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THE ASSOCIATION *GENTIANO TERGLOUENSIS-CARICETUM FIRMAE* T. WRABER 1970 IN THE KRN MOUNTAINS (THE JULIAN ALPS)

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ABSTRACT

The syntaxonomy and ecology of the Carex firma *stands in the Krn Mts. (eastern Julian Alps) are presented by applying the sigmatistic method and cluster analysis. The researched stands are classified in the association* Gentiano terglouensis-Caricetum firmae *T. Wraber 1970 and are further subdivided into three subassociations:* -dryadetosum octopetalae *Poldini & Feoli 1976,* -drepanocladetosum uncinati *subass. nova and* -potentilletosum nitidae *subass. nova.*

Key words: phytosociology, phytogeography, endemic species, *Elyno-Seslerietea*, *Caricion firmae*, *Caricetum firmae*, Southeastern Calcareous Alps

L'ASSOCIAZIONE *GENTIANO TERGLOUENSIS-CARICETUM FIRMAE* T. WRABER 1970 SUL MASSICCIO DEL MONTE NERO (ALPI GIULIE)

SINTESI

Mediante il metodo sigmatista e l'analisi a grappolo, l'autore presenta la sintassonomia e l'ecologia delle formazioni a Carex firma *sul massiccio del Monte Nero (Alpi Giulie orientali). Le formazioni studiate sono distribuite nelle comunità* Gentiano terglouensis-Caricetum firmae *T. Wraber 1970 e quindi distribuite in tre subassociazioni:* -dryadetosum octopetalae *Poldini & Feoli 1976,* -drepanocladetosum uncinati *subass. nova e* -potentilletosum nitidae *subass. nova.*

Parole chiave: fitosociologia, fitogeografia, specie endemiche, *Elyno-Seslerietea*, *Caricion firmae*, *Caricetum firmae*, Alpi calcaree sud-orientali

INTRODUCTION

The first review of the botanical research carried out in the Julian Alps that also embraced floristic activity in the Krn Mts. was prepared by Wraber (1969). Subsequently, botanical activity was presented by Dakskobler for the Upper Soča Valley (Dakskobler, 1997) and again by Wraber for the wider area of Triglav National Park (Wraber, 2001), while Surina & Vreš (2003) recently collected data on the botanical research carried out to date on Mt. Lemež. A more detailed review of the botanical research for the Krn Mts. was prepared by Surina (2004).

The knowledge about the subalpine and alpine vegetation of the Krn Mts. is still poor in comparison with the knowledge about its flora. It has mainly been studied by T. Wraber and I. Dakskobler. In the first overall phytosociological study of the vegetation of rocky crevices and screes in the Julian Alps, Wraber (1972) made five relevés of the association *Festucetum laxae* (Aichinger 1933) Wraber 1970, two at Jezero v Lužnici and three at Krnsko jezero. He discovered *Bupleurum longifolium*, so far known only from Mt. Nanos, at the end of the Krn-Srednji vrh-Krnčica ridge on the northern slope of the peak Vršič, and thus made the relevé of the stand – *Salicetum waldsteinianae* Beger 1922 corr. Zupančič & Žagar 2001 (Wraber, 1980). In the context of his paper on phytosociological conditions of the species *Minuartia rupestris* in the Julian Alps, he also made three relevés on Mt. Rdeči rob (Wraber, 1986) and described a new association of rocky crevices in the Julian Alps – *Paederoto luteae-Minuartietum rupestris* Wraber 1986. The discovery of *Viola cornuta* on Mt. Lemež was surprising and phytogeographically important (found by forest engineer Ivan Veber), which gave rise to an individual paper in which Wraber (1995) discussed its origin in details, as well as provided a thorough phytosociological assessment (a relevé) of the site (*Caricetum ferrugineae* Lüdi 1921 s. lat.).

Since 1990s, Dakskobler has been active on this floristically very rich and phytogeographically exciting southern edge of the Julian Alps. He has contributed a whole series of interesting novelties to the knowledge of the flora and vegetation of the Soča Valley and its surroundings. In a paper on the flora of the southern Julian Alps and its foothills he reported, among other things, on the find of the species *Asplenium seelosii* southeast of Mt. Veliki Kuntar, where he also supplemented the relevé of the site and classified it in the association *Potentillo clusianae-Campanuletum zoysii* Aichinger 1933 (Dakskobler, 1994). In 2000, he published a paper in which he thoroughly examined the phytosociological and environmental conditions of growth sites of the stenoendemic species *Moehringia villosa* (Dakskobler, 2000). In a detailed review of all sites known to date, he also stated, for the Krn Mts., the peak Palec above Lašca pasture, Mt. Rdeči rob above Ovčje medrje and Slemenske peči by Snegova grapa gorge. Altogether he made seven relevés at the aforementioned locations belonging to the newly described association *Campanulo carnicae-Moehringietum villosae* Dakskobler 2000 (Dakskobler, 2000). The excellent find of *Paradisea liliastrum* below the Krnčica ridge was first publicly presented in a popular paper, and eventually also in an original scientific paper (Dakskobler, 2001a, b). In establishing the succession stands with overgrowing hayfields in former habitats of subalpine beech forests *Polysticho lonchitis-Fagetum* (Horvat 1938) Marinček in Poldini & Nardini 1993, he made two relevés on the southern slope of Mt. Lemež, which were classified in the association *Centaureo haynaldii-Laserpitietum sileri* Dakskobler 2003 prov. and one below the peak Debeljak by Krasji vrh in the pioneer spruce forest *Adenostylo glabrae-Piceetum* M. Wraber ex Zukrigl 1973 corr. Zupančič 1993 var. geogr. *Cardamine trifolia* Zupančič 1999 subvar. geogr. *Luzula nivea* Zupančič 1999 *betonicetosum alopecuri* Dakskobler 2003 (Dakskobler, 2003b). Surina and Vreš again initiated, with their discovery of three new localities of *Viola cornuta* between Mt. Lemež, peak Debeljak and Krnsko jezero, a discussion on the origin of its appearance in the Julian Alps, and with three relevés (*Caricetum ferrugineae* s. lat. – southwest slope of Debeljak, *Avenastro parlatorei-Festucetum calvae* (Aichinger 1933 corr. Franz 1980) Poldini & Feoli Chiapella in Feoli Chiapella & Poldini 1993 – the Škrbina pass and a relevé on a nitrophilous habitat in a small basin by lake Krnsko jezero) also researched the phytosociological characteristics of the sites (Surina & Vreš, 2003). In 2002 and 2003, B. Surina studied the subalpine and alpine vegetation of the Krn Mts. (Surina, 2004); the aim of this paper is thus to present some of the results of phytosociological research of the stands with predominating *Carex firma*.

The published phytosociological data on the *Carex firma* stands in the Julian Alps are indeed scarce. The next inventory of the *Carex firma* stands in the Julian Alps in addition to Wraber's inventory from Mt. Jalovec and his synoptic table (1970), was only recently contributed by Dakskobler, who carried out a research into the phytosociological characteristics of a *Carex rupestris* site in the vicinity of Mt. Črna prst and temporarily classified the relevé in the association *Gentiano terglouensis-Caricetum firmae* (Dakskobler, 2003a). In the Karavanke Mts. (partly also in the Kamnik-Savinja Alps), Aichinger (1933) provided grounds for the association *Gentiano-Caricetum* with two phytosociological tables, while Haderlapp (1982) and Seliškar (1993) provided them in the Kamnik-Savinja Alps. In the Carnic Alps, Poldini & Feoli (1976) studied the association's phytosociology and ecology, while Wikus (1960) studied them in the Lienz Dolomites.

MATERIAL AND METHODS

Studied area

The Krn massif is the extreme western edge of the eastern Julian Alps (Fig. 1). It is surrounded on almost all sides by the valley of the Soča river and its tributaries, the rivers of Tolminka and Lepenica: to the north and northeast it is bounded by the Bovec basin and the Lepena valley, to the west and south by the Soča valley, and to the southeast by the Tolminka valley. Towards the east, the relief boundary is not so sharp; it is divided from the Komna plateau by a north-south mountain ridge from Velika Baba (2008 m) above the Lepena valley, Lanževica (2003 m) to Mahavšček (Veliki Bogatin, 2008 m) above the Tolminka valley. Two larger and two smaller crests and the group of mountains around Krnsko jezero stand out in the massif. The crests are not uniform and are broken here and there by smaller or larger passes ("škrbina"). Thus, in the longest ridge, between the peaks of Vršič and Lipnik above the Tolminka valley in the ridge in addition to the Krnska and Batogniška škrbina, more important passes or steps are Vratca (around 2000 m) between the peaks of Lopatnik and Krnčica and Lužnica valley (around 1750 m), which is surrounded by the peaks of Maselnik, Škofič and Mt. Rdeči rob. The highest mountains on the ridge are Krn (2244 m), Batognica (2164 m), Krnčica (2142 m) and Srednji vrh (2134 m). The other major mountain chain, the deeply indented Polovnik ridge, is situated in the bend of the Soča river, climbing steeply and in places precipitously above the Soča valley from the northwest towards the southeast between the villages of Log Čezsoški and Drežniške Ravne.

On the rock basis predominates the Upper Triassic stratified Dachstein limestone. Between the light grey Upper Triassic Dachstein limestone, deposits of the Upper flat micrite platy and calcarenite limestone of Volče with chert stand out from afar due to their characteristic reddish colour. They are particularly well seen on Mt. Rdeči rob, the stony edge between Lužnica and Peski, the eastern slope of Mt. Batognica and on the ridge between the Vogel and Lemež Mts. (Buser, 1986, 1987).

Because of the prevailing carbonate bedrock, the Krn massif is strongly karstified, especially in some places. It is a typical high mountain karst world, with broken relief or numerous sink-holes, swallow holes, basins, abysses and caves. Glacial lakes, like the largest ones – Krnsko jezero, Dupeljsko jezero and Jezero v Lužnici – are found in sink-holes and at the dry valleys' bottoms. From a geotectonic aspect, the Krn massif is part of the Outer Dinarides, cutting into the Inner Dinarides with its southern edge.

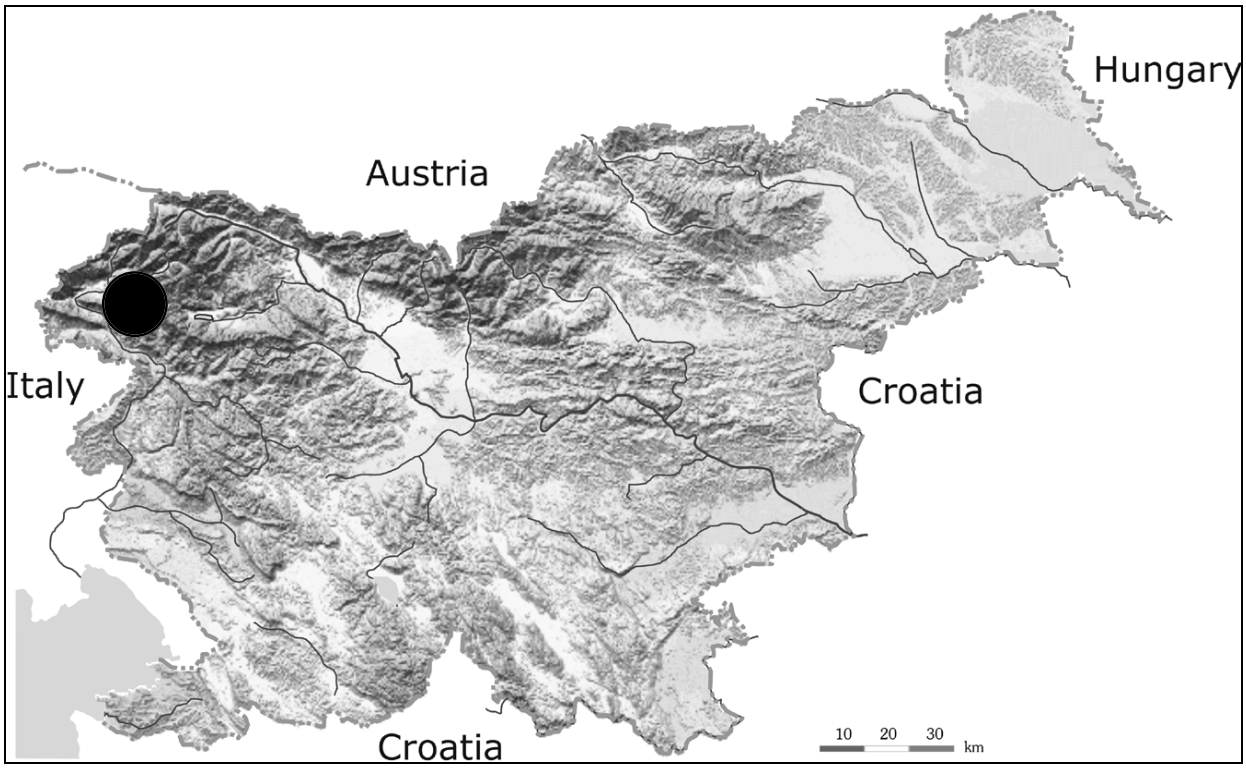

Fig. 1: Krn Mts. in the Julian Alps.
Sl. 1: Krnsko pogorje v Julijskih Alpah.

The Krn Mts. have Alpine climate. Because of the vicinity of the Mediterranean and the exposed position, the Krn massif is known for one of the highest amounts of rainfall in Slovenia. In the nearest and comparable meteorological station at Dom na Komni (1520 m), 2934 mm of rainfall annually was measured in the 1961-1991 period and a mean annual temperature of 3.7 °C (Mekinda-Majaron, 1995; Zupančič, 1995).

The entire area is distinctly characterized by traces of the intense military activities from the First World War I, for this was the area of the Soča Front (Isonzo Front) during the years 1915 and 1917.

Methods

Phytosociological research of the *Carex firma* stands was conducted by applying the sigmatistic method (Braun-Blanquet, 1964). Two indices were calculated for each taxon while we first performed a linear transformation of coverage values for individual taxa (van der Maarel, 1979): (a) coverage index (I_c) according to Lausi *et al.* (1982), and (b) a share of coverage ($D_{\%}$), using the following formula:

$$D_{\%} = \sum_{1}^{n} \frac{c_i}{c_{sum}} 100$$

n – number of relevés in the phytosociological table

c_i – coverage value of registered taxa

c_{sum} – sum of coverage values of all taxa in the phytosociological table (Tab. 1)

With the aid of the computer programme SYN-TAX (Podani, 1993) and extensive synoptic phytosociological table, comparisons with similar stands from the Alps and Dinaric mountains were made.* The measure of dissimilarity was the complement of the "similarity ratio" coefficient. We used the Furthest neighbour – Complete linkage clustering method (CL), Minimization of Increase of Error Sum of Squares (MISSQ) and the ordination method of Principal Coordinates Analysis (PCoA). Groups of diagnostic species were formed on the basis of our own criteria, but with regard to numerous authors. The floristic composition of the researched stands was also analysed according to chorological groups and Raunkiaer's plant life forms. Here we followed the Chorological Atlas of Vascular Plants in the Friuli-Venezia Giulia region (Poldini, 1991). Nomenclature sources for phanerogams are Register of the Flora of Slovenia (Trpin & Vreš, 1995) as well as some supplements in the Mala flora Slovenije (Martinčič *et al.*, 1999).

* Synoptic phytosociological table is available from the author.

RESULTS AND DISCUSSION

Floristic composition of stands

The edificator and one of the characteristic species of the association is *Carex firma*$^{1-5}$ (I_c=85), which appears with the greatest constancy and cover values. Other characteristic species of the association are *Phyteuma sieberi*$^{+-1}$ (I_c=21), *Helianthemum alpestre*$^{+-2}$ (I_c=21), *Crepis kerneri*$^{+}$ (I_c=12), *Saussurea pygmea*$^{+-1}$ (I_c=6), *Chamorchis alpina*$^{+}$ (I_c=2) and *Saxifraga caesia*$^{+}$ (I_c=1), of which only the first appears in more than half of the inventories. Differential species and some characteristic species of the contrasting Central Alpine association *Caricetum firmae* Lüdi 1911 are *Pedicularis rostratocapitata*$^{+-1}$ (I_c=15), *Saxifraga squarrosa*$^{+-1}$ (I_c=14), *Sesleria sphaerocephala*$^{+-2}$ (I_c=12), *Achillea clavenae*$^{+}$ (I_c=9) and *Gentiana terglouensis*$^{+}$ (I_c=5). Species of the association *Caricion austroalpinae* Sutter 1962 occur only rarely in these stands, namely *Koeleria eriostachya, Linum julicum, Laserpitium peucedanoides, Senecio abrotanifolius* and *Trifolium noricum*. The highest number of species in the association concerns to the alliance *Caricion firmae* Gams 1936 (order *Seslerietalia albicantis* Oberd. 1978 corr. Oberd. 1990 and the class *Elyno-Seslerietea* Br.-Bl. 1948), in which only *Dryas octopetala*$^{+-5}$ (I_c=44), *Aster bellidiastrum*$^{+-1}$ (I_c=18) and *Sesleria albicans*$^{+-3}$ (I_c=19) were recorded in more than half of the relevés. *Gentiana clusii, Leontopodium alpinum, Anthyllis vulneraria* subsp. *alpestris* and *Ranunculus hybridus* are additionally more common. Scree species (class *Thlaspietea rotundifolii* Br.-Bl. 1948) are well established in habitats in which succession development has gradually led from scree syntaxa through stands of *Dryas octopetala* to *Carex firma* (*Caricetum firmae* s. lat.), *e.g., Athamanta cretensis* (I_c=7), *Leontodon hispidus* subsp. *hyoseroides* (I_c=6), *Campanula cohleariifolia* (I_c=11), *Soldanella minima* (I_c=8) and *Ranunculus traunfellneri* (I_c=10). Rockier habitats with steeper incline suit species occurring in rock crevices (*Asplenietea trichomanis* [Br.-Bl. in Meier & Br.-Bl. 1934] Oberdorfer 1977, *Potentilletalia caulescentis* Br.-Bl. and Meier & Br.-Bl. 1926), namely *Potentilla nitida* (I_c=14), *Primula auricula* (I_c=6), *Valeriana saxatilis* (I_c=17), *Saxifraga crustata* (I_c=12), *Viola biflora* (I_c=10), *Campanula zoysii, Paederota lutea* and *Petrocallis pyrenaica* (the last three with I_c=3). We recorded *Rhodothamnus chamaecistus*$^{+-3}$ (*Erico-Pinetea*), with a degree of constancy IV, and in half of the relevés the species *Selaginella selaginoides*$^{+-1}$, *Tofieldia calyculata*$^{+-2}$ and *Rhododendron hirsutum*$^{+-2}$. The floristic composition of the association is given in Table 1.

Phanerogams cover from 40 to 100% of the sites (the mean value is 90%). The moss layer in general does not cover a major area of the sites; the mean value is 1% (minimum 0 and maximum 20%), but it is well established in some *Carex firma* stands and reaches a mean

value of 20% (see Table 1, rel. 7-13). The species *Oncophorus virens*$^{+\cdot1}$ and *Drepanocladus uncinatus*$^{+\cdot3}$ are established there with greater constancy and large cover values.

Hemicryptophytes predominate (Tab. 2), around 20 % of the relevé areas being covered by chamaephytes, which indicates the unfavourable habitat conditions. Phanerophytes cover around 10% of the relevé areas, while the share of the relevé areas covered by geophytes and therophytes is low.

Tab. 2: Plant life forms spectrum in the association *Gentiano terglouensis-Caricetum firmae* ***in the Krn Mts. (the Julian Alps).***
Tab. 2: Biološki spekter asociacije *Gentiano terglouensis-Caricetum firmae* ***v Krnskem pogorju (Julijske Alpe).***

abs. No.					Σ	$D_{\%}$				
Fa	Ha	He	Ge	Te		Fa	Ha	He	Ge	Te
12	32	93	6	8	**151**	9	23	63	4	2

Ecology, variability and sindynamics of the stands

Carex firma is dominant in most associations of the alliance *Caricion firmae*. It is a very long-lived species and creates populations at sites due to its own clones. These gradually completely overgrow the sites, making the specific individuals no longer recognisable. Because of its longevity and gradual decay of the plants'ground parts, a layer of humus slowly accumulates under the turfs of *Carex firma* (in Schroeter, 1926). In the case in which the turfs in stands remain close-packed, friable rendzina can develop and gradual acidification occurs during further development of the soil due to the reaction of the soil basis and organic material, which is shown in the floristic composition with the establishment and final predominance of heathers (*Arctostaphyllos alpina, Vaccinium gaultherioides, V. vitis-idaea, Loiseleuria procumbens, Empetrum hermaphroditum* and others) or a succession development towards the associations *Empetro-Vaccinietum gaultherioidis* Br.-Bl. in Br.-Bl. & Jenny 1926 corr. Grabherr 1993 or the association *Loiseleurio-Cetrarietum* Br.-Bl. & al. 1939 (both from the class *Loiseleurio-Vaccinietea* Grabherr 1993). Lüdi's conclusion that the species *Carex firma* creates humus certainly applies, although it does not thrive well in it (Lüdi 1911, in Schroeter, 1926). Together with *Dryas octopetala, Carex firma* plays, among other things, an important role in the stabilisation of screes, which can also be frequently observed in the Krn Mts.

The stands of the association *Gentiano terglouensis-Caricetum firmae* prefer shady and northern exposition (Fig. 2) in the subalpine and alpine belt. The median altitude value of relevés in the Krn Mts. is 1910 m (maximum 2120 m), whereby the lowest relevé was made at an altitude of 1330 m. This was a relevé at a growth site in which a special form of *Carex firma* stands had been created after a long successional development of vegetation from scree to grassland. Areas covered by the stands are in principle small (mean value is 4, minimum 1 and maximum 25 m^2). Exceptionally, there are connected areas larger than 100 m^2, such as on the saddle between the peaks of Mali Peski and Vrh nad Peski, where sheep have almost totally grazed the *Carex firma* turfs.

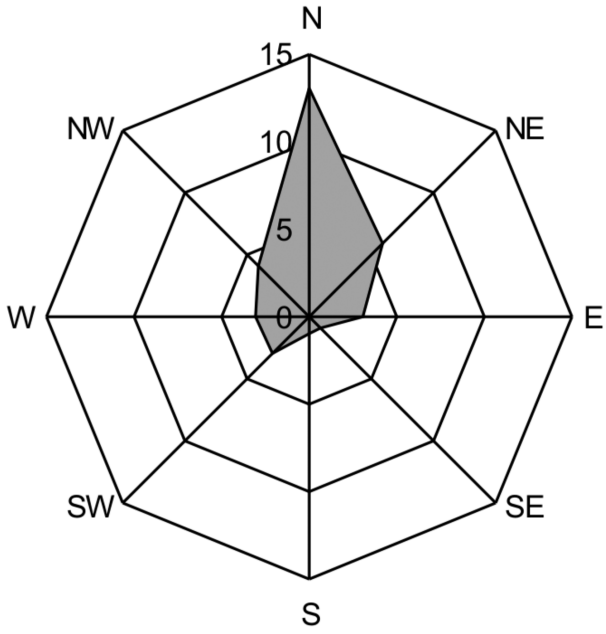

Fig. 2: Exposition of stands of the association *Gentiano terglouensis-Caricetum firmae* ***in the Krn Mts. (the Julian Alps).***
Sl. 2: Ekspozicija sestojev asociacije *Gentiano terglouensis-Caricetum firmae* ***v Krnskem pogorju (Julijske Alpe).***

We made 28 relevés and recorded 151 taxa, a minimum of 12 and maximum of 58 per relevé (the mean value is 28.5) The coefficient of variation is relatively high – 38%. A lack of floristic homogeneity of the association is probably the result of different growth sites in which *Carex firma* stands have been established. Where stands have formed, after gradual successions, on former screes, scree species are more frequent and they reach higher coverage indices. Much the same applies to the stands in rocky crevices, where plants from the class *Asplenietea trichomanis* are more frequent (Fig. 3). On the basis of diagnostic species and with the aid of numerical analysis of the association's stands, we thus divided the association into lower syntaxonomic units, which are well distinguished between themselves both floristically and ecologically (Fig. 3).

Relevés at sites with lengthy snow cover, which are therefore colder and wetter, were classified in the subassociation *Gentiano-Caricetum drepanocladetosum uncinati* subass. nova (Fig. 3, rel. 7-13). It is well marked by the presence and greater cover values of species of the snow-bed vegetation on a calcareous bedrock (*Soldanello-Salicion retusae* Englisch 1999, *Arabidetalia caeruleae* Rübel ex Br.-Bl. 1949), *e.g., Festuca nitida*$^{+-2}$, *Polygonum viviparum*$^{1-2}$, *Geranium argenteum*$^{+-2}$, *Oncophorus virens*$^{+-1}$ and *Drepanocladus uncinatus*$^{+-3}$. The enumerated moss species are good indicators of fresh and damp sites. The moss layer covers the major share of the surface of the habitats in this subassociation.

The holotype of the subassociation *Gentiano terglouensis-Caricetum firmae drepanocladetosum uncinati* subass. nova is the relevé No. 8 in Table 1, *holotypus* hoc loco.

Everything indicates that stands of this subassociation are the result of a successional transition from the snow-bed vegetation (*Soldanello-Salicion retusae*) or the associations *Homogyno discoloris-Salicetum retusae* Aichinger 1933 or *Salici retusae-Geranietum argentei* Surina 2004 to the stands of the association *Gentiano terglouensis-Caricetum firmae* s. lat. (Fig. 3).

In shady habitats with mean values of inclination around 35 °, where turfs of *Carex firma* are not completely linked (phanerogams cover from 40-80 % of the relevé areas), we noticed stands in which a rocky crevice species *Potentilla nitida*$^{2-3}$ predominates. In addition, *Oxytropis jacquinii*$^{+-1}$, *Primula auricula*$^{+}$, *Campanula zoysii*$^{+}$, *Paederota lutea*$^{+}$ and *Petrocallis pyrenaica*$^{+}$ are abundant, which are also differential species of the new subassociation *potentilletosum nitidae* subass. nova. In this subassociation, with the exception of the species

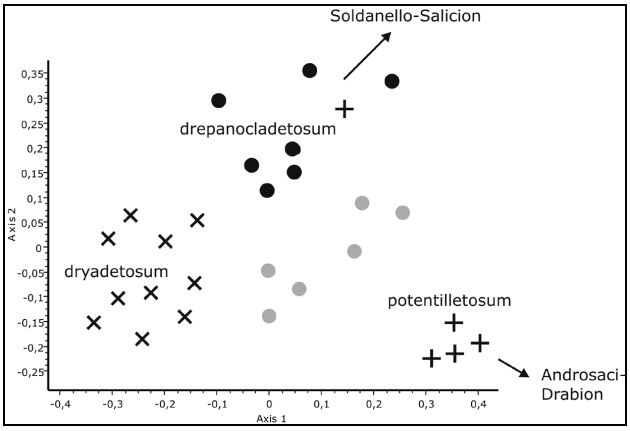

Fig. 3: Two-dimensional scatter diagram of relevés of the association *Gentiano terglouensis-Caricetum firmae* ***from Krn Mts. (the Julian Alps; PCoA, simliarity ratio).***
Sl. 3: Dvorazsežni ordinacijski diagram sestojev asociacije *Gentiano terglouensis-Caricetum firmae* ***v Krnskem pogorju (Julijske Alpe, PCoA, podobnost).***

Campanula cochleariifolia, species of the class *Thlaspietea rotundifolii* are poorly represented, which was indeed expected: stands of the subassociation *potentilletosum nitidae* are in contact with the subalpine and alpine stands of vegetation of rocky crevices and subalpine and alpine grasslands or the associations *Potentilletum nitidae* and *Gentiano terglouensis-Caricetum firmae* (Fig. 3).

The holotype of the subassociation *Gentiano terglouensis-Caricetum firmae potentilletosum nitidae* subass. nova is the relevé No. 18 in Table 1, *holotypus* hoc loco.

The relevés 19-28 (Tab. 1) are floristically most impoverished (the mean number of species per relevé is 19.5). This is mainly the result of a complete dominance of *Carex firma*$^{2-5}$ and *Dryas octopetala*$^{1-5}$, which on habitats with close-knit or joined turfs prevent other plants from thriving. The presence of a larger number of species of the class *Thlaspietea rotundifolii* in the stands of *Carex firma*, *e.g., Crepis kerneri*$^{+}$ (characteristic species of the association, which was observed almost exclusively in this form), *Athamanta cretensis*$^{+-1}$, *Leontodon hispidus* subsp. *hyoseroides*$^{+-1}$ and *Ranunculus traunfellneri*$^{+-1}$, indicate the sindynamical connection of scree syntaxa with stands of subalpine and alpine grasslands (Fig. 3). Actually, in many cases these are *Carex firma* stands which, after prior stabilisation of screes with *Dryas octopetala,* have developed on more or less stabilised screes *(e.g.* relevé No. 19, which we performed very low, 1330 m). *Dryas octopetala* has an important role here, for it creates more favourable conditions for other species to thrive. On the other hand, this form appears exclusively in shady and cooler habitats (northern exposures predominate – see Table 1) with long-lasting snow cover. Poldini & Feoli (1976) noticed similar stands of *Carex firma* with *D. octopetala* in the Carnic Alps. From the syntaxonomic and sindynamic point of view, we followed the authors who classified them in the subassociation *dryadetosum octopetale* Poldini & Feoli 1976.

The relevés 1-5 do not show particular floristic and environmental differentiation, so we have not typologically divided them further.

Geoelements

In terms of the number of species (42) and coverage index (I_c=219), the Mediterranean-montane geoelement predominates in stands (Tab. 3). Of all the syntaxa observed in the Krn Mts., most of the species, 23 (I_c=148), belong to the Arctic-Alpine geoelement of the association under discussion. There was also a large number of species of the East-Alpine geoelement (13; I_c=100) and, together with the association *Ranunculo hybridi-Caricetum sempervirentis* Poldini & Feoli Chiapella in Feoli Chiapella & Poldini 1993, most are in the class

Tab. 3: Chorological groups and coverage indices (I_c) of phanerogams in the association *Gentiano terglouensis-Caricetum firmae* ***in the Krn Mts. (the Julian Alps).***
Tab. 3: Horološke skupine in indeksi pokrovnosti (I_c) fanerogamov v asociaciji *Gentiano terglouensis-Caricetum firmae* ***v Krnskem pogorju (Julijske Alpe).***

Number of taxa / Σc_i													
koz-mop	cirkum bor	paleo-temp	euro-sib	euro-asi	euri-med	arct-alp	alp-karp	europ	alp	med-mont	E-alp	N-ilir	ende-mits
2/2	9/31	1/1	4/7	8/37	1/2	23/148	3/24	8/54	10/54	42/219	13/100	11/40	12/55

Elyno-Seslerietea. Within the framework of the same class, we also recorded the largest number of endemic species in the association *Gentiano terglouensis-Caricetum firmae* (12; I_c=55); 11 species (I_c=40) belong to the Northern-Illyrian geoelement, 10 (I_c=54) to the Alpine, nine species to the Circumboreal geoelement (I_c=31), and eight each to the European (I_c=54) and European-Asian (I_c=37) geoelements. The number of species by geoelements and their coverage indices are shown in Table 3.

Distribution of the association and syntaxonomical position of the stands

Braun-Blanquet (1926) drew attention to the floristic and phytogeographic peculiarities of stands of the association *Caricetum firmae* s. lat. in the South Tyrolian Dolomites. He found that because of the presence of a larger number of endemic species *(e.g., Gentiana terglouensis, Sesleria sphaerocephala, Pedicularis rosea, P. rostrato-capitata, Achillea clavenae, Valeriana saxatilis, Potentilla nitida, Soldanella minima, Phyteuma sieberi*), they are well distinguished from central Alpine stands of the association and in the basic inventories of Aichinger (1933: Tab. 26 in 27) he proposed a Southeast-Alpine vicariant *Firmeto-Primuletum wulfenianae* Br.-Bl. 1933. The association was suitably described and typified by Wraber (1970) as *Gentiano terglouensis-Caricetum firmae* T. Wraber 1970, with an inventory that he surveyed on Mt. Jalovec at an altitude of 2600 m. Poldini & Feoli (1976) confirmed by phytogeographical and numerical analysis the association *Caricetum firmae* s. lat. in the South- and Southeastern Calcareous Alps in the context of a special, new association (*Gentiano terglouensis-Caricetum firmae*) or distinct phytogeographical race, in which they also took into account a synoptic table of respective association from the Julian Alps (39 unpublished relevés surveyed by T. Wraber).

The area of distribution of the association embraces the entire south-eastern Alps. The western boundary of the distribution area accords with the boundary of the alliance *Caricion austroalpinae*, in the Insubrian region (between the lakes Lago di Como and Lago Maggiore). The most south-easterly stands thrive in the Kamnik-Savinja Alps. In Austria, impoverished stands of the association have also been observed on Dobrač (in Grabherr *et al.*, 1993). *Carex firma* stands extend to the Dinarides, all the way to Mt. Lička Plješivica (Horvat, 1930, 1952), and in the distribution area between Mts. Snežnik (SW Slovenia) and Trovrh (NW Croatia) they form a Dinaric vicariant *Edraiantho graminifolii-Caricetum firmae* Horvat (1930) 1934 (*Seslerion juncifoliae* Horvat 1930, *Seslerietalia juncifoliae* Horvat 1930), for which the presence of Illyrian and Dinaric or the absence of several Alpine species is characteristic.

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Appendix

Localities of relevés: Slovenia, Julian Alps, Krn mountains:

1. slope above the Zelena škrbina pass, on top of the gorge between Velika Montura and Velika Baba Mts. MTB: 9748/1, UTM: VM02; leg. & det.: B. Surina, 5.7.2002. **2**. just below the summit of Velika Montura. MTB: 9748/1, UTM: VM02; leg. & det.: D. Stešević & B. Surina, 29.7.2003. **3**. stony ridge above the Škedenj ridge. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina, 8.8.2002. **4**. the summit of Mt. Mali Šmohor. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 9.7.2002. **5**. eastern slope of peak Palec. MTB: 9748/1, UTM: VM02; leg. & det.: I. Dakskobler & B. Surina, 8.8.2002. **6**. Polovnik ridge, between the peaks Krasji vrh and Veliki vrh. MTB: 9747/2, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina, 18.7.2003. **7**. between Škofič and Rdeči rob Mts. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina,

12.6.2002. **8**. north-eastern slope of Mt. Krnčica. MTB: 9747/2, UTM: UM92; leg. & det.: B. Surina, 23.7.2003. **9**. ridge of Mt. Škofič above Gorenja Lašca. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina, 15.7.2003. **10**. north-eastern slope of Mt. Lopatnik. MTB: 9747/2, UTM: UM92; leg. & det.: B. Surina, 22.7.2003. **11**. north-western slope of Mt. Krnčica (the vegetation was overgrazed by sheep). MTB: 9747/2, UTM: UM92; leg. & det.: B. Surina, 23.7.2003. **12**. ridge between Krn and Srednji vrh Mts. MTB: 9747/2, UTM: UM92; leg. & det.: B. Surina, 22.8.2003. **13**. rocky ledge on south-western slope of Mt. Krnčica by »via ferrata« from Vratca pass to the summit of Mt. Krnčica (remnants from World War I.). MTB: 9747/2, UTM: UM92; leg. & det.: B. Surina, 23.7.2003. **14**. rocky grassland on north-western slope of Mt. Rdeči rob. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina, 15.7.2003. **15**. Polovnik ridge, gorge in the ridge of peak Veliki vrh. MTB: 9747/1, UTM: UM82; leg. & det.: I. Dakskobler & B. Surina, 18.7.2003. **16-18**. Polovnik ridge, gorge in the ridge of peak Veliki vrh. MTB: 9747/1, UTM: UM82; leg. & det.: I. Dakskobler & B. Surina, 18.7.2003. **19**. Planina Duplje pasture, scree above the lake at Planina Duplje beneath the paths from Koča pri Krnskih jezerih mountain chalet to Lepoče. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 24.6.2002. **20-21**. Gorenja Lašca. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina, 8.8.2002. **22**. Peak Mali Peski, northwest from the monument. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 30.8.2002. **23**. western slope of Mt. Vrh nad Peski, above Batogniška škrbina pass. MTB: 9748/1, UTM: UM92; leg. & det.: D. Stešević & B. Surina, 30.7.2003. **24**. Peak Škofič. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 30.8.2002. **25**. Gorenja Lašca, scree below the path from Mt. Veliki Peski to Lašca pasture. MTB: 9748/1, UTM: UM92; leg. & det.: I. Dakskobler & B. Surina. **26-27**. ridge between the peaks Mali Peski and Škofič. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 30.8.2002. **28**. Peak Škofič, pass between Lašca and Peski. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 30.8.2002.

ZDRUŽBA *GENTIANO TERGLOUENSIS-CARICETUM FIRMAE* T. WRABER 1970 V KRNSKEM POGORJU (JULIJSKE ALPE)

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POVZETEK

*Prispevek obravnava fitocenološke in okoljske razmere čvrstega šašja (*Caricetum firmae *s. lat.) v Krnskem pogorju (Julijske Alpe). Pri raziskavah, kjer smo uporabljali sigmatistično (srednjeevropsko) metodo (Braun-Blanquet, 1964), smo fitocenološke popise najprej razvrstili v diagnostične skupine in jih kasneje potrdili s pomočjo računalniškega programa SYN-TAX oziroma z metodo hierarhične klasifikacije (Podani, 1993). Za mero različnosti smo uporabljali komplement koeficienta "similarity ratio". Večinoma smo uporabljali metodo minimalnega porasta vsote kvadratov ostanka (Minimization of increase of error sum of squares - MISSQ), metodo kopičenja na osnovi najbolj oddaljenega soseda (Farthest neighbour-Complete linkage clustering) ter ordinacijsko metodo (Principal coordinates analysis - PCoA). Če se je izkazalo za potrebno in smiselno, smo preučevane sestoje členili na nižje enote. Pri primerjavi življenjskih oblik s pomočjo numerične analize smo po predhodno opravljeni linearni transformaciji ocen pokrovnosti za posamezne taksone (van der Maarel, 1979: r=1, +=2, 1=3, 2=5, 3=7, 4=8, 5=9) izračunali tudi indeks pokrovnosti (I_C, Lausi* et al.*, 1982) in delež pokrivanja vsakega taksona v okviru popisa oziroma celotne asociacije ($D_{\%}$). Skupine diagnostičnih vrst smo ob upoštevanju več avtorjev oblikovali po lastnih kriterijih. Floristično sestavo sestojev smo analizirali tudi po horoloških skupinah in Raunkiaerovih bioloških oblikah. Pri tem smo se ravnali po Atlasu flore Furlanije-Julijske krajine (Poldini, 1991), imena praprotnic in semenk pa navajamo po Registru flore Slovenije (Trpin & Vreš, 1995) ter Mali flori Slovenije (*Martinčič* et al.*, 1999).*

Sestoji s prevladujočo vrsto Carex firma *poraščajo vetrovom izpostavljena rastišča na vršnih predelih gora v subalpinskem in alpinskem pasu. Ponekod jih najdemo na izrazito hladnih rastiščih na manjši nadmorski višini. Po predhodnih primerjavah s podobnimi sestoji iz jugovzhodnih apneniških Alp smo jih uvrstili v asociacijo* Gentiano terglouensis-Caricetum firmae *T. Wraber 1970. Sestoje te asociacije, v primerjavi s sestoji centralno-alpske (*Caricetum firmae *Gams 1936), zaznamuje obstoj večjega števila endemitov in južno- oziroma jugovzhodnoalpskih vrst.*

Asociacijo smo na podlagi floristične sestave posameznih sestojev in numeričnih analiz tipološko dalje členili na subasociacije -dryadetosum octopetalae *Poldini & Feoli 1976,* -geranietosum argentei *subass. nova in* -potentilletosum nitidae *subass. nova. Sestoji subasociacije* -dryadetosum octopetalae *so v sindinamični povezavi s sestoji asociacije* Dryadetum octopetalae *Rübel 1911 oziroma s stadijem* Dryas octopetala*, ki je pionirski tip vegetacije predvsem na deloma ustaljenih meliščih. Za razlikovalnice subasociacije* -dryadetosum *smo izbrali vrste* Dryas octopetala, Athamantha cretensis *in* Leontodon hispidus *s. lat.*

Sestoji subasociacije -potentilletosum nitidae *kažejo floristično in sintaksonomsko podobnost s sestoji asociacije* Potentilletum nitidae *Wikus 1959 iz razreda* Asplenietea trichomanis *(Br.-Bl. in Meier & Br.-Bl. 1934) Oberdorfer 1977; poraščajo vlažna in hladna, proti severu izpostavljena rastišča. Razlikovalne vrste za subasociacijo* -potentilletosum nitidae *so vrste* Potentilla nitida, Oxytropis jacquinii, Primula auricula, Campanula zoysii, Paederota lutea *in* Petrocallis pyrenaica*. Sindinamično povezanost in posledično floristično sorodnost sestojev asociacije* Gentiano terglouensis-Caricetum firmae *s sestoji vegetacije snežnih tal iz zveze* Soldanello alpinae-Salicion retusae *Englisch 1999 (predvsem s sestoji asociacij* Homogyno discoloris-Salicetum retusae *Aichinger 1933 in* Salici retusae-Geranietum argentei *Surina 2004) pa kažejo sestoji, ki smo jih uvrstili v subasociacijo* -geranietosum argentei*. Za razlikovalnice slednje smo določili vrste* Geranium argenteum, Polygonum viviparum, Festuca nitida, Drepanocladus uncinatus *in* Oncophorus virens*. Uveljavljajo se na rastiščih z dolgotrajno snežno odejo.*

Sestoji asociacije Gentiano terglouensis-Caricetum firmae *so razširjeni v celotnih jugovzhodnih Alpah. Areal asociacije sega na zahodu do Insubrijske regije oziroma do gora med jezeroma Lago di Como in Lago Maggiore ter na vzhodu do Kamniško-Savinjskih Alp. V slovenskih Alpah (skupaj s Karnijskimi pripadajo Jugovzhodnim Apneniškim Alpam) uspevajo v Julijskih Alpah, Karavankah in v Kamniško-Savinjskih Alpah. V Avstriji so floristično obubožane sestoje te asociacije opazili na Dobraču. Sestoje čvrstega šašja iz Liburnijskega krasa med Snežnikom in Ličko Plješivico uvrščamo v dinarsko vikarianto* Edraiantho graminifolii-Caricetum firmae *Horvat (1930) 1934 iz zveze* Seslerion juncifoliae *Horvat 1930 in reda* Seslerietalia juncifoliae *Horvat 1930. Za sestoje te asociacije je že značilna prisotnost ilirskih (dinarskih) vrst na eni ter odsotnost nekaterih alpskih vrst na drugi strani.*

Ključne besede: fitocenologija, fitogeografija, endemične vrste, *Elyno-Seslerietea*, *Caricion firmae*, *Caricetum firmae*, Jugovzhodne Apneniške Alpe

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Tab. 1: Phytosociological table: analytical table of the association *Gentiano terglouensis-Caricetum firmae* ***T. Wraber 1970 in the Krn Mts. (the Julian Alps).***

Tab. 1: Fitocenološka tabela: analizna tabela asociacije *Gentiano terglouensis-Caricetum firmae* ***T. Wraber 1970 v Krnskem pogorju (Julijske Alpe).***

Relevé number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8***	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18***	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**					
Altitude (m a.s.l.)		1900	1945	1740	1944	1580	1700	1884	2120	1920	1965	2040	2050	2040	1900	1700	1680	1700	1680	1330	1605	1705	2020	2110	1955	1755	1965	1975	1945					
Exposition		N	N	NW		N	N	W	SW	NW	SW	E	NE	W	NE	N	NE	N	E	N	NE		NW	N	N	NE	N	N	N					
Inclination (^{0})		10	15	30	0	45	50	60	5	15	15	45	5	10	25	20	30	20	70	30	5	0	10	20	20	40	10	20	10					
Coverness (%) Herb layer		90	90	100	80	70	80	90	95	95	70	95	100	90	40	70	70	80	70	80	90	75	95	95	90	60	90	90	100					
Moss layer	D	1	1			10	10	20	20	10	20	1	5	20						5	5	5	1	1	1	1	1	10						
Relevé area (m^2)		6	3	2	6	5	4	4	4	25	4	8	2	4	12	4	4	4	4	6	4	4	25	2	6	12	4	4	1					
Number of species		27	27	20	26	42	43	38	29	58	25	37	34	22	28	21	18	21	22	30	40	28	28	12	15	19	20	18	13	**fr**	**%**		**I_c**	**$D_{\%}$**
Characteristic species of the association																																		
Carex firma	He	4	4	4	4	4	4	4	4	4	4	5	5	5	1	4	4	4	4	4	3	3	4	4	5	3	2	3	2	28	100	**V**	85	10.8
Helianthemum alpestre	Ha	+	+	.	2	+	1	1	+	1	.	+	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	39	**II**	12	1.5
Crepis kerneri	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	+	+	+	8	29	**II**	6	0.8
Saussurea pygmaea	He	.	.	.	.	.	.	.	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	11	**I**	3	0.4
Chamorchis alpina	Ge	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	**I**	2	0.2
Saxifraga caesia	Ha	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	**I**	1	0.1
Differential species of the association (versus Caricetum firmae Lüdi 1911)																																		
Phyteuma sieberi	He	1	+	+	+	+	.	+	1	1	+	+	+	1	+	.	+	+	.	.	.	1	+	+	+	+	+	1	+	23	82	**V**	21	2.6
Pedicularis rostrato-capitata	He	+	+	+	+	+	1	+	+	+	+	+	+	+	+	+	.	+	+	.	.	.	.	.	.	.	.	+	.	.	18	64	**IV**	15	1.9
Saxifraga squarrosa	Ha	+	+	.	+	1	+	+	.	+	1	+	+	+	.	+	.	+	+	.	.	.	.	+	+	.	.	+	.	17	61	**IV**	14	1.8
Sesleria sphaerocephala	He	+	.	2	+	1	.	.	+	.	+	.	+	1	.	.	.	.	.	.	.	.	+	+	.	.	.	1	+	12	43	**III**	12	1.5
Achillea clavenae	He	.	.	.	+	+	+	+	.	1	.	.	.	.	+	.	.	.	.	.	+	+	+	+	.	.	.	.	+	11	39	**II**	9	1.2
Gentiana terglouensis	He	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	6	21	**II**	5	0.6
Differential species of subassociations																																		
Polygonum viviparum	Ge	.	+	.	+	.	1	1	2	1	1	.	1	1	+	1	.	.	.	1	+	1	+	+	.	+	+	.	.	18	64	**IV**	19	2.4
Festuca nitida	He	.	.	.	.	.	+	.	2	1	+	.	1	.	.	+	.	.	.	.	+	+	+	.	.	.	.	.	.	9	32	**II**	9	1.2
Drepanocladus uncinatus	D	.	.	.	.	.	.	+	2	2	3	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	21	**II**	.	
Geranium argenteum	He	.	.	.	.	.	.	2	+	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	21	**II**	6	0.8
Oncophorus virens	D	.	.	.	.	.	.	+	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	14	**I**	.	
Potentilla nitida	Ha	+	.	.	.	.	.	.	.	.	.	.	.	1	.	2	3	2	3	.	.	.	.	1	.	.	.	+	+	9	32	**II**	14	1.8
Oxytropis jacquinii	He	.	.	.	1	.	.	+	+	.	.	.	.	.	1	+	+	+	+	.	.	.	.	.	.	.	.	.	.	8	22	**I**	7	0.9
Primula auricula	He	.	.	.	.	1	+	.	.	.	.	+	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	7	25	**II**	6	0.8
Campanula zoysii	He	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	4	14	**I**	3	0.4
Paederota lutea	He	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	4	14	**I**	3	0.4
Petrocallis pyrenaica	Ha	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	4	14	**I**	3	0.4
Dryas octopetala	Ha	1	2	1	.	+	.	.	1	3	+	2	2	2	+	.	.	.	.	1	4	4	2	2	3	4	4	3	5	21	75	**IV**	44	5.6
Athamanta cretensis	He	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	+	.	.	.	+	+	+	+	8	29	**II**	7	0.9
Leontodon hispidus s. lat.	He	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	1	1	.	.	.	.	.	+	+	6	21	**II**	6	0.7
Caricion austroalpinae																																		
Koeleria eriostachya	He	.	+	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	5	18	**I**	4	0.5
Linum julicum	He	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	3	11	**I**	2	0.3
Laserpitium peucedanoides	He	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	7	**I**	2	0.2
Senecio abrotanifolius	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	4	**I**	1	0.2
Trifolium noricum	He	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	**I**	1	0.1

Caricion firmae, Seslerietalia caeruleae & Elyno-Seslerietea

Aster bellidiastrum	He	+	+	+	+	+	+	+	.	1	+	+	1	.	.	+	+	+	.	1	.	.	1	.	1	+	1	.	+	20	71	IV	18	2.3
Sesleria albicans	He	+	+	.	+	1	1	+	1	+	.	1	1	.	+	1	1	1	2	.	+	.	+	+	.	.	.	.	.	18	64	IV	19	2.5
Gentiana clusii	He	+	+	+	2	+	+	+	.	+	.	1	1	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	13	46	III	12	1.6
Leontopodium alpinum	He	+	.	.	+	+	.	+	+	+	.	+	.	.	.	1	+	.	+	.	.	.	.	.	.	.	.	.	.	10	36	II	8	1.1
Anthyllis vulneraria / alpe stris	He	+	.	.	+	+	.	.	.	+	.	+	1	.	+	.	.	.	.	+	+	.	.	.	.	.	+	.	.	10	36	II	8	1.1
Ranunculus hybridus	He	.	.	.	.	1	1	+	.	.	.	1	.	.	+	+	1	+	+	.	.	.	.	.	.	.	.	.	.	9	32	II	9	1.1
Silene acaulis	Ha	.	.	.	.	.	.	+	+	1	.	+	+	+	2	.	.	.	.	.	+	1	.	.	.	.	.	.	.	9	32	II	9	1.2
Pinguicula alpina	He	+	+	+	.	+	1	.	.	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.	1	.	.	.	.	9	32	II	8	1.0
Salix alpina	Fa	.	+	.	.	.	.	+	+	1	.	+	.	.	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	8	29	II	7	0.9
Thymus alpigenus	Ha	.	.	.	+	.	.	.	.	1	+	1	+	.	+	.	.	.	.	2	+	.	.	.	.	.	.	.	.	8	29	II	8	1.1
Homogyne discolor	He	1	1	.	.	.	.	.	.	1	.	+	+	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	7	25	II	7	0.9
Carex sempervirens	He	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	7	25	II	6	0.7
Hieracium villosum	He	.	.	+	.	+	+	.	.	+	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	7	25	II	6	0.7
Hedysarum hedysaroides	He	.	.	.	.	+	1	+	2	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	25	II	7	0.9
Poa alpina	He	.	+	.	.	.	.	.	.	+	.	1	.	+	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	7	25	II	6	0.8
Androsace villosa	Ha	1	1	.	1	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	6	21	II	6	0.8
Galium anisophyllum	He	.	.	.	+	.	+	.	+	1	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	6	21	II	6	0.7
Bartsia alpina	He	.	.	.	.	+	+	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1	.	.	6	21	II	5	0.7
Euphrasia salisburgensis	Te	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	6	21	II	5	0.6
Erigeron glabratus	He	.	.	.	.	.	+	+	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	18	I	4	0.5
Aster alpinus	He	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.	.	.	.	+	+	5	18	I	4	0.5
Astrantia bavarica	He	.	.	.	.	1	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	14	I	4	0.5
Carex mucronata	He	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	4	14	I	3	0.4
Heliosperma alpestre	Ha	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	4	14	I	4	0.5
Biscutella laevigata	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	3	11	I	3	0.4
Salix serpyllifolia	Fa	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	3	11	I	2	0.3
Potentilla crantzii	He	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	3	11	I	2	0.3
Pedicularis verticillata	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	3	11	I	2	0.3
Gentianella anisodonta	Te	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	3	11	I	2	0.3
Euphrasia picta	Te	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	3	11	I	2	0.3
Ranunculus carinthiacus	He	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	3	11	I	2	0.3
Gentiana verna	He	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2	7	I	2	0.2
Carlina acaulis / simplex	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	2	7	I	2	0.2
Pulsatilla alpina	He	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Thesium alpinum	He	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Anemone narcissiflora	Ge	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Campanula scheuchzeri	He	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Daphne striata	Fa	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Coeloglossum viride	Ge	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.2
Gentiana nivalis	Te	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Betonica alopecuros	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Helianthemum grandifl orum	Ha	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Hieracium bifidum	He	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Myosotis alpestris	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Polygala alpestris	He	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Rhinanthus aristatus / aristatus	Te	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Alchemilla velebitica	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Anthoxanthum nipponicum	He	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Arabis vochinensis	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Cerastium subtriflorum	He	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Euphrasia pulchella	Te	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Gentiana pumila	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Gentiana utriculosa	Te	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Lotus corniculatus	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1

TR **Thlaspietea rotundifolii s. lat.**																																			
Campanula cochleariifolia	He	.	.	.	.	.	.	.	.	.	1	.	.	+	+	+	+	1	+	.	+	1	.	.	.	+	+	+	.	12	43	III	11	1.4
Ranunculus traunfellneri	He	+	+	.	.	+	.	.	.	.	+	.	+	.	.	.	.	.	.	1	+	+	+	+	.	+	.	.	+	12	43	III	10	1.3
Soldanella minima	He	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	1	.	.	+	1	.	.	8	29	II	8	1.0
Salix retusa	Fa	.	.	.	.	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	1	4	.	+	.	.	.	8	29	II	8	1.1
Juncus monanthos	He	.	.	.	.	.	.	1	.	+	+	.	.	.	.	.	+	+	.	+	.	+	.	.	.	.	.	.	.	7	25	II	6	0.8
Saxifraga aizoides	Ha	.	.	.	.	+	+	+	.	.	+	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	21	II	5	0.7
Cerastium austroalpinum	Ha	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	4	14	I	3	0.4
Gypsophila repens	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	3	11	I	2	0.3
Thlaspi kerneri	Ha	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	3	11	I	2	0.3
Soldanella alpina	He	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.3
Achillea atrata	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	2	7	I	2	0.2
Armeria alpina	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	7	I	2	0.2
Festuca laxa	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	2	7	I	2	0.2
Minuartia austriaca	Ha	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Silene vulgaris / glareosa	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	2	7	I	2	0.2
Alyssum ovirense	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4	I	1	0.1
Moehringia ciliata	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Poa minor	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Rumex scutatus	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	4	I	1	0.1
AT **Asplenietea trichomanis**																																			
Valeriana saxatilis	He	1	1	1	.	1	1	.	.	+	.	+	.	+	.	1	1	2	+	.	+	.	.	.	+	+	+	.	.	16	57	III	17	2.1
Saxifraga crustata	Ha	.	+	.	.	+	1	+	+	.	+	+	.	+	1	+	+	+	+	.	.	.	.	.	+	.	.	.	.	14	50	III	12	1.5
Viola biflora	He	+	1	+	.	+	.	+	+	.	+	.	.	.	.	+	+	.	+	.	+	.	+	.	.	.	.	.	.	12	43	III	10	1.3
Minuartia sedoides	Ha	.	.	.	.	.	.	+	+	+	2	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	21	II	6	0.8
Potentilla clusiana	He	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	4	14	I	4	0.5
Saxifraga paniculata	Ha	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	11	I	2	0.3
Saxifraga burseriana	Ha	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Asplenium viride	He	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Bupleurum petraeum	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.2
Asperula aristata	He	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Astragalus australis	He	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Carex atrata	He	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Carex capillaris	He	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Minuartia rupestris	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Saxifraga tenella	Ha	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Arabis pumila / stellulata	Ha	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Valeriana elongata	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	4	I	1	0.1
EP **Erico-Pinetea**																																			
Rhodothamnus chama ecistus	Fa	+	+	1	+	2	3	.	.	+	1	2	2	2	.	2	.	2	+	.	.	+	.	.	1	+	2	1	.	19	68	IV	27	3.5
Rhododendron hirsutum	Fa	.	+	+	.	+	+	.	.	+	+	2	+	+	.	.	.	.	.	.	+	.	.	.	+	+	1	+	.	14	50	III	13	1.6
Arctostaphyllos alpina	Fa	.	+	+	+	1	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	8	29	II	8	1.1
Calamagrostis varia	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Larix decidua	Fa	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
VP **Vaccinio-Piceetea**																																			
Selaginella selaginoides	Ha	1	1	+	.	1	+	.	.	+	.	+	+	+	.	.	.	+	.	+	1	1	+	.	.	.	.	.	.	14	50	III	13	1.7
Picea abies	Fa	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Pinus mugo	Fa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Vaccinium vitis-idaea	Ha	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Huperzia selago	Ha	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Other species																																			
Salix waldsteiniana	Fa	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	3	11	I	2	0.3
Salix appendiculata	Fa	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Tofieldia calyculata	He	1	+	.	+	+	1	.	.	+	.	.	.	.	.	.	.	+	.	2	1	+	+	.	.	.	+	.	.	12	43	III	12	1.5
Festuca sp.	He	.	+	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	14	I	3	0.4
Parnassia palustris	He	.	.	.	.	.	+	+	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	4	14	I	3	0.4

Homogyne alpina	He	.	.	.	.	1	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	11	I	3	0.4
Lloydia serotina	Ge	.	.	.	.	.	.	1	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	11	I	3	0.4
Alchemilla flabellata	He	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Carex ornithopoda	He	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Daphne mezereum	Fa	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Globularia cordifolia	Ha	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	7	I	2	0.2
Linum catharticum	Te	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	2	7	I	2	0.2
Alchemilla cinerea	He	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Festuca nigrescens	He	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Gentianella ciliata	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	4	I	1	0.1
Gnaphalium supinum	He	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Hieracium sylvaticum	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Laserpitium siler	He	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Luzula multiflora	He	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Poa sp.	He	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1
Pseudorchis albida	Ge	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	4	I	1	0.1
Trifolium pallescens	He	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	I	1	0.1