

Plant communities with *Carex frigida* in the Julian Alps (northwestern Slovenia)

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Ključne besede: fitocenologija, sinsistematika, *Cystopteridion*, *Adenostylyon alliariae*, *Cratoneurion*, Triglavski narodni park, Natura 2000, Slovenija.

Abstract

In already known localities in the Julian Alps (Mangart, Malo Polje, Zeleno Jezero, Blehe under Šoštar) and in several new ones (Loška Koritnica, Bavh, Spodnji Lepoč, Mlinarica, Konjska planina, Mali Babanski Skedenj) we inventoried the stands along the subalpine-alpine springs and spring areas where *Carex frigida* frequently occurs as the predominant vascular plant. We classified them into the following associations: *Saxifrago aizoidis-Caricetum ferrugineae*, *Caricetum davallianae* s. lat., *Ranunculo traunfellneri-Paederotetum luteae*, *Carici frigidae-Petasitetum albi* (alliance *Adenostylyon alliariae*) and *Palustriello decipientis-Caricetum frigidae* (alliance *Cratoneurion*). The latter two were described as new. Based on comparisons with similar communities along mountain springs we discussed the most appropriate classification of the latter into higher syntaxonomic units.

Izvleček

V Julijskih Alpah smo na že znanih (Mangart, Malo polje, Zeleno jezero, Blehe pod Šoštarjem) in tudi nekaterih novih nahajališčih (Loška Koritnica, Bavh, Spodnji Lepoč, Mlinarica, Konjska planina, Mali Babanski Skedenj) popisali sestoje ob subalpinsko-alpinskih izvirih in povirjih, v katerih med cevnicami pogosto prevladuje vrsta *Carex frigida*. Uvrstili smo jih v naslednje asociacije: *Saxifrago aizoidis-Caricetum ferrugineae*, *Caricetum davallianae* s. lat., *Ranunculo traunfellneri-Paederotetum luteae*, *Carici frigidae-Petasitetum albi* (zveza *Adenostylyon alliariae*) in *Palustriello decipientis-Caricetum frigidae* (zveza *Cratoneurion*). Slednji dve asociaciji smo opisali kot novi in pri drugi na podlagi primerjav s podobnimi združbami ob gorskih izvirih razpravljali o najbolj ustreznih uvrstitvi v višje sintaksonomske enote.

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Introduction

Carex frigida (ice sedge) is a south-European montane species distributed across most of the Alps, a character species of the order *Caricetalia davallianae* (Aeschimann et al. 2004b: 826). In the Slovenian Red List it is classified as rare (R) (Anon. 2002). It thrives on wet sites along streams and springs in the alpine belt (Martinčič 2007: 820). The list of ice sedge localities was published by T. Wraber & Skoberne (1989: 89–90), who made the map of its distribution area that was referred to also by Jogan et al. (2001: 86). Its localities and sites were discussed the most extensively by T. Wraber (1967: 61, 1969: 82, 1983: 121), who mainly reported those under Mangart: Gladki Rob, Rdeča Skala, Rdeča Glava, under Rateški Mali Mangart (to the NW above Prodi), Na Jami, on Malo Polje at Velo Polje, and along the lake of Zeleno Jezero in the Triglav Lakes Valley. At the beginning of fieldwork with his students on Komna on 4 July 1979 Wraber found its lowest locality on “rocks wet with the sprinkling of the Savica spring at the elevation of 900 m” (this information was published in T. Wraber & Skoberne, *ibid.*, but the description of the find and the locality was recorded in his field notes, which are kept at Wraber’s library in the Ljubljana Botanical Garden). The southernmost known locality of this sedge in Slovenia, Blehe under Šoštar at Mt. Črna Prst, was published and described with a phytosociological table, but without mosses (Dakskobler 2003: 46, 62–63). In the Italian part of the Julian Alps it was reported for the locality under Viš/Jof Fuart (Marchesetti 1879, as reported by T. Wraber 1967: 61). This locality is recorded also in the distribution map for Friuli Venezia Giulia (Poldini 2002: 110). Other localities in Friuli are more to the west, in the Carnic Alps. Similarly, ice sedge localities in Carinthia, Austria, are situated to the west and north of the Julian Alps and the Karawanks (Hartl et al. 1992: 120). T. Wraber (1967, *ibid.*) found the ice sedge under Viš / Jof Fuart on 21.9.1966 at a well on spring soil on the southeastern slopes of this mountain directly behind the Corsi hut at the elevation of 1870 m, accompanied by *Deschampsia cespitosa*, *Saxifraga stellaris* subsp. *alpigena*, *Arabis pumila*, *Ranunculus traunfellneri*, *Achillea atrata*, *Soldanella minima*, *Salix alpina*, *Tussilago farfara*, *Campanula cochleariifolia* and *Cerastium austroalpinum*, among others. We also recorded ice sedge under Mt. Viš: in the gravelly spring area (source) under the Corsi hut, at the elevation of 1750 m, together with *Heliosperma pusillum* and *Valeriana saxatilis*, but did not make a detailed inventory (Det. I. & V. Dakskobler, 22. 7. 2013). This clearly suggests that there are more localities under Viš / Jof Fuart.

Our findings corroborate T. Wraber’s observation (1983: 121) that “the floristic composition of stands with *Carex frigida* is very heterogeneous”.

After 2003 we visited and confirmed some of the previously known localities of ice sedge under Mangart (Prodi, Na Jami), on Malo Polje and at Zeleno Jezero, and found several new localities in the Julian Alps. We made phytosociological relevés for most of them. We collected the mosses and identified them, which enabled us to process and classify the recorded communities using a syntaxonomic system.

Methods

Our analysis was based on the relevés recorded on the sites of *Carex frigida* using the Central-European (Braun-Blanquet 1964) phytosociological approach. They were entered into the FloVegSi database (Fauna, Flora, Vegetation and Paleovegetation of Slovenia) of the Jovan Hadži Institute of Biology at ZRC SAZU (Seliškar et al. 2003) and processed using hierarchical classification, unweighted average linkage method – UPGMA and Wishart’s similarity ratio. We transformed the combined cover-abundance values with numerical values (1–9) according to van der Maarel (1979). Numerical comparisons were performed with the SYN-TAX 2000 program package (Podani 2001). The nomenclatural source for the names of vascular plants were the Mala flora Slovenije (Martinčič et al. 2007) and Flora alpina (Aeschimann et al. 2004a,b). Ros et al. (2007) was the nomenclatural source for the names of liverworts (*Marchantiophyta*) and Ros et al. (2013) for the names of mosses. Steiner (1993), Zechmeister (1993), Tomaselli et al. (2011), Šilc & Čarni (2012), Mucina et al. (2016) and Hinterlang (2017) served as nomenclatural sources for the names of the syntaxa. The data source for the geological bedrock was Buser (2009). The geographic coordinates of the relevés were determined based on the Slovenian geographic coordinate system D 48 (Zone 5) on the Bessel ellipsoid and with Gauss-Krüger projection.

Results

New localities of *Carex frigida* and its currently known distribution in Slovenia

9547/4 (UTM 33TUM94) Slovenia: Primorska, Julian Alps, Loška Koritnica, V Mlakah to the west of Veliki Žleb under Mangart, 1750 m – 1770 m a.s.l., wet rock wall and spring streams. Leg. & det. I. Dakskobler,

8. 9. 2004 and 12. 7. 2007, herbarium LJS, relevés 7 and 8 in Table 2. New locality in an already known quadrant.

9547/4 (UTM 33TUM94) Slovenia: Primorska, Julian Alps, Loška Stena, under Bavh, Pri Kamnih, wet rocks, 1910 m a.s.l. Det. I. Dakskobler, 17. 8. 2012, author's photographs, relevé 12 in Table 2. New locality in an already known quadrant.

9548/4 (UTM 33TVM04) Slovenia: Primorska, Julian Alps, Trenta, Mlinarica headwaters under Zadnje Plate, 1680 m a.s.l. Leg. & det. I. Dakskobler, 6. 8. 2008, herbarium LJS, spring community with dominant *Palustriella commutata* and *Saxifraga stellaris* subsp. *alpigena*, which we are still studying, so this relevé was not included in Table 2, *Carex frigida* is rare (+) here. New locality in the new quadrant.

9646/4 (UTM 33TUM83) Slovenia: Primorska, Julian Alps, Kanin Mts. Scree spring area to the west of Mali Babanski Skedenj, 1880 m a.s.l. Leg. & det. I. Dakskobler, 27. 7. 2020, herbarium LJS, relevé 11 in Table 2. New locality in the new quadrant.

9647/2 (UTM 33TUM93) Slovenia: Primorska, Julian Alps, Bala, Spodnji Lepoč, springs above or along the perimeter of the fen, 1690–1750 m a.s.l. Leg. & det. I. Dakskobler, B. Vreš, B. Anderle & A. Trnkoczy, 13. 7. 2007 and I. Dakskobler, 7. 8. 2020, herbarium LJS, relevés 15, 16 and 17 in Table 2. New locality in the new quadrant.

9649/1 (UTM 33TVM13) Slovenia: Gorenjska, Julian Alps, Triglav mountain range, Konjska planina under Cesar, 2020 m a.s.l., headwaters. Leg. & det. B. Zupan, S. Behrič & I. Dakskobler, 1. 8. 2019, herbarium LJS, relevé 18 in Table 2. New locality in an already known quadrant.

9849/2 (UTM 33TVM11) Slovenia: Primorska, foothills of the Julian Alps, Mt. Porezen, under the village of Porezen, Prodarjeva Grapa gorge, wet rocks in the spring area, 460 m – 510 m a.s.l. Leg. & det. I. Dakskobler, 9. 5. 2020 and 13. 6. 2020, herbarium LJS. The lowest

locality of this sedge in Slovenia (a special community of *Carex frigida*, *Pinguicula vulgaris*, *Molinia arundinacea*, *Carex flacca*, *Palustriella commutata* and other species will be discussed in a separate article). New locality in the new quadrant.

Communities with *Carex frigida*

In Austria, Steiner (1993: 155–156) reports only the association *Caricetum frigidae* Rübel 1911 (which according to him comprises also the stands of associations *Tofieldio-Caricetum frigidae* Oberdorfer 1956 and *Eriophoro-Caricetum frigidae* Oberdorfer 1956). *Carex frigida* is a character species of the association and its constant companions are *Campylium stellatum*, *Carex flava*, *C. nigra*, *Deschampsia cespitosa*, *Scorpidium revolvens* (*Drepanocladus revolvens*), *Eleocharis quinqueflora*, *Eriophorum angustifolium* and *Trichophorum cespitosum*. Steiner classifies this association into the alliance *Caricion davallianae*, order *Caricetalia davallianae* and class *Scheuchzerio-Caricetea fuscae*.

Zechmeister (1993: 229) describes the association *Cratoneuretum falcati* Gams 1927 with diagnostic species *Cratoneurum falcatum*, *Philonotis calcarea*, *Silene pudibunda* (*Heliosperma pusillum* subsp. *pudibundum*), *Silene pusilla* (*Heliosperma pusillum* subsp. *pusillum*), a differential species *Pericaria vivipara* (*Polygonum viviparum*) and dominating and constant species *Saxifraga aizoides*, *Agrostis stolonifera*, *Bryum pseudotriquetrum* (*Ptychostomum pseudotriquetrum*), *Carex frigida*, *Epilobium alsinifolium*, *Poa alpina*, *Ranunculus montanus* and *Saxifraga stellaris* subsp. *robusta*.

In Germany, Hinterlang (2017) reports *Carex frigida* as differential species of the order *Montio-Cardaminetalia* in communities of alliances *Philonotidion seriatae* and *Cratoneurion commutati*.

According to him (Hinterlang, *ibid.*), diagnostic species of the alliance *Cratoneurion commutati* include character species *Philonotis calcarea*, *Aneura pinguis*, *Bryum turbinatum*, *Preissia quadrata* and differential species *Pinguicula alpina*, *P. vulgaris* and *Cratoneuron commutatum* (as character species of the class *Montio-Cardaminetea*). He mentions four associations from this alliance. One of them, *Cardamino-Cratoneuretum* Kornas & Medwecka-Kornas 1967, comprises also *Carex frigida*. Differential species of this association are *Philonotis calcarea*, *Calycocorsus stipitatus*, *Bryum turbinatum*, *Carex dioica*, *Triglochin palustre*, *Carex flava*, *Equisetum palustre*, *Molinia caerulea*, *Tussilago farfara* and *Carex frigida*.

In the Grison Alps in the Swiss canton of Graubünden, Braun-Blanquet (1971: 33–36) described the association *Saxifrago aizoidis-Caricetum frigidae* Braun-Blanquet 1971, which is known also in the Alpine region of France,

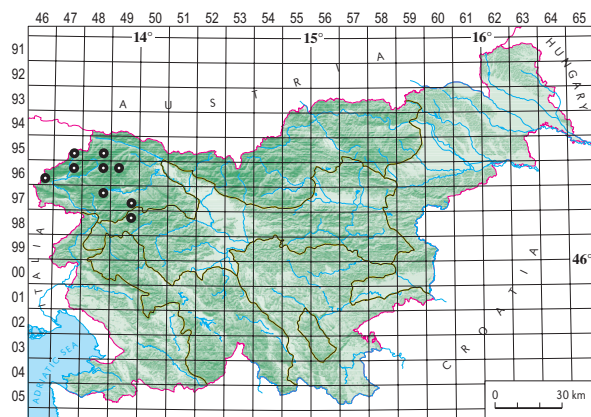


Figure 1: Distribution of *Carex frigida* in Slovenia.

Slika 1: Razširjenost vrste *Carex frigida* v Sloveniji.

where the association *Caltho palustris-Caricetum frigidae* Julve 2007 was also reported (eVeg, 2020).

Tomaselli et al. (2011) in the Fassa Dolomites (Trentino, SE Alps) recorded *Carex frigida* in the stands of the associations *Cratoneuretum falcati* (frequency 7%), *Montio-Bryetum schleicheri* (frequency 5%) and *Blindio-Scapanietum undulatae* (frequency 25%).

E. and S. Pignatti (2016) mention *Carex frigida* only as an accidental species of associations *Cratoneuretum commutati* (one relevé) and *Cratoneuretum falcati* (two relevés).

Syntaxonomic classification of the studied communities and site descriptions

We made 24 relevés and arranged them in Table 2. We omitted two relevés in which we recorded *Carex frigida*, but were unable to find support material for them in the working herbarium of the Institute of Biology of the ZRC SAZU, Regional Unit Tolmin. Both relevés comprise stands that are dominated by *Carex ferruginea* (*Caricetum ferrugineae* s. lat.) and are located in the regions where *Carex frigida* was recorded on other sites and documented with herbarium specimens or photographs:

9548/4: Trenta, Mlinarica spring area under Zadnje Plate, grassland along a spring stream, 1720 m a.s.l. Relevé I. Dakskobler, 31.8. 2009.

9547/4: Bala Valley, Loška Stena, a wet gully on the sunny side of the ridge towards Plešivec, 2070 m a.s.l., tall herbs in the gully (with dominating *Carex ferruginea* and *Peucedanum ostruthium*). Relevé and photograph of the stand I. Dakskobler, 17. 8. 2012.

The relevés were arranged in Table 2 based on the results of hierarchical classification (Figure 2).

In the main, the relevés formed two distinct clusters. The relevés on the right side of the dendrogram are from Blehe under Šoštar (at Črna Prst). When we first published their table (excluding moss species) we classified them into the provisional association *Carici frigidae-Petasitetum albi* nom. prov. (Dakskobler 2003). At the time we gave the following description of the site of its stands: a gully above and along the source of a small stream at around 1370 m – 1400 m a.s.l., tall herb communities on the scree slope in the gully and on small, unstable landslide sites along its edge. Shaly claystone (perhaps siltstone) with admixture of chert predominates, and scree is admixed with limestone (which predominates at slightly higher elevations; the source is connected with the contact of geological layers).

Determination of mosses collected at the time demonstrated that most of the relevés are dominated by *Bryum pseudotriquetrum* (*Ptychostomum pseudotriquetrum*) and *Brachythecium rutabulum*, *Cratoneuron filicinum* occurs in two relevés and one relevé comprises also several other species diagnostic for the class *Montio-Cardaminetea*: *Palustriella commutata*, *Philonotis fontana*, *Didymodon vinealis*, *Calliergonella cuspidata* and *Brachythecium rivulare*. Other determined mosses, many of which are acidophilic, include rare species *Rhabdoweisia fugax* and *Pogonatum nanum*, whose localities had not previously been reported in the Slovenian part of the Julian Alps (Martinčič 2003). The only known localities of *Rhabdoweisia fugax* (altogether 17) are in Eastern Slovenia, in the eastern Karawanks, Kamnik-Savinja Alps, Pohorje mountain range, Dravski Kozjak and on Strojna. *Pogonatum*

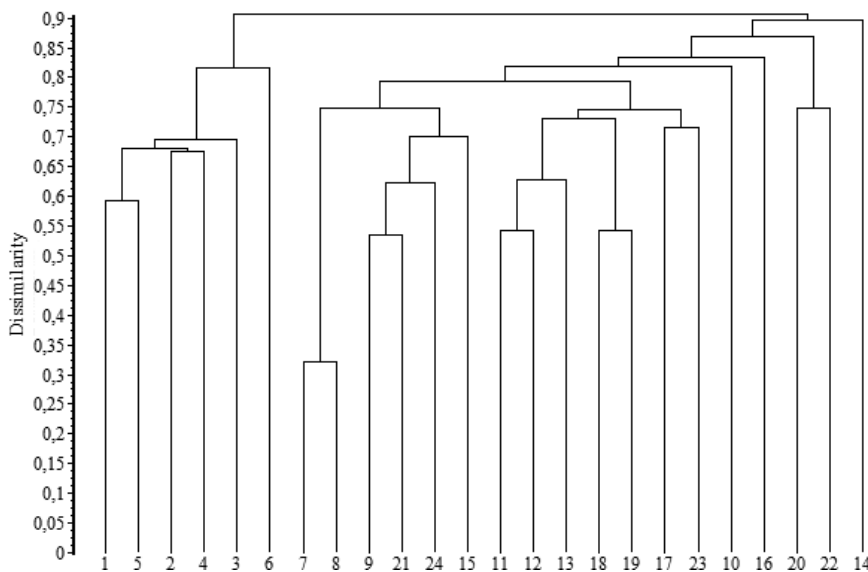


Figure 2: Dendrogram of relevés with *Carex frigida* in the Julian Alps (UPGMA, 1 – similarity ratio).

Slika 2: Dendrogram popisov sestojev z vrsto *Carex frigida* v Julijskih Alpah (UPGMA, 1 – similarity ratio).

nanum, on the other hand, has more localities in all phytogeographic units of Slovenia other than the Julian Alps (A. Martinčič's database). Both species are acidophilic, with boreal-montane distribution.

In terms of their constancy and mean cover the listed mosses do not justify the classification of this community into the class *Montio-Cardaminetea*, so we can confirm its original classification into the association *Carici frigidae-Petasitetum albi* (Dakskobler 2003) Dakskobler et Martinčič ass. nov. hoc loco (relevés 2–6 in Table 2). Its diagnostic species are *Petasites albus*, *Carduus carduelis*, *Heracleum sphondylium* subsp. *pollinianum*, *Senecio ovatus* (*S. fuchsii*) and *Carex frigida*. The nomenclatural type, *holotypus*, of the new association is relevé 4 in Table 2. The association is classified into the alliance *Adenostyliion alliariae* and class *Mulgedio-Aconitetea*. Relevé 1 in Table 2 from the same locality is classified into the association *Saxifrago aizoidis-Caricetum ferrugineae* Dakskobler 1996 (Dakskobler 2003). It is characterised by *Cynodontium fallax*, a rare acidophilic moss included on the Red List as endangered (EN) (Martinčič 2016). Its previously known localities in Slovenia were in the Pohorje mountain range (between Vitanje and Rakovec, Bukovje at Pukštajn), in the eastern Karawanks (valley of the Bistra River and Uršlja Gora) and on Košenjak (the Velka valley at Lapanova Stena) – Martinčič (2018). The herbarium features also specimens from Grom's herbarium (incorrectly classified as *Cnestrum schisti*) from the Mežica Valley, but does not provide the exact locality (A. Martinčič's database). It grows on wet, shady silicate rocks in the montane, rarely also subalpine belt (at 500 m – 1500 m a.s.l.).

In terms of species composition, relevés 7–21 in Table 2 cannot be classified into any of the above listed associations named after *Carex frigida*, because they obviously do not have enough species in common. Floristic similarity with the stands of the association *Saxifrago aizoidis-Caricetum frigidae* according to Sørensen (1948) is only 28.5% (see also Table 1 and Figures 3 and 4).

Our stands also have only a few species in common with the stands of the association *Cardamino-Cratoneuretum*: *Carex frigida*, *Cratoneuron commutatum* (*Palustriella commutata*), *Tussilago farfara*, *Soldanella alpina*, *Bryum pseudotriquetrum* (*Ptychostomum pseudotriquetrum*), *Epilobium alsinifolium*, *Palustriella decipiens*, *Cardamine amara*, *Deschampsia cespitosa*, *Carex nigra*, *Juncus articulatus*.

If we compare the diagnostic species of classes *Montio-Cardaminetea* and *Scheuchzerio-Caricetea fuscae*, whose stands usually comprise *Carex frigida*, the species of the class *Montio-Cardaminetea* are more numerous and have higher mean cover, especially considering that *Carex frigida* is not only a character species of the order *Caricetalia*

davallianae, but occurs also in the communities of the alliance *Cratoneurion commutati*.

The following diagnostic species of the class *Montio-Cardaminetea* and in particular of the alliance *Cratoneurion* frequently occur in our stands: *Palustriella commutata*, *P. decipiens*, *Bryum pseudotriquetrum* (*Ptychostomum pseudotriquetrum*), *Cratoneuron filicinum*, *Saxifraga aizoides* and *Epilobium alsinifolium*. *Heliosperma pusillum* and *Preissia quadrata* (which are diagnostic also for the alliance *Cystopteridion* s. lat.) can also be considered diagnostic for this class and alliance. In addition to *Carex frigida*, the more frequent species of the order *Caricetalia davallianae* and class *Scheuchzerio-Caricetea fuscae* in our stands include only *Parnassia palustris*, *Carex capillaris*, *Campyllum stellatum* and *Calliergonella lindbergii*.

Species of the order *Arabidetalia caeruleae* (most frequently *Veronica alpina*, *Soldanella alpina*, *Salix retusa* and *Trifolium pallescens*), class *Thlaspietea rotundifolii* (the most frequent are *Festuca nitida*, *Achillea atrata*, *Adenostyles glabra* and *Rhodiola rosea*), alliance *Caricion ferrugineae* (*Carex ferruginea*, *Cerastium subtriflorum*, *Gentiana pumila*), order *Seslerietalia caeruleae* and class *Elyno-Seslerietea* (*Galium anisophyllum*, *Aster bellidiastrum*, *Polygonum viviparum*, *Myosotis alpestris*), class *Mulgedio-Aconitetea* (*Viola biflora*, *Aconitum lycoctonum* s. lat., *Peucedanum ostruthium*), class *Juncetea trifidi* s. lat. (*Festuca nigrescens*, *Euphrasia minima*, *Juncus jacquini*), and order *Poo alpinae-Trisetetalia*, class *Molinio-Arrhenatheretea* (*Poa alpina*, *Crepis aurea*, *Deschampsia cespitosa*), are quite evenly represented in other phytosociological groups. Species diversity is therefore considerable, but the site description, on the other hand, is very similar. These are mainly communities along small springs in the subalpine and alpine belt (1690–2050 m a.s.l.), stands along running cold waters, on gravelly or rocky sites, where limestone (rarely dolomite) is frequently admixed with marlstone and in places also with chert.

We find that the most appropriate classification of these stands is into the alliance *Cratoneurion commutati*, order *Montio-Cardaminetalia* and class *Montio-Cardaminetea*. Admittedly, our relevés do not meet all the criteria for the classification into the alliance *Cratoneurion* (Zechmeister 1993: 229): sunny springs, water contains a high concentration of oxygen and calcium ions, mosses (cryptogams) almost never cover less than a half of the site area and vascular plants usually do not cover more than a third; nevertheless, we find that classifying them into any other alliance is even less justified.

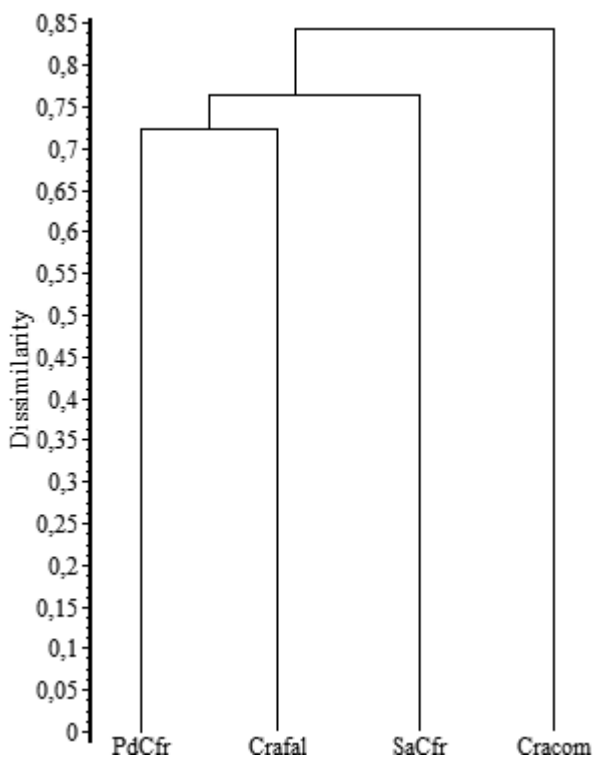
Two associations from this alliance have been documented with a phytosociological table for the territory of Slovenia and its immediate vicinity: *Cratoneuretum commutati* Aichinger 1933 (Aichinger 1933: 64–65) and

Cratoneuretum falcati Gams 1927 (Surina 2005a, b). Previously (Martinčič 2003), the taxon *Palustriella falcata* was discussed only at the rank of variety *Palustriella commutata* var. *falcata*, and only since recently (Martinčič 2014) as an independent species *Palustriella falcata*. Although at higher elevations taxon *P. falcata* generally replaces taxon *P. commutata* (Surina 2005b: 102), this is not supported by the list of localities in the Karawanks (Martinčič 2014: 336). The highest locality of taxon *P. commutata* is Mt. Stol (2000 m a.s.l.), and Pusti Rovt under Korenščica (1500 m a.s.l.) is the highest locality of taxon *P. falcata*.

We made a synoptic table (Table 1) with four columns that comprise our community as well as the stands of both previously listed associations and stands of the asso-

ciation *Saxifraga aizoidis-Caricetum frigidae* (Braun-Blanquet 1971). Taxon *P. commutata* and taxon *P. falcata* were treated as a single species. We obtained two dendrograms, which differ slightly if we take into account species constancy (Figure 3) or merely presence/absence of species (Figure 4).

In terms of species constancy our relevés are the most similar to the relevés of the association *Cratoneuretum falcati* from the Krn Mountains, but if we take into account only the presence or absence of species they are more similar to the stands of the association *Saxifraga aizoidis-Caricetum frigidae*. In both cases, however, floristic similarity is too low to allow us to classify them into either of these associations.

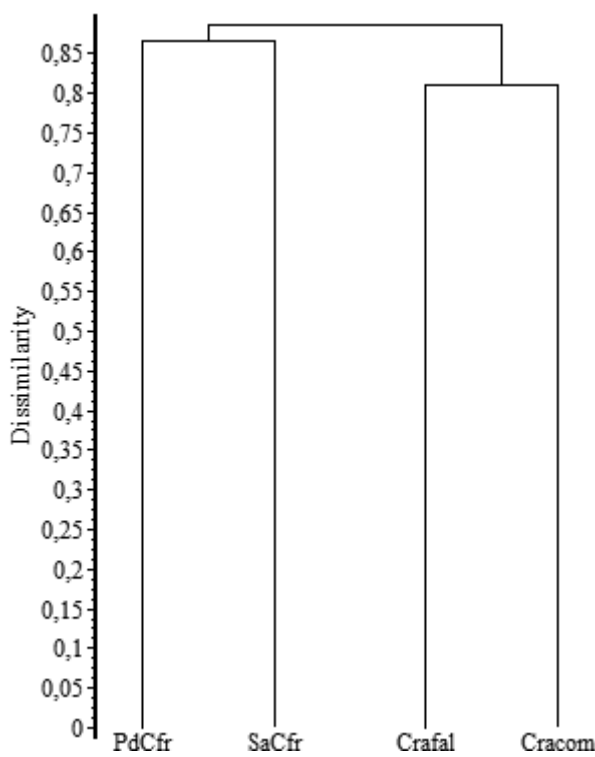


Legend (Legenda):

- PdCfr *Palustriello decipientis-Caricetum frigidae*, Julian Alps, this article
- Crafal *Cratoneuretum falcati*, Julian Alps, Krn Mountains, Surina (2005a, Table 1)
- SaCfr *Saxifraga aizoidis-Caricetum frigidae*, Rätischen Alps, Braun-Blanquet (1971, Table 8)
- Cracom *Cratoneuretum commutati*, Karavanke, Aichinger (1933, Table 17)

Figure 3: Dendrogram of four communities of mountain springs in the Alps (UPGMA, 1 – similarity ratio).

Slika 3: Dendrogram štirih združb gorskih povirij v Alpah (UPGMA, 1 – similarity ratio).



Legend (Legenda): – see Figure 3

Figure 4: Dendrogram of four communities of mountain springs in the Alps (UPGMA, 1 – Jaccard).

Slika 4: Dendrogram štirih združb gorskih povirij v Alpah (UPGMA, 1 – Jaccard).

Likewise, the recorded stands cannot be classified into the association *Cratoneuretum falcati*, because in terms of mean cover *Palustriella commutata* (*Cratoneuron commutatum* s. lat.) dominates over *Carex frigida* only in several stands. In our case, it is therefore more appropriate to use the species that dominate the herb layer as

the name-giving species of the association. The recorded stands are classified into the new association *Palustriello decipiens-Caricetum frigidae* ass. nov. hoc loco. Diagnostic (character and differential) species of the association are *Carex frigida*, *Palustriella decipiens*, *Festuca nitida* (the southeast-European montane species of wet screes), *Achillea atrata*, *Carex ferruginea* and *Paederota lutea* (southeastern-Alpine-north-Dinaric chasmophytic species). *Palustriella decipiens* is a Eurasiatic, boreal-montane moss that is preferentially encountered on calcareous micascists in crenic waters with low mineral content (Dierßen 2001). It must also survive more severe climates than *Palustriella commutata* (Tomaselli et al. 2011). It is diagnostic of the order *Montio-Cardaminetalia* (Hinterlang 2017). In Slovenia, it was recorded in the Julian Alps, the Karawanks and in the Kamnik-Savinja Alps, only rarely in their foothills and (in) the Dinaric Alps. It grows in the subalpine and alpine belt, up to 2100 m a.s.l. Some of its localities are also in the montane and submontane belt, descending as low as 480 m a.s.l. (Višče near Lake Bled), 460 m a.s.l. (Brdo pri Kranju, near the Vršek rivulet), 450 m a.s.l. (under Komar near Koritno), 300 m a.s.l. (Spodnje Pirniče under Šmarna Gora, warm spring), 200 m a.s.l. (the left bank of the Idrijca River near Stopnik) and even 80 m a.s.l. (the left bank of the Soča River near Deskle). Its sites are moist to wet: fens, cold springs, wet rocks with splashed water, rarely meadows (Martinčič 2003, A. Martinčič's database). In the upper montane belt of the Fassa Dolomites (Trentino, SE Alps) a spring community named phytocoenon of *Palustriella decipiens* was described (Tomaselli et al., *ibid.*).

The nomenclatural type, *holotypus*, of the new association is relevé 10 in Table 2. Two variants can be distinguished: var. *Heliosperma pusillum* (relevés 7–14 in Table 2, stands are more typical for cold springs, the differential species of the variant is also *Cerastium subtriflorum*) and var. *Veronica alpina* (relevés 15–21, which are slightly more similar to fen communities from the alliance *Caricion davallianae* or in contact with them, the differential species of the variant is also *Gentiana pumila*).

Relevés 22 and 23 in Table 2 (under Mangart, Na Jami) are provisionally classified into the subassociation *Ranunculo traunfellneri-Paederotetum luteae* Surina 2005 *caricosum frigidae* nom. prov. and alliance *Cystopteridion. Blinda caespiticia*, which is included in the Red List as endangered (EN) (Martinčič 2016) was also identified in one of the relevés. Relevé 24 (Malo Polje at Velo Polje) belongs to the association *Caricetum davallianae* s. lat. (*Equiseto palustris-Caricetum davallianae* nom. prov.), alliance *Caricion davallianae*, order *Caricetalia davallianae* and class *Scheuchzerio-Caricetea fuscae*.

Conspectus of the syntaxa described herein, ordered in a syntaxonomic scheme:

- Montio-Cardaminetea* Br.-Bl. et Tx. ex Klika et Hadač 1944
- Montio-Cardaminetalia* Pawłowski et al. 1928
- Cratoneurion commutati* Koch 1928
- Palustriello decipiens-Caricetum frigidae* Dakskobler et Martinčič 2021
- var. *Heliosperma pusillum*
- var. *Veronica alpina*
- Scheuchzerio palustris-Caricetea nigrae* Tx. 1937 nom. mut.
- Caricetalia davallianae* Br.-Bl. 1950 nom. conserv. propos.
- Caricion davallianae* Klika 1934
- Caricetum davallianae* Dutoit 1924 s. lat. (*Equiseto palustris-Caricetum davallianae* nom. prov.)
- Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977
- Potentilletalia caulescentis* Br.-Bl. in Br.-Bl. et Jenny 1926
- Cystopteridion fragilis* Richard 1972 s. lat.
- Ranunculo traunfellneri-Paederotetum luteae* Surina 2005
- caricosum frigidae* nom. prov.
- Mulgedio-Aconitetea* Hadač et Klika in Klika et Hadač 1944
- Adenostyletalia alliariae* Br.-Bl. 1930
- Adenostylion alliariae* Br.-Bl. 1926
- Carici frigidae-Petasitetum albi* (Dakskobler 2003) Dakskobler et Martinčič 2021

Conclusions

Carex frigida is rare in Slovenian flora and its localities in the montane to the alpine belt (900 m – 2070 m) have previously been reported only in the Julian Alps. In our research we confirmed most of the previously known localities and found several new ones (the spring area of the Mlinarica, Loška Stena: Bavh, Spodnji Lepoč, Konjska Planina under Cesar in the Triglav range, Mali Babanski Skedenj in the Kanin Mountains, Prodarjeva Grapa gorge on the northern side of Mt. Porezen, 460–510 m a.s.l., the lowest locality in Slovenia). We made relevés of the stands with this hygrophilous sedge and after identifying the collected mosses we were able to classify the studied communities using a syntaxonomic system. We confirmed and typified the previously described association *Carici frigidae-Petasitetum albi* at the altimontane spring at the contact of geological layers (claystone/siltstone with admixture of chert and limestone) in Blehe under Šoštar at Črna Prst. These stands are characterised by rare mosses, which until now had no known localities in the Slovenian part

of the Julian Alps: *Rhabdoweisia fugax*, *Pogonatum nanum* and *Cynodontium fallax* (the latter occurs in a stand of the contact association *Saxifraga aizoidis-Caricetum ferrugineae*). Most of the other stands were recorded along small springs, on gravelly or rocky sites, where limestone (rarely dolomite) is frequently admixed with marlstone and in places also with chert. Some relevés belong to a chasmophytic (*Ranunculo traunfellneri-Paederotetum luteae*) or fen community *Caricetum davallianae* s. lat. The relevés with *Carex frigida* as the dominating vascular plant were classified into the new association *Palustriello decipiens-Caricetum frigidae*, whose diagnostic species are *Carex frigida*, *Palustriella decipiens*, *Festuca nitida*, *Achillea atrata*, *Carex ferruginea* and *Paederota lutea*. As the moss cover is abundant and dominated by species characteristic for the class *Montio-Cardaminetea* (*Palustriella commutata*, *P. decipiens*, *Cratoneuron filicinum* and *Bryum pseudotriquetrum* / *Ptychostomum pseudotriquetrum*), as well as several vascular plants characteristic for mountain spring communities (*Saxifraga aizoides*, *Epilobium alsinifolium*, *Heliosperma pusillum*), are presented, these stands can be classified into the alliance *Cratoneurion*. This was confirmed also by the comparison with previously described communities from this alliance in Slovenia, mainly with stands of the association *Cratoneuretum falcati* from the Krn Mountains. Because of low floristic similarity (Sørensen's similarity index, Sørensen 1948, is 28.5%) they cannot be classified into the association *Saxifraga aizoidis-Caricetum frigidae*, which is described in the Grison Alps of the Swiss canton Graubünden and reported also in the French Alps.

Stands with *Carex frigida* in the Julian Alps can mainly be classified into the Natura 2000 habitat type 7220* (Physis code 54.12) Petrifying springs with tufa formation (*Cratoneurion*). They are a habitat of several protected vascular plants (Anon. 2004): *Gentiana lutea* subsp. *symphyandra*, *Gymnadenia conopsea*, *Pinguicula alpina*, *P. vulgaris*, red-listed vascular plants (Anon. 2002): *Carex bicolor*, *C. davalliana*, *C. frigida*, *Eriophorum scheuchzeri*, *Trifolium thalii*, and red-listed mosses (Martinčič 2016): *Blinda caespiticia* and *Cynodontium fallax*. According to our findings, these communities are not threatened, despite occasional grazing of small ruminants (sheep) in the vicinity, e.g. under Mangart, Bavh, on Konjska Planina and at Spodnji Lepoč. Although some of the stands under Mangart are in the immediate vicinity of mountain trails (Na Jami), most of them are well off the beaten tracks, in particular the spring in Blehe under Šoštar and the fen at Spodnji Lepoč above Bala. Nevertheless, all of the described springs are indirectly threatened by climate change as a result of less snowfall and precipitation in general.

Povzetek

Združbe z vrsto *Carex frigida* v Julijskih Alpah (severozahodna Slovenija)

Carex frigida je redka vrsta v flori Slovenije, z do zdaj znanimi nahajališči od montanskega do alpskega pasu (900 m do 2070 m) le v Julijskih Alpah. Pri naših raziskavah smo potrdili večino do zdaj znanih nahajališč in našli še nekaj novih (povirje Mlinarice, Loška stena: Bavh, Spodnji Lepoč, Konjska planina pod Cesarjem v Triglavskem pogorju, Babanska planina pod Cesarjem v Kaninskem pogorju, Prodarjeva grapa pod Poreznom z nadmorsko višino 460 do 510 m nm. v., do zdaj najnižje ležeče nahajališče v Sloveniji). Sestojte, v katerih uspeva ta vlagoljubni šaš, smo fitocenološko popisali in ko nam je uspelo določiti na popisih nabrane mahove, smo proučene združbe lahko uvrstili v sintaksonomski sistem. Potrdili in tipizirali smo že pred leti opisano asociacijo *Carici frigidae-Petasitetum albi* pri altimontanskem izviru na stiku geoloških plasti (glinavec / meljevec s primesjo roženca in apnenec) v Blehah pod Šoštarjem pri Črni prsti. Posebnost teh sestojev so redke mahovne vrste, ki v slovenskem delu Julijskih Alp do zdaj niso imele znanih nahajališč: *Rhabdoweisia fugax*, *Pogonatum nanum* in *Cynodontium fallax* (slednja uspeva v sestoji stične asociacije *Saxifraga aizoidis-Caricetum ferrugineae*). Večino ostalih sestojev smo popisali ob majhnih izviroh, na gruščnatih ali skalnatih rastiščih, kjer je apnencu (redkeje dolomitu) pogosto primešan laporovec ali ponekod tudi roženec, v subalpskem in alpskem pasu na nadmorski višini od 1690 do 2050 m. Nekateri popisi sodijo v združbo skalnih razpok (*Ranunculo traunfellneri-Paederotetum luteae*), ali nizkobarjansko združbo *Caricetum davallianae* s. lat. Popise, v katerih je med cevnicami prevladujoča vrsta *Carex frigida* pa smo uvrstili v novo asociacijo *Palustriello decipiens-Caricetum frigidae*, katere diagnostične vrste so *Carex frigida*, *Palustriella decipiens*, *Festuca nitida*, *Achillea atrata*, *Carex ferruginea* in *Paederota lutea*. Po dobro zastopani mahovni plasti s prevladujočimi vrstami, značilnimi za razred *Montio-Cardaminetea*: *Palustriella commutata*, *P. decipiens*, *Cratoneuron filicinum* in *Bryum pseudotriquetrum* (*Ptychostomum pseudotriquetrum*), a tudi z nekaterimi za združbe gorskih izvirov značilnimi cevnicami *Saxifraga aizoides*, *Epilobium alsinifolium*, *Heliosperma pusillum*, te sestojte lahko uvrstimo v zvezo *Cratoneurion*. To je potrdila tudi primerjava z nekaterimi do zdaj opisanimi združbami iz te zveze v Sloveniji, predvsem s sestoji asociacije *Cratoneuretum falcati* iz Krnskega pogorja. Uvrstitev v asociacijo *Saxifraga aizoidis-Caricetum frigidae*, ki je opisana v švicarskih Alpah in jo poznajo tudi v francoskih Alpah, zaradi zelo majhne floristične podobnosti (le 28,5% po Sørensen 1948) ni mogoča.

Sestoje z mraznim šašem v Julijskih Alpah večinoma lahko uvrstimo v Natura 2000 habitatni tip 7220* (Physis koda 54.12) Lehnjakotvorni izviri (*Cratoneurion*). V njih uspevajo nekatere zavarovane cevnice (Anon. 2004): *Gentiana lutea* subsp. *symphyandra*, *Gymnadenia conopsea*, *Pinguicula alpina*, *P. vulgaris* in nekatere vrste iz rdečega seznama cevnice (Anon. 2002): *Carex bicolor*, *C. davalliana*, *C. flavella*, *C. frigida*, *Eriophorum scheuchzeri*, *Trifolium thalii* ter iz rdečega seznama mahov (Martinčič 2016): *Blinda caespiticia* in *Cynodontium fallax*. Po naših spoznanjih za zdaj te združbe niso ogrožene, čeprav je občasno v okolici prisotna paša drobnice (ovac) – na primer pod Mangartom, Bavhom, na Konjski planini in v Spodnjem Lepoču. Nekateri sestoji pod Mangartom so zelo blizu planinskih poti (Na jami), ostali so večinoma odmaknjeni od bolj obljudenih poti. Še posebej to velja za izvir v Blehah pod Šoštarjem, prav tako za nizko barje Spodnji Lepoč in njegovo obrobje nad Balo. Posredno pa vse opisane izvire ogrožajo podnebne spremembe z vedno manjšo količino snežnih padavin in padavin na sploh.

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Table 1: Synoptic table of some communities of mountain springs in the Alps

Preglednica 1: Sintezna tabela nekaterih združb gorskih izvirov v Alpah

Successive number (Zaporedna številka)		1	2	3	4
Sign for syntaxa (Oznaka sintaksona)		PdCfr	SaCfr	Crafal	Cracom
Authors (Avtorji)		IDAM	BrBl	BS	EA
Number of relevé (Število popisov)		15	14	6	5
Montio-Cardaminetea					
<i>Palustriella commutata</i> s. lat. (inc. var. <i>falcata</i>)	E0	60	43	100	100
<i>Bryum pseudotriquetrum</i> (<i>Ptychostomum pseudotriquetrum</i>)	E0	67	.	.	.
<i>Palustriella decipiens</i>	E0	67	.	.	.
<i>Cratoneuron filicinum</i>	E0	53	.	.	.
<i>Epilobium alsinifolium</i>	E1	47	7	67	.
<i>Saxifraga aizoides</i>	E1	40	93	50	40
<i>Heliosperma pusillum</i>	E1	40	.	67	20
<i>Preissia quadrata</i>	E0	13	.	.	.
<i>Philonotis fontana</i>	E0	13	.	.	.
<i>Cardamine amara</i>	E1	7	14	.	.
<i>Hymenostylium recurvirostre</i>	E0	7	.	.	.
<i>Gymnostomum aeruginosum</i>	E0	7	.	.	.
<i>Campylidium calcareum</i>	E0	7	.	.	.
<i>Bryum schleicheri</i>	E0	7	.	.	.
<i>Conocephalum conicum</i>	E0	7	.	.	.
<i>Saxifraga stellaris</i> subsp. <i>alpigena</i> (inc. subsp. <i>robusta</i>)	E1	.	43	50	.
<i>Philonotis calcarea</i>	E0	.	21	50	.
<i>Philonotis seriata</i>	E0	.	14	.	.
<i>Eucladium verticillatum</i>	E0	.	.	.	20
Caricetalia davallianae					
<i>Carex frigida</i>	E1	100	100	.	.
<i>Parnassia palustris</i>	E1	47	43	50	20
<i>Carex capillaris</i>	E1	33	7	.	.
<i>Campylium stellatum</i>	E0	27	21	.	.
<i>Carex flava</i> s. lat.	E1	13	.	.	.
<i>Tofieldia calyculata</i>	E1	7	14	.	100
<i>Carex bicolor</i>	E1	7	.	.	.
<i>Juncus triglumis</i>	E1	.	71	.	.
<i>Primula farinosa</i>	E1	.	29	.	.
<i>Carex davalliana</i>	E1	.	21	.	.
<i>Willemetia stipitata</i> (<i>Calycocursus stipitatus</i>)	E1	.	21	.	.
<i>Carex viridula</i>	E1	.	21	.	.
<i>Equisetum variegatum</i>	E1	.	14	.	.
<i>Triglochin palustre</i>	E1	.	14	.	.
<i>Carex panicea</i>	E1	.	14	.	.
<i>Eriophorum latifolium</i>	E1	.	7	.	.
<i>Dactylorhiza majalis</i>	E1	.	7	.	.
<i>Lachnea scutellata</i> (<i>Scutellinia scutellata</i>)	Fu	.	7	.	.
<i>Blysmus compressus</i>	E1	.	7	.	.
<i>Eleocharis quinqueflora</i>	E1	.	7	.	.
<i>Kobresia simpliciuscula</i>	E1	.	7	.	.
<i>Molinia caerulea</i> subsp. <i>caerulea</i>	E1	.	7	.	.
<i>Luzula sudetica</i>	E1	.	7	.	.
<i>Pinguicula alpina</i>	E1	.	.	17	100
<i>Carex lepidocarpa</i>	E1	.	.	.	20
<i>Dactylorhiza incarnata</i>	E1	.	.	.	20

Successive number (Zaporedna številka)		1	2	3	4
<i>Scheuchzerio-Caricetea fuscae</i>					
<i>Calliergonella lindbergii</i>	E0	20	.	.	.
<i>Amblystegium serpens</i>	E0	13	.	.	.
<i>Juncus filiformis</i>	E1	13	14	.	.
<i>Carex nigra</i>	E1	7	29	.	.
<i>Allium schoenoprasum</i> subsp. <i>alpinum</i>	E1	7	7	.	.
<i>Juncus articulatus</i>	E1	7	.	.	.
<i>Scorpidium cossonii</i> (<i>Drepanocladus cossonii</i>)	E0	7	.	.	.
<i>Taraxacum</i> sect. <i>Palustria</i>	E1	7	.	.	.
<i>Eriophorum scheuchzeri</i>	E1	7	.	.	.
<i>Aulacomnium palustre</i>	E0	7	.	.	.
<i>Pinguicula leptoceras</i>	E1	.	57	.	.
<i>Juncus alpinoarticulatus</i>	E1	.	43	.	.
<i>Eriophorum angustifolium</i>	E1	.	29	.	.
<i>Juncus articulatus</i>	E1	.	14	.	.
<i>Trichophorum cespitosum</i>	E1	.	14	.	.
<i>Carex echinata</i>	E1	.	14	.	.
<i>Scapania paludosa</i>	E1	.	14	.	.
<i>Straminergon stramineum</i>	E0	.	7	.	.
<i>Equisetum palustre</i>	E1	.	7	.	.
<i>Cystopteridion fragilis</i>					
<i>Cystopteris fragilis</i>	E1	13	.	17	.
<i>Cystopteris regia</i>	E1	13	.	.	.
<i>Valeriana tripteris</i>	E1	7	.	.	.
<i>Carex brachystachys</i>	E1	.	.	.	40
<i>Orthothecium rufescens</i>	E0	.	.	.	20
<i>Valeriana saxatilis</i>	E1	.	.	.	20
<i>Physoplexido comosae-Saxifragion petraeae</i>					
<i>Paederota lutea</i>	E1	40	.	.	.
<i>Potentilletalia caulescens</i>					
<i>Campanula cochleariifolia</i>	E1	27	7	50	.
<i>Valeriana elongata</i>	E1	7	.	.	.
<i>Arabidetalia caeruleae</i> (inc. <i>Salicion herbaceae</i>, <i>Androsacion alpinae</i>)					
<i>Veronica alpina</i>	E1	33	.	.	.
<i>Soldanella alpina</i>	E1	27	21	.	.
<i>Salix retusa</i>	E1	27	.	.	.
<i>Trifolium pallescens</i>	E1	27	.	.	.
<i>Carex parviflora</i>	E1	13	7	.	.
<i>Taraxacum</i> sect. <i>Alpina</i>	E1	13	7	.	.
<i>Alchemilla fissa</i>	E1	13	.	.	.
<i>Saxifraga sedoides</i>	E1	7	.	17	.
<i>Epilobium anagallidifolium</i>	E1	7	.	.	.
<i>Galium noricum</i>	E1	7	.	.	.
<i>Ranunculus traunfellneri</i>	E1	7	.	.	.
<i>Sibbaldia procumbens</i>	E1	7	.	.	.
<i>Doronicum glaciale</i>	E1	7	.	.	.
<i>Rumex nivalis</i>	E1	7	.	.	.
<i>Gentiana bavarica</i>	E1	.	43	.	.
<i>Cerastion cerastioides</i>	E1	.	7	.	.
<i>Thlaspietea rotundifolii</i>					
<i>Festuca nitida</i>	E1	60	.	.	.
<i>Achillea atrata</i>	E1	33	.	.	.
<i>Adenostyles glabra</i>	E1	33	.	33	100

Successive number (Zaporedna številka)		1	2	3	4
<i>Rhodiola rosea</i>	E1	27	.	17	.
<i>Cirsium spinosissimum</i>	E1	27	.	.	.
<i>Valeriana montana</i>	E1	13	.	.	.
<i>Doronicum grandiflorum</i>	E1	13	.	.	.
<i>Tussilago farfara</i>	E1	7	14	.	80
<i>Poa minor</i>	E1	7	.	.	.
<i>Sedum atratum</i>	E1	7	.	.	.
<i>Heracleum pollinianum</i>	E1	7	.	.	.
<i>Arabis bellidifolia</i>	E1	.	14	.	.
<i>Gypsophila repens</i>	E1	.	7	.	.
<i>Leontodon hyoseroides</i>	E1	.	.	33	.
<i>Cerastium carinthiacum</i> subsp. <i>austroripinum</i>	E1	.	.	17	.
<i>Hieracium bifidum</i>	E1	.	.	17	.
<i>Heliosperma alpestre</i>	E1	.	.	.	100
<i>Petasites paradoxus</i>	E1	.	.	.	60
<i>Astrantia carniolica</i>	E1	.	.	.	20
Caricion ferrugineae					
<i>Carex ferruginea</i>	E1	33	.	.	20
<i>Cerastium subtriflorum</i>	E1	27	.	17	.
<i>Gentiana pumila</i>	E1	27	.	.	.
<i>Trifolium thalii</i>	E1	7	.	.	.
Caricetum firmae, Oxytropido-Elynyon					
<i>Silene acaulis</i>	E1	7	.	.	.
<i>Minuartia verna</i> (<i>M. gerardii</i>)	E1	7	7	.	.
<i>Gentiana nivalis</i>	E1	7	.	.	.
<i>Saussurea alpina</i>	E1	.	7	.	.
Caricion autroalpinae					
<i>Festuca calva</i>	E1	20	.	.	.
Seslerietalia coeruleae					
<i>Galium anisophyllum</i>	E1	40	.	17	.
<i>Achillea clavinae</i>	E1	27	.	.	.
<i>Ranunculus carinthiacus</i>	E1	13	.	17	.
<i>Juncus monanthos</i>	E1	13	.	17	.
<i>Saussurea discolor</i>	E1	7	.	.	.
Elyno-Seslerietea					
<i>Polygonum viviparum</i>	E1	47	36	17	.
<i>Aster bellidiastrum</i>	E1	33	50	17	100
<i>Myosotis alpestris</i>	E1	27	.	.	.
<i>Thymus praecox</i> subsp. <i>polytrichus</i>	E1	20	.	17	.
<i>Pedicularis verticillata</i>	E1	20	.	.	.
<i>Alchemilla vulgaris</i> s. lat.	E1	20	14	.	.
<i>Bartsia alpina</i>	E1	13	57	.	.
<i>Selaginella selaginoides</i>	E1	13	29	17	20
<i>Carex sempervirens</i>	E1	13	.	17	.
<i>Cerastium strictum</i>	E1	13	.	.	.
<i>Lotus alpinus</i>	E1	13	.	.	.
<i>Gentianella anisodonta</i>	E1	13	.	.	.
<i>Astrantia bavarica</i>	E1	13	.	.	.
<i>Agrostis alpina</i>	E1	13	.	.	.
<i>Sesleria caerulea</i>	E1	7	21	.	.
<i>Rhinanthus glacialis</i>	E1	7	7	.	.
<i>Phyteuma orbiculare</i>	E1	7	.	.	.
<i>Scabiosa lucida</i> subsp. <i>lucida</i>	E1	7	.	.	.

Successive number (Zaporedna številka)		1	2	3	4
<i>Polygala alpestris</i>	E1	7	.	.	.
<i>Homogyne discolor</i>	E1	7	.	.	.
<i>Ligusticum mutellina</i>	E1	.	29	.	.
<i>Ranunculus montanus</i>	E1	.	7	.	.
Mulgedio-Aconitetea					
<i>Viola biflora</i>	E1	53	21	33	.
<i>Aconitum lycoctonum</i> subsp. <i>ranunculifolium</i>	E1	33	.	.	.
<i>Peucedanum ostruthium</i>	E1	27	.	.	.
<i>Chaerophyllum hirsutum</i>	E1	20	.	.	20
<i>Veratrum album</i>	E1	20	.	.	.
<i>Thalictrum aquilegifolium</i>	E1	13	.	.	.
<i>Hypericum maculatum</i>	E1	13	.	.	.
<i>Alchemilla xanthochlora</i>	E1	7	.	.	.
<i>Epilobium alpestre</i>	E1	7	.	.	.
<i>Lamium maculatum</i>	E1	7	.	.	.
<i>Pedicularis recutita</i>	E1	.	7	.	.
Juncetea trifidi, Nardion strictae					
<i>Festuca nigrescens</i>	E1	20	.	.	.
<i>Juncus jacquinii</i>	E1	27	50	.	.
<i>Euphrasia minima</i> (inc. <i>E. pulchella</i>)	E1	27	.	.	.
<i>Campanula scheuchzeri</i>	E1	7	.	.	.
<i>Anthoxanthum nipponicum</i>	E1	7	.	.	.
<i>Scorzoneroides helvetica</i>	E1	7	.	.	.
<i>Potentilla erecta</i>	E1	.	14	.	.
<i>Primula integrifolia</i>	E1	.	7	.	.
Poo alpinae-Trisetetalia					
<i>Poa alpina</i>	E1	53	.	50	.
<i>Crepis aurea</i>	E1	33	21	.	.
<i>Trifolium badium</i>	E1	13	21	.	.
<i>Euphrasia picta</i>	E1	13	.	17	.
<i>Trollius europaeus</i>	E1	7	.	.	.
Calthion					
<i>Crepis paludosa</i>	E1	.	14	.	60
<i>Caltha palustris</i>	E1	.	14	.	.
<i>Ranunculus aconitifolius</i>	E1	.	7	.	.
Molinio-Arrhenatheretea					
<i>Deschampsia cespitosa</i>	E1	33	93	33	40
<i>Leontodon hispidus</i>	E1	27	29	.	.
<i>Dactylis glomerata</i>	E1	7	.	.	.
<i>Festuca arundinacea</i>	E1	7	.	.	.
<i>Trifolium repens</i>	E1	7	.	.	.
<i>Trifolium pratense</i>	E1	7	.	.	.
<i>Agrostis stolonifera</i>	E1	.	64	.	.
<i>Leontodon autumnalis</i>	E1	.	7	.	.
Festuco-Brometea					
<i>Cirsium erisithales</i>	E1	20	.	.	.
<i>Bupthalmum salicifolium</i>	E1	13	.	.	.
<i>Koeleria pyramidata</i>	E1	7	.	.	.
<i>Carlina acaulis</i>	E1	7	.	.	.
<i>Helictotrichon praeustum</i>	E1	7	.	.	.
<i>Briza media</i>	E1	.	21	.	.
<i>Cirsium acaule</i>	E1	.	7	.	.
<i>Gymnadenia conopsea</i>	E1	.	7	.	.

Successive number (Zaporedna številka)		1	2	3	4
Betulo-Alnetea					
<i>Salix waldsteiniana</i>	E1	27	7	.	.
Vaccinio-Piceeta					
<i>Calamagrostis arundinacea</i>	E1	.	.	.	60
Fagetalia sylvaticae					
<i>Daphne mezereum</i>	E1	13	.	.	.
Quercu-Fagetea					
<i>Carex flacca</i>	E1	.	14	.	40
Alnion incanae, Salicetea purpureae					
<i>Alnus incana</i>	E2	.	.	.	20
<i>Salix eleagnos</i>	E2	.	.	.	20
Other species (Ostale vrste)					
<i>Agrostis</i> sp.	E1	7	.	.	.
<i>Sagina</i> sp.	E1	7	.	.	.
Mosses (Mahovi)					
<i>Brachythecium rutabulum</i>	E0	47	.	.	.
<i>Plagiochila porelloides</i>	E0	20	.	.	.
<i>Ptilidium ciliare</i>	E0	7	7	.	.
<i>Plagiomnium rostratum</i>	E0	7	.	.	.
<i>Hylocomium splendens</i>	E0	7	.	.	.
<i>Lescuraea incurvata</i>	E0	7	.	.	.
<i>Rhytidium rugosum</i>	E0	7	.	.	.
<i>Barbilophozia attenuata</i>	E0	7	.	.	.
<i>Barbilophozia hatcheri</i>	E0	7	.	.	.
<i>Climacium dendroides</i>	E0	7	.	.	.
<i>Hypnum vaucheri</i>	E0	7	.	.	.
<i>Tortella densa</i>	E0	7	.	.	.
<i>Timmia norvegica</i>	E0	7	.	.	.
<i>Sciuro-hypnum curtum</i> (<i>Brachythecium curtum</i>)	E0	7	.	.	.
<i>Drepanocladus</i> sp.	E0	.	21	.	.
<i>Alectoria subulata</i>	E0	.	7	.	.
<i>Blinda acuta</i>	E0	.	7	.	.
<i>Bryum torquescens</i>	E0	.	7	.	.
<i>Dicranella squarrosa</i>	E0	.	7	.	.
<i>Poblia wahlenbergii</i> (<i>Mniobryum albicans</i>)	E0	.	7	.	.
<i>Mnium</i> sp.	E0	.	7	.	.
<i>Meesia trichodes</i>	E0	.	7	.	.
<i>Sphagnum subsecundum</i>	E0	.	7	.	.
<i>Bryum</i> sp.	E0	.	14	33	20
<i>Meesia uliginosa</i>	E0	.	.	33	.
<i>Hygroamblystegium tenax</i> (<i>Amblystegium tenax</i>)	E0	.	.	33	.
<i>Eurhynchium angustirete</i>	E0	.	.	17	.
<i>Isoetium alopecuroides</i>	E0	.	.	17	.
<i>Brachythecium</i> sp.	E0	.	.	17	.

Legend – Legenda

- 1 *Palustriello decipiens-Caricetum frigidae*
- 2 *Saxifrago aizoidis-Caricetum frigidae*
- 3 *Cratoneuretum falcati*
- 4 *Cratoneuretum commutati*

- ID Igor Dakskobler
AM Andrej Martinčič
BrBl Josias Braun-Blanquet
BS Boštjan Surina
EA Ervin Aichinger

Table 2: Communities with *Carex frigida* in the Julian AlpsPreglednica 2: Združbe z vrsto *Carex frigida* v Julijskih Alpah

Successive number of relevés (Zaporedna številka popisa)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Database number of relevés (Delovna številka popisa)	202685	202680	202684	202681	202683	202682	217622	214119	213529	277220	282139	244429	276815	276875	217599	217606	217607	276332	277263	217528	259695	276877	277221	244220	
Author of relevés (Avtor popisa)																									
Elevation in m (Nadmorska višina v m)	1370	1380	1370	1388	1390	1400	1780	1770	2050	2000	1880	1910	1950	1940	1720	1690	1695	2020	1970	1985	1920	1940	2000	1670	
Aspect (Lega)	NW	SW	SW	SW	SE	S	SE	S	SW	SW	S	SE	SE	SW	SW	NW	NW	S	S	0	S	S	SW	SE	
Slope in degrees (Nagib v stopinjah)	50	20	40	30	30	30	09	09	20	80	15	10	10	10	20	5	5	1	0	0	0	0	70	95	25
Parent material (Matična podlaga)	CiCh	CiCh	CiCh	CiCh	CiCh	CiCh	L	L	L	L	L	L	L	L	L	L	L	LM	L	L	L	L	L	L	Gf
Soil (Tla)	Co	Co	Co	Co	Co	Co	L	L	L	L	L	L	L	L	L	L	L	GL	L	L	L	L	L	L	GL
Stoniness in % (Kamnitost v %)	20	5	5	0	0	5	10	10	10	80	40	30	5	20	20	0	0	5	15	30	40	100	100	10	10
Cover of herb layer in % (Zastiranje zeliščne plasti v %):	80	100	100	100	100	100	90	100	80	80	60	70	70	70	80	100	100	70	85	70	60	30	30	25	70
Cover of moss layer in % (Zastiranje mahovne plasti v <+%):	20	15	10	15	5	30	20	40	40	60	20	30	30	30	20	20	20	20	15	10	30	10	10	40	40
Number of species (Število vrst)	95	31	40	53	44	47	22	20	21	32	25	20	29	37	31	27	27	24	37	15	25	25	17	24	24
Relevé area (Velikost popisne ploskve)	4	1	2	4	2	5	10	2	10	10	5	2	2	10	2	10	10	20	4	10	10	10	10	20	20
Date of taking relevés (Datum popisa)	23. 7. 2002 and 11. 6. 2003	23. 7. 2002 and 11. 6. 2003	23. 7. 2002 and 11. 6. 2003	23. 7. 2002 and 11. 6. 2003	23. 7. 2002 and 11. 6. 2003	23. 7. 2002 and 11. 6. 2003	7/12/2007	9/8/2004	7/28/2005	7/17/2019	7/27/2020	8/17/2012	8/28/2019	8/28/2019	7/13/2007	7/13/2007	7/13/2007	8/1/2019	7/23/2019	7/26/2007	8/6/1983	8/28/2019	7/17/2019	7/31/2012	
Locality (Nahajališče)	Blehe-Šoštar	Blehe-Šoštar	Blehe-Šoštar	Blehe-Šoštar	Blehe-Šoštar	Blehe-Šoštar	V Mlakah-Loška Koritnica	V Mlakah-Loška Koritnica	Mangart-Prodi	Mangart-Prodi	Mali Babanski Skedenj	Bala-Bavh-Pri Kamnih	Mangart-Na jami	Mangart-Na jami	Bala-Spodnji Lepoč	Bala-Spodnji Lepoč	Bala-Spodnji Lepoč	Konjska planina-Cesar	Mangart-Prodi	Triglavska jezera-Zeleno jezero	Mangart-Rdeča skala	Mangart-Na jami	Mangart-Na jami	Velo polje-Malo polje	

Quadrant (Kvadrant)	Coordinate GK Y (D-48)	Coordinate GK X (D-48)	Diagnostic species of the associations (Diagnostične vrste asociacij)	5121101 419030 9749/4	5121113 419027 9749/4	5121100 419026 9749/4	5121120 419033 9749/4	5121126 419028 9749/4	5121137 419042 9749/4	5143896 396656 9547/4	5143949 396680 9547/4	5145220 396451 9547/4	5145197 396505 9547/4	5133224 382336 9646/4	5141189 397266 9547/4	5144926 395940 9547/4	5144887 395977 9547/4	5140235 396990 9647/2	5140106 396857 9647/2	5140114 396861 9647/2	5136330 412583 9649/1	5145126 396273 9547/4	5134856 407590 9648/2	5144158 396123 9547/4	5144888 395978 9547/4	5145208 396503 9547/4	5135157 412289 9649/1					
Cifer	E1	3																											Pr.	Fr.		
<i>Carex ferruginea</i>		+																												10	42	
<i>Soxifraga aizoides</i>		+																												9	38	
<i>Petasites albus</i>			4				2	2	4																					5	21	
<i>Senecio ovatus</i>		+	+	+	+	+	+	+	1																					6	25	
<i>Hieracium sphenophyllum</i> subsp. <i>pollinianum</i>		+	+	+	+	+	+	+	+																					7	29	
<i>Carduus carduelis</i>		+	+	+	+	+	+	+	+																					5	21	
<i>Carduus arvensis</i>		+	+	+	+	+	+	+	+																					5	21	
<i>Carex frigida</i>		+	1	1	1	1	2	2	1	3	3	3	3	3	3	3	3	3	3	4	3	3	3	2	+	+	+	+	24	100		
<i>Festuca nitida</i>																														2	11	46
<i>Palustricola decipiens</i>	E0									2	2	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	10	42	
<i>Paederota lutea</i>	E1																													8	33	
<i>Achillea atrata</i>	E1																													7	29	
<i>Soxifraga paniculata</i>	E1																													2	8	
<i>Equisetum palustre</i>	E1																													3	1	4
<i>Carex davalliana</i>	E1																													2	1	4
<i>Pinguicula alpina</i>	E1																													1	1	4
Mulgedio-Aconitetea																																
<i>Viola biflora</i>	E1	1																													12	50
<i>Aconitum lycoctonum</i> subsp. <i>nanunculifolium</i>	E1	+																													9	38
<i>Thalictrum aquilegifolium</i>	E1	+																													6	25
<i>Chaerophyllum hirsutum</i>	E1	+																													6	25
<i>Alchemilla xanthochlora</i>	E1																														6	25
<i>Peucedanum ostruthium</i>	E1																														4	17
<i>Veratrum album</i>	E1																														4	17
<i>Chaerophyllum villarsii</i>	E1																														3	13
<i>Aconitum degenii</i> subsp. <i>paniculatum</i>	E1																														3	13
<i>Stellaria nemorum</i>	E1																														3	13
<i>Hypericum maculatum</i>	E1																														3	13
<i>Silene vulgaris</i> subsp. <i>antedopum</i>	E1																														2	8
<i>Pterospermum austriacum</i>	E1	+																													2	8
<i>Aconitum angustifolium</i>	E1	r																													2	8

Successive number of relevés (Zaporedna številka popisov)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Pr.	Fr.			
FB	<i>Trifolium repens</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	
	<i>Trifolium pratense</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Prunella vulgaris</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
TG	Festuco-Brometea	E1	+	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	33
	<i>Cirsium erisithales</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	13
	<i>Prunella grandiflora</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Bromopsis transsilvanica</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Koeleria pyramidata</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Carlina acaulis</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Buphthalmum salicifolium</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Gymnadenia conopsea</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Helictotrichon praecustum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	Trifolio-Geranietea	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
EA	<i>Libanotis sibirica</i> subsp. <i>montana</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Digitalis grandiflora</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Origanum vulgare</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Achillea distans</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	Epilobietea angustifolii, Galio-Urticetea	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Rubus idaeus</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Urtica dioica</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Lamium maculatum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	Betulo-Alnetea	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	<i>Salix waldsteiniana</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
VP	<i>Alnus viridis</i>	E2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
	<i>Sorbus aucuparia</i>	E1	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
	Vaccinio-Piceeta	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	21
	<i>Veronica urticifolia</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
	<i>Aposperis foetida</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
	<i>Calamagrostis arundinacea</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
	<i>Luzula luzuloides</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	13
	<i>Solidago virgaurea</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	13
	Fagetalia sylvaticae	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	21
	FS	<i>Knautia drymeia</i>	E1	4	17
<i>Campanula trachelium</i>		E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
<i>Symphytum tuberosum</i>		E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	17
<i>Galobolus flavidulus</i>		E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
<i>Daphne mezereum</i>		E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8
<i>Galium laevigatum</i>		E1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
<i>Scrophularia nodosa</i>		E1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4

Successive number of relevés (Zaporedna številka popisa)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Pr.	Fr.		
<i>Timmia norvegica</i>	E0	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	
<i>Pseudoleskea incurvata</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
<i>Rhytidium rugosum</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	4
<i>Barbilophozia attenuata</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4
<i>Barbilophozia hutcheri</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4
<i>Climacium dendroides</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4
<i>Hypnum vaucherii</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4
<i>Prilidium ciliare</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4
<i>Tortella densa</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	4
<i>Tortella tortuosa</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	4
<i>Bryocryptobryllum recurvirostre</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
<i>Encalypta streptocarpa</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4
<i>Syntrichia norvegica</i>	E0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4

Legend – Legenda

- 1 *Saxifraga aizoides-Caricetum ferrugineae*
- 2–6 *Carex frigidae-Patasitetum albi*
- 7–21 *Palustriella decipiens-Caricetum frigidae*
- 22–23 *Ranunculo traunfellneri-Paedoretetum luteae caricetosum frigidae*
- 24 *Equisetum palustris-Caricetum danallianae* nom. prov.

ID Igor Dakskobler

BZ Branko Zupan

BV Branko Vreš

SB Sanja Behrič

TW Tone Wraber

AM Andrej Martinčič

Cl Claystone – glinavec

Ch Chert – roženec

D Dolomite – dolomit

L Limestone – apnenec

M Marlstone – laporovec

Gr Gravel – grušč

Co Colluvial soil – koluvalna tla

Li Lithosol – kamnišče

Gl Molic Gleysols – organsko-mineralna tla

Pr: Presence (number of relevés in which the species is presented) – število popisov, v katerih se pojavlja vrsta

Fr: Frequency in % – frekvenca v %

PS *Physoplexido comosae-Saxifragion petraeae*

Grey colored columns – nomenclatural type (sivo pobarvana stolpca sta nomenklaturni tip)