

# LOCALITIES AND SITES OF *PULSATILLA VERNALIS* IN THE JULIAN ALPS

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## Abstract

Applying the standard Central-European method we phytosociologically studied the sites of *Pulsatilla vernalis*, a rare and protected species of Slovenian flora, in the frost hollows on mountain pastures Ovčarija and Za Grivo in the Fužina pasturelands (the Triglav mountains, the Julian Alps). We established that it grows in a unique community of swards and heaths which usually extends over small surfaces (4–10 m<sup>2</sup>) and is dominated by herbaceous perennial species (hemicryptophytes) and dwarf shrubs (chamaephytes) with mostly arctic-alpine and south-European montane distribution. This community is explicitly (floristically and ecologically) different from the communities of swards and heaths described in the Julian Alps so far, so we classified it into a new association *Pulsatillo vernalis-Dryadetum octopetalae* ass. nova (order *Rhododendro hirsuti-Ericetalia carneae*) and subdivided it into two, floristically and ecologically clearly distinguished subassociations *-ericetosum carneae* subass. nova and *-vaccinietosum* subass. nova.

**Key words:** *Pulsatilla vernalis*, *Rhododendro hirsuti-Ericetalia carneae*, phytosociology, syntaxonomy, frost hollows, the Fužina pasturelands (Fužinske planine), the Julian Alps, Slovenia.

## Izvleček

Po standardni srednjeevropski metodi smo v mraziščnih kotanjah na pl. Ovčarija in Za Grivo v Fužinskih planinah (Triglavsko pogorje, Julijske Alpe) fitocenološko preučili rastišča redke in zavarovane vrste slovenske flore, *Pulsatilla vernalis*. Ugotovili smo, da raste v svojevrstni, navadno na majhnih površinah (4–10 m<sup>2</sup>) razširjeni združbi rušnatih trav in resav, v kateri prevladujejo zelnate trajnice (hemikriptofiti) ter polgrmi in nizki grmiči (hamefiti) predvsem z arktično-alpinski in južnoevropsko gorsko razširjenostjo. Ker se ta združba floristično in ekološko očitno razlikuje od doslej v Julijskih Alpah opisanih združb rušnatih trav in resav, jo uvrščamo v novo asociacijo *Pulsatillo vernalis-Dryadetum octopetalae* ass. nova (red *Rhododendro hirsuti-Ericetalia carneae*) in jo členimo na dve floristično in ekološko dobro prepoznavni subasociaciji *-ericetosum carneae* subass. nova in *-vaccinietosum* subass. nova.

**Gljučne besede:** *Pulsatilla vernalis*, *Rhododendro hirsuti-Ericetalia carneae*, fitocenologija, sintaksonomija, mrazišča, Fužinske planine, Julijske Alpe, Slovenija.

## 1. INTRODUCTION

*Pulsatilla vernalis* is an arctic-alpine or European montane species (Pignatti 1982: 298, Poldini 1991: 621, Aeschimann & al. 2004 a: 148) of subalpine and alpine basophile and acidophile swards (Pignatti, ibid.) or (according to Oberdorfer 1983: 403

and Adler & al. 1994: 275) species of dry grasslands (»Magerrasen«) on silicate bedrock and acid soil in the (subalpine)-alpine belt, very rarely also in the submontane and montane belt, where it grows also in Scots pine heaths. The species is most frequently found on moderately fresh and base-rich, as well as more or less acid, humose loamy soil (Oberdor-

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fer, *ibid.*). Aeschimann & al. (*ibid.*) find that it grows on calcareous, calcareous-silicate and silicate geological bedrock, on acid to neutral soil which is nutrient- (nitrogen) poor and not very well supplied with water (medium dry), mostly in the subalpine and alpine belt. It is a character species of subalpine-alpine swards on acid soil of the Central and South-European mountain ranges from the class *Juncetea trifidi* Hadač 1946 (= *Caricetea curvulae* Braun-Blanquet 1948) – Aeschimann & al. (*ibid.*) and order *Caricetalia curvulae* Br.-Bl. in Br.-Bl. & Jenny 1926 (Grabherr 1993 a: 345). Within the territory of former Yugoslavia, Trinajstić (1973: 288) mentions it for Montenegro (Kom planina) and for Serbia. According to Lakušić (2008, in litt.) and Vukojičić (2008, her data is based on revision of herbarium collections of public Herbaria BEOU and BEO as well as on many publications from this territory, for example Rohlena 1942, Micevski 1979, 1985, Nikolić & al. 1986, Diklić 1992, Krivošej & Ran elović 1996, Amidžić & Panjković 2003 and Niketić & al. 2007) the localities of *Pulsatilla vernalis* in Serbia (Kosovo) are in the Prokletije mountains (Đeravica, Derviš Kom, Kurvala), in Montene-

gro in the Komovi mountains and in the Republic of Macedonia in the Šar planina (Rudoka–Popova Šapka) and Jablanica mountains (Crni kamen). It grows there at the altitudes between 1700 to 2650 m on carbonate and silicate bedrock, in dwarf shrub communities of the alliance *Juniperion nanae* (= *Juniperion sibiricae*), in rock-crevice communities of the class *Asplenieta trichomanis* and in the alpine grasslands of the orders *Onobrychido-Seslerietalia* (on calcareous bedrock) and *Seslerietalia comosae* (on silicate bedrock) – Vukojičić (*ibid.*).

Acidophilous high-mountain swards from the class *Juncetea trifidi* are rather rare in the Slovenian Alps (mostly because of the prevailing calcareous bedrock) and still insufficiently researched (the results of the research conducted by T. Wraber, partly together with B. Surina, have been published only fragmentarily – T. Wraber 1969, 1983, 1984). The largest surfaces covered by these swards are in the vicinity of Mangrt. T. Wraber (1996: 110) mentions several floristic rarities within them, among which are *Helictotrichon versicolor*, *Juncus trifidus*, *Carex curvula* and *Pulsatilla alba* (= *P. alpina* subsp. *alba*), but not *Pulsatilla vernalis*, which had been unknown in

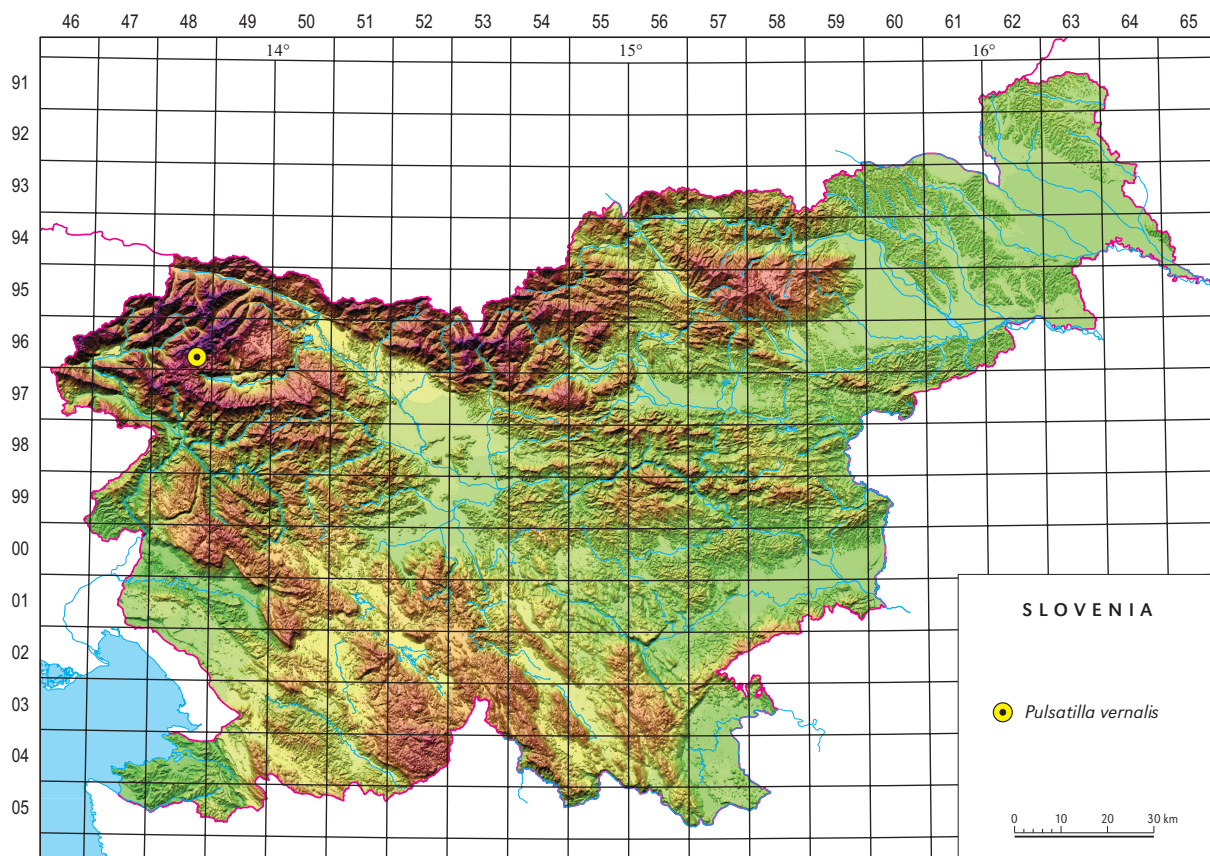


Figure 1: Distribution of *Pulsatilla vernalis* in Slovenia

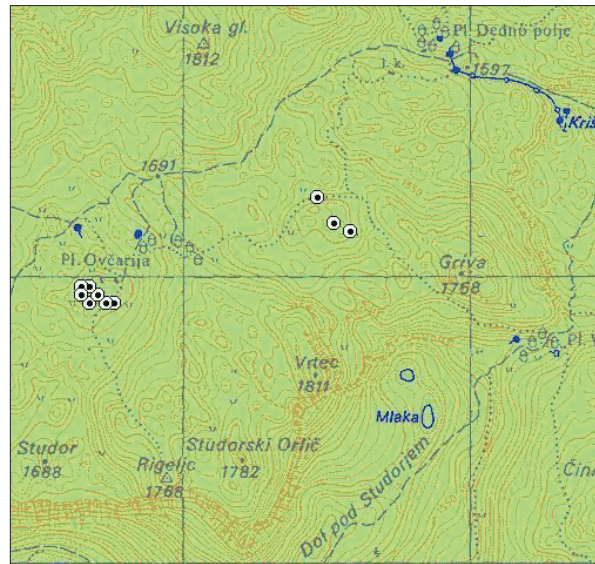
Slika 1: Razširjenost vrste *Pulsatilla vernalis* v Sloveniji

Slovenia until a few years ago. In the neighbouring Carinthia in Austria it is distributed above all in the northern and northwestern part of the country, but its localities along the border with Slovenia are not known (Hartl & al. 1992: 291). Even in Friuli the localities are in the northern part of the country, mostly on the border with Austria, but not in the Western Julian Alps (Poldini 2002: 395). Poldini (2008, in litt.) noticed *Pulsatilla vernalis* on silicate sites in the Carnian Alps, within the stands of the association *Sieversio-Nardetum*.

The unusual hairy plant with purple flowers (*Pulsatilla* sp.) was first noticed in the Julian Alps, on the southwestern part of the Bohinj mountain pasture Ovčarija in 2002 by the photographer Marko Pogačnik. He informed Ivan Veber about his find and in the following years the latter examined the locality and the plant in flowering and fructifying stage several times. Peter Skoberne helped him to determine it as a species new to the Slovenia flora – *Pulsatilla vernalis* (Veber 2006). Veber's publication is already included in the last edition of the *Mala flora Slovenije* (T. Wraber 2007: 133–134) and its distribution map in Slovenia was made on this basis (Figure 1). In the spring and summer of 2007 we closely examined the localities of this vernal plant on the mountain pasture Ovčarija. We found a new locality in a frost hollow Za Grivo (at the altitude of 1635–1650 m, near the path between the mountain pastures Viševnik and Ovčarija) and recorded its stands (Figure 2). Our findings are summed up in this paper.

## 2. METHODS

The air temperature in the dolines (pits) on pastures Ovčarija and Za Grivo in the period from October 2006 to September 2007 was measured by an automatic temperature recorder “thermo button” or “i-button” (button-shaped thermometer) with the time interval of 15 minutes. The provider is Dallas Semiconductor. The recorder was placed in a special, home-made shelter which protected it from the unfavourable weather conditions (rainfall) and albedo. The air temperature data on the official meteorological station Vogel were provided by the Meteorological Office of the Environmental Agency of the Republic of Slovenia (ARSO). The vegetation on the localities of *Pulsatilla vernalis* was recorded applying the standard Central-European method (Braun-Blanquet 1964). The collected relevés were entered into the FloVegSi database



**Figure 2:** Localities of *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (Source: State topographical map 1 : 25 000, GURS)

**Slika 2:** Nahajališča vrste *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo. (Vir: Državna topografska karta RS 1 : 25 000, GURS)

(T. Seliškar & al. 2003) and then compared applying the methods of hierarchical classification and Principal Coordinates Analysis (PCoA). We used the SYN-TAX program package (Podani 2001). The combined cover-abundance values were transformed into the ordinal scale as proposed by van der Maarel (1979). When conducting our comparisons the following methods of hierarchical clustering were used: »complete linkage (farthest neighbour) method – FNC«, »(Unweighted) average linkage method – UPGMA«, »(Weighted) average linkage method – WPGMA«, »Incremental sum of squares – MISSQ« and the Principal Coordinates Analysis (PCoA) ordination method. The similarity measures were the Sørensen and Jaccard indexes (when only presence or absence of species was considered) and Wishart's coefficient (similarity ratio). On the basis of these comparisons a phytosociological table was made (Table 1), in which we calculated not only the presence and frequency for each taxon, but also its cover index ( $I_c$ ) – Lausi & al. (1982: 124) and its share of coverage ( $D\%$ ) – Surina (2004: 102, 2005: 15). The recorded species were arranged and analyzed according to Raunkiaer's life forms, chorological affinity (geoelemental composition) and phytosociological groups (groups of diagnostic species). Most of the listed

data come from the *Flora alpina* (Aeschimann & al. 2004 a,b,c).

The nomenclature source for the names of vascular plants is the *Mala flora Slovenije* (Martinčič & al. 2007), Frahm & Frey (1992) and Martinčič (2003) for the names of mosses, and Wirth (1995) for the names of lichens. We were unable to determine all of the moss and lichen species, so some of the analyses do not include the moss layer. For the names of the syntaxa we mainly follow Theurillat & al. (1995), Theurillat in Aeschimann & al. (2004 c), Grabherr (1993 a, b, c) and Surina (2005). All the taxonomical units in the paper and their authors are listed in the Appendix.

### 3. ECOLOGICAL CHARACTERIZATION OF THE RESEARCH AREA

The only localities of *Pulsatilla vernalis* in Slovenia known so far are in the Fužina pasturelands – Fužinske planine (the Julian Alps, the Triglav mountains, Figures 1 and 2). Fužinske planine are the common name for the region between the valley of Voje and Velo polje in the east and the Triglav Lakes Valley in the west, which belongs to the pasture community Studor–Stara Fužina (Mihelič 1992: 130–134, Novak 1985: 148; Cevc 1992: 39–42, Melik 1950: 179–180). The pasture Ovčarija is a vast and elongated mountain pasture that occupies a large part of the western fringes of the Fužinske planine. It is one of the highest (1660 m) and remotest mountain pastures in our Alps (Mihelič, *ibid.*). The geological bedrock is massive Triassic limestone (Buser 1986: 40–41, 1987) and the overall climate of the Fužinske planine is montane (Ogrin 1996: 46–47). It can be loosely described with the climate data for the meteorological observatory Dom na Komni (1520 m) – Mekinda–Majaron (1995: 41), B. Zupančič (1995: 46). The mean annual temperature here in the period between 1961–1990 was 3,7 °C (interpolated value), the mean temperature of the warmest month in July in the same period was 12,4 °C, the vegetation period with the mean monthly temperature of above 5 °C lasted from May to October (about five months). The mean temperature of the coldest months was –4 °C (January, February). In the same period (1961–1990), an average of 2934 mm of precipitation evenly distributed across the year was measured on Komna, with the highest average in April (283 mm) and November (395 mm), in the cold period from November to March mostly as snow. On Vogel (1535

m), in the period between 1981–1990, there was on average even a little more precipitation (3077 mm), also with a high in November (395 mm) – B. Zupančič (1996: 337). However, the values for the temperature conditions and precipitation quantity on meteorological observatories Dom na Komni and Vogel are only approximate indicators of the local climate on the mountain pastures Ovčarija and Za Grivo, mostly because of their distance from the ridge of the Bohinj–Tolmin mountains (the Lower Bohinj mountains), where the precipitation is more common because of the orographic effects and morphological characteristics of the localities' surroundings. The pasture Ovčarija is situated in a 'konta' (a larger Karstic depression or doline with the diameter of several hundred metres – Kunaver 1985: 55), similarly to the doline (konta) Za Grivo. Both these locations are frost hollows, which means that on clear tranquil nights the temperatures there are often considerably lower than in the vicinity (Martinčič 1977: 231, Ogrin & al. 2007: 198). The temperature conditions in both dolines are therefore significantly different from those on the plateaus of Komna and Vogel. This was confirmed also by the measurements of the researchers from the Slovenian meteorological forum. They had set up instruments for measuring air temperature in these two frost hollows (frost hollow of the pasture Ovčarija and frost hollow Vrtec or the hollow Za Grivo, which lies to the north under Mt. Vrtec, 1811 m) – Sinjur & al. (2007). Based on the air temperature measurements on pastures Ovčarija and Za Grivo it was established that both localities of *Pulsatilla vernalis* known in the Julian Alps so far have very harsh growth conditions, mostly because



**Figure 3:** The lowest temperature by months on Vogel (1535 m) and in dolines (pits) of the pastures Ovčarija and Za Grivo

**Figure 3:** Najnižja temperatura po mesecih na Voglu (1535 m) in v kontah na pl. Ovčarija in Za Grivo

of the low morning temperatures (that can be as low as  $-30^{\circ}\text{C}$  or less in the winter – Sinjur & Ogrin 2006, and which relatively often stay a few degrees Celsius below zero even during the calendar summer) – Figure 3.

The localities of *Pulsatilla vernalis* on the pasture Ovčarija are on the south and southwestern rim of the doline (Fig. 2) and are only slightly elevated above its lowest point (where the measuring instruments are), i.e. definitely still in the cold air belt. The localities of the vernal hairy plant in the hollow Za Grivo are mostly also very near the lowest point of the doline (to the south of the doline, with the exception of one locality which is to the north of this gauging station, near the mountain path towards the pasture Ovčarija). Presumably, these are the potential sites of an Alpine dwarf pine community on calcareous bedrock (*Rhododendro hirsuti-Pinetum prostratae*) that was cleared out in the past in order to extend pastures. The forest had probably been overgrowing only the higher-lying slopes on the rims of both dolines. The current open larch stands on the slopes south of the pasture Ovčarija and doline Za Grivo are mostly classified into the syntaxon *Rhodothamno-Laricetum*. The slopes might once have been overgrown also with the subalpine spruce forest (*Adenostylo glabrae-Piceetum* sensu Zupančič 1999 or *Homogyno sylvestris-Piceetum* sensu Exner 2006 and Poldini & Bressan 2007).

The soil under the swards of perennial herbs, dwarfs and (semi)bushes overgrowing the rims of the dolines on the pasture Ovčarija are organogenic rendzinas (*follic leptosols* – WRB, 2006), whose characteristic feature is raw humus (Mor) – Urbančič & al. (2005: 9–10, 2008, in litt.). Organogenic rendzinas occur above all in very cold, humid conditions in the high-mountains and frost hollows, where the decomposition of organic matter is slow. This is similar to peat soil, for example, which develops upwards with accumulation of raw humus. The leaching of base cations can make the soil very acid, poorly fertile and for the most part overgrown with acidophilous and “piceetal” vegetation (Urbančič & al., ibid.). In our case, the slow decomposition of organic matter is related above all to the cold expositions and less so to the altitude.

#### 4. RESULTS AND DISCUSSION

Table 1 comprises 14 relèves of the stands with *Pulsatilla vernalis* on the pastures Ovčarija and Za Grivo, arranged with hierarchical classification. On

average 34 species were found, standard deviation was 4 and coefficient of variation 11 %. Biological spectrum analysis, in which mosses and lichens were not considered, gave the following results (Table 2).

**Table 2:** Plant life forms spectrum of the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (relative frequencies). Fr. – Frequency;  $I_c$  – Cover index;  $D_{\%}$  – Share of coverage.

**Tabela 2:** Spekter življenjskih oblik v sestojih z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (relativne frekvence). Fr. – frekvenca;  $I_c$  – indeks pokrovnosti;  $D_{\%}$  – delež pokrovnosti.

Weight (Utež)		Fr.	$I_c$	$D_{\%}$	
Phanerophytes (Fanerofiti)	P	3.6	2.9	2.1	2.1
Chamaephytes (Hamefiti)	Ch	<b>21</b>	<b>26</b>	<b>35</b>	<b>35</b>
Hemicryptophytes (Hemikriptofiti)	H	<b>70</b>	<b>68</b>	<b>60</b>	<b>60</b>
Geophytes (Geofiti)	G	2.4	2.9	2.6	2.6
Therophytes Terofiti)	T	2.4	0.4	0.3	0.3
Total (Skupaj)		100	100	100	100

If the species are given equal consideration regardless of their frequency, the prevailing species are herbaceous perennials, hemicryptophytes (70 %), followed by semi-bushes, dwarf shrubs and perennial swards (chamaephytes) – altogether 21 %. Other life forms, phanerophytes (trees and shrubs), geophytes and therophytes (annual plants) are represented with only a few species within the stands studied. If we use species frequency as weight, the proportion of chamaephytes increases (26 %), while the proportion of other groups decreases. If weight is cover index or share of coverage, the proportion of chamaephytes increases to 35 % and the proportion of hemicryptophytes is 60 %. A high proportion of chamaephytes in the studied community undoubtedly indicates very harsh life conditions for its growth. Such a high proportion of chamaephytes (about 20 % and more) is characteristic only for deserts, the arctic and high-mountain (alpine) belt (Stefanović 1986: 29).

Analysis according to chorological affinity is presented in Table 3.

Considering only the presence of species, regardless of their frequency and abundance, the prevailing species are the South-European montane species (31 %) and arctic-alpine species (17 %). A similar proportion is obtained if weight is frequency of species. If cover index is considered, the proportion of arctic-alpine species slightly in-

creases (19 %), while the proportion of South-European montane species slightly decreases (28 %). This analysis also indicates extreme life conditions that mostly arctic-alpine and montane species can handle.

**Table 3:** Chorological groups in the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (relative frequencies). Fr. – Frequency; I<sub>c</sub> – Cover index; D<sub>%</sub> – Share of coverage.

**Tabela 3:** Horološke skupine v sestojih z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (relativne frekvence). Fr. – frekvenca; I<sub>c</sub> – indeks pokrovnosti; D<sub>%</sub> – delež pokrovnosti.

Weight (Utež)	Fr.	I <sub>c</sub>	D <sub>%</sub>
Alpine and Alpine-Carpathian species (Alpske in alpsko-karpatске vrste)	2.4	2	3.3
Arctic-alpine species (Arktično-alpske vrste)	<b>17</b>	<b>15.7</b>	<b>19</b>
E-Alpine species (Vzhodnoalpske vrste)	4.8	5.9	5.8
E-Alpine-Illyrian species (Vzhodnoalpsko-ilirske vrste)	6	7	5.9
European species (Evropske vrste)	9.5	14	12.8
European montane species (Evropske gorske vrste)	4.8	4.1	4.8
SE-European montane species (Jugovzhodnoevropske gorske vrste)	8.3	6.3	4.7
S-European montane species (Južnoevropske gorske vrste)	<b>31</b>	<b>28.7</b>	<b>28</b>
Eurosiberian and Euroasian species (Eurosibirske in evroazijske vrste)	6	4.8	3.9
Eurosiberian-N-American species (Evrosibersko-severnoameriške vrste)	11	11.5	11.9
Total (Skupaj)	100	100	100

The highest proportion in the studied community, regardless of whether they are given equal consideration or whether we take into consideration also their frequency and abundance, have the species of subalpine-alpine grasslands and swards on calcareous bedrock (i.e. the species from the alliances *Caricion firmae* and *Caricion austroalpinæ*, order *Seslerietalia varia* and class *Elyno-Seslerietea*, species of the alliance *Oxytropido-Elynion* are treated separately). Their total proportion is about 50 % (considering the presence and frequency of species) or 44 % (if cover index and share of coverage are used as the weight). After these calculations the studied community should definitely be classified into the class *Elyno-Seslerietea*. The species of the order *Rhododendro hirsuti-Ericetalia carneae* Grabherr, Greimler & Mucina 1993, which comprises Alpine

**Table 4:** Phytosociological groups (= groups of diagnostic species) in the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (relative frequencies). Fr. – Frequency; I<sub>c</sub> – Cover index; D<sub>%</sub> – Share of coverage.

**Tabela 4:** Sestava po skupinah diagnostičnih vrst v sestojih z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (relativne frekvence). Fr. – frekvenca; I<sub>c</sub> – indeks pokrovnosti; D<sub>%</sub> – delež pokrovnosti.

Weight (Utež)	Fr.	I <sub>c</sub>	D <sub>%</sub>
<i>Rhododendro hirsuti-Ericetalia carneae</i>	<b>7.1</b>	<b>9.3</b>	<b>12</b>
<i>Caricion firmae</i>	4.8	3.7	2.8
<i>Caricion austroalpinæ</i>	6	6.5	4.8
<i>Seslerietalia varia</i>	<b>17</b>	<b>11</b>	<b>9.4</b>
<i>Elyno-Seslerietea</i>	<b>24</b>	<b>30</b>	<b>27</b>
<i>Juncetea trifidi</i>	11	<b>12</b>	<b>11.9</b>
<i>Calluno-Ulicetea</i>	3.6	1.7	1.4
<i>Oxytropido-Elynion</i>	6	4.8	<b>8.4</b>
<i>Leuseleurio-Vaccinietea</i>	1.2	2.2	3.4
<i>Caricetalia davallianæ</i>	3.6	3	2.8
<i>Arabidetalia caeruleæ</i>	<b>7.1</b>	<b>6.5</b>	5.9
<i>Mulgedio-Aconitetea</i>	1.2	0.2	0.2
<i>Molinio-Arrhenatheretea</i>	3.6	4.6	3.6
<i>Vaccinio-Piceetea</i>	4.8	4.6	<b>6.2</b>
Total (Skupaj)	100	100	100

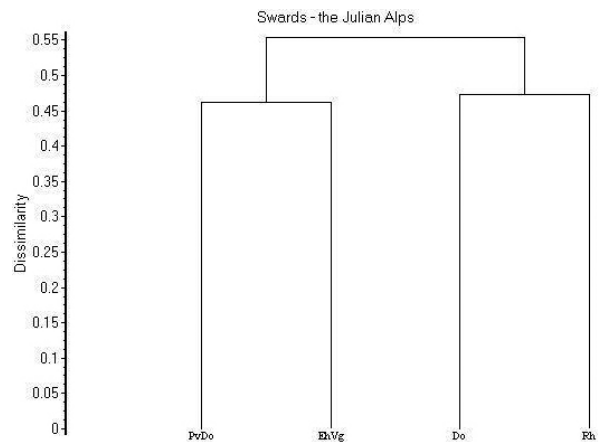
(montane) heaths on calcareous bedrock (Grabherr & al. 1993: 434), were treated separately. These are mostly pioneer communities on dolomite and limestone bedrock, on coarse rubble, on collapse blocks, in alpine karst with karrens. Diagnostic (character and differential) species of this order are *Daphne striata*, *Genista radiata*, *Rhodothamnus chamaecistus*, *Erica carneae*, *Juniperus alpina*, *Rhododendron hirsutum*, *Pinus mugo* etc. Its authors classify it into the class *Elyno-Seslerietea* (Grabherr & al., ibid.). Theurillat (in Aeschmann & al. 2004 c: 310) classifies the order *Rhododendro hirsuti-Ericetalia carneae* Grabherr, Greimler & Mucina and Grabherr & Mucina 1993 into the class *Loiseleurio-Vaccinietea* Egger ex Schubert 1948, which comprises the communities of subalpine-alpine heaths – Theurillat & al. (1995: 224), or heaths from the Arctic regions and mountains of boreal and nemoral belt – Grabherr (1993 c: 447). Among the diagnostic species of this class is *Vaccinium gaultherioides* (Grabherr 1993 c, ibid.), which occurs also in our relèves. The total proportion of the species of arctic-alpine heaths in our relèves is about 8 % (when given equal consideration) or 12 % (considering their frequency) and 15,5 % (considering also medium coverage,

cover index). The species characteristic for heaths on calcareous bedrock prevail.

Species of subalpine-alpine swards on acid soil (class *Juncetea trifidae* = *Caricetea curvulae*) also have a significant proportion (11 or 12 %) in the studied community. Common species from this diagnostic group in our relèves, apart from *Pulsatilla vernalis*, are also *Festuca nigrescens*, *Campanula scheuchzeri* and *Potentilla aurea*. Other more acidophilous species that grow in the studied community are classified into the classes *Calluno-Ulicetea* and *Vaccinio-Piceetea* (in our relèves, *Vaccinium vitis-idaea*, which is differential also for the communities of acidophilous heaths, is the most constant and abundant species among those diagnostic for this class). Diagnostic species from the alliance *Oxytropido-Elyinion* (according to Grabherr 1993 and Theurillat in Aeschmann & al. 2004 c this alliance is classified into the class *Carici rupestris-Kobresietea bellardii*, while according to Oriolo 2001 classification within the class *Elyno-Seslerietea* is more proper), which comprises the communities of naked-rush swards (*Elyna myosuroides*), also indicate the characteristics of the studied community with their proportion (5 to 8 %, depending on the weight). These species occur only on special sites in the Central- and South-European mountain ranges (above all on wind-exposed ridges, on edges with low snow cover, on base and weakly acid soil). They therefore occur extrazonally and are in contact with the grasslands from the classes *Caricetea curvulae* (= *Juncetea trifidi*) and *Elyno-Seslerietea* (Grabherr 1993 b: 373). The diagnostic species of the alliance *Oxytropido-Elyinion* which occur in the studied community are mostly *Dryas octopetala*, *Antennaria carpatica* and *Carex rupestris*, possibly also *Carex capillaris* and *C. atrata*, although these two sedges are diagnostic also for the snow-bed communities from the order *Arabidetalia caeruleae* (class *Thlaspietea rotundifolii*). Within the studied community, the most frequent among the species from this order are *Homogyne discolor* and *Soldanella alpina*, which indicate that the snow on these sites keeps rather long into the spring.

Analysis of sociological groups shows a unique plant community with elements of different associations, alliances and even classes. According to our findings, the reasons for their collective growth are sites in frost hollows (frost exposed aspects) with long snow cover periods, slow decomposition of organic matter and raw, acid humus. The species with the highest cover index in the studied community ( $I_c = 67$ ) and the highest share of coverage ( $D\% = 6,9\%$ ) is *Dryas octopetala*, followed by *Vaccinium vi-*

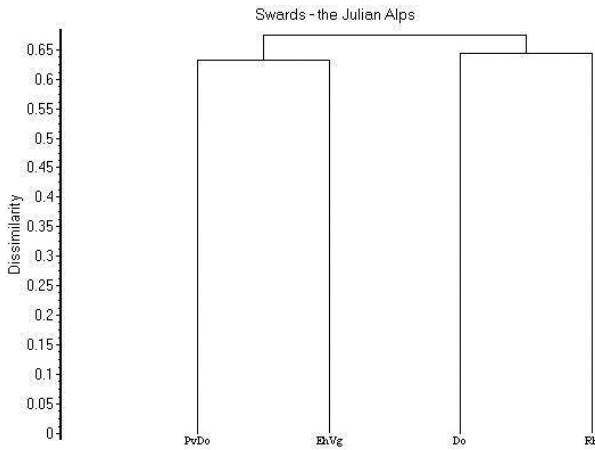
*tis-idaea* ( $I_c = 44$ ,  $D\% = 4,6$ ) and *Pulsatilla vernalis* ( $I_c = 39$ ,  $D\% = 4$ ). The most thoroughly studied in the Julian Alps are the subalpine-alpine plant communities in the Krn mountains (Surina 2005). Among the Fužinske planine and the Krn mountains is a large plateau of Komna. Nevertheless, these regions are still geographically and ecologically very similar. Among the communities described in the Krn mountains by Surina (ibid.), the stands which are the most similar to the studied stands are those from the associations *Dryadetum octopetalae* Rübél 1911 (cover index and share of coverage of *Dryas octopetala* are considerably higher here,  $I_c = 98$ ,  $D\% = 19,9$ ), *Rhododendretum hirsuti* Lüdi 1921 and *Empetro-Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. & Jenny 1926 corr. Grabherr 1993. We made a synthetic table (Table 5) and compared all four syntaxa (Figures 4–7).



**Figure 4:** Dendrogram of subalpine-alpine swards and heaths (PvDo – *Pulsatilla vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, the Sørensen index

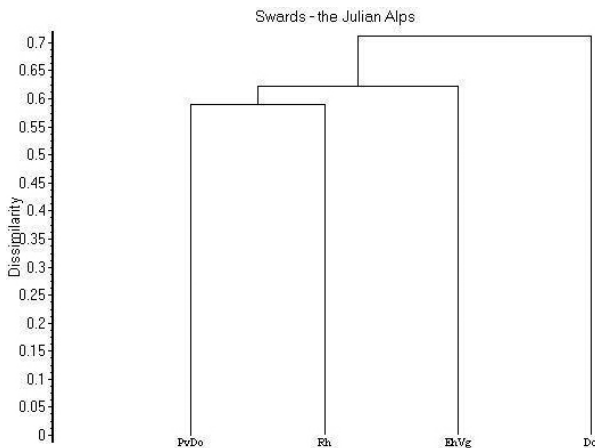
**Slika 4:** Dendrogram subalpinsko-alpinskih rušnatih trat in resav (PvDo – *Pulsatilla vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, Sørensenov količnik

Considering only the presence and absence of species, the association *Empetro-Vaccinietum gaultherioidis* is the most similar to the studied community, but the coefficient of floristic similarity according to Sørensen is only about 54 % (Figure 4) and 38 % according to Jaccard (Figure 5). However, if we take into consideration also the frequency of species, our relèves become more similar to the stands of the association *Rhododendretum hirsuti* (Figure 6).



**Figure 5:** Dendrogram of subalpine-alpine swards and heaths (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, the Jaccard index

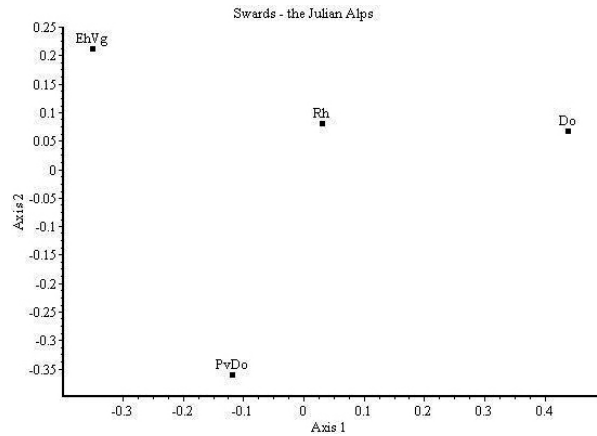
**Slika 5:** Dendrogram subalpinsko-alpinskih rušnatih trat in resav (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, Jaccardov količnik



**Figure 6:** Dendrogram of subalpine-alpine swards and heaths (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, similarity ratio

**Slika 6:** Dendrogram subalpinsko-alpinskih rušnatih trat in resav (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – UPGMA, similarity ratio

The two-dimensional scatter diagram (Figure 7) clearly shows that four different communities were compared. Based on these comparisons, the stands



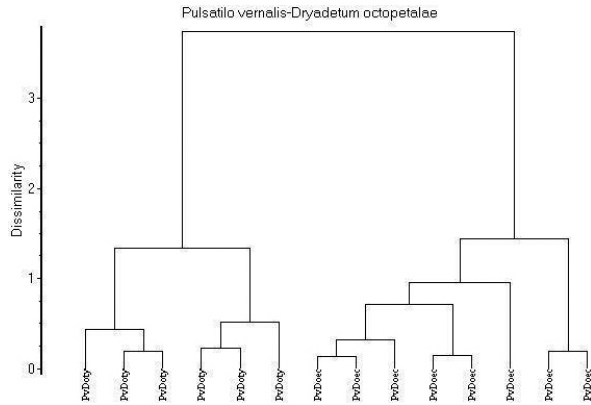
**Figure 7:** Two dimensional scatter-diagram of subalpine-alpine swards and heaths (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – PCoA, similarity ratio

**Slika 7:** Dvoroazsežn ordinacijski diagram subalpinsko-alpinskih rušnatih trat in resav (PvDo – *Pulsatillo vernalis*-*Dryadetum*, Do – *Dryadetum octopetalae*, Rh – *Rhododendretum hirsuti*, EhVg – *Empetro-Vaccinietum gaultherioidis*) – PCoA, similarity ratio

on pastures Ovčarija and Za Grivo, where *Pulsatilla vernalis* grows, are classified into a new association *Pulsatillo vernalis*-*Dryadetum octopetalae* ass. nova, which is classified into the alliance *Ericion* Rübél ex Grabherr, Greimler & Mucina 1993 and order *Rhododendro hirsuti-Ericetalia carnea* Grabherr, Greimler & Mucina 1993. The question whether this order should be included into the class *Loiseleurio-Vaccinietea* (as proposed in the *Flora alpina* – Theurillat in Aeschmann & al. 2004 c: 310), or into the class *Elyno-Seslerietea* (Grabherr & al. 1993) is left unanswered. According to the analysis of groups of diagnostic species (Table 4), priority in this case should be given to the class *Elyno-Seslerietea*. The diagnostic (differential) species of the new association are *Dryas octopetala*, *Pulsatilla vernalis*, *Vaccinium vitis-idaea*, *Homogyne discolor*, *Juniperus alpina* and *Vaccinium gaultherioides*. Each of them is diagnostic for a different phytosociological group and their collective growth indicates a quite unique site. The species *Dryas octopetala* indicates initial soil and the pioneer stage of development of the community, *Pulsatilla vernalis*, *Vaccinium vitis-idaea* and *V. gaultherioides* are indicative of a slow decomposition of organic matter and acid humus, *Homogyne discolor* indicates a site where the snow keeps for a long time and *Juniperus alpina* a syndynamic connection with a dwarf pine community.

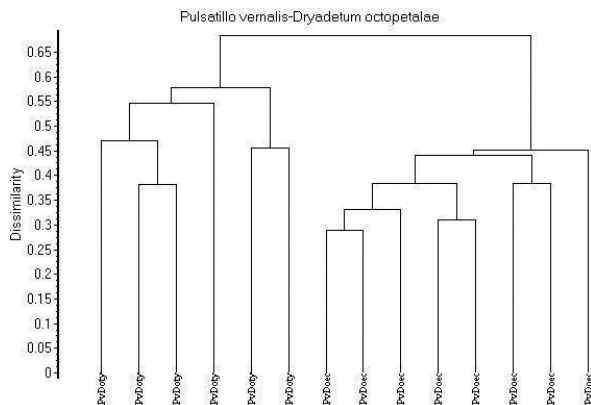


The relèves in Table 1 were compared with hierarchical classification and PCoA ordination method (Figures 8 to 10). In all the methods tested they united into two groups which are treated as two subassociations. Axis 1 in Figure 10 also indicates the temperature gradient, on the left are relèves from a slightly warmer rim and on the right are the relèves from a slightly colder point of the dolines.



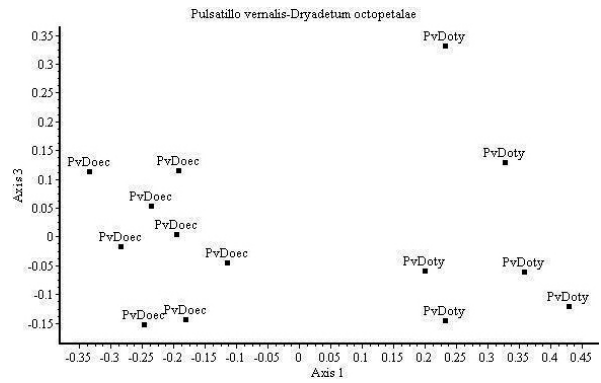
**Figure 8:** Dendrogram of the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (MISSQ – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*

**Slika 8:** Dendrogram sestojev z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (MISSQ – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*



**Figure 9:** Dendrogram of the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (UPGMA – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*

**Slika 9:** Dendrogram sestojev z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (UPGMA – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*



**Figure 10:** Two-dimensional scatter diagram of the stands with *Pulsatilla vernalis* on the pasture Ovčarija and Za Grivo (PCoA – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*

**Slika 10:** Dvorazsežni diagram sestojev z vrsto *Pulsatilla vernalis* na pl. Ovčarija in Za Grivo (PCoA – similarity ratio); PvDoty – *Pulsatillo vernalis-Dryadetum vacciniotosum*, PvDoec – *Pulsatillo vernalis-Dryadetum ericetosum carnea*

The relèves on the pasture Ovčarija were made on the rim above the lowest point of the doline, i.e. on a little less frosty exposition in comparison with the relèves on Za Grivo, with a thinner layer of raw humus (the vegetation manifests a more obvious influence of calcareous, limestone bedrock). This is indicated above all by *Erica carnea*, *Daphne striata* and *Rhodothamnus chamaecistus* (the diagnostic species of the order *Rhododendro hirsuti-Ericetalia carnea*), as well as by *Carex sempervirens* and *Senecio abrotanifolius*. The species listed are the differential species of the subassociation *Pulsatillo vernalis-Dryadetum octopetalae ericetosum carnea* subass. nova. Its nomenclature type (*holotypus*) is reléve No. 9 in Table 1, which is also the nomenclature type (*holotypus*) of the new association. The relèves on Za Grivo were made in the frost hollow itself (although the *Pulsatilla vernalis* there can grow also on the rim of the doline, together with *Erica carnea*, so the stands of the subassociation - *ericetosum carnea* are presented also on locality Za Grivo), on very acid soil. They are classified into the new subassociation *Pulsatillo vernalis-Dryadetum octopetalae vacciniotosum* subass. nova. Characteristic for these stands is an abundant growth of three species from the order *Vaccinium* (*V. vitis-idaea*, *V. gaultherioides* and *V. myrtillus*), while the differential species of the subassociation are also *Primula halleri*, *Salix retusa* and *S. alpina* (which indicate a certain similarity with snow-bed communities).

The nomenclature type (*holotypus*) of this subassociation is reléve No. 2 in Table 1. As regards the dilemma between the classes *Loiseleurio-Vaccinietea* and *Elyno-Seslerietea* it can be said that the reléves of the syntaxon *Pulsatilla vernalis-Dryadetum octopetalae vaccinietosum* are slightly more similar to the community *Empetro-Vaccinietum gaultherioidis* and are closer to the class *Loiseleurio-Vaccinietea*, while the reléves of the syntaxon *Pulsatilla vernalis-Dryadetum octopetalae ericetosum carneae* are a little more similar to the association *Rhododendretum hirsuti* and are closer to the class *Elyno-Seslerietea*.

## 5. CONCLUSIONS

Applying the standard Central-European method we phytosociologically studied the sites of *Pulsatilla vernalis*, a rare and protected species of Slovenian flora, in the frost hollows on the mountain pastures Ovčarija and Za Grivo (new locality!) in the Fužina pasturelands (the Triglav mountains, the Julian Alps). The humid montane climate with a thick snow cover in the cold part of the year and an explicit frost hollow site, confirmed by the measurements of the Slovenian meteorological forum, are the reasons for a slow decomposition of organic matter and development of the organogenic rendzina (*folie leptosols*) characterized by raw humus (Mor). On small surfaces on the rims of frost hollows developed a unique vegetation dominated by herbaceous perennials (hemicryptophytes), half-bushes and dwarf shrubs (chamaephytes). Such vegetation is actually characteristic of the Arctic regions, high mountains and deserts, i.e. for extreme life conditions. The species able to adapt to such circumstances are above all those with south-European montane distribution and arctic-alpine species. Regarding their phytosociological affiliation they belong above all to the class of subalpine-alpine swards and grasslands on calcareous bedrock *Elyno-Seslerietea*, the order of Alpine (montane) heaths on calcareous bedrock *Rhododendro hirsuti-Ericetalia carneae*, the class of subalpine-alpine swards on acid soil *Juncetea trifidae* (= *Caricetea curvulae*), the class of subalpine-alpine heaths *Loiseleurio-Vaccinietea*, to the alliance of naked-rush swards *Oxytropido-Elynion* and the order of snow-bed vegetation *Arabidetalia caeruleae*. The highest cover index ( $I_c$ , Lausi & al. 1982) among them and the largest share of coverage ( $D_{\%}$ , Surina 2004, 2005) have *Dryas octopetala*, *Vaccinium vitis-idaea* and *Pulsatilla vernalis*. Three slightly

similar communities have been described in the Julian Alps (the Krn mountains) so far: *Dryadetum octopetalae*, *Rhododendretum hirsuti* and *Empetro-Vaccinietum gaultherioidis* (Surina 2005). However, they are floristically clearly different from the community with *Pulsatilla vernalis* (Figures 4–7) and the latter is therefore classified into a new association *Pulsatilla vernalis-Dryadetum octopetalae* ass. nova, which is characterized (differentiated) by *Pulsatilla vernalis*, *Dryas octopetala*, *Vaccinium vitis-idaea*, *V. gaultherioides*, *Homogyne discolor* and *Juniperus alpina*. The new association is subdivided into two subassociations (Figures 8–10): *-ericetosum carneae* subass. nova on sites with a thinner layer of raw humus and a more explicit influence of calcareous bedrock (nomenclature type, *holotypus*, is reléve No. 9 in Table 1, which is also the nomenclature type, *holotypus*, of the new association, while the differential species are *Erica carnea*, *Daphne striata*, *Rhodothamnus chamaecistus*, *Carex sempervirens* and *Senecio abrotanifolius*) and *-vaccinietosum* on explicitly frost hollow sites with acid raw humus (nomenclature type, *holotypus*, is reléve No. 2 in Table 1, and the differential species are *Vaccinium vitis-idaea*, *V. gaultherioides* – both on account of their abundance, *V. myrtillus*, *Primula halleri*, *Salix retusa* and *S. alpina*). The new association is classified into the alliance *Ericion carneae*, order *Rhododendro hirsuti-Ericetalia carneae* and class *Elyno-Seslerietea*. Because *Pulsatilla vernalis* is a rare and protected species of the Slovenian flora (Skoberne 2007: 9, T. Wraber 2007: 134) its localities on the pasture Ovčarija and Za Grivo deserve our undivided attention. Despite the fact that Slovenian Alps have been well researched the species may have been somewhat overlooked because of its early spring flowering (as soon as the snow thaws). With a more thorough examination of similar sites (frost hollows) elsewhere in the Fužinske planine, on Komna and similar high-Karst plateaus, new localities of this species may be found.

## 6. POVZETEK

### Nahajališča in rastišča vrste *Pulsatilla vernalis* v Julijskih Alpah

V Fužinskih planinah, na pl. Ovčarija, 1660 m nm. v. (Triglavsko pogorje, Julijske Alpe, severozahodna Slovenija), je leta 2002 fotograf Marko Pogačnik odkril vijoličasto cvetočega kosmatinca, ki sta ga

Ivan Veber in Peter Skoberne spoznala za vrsto *Pulsatilla vernalis* (Veber 2006). Spomladi (maja) in poleti (julija) 2007 smo si njegova nahajališča na pl. Ovčarija podrobno ogledali in odkrili še eno nahajališče v bližnji kotanji Za Grivo, na podobni nadmorski višini (1635–1650 m nm. v.) – sliki 1 in 2. To so doslej edina znana nahajališča te evropske montanske vrste, značilnice kisloljubnih subalpinsko-alpinskih travšč iz razreda *Juncetea trifidi* (= *Caricetea curvulae*) v Julijskih Alpah in v Sloveniji, zato smo jih podrobno fitocenološko preučili po standardni srednjeevropski metodi (Braun-Blanquet 1964) – tabela 1. Na pl. Ovčarija in Za Grivo vrsta *Pulsatilla vernalis* raste na obodu mraziščnih kotanj oz. prav v njihovem dnu, na triasnem apnencu. Potencialno naravna vegetacija teh kotanj je bilo najbrž ruševje (*Rhododendro hirsuti-Pinetum prostratae*), ki so ga v preteklosti izkrcili za potrebe planine. Ruševje še zdaj uspeva na robovih kotanj, višje na pobočjih tudi vrzelasto macesnovje (*Rhodothamnus-Laricetum*). Humidno gorsko podnebje z obilno snežno oddejo v hladnem delu leta in še posebej očitna, z meritvami Slovenskega meteorološkega foruma potrjena mraziščna lega (slika 3) sta vzrok za počasen razkroj organske snovi in razvoj organogene rendzine, za katero je značilen surov humus. Na obodih mraziščnih kotanj se je na majhnih površinah razvilo svojevrstno rastje, v katerem prevladujejo zelnate trajnice (hemikriptofiti) ter polgrmi in nizki grmiči (hamefiti) – tabela 2. Takšno rastje je sicer značilno za Arktiko, visokogorje in puščave, torej za skrajne življenjske razmere. Vrste, ki se jim lahko prilagodijo, so po svoji razširjenosti predvsem južnoevropske gorske (31 %) in arktično-alpinske (17 %) – tabela 3. Po svoji fitocenološki navezanosti pripadajo predvsem razredu subalpinsko-alpinskih travšč na karbonatni podlagi *Elyno-Seslerietea*, redu alpskih (gorskih) resav na karbonatni podlagi *Rhododendro hirsuti-Ericetalia carnea*, razredu subalpinsko-alpinskih travšč na kisljih tleh *Juncetea trifidae* (= *Caricetea curvulae*), razredu subalpinsko-alpinskih resav *Loiseleurio-Vaccinietea*, zvezi rušnatih trat z elino *Oxytropido-Elynion* in redu rastja snežnih dolinic *Arabidetalia caeruleae* – tabela 4. Med njimi imajo največji indeks pokrovnosti ( $I_c$ , Lausi & al. 1982) in največji delež pokrovnosti ( $D_{\%}$ , Surina 2004, 2005) vrste *Dryas octopetala*, *Vaccinium vitis-idaea* in *Pulsatilla vernalis* – tabela 1. V Julijskih Alpah, v Krnskem pogorju, je Surina (2005) ugotovil tri nekoliko podobne združbe: *Dryadetum octopetalae*, *Rhododendretum hirsuti* in *Empetro-Vaccinietum gaultherioidis*. Vse so floristično očitno precej različne

od združbe, kjer raste vrsta *Pulsatilla vernalis* (slike 4–7). Zato to uvrščamo v novo asociacijo *Pulsatilla vernalis-Dryadetum octopetalae* ass. nova, ki jo označujejo (razlikujejo) vrste *Pulsatilla vernalis*, *Dryas octopetala*, *Vaccinium vitis-idaea*, *V. gaultherioides*, *Homogyne discolor* in *Juniperus alpina*. Novo asociacijo členimo na dve subasociaciji (slike 8–10): *-ericetosum carnea* subass. nova na rastiščih s tanjšo plastjo surovega humusa in bolj očitnim vplivom karbonatne matične podlage (nomenklaturni tip, *holotypus*, je fitocenološki popis št. 9 v tabeli 1, to je tudi nomenklaturni tip, *holotypus*, nove asociacije, razlikovalnice pa so vrste *Erica carnea*, *Daphne striata*, *Rhodothamnus chamaecistus*, *Carex sempervirens* in *Senecio abrotanifolius*) in *-vaccinietosum* na izrazito mraziščnih legah s kislim surovim humusom. Njen nomenklaturni tip, *holotypus*, je fitocenološki popis št. 2 v tabeli 1, razlikovalnice pa so vrste *Vaccinium vitis-idaea*, *V. gaultherioides* (obe zaradi svoje obilnosti), *V. myrtillus*, *Primula halleri*, *Salix retusa* in *S. alpina*. Novo asociacijo uvrščamo v zvezo *Ericion carnea*, v red *Rhododendro hirsuti-Ericetalia carnea* in v razred *Elyno-Seslerietea*. Ker je *Pulsatilla vernalis* redka in zavarovana vrsta slovenske flore (Skoberne 2007: 9, T. Wraber 2007: 134) zaslužijo njena nahajališča na pl. Ovčarija in Za Grivo vso našo pozornost. Mogoče je, da je bila ta vrsta zaradi zgodnjega cvetenja na začetku gorske pomladi (takoj ko skopni sneg) doslej kljub dobri botanični raziskanosti naših Alp nekoliko prezrta in morda bomo s podrobnim pregledom podobnih rastišč (mraziščnih kotanj) drugod v Fužinskih planinah, na Komni in na podobnih visokokraških planotah našli njena nova nahajališča.

## 7. ACKNOWLEDGEMENTS

The photographer Marko Pogačnik with his find was the key person in writing this paper. Brane Anderle cooperated in the flora inventory in the doline Za Grivo. Mihej Urbančič, B.Sc., kindly advised us in the soil description and Dr. Tinka Bačič helped by determining the taxon *Luzula exspectata*. Researchers of frost hollows from the Slovenian meteorological forum provided the valuable temperature data. Prof. Dr. Livio Poldini, Prof. Dr. DMITAR Lakušič and Dr. Snežana Vukojičić gave us a lot of useful information on the localities and sites of *Pulsatilla vernalis*. Prof. Dr. Paul Heiselmayer, Doc. Dr. Boštjan Surina and Prof. Dr. Vlado Matevski improved the text with valuable corrections. English translation by Andreja Šalamon Verbič.

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- Molinio-Arrhenatheretea* R. Tüxen 1937 em. R. Tüxen 1970
- Mulgedio-Aconitetea* Hadač & Klika in Klika 1948
- Onobrychido-Seslerietalia* Ht. 1949
- Oxytropido-Elyinion* Br.-Bl. 1949
- Poo alpinae-Trisetalia* Ellmauer & Mucina 1993
- Rhododendro hirsuti-Ericetalia carnea* Grabherr, Greimler & Mucina 1993
- Rhododendro hirsuti-Pinetum prostratae* Zöttl 1951
- Rhododendretum hirsuti* Lüdi 1921
- Rhodothamno-Laricetum deciduae* Willner & Zukrigl 1999
- Seslerietalia comosae* Simon 1957
- Seslerietalia varia* Br.-Bl. in Br.-Bl. & Jenny 1926
- Sieversio-Nardetum strictae* Lüdi 1948
- Thlaspietea rotundifolia* Br.-Bl. in Br.-Bl. & Jenny 1926
- Vaccinio-Piceetea* Br.-Bl. 1939 emend. Zupančič (1976) 2000

## ABBREVIATIONS – OKRAJŠAVE

### Parent material (Geološka podlaga)

A – limestone – apnenec

### Soil types (Talni tipi)

FoL – *Folic Leptosols* – organogena rendzina

## 8. APPENDIX

List of syntaxa mentioned in the article with authors:

- Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973 corr. Zupančič 1993 (= *Homogyno sylvestris-Piceetum* Exner in Poldini & Bressan 2007)
- Arabidetalia caeruleae* Rübel ex Nordhagen 1936
- Asplenetalia trichomanis* Br.-Bl. in Meier & Br.-Bl. 1934
- Calluno-Ulicetea* Br.-Bl. & R. Tüxen ex Klika 1948
- Caricetalia davalliana* Br.-Bl. 1949
- Carici rupestris-Kobresietea bellardii* Ohba 1974
- Caricion austroalpinae* Sutter 1962
- Caricion firmae* Gams 1936
- Dryadetum octopetalae* Rübel 1911
- Elyno-Seslerietea* Br.-Bl. 1948
- Empetro-Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. & Jenny 1926 corr. Grabherr 1993
- Ericion* Rübel ex Grabherr, Greimler & Mucina 1993
- Festuco-Brometea* Br.-Bl. & Tüxen 1943
- Juncetea trifidi* Hadač 1946 (= *Caricetea curvulae* Braun-Blanquet 1948)
- Juniperion nanae* Br.-Bl. in Br.-Bl., Sissingh & Vlieger 1939

Received 1. 4. 2008

Revision received 17. 6. 2008

Accepted 19. 6. 2008

**Table 1 (Tabela 1): *Pulsatilla vernalis-Dryadetum octopetalae* ass. nova**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of relevé (Zaporedna številka popisa)	217448	217447	217445	217441	217442	217443	217489	217491	217492	217494	217497	217493	217495	217496
Working number of relevé (Delovna številka popisa)	1650	1640	1640	1635	1635	1636	1645	1640	1640	1640	1640	1640	1640	1640
Altitude in m (Nadmorska višina v m)	NW	SW	SW	NNE	E	SE	NW	N	N	NE	W	NE	E	NNW
Aspect (Lega)	5	5	5	15	20	20	10	5	10	15	35	10	10	10
Slope in degrees (Nagib v stopinjah)	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Parent material (Matična podlaga)	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL	FoL
Soil (Tla)	5	5	0	0	10	5	10	5	5	5	20	5	10	20
Stoniness in % (Kamnitost v %)														
Cover in % (Zastiranje v %):	E1	100	100	100	66	66	100	90	90	95	70	56	90	80
Herb layer (Zeliščna plast)	E0							5	5			5		
Moss layer (Zeliščna plast)	m <sup>2</sup>	5	10	10	10	5	10	4	5	10	10	5	5	10
Relevé area (Velikost popisne ploskve)		32	34	35	38	27	35	29	33	37	36	39	30	38
Number of species (Število vrst)														
Date of taking relevé (Datum popisa)	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4	9648/4
Locality (Nahajališče)	Za Gtvo	Za Gtvo	Za Gtvo	Za Gtvo	Za Gtvo	Za Gtvo	Ovčarija	Ovčarija	Ovčarija	Ovčarija	Ovčarija	Ovčarija	Ovčarija	Ovčarija
Quadrant (Kvadrant)							Pl	Pl	Pl	Pl	Pl	Pl	Pl	Pl
<b>Diagnostic species of the association (Diagnostične vrste asociacije)</b>														
OE <i>Dryas octopetala</i>	E1	2	1	2	3	2	3	4	3	2	3	2	3	3
JT <i>Pulsatilla vernalis</i>	E1	1	2	2	1	3	1	1	1	1	1	1	1	1
VP <i>Vaccinium vitis-idaea</i>	E1	2	2	2	1	2	2	2	2	3	2	1		
AC <i>Homogyne discolor</i>	E1	1	+		1	+	1	1	1	2	+	1		+
RE <i>Juniperus alpina</i>	E1	+	+		1	+	+		+		1	1		+
LV <i>Vaccinium gaultherioides</i>	E1	3	3	2	1	2	2	1	+		+			1
<b>Differential species of the subassociations (Razlikovalnice subasociacij)</b>														
VP <i>Vaccinium myrtillus</i>	E1	2	1	+		+								
SV <i>Primula halleri</i>	E1		1	+	1									
AC <i>Salix retusa</i>	E1	+		+		+								
ES <i>Salix alpina</i>	E1					1								
	Pr	Fr.	Ic	D %										
	14	100	67	6,9										
	14	100	39	4,0										
	12	86	44	4,6										
	11	79	25	2,5										
	11	79	21	2,143										
	10	71	33	3,4										
	4	29	10	0,989										
	4	29	8	0,824										
	4	29	6	0,660										
	3	21	6	0,577										

		Number of relevé (Zaporedna številka popisa)																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14				
RE	<i>Erica carnea</i>	E1	.	.	.	.	.	3	2	2	2	2	3	3	8	57	38	3,9	
CA	<i>Senecio abrotanifolius</i>	E1	.	.	.	.	.	1	+	+	+	+	+	1	+	8	57	14	1,5
RE	<i>Daphne striata</i>	E1	.	.	.	.	.	2	2	2	2	2	2	3	.	7	50	29	3,0
SV	<i>Carex sempervirens</i>	E1	.	.	.	.	.	+	.	+	2	2	2	2	2	7	50	23	2,391
RE	<i>Rhodothamnus chamaecistus</i>	E1	.	.	.	.	.	.	.	+	1	+	+	2	+	6	43	13	1,319
RE	<b><i>Rhododendro hirsuti-Ericetalia carneae</i></b>																		
	<i>Rhododendron hirsutum</i>	E1	+	.	1	.	.	+	+	.	.	+	+	.	+	7	50	12	1,237
	<i>Pinus mugo</i>	E1	.	.	.	.	.	.	.	+	+	r	.	.	+	4	29	6	0,577
CF	<b><i>Caricion firmae</i></b>																		
	<i>Carex firma</i>	E1	+	.	.	.	+	+	+	.	+	+	+	.	+	8	57	13	1,3
	<i>Helianthemum alpestre</i>	E1	.	.	.	.	.	.	.	+	+	+	+	+	.	5	36	8	0,824
	<i>Silene acaulis</i>	E1	.	+	.	.	.	.	.	.	.	.	.	.	.	2	14	3	0,330
	<i>Festuca quadriflora</i>	E1	.	.	.	.	.	+	.	.	.	.	.	.	+	2	14	3	0,330
CA	<b><i>Caricion austroalpinae</i></b>																		
	<i>Koeleria eriostachya</i>	E1	.	+	+	.	+	+	.	.	+	+	+	+	.	9	64	14	1,5
	<i>Achillea clavatae</i>	E1	.	.	.	.	+	.	.	+	+	+	+	+	+	7	50	11	1,1
	<i>Pulsatilla alpina</i> subsp. <i>austroalpina</i>	E1	.	.	r	.	.	.	.	+	r	.	.	.	r	4	29	4	0,412
	<i>Laserpitium peucedanoides</i>	E1	.	.	.	.	.	.	.	.	.	.	+	.	.	2	14	3	0,330
SV	<b><i>Seslerietalia variae</i></b>																		
	<i>Aster bellidiastrum</i>	E1	.	+	1	1	1	.	+	1	1	1	.	1	1	10	71	22	2,308
	<i>Potentilla crantzii</i>	E1	+	.	+	1	.	+	.	+	.	.	.	.	+	7	50	12	1,237
	<i>Aster alpinus</i>	E1	.	.	.	.	.	+	+	.	+	.	.	1	.	5	36	9	0,907
	<i>Erigeron glabratus</i>	E1	.	.	.	.	+	.	.	.	.	+	+	+	.	4	29	6	0,660
	<i>Ranunculus carinthiacus</i>	E1	.	.	.	.	.	+	.	.	+	.	.	.	+	4	29	6	0,660
	<i>Biscutella laevigata</i>	E1	.	.	.	.	.	.	+	.	.	.	.	+	+	4	29	6	0,660
	<i>Galium anisophyllum</i>	E1	.	+	.	.	+	.	.	.	.	.	1	.	.	3	21	6	0,577
	<i>Thesium alpinum</i>	E1	.	+	.	.	.	.	.	.	+	.	.	.	.	3	21	5	0,495
	<i>Saussurea discolor</i>	E1	.	+	.	.	1	.	.	.	.	.	.	.	.	2	14	4	0,412
	<i>Hieracium pilosum</i>	E1	.	.	.	.	+	.	.	.	+	.	.	.	.	2	14	3	0,330
	<i>Alchemilla alpigena</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	1	7	2	0,165
	<i>Pedicularis rostrato-capitata</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	7	1	0,082
	<i>Leucanthemum adustum</i>	E1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	7	2	0,165
ES	<b><i>Elyno-Seslerietea</i></b>																		
	<i>Sesleria caerulea</i> subsp. <i>calcaria</i>	E1	+	+	+	+	+	1	1	1	+	+	1	1	1	14	100	27	2,8
	<i>Polygonum viviparum</i>	E1	1	1	1	1	1	+	+	1	.	.	+	+	.	12	86	24	2,4
	<i>Agrostis alpina</i>	E1	.	+	1	1	+	1	.	+	+	+	+	.	+	11	79	21	2,143
	<i>Astrantia bavarica</i>	E1	.	+	.	1	1	1	1	1	1	1	1	1	1	11	79	25	2,6
	<i>Carex ornithopoda</i>	E1	+	+	1	+	+	+	.	1	1	.	.	1	.	11	79	21	2,2





Number of relevé (Zaporedna številka popisa)	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
<i>Trifolium pallescens</i>	E1	+	.	.	.	.	.	.	.	.	.	.	.	.	1	7	2 0,165
MuA <i>Mulgedio-Aconitetea</i>	E1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	7	2 0,247
<i>Viola biflora</i>																	
MA <i>Molinio-Arrhenatheretea</i>																	
PT <i>Trollius europaeus</i>	E1	+	.	r	.	+	.	.	+	+	+	+	.	9	64	13 1,4	
<i>Leontodon hispidus</i>	E1	1	1	+	.	+	.	.	.	.	+	.	.	7	50	13 1,4	
<i>Trifolium pratense</i>	E1	+	+	.	.	.	.	.	.	.	.	+	.	5	36	8 0,824	
VP <i>Vaccinio-Piceetea</i>																	
<i>Huperzia selago</i>	E1	.	.	.	.	.	r	.	.	+	.	.	.	3	21	4 0,412	
<i>Larix decidua</i>	E1	.	.	r	+	.	.	.	.	.	.	.	.	2	14	2 0,247	
ML <b>Mosses and lichens (Mahovi in lišaji)</b>																	
<i>Tortella</i> sp.	E0	.	.	.	.	.	+	+	+	.	+	+	+	7	50	11	
<i>Cetraria islandica</i>	E0	.	+	+	.	.	.	.	.	.	.	.	.	3	21	5	
<i>Dicranum</i> sp.	E0	.	.	.	.	.	.	.	+	.	.	+	.	3	21	5	
<i>Disitchium capillareum</i>	E0	.	.	.	.	.	.	+	.	.	.	.	.	1	7	2	

\* det. Tinka Bačič

**Table 5:** Synoptic table of subalpine-alpine swards and heaths communities in the Julian Alps**Tabela 5:** Sintezna tabela subalpinsko-alpinskih rušnatih trav in resav v Julijskih Alpah

Successive number of relevé (Zaporedna številka popisa)		1	2	3	4	
Number of relevés (Število popisov)		14	6	7	3	
Sign for syntaxa (Oznaka sintaksonov)		PvDo	Do	RH	EhVg	
Author of the table (Avtor tabele)		ID	BS	BS	BS	
<b>Diagnostic species of the associations (Diagnostične vrste asociacij)</b>						
OE	<i>Dryas octopetala</i>	E1	100	100	57	100
JT	<i>Pulsatilla vernalis</i>	E1	100	.	.	.
VP	<i>Vaccinium vitis-idaea</i>	E1	86	.	29	100
AC	<i>Homogyne discolor</i>	E1	79	.	43	67
RE	<i>Juniperus alpina</i>	E1	79	.	14	.
LV	<i>Vaccinium gaultherioides</i>	E1	71	.	29	100
RE	<i>Rhododendron hirsutum</i>	E1	50	17	100	67
RE	<i>Rhodothamnus chamaecistus</i>	E1	43	17	100	67
ML	<i>Cetraria islandica</i>	E0	21	.	.	100
ML	<i>Cladonia stellaris</i>	E0	.	.	.	100
ML	<i>Hylocomium splendens</i>	E0	.	.	.	67
ML	<i>Rhytidiadelphus triquetrus</i>	E0	.	.	.	67
<b>Differential species of the subassociations (Razlikovalnice subasociacij)</b>						
RE	<i>Erica carnea</i>	E1	57	.	.	.
CA	<i>Senecio abrotanifolius</i>	E1	57	17	.	.
SV	<i>Carex sempervirens</i>	E1	50	83	57	.
RE	<i>Daphne striata</i>	E1	50	.	14	.
AC	<i>Salix retusa</i>	E1	29	.	43	67
VP	<i>Vaccinium myrtillus</i>	E1	29	.	29	.
SV	<i>Primula halleri</i>	E1	29	.	.	.
ES	<i>Salix alpina</i>	E1	21	50	14	.
CF	<b><i>Caricion firmae</i></b>					
	<i>Carex firma</i>	E1	57	83	57	33
	<i>Helianthemum alpestre</i>	E1	36	17	.	67
	<i>Silene acaulis</i>	E1	14	.	.	33
	<i>Festuca quadriflora</i>	E1	14	.	.	.
	<i>Crepis kernerii</i>	E1	.	17	.	.
	<i>Phyteuma sieberi</i>	E1	.	17	14	.
	<i>Sesleria sphaerocephala</i>	E1	.	.	14	.
	<i>Chamorchis alpina</i>	E1	.	.	.	33
CA	<b><i>Caricion austroalpinae</i></b>					
	<i>Koeleria eriostachya</i>	E1	64	17	14	33
	<i>Achillea clavinae</i>	E1	50	17	29	100
	<i>Pulsatilla alpina</i> subsp. <i>austroalpina</i>	E1	29	.	29	.
	<i>Laserpitium peucedanoides</i>	E1	14	.	57	.
	<i>Ranunculus hybridus</i>	E1	.	17	14	.
	<i>Pimpinella alpina</i>	E1	.	.	14	33
SV	<b><i>Seslerietalia varia</i></b>					
	<i>Aster bellidiastrum</i>	E1	71	17	100	67
	<i>Potentilla crantzii</i>	E1	50	17	29	33
	<i>Aster alpinus</i>	E1	36	17	.	33

Sucesive number of relevé (Zaporedna številka popisa)		1	2	3	4
	<i>Erigeron glabratus</i>	E1	29	.	33
	<i>Ranunculus carinthiacus</i>	E1	29	.	43
	<i>Biscutella laevigata</i>	E1	29	17	43
	<i>Galium anisophyllum</i>	E1	21	33	29
	<i>Thesium alpinum</i>	E1	21	.	.
	<i>Saussurea discolor</i>	E1	14	.	.
	<i>Hieracium pilosum</i>	E1	14	.	.
	<i>Alchemilla alpigena</i>	E1	7	17	14
	<i>Pedicularis rostrato-capitata</i>	E1	7	.	43
	<i>Leucanthemum adustum</i>	E1	7	.	.
	<i>Geranium argenteum</i>	E1	.	17	14
ES	<b><i>Elyno-Seslerietea</i></b>				
	<i>Sesleria caerulea</i> subsp. <i>calcaria</i>	E1	100	83	86
	<i>Polygonum viviparum</i>	E1	86	100	59
	<i>Agrostis alpina</i>	E1	79	.	.
	<i>Astrantia bavarica</i>	E1	79	17	71
	<i>Carex ornithopoda</i>	E1	79	.	29
	<i>Selaginella selaginoides</i>	E1	71	17	86
	<i>Gentiana clusii</i>	E1	71	33	57
	<i>Phyteuma orbiculare</i>	E1	64	17	.
	<i>Thymus praecox</i> subsp. <i>polytrichus</i>	E1	64	17	14
	<i>Linum julicum</i>	E1	57	.	43
	<i>Anthyllis vulneraria</i> subsp. <i>alpestris</i>	E1	43	17	14
	<i>Pedicularis verticillata</i>	E1	29	.	43
	<i>Bartsia alpina</i>	E1	29	.	57
	<i>Poa alpina</i>	E1	21	.	.
	<i>Prunella grandiflora</i>	E1	21	.	.
	<i>Gentianella anisodonta</i>	E1	7	17	.
	<i>Euphrasia salisburgensis</i>	E1	7	17	.
	<i>Gentiana verna</i>	E1	7	.	.
	<i>Heliosperma alpestre</i>	E1	.	17	53
	<i>Leontopodium alpinum</i>	E1	.	17	.
	<i>Arabis vochinensis</i>	E1	.	17	.
	<i>Cerastium strictum</i>	E1	.	17	.
	<i>Juncus monanthos</i>	E1	.	.	57
	<i>Carex ferruginea</i>	E1	.	.	29
	<i>Hieracium villosum</i>	E1	.	.	29
	<i>Helianthemum nummularium</i> subsp. <i>grandiflorum</i>	E1	.	.	14
	<i>Anemone narcissiflora</i>	E1	.	.	14
	<i>Phleum rhaeticum</i>	E1	.	.	14
	<i>Hedysarum hedysaroides</i>	E1	.	.	14
	<i>Euphrasia picta</i>	E1	.	.	.
JT	<b><i>Juncetea trifidi</i></b>				
	<i>Festuca nigrescens</i>	E1	86	.	14
	<i>Campanula scheuchzeri</i>	E1	79	17	29
	<i>Potentilla aurea</i>	E1	50	.	.
	<i>Anthoxanthum nipponicum</i>	E1	36	.	14
	<i>Agrostis rupestris</i>	E1	14	.	.
	<i>Antennaria dioica</i>	E1	14	.	.
	<i>Solidago virgaurea</i> subsp. <i>minuta</i>	E1	7	17	14
	<i>Euphrasia minima</i>	E1	7	.	.

Successive number of relevé (Zaporedna številka popisa)		1	2	3	4
CU	<b>Calluno-Ulicetea</b>				
	<i>Luzula multiflora</i> s. lat. (inc. <i>L. exspectata</i> )	E1	36	17	.
	<i>Potentilla erecta</i>	E1	14	.	.
	<i>Coeloglossum viride</i>	E1	7	.	29
OE	<b>Oxytropido-Elynion</b>				
	<i>Carex capillaris</i>	E1	29	.	67
	<i>Antennaria carpatica</i>	E1	14	.	.
	<i>Carex atrata</i>	E1	7	17	14
	<i>Carex rupestris</i>	E1	7	.	.
	<i>Arctospahylos alpina</i>	E1	.	17	57
	<i>Gentiana nivalis</i>	E1	.	.	67
RE	<b>Rhododendro hirsuti-Ericetalia carneae</b>				
	<i>Pinus mugo</i>	E1	29	33	29
	<i>Sorbus chamaemespilus</i>	E1	.	.	14
CD	<b>Caricetalia davallianae</b>				
	<i>Parnassia palustris</i>	E1	50	.	57
	<i>Tofieldia calyculata</i>	E1	29	50	78
	<i>Pinguicula alpina</i>	E1	21	17	43
AC	<b>Arabidetalia caeruleae</b>				
	<i>Soldanella alpina</i>	E1	57	17	14
	<i>Alchemilla fissa</i>	E1	21	.	.
	<i>Rhodiola rosea</i>	E1	21	.	14
	<i>Trifolium pallescens</i>	E1	7	17	14
	<i>Soldanella minima</i>	E1	.	17	14
	<i>Saxifraga aizoides</i>	E1	.	.	29
	<i>Salix serpyllifolia</i>	E1	.	.	14
	<i>Festuca nitida</i>	E1	.	.	.
	<i>Doronicum glaciale</i>	E1	.	.	67
TR	<b>Thlaspietea rotundifolii</b>				
	<i>Festuca laxa</i>	E1	.	50	14
	<i>Ranunculus traunfellneri</i>	E1	.	33	14
	<i>Aquilegia eniseleana</i>	E1	.	17	29
	<i>Cerastium carinthiacum</i>	E1	.	17	.
	<i>Moehringia ciliata</i>	E1	.	17	.
	<i>Rumex scutatus</i>	E1	.	17	14
	<i>Soldanella minima</i>	E1	.	17	.
	<i>Thlaspi kernerii</i>	E1	.	17	14
	<i>Cerastium subtriflorum</i>	E1	.	17	.
	<i>Armeria alpina</i>	E1	.	.	29
	<i>Athamnatha cretensis</i>	E1	.	.	29
	<i>Polystichum lonchitis</i>	E1	.	.	14
	<i>Gymnocarpium robertianum</i>	E1	.	.	14
	<i>Aconitum lycoctonum</i> subsp. <i>ranunculifolium</i>	E1	.	.	14
AT	<b>Asplenietea trichomanis</b>				
	<i>Valeriana saxatilis</i>	E1	.	50	100
	<i>Saxifraga crustata</i>	E1	.	17	.
	<i>Asplenium viride</i>	E1	.	17	43
	<i>Carex brachystachys</i>	E1	.	.	29
	<i>Primula auricula</i>	E1	.	.	14
	<i>Cystopteris regia</i>	E1	.	.	14

Successive number of relevé (Zaporedna številka popisa)		1	2	3	4	
MuA	<b>Mulgedio-Aconitetea</b>					
	<i>Viola biflora</i>	E1	7	.	71	33
	<i>Salix waldsteiniana</i>	E1	.	.	43	.
	<i>Geranium sylvaticum</i>	E1	.	.	29	.
	<i>Veratrum album</i>	E1	.	.	29	.
	<i>Alnus viridis</i>	E1	.	.	14	.
	<i>Salix appendiculata</i>	E1	.	.	14	.
MA	<b>Molinio-Arrhenatheretea</b>					
PT	<i>Trollius europaeus</i>	E1	64	.	.	.
	<i>Leontodon hispidus</i>	E1	50	.	14	33
	<i>Trifolium pratense</i>	E1	36	.	.	.
	<i>Veronica chamaedrys</i>	E1	.	.	14	.
	<i>Potentilla reptans</i>	E1	.	.	14	.
	<i>Trifolium repens</i>	E1	.	.	14	.
	<i>Ranunculus nemorosus</i>	E1	.	.	14	.
VP	<b>Vaccinio-Piceetea</b>					
	<i>Huperzia selago</i>	E1	21	17	14	.
	<i>Larix decidua</i>	E1	14	.	14	.
	<i>Pyrola rotundifolia</i>	E1	.	17	14	.
	<i>Homogyne alpina</i>	E1	.	17	43	33
	<i>Moneses uniflora</i>	E1	.	17	.	.
	<i>Picea abies</i>	E1	.	17	29	.
	<i>Clematis alpina</i>	E1	.	.	29	.
	<i>Luzula luzuloides</i>	E1	.	.	14	33
	<i>Rosa pendulina</i>	E1	.	.	14	.
	<i>Lonicera caerulea</i>	E1	.	.	14	.
	<i>Lycopodium annotinum</i>	E1	.	.	14	.
	<i>Maianthemum bifolium</i>	E1	.	.	14	.
	<i>Saxifraga cuneifolia</i>	E1	.	.	.	33
O	<b>Other species (Druge vrste)</b>					
	<i>Festuca sp.</i>	E1	.	.	14	33
	<i>Laserpitium siler</i>	E1	.	.	14	.
	<i>Lotus corniculatus</i>	E1	.	.	14	.
	<i>Libanotis sibirica</i> subsp. <i>montana</i>	E1	.	.	14	.
	<i>Sorbus aucuparia</i>	E1	.	.	14	.
	<i>Alchemilla fallax</i>	E1	.	.	14	.
ML	<b>Mosses and lichens (Mahovi in lišaji)</b>					
	<i>Tortella sp.</i> (inc. <i>T. tortuosa</i> )	E0	50	.	.	100
	<i>Dicranum sp.</i>	E0	21	.	.	.
	<i>Distichium capillaceum</i>	E0	7	.	.	.
	<i>Cladonia pyxidata</i>	E0	.	.	.	100
	<i>Cetraria nivalis</i>	E0	.	.	.	67
	<i>Cladonia furcata</i>	E0	.	.	.	67
	<i>Dicranum scoparium</i>	E0	.	.	.	33

PvDo – *Pulsatillo vernalis*-*Dryadetum octopetalae*Do – *Dryadetum octopetalae*Rh – *Rhododendretum hirsuti*EhVg – *Empetro-Vaccinietum gaultherioidis*