

CONTRIBUTION TO THE SPRING VEGETATION OF THE JULIAN ALPS: THE ASSOCIATION *CRATONEURETUM FALCATI* GAMS 1927

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Izveček

V prispevku je podana fitocenološka oznaka povirnih sestojev s prevladujočo mahovno vrsto *Cratoneuron commutatum* var. *falcatum* (= *Palustriella commutata* var. *falcata*) v Krnskem pogotju in na Mangartu (Julijske Alpe). Po primerjavi s podobnimi sestoji s Karavank smo jih uvrstili v asociacijo *Cratoneuretum falcati* (*Cratoneurion commutati*, *Montio-Cardaminetea*).

Abstract

Phytosociological characteristics of stands with predominating *Cratoneuron commutatum* var. *falcatum* (= *Palustriella commutata* var. *falcata*) in the Krn Mts. and Mt. Mangart (the Julian Alps) are presented. After the comparison with similar stands from the Karavanke Mts. they are ranged into the association *Cratoneuretum falcati* (*Cratoneurion commutati*, *Montio-Cardaminetea*).

Cljučne besede: fitocenologija, vegetacija, *Cratoneuretum falcati*, *Cratoneurion commutati*, *Montio-Cardaminetea*, Julijske Alpe

Key words: phytosociology, vegetation, *Cratoneuretum falcati*, *Cratoneurion commutati*, *Montio-Cardaminetea*, Julian Alps

INTRODUCTION

Vegetation of cold springs, commonly dominated by bryophytes (*Montio-Cardaminetea* Br.-Bl. et R. Tx. ex Klika et Hadač 1944 em. Zechmeister 1993), is in Slovenia still poorly known. The only phytosociological data on the vegetation of calcareous spring communities (*Cratoneurion commutati* Koch 1928) gave Aichinger (1933: 65, Tab. 17, 6 relevés). While investigating the vegetation of the Karavanke Mts. (Southeastern Calcareous Alps) he described the new association *Cratoneuretum commutati* Aichinger 1933 although it is still far from clear whether or not it would be properly to place selective stands into the already described association *Cratoneuretum commutati* Koch 1928 (Aichinger 1933: 64) since no comparison has been made to date. To solve the selective syntaxonomic problem further

analyses should be provided. During our extensive resesarch on subalpine and alpine vegetation of the Julian Alps, mainly in the Krn Mts. (Southeastern Calcareous Alps), we came across similar stands with predominating *Cratoneuron commutatum* s. lat. (= *Palustriella commutata*) and some other higrophilous species of mosses and phanerogams. Thus the aim of the paper is to contribute to the knowledge of the vegetation of the class *Montio-Cardaminetea* in Slovenia.

METHODS

Phytosociological research was performed in the Krn Mts. and Mt. Mangart (the Julian Alps, Southeastern Calcareous Alps) applying the sigmatistic phytosociological method (Braun-Blanquet 1964).

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For individual taxa a coverage index (I_c) (Lausi & al. 1982) and a share of coverage of each taxon in association ($D_{\%}$) were calculated using the following formula:

$$D_{\%} = \sum_1^n \frac{c_i}{c_{sum}} \cdot 100$$

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

For that purpose we first performed a linear transformation of cover values for individual taxa (van der Maarel 1979: $r=1$, $+2$, $1=3$, $2=5$, $3=7$, $4=8$, $5=9$).

The nomenclature source for phanerogams was the Register of the Flora of Slovenia (Trpin & Vreš 1995) and for mosses the Annotated check-list of the mosses of Slovenia (Martinčič 2003). The exception is the moss species *Cratoneuron commutatum* (= *Palustriella commutata*), where we follow the older nomenclature, which is in agreement with the present-day syntaxonomic treatise of the spring vegetation (*Montio-Cardaminetea*). With the syntaxonomical treatise of the stands we followed Zechmeister (1993). Collected specimens are stored at the Herbarium of the Scientific Research Centre of Slovenian Academy of Sciences and Arts (ZRC).

RESULTS AND DISCUSSION

Floristic composition of the stands

Characteristic combination of species is composed of *Cratoneuron commutatum* var. *falcatum*, *Philonotis calcarea*, *Epilobium alsinifolium* and *Heliosperma quadridentatum* which is for the most part in agreement with Zechmeister (1993: 230).

An edificator of the association is moss species *Cratoneuron commutatum* var. *falcatum*⁴⁻⁵ practically overgrowing the stands ($I_c=93$, Fig. 1). Other characteristic species also achieve a rather high frequency and coverage values, e.g. *Heliosperma quadridentatum*¹⁻³ ($I_c=37$), *Epilobium alsinifolium*¹⁻² ($I_c=33$) and *Philonotis calcarea*¹⁻² ($I_c=24$). *C. commutatum* s. lat. and *Epilobium alsinifolium* are also transgressive characteristic species of the class *Montio-Cardaminetea*. Among the species of the order *Mon-*

io-Cardaminetalia and class *Montio-Cardaminetea* we noticed *Saxifraga stellaris*⁺³ ($I_c=26$), *S. aizoides*⁺² ($I_c=19$) and *Pinguicula alpina*⁺ ($I_c=4$). Other species of various syntaxonomical groups have lower frequency and coverage values in the stands; in half of relevés we noticed *Campanula cohlearifolia*⁺ (*Thlaspietea rotundifolii* s. lat.), *Parnassia palustris*⁺ and *Poa alpina*⁺¹ (*Elyno-Seslerietea*), the last one as constant companion species of the association. Total floristic composition is evident in the phytosociological Table 1.



Figure 1: Stand of the association *Cratoneuretum falcati* Gams 1927 from the Swiss Alps (Murgsee, 1790 m a. s. l.). Photo: B. Surina.

Slika 1: Sestoj asociacije *Cratoneuretum falcati* Gams 1927 iz Švicarskih Alp (Murgsee, 1790 m nm. v.). Foto: B. Surina.

Mosses totally dominate in stands covering at least 50 % while ferns (*Cystopteris regia* only) and flowering plants at the most 50 % of the relevé area. Most species of ferns and flowering plants are hemicryptophytes (20), six species belong to chamaephytes while there are only one geophyte and therophyte. In the stands, no phanerophyte was observed (see Phytosoc. Tab. 1 and Fig. 2).

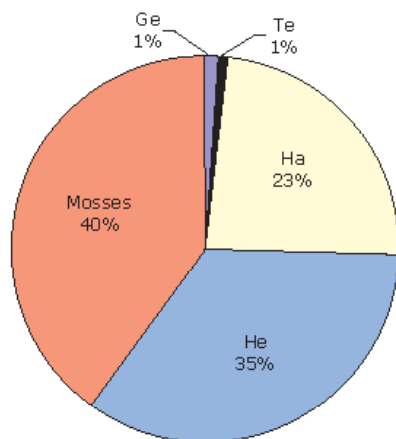


Figure 2: Plant life forms spectrum and a share of their coverage ($D_{\%}$) in the stands of the association *Cratoneuretum falcati* Gams 1927.

Slika 2: Biološki spekter in delež pokrovnosti ($D_{\%}$) življenjskih oblik v sestojih asociacije *Cratoneuretum falcati* Gams 1927.

Ecology and floristical variability of the stands

Stands of the association *Cratoneuretum falcati* are optimally developed in the subalpine and alpine belt. According to the literature data, the pH value of water is at least 7,1 (see Zechmeister 1993: 230). It looks that calcareous soil is even more important ecological parameter for the establishment of stands of the association, since it determines the water chemistry. Soil layer is rather thin and composed of mixture of humus and tiny sand particles or the stands thrive on bare rock (lithosols) with permanently trickled water, as in most of our cases. On some localities in the Krn Mts. (the locality »Čez Potoče«), stands are developed in the spring channel. In the Krn Mts. the stands beside the path from Pl. Polje pasture to the Čez Potoče pass are developed at an altitude between 1590–1864 m a. s. l. but they were also observed on shaded, calcareous rocks (2035 m a. s. l.) between the Krnska Škrbina pass and Mt. Krn (2242 m a. s. l.). The inclination of stands is quite variable; the median is $62,5^{\circ}$, minimal 10° and maximal 80° .

The relevé area rarely exceeds 4 m² (median is 2 m²). Altogether we noted 35 taxa, 28 species of phanerogams and seven moss species in stands. Four moss species stayed unidentified and they are not included in the phytosociological table. The median of the number of species per plot size is 10, minimal 6 and maximal 17 and it depends on cover values of mosses, specially of *Cratoneuron commutatum* var. *falcatum*: where mosses cover majority of

stands the number phanerogams is low and vice versa. Because of small number of species in stands of the association, the coefficient of variation of number of species per plot size is rather high (42,5 %).

Distribution and syntaxonomical position of the stands

Stands of the association *Cratoneuretum falcati* are distributed throughout the entire holarctic area (Philippi 1975). On the other hand, phytosociological data on the subject from the Southeastern Calcareous Alps are rather scarce. Aichinger (1933: Tab. 17) studied similar stands from the Karavanke Mts. and performed five relevés of spring vegetation with totally dominating *Cratoneuron commutatum*³⁻⁵. Subsequently, he placed them in the association *Cratoneuretum commutati* Aichinger 1933. These stands are most typically developed in a montane belt and they differ from stands of the association *Cratoneuretum falcati* Gams 1927 by absence or only sporadic presence of some of the characteristic species of latter, such as *Epilobium alsinifolium*, *Philonotis calcarea* and *Heliosperma quadridentatum*.

Because of taxonomic problems and difficulties in distinguishing the taxa within the *C. commutatum* aggregate, the precise evaluation of area of distribution and ecology of the association, specially on the basis of older literature data, is not possible. It is generally established that at higher altitude (above 1500 m a. s. l.) the typical form (variety) *C. commutatum* var. *commutatum* is replaced by *C. commutatum* var. *falcatum* (Zechmeister 1993: 230, Mertz 2000: 338). Although the first recordings for the Julian Alps (namely from the Mts. of Krn and Mangart) are given in the present paper, stands of the association *Cratoneuretum falcati* are much more frequent. Dakskobler observed relevant stands on many places, e.g. on slopes of Loška stena above the Koritnica valley, beneath the Mt. Šplevta above the Beli potok valley, around the spring of Mala Pišnica and many other localities (Dakskobler, pers. comm.).

Phytosociologists do not agree on the syntaxonomical treatment of stands dominated by *Cratoneuron commutatum* agg. in the Alps (*Montio-Cardaminetea*). Differences derive from the fact that the taxonomic problem concerning polymorphism of *Cratoneuron commutatum* agg. is still not completely solved. Although the taxa *Cratoneuron commutatum* (Hedw.) Roth (= *Palustriella commutata* [Hedw.] Ochrya) and *C. commutatum* var. *falcatum* (Brid.)

Mönk. prefer different habitats it is far from clear whether or not morphological characteristics of the variety "*falcatum*" are fixed genetically (Hill & al. 1994). Nevertheless, many bryologist distinguish the taxa on the level of variety (e.g. Pavletič 1955: 414, 1968: 335, Frahm & Frey 1992: 425, Smith 1996: 543, Martinčič 2003: 112) or even species level (e.g. Dierssen 2001: 137), whereas some of them within a polymorphic taxon *C. commutatum* (Hill & al. 1994, Huber 1998: 261–262). Many phytosociologists who have studied the vegetation of cold, calcareous springs, dominated by bryophytes (order *Montio-Cardaminetalia* and alliance *Cratoneurion commutati* s. lat.), have treated relevant stands within the association *Cratoneuretum commutati* Koch 1928 (e.g. Oberdorfer 1994: 37, Rodwell & al. 2002: 63) or *Cratoneuretum commutati* Aichinger 1933 (Mertz 2000: 338) within the alliances *Cratoneurion* Koch 1928 either *Adiantion* Br.-Bl. ex Horvatić 1939 (Zechmeister 1993: 232–234). In contrast, Zechmeister has been more subtle and has distinguished homogenous stands with dominating *Cratoneuron commutatum* (montane belt) from stands with *Cratoneuron commutatum* var. *falcatum* (subalpine and alpine belt). He placed the association *Cratoneuretum commutati* Aichinger 1933 in the alliance *Adiantion*, whereas the association *Cratoneuretum falcati* Gams 1927 in the alliance *Cratoneurion* (Zechmeister 1993: 229–234). In the paper we followed Zechmeister's syntaxonomical proposition.

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POVZETEK

Prispevek k poznavanju povirne vegetacije Julijskih Alp: asociacija *Cratoneuretum falcati* Gams 1927

Vegetacija hladnih povirij, v katerih prevladujejo mahovi (*Montio-Cardaminetea*), je v Sloveniji še zelo slabo raziskana. Prve tovrstne podatke za Jugovzhodne Apneniške Alpe je prispeval Aichinger (1933) pri proučevanju vegetacije Karavank. Podal

je pet fitocenoloških popisov, v katerih prevladuje takson *Cratoneuron commutatum* (= *Palustriella commutata*), in jih uvrstil v novo opisano asociacijo *Cratoneuretum commutati* Aichinger 1933. Pri raziskovanju subalpinske in alpinske vegetacije v Julijskih Alpah, predvsem v Krnskem pogorju in okolici Mangarta, smo opazili podobne povirne sestoje, v katerih prevladujejo mahovna vrsta *Cratoneuron commutati* var. *falcatum* ter nekatere vlagoljubne vrste semenk. V prispevku smo želeli podati fitocenološko oznako teh sestojev ter tako prispevati k poznavanju vegetacije razreda *Montio-Cardaminetea* v Sloveniji.

Značilno kombinacijo vrst v proučevanih sestojih sestavljajo vrste *Cratoneuron commutatum* var. *falcatum*, *Philonotis calcarea*, *Epilobium alsinifolium* in *Heliosperma quadridentatum*. Mahovna vrsta *Cratoneuron commutatum* var. *falcatum*⁴⁻⁵ je graditeljica asociacije in praktično prekriva rastišča ($I_c = 93$). Veliko pokrovno vrednost dosegajo tudi ostale značilnice asociacije, in sicer vrste *Heliosperma quadridentatum*¹⁻³ ($I_c = 37$), *Epilobium alsinifolium*¹⁻² ($I_c = 33$) in *Philonotis calcarea*¹⁻² ($I_c = 24$). Od vrst reda *Montio-Cardaminetalia* oz. razreda *Motnio-Cardaminetea* smo zapisali vrste *Saxifraga stellaris*³ ($I_c = 26$), *S. aizoides*² ($I_c = 19$) in *Pinguicula alpina*¹ ($I_c = 4$). Vse ostale vrste, ki pripadajo različnim sintaksonomskim skupinam, imajo majhno stalnost in pokrovno vrednost; v polovici popisov smo opazili le vrste *Campanula cochlearifolia*¹ (*Thlaspietea rotundifolii* s. lat.), *Parnassia palustris*¹ (spremljevalna vrsta) in *Poa alpina*¹⁻¹ (*Elyno-Seslerietea*), slednjo navaja Zechmeister (1993: 230) kot konstantno spremljevalko. Ostale vrste, ki se pojavljajo v manj kot polovici popisov, so razvidne iz fitocenološke tabele 1. V asociaciji po pokrovnosti prevladujejo mahovne vrste in pokrivajo najmanj 50 in največ 90 % površine rastišč (srednja vrednost je 65 %) (slika 2). Nekaj primerkov je ostalo nedoločenih in jih nismo vključili v fitocenološko tabelo. Praprotnice (le vrsta *Cystopteris regia*) in semenke pokrivajo največ 50 % površine rastišč, najmanj 10 %, srednja vrednost pa je 30 %. Največ praprotnic in semenk smo uvrstili v skupino hemikriptofitov (20), po eno vrsto pa med geofite in terofite. V sestojih smo opazili šest vrst, ki smo jih uvrstili v skupino hemikriptofitov.

Asociacija je optimalno razvita v subalpskem in alpskem pasu. Po podatkih iz literature dosega pH vode vrednost vsaj 7,1 (glej Zechmeister, 1993: 230), še pomembnejši okoljski parameter za razvoj asociacije pa je karbonatna podlaga, ki določa kemizem vode. Talno podlago navadno gradi tanka plast humusa in drobnega peska, a se asociacija

(kar velja v našem primeru) lahko razvije tudi na goli skali v ostenju, čez katero v večini leta meži voda oziroma na drobnem prodnem pesku v strugi manjšega potoka ali ob njej. V Krnskem pogorju smo jo opazili v nadmorski višini 1590 in 1864 m (potok ob stezi, ki od Pl. Polje vodi na prelaz Čez Potoče) oziroma 2035 m v osojnim ostenju med Krnsko Škrbino in Krnom. Naklon rastišč lahko precej niha. Njegova srednja vrednost v šestih popisih je bila 62,5⁰, najmanj 10⁰ in največ 80⁰. Sestoj smo popisali na majhni površini, in sicer na najmanj dveh in največ štirih kvadratnih metrih (srednja vrednost je 2 m²). V šestih popisih smo zapisali 35 taksonov, 27 vrst semenk, eno vrsto praproti in sedem mahovnih vrst. Štiri mahovni primerki so ostali nedoločeni in jih nismo uvrstili v fitocenološko tabelo. Da bi dobili boljši vpogled v floristično zgradbo in okoljske razmere rastišč asociacije, smo opravili tudi tri popise v območju Mangarta in jih vključili v fitocenološko tabelo.

Srednje število vrst na popisno ploskev je deset, najmanj šest in največ 17 in je odvisno od pokrovne vrednosti mahov, zlasti vrste *Cratoneuron commutatum* var. *falcatum*: kjer mahovna plast pokriva večji delež površine rastišč, se pojavlja manjše število semenk in vice versa. Koefficient variacije števila vrst na popisno ploskev je velik in znaša 42,5 %.

Philippi (1975) meni, da uspeva asociacija *Cratoneuretum falcati* v celotnem holarktičnem območju. V Julijskih Alpah smo jo zaenkrat dokumentirali le z našimi fitocenološkimi popisi (s Krnskega pogorja in Mangarta), a je gotovo bolj pogosta, saj je Dakskobler sestoj asociacije *Cratoneuretum falcati* opazil še na veliko krajih, npr. na pobočjih pod Loško steno v dolini Koritnice, pod Šplevto nad dolino Belega potoka v Trenti, v povirju Male Pišnice in drugod (Dakskobler, pisno sporočilo).

Aichinger (1933: tab. 17) je v Karavankah opravil 5 fitocenoloških popisov povirnih sestojev, kjer popolnoma dominira vrsta *Cratoneuron commutatum*³⁻⁵, in jih uvrstil v novo opisano asociacijo *Cratoneuretum commutati* Aichinger 1933. Ta asociacija dosega svoj optimum v montanskem pasu in se razlikuje od asociacije *Cratoneuretum falcati* Gams 1927 med drugim tudi v odsotnosti in skromni zastopanosti nekaterih značilnic in pogostih vrst slednje, in sicer vrst *Epilobium alsinifolium*, *Philonotis calcarea* in *Heliosperma quadridentatum*.

Taksonomske težave agregata *Cratoneuron commutatum* agg. onemogočajo natančno sintaksonomsko in okoljsko vrednotenje asociacije, saj so predvsem starejši literarni podatki o pojavljanju tega taksona nezanesljivi. Načeloma velja, da varieteta

C. commutatum var. *falcatum* v višjih legah nadomešča tipično – *C. commutatum* var. *commutatum*.

APPENDIX

Localities of relevés

1. Slovenia, the Julian Alps, Krn Mts., spring by the path from Pl. Pollje pasture to Čez Potoče pass. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 6.8.2003. 2. Slovenia, the Julian Alps, Krn Mts., spring by the path from Pl. Polje pasture to Čez Potoče pass. MTB: 9748/113, UTM: UM92; leg. & det.: B. Surina, 6.8.2003. 3. Slovenia, the Julian Alps, Mt. Mangart, above the road to Mangartsko sedlo pass, just before the highest tunnel. MTB: 9547/4, UTM: UM94; leg. & det.: D. Stešević & B. Surina, 10.8.2003. 4. Slovenia, the Julian Alps, Mt. Mangart, above the road to Mangartsko sedlo pass, just before the highest tunnel. MTB: 9547/4, UTM: UM94; leg. & det.: D. Stešević & B. Surina, 10.8.2003. 5. Slovenia, the Julian Alps, Mt. Mangart, above the road to Mangartsko sedlo pass, just before the highest tunnel. MTB: 9547/4, UTM: UM94; leg. & det.: D. Stešević & B. Surina, 10.8.2003. 6. Slovenia, the Julian Alps, Krn Mts., shady and moist rock crevices between the Krnska škrbina pass and Mt. Krn. MTB: 9748/1, UTM: UM92; leg. & det.: B. Surina, 22.8.2003.

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Table 1 (Tabela 1): *Cratoneuretum falcati* Gams 1927

Number of relevé		1	2	3	4	5	6					
Altitude (m)		1590	1864	1818	1800	1800	2035					
Exposition		E	SE	S	S	S	N					
Inclination (°)		45	10	15	45	80	80					
Cover (%)	Herb layer	C	10	40	20	20	40	50				
	Moss layer	D	90	60	70	50	90	50				
Relevé area (m ²)		2	2	2	4	3	2					
Number of taxa		7	13	17	13	7	6	fr	%	I _c	D _%	
Characteristic species combination												
<i>Cratoneuron commutatum</i> var. <i>falcatum</i>		D	5	4	4	4	5	4	6	100	92.592	23
<i>Heliosperma quadridentatum</i>		C	.	.	1	2	2	3	4	67	37.037	9 Ha
<i>Philonotis calcarea</i>		D	.	.	2	2	1	.	3	50	24.074	6
Cratoneurion, Montio-Cardaminetalia & Montio-Cardaminetea												
<i>Epilobium alsinifolium</i>		C	2	2	.	1	2	.	4	67	33.333	8 He
<i>Saxifraga stellaris</i>		C	.	.	+	2	3	.	3	50	25.925	6 Ha
<i>Saxifraga aizoides</i>		C	.	2	1	.	.	+	3	50	18.518	5 Ha
<i>Pinguicula alpina</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
Thlaspietea rotundifolii s. lat.												
<i>Campanula cochleariifolia</i>		C	+	.	+	+	.	.	3	50	11.111	3 He
<i>Adenostyles glabra</i>		C	+	+	.	.	.	.	2	33	7.407	2 He
<i>Saxifraga sedoides</i>		C	.	.	.	.	.	1	1	17	5.555	1 Ha
<i>Cerastium carinthiacum</i> / <i>austroalpinum</i>		C	.	.	.	.	+	.	1	17	3.703	1 Ha
<i>Polygonum viviparum</i>		C	.	+	.	.	.	.	1	17	3.703	1 Ge
<i>Rhodiola rosea</i>		C	.	+	.	.	.	.	1	17	3.703	1 He
<i>Leontodon hispidus</i> / <i>hyoseroides</i>		C	.	+	.	+	.	.	2	33	7.407	2 He
Elyno-Seslerietea												
<i>Poa alpina</i>		C	.	+	.	+	.	1	3	50	12.962	3 He
<i>Aster bellidiastrum</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
<i>Carex sempervirens</i>		C	.	.	.	+	.	.	1	17	3.703	1 He
<i>Thymus alpigenus</i>		C	.	+	.	.	.	.	1	17	3.703	1 He
<i>Galium anisophyllum</i>		C	.	+	.	.	.	.	1	17	3.703	1 He
<i>Juncus monanthos</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
<i>Ranunculus carinthiacus</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
Other species												
<i>Parnassia palustris</i>		C	.	+	+	+	.	.	3	50	11.111	3 He
<i>Viola biflora</i>		C	.	+	+	.	.	.	2	33	7.407	2 He
<i>Deschampsia caespitosa</i>		C	+	+	.	.	.	.	2	33	7.407	2 He
<i>Cystopteris fragilis</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
<i>Cerastium subtriflorum</i>		C	.	.	+	.	.	.	1	17	3.703	1 Ha
<i>Euphrasia picta</i>		C	.	.	.	+	.	.	1	17	3.703	1 Te
<i>Hieracium bifidum</i>		C	+	.	.	.	.	.	1	17	3.703	1 He
<i>Selaginella selaginoides</i>		C	.	.	+	.	.	.	1	17	3.703	1 He
Mosses												
<i>Bryum</i> sp.		D	.	1	.	1	.	.	2	33	11.111	3
<i>Meesia uliginosa</i>		D	.	.	.	+	1	.	2	33	9.259	2
<i>Amblystegium tenax</i>		D	.	.	2	.	.	.	1	17	9.259	2
<i>Brachythecium</i> sp.		D	.	.	.	.	.	1	1	17	5.555	1
<i>Eurhynchium striatum</i>		D	.	.	1	.	.	.	1	17	5.555	1
<i>Isoetecium myurum</i>		D	+	.	.	.	.	.	1	17	3.703	1