Thaiszia - J. Bot., Košice, 9: 49-62, 1999

THAISZIA
JOURNAL OF
BOTANY

Altitudinal differentiation of oligotrophic water-spring vegetation in Slovakia

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VALACHOVIČ M. & JANOVICOVÁ K. (1999): Altitudinal differentiation of oligotrophic water-spring vegetation in Slovakia. – Thaiszia - J. Bot. 9: 49-62. – ISSN 1210-0420.

ABSTRACT: The classification of spring plant communities occurring at low altitudes of Slovakia was made and compared with syntaxa described from neighbouring countries. All relevés were evaluated using their general ecological features (incl. content of silt, humidity, level of shade), vegetation structure, and floristical composition. We report on the occurrence of the *Caricion remotae* and two associations, such as the *Caricetum remotae* and *Carici remotae -Calthetum laetae* firstly from Slovakia.

KEYWORDS: Carpathians, syntaxonomy, water-spring communities, *Caricion remotae*

Introduction

The species-rich and physiognomic conspicuous water-spring communities in high mountains above timberline have ever been on interesting subject for plant sociologists. First associations were described in the 1920s in the Alps and the Carpathians, and were classified into high-ranked syntaxa according to synecological features, such as content of soluble calcium in water (*Cratoneurion commutati* KOCH 1928) and acidic (*Cardamino-Montion* BR.-BL. 1926). Before the World War II no data were obtained and no relevant classification was made in the lowland and montane spring communities in Europe. Until 1941 the alliance of *Caricion remotae* KÄSTNER 1941 (*Cardaminion amarae* MAAS 1959; the later name is the syntaxonomical synonym of the former) was described to enclose

spring vegetation in the realm alder and ash forests such as the *Carici remotae-Fraxinetum* KOCH ex FABER 1936 and other forest types. At present the classification into the order of *Cardamino-Chrysosplenietalia* HINTERLANG 1992 (see HINTERLANG 1992) became also accepted in Central Europe.

The group of the lowland/montane spring communities in Slovakia was for a long time overlooked. Only scarce data were published from Slovakia by PASSARGE (1979), HADAČ & SOLDÁN (1989), and FAJMONOVÁ (1991), in advance classified in the alliance of oligotrophic lowland and montane water-spring communities. Though these communities showed only small floristical differences, the authors did describe them as different associations. During the mapping and coenotic evaluation of spring biotopes in the field there was serious problem to distinguish these units one from another.

The aim of this study is to define floristical differences between the spring communities as well as to ascertain the occurrence of rare and threatened vascular plants and mosses in these units and to reveal main ecological factors controlling their differentiation. A direct motivation for a detailed study was the survey of high-ranked syntaxa, published by ZECHMEISTER & MUCINA (1994), where several data sources from Slovakia were not considered, though were known in available papers (e.g. KRAJINA, 1933; HADAČ, 1956; 1983). We attempt to test the validity of the latter synthetic survey in conditions of Slovakia, using the area of Malé Karpaty Mts as model.

Material and methods

The phytosociological data (over 100 relevés) from springs occurring in the lowlands and lower hills of Slovakia were stored in a TURBOVEG database. The relevés in the field were made using traditional methods of the Zürich-Montpellier approach using the estimation scale of BARKMAN et al. (1964). The abundance/ dominance scale were transformed according to van der MAAREL (1979) and used also in the resulting table (Tab. 1). After excluding relevés of evident transitional character to the alder forest or fen communities, the selected 79 relevés were classified using TWINSPAN (HILL, 1979). Final results were compared with similar communities from other areas in Slovakia, Romania, and the Czech Republic (Tab. 1).

Unpublished data were collected mainly in W Slovakia, in the Malé Karpaty Mts. The geology in the Malé Karpaty Mts is varied; pH of spring water depends on character of rock types, such as limestone and dolomite with alkaline reaction, and sandstone, quartzite, and slates with acidic reaction, respectively. LEHOTSKÝ & TOTH (1992) measured temperature and pH in more than 90 springs and wells located in the Malé Karpaty Mts, and found values between 4.4 - 8.7 (°C) and 4.7 - 6.7 (pH). The information on water in combination with geological maps and configuration of terrain were successfully used for searching for optimal spring-localities in the field. For the comparison with literature, the temperature and pH-values were measured directly in the field using thermo-meter and pH-meter, respectively. On each localities we estimate a content of silt and shade using simple 3-stage scale (Tab. 1).

The nomenclature of plant species follows MARHOLD & HINDÁK (1998). The names of mountains are used according map of orographic units as incorporated in a database of Slovak fauna in 1983.

Results

The traditional approach of classification of the spring communities into calciphilous and acidophilous appears at low altitudes to be impracticable. It is the mere presence of running water on decisive factor controlling spring community structure. Plant communities of varied species combination were found. Ecological interpretation of the differences between vegetation types was difficult. Nevertheless, after excluding of relevés with transitional character, three communities of the *Caricion remotae*, the alliance which is also recognised first time for Slovakia, were distinguished:

***Caricetum remotae* (Kästner 1941) Schwickerath 1944**
(Tab 1, rels. 1-32)

According to ZECHMEISTER & MUCINA (1994) the *Caricetum remotae* represents a nomenclatural type of alliance. The association was studied in Slovakia by PASSARGE (1979). Three relevés published by PASSARGE (1979) under the name *Caricetum remotae* from the Volovské vrchy Mts (see Tab. 1, column a) were overlooked and association has not been included in checklist of plant communities by MUCINA & MAGLOCKÝ et al. (1985).

Besides the diagnostic species of association, such as *Carex remota, Rumex sanguineus, Festuca gigantea,* (locally also *Veronica montana* or *Brachypodium sylvaticum*) are present in stands of the association house several sciophilous and hygrophilous plants such as *Chrysosplenium alternifolium, Circaea lutetiana, Scrophularia umbrosa, Solanum dulcamara* and forest herbs (*Geranium robertianum, Epilobium montanum, Mycelis muralis*). The latter form a group of weak differential species against other spring communities. The mean cover of herb layer is around 70 %. Mosses such as *Brachythecium rivulare* and *Palustriella commutata* play an unimportant role (less than 10 % of cover) in this community, and cover especially old timber and rocks. Locally, some species such as *Calamagrostis epigejos* and *Cirsium vulgare* indicate disturbance. Special role in relevés 1-6 plays *Veronica beccabunga.* In some habitats characterised by slowly running water, it adopts the function of a dominating species *Carex remota* becomes absent. The average number of taxa in the *Caricetum remotae* is around 15.

Typical stands of the *Caricetum remotae* are flooded depressions with irregular water regime and gravely bottom (small streams irrigating the forest roads, and forest springs disturbed by animals). The water shows an oligotrophic character, its temperature is rather high, above 7.5 °C. The content of silt is relatively low. The raw humus from poorly decomposed leaf litter dominates. Stands of the community were found in closed-canopy woodlands in the colline

and submontane belts (169-780 m a.s.l.), mostly in W Slovakia (Malé Karpaty Mts), but in similar habitats also in C and E Slovakia (see Appendix 1) .

2. *Cardamino-Chrysosplenietum alternifolii* MAAS 1959
(Syn.: *Cardaminetum amarae* MAAS 1959 p.p.)
(Tab 1, rels. 33-57)

The *Cardamino-Chrysosplenietum alternifolii* is one of the most widespread spring community in low-altitude mountain areas of Slovakia. The dominating species are *Chrysosplenium alternifolium, Cardamine amara, Impatiens noli-tangere*, *Circaea lutetiana,* and *Stellaria nemorum* - all frail hygrophilous plants. The *Carex remota* is regularly present, but only less abundant. In typical habitats, *Caltha palustris* subsp. *laeta* is absent. Moss layer is more significant due local occurrence of *Brachythecium rivulare, Plagiomnium undulatum, Conocephalum conicum,* and *Eurhynchium hians*. Average number of species is around 16 per relevé; the cover of the herb and moss layers is around 80 % and 10 %, respectively.

The habitats of this association are springs with permanently flowing water. The temperature of water is on the average 7.0 °C. The silt content is higher, especially near the slow-flowing streams. This association was recorded in the montane belt in W Slovakia (the Malé Karpaty and the Biele Karpaty Mts) as well as in central (the Kremnické vrchy Mts, the Malá Fatra Mts) and eastern parts of Slovakia (the Slovenský kras Karst and Revúcke vrchy Mts). Occasionally it can be floated near streams in lowlands (the Borská nížina lowland; ŠOMŠÁK 1993).

In case of muddy substrate, species demanding higher content of nitrates start to penetrate this community. Some of the authors (HADAČ, SOLDÁN 1989; FAJMONOVÁ 1991) ascribed such stands as the subassociation *Cardamino -Chrysosplenietum alternifolii calthetosum laetae*.

At present, the ***Chaerophyllo-Petasitetum albi* SÝKORA et HADAČ 1984** with higher abundance of *Petasites albus, Stellaria nemorum, Athyrium filix-femina* and *Impatiens noli-tangere*) and with presence of some East-Carpathian floristic elements (*Symphytum cordatum, Valeriana montana*) was separated by HADAČ & SOLDÁN (1989). from the eastern Slovakia (the Bukovské vrchy Mts). For authors it was sufficient reason to describe a new community, if the finding of *Valeriana montana* is more or less fallible. We consider ecological differences between syntaxa as negligible. Therefore we classified this vegetation type to be merely a phytogeographical variant. Some of the differences can be evoked by choice of sampling area and peculiar geology (watertight slates) typical for the Carpathian Flysch Zone. Physiognomically similar stands with dominating *Petasites albus* and *Chaerophyllum hirsutum* are common along forest roads and wet places far from water-springs in several mountains of Slovakia.

In wet places near rivulets in the Malé Karpaty Mts, similar to those in the other parts of Slovakia there are stands dominated by *Carici remotae-Calthetum laetae* COLDEA 1978. In the submontane and montane belts all of the alpine association *Calthetum laetae* KRAJINA 1933 are almost missing.

3. *Carici remotae-Calthetum laetae* COLDEA 1978
(Tab 1, rels. 58-65)

Besides the dominating *Caltha *laeta* with higher abundance in this community are present the species such as *Ranunculus repens, Lycopus europaeus, Angelica sylvestris, Crepis paludosa, Filipendula ulmaria,* and *Rhizomnium punctatum* - nearly the complete set of diagnostic species of the *Caricion remotae.* Species of the *Caricetum remotae* such as *Veronica beccabunga* and name giving *Carex remota* are occurring with lower constancy. The average number of species is 16-17. The cover of the moss layer is very low (8 % on average) and that of herb layer is around 80 %.

This association was described from submontane belt of the Plopiş Mts (Romania) as an altitudinal vicariant to the alpine *Calthetum laetae*. Small floristical difference to the relevés from Slovakia are only East-Carpathian elements such as *Oenanthe banatica* and *Telekia speciosa*, but majority of the species are common for both areas (see Tab. 1, column d).

Typical habitats are muddy alluvia of meanders of streams, and small-sized forest springs. The community occurs in low-altitude localities of Slovak mountains, where some high-altitude species are replaced by taxa such as *Carex acutiformis, Iris pseudacorus, Solidago gigantea* etc. Up to now the community is known from the Malé Karpaty Mts, the Biele Karpaty Mts, the Kremnické vrchy Mts, the Javorníky Mts, the Muránska planina Mts (VALACHOVIČ, KLIMENT, KOCHJAROVÁ, MUCINA, all unpubl.), and however it can be expected in other localities as well. In the supramontane and subalpine belts it is gradually replaced by the association *Calthetum laetae*. This pattern of floristic gradual step-by-step change is common to many of plant communities growing along streams. From this point of view a differentiation of spring communities is rather unclear. Some ecological observations of each relevé (content of silt and shade) are depicted in headings to the Tab. 1.

Discussion

The *Caricion remotae* communities are found mainly in montane belt, therefore the additional phytogeographical separation between West-European *Caricenion remotae* (Germany, Austria, the Netherlands) and East-European *Cratoneuro-Calthenion* becomes redundant (ZECHMEISTER & MUCINA 1994). Except for some character species of the class and the order (such as *Chrysosplenium alternifolium, Stellaria nemorum*), which have a broad scale of habitats and altitudinal range, the diagnostic species of both alliances (*Cratoneuro filicini-Calthion* and *Caricion remotae*) show clear altitudinal differences. The western boundary of the *Caricion remotae* must be shifted because lowland spring communities from East Slovakia and Romania should be also classified here. *Caltha * laeta* remains an unclear taxonomical problem. It occurs both in the lowland to alpine belts. The determination using follicles between *Caltha palustris* agg. (incl*. C. palustris* subsp. *cornuta*) and *Caltha palustris* subsp. *laeta* is not sufficient. Closely related species, such as *Myosotis*

palustris agg. could help by differentiation of units, of course only after detailed determination of plants.

We consider the *Caricion remotae* as altitudinal vicariant to the alpine *Cratoneuro filicini-Calthion laetae* Hadač 1983, while this differentiation can be applied to the whole Carpathians including Romania. The character species of the alliance and order are: *Carex remota, Cardamine *amara,* and *Veronica montana;* differential taxa of the alliance includes: *Circaea lutetiana, Epilobium montanum, Galium palustre, Impatiens noli-tangere, Myosotis palustris* agg., *Urtica dioica,* and *Veronica beccabunga*.

Syntaxonomical synopsis

Montio-Cardaminetea BR.-BL. et R.TX. ex KLIKA et HADAČ 1944

Cardamino-Chrysosplenietalia HINTERLANG 1992

Caricion remotae KÄSTNER 1941

Caricetum remotae (KÄSTNER 1941) SCHWICKERATH 1944
Cardamino-Chrysosplenietum alternifolii MAAS 1959
Carici remotae-Calthetum laetae COLDEA 1978

Acknowledgements

We thanks to J. Rodwell and J. Dring (Lancaster University) who provided valuable comments and linguistic corrections on an earlier draft of the paper and the Darwin Initiative that has supported this study as a partial project. We are indebted to colleagues, namely I. Háberová (B. Bystrica), M. Hájek (Brno), R. Hrivnák (Zvolen), J. Kliment, D. Bernátová, and J. Kochjarová (Blatnica) for making unpublished data available. This study was partly supported by grant from the VEGA, Bratislava, no. 4105.

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Tab. 1 on the p. 57-62.

Appendix 1: Headings to the table 1. C = the scale of content of silt: ++ high; +- medium; -- low; I = the scale of insolation: ++ sunny; +- half shaded; -- fully shaded; * no data

Rel. nr.	Area (m^2)	Alt. (m)	Exp.	Slope (°)	E_1 (%)	E_0 (%)	**C**	**I**	**OU****	Date (D/M/Y)
Caricetum remotae										
1	16	500	NW	10	75	30	--	+-	MK	18/07/1995
2	2	371	NNW	5	80	0	--	+-	MK	18/07/1995
3	20	462	W	1	90	15	++	+-	MK	19/08/1995
4	6	468	0	0	60	0	++	+-	MK	19/08/1995
5	14	522	W	10	95	0	+-	+-	MK	19/08/1995
6	9	422	0	0	90	0	+-	+-	MK	19/08/1995
7	25	335	0	0	80	5	++	+-	MK	25/05/1995
8	12	531	S	1	85	0	++	+-	MK	27/08/1995
9	16	479	SW	5	70	5	+-	+-	MK	26/08/1995
10	8	471	S	5	80	0	+-	+-	MK	26/08/1995
11	32	447	S	3	50	50	--	+-	MK	26/08/1995
12	7	371	0	0	60	0	+-	+-	MK	26/08/1995
13	9	398	0	0	95	0	++	+-	MK	19/08/1995
14	15	451	0	0	100	3	++	--	MK	19/08/1995
15	8	320	0	0	75	5	++	+-	MK	22/07/1995
16	6	320	0	0	85	0	++	+-	MK	22/07/1995
17	10	480	SSE	5	75	0	--	+-	MK	13/05/1998
18	25	590	S	5	50	3	++	+-	MK	16/08/1998
19	4	200	0	0	70	0	++	--	BN	29/06/1997
20	7.5	165	0	0	45	0	++	+-	BN	08/07/1998
21	8	165	0	0	85	0	+-	--	BN	08/07/1998
22	9	169	N	5	95	3	++	--	BN	08/07/1998
23	6	410	S	10	80	40	+-	--	MF	16/08/1997
24	12	410	W	10	90	50	+-	--	MF	16/08/1997
25	4	515	S	5	20	25	+-	--	BK	22/06/1995
26	7.5	461	S	25	20	3	+-	--	BK	23/07/1998
27	16	585	N	5	90	1	*	*	RV	25/08/1996
28	4	580	NNE	3	60	1	*	*	RV	25/08/1996

29	9	580	EEN	5	95	15	*	*	RV	25/08/1996
30	6	580	NE	5	75	0	*	*	RV	25/08/1996
32	15	600	SE	10	85	0	*	*	SK	15/08/1988
33	15	475	S	5	50	20	*	*	SK	23/06/1986
34	6	755	0	0	100	0	+-	+-	BK	08/10/1997
Cardamino-Chrysosplenietum alternifolii										
35	4	420	0	0	90	5	+-	+-	MK	26/05/1995
36	21	170	0	0	80	15	++	+-	BN	01/05/1996
37	15	450	SE	7	60	0	*	*	SK	23/06/1986
38	15	450	E	6	50	0	*	*	SK	23/06/1986
39	6	380	SW	10	30	1	++	+-	MK	06/08/1995
40	8	320	0	0	90	3	+-	--	MK	21/05/1998
41	9	360	S	2	90	3	+-	+-	MK	06/08/1995
42	16	550	E	10	85	0	*	*	SK	11/07/1988
43	12	550	E	7	50	0	*	*	SK	11/07/1988
44	12	525	E	6	75	5	*	*	SK	11/07/1988
45	16	525	E	8	100	0	*	*	SK	11/07/1988
46	16	500	SE	7	80	50	*	*	SK	11/07/1988
47	6	350	0	0	80	10	++	--	MK	25/05/1995
48	9	430	0	0	90	0	+-	+-	MK	26/05/1995
49	15	470	NW	2	85	30	+-	--	MK	26/05/1995
50	9	492	N	2	85	5	++	+-	MK	26/05/1995
51	25	390	N	3	60	3	++	--	MK	06/08/1995
52	12	365	NE	10	70	0	++	+-	MK	11/06/1995
53	3	457	W	1	50	0	+-	+-	MK	11/06/1995
54	2.5	465	EES	3	35	1	++	--	MK	24/09/1995
55	9	415	W	2	95	20	+-	--	MK	21/05/1998
56	6	307	N	5	50	50	+-	++	MK	22/07/1995
57	12	500	E	5	90	2	++	+-	MK	02/07/1995
58	15	457	W	3	60	0	+-	--	MK	27/08/1995
59	30	390	S	10	35	1	++	--	MK	26/08/1995
61	24	765	S	4	85	0	*	*	KV	*
Carici remotae-Calthetum laetae										
62	4	400	0	0	70	5	+-	+-	MK	03/06/1995
63	25	390	W	2	80	5	++	+-	MK	03/06/1995
64	10	166	0	0	95	0	+-	+-	BN	09/05/1997
65	2	235	N	5	80	15	+-	+-	MK	03/06/1995
66	20	397	E	2	50	20	++	--	BK	23/06/1995
67	10	387	0	0	85	10	+-	+-	BK	23/06/1995
68	18	170	0	0	90	2	++	+-	BN	01/05/1996
69	25	750	N	10	90	25	++	+-	BK	08/10/1997
70	10	260	0	0	40	5	++	+-	RV	18/06/1997
71	20	410	SWW	5	70	60	+-	+-	MF	16/08/1997
72	12	412	W	1	80	10	++	--	MK	03/06/1995
74	3	750	N	5	85	5	+-	+-	BK	08/10/1997
75	20	172	0	0	90	0	++	--	BN	01/05/1996
78	20	572	NNE	5	70	50	*	*	VV	10/05/1998
79	7	*	E	15	100	40	*	*	LV	01/06/1978

**** Orographic units (OU):** MK = Malé Karpaty, BK = Biele Karpaty, RV = Revúcka vrchovina, SK = Slovenský kras, BN = Borská nížina, MF = Malá Fatra, NT = Nízke Tatry, LV = Laborecká vrchovina, VV = Volovecké vrchy Mts. Headings to rels. 30, 60, 73, 76, and 77 from KV = Kremnické vrchy Mts and Muránska planina Plain were uncomplete.

Tab. 1: Plant communities of *Caricion remotae* and their comparison with published data (a - 3 rels. PASSARGE 1979; b - 10 rels. FAJMONOVÁ 1991, tab. 1, 7 rels. HÁBEROVÁ in SLÁVIKOVÁ et al. 1996, 1 rel. ŠOMŠÁK; c - 17 rels. HADAČ, SOLDÁN 1989, tab. 2-3; d - 5 rels. COLDEA 1978, tab. 2).

Relevé number	123456789111111111122222222223333			333334444444444555555555566				6666666677777777		
	012345678901234567890123 4	C. %	a	567890123456789012345678901	C. %	b %	c %	234567890123456789	C. %	d %
Caricetum remotae - characteristic (c) and differential (d) taxa										
Carex remota c	**433b34a1+13++...4a31b543bb1354133.**	**88**	*3*	1++r........1a1..+a++.+++.+	56	28	41	........+1...+....	17	100
Veronica beccabunga d	**+1+..+b4341b5444++.b...+..3a+1++.5**	**74**	*2*	.....+.............1....4.	11	11	-	....+...++.1......	22	40
Rumex sanguineus d	**+r.+++.+++++1..+**.....	**35**	-	.....+..	4	-	-	.......1....+.....	11	-
Festuca gigantea d	**...+.+.....+.1+.+.r.....+**.....	**24**	*1*	......+.....	4	-	6	.....	-	-
Scrophularia umbrosa d	**1.....1.++..+3a.....a..r**	**27**	-	.....a+.....	7	-	-	...+........+.....	11	-
Cardamino-Chrysosplenietum alternifolii										
Chrysosplenium alternifol.	..3a413ba.+b...+b.....b1b.ra..	47	*3*	**.....4r13a333b3bba1b3a3a11**	**78**	**83**	**82**	.....1..+...++1	28	40
calthetosum laetae										
Chaerophyllum hirsutum d	.....	-	*2*	.....r4	7	**94**	**82**	.....+....++..	17	80
Petasites albus d	.....+	3	-	.....	-	**61**	**82**	.....	-	-
Stellaria nemorum agg. d	.....r....+.....	6	*2*	.+.....+.....+a	15	**61**	**88**	.....+r..+....+.	22	-
Geum rivale d	.....	-	-	.....+	4	**39**	**35**	.....++r.	17	-
Lysimachia nemorum	.....	-	-	.....	-	**39**	**29**	.....	-	-
variant ?										
Symphytum cordatum	.....	-	-	.....	-	-	**47**	.....	-	-
Brachythecium rutabulum	.....	-	-	.....	-	-	**41**	.....	-	-
Carici remotae-Calthetum laetae										
Caltha palustris c	.....b....+1.....+	12	-	.+r.....13	15	**94**	**71**	**3443bbab314ab13334**	**100**	**100**
Equisetum arvense d	.1.+.....+.+.+...+.1.....r	24	-	.+.....+.....	7	-	6	**..1+a.+1+...+++..+**	**56**	**-**
Lycopus europaeus	+.+1.+.....1..+r+.+...+.....	29	*1*	1.....r.....	7	-	6	**+1a1.1..r+rr**.....	**50**	**-**

Caricion remotae and Cardamino-Chrysosplenietalia										
*Cardamamine * amara* c	.aa...3....brm.+1+ma..++..4bbb3a1r	62	*2*	**45a3a5a43+4ab44433bb4....33**	**85**	**83**	**82**	+.....55aaa445++ba	72	40
Athyrium filix-femina d	+.1.+..+...+....+....+aa......+.+.	32	*3*	..r++.++++r..+...++r..1++++	63	50	100	.........+......+.	11	-
Impatiens noli-tangere d	+.3a11bb...1.a1.a11...++.rb1ba11+.	68	*2*	1.a++abaaa1aa+ba1a++aa3aaa3	96	72	77	++.....a+++++...+.	50	40
Ranunculus repens d	..+1+1......++1a.a1...aa..aab1a1a.	56	*2*	a+...+...1+..+..+...1+...a+	41	39	47	11b11a+.++1....+11	72	100
Urtica dioica d	..1.11+.++++...r+.+........r+.1rr.	47	*2*	1+.r++1r.rr.11.+++1.+.a+++1	78	39	47	..r....++...+..+..	28	-
Circaea lutetiana d	+rb+1+.+++.+..+.a11..+...+........	47	-	.r..++b.......1+1.++.+11+..	48	-	29	............+....+	11	-
Veronica montana c	.+.1.+.+......+...................	15	-	.....................+.....	4	-	24	....	-	-
Montio-Cardaminetea										
Crepis paludosa	......................r+..........	6	*1*	.........................+1	7	44	18	....13..........++	22	40
Stellaria alsine	.....1.................+.......+..	9	-	.......r..+.....1........3.	15	11	-	...........3......	6	40
Cardamine flexuosa	.....+............................	3	-	.........................r..	4	-	12	....	-	-
Brachythecium rivulare	..a..+..1....+a..+...+.b.+........	27	*1*	1b..+++.......31+...b3+.+..	44	22	41	11.aa1.b.+a+3...3.	61	60
Plagiomnium undulatum	+.1...................aa..........	12	*2*	............a..............	4	33	29	.........+......1.	11	60
Rhizomnium punctatum	.....................+aa..........	9	*1*	....	-	44	53	.........a....+3a.	24	40
Palustriella commutata	3.........3.............3.........	9	-	....................+......	4	-	6	.........1........	6	-
Cratoneuron filicinum	........1.....+...................	6	-	....	-	-	-	...1...1....a.....	18	-
Others										
Myosotis palustris agg.	.+.1.a.....aa+.b....1.++.......a1.	35	-	.r.......1+1........+1...aa	29	72	-	.+.1+...+4++.....1	44	80
Geranium robertianum	++..+...++....+..+......++.r..ra..	35	*2*	...r..ar.r+1........+.++...	33	11	6	.....1...........+	11	-
Carex sylvatica	..........+...a.1........+........	12	-	....b.+.........++...+..++.	26	39	24	.......+..........	6	-
Oxalis acetosella	....+..+......+...a..a+1....+..1..	27	*1*	....+.1..+.......a.+.+.1...	26	33	18	.........+.....1+.	17	-
Epilobium montanum	.+..+..++.....+.r.............r...	21	-	....+.........+.........+b.	15	6	12	..........ra......	11	-
Deschampsia cespitosa	....................1.........a1.	9	-	..........r.............+.	7	17	12	........b.....1...	11	-
Senecio ovatus	..r..r.................+.........	9	-	..............+1.++........	15	33	18	.+................	6	-
Acer pseudoplatanus	..+...................r.......r..	9	-	...r..................+....	7	6	18	.+........r.......	11	-
Ajuga reptans	.........+.......1...+r...........	12	-	.............+1.....+......	11	28	18	.+..1.............	11	-
*Rumex * sylvestris*	...r............+..........r++....	15	*2*	1...r...........+...1.1....	19	6	-	............+.....	6	-

Galium palustre	...+.+......++....+.+............	18	*2*	.............1.+...r......	11	11	6	.....+.+.........	11	-
Circaea alpina	..........................rrr..++.	15	*2*	.........1+...............	7	6	-	....	-	-
Myosotis nemorosa	....	-	*3*	....	-	6	53	.............++..	11	-
Dryopteris filix-mas	..................a...........++.	9	-	.........+.+....+.+.......	15	-	6	..............1..	6	-
Stachys sylvatica	..........................r.1.....	6	*1*	..................+.......	4	6	18	....	-	-
Lysimachia nummularia	..........+...1...........+......	9	-	....................1.....	4	-	6	.....+.+....1.....	17	100
Angelica sylvestris	.......................r..........	3	-	................r.........	4	6	-	11.r..1...+.......	28	-
Poa nemoralis	......................+..........	3	-	........+..+.............+.	11	11	6	.........+........	6	-
Milium effusum	......1..........................	3	-	............+.+..........+.	11	11	-	...........+......	6	-
Chiloscyphus polyanthos	....................+............	3	-	....	-	-	18	.........3........	6	-
Dryopteris carthusiana	......................+...........	3	-	.+............+...........r	11	-	-	......+......r..+.	17	-
Equisetum palustre	......+.....+4...................	9	-	.............1..........a.	7	11	12	.....1....+.......	11	60
Filipendula ulmaria	.................+.............+.	6	-	.+........................1	7	11	41	..+...+.1......1+.	28	60
Galium odoratum	..1.+............................	6	-	.............++....+..+....	15	6	24	....	-	-
Atrichum undulatum	......................ab..........	6	-	....	-	-	29	.........+........	6	-
Solanum dulcamara	1+...1a.+.+.1+..+1...............	29	-	.....b+.....+.1..1...13.1..	30	-	-	.1+.....+.+.....+.	28	-
Juncus effusus	...+............+..+.1+b....+.+...	24	-	....	-	11	12	..............3.r.	11	20
Lysimachia vulgaris	............+....+++++.a..........	21	-	....	-	6	-	....++..r.......r.	22	20
Mentha longifolia	..........+..................a.++	12	-	.........................r.	4	-	-	...1...1...a+.....	22	60
Conocephalum conicum	......................+..........	3	-	....	-	28	6	.........b........	6	-
Rubus idaeus	..+..............+..+...........	9	-	+............++...+......r.	19	11	-	.....a............	6	-
Rumex acetosa	................................1.	3	-	....	-	11	.	..............+...	6	-
Equisetum sylvaticum	......................+a.........	6	-	1	4	-	6	..............1+.	11	-
Glechoma hederacea	...+a..........1.................	9	-	....r+1.....1....1...+.....	22	-	-	.+................	6	-
Carex acutiformis	.............+.....+b............	9	-	.1.........................	4	-	-	......b......a....	11	-
Fraxinus excelsior	++......++..............r........	15	-	.r................+.......	7	-	-	..........+.......	6	-
Epilobium ciliatum	.....+..1..+.....................1	12	-	................+..r.......	7	-	-	.......+....+.....	11	-
Persicaria hydropiper	....11......+.....................	9	*1*	................+..........	4	-	-	........r.........	6	-

Eupatorium cannabinum	..............+..1......1.........	9	-	.....................r..+..	7	-	-	...+1....r........	17	-
Sambucus nigra	..r....r................r.........	9	-	..............r.........r..	7	-	-	.+................	6	-
Eurhynchium hians	..1...1...........................	6	-	.a..........a.+............	11	-	-	......+...........	6	-
Aegopodium podagraria	.................+.....+..........	6	-	.....a........1.....1+.....	15	6	6	....	-	-
Scrophularia nodosa	................r....r............	6	-	..........r.........+...+r.	15	-	-	....	-	-
Epilobium roseum	...........................rr.....	6	*1*	+.....r.......+.+..........	15	6	-	....	-	-
Poa trivialis	....	-	-	.....++.............a......	11	17	-	..a.+..++...+.....	28	100
Doronicum austriacum	....	-	-	.........................++	7	11	6	...............+..	6	40
Cardamine pratensis agg.	....	-	-	..........................+	4	-	-	..............a...	6	60
Scirpus sylvaticus	....	-	-	.........................++	7	11	-	....+.........a.+.	17	40
Epilobium parviflorum	........+1...+.................1..	12	-	..r.....r++................	15	-	-	....	-	40
Iris pseudacorus	...................r..............	3	-	....	-	6	-	.............1....	6	-
Valeriana officinalis	...............................r..	3	-	....	-	11	-	................+.	6	-
Viola sp.	....+.............................	3	-	....r......................	4	-	-	....	-	-
Petasites kablikianus	...............................a..	3	-	........r..................	4	-	-	....	-	-
Luzula luzuloides	...............................1..	3	-	........+..................	4	-	-	....	-	-
Acer platanoides	.....................+............	3	-	.................r.........	4	-	-	....	-	-
Scutellaria galericulata	....+.......1......+..............	9	-	................+..........	4	-	-	....	-	-
Persicaria dubia	........3+.1......................	9	-	........................+..	4	-	-	....	-	-
Rumex crispus	..............................+...	3	-	.......r+rr................	15	-	-	....	-	-
Impatiens parviflora	..........+.......................	3	-	.............++..a.....a1..	19	-	-	....	-	-
Myosoton aquaticum	...............................1..	3	-	.......a1+aa...............	19	-	-	....	-	-
Mycelis muralis	....+...r+....r..r......1...+.....	21	-	....r......................	4	-	-	....	-	-
Juncus conglomeratus	................................+.	3	-	1	4	11	-	....	-	-
Agrostis stolonifera	............3............1....+1..	12	*1*	.........................+.	4	6	-	....	-	-
Glyceria declinata	...++.......+..........+..........	12	-	....	-	-	-	...+.....1........	11	-
Galeobdolon montanum	......................r1..........	6	-	....	-	17	-	....	-	-
Lythrum salicaria	...+...............+..............	6	-	....	-	-	-	....++............	11	-

Acer campestre	....+.............................	3	-	....	-	-	-	....r.............	6	-
Pulmonaria officinalis	.r................................	3	-	....	-	-	-	....+.............	6	-
Mentha arvensis	...........................+......	3	-	....	-	-	-	..a...............	6	-
Berula erecta	....................a............	3	-	....	-	-	-	...a..............	6	-
Pellia sp.	..............+...................	3	*2*	....	-	-	-	................+.	6	-
Plagiomnium affine	....	-	-	..............1............	4	-	12	.......+..........	6	-
Plagiomnium sp.	....	-	-	.....................1.....	4	6	-	....	-	-
Plagiomnium cuspidatum	....	-	-	.1.........................	4	-	6	....	-	-
Galium aparine	....	-	-	.....+..............+......	7	6	-	....	-	-
Ficaria bulbifera	....	-	-	.....r.......rab...........	15	-	-	...1..............	6	-
Geum urbanum	....	-	-	.....r+....................	7	-	-	......r...........	6	-
Solidago gigantea	....	-	-	.r.........................	4	-	-	..1...+......+....	17	-
Valeriana dioica	....	-	-	.r..................+.....	7	-	-	.....+r...........	11	-
Ribes uva-crispa	....	-	-	.+.........................	4	-	-	......+......r....	11	-
Cirsium oleraceum	....	-	-	....	-	11	6	++......+.+.....br	33	-
Plagiochila asplenioides	....	-	-	....	-	6	-	...........++..1+.	22	-
Tephroseris crispa	....	-	-	1	4	28	-	..............a1..	11	-
Cirsium palustre	....	-	-	.........................r.	4	11	6	..............+...	6	-
Carex paniculata	....	-	-	.........................+.	4	6	-	......+...........	6	-
Poa remota	....	-	-	1	4	11	-	..........1......	6	-
Poa palustris	....	-	-	.........................1.	4	-	-	..........+......	6	-
Brachypodium sylvaticum	+.+..a...+.......+....r+..........	21	-	....	-	-	-	....	-	-
Persicaria sp.	..................1......1+1+....	15	-	....	-	-	-	....	-	-
Tussilago farfara	a....+...+.....................+.	12	*1*	....	-	-	-	....	-	-
Myosotis caespitosa	.........................b+a+....	12	-	....	-	-	-	....	-	-
Calamagrostis epigejos	b....+..++.......................	12	-	....	-	-	-	....	-	-
Cirsium vulgare	+....+...1.......................	9	-	....	-	-	-	....	-	-
Glyceria notata	........+..........+............b	9	-	....	-	-	-	....	-	-

Hypnum cupressiforme	......................b1..........	6	-	....	-	-	-	....	-	-
Parietaria officinalis	.....a...r........................	6	-	....	-	-	-	....	-	-
Rumex conglomeratus	.........+..+.....................	6	-	....	-	-	-	....	-	-
Allium ursinum	....	-	-	....	-	-	-	++........+.......	17	-
Veronica chamaedrys	....	-	-	....	-	-	-	.....+........+...	11	-
Cruciata laevipes	....	-	-	....	-	-	-	..r............+..	11	-

In one relevé only: rel. 1: *Encalypta streptocarpa* +; **3:** *Dryopteris dilatata* +; **6:** *Prunella grandiflora* +, *Potentilla anserina* r; **9:** *Poa annua* +; **10:** *Atropa bella-donna* +; **17:** *Glyceria nemoralis* +; **18:** *Fraxinus excelsior* (E_3) 2a; **19:** *Euonymus europaeus* r; **21:** *Lemna minor* 2a, *Phalaroides arundinacea* +, *Veronica anagallis-aquatica* r; **22:** *Tilia cordata* +, *Mnium hornum* 1, *Eurhynchium* sp. +; **23:** *Rubus caesius* +, *Rosa* sp. r; **24:** *Dactylis polygama* +, *Alnus glutinosa* r; **26:** *Equisetum telmateia* r; **29:** *Ulmus glabra* r; *Salvia glutinosa* r, **31:** *Circaea x intermedia* +, **34:** *Agrostis gigantea* r; **47:** *Stellaria holostea* 2a; **49:** *Maianthemum bifolium* r; **51:** *Philonotis* sp. +; **52:** *Dentaria bulbifera* r; **55:** *Sambucus ebulus* 1, *Galeopsis speciosa* r; **56:** *Cornus sanguinea* r; **58:** *Galeopsis tetrahit* r; **60:** *Calliergonella cuspidata* 2a, *Mnium* sp. 1, *Carex canescens* +, *C. pallens* +, *Hypericum hirsutum* +, *H. maculatum* r, *Galium mollugo* +, *Lathyrus pratensis* +, *Juncus* sp. +, *Festuca rubra* +, *Salix* sp. r, *Luzula pilosa* r, *Silene dioica* r; 61: *Rumex* sp. +; **64:** *Ligustrum vulgare* (E_2) +, *Humulus lupulus* +, *Padus avium* +; **67:** *Ranunculus acris* +, *Dactylis glomerata* +, *Cerastium fontanum* +, *Listera ovata* +, *Colchicum autumnale* +, *Carex hirta* +, *Allium scorodoprasum* +, *Cirsium erisithales* +, *C. rivulare* +; **69:** *Myosotis sylvatica* agg. 1, *Anthriscus sylvestris* +, *Taraxacum* sect. *Ruderalia* r; **70:** *Viburnum opulus* +, *Rhizomnium* sp. 1; **72:** *Carex acuta* +; **73:** *Acetosella vulgaris* +, *Galium uliginosum* +, *Gymnadenia conopsea* r, *Veratrum album* r, **74:** *Geranium palustre* +, *Galium* sp. 1, *Alchemilla* sp. r, *Cirsium arvense* r; **75:** *Peucedanum palustre* +; **76:** *Anthoxanthum odoratum* 1, *Luzula luzulina* +, *Ranunculus auricomus* +, *Carex flacca* +, *Cruciata glabra* +, *Sphagnum capillifolium* 2a, *Plagiomnium elatum* 2a, *Polytrichum formosum* +, *Rhytidiadelp triquetrus* 1, *Climacium dendroides* +; **77:** *Valeriana simplicifolia* +, *Athyrium distentifolium* +, *Dryopteris* sp. +, *Silene nemoralis* +, *Eurhynchium angustirete* 2a, *Plagiothecium denticulatum* 2a, *Lophocolea bidentata* +; **78:** *Myosotis scorpioides* 2a, *Polytrichum gracile* +, *Dicranum scoparium* +, *Salix caprea* juv. +; **79:** *Equisetum pratense* r.

Received: 16 October 1998
Revised: 4 May 1999
Accepted: 10 May 1999