v posebni obliki subalpinskega bukovega gozda (*Polystichо lonchitis-Fagetum*) na orografski zgornji gozdni meji, ki jo pogojujejo vsakoletni snežni plazovi. Sprva smo jo določili kot tipsko podvrsto *Betula pubescens* subsp. *pubescens* – Dakskobler & Rozman (2010). V letih 2010 in 2011 smo to brezo našli na podobnih nahajališčih, na izrazito hladnih, osojnih pobočjih, v kotanjah izpostavljenih vsakoletnim snežnim plazovom, v subalpinskem bukovem gozdu ali v ruševju, tudi v povirnem delu doline Belega potoka, v gozdnem rezervatu Smrajka in v krnici Pod Srcem (pod Špikom). Na opozorilo soavtorja W. R. Franza, da gre najbrž za podvrsto *B. pubescens* subsp. *carpatica*, smo našo določitev ponovno preverili. Pri tem smo, kolikor je bilo mogoče, upoštevali razlikovalne znake, ki jih navajajo Fischer, Adler & Oswald (2008: 470–471). Ugotovili smo, da pri naših primerkih letošnji poganjki sicer navadno ostanejo dlakavi (kar je sicer značilno za takson *Betula pubescens* s. str.), a je njihova listna ploskev bolj ali manj rombasta, večinoma dvakrat nepravilno nažagana, na spodnji strani v glavnem ogolela (pri tipični podvrsti je listna ploskev jajčasta do okroglasto-jajčasta, v glavnem enakomerno enojno nazobčana, listi vsaj v žilnih kotih ostanejo dlakavi), in da so stebla pogosto usločena, ukrivljena in grčasto odebeljena (pri tipični podvrsti so navadno pokončna). Prevladujoča panjevska razrast je deloma posledica vsakoletnih snežnih plazov. Skorja je bela, včasih rdečkasta (na Koroškem včasih tudi precej temna, skoraj črna). Cvetočih rastlin nismo opazili (pri primerkih iz Avstrijske Koroške pa so ženske mačice sprva pokončne, brazda pa je rožnata). Pri taksonu *Betula pubescens* s. str. sta stranski krili plodnih lusk polkrožni, vodoravno štrleči ali nekoliko navzdol, le redko tudi navzgor ukrivljeni. Pri podvrsti *B. pubescens* subsp. *carpatica* sta stranski krili plodnih lusk širši kot dolgi in vodoravno do navzgor štrleči. Taksonomski status podvrste *B. pubescens* subsp. *carpatica* je nekoliko negotov in nekatera pregledna dela je ne obravnavajo na rangu samostojne podvrste (npr. Flora alpina – Aeschimann et al. 2004: 228).

Ker so velikost in oblika listov, videz stebla in celoten habitus primerkov puhaste breze iz nahajališč v altimontanskem in subalpinskem pasu v vzhodnih Julijskih Alpah zelo podobni znakom, kakršne ima puhasta breza, ki jo v Avstriji vrednotijo kot takson *Betula pubescens* subsp. *carpatica*, je smisleno, da ta takson uvedemo tudi v floro Slovenije. Ker ga novejše pregledno delo o flori Slovenije (Martinčič et al. 2007) še ne omenja, bomo v članku opisali njegovo razširjenost, rastišča in združbene razmere.

5.2 Metode

Floro in vegetacijo na rastiščih taksona *Betula pubescens* s. lat. smo preučevali po ustaljenih srednjeevropskih metodah (Braun-Blanquet 1964, Ehrendorfer & Hamann 1965). Floristične in fitocenološke popise smo vnesli v bazo FloVegSi (T. Seliškar, Vreš & A. Seliškar 2003). Kombinirane ocene zastiranja in pogostnosti smo pretvorili v številke 1 do 9 (van der Maarel 1979). Numerične primerjave smo opravili z R programskim okoljem. Uporabljali smo paket "vegan" (Oksanen & al. 2011). Popise smo primerjali s pomočjo metode kopičenja na podlagi povezovanja (netehtanih) srednjih razdalj – "(Unweighted) average linkage" – UPGMA in z ordinacijsko metodo glavnih koordinat – "Principal coordinates analysis" – PCoA. Pri obeh metodah smo uporabljali Bray-Curtisov količnik različnosti. Nomen-

klaturni vir za imena praprotnic in semenk je Mala flora Slovenije (Martinčič & al. 2007), razen za podvrsto *Betula pubescens* Ehrh. subsp. *carpatica* (Willd.) Ascherson & Graebner. Martinčič (2003, 2011) je nomenklaturni vir za imena mahov in Suppan, Prügger & Mayrhofer (2000) za imena lišajev. Nomenklaturni vir za imena sintaksonov višjega ranga od asociacije je Theurillat (2004). Podatke o geološki podlagi črpamo po virih Jurkovšek (1987 a, b) in Buser (2009), vir za poimenovanje talnih tipov so Urbančič et al. (2005). Podnebne podatke (količina padavin, srednja temperatura) povzemamo po J. Pristov, N. Pristov & Zupančič (1998). Herbarijske primerke taksona *Betula carpatica* iz vzhodnih Julijskih Alp hranimo v Herbariju ZRC SAZU (LJS) – glej http://sweetgum.nybg.org/ih/herbarium.php?irn=167779.

Opis okoljskih razmer raziskovanega območja

Prevladujoča geološka podlaga v raziskanem delu vzhodnih Julijskih Alp sta triasni debeloplastnat dachsteinski apnenec s prehodi v dolomit in masiven debelozrnat dolomit in apnenec, le na majhnih površinah dobimo tudi skrilavi glinavec, meljevec in tuf. Podnebje je gorsko, humidno (s povprečno letno količino padavin okoli 2500 mm), z obilo snega od jeseni do pozne pomladi (150 do 200 dni s snežno odejo), zaradi prevladujoče osojne lege hladno, še posebno v alpskih krnicah kot so Za Akom, Pod Srcem (Pod Špikom), Smrajka in v zatrepu Belega potoka nekoliko mraziščno (s srednjo letno temperaturo 2 °C do 4 °C). Sneg s sten se kopiči v krnicah in se v njih obdrži pozno v pomlad. Kjer orografski dejavniki to dopuščajo, je zgornja gozdna meja na nadmorski višini okoli 1800 m. Na njej prevladuje macesen in njegove sestoje uvrščamo v asociacijo *Rhodothamno-Laricetum* Willner & Zukrigl 1999. Smrekovi sestoji asociacije *Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973 corr. Zupančič 1999 = *Homogyno sylvestris-Piceetum* Exner ex Poldini & Bressan 2007 se pojavljajo krajevno na mešani podlagi in podornem skalovju na nekaj krajih v Smrajki, nad Belim potokom in Za Akom. Bukov gozd ponekod uspeva do nadmorske višine 1600 m, posamezna bukova drevesa pa skoraj do 1700 m nm. v. V glavnem ga uvrščamo v asociacijo *Anemono-Fagetum* Tregubov 1962, v krnicah Za Akom in pod Špikom pa smo ugotovili tudi sestoje asociacije *Polysticho lonchitis Fagetum* (I. Horvat 1938) Marinček in Poldini & Nardini 1993, med drugim sestoje subasociacije *Polysticho lonchitis-Fagetum betuletosum pubescentis* Dakskobler & Rozman 2010 – ime te subasociacije zdaj popravljamo v *Polysticho lonchitis-Fagetum betuletosum carpaticae* Dakskobler & Rozman 2010. V Smrajki in nad dolino Belega potoka uspevajo tudi sestoji asociacije *Homogyno sylvestris-Fagetum* Marinček et al. 1993. Sklenjeno ruševje, *Rhododendro hirsuti-Pinetum prostratae* Zöttl 1951 = *Rhodothamno-Rhododendretum hirsuti* (Aichinger 1933) Br.-Bl. & Sissingh in Br.-Bl. & al. 1939, je razširjeno nad pasom macesnovja, pogosto pa v krnicah in ob hudourniških žlebovih raste tudi veliko nižje, vse do nadmorske višine 900 m. Preučeni sestoji s karpatsko brezo so v glavnem omejeni na zelo hladna, senčna pobočja in kotanje, izpostavljene vsakoletnim snežnim plazovom, na nadmorski višini med 1100 in 1400 m.

5.3 Rezultati in razprava

Opis nahajališč podvrste *Betula pubescens* subsp. *carpatica* v Sloveniji

9650/3 (UTM 33TVM22): Slovenija, Julijske Alpe, Bohinj, Soteska, vznožje Jelovice, krajevno mrazišče na podornem skalovju, 520 m nm. v., *Rhodothamno-Laricetum*. Puhasto brezo (*Betula pubescens*) je na tem nahajališču prvi navajal Martinčič (1977: 294). Na podlagi primerkov, ki smo jih nabrali pomladi 2010 (leg. I. Dakskobler & A. Rozman) in naših fotografskih posnetkov, je določitev revidiral W. R. Franz, 2011, herbarij LJS.

9549/1 (UTM 33TVM14): Slovenija, Julijske Alpe, Martuljške gore, krnica Za Akom, subalpinski bukov gozd (*Polysticho lonchitis-Fagetum betuletosum carpaticae*) na prehodu v ruševje, 1350 do 1360 m nm. v. m. Leg. & det. I. Dakskobler & A. Rozman, 27. 7. 2009 in I. Dakskobler, 24. 8. 2009 sub. *Betula pubescens* subsp. *pubescens*, rev. W. R. Franz, 2010, LJS; Smrajka, ledeniška kotanja in hudourniški vršaj izpod grebena Vrtaški vrh–Vrtaško Sleme, 1130 do 1270 m nm. v., smrekov gozd (*Adenostylo glabrae-Piceetum*) in združba karpatske breze (*Rhododendro hirsuti-Betuletum carpaticae*). Leg. & det. I. Dakskobler & A. Rozman, 2. 7. 2010, rev. W. R. Franz, 2010, LJS; Beli potok, gruščnat stožec na vznožju Krničnikov, 1180 m nm. v., *Rhododendro hirsuti-Betuletum carpaticae*. Leg. & det. I. Dakskobler & A. Rozman, 2. 7. 2010 in 30. 8. 2011, rev. W. R. Franz, 2011, LJS; Beli potok, gruščnata kotanja pod Robičevo planino, 1320 do 1450 m nm. v., *Rhodothamno-Laricetum*, *Rhododendro hirsuti-Betuletum carpaticae, Rhododendro hirsuti-Pinetum mugo*. Leg. & det. I. Dakskobler, 10. 8. 2010, rev. W. R. Franz, 2011, LJS.

9548/2 (UTM 33T VM04): Slovenija, Julijske Alpe, Pod Špikom, 1350 do 1370 m nm. v., spodnji del ledeniške krnice, subalpinsko bukovje (*Polysticho lonchitis-Fagetum*) in ruševje *(Rhododendro hirsuti-Pinetum mugo*). Leg. & det. I. Dakskobler & B. Zupan, 28. 9. 2011, rev. W. R. Franz, 2011, LJS.

9653/1 (UTM 33TVM63): Slovenija, Kamniške Alpe, Zgornje Jezersko, Ravenska Kočna, 1120 m nm. v., hudourniški vršaj, grobo melišče, poraslo s prevladujočima vrstama *Salix eleagnos* in *Petastes paradoxus*. Leg. & det. I. Dakskobler & A. Seliškar, 7. 7. 2010, rev. W. R. Franz, 2011, LJS.

Na Zgornjem Jezerskem, v Ravenski Kočni, pri Anclju, okoli 1000 m nm. v., je takson *Betula pubescens* popisal tudi B. Anderle, 3. 8. 2008. Isti avtor (Anderle, in litt.) je vrsto *Betula pubescens* popisal tudi v Karavankah, na Ljubelju, pri Juriju (9551/4), na nadmorski višini 950 m (det. B. Anderle, 21. 7. 2004) in mogoče je, da gre tudi v tem primeru za podvrsto *B. pubescens* subsp. *carpatica*. Karta razširjenosti karpatske breze v Sloveniji (slika 1) je zato še precej nepopolna.

Opis združbe z dominantnim taksonom *Betula pubescens* subsp. *carpatica* v drevesni plasti

Med opisanimi nahajališči karpatske breze v Sloveniji posebej izstopajo sestoji, v katerih je ta podvrsta dominantna v drevesni plasti, v grmovni pa je prevladujoče rušje (*Pinus mugo*) in pogosta primešana zelena jelša (*Alnus viridis*). Takšne sestoje smo opazili v Smrajki in v dolini Belega potoka (slika 2). Skupno smo naredili 8 popisov (tabela 1) in jih primerjali s 50 popisi ruševja iz Julijskih Alp (sliki 3 in 4). Kot primerjalno gradivo smo vzeli lastne popise, ne pa popisov ruševja, ki so jih objavili Zupančič, Žagar & Culiberg (2006) in so vrstno bogatejši in z obravnavano obliko ruševja manj primerljivi. Popisi sestojev z dominantno karpatsko brezo se združujejo ločeno od ostalih popisov ruševja. Lahko jih sintaksonomsko vrednotimo kot posebno obliko alpskega ruševja, kot subasociacijo *Rhododendro hirsuti-Pinetum mugo betuletosum carpaticae*. Po Kodeksu fitocenološke nomenklature (Weber, Moravec & Theurillat 2000: 753, Člen 29 b), mora plast, za katero štejemo, da določa strukturo vegetacije, zastirati vsaj 25 % (imeti mora oceno najmanj 3 po Braun-Blanquetovi lestvici zastiranja in obilnosti). V našem primeru v večini popisov (z izjemo enega) strukturo vegetacije določa drevesna plast, ki zastira od 30 % do 70 % popisane površine. Potemtakem mora biti vsaj eden od taksonov, po katerem imenujemo asociacijo, iz drevesne plasti. Ker v njej prevladuje karpatska breza, je po našem mnenju umestna uvrstitev preučenih sestojev v novo asociacijo *Rhododendro hirsuti-Betuletum carpaticae*. Z njo označujemo dokaj dolgotrajen sukcesijski stadij v pasu altimontanskih in subalpinskih bukovih in iglastih gozdov na ekološko zelo posebnih rastiščih – v hladnih, osojnih gruščnatih gorskih kotanjah, kamor polzijo snežni plazovi in se v njih sneg zadržuje dolgo v pomlad, na organogeni in (ali) prhninasti rendzini. Progresivni razvoj v smrekov, macesnov ali bukov gozd (njihovi sestoji uspevajo v neposredni okolici, na manj skrajnih rastiščih) je zaradi naravnih danosti zelo otežkočen oz. upočasnjen. V sinteznem pregledu evropskih ruševij, ki so ga objavili Zupančič, Žagar & Culiberg (2006, sintezna tabela 2), se takson *Betula carpatica* pojavlja le v sintaksonu *Pinetum mughi carpaticum silicicolum* Pawłowski 1928 = *Pinetum mugo* var. geogr. *typicum* (Pawł. 1928) Zupančič & Žagar in Zupančič et al. 2006 in je v tej tabeli predstavljena med ostalimi vrstami, brez vsakršne diagnostične vrednosti. To potrjuje, da gre v našem primeru res za posebno, do zdaj fitocenološko neobdelano obliko alpskega ruševja, ki kljub zelo majhnim površinam, na katerih se pojavlja, zasluži ustrezno pozornost. V precej podobnih rastiščnih razmerah in združbah so karpatsko brezo našli na sosednjem Avstrijskem Koroškem (tudi na severnih pobočjih Karavank), vendar popisov eden izmed nas (Franz) za zdaj še ni obdelal. Nomenklaturni tip, *holotypus*, nove asociacije *Rhododendro hirsuti-Betuletum carpaticae* je fitocenološki popis št. 4 v tabeli 1. Za zdaj jo uvrščamo v zvezo *Pinion mugo* Pawł. 1928 (*Erico-Pinion mugo* Leibundgut 1948), v red *Junipero-Pinetalia* Boşcaiu 1971 in v razred *Vaccinio-Piceetea* Br.-Bl. et al. 1939 em. Zupančič (1976) 1980. Ekološko bi sestoje nove asociacije lahko primerjali tudi s sestoji asociacije *Betuletum pubescenti-carpaticae* iz Pirenejev. Zanjo je značilno, da je združba žlebov, vršajev, podornega skalovja in v njej v drevesni plasti prevladujeta takson *Betula carpatica* in *B. pubescens*, v grmovni plasti pa vrsta *Rhododendron ferrugineum* (Rivas-Martínez et al. 2002). V pirenejskih sestojih ni vrst *Pinus mugo* in *Alnus viridis*, ki sta poleg taksonov *Betula carpatica*, *Rhododendron hirsutum*, *Cystopteris montana*, *Saxifraga cuneifolia* in *Cypripedium calceolus* diagnostični za asociacijo *Rhododendro hirsuti-Betuletum carpaticae*.

5.4 Zaključki

Betula pubescens subsp. *carpatica* je takson z največjo razširjenostjo v severni Evropi, a uspeva tudi v zahodno-, srednje- in vzhodnoevropskih gorovjih (Pireneji, Alpe, Karpati). Morfološko in ekološko se nekoliko razlikuje od tipične puhaste breze (*Betula pubescens* s. str.) in je zato vrednotenje na rangu podvrste smiselno. Do zdaj so bile opisane večinoma barjanske in močvirne združbe, v katerih je dominantna karpatska breza. V Jugovzhodnih Alpah so jo najprej spoznali v Avstriji (Franz 2000, Fischer, Adler & Oswald 2008), kjer uspeva v subalpinskih grmiščih, na vlažnem podornem skalovju in na hudourniških ali plazovnih vršajih. Zelo podobna so njena rastišča v Julijskih Alpah, na katera smo postali pozorni pred nekaj leti. Sprva smo jo dolo-

čali kot tipsko podvrsto, *Betula pubescens* subsp. *pubescens*, pozneje pa smo našo določitev kritično preverili. Na podlagi primerjav s primerki puhaste breze na Avstrijskem Koroškem lahko primerke iz Julijskih in Kamniških Alp uvrstimo v podvrsto *B. pubescens* subsp. *carpatica*. Njene sestoje smo zato fitocenološko preučili. Ugotovili smo, da jih lahko uvrstimo v vsaj pet sintaksonov: *Adenostylo glabrae-Piceetum* sensu Zupančič = *Homogyno sylvestris-Piceetum* sensu Exner, *Rhodothamno-Laricetum*, *Rhododendro hirsuti-Pinetum mugo, Polystricho lonchitis-Fagetum betuletosum carpaticae* in *Rhododendro hirsuti-Betuletum carpaticae* ass. nov. hoc loco., pri čemer je v sestojih slednjih dveh najbolj obilna in dominantna ali kodominantna tudi v drevesni plasti. V novo opisano asociacijo *Rhododendro hirsuti-Betuletum carpaticae* uvrščamo sestoje karpatske breze, rušja, zelene jelše in dlakavega sleča v hladnih, deloma mraziščnih in razmeroma vlažnih kotanjah gozdnega (altimontansko-subalpinsekga) pasu, kamor iz ostenij plazi sneg in se tam zadržuje pozno v pomlad. Rastiščne razmere za uspevanje gozda so zato zelo neugodne in ne omogočajo drugim drevesnim vrstam (bukvi, smreki, macesnu), da bi se močneje uveljavili in v sukcesiji nadomestili karpatsko brezo in rušje. Razmeroma dolgotrajen sukcesijski stadij ima kljub majhnim površinam, na katerih smo ga ugotovili, veliko varovalno in biotopsko vlogo, tudi kot rastišče evropsko varstveno pomembne vrste *Cypripedium calceolus* (prim. Jogan 2004), nahajališče nekaterih drugih zavarovanih vrst (npr. *Listera cordata, Lycopodium annotinum, Platanthera bifolia, Lilium martagon, Sphagnum* sp.) in redke vrste *Cirsium helenioides* = *C. heterophyllum* (Beli potok je prvo znano nahajališče te vrste v Julijskih Alpah). Združba karpatske breze, rušja, zelene jelše in dlakavega sleča je med evropskimi ruševji posebnost in novost (prim. Zupančič, Žagar & Culiberg 2006).

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Figure 5: Cold cirque in Smrajka under Votlo Sleme in the eastern Julian Alps, typical site of Betula carpatica. Photo I. Dakskobler
Slika 5: Hladna krnica v Smrajki pod Votlim Slemenom v vzhodnih Julijskih Alpah, tipično rastišče za karpatsko brezo. Foto I. Dakskobler

Figure 6: Leaf lamina of Betula pubescens subsp. carpatica is more or less rhomb-shaped, predominantly irregularly doubly serrate, Beli potok. Photo I. Dakskobler
Slika 6: Listna ploskev podvrste Betula pubescens subsp. carpatica je bolj ali manj rombasta, večinoma dvakrat nepravilno nažagana, Beli potok. Foto I. Dakskobler

Figure 7: The stems of Betula carpatica are often arched, twisted and have thick knobby nodes, Smrajka. Photo A. Rozman
Slika 7: Stebla taksona Betula carpatica so pogosto usločena, ukrivljena in grčasto odebeljena, Smrajke. Foto A. Rozman

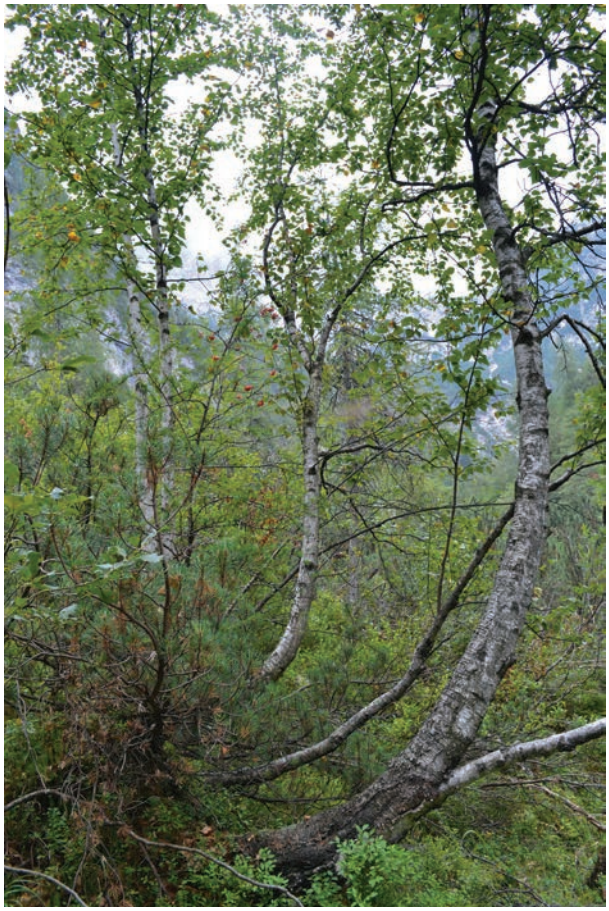

Figure 8: The stand of Betula carpatica in the Beli potok valley. Photo I. Dakskobler
Slika 8: Sestoj karpatske breze v Belem potoku. Foto I. Dakskobler

Figure 9: The Rhododendro hirsuti-Betuletum carpaticae in Smrajka. Photo A. Rozman
Slika 9: Sestoj asociacije Rhododendro hirsuti-Betuletum carpaticae v Smrajki. Foto A. Rozman

Figure 10: The stand of Betula carpatica and Pinus mugo on the northern slopes of the Kamnik-Savinja Alps (the Steiner Alps) in Austria, Vellacher Kotschna / Belska Kočna. Photo W. R. Franz
Slika 10: Sestoj karpatske breze in rušja na severnih pobočjih Kamniško-Savinjskih Alp v Avstriji – Belska Kočna / Vellacher Kotschna. Foto W. R. Franz

Figure 11: The herb layer of the association Rhododendro hirsuti-Betuletum carpaticae with Cypripedium calceolus, Smrajka. Photo A. Rozman
Slika 11: Zeliščna plast v sestoju asociacije Rhododendro hirsuti-Betuletum carpaticae z lepim čeveljcem (Cypripedium calceolus), Smrajka. Foto A. Rozman

Figure 12: Cypripedium calceolus, Natura 2000 species, diagnostic also for the association Rhododedro hirusti-Betuletum carpaticae. Smrajka, Photo A. Rozman
Slika 12: Lepi čeveljc (Cypriopedium calceolus), evropsko varstveno pomembna vrsta, je diagnostična tudi za asociacijo Rhododedro hirusti-Betuletum carpaticae, Smrajka. Foto A. Rozman

Table 1: *Rhdodendro hirsuti-Betuletum carpaticae* ass. nov. - the eastern Julian Alps, Slovenia
Tabela 1: *Rhdodendro hirsuti-Betuletum carpaticae* ass. nov. - vzhodne Julijske Alpe, Slovenija

Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8		
Database number of relevé (Številka popisa v podatkovni bazi)		238438	238439	240912	238509	238440	238510	238511	238512		
Altitude in m (Nadmorska višina v m)		1370	1370	1180	1150	1320	1160	1170	1270		
Aspect (Lega)		E	E	NNW	N	SE	NE	NNE	E		
Slope in degrees (Nagib v stopinjah)		25	25	25	15	35	10	10	15		
Parent material (Matična podlaga)		Gr	Gr	Gr	Mo	Mo	Mo	Mo	Mo		
Soil (Tla)		Re	Re	Re	Re	Re	Re	Re	Re		
Stoniness in % (Kamnitost v %)		10	10	10	5	5	10	10	10		
Cover in % (Zastiranje v %):											
Cover of tree layer in % (Zastiranje drevesne plasti v %)	E3	60	40	30	70	10	70	70	50		
Cover of shrub layer in % (Zastiranje grmovne plasti v %):	E2	80	90	70	30	100	30	30	50		
Cover of herb layer in % (Zastiranje zeliščne plasti v %):	E1	60	60	80	90	50	90	80	80		
Cover of moss layer in % (Zastiranje mahovne plasti v %)	E0	30	10	30	10	5	10	10	10		
Maximum diameter of trees (Največji prsni premer dreves)	cm	25	30	15	35	20	30	35	25		
Maximum height of tress (Največja drevesna višina)	m	15	16	15	20	6	14	15	10		
Number of species (Število vrst)		55	50	62	40	42	63	76	75		
Relevé area (Velikost popisne ploskve)	m^2	200	200	200	200	100	200	400	200		
Date of taking relevé (Datum popisa)		8/10/2010	8/10/2010	8/30/2011	7/2/2010	8/10/2010	7/2/2010	7/2/2010	7/2/2010		
Locality (Nahajališče)		Beli potok - Robičeva planina	Beli potok - Robičeva planina	Beli potok, pod Macesnjem	Smrajka	Beli potok - Robičeva planina	Smrajka	Smrajka	Smrajka		
Quadrant (Kvadrant)		9549/1	9549/1	9549/1	9549/1	9549/1	9549/1	9549/1	9549/1		
Diagnostic species of the association (Diagnostične vrste asociacije)										Pr.	Fr.
SC *Betula pubescens subsp. carpatica*	E3	3	2	2	4	+	4	4	3	8	100
SC *Betula pubescens subsp. carpatica*	E2b	+	1	+	+	1	+	+	1	8	100
SC *Betula pubescens subsp. carpatica*	E2a	.	+	.	.	.	.	.	.	1	13
SC *Betula pubescens subsp. carpatica*	E1	+	.	.	.	+	.	.	.	2	25
EP *Pinus mugo*	E2b	4	4	3	3	5	3	+	3	8	100
EP *Rhododendron hirsutum*	E2a	3	3	1	1	2	1	+	2	8	100
MuA *Alnus viridis*	E2b	2	3	1	1	1	+	.	+	7	88
TR *Cystopteris montana*	E1	.	+	+	.	+	1	1	1	6	75
VP *Saxifraga cuneifolia*	E1	.	.	1	+	.	1	+	1	5	63
FS *Cypripedium calceolus*	E1	.	.	.	.	.	1	+	1	3	38
VP ***Vaccinio-Piceetea***											
Vaccinium myrtillus	E1	4	3	4	4	3	2	+	1	8	100
Larix decidua	E3	1	1	2	1	+	+	1	1	8	100
Larix decidua	E2b	.	+	1	.	.	.	.	+	3	38
Larix decidua	E2a	.	.	.	+	+	+	.	+	4	50
Lonicera caerulea	E2a	1	1	+	+	+	+	+	+	8	100
Clematis alpina	E2a	+	+	+	+	+	+	+	1	8	100
Solidago virgaurea	E1	+	+	+	+	+	+	+	+	8	100
Gymnocarpium dryopteris	E1	1	1	1	1	+	2	2	.	7	88
Luzula sylvatica	E1	1	+	1	+	.	+	+	1	7	88
Homogyne alpina	E1	1	+	+	+	.	1	+	+	7	88
Maianthemum bifolium	E1	+	+	+	+	+	.	+	1	7	88
Vaccinium vitis-idaea	E1	2	2	3	2	.	3	.	2	6	75
Lycopodium annotinum	E1	2	2	2	2	3	.	.	+	6	75
Calamagrostis villosa	E1	1	2	1	2	.	2	1	.	6	75
Valeriana tripteris	E1	+	.	1	+	.	1	1	1	6	75
Luzula pilosa	E1	+	+	.	+	.	+	+	+	6	75
Rosa pendulina	E2a	+	+	+	+	+	.	.	+	6	75
Homogyne sylvestris	E1	+	.	.	+	+	+	+	1	6	75
Phegopteris connectilis	E1	1	1	1	+	+	.	.	.	5	63
Picea abies	E3	r	+	.	+	.	+	+	.	5	63
Picea abies	E2b	.	+	.	+	.	+	+	+	5	63
Picea abies	E2a	+	+	1	.	.	.	.	.	3	38
Picea abies	E1	.	.	.	+	.	.	+	.	2	25
Oxalis acetosella	E1	+	.	1	.	.	1	1	.	4	50

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	Pr.	Fr.
	Lonicera nigra	E2a	+	.	.	+	.	+	+	.	4	50
	Orthilia secunda	E1	.	+	+	.	.	1	.	.	3	38
	Abies alba	E2b	r	.	+	.	.	.	.	.	2	25
	Abies alba	E1	.	.	+	.	.	.	+	.	2	25
	Melampyrum sylvaticum	E1	.	+	.	1	.	.	.	.	2	25
	Aposeris foetida	E1	.	+	.	.	.	.	.	1	2	25
	Veronica urticifolia	E1	.	.	.	.	.	+	+	.	2	25
	Listera cordata	E1	.	.	+	.	.	.	.	.	1	13
	Dryopteris dilatata	E1	.	.	+	.	.	.	.	.	1	13
	Luzula luzuloides	E1	.	.	+	.	.	.	.	.	1	13
	Gentiana asclepiadea	E1	.	.	.	.	+	.	.	.	1	13
	Hieracium murorum	E1	.	.	.	.	.	.	+	.	1	13
	Polystichum lonchitis	E1	.	.	.	.	.	.	+	.	1	13
EP	***Erico-Pinetea***											
	Rubus saxatilis	E1	1	1	1	1	+	1	+	1	8	100
	Pyrola rotundifolia	E1	+	+	2	.	.	1	.	+	5	63
	Erica carnea	E1	2	1	1	.	.	.	.	1	4	50
	Calamagrostis varia	E1	.	+	+	.	+	.	.	1	4	50
	Rhodothamnus chamaecistus	E1	+	+	.	.	+	.	.	.	3	38
	Carex ornithopoda	E1	+	.	.	.	.	.	.	+	2	25
	Juniperus sibirica	E2a	+	.	.	.	.	.	.	+	2	25
	Pyrola minor	E1	+	.	.	.	.	.	.	.	1	13
	Pyrola chlorantha	E1	r	.	.	.	.	.	.	.	1	13
	Amelanchier ovalis	E2a	.	.	.	.	+	.	.	.	1	13
	Ribes alpinum	E2a	.	.	.	.	.	.	+	.	1	13
AF	***Aremonio-Fagion***											
	Anemone trifolia	E1	1	+	+	.	+	+	+	1	7	88
	Cardamine enneaphyllos	E1	1	+	.	1	.	1	1	1	6	75
	Cyclamen purpurascens	E1	.	+	+	.	.	.	.	+	3	38
	Knautia drymeia	E1	.	.	.	.	.	+	+	1	3	38
	Cardamine trifolia	E1	.	.	.	.	.	+	.	.	1	13
	Helleborus niger	E1	.	.	.	.	.	.	.	1	1	13
	Rhamnus fallax	E2a	.	.	.	.	.	.	.	+	1	13
FS	***Fagetalia sylvaticae***											
	Melica nutans	E1	+	1	1	.	+	+	1	+	7	88
	Daphne mezereum	E2a	+	+	.	.	+	+	1	1	6	75
	Paris quadrifolia	E1	.	+	+	.	+	+	1	+	6	75
	Fagus sylvatica	E3a	r	+	.	+	+	.	.	r	5	63
	Fagus sylvatica	E2a	.	.	.	.	.	.	+	+	2	25
	Fagus sylvatica	E1	+	.	+	.	.	.	.	.	2	25
	Mercurialis perennis	E1	.	+	+	.	.	+	+	+	5	63
	Galium laevigatum	E1	.	.	+	.	.	+	+	+	4	50
	Lonicera alpigena	E2a	+	.	+	.	.	.	+	.	3	38
	Acer pseudoplatanus	E3a	.	.	.	.	.	.	+	.	1	13
	Acer pseudoplatanus	E2b	.	.	.	.	.	.	.	+	1	13
	Acer pseudoplatanus	E1	.	.	.	.	.	+	+	+	3	38
	Myosotis sylvatica	E1	.	.	.	.	+	+	+	.	3	38
	Prenanthes purpurea	E1	+	.	.	+	.	.	.	.	2	25
	Poa nemoralis	E1	.	.	+	.	.	.	+	.	2	25
	Galeobdolon flavidum	E1	.	.	.	.	.	+	+	.	2	25
	Laburnum alpinum	E3a	.	.	.	.	.	.	+	.	1	13
	Laburnum alpinum	E2b	.	.	.	.	.	.	.	+	1	13
	Laburnum alpinum	E2a	.	.	.	.	.	.	+	.	1	13
	Laburnum alpinum	E1	.	.	.	.	.	+	.	.	1	13
	Dryopteris filix-mas	E1	.	.	.	.	.	.	+	.	1	13
	Euphorbia amygdaloides	E1	.	.	.	.	.	.	.	1	1	13
	Lilium martagon	E1	.	.	.	.	.	.	.	+	1	13
QF	***Querco-Fagetea***											
	Hepatica nobilis	E1	+	+	+	.	.	+	+	1	6	75
	Sorbus aria	E2a	.	.	+	.	+	.	.	+	3	38
	Cruciata glabra	E1	.	.	.	.	.	+	+	.	2	25
	Betula pendula	E3a	+	.	.	.	.	.	.	.	1	13
	Melampyrum pratense subsp. vulgatum	E1	.	+	.	.	.	.	.	.	1	13
	Viola riviniana	E1	.	.	.	.	+	.	.	.	1	13
	Populus tremula	E3a	.	.	.	.	r	.	.	.	1	13
	Platanthera bifolia	E1	.	.	.	.	.	1	.	.	1	13
MuA	***Mulgedio-Aconitetea***											
	Sorbus chamaemespilus	E2a	1	1	+	1	+	1	+	+	8	100
	Viola biflora	E1	+	.	+	.	.	+	1	1	5	63
	Salix appendiculata	E3	.	.	.	.	.	+	+	.	2	25
	Salix appendiculata	E2b	+	.	1	.	+	+	.	+	5	63
	Salix appendiculata	E2a	1	.	+	.	.	.	.	+	3	38
	Salix appendiculata	E1	.	+	.	+	.	.	.	.	2	25

	Number of relevé (Zaporedna številka popisa)		1	2	3	4	5	6	7	8	Pr.	Fr.
	Salix waldsteiniana	E2a	.	.	+	.	+	+	+	+	5	63
	Salix glabra	E2b	.	.	+	+	+	.	.	+	4	50
	Geranium sylvaticum	E1	+	+	.	.	.	.	.	+	3	38
	Polygonatum verticillatum	E1	+	.	.	.	+	.	.	+	3	38
	Saxifraga rotundifolia	E1	.	.	+	.	.	+	+	.	3	38
	Aconitum lycoctonum subsp. ranunculifolium	E1	.	.	+	.	+	.	.	.	2	25
	Chaerophyllum hirsutum	E1	.	.	.	.	.	.	1	+	2	25
	Veratrum album	E1	.	.	.	.	.	.	+	+	2	25
	Athyrium filix-femina	E1	.	.	.	.	+	.	.	.	1	13
	Geum rivale	E1	.	.	.	.	.	.	+	.	1	13
	Senecio ovatus	E1	.	.	.	.	.	.	+	.	1	13
	Crepis paludosa	E1	.	.	.	.	.	.	.	+	1	13
ES	***Elyno-Seslerietea***											
	Heliosperma alpestre	E1	+	.	.	.	.	+	+	.	3	38
	Phyteuma orbiculare	E1	.	.	.	.	.	+	+	+	3	38
	Campanula witasekiana	E1	.	+	.	.	.	+	.	.	2	25
	Sesleria caerulea subsp. calcaria	E1	.	.	.	.	.	+	.	+	2	25
	Bartsia alpina	E1	.	.	.	.	.	+	.	.	1	13
	Galium anisophyllum	E1	.	.	.	.	.	.	+	.	1	13
	Astrantia bavarica	E1	.	.	.	.	.	.	+	.	1	13
PT	*Campanula scheuchzeri*	E1	.	.	.	.	.	.	+	.	1	13
	Betonica alopecuros	E1	.	.	.	.	.	.	.	+	1	13
	Carex ferruginea	E1	.	.	.	.	.	.	.	+	1	13
	Ranunculus montanus	E1	.	.	.	.	.	.	.	+	1	13
PT	*Trollius europaeus*	E1	.	.	.	.	.	.	.	+	1	13
TR	***Thlaspietea rotundifolii***											
	Gymnocarpium robertianum	E1	+	.	1	.	.	.	1	1	4	50
	Adenostyles glabra	E1	.	.	.	.	.	+	+	+	3	38
	Minuartia austriaca	E1	.	.	r	.	.	.	.	.	1	13
	Valeriana montana	E1	.	.	.	.	.	.	.	+	1	13
	Astrantia carniolica	E1	.	.	.	.	.	.	.	+	1	13
AT	*Asplenietea trichomanis*											
	Asplenium viride	E1	+	+	+	.	.	.	+	+	5	63
	Moehringia muscosa	E1	.	.	.	.	.	+	+	.	2	25
	Asplenium ruta-muraria	E1	.	+	.	.	.	.	.	.	1	13
	Paederota lutea	E1	.	.	.	.	.	.	+	.	1	13
O	**Other species (Druge vrste)**											
	Sorbus aucuparia	E3	.	+	+	+	.	+	+	+	6	75
	Sorbus aucuparia	E2b	.	.	1	+	1	.	.	.	3	38
	Sorbus aucuparia	E1	.	+	+	+	.	+	+	+	6	75
	Fragaria vesca	E1	.	.	.	.	.	+	+	+	3	38
	Urtica dioica	E1	.	.	.	.	.	+	+	.	2	25
	Cirsium helenioides	E1	.	.	+	.	.	.	.	.	1	13
	Rubus idaeus	E1	.	.	.	.	.	+	.	.	1	13
	Cerastium sp.	E1	.	.	.	.	.	.	+	.	1	13
	Ranunculus repens	E1	.	.	.	.	.	.	+	.	1	13
	Taraxacum officinale	E1	.	.	.	.	.	.	.	+	1	13
ML	**Mosses and lichens (Mahovi in lišaji)**											
	Hylocomium splendens	E0	1	1	3	+	+	+	+	+	8	100
	Rhytidiadelphus triquetrus	E0	3	1	3	+	+	+	+	+	8	100
	Tortella tortuosa	E0	+	+	+	+	.	+	+	+	7	88
	Dicranum scoparium	E0	+	.	1	+	.	.	+	.	4	50
	Sphagnum sp.	E0	.	.	+	+	.	+	.	.	3	38
	Ctenidium molluscum	E0	+	.	+	.	.	.	.	.	2	25
	Peltigera leucophlebia	E0	.	+	.	.	+	.	.	.	2	25
	Eurhynchium striatum	E0	.	.	+	.	.	.	.	.	1	13
	Hypnum cupressiforme	E0	.	.	.	+	.	.	.	.	1	13
	Cladonia sp.	E0	.	.	.	+	.	.	.	.	1	13
	Homalothecium lutescens	E0	.	.	.	.	.	.	+	.	1	13
	Peltigera canina	E0	.	.	.	.	.	.	+	.	1	13
	Sanionia uncinata	E0	.	.	.	.	.	.	.	+	1	13

SC - ***Salicion cinereae***
PT - ***Poo alpinae-Trisetalia***
D Dolomite /dolomit
M Moraine - Till/ Morena - Til
Gr Gravel /pobočni grušč
Re Rendzina /rendzina