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Distribution and habitat requirements of the moss *Hamatocaulis vernicosus* (Mitt.) Hedenäs in the Bohemian Forest

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Abstract
The species *Hamatocaulis vernicosus* is a fen moss, which is endangered and protected in Europe. Recently we have known 9 localities of this species in the Bohemian Forest. Vegetation relevés and detailed water chemistry were investigated at all localities and subsequently compared with data on *H. vernicosus* from different parts of the Czech Republic. The studied species grows in similar vegetation types in all of the Czech localities, including the Bohemian Forest. However, in the Bohemian Forest sites, chemical composition of water differs markedly, particularly in Ca, Mg and NO_3^- contents.

Key words: bryophytes, Czech Republic, fens, Šumava Mts., vegetation, water chemistry

Introduction

Hamatocaulis vernicosus is a red-list moss species throughout most of Europe, attaining even the official listing of the Bern Convention (Council Directive 92/43/EEC 1992). An increased focus on *Hamatocaulis vernicosus* because of its protection under the EU Habitat Directive led to a more detailed exploration of its habitat requirements in Europe (e.g., Hugonnot 2003, Müller & Baumann 2004).

The species prefers mineral rich habitats with a high groundwater table. However, sometimes it occurs also at fishpond margins, where it is able to survive even slight eutrophication by nutrient-rich pond water, or in fen meadows, where abundance and vitality of the moss decrease due to a lack of water (Hedenäs 1989, Navrátilová et al. 2006, Štechová & Kučera 2007, Štechová et al. 2008).

In the Czech Republic, 50 recent localities of *H. vernicosus* are known. The localities occur predominantly in the Třeboňská Pánev basin and Českomoravská Vrchovina highland, where natural conditions favour abundant mire and spring occurrences. The Bohemian Forest (Šumava Mts.) is also very rich in mires, but until 2003, only two records of *Hamatocaulis vernicosus* were known from this region. Velenovský (1894) mentioned the occurrence of the species in the vicinity of Železná Ruda and Hůrka. Since 2003, more intense bryofloristic research has started and the moss was found in different parts of the Bohemian Forest as well (Holá & Jakšičová 2004, Mikulášková 2007, Štechová et al. 2007). Currently, the species is known from nine localities in the Bohemian Forest. These localities

differ from localities in other parts of the Czech Republic not only by a markedly higher altitude, but also by the different composition of the vegetation at some sites. Hence we decided to study the vegetation relationships of *Hamatocaulis vernicosus* and groundwater chemistry at its localities in the Bohemian Forest. We asked the following specific questions:

1. What is the distribution of *H. vernicosus* in the Bohemian Forest and how big are the populations at the different localities?
2. Under which water chemistry does the species occur?
3. Which species do grow together with *H. vernicosus*?
4. Are *H. vernicosus* populations endangered? What kind of management is most suitable for the long term conservation of the *H. vernicosus* populations?

Material and Methods

In the summers 2005–2008, vegetation at nine localities of *Hamatocaulis vernicosus* in the Bohemian Forest was assessed in the same way as the other localities of this moss in the Czech Republic (Štechová & Kučera 2007, Štechová & Štech, 2009). In each locality, vegetation was analysed in one plot of 4×4 m. The plots were placed to cover the largest part of *H. vernicosus* populations. At the sites, where populations of *H. vernicosus* were small, the 4×4 m plots were rather large for bryological investigation and the large plot size can be responsible for the large variation in the species composition. However, the same sizes were used for all sites to obtain comparable results of investigation. Percentage cover of all vascular plants and bryophytes was visually estimated.

Because the chemistry is more stable in autumn (Tahvanainen et al. 2003), all water samples for detailed analyses of water chemistry were collected at one day in November (2008). The samples (one sample per plot; each sample was mixed from three parts that ware collected at points in the immediate vicinity of the studied moss) were filtered over a glass filter and frozen within 24 hours for later analyses. NH_4^+, NO_3^- and PO_4^{3-} were determined colorimetrically by flow injection analysis (FIA Lachat QC8500 – Lachat Instruments, USA), total N (LiquiTOC), Ca^{2+}, Fe, Mg^{2+}, Na^+ and K^+ concentration was analyzed spectrophotometrically (SpectrAA 640, Australia). Water pH was measured *in situ* using a portable device (Vario pH, WTW, Germany). The measurements were conducted directly in free spring water circumfluent the studied mosses. When the water level was several centimetres below the surface, the small shallow pit was dug and spring water was allowed to clarify before measurement. Measurements were made at three spots in *Hamatocaulis* patches within each of the sampling plots.

Differences between water chemistry of localities in the Bohemian Forest and 19 sites in other parts of the Czech Republic (Štechová & Kučera 2007, Štechová & Manukjanová, unpubl.) were tested by non-parametric Mann Whitney U-tests in the Statistica for Windows package ver. 8 (StatSoft Inc. 2007).

The nomenclature of bryophytes follows Kučera & Váňa (2005), the nomenclature of vascular plants follows Kubát et al. (2002).

Results and Discussion

Distribution of *Hamatocaulis vernicosus* in the Bohemian Forest

We found *Hamatocaulis vernicosus* at nine localities in the Bohemian Forest (Table 1, Fig. 1). All sites belong to large complexes (usually tens of hectares) of peaty habitats in

Table 1. Geographic information on the localities of *Hamatocaulis vernicosus* in the Bohemian Forest, the Šumava National Park (NP). Co-ordinates measured by GPS (WGS 84; accuracy approximately 5 m).

Locality	Zonation of national park	Altitude (m)	Co-ordinates	Cadastral unit
Chalupská Slať	I zone NP	960	N49°00′09″ E13°39′44″	Svinná Lada
Jezerní Potok near Cetlova Hůrka	I zone NP	860	N49°08′01″ E13°21′30″	Prášily
Kvilda	II zone NP	1060	N49°00′31″ E13°33′55″	Kvilda
Slunečná near Prášily	II zone NP	898	N49°06′02″ E13°24′03″	Prášily
Velký Bor	II zone NP	855	N49°05′49″ E13°26′22″	Prášily
Zhůří near Horská Kvilda	II zone NP	1124	N49°04′55″ E13°33′17″	Zhůří near Horská Kvilda
Zhůří near Křemelná 1	II zone NP	898	N49°10′21″ E13°19′54″	Zhůří
Zhůří near Křemelná 2	II zone NP	910	N49°10′13″ E13°19′58″	Zhůří
Zhůřská Pláň, PR	NR; PLA	1000	N49°11′34″ E13°20′02″	Zhůří

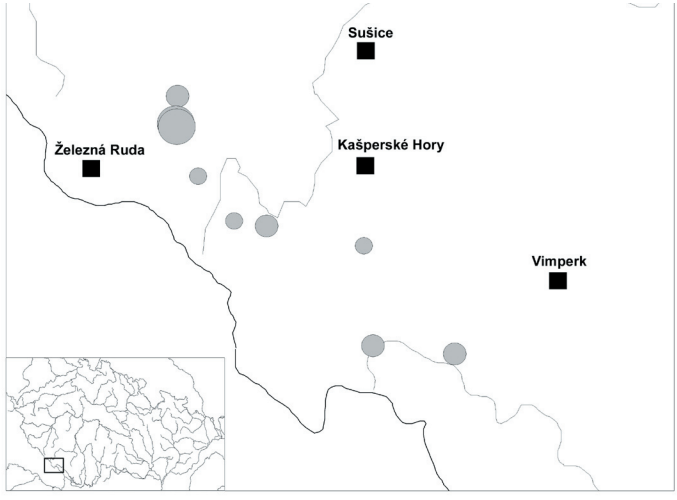

Fig. 1. Map of the studied localities. The symbol size corresponds to a population size of the species at localities.

various stages of succession. Three localities are located in the surrounding of the former village of Zhůří NE of Železná Ruda, three other localities occur around the village of Prášily and the other localities are situated close to the villages Horská Kvilda, Kvilda, and Borová Lada. Compared with localities in other parts of the Czech Republic (e.g., Štechová & Štech, 2009), most of the populations of *H. vernicosus* are rather small. At the locality "Slunečná near Prášily", the population of *H. vernicosus* comprises only of about ten stems. The moss grows here in a narrow moist ditch directly among *Sphagnum teres* and *S. flexuosum*. Populations of *H. vernicosus* are small also at the "Zhůří near Horská Kvilda" and "Jezerní Potok" localities; about one hundred stems were found at each site. At the two latter localities, no intense competition with *Sphagnum* species is presumed, as *H. vernicosus* grows mainly among *Warnstorfia exannulata* and *Calliergonella cuspidata*. At the "Kvilda", "Velký Bor" and "Zhůřská Pláň" localities, the populations of *H. vernicosus* are larger, and

the moss grows in rather compact clumps with size of about 500 cm^2. The population at the "Chalupská Slať" mire has approximately the same size as at the previous three localities, but pattern of the moss growth is more similar to the first three localities: the stems were dispersed in a wet stretch of about 5 m among *Sphagnum flexuosum* and *S. teres*. At the "Zhůří near Křemelná 1 and 2" localities, the species grows in mosaic with *Sphagnum* species (most often *S. flexuosum*, *S. contortum,* and *S. warnstorfii*) and other brown mosses (*Calliergonella cuspidata*, *Calliergon giganteum*, *Campylium stellatum,* or *Scorpidium cossonii*). Its absolute cover is a few square metres. This population belongs to the largest populations of *H. vernicosus* in the Czech Republic.

With respect to both great fen commonness in the Bohemian Forest and limited knowledge of their bryoflora, we can not exclude new findings of *H. vernicosus* at other localities in future. Therefore, thorough exploration of this area would be very desirable.

Chemistry at the localities

Water chemistry at *H. vernicosus* localities in the Bohemian Forest (Table 2) differs significantly from that at other Czech localities in Ca^{2+} content (U = 12, p = 0.0003), Mg^{2+} content (U = 6, p = 0.0001), and NO_3^-content (U = 41, p = 0.03). Calcium, magnesium and nitrate concentrations are obviously lower at the Bohemian Forest sites. Analogous, but not statistically significant pattern was found also for iron and potassium (Table 3, Fig. 2). It is interesting that for some of the water chemistry measurements (pH, Na^+, total N, NH_4^+, and NO_3^-), variation in the Bohemian Forest (9 localities) was larger than in other sites of the Czech Republic (19 localities).

In the Bohemian Forest, the average pH values (6.1) are very similar to the average values previously found in other parts of the Czech Republic (6.2; Štechová & Kučera 2007, Štechová & Štech, 2009), and in Scandinavia (6.3; Hedenäs & Kooijman 1996). All of our pH measurements fall within the range reported from Scandinavia (5.4–7.8; Hedenäs 2003). It is likely that pH of the habitats plays some role in shaping the population size of *H. vernicosus*. In more acid conditions, abundance of *Sphagnum* spp. is very high and spatial competition between *Sphagnum* spp. and *H. vernicosus* as well as other mosses of neutral habitats is presumed to be very strong with advantages for the *Sphagnum* species (cf. Kooijman

Table 2. Chemical composition of the water at nine localities with occurrences of *Hamatocaulis vernicosus* n the Bohemian Forest.

Locality	pH	Ca^{2+}	Na^+	K^+	Mg^{2+}	Fe	N-NH^4	N-NO^3	total N	P-PO^4
		$mg.l^{-1}$	$mg.l^{-1}$	$mg.l^{-1}$	$mg.l^{-1}$	$mg.l^{-1}$	$\mu g.l^{-1}$	$\mu g.l^{-1}$	$mg.l^{-1}$	$\mu g.l^{-1}$
Chalupská slať	6.20	4.16	50.92	1.60	1.54	0.55	9.02	34.64	0.90	9.11
Jezerní potok near Cetlova Hůrka	5.40	3.22	6.36	0.41	0.76	0.50	42.05	37.61	0.90	8.57
Kvilda	5.70	2.20	5.29	0.26	0.71	0.48	14.46	25.26	0.68	8.57
Slunečná near Prášily	6.10	1.97	1.74	2.99	0.37	0.22	28.26	23.45	0.93	16.91
Velký Bor	6.10	2.85	4.26	0.68	0.70	0.53	85.61	94.07	1.33	10.19
Zhůří near Horská Kvilda	5.60	2.71	6.75	7.04	1.10	0.16	738.63	15.88	1.60	14.49
Zhůří near Křemelná 1	6.30	3.31	6.36	0.36	0.91	0.34	41.69	22.30	0.74	14.76
Zhůří near Křemelná 2	7.00	3.16	6.52	0.35	0.91	0.28	17.00	44.19	0.55	11.26
Zhůřská pláň, PR	6.70	6.49	8.27	3.42	1.08	0.43	274.00	45.84	2.29	12.61

& Bakker 1994, 1995). The highest pH we measured was about 7 at "Zhůří near Křemelná 2", where the population size is comparable to the three largest populations of the species in the Czech Republic. Interestingly, sites of these largest populations also have pH ~7 (Štechová & Kučera 2007, Štechová & Štech in prep.).

On the other hand, Ca^{2+} content, which is also one of the most crucial factors influencing species composition of fen vegetation (e.g., Tahvanainen 2004), is very low at the localities in the Bohemian Forest, ranging between 2 and 6.5 mg.l^{-1}. At all other Czech localities of *H. vernicosus*, Ca^{2+} content was not lower than 3.5 mg.l^{-1} and its mean value was about 10 mg.l^{-1} (Štechová & Kučera 2007, Štechová & Manukjanová, unpubl.), which is analogous to Scandinavian localities of the species, where the lowest reported value is 2.5 mg.l^{-1} (Hedenäs 2003), and the mean value is about 14.8 mg.l^{-1} (Hedenäs & Kooijman 1996).

Contents of Fe was slightly lower (mean values 0.39 mg.l^{-1}) than at other Czech localities (mean content about 0.8 mg.l^{-1}; Štechová & Kučera 2007), and considerably lower than at localities in Scandinavia, where mean Fe content was 2.24 mg.l^{-1} (Hedenäs & Kooijman 1996) and the lowest measured value was 0.41 mg.l^{-1} (Hedenäs 2003). Our results thus disagree with an opinion of Hedenäs & Kooijman (1996), who argue that high iron concentration is an important factor in determining the distribution of *H. vernicosus* (cf. Štechová et al. 2008).

Mean content of K^+ is 1.9 mg.l^{-1} in the Bohemian Forest, whereas it is 4.3 mg.l^{-1} at other parts of the Czech Republic and 1.25 mg.l^{-1} in Scandinavia (Hedenäs & Kooijman 1996). Mean Mg^{2+} concentration is significantly lower in the Bohemian Forest (0.8 mg.l^{-1}) than in other parts of the Czech Republic (3.5 mg.l^{-1}). In Scandinavia, mean Mg^{2+} concentration is 2.5 mg.l^{-1} (Hedenäs & Kooijman 1996). Mean Na^+ content (10.7 mg.l^{-1}) is higher than at Scandinavian localities (4 mg.l^{-1}; Hedenäs & Kooijman 1996) and it does not differ from other Czech localities (Štechová & Manukjanová, unpubl.).

Content of NO_3^- was significantly lower in the Bohemian Forest (38 µg.l^{-1}) than at other Czech localities (50 µg.l^{-1}). Mean value reported from Scandinavia is much higher (90 µg.l^{-1}; Hedenäs & Kooijman 1996).

Other nutrient contents (total N, NH_4^+, and PO_4^{3-}) do not differ from other Czech localities (Štechová & Kučera 2007, Štechová & Manukjanová, unpubl.). However, NH_4^+ and PO_4^{3-} are lower comparing to localities in Scandinavia, where the NH_4^+ mean concentration is 350 µg.l^{-1} and the mean PO_4^{3-} concentration is 20 µg.l^{-1}. (Hedenäs & Kooijman 1996).

Table 3. Mean values and standard errors of the chemistry at localities in the Bohemian Forest Mts. and in other parts of the Czech Republic. The last column contains the p-values of the Mann Whitney U-tests.

	Bohemian Forest Mts.	**Czech Republic**	**p-level of M-W U-test**
	mean±SE	**mean±SE**	
pH	6.10±0.17	6.24±0.11	0.5884
Ca^{2+} (mg.l^{-1})	3.34±0.45	9.71±1.62	0.0003
Na^+ (mg.l^{-1})	10.72±5.06	11.01±3.64	0.2378
K^+ (mg.l^{-1})	1.90±0.76	4.33±1.85	0.1155
Mg^{2+} (mg.l^{-1})	0.90±0.11	3.52±0.51	0.0001
Fe (mg.l^{-1})	0.39±0.05	0.87±0.26	0.4312
NH_4 (µg.l^{-1})	122.09±88.49	125.65±33.17	0.3016
NO_3 (µg.l^{-1})	38.14±7.79	50.09±3.48	0.0304
PO_4 (mg.l^{-1})	11.83±1.01	10.19±1.01	0.4030
N (µg.l^{-1})	1.10±0.18	1.06±0.15	0.6228

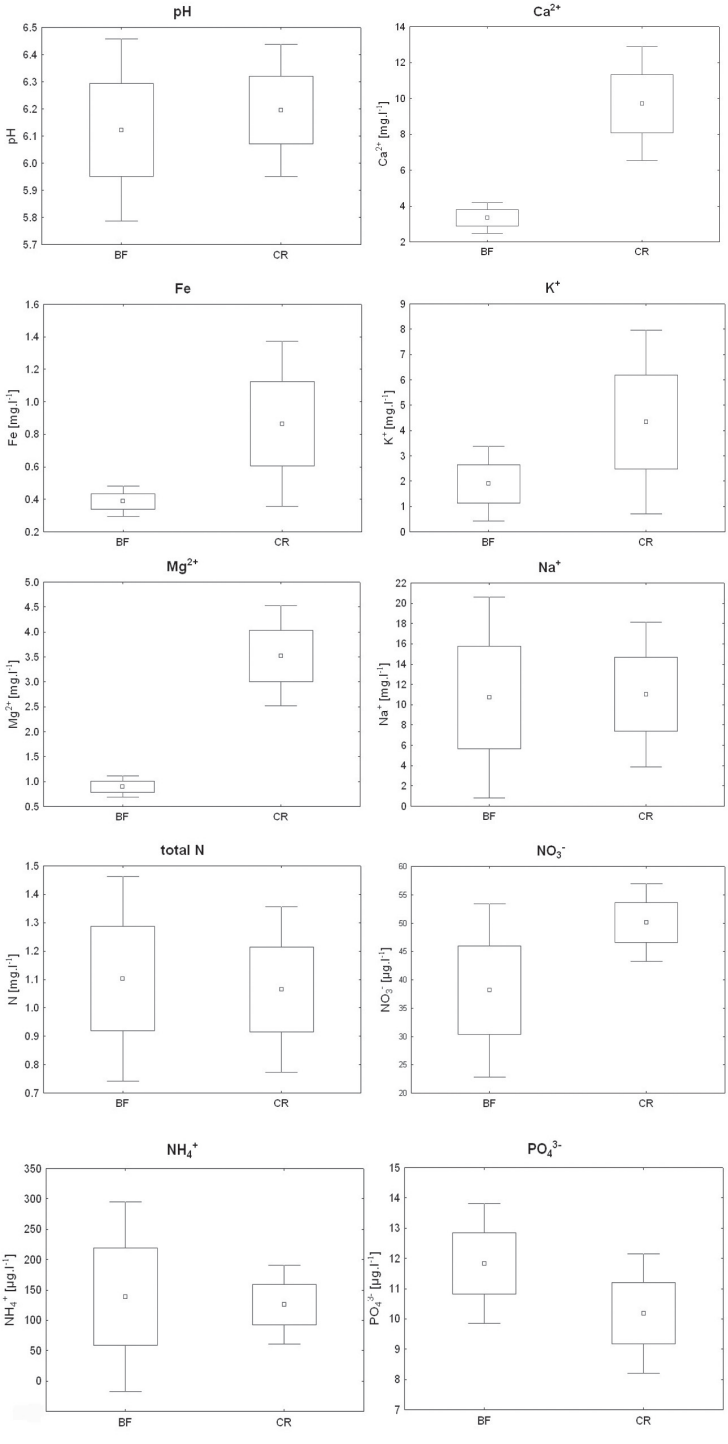

Fig. 2. Comparison of water chemistry at localities in the Bohemian Forest (BF, n = 9) and other parts of the Czech Republic (CR, n = 19).

Species composition at the localities

86 species (28 bryophytes and 58 vascular plants) were noted within the nine vegetation samples. Although the species composition at the localities of *H. vernicosus* varied considerably among the studied localities, the associated species were mostly species of moderately rich fens, at most of the localities without presence of any calcium indicators. The most commonly associated species (Table 4) were similar to species associated with *H. vernicosus* in other parts of the Czech Republic (Štechová & Kučera 2007, Štechová et al. 2008).

Fairly atypical species composition was found at Chalupská Slať, where *H. vernicosus* grew together with *Sphagnum magellanicum*, *Andromeda polifolia*, *Calluna vulgaris*, and *Eriophorum vaginatum*, which are rather diagnostic species of submontane and montane raised bogs (Chytrý & Tichý 2003). However, chemical composition of groundwater at this locality is very similar to other localities and therefore we suppose that some local springs in the immediate vicinity of the *H. vernicosus* patches are more basic.

Conservation recommendation for localities

At the monitored plots of the Bohemian Forest fens, *H. vernicosus* seems to not be endangered by water deficiency and groundwater table decrease, or eutrophication, and will prosper as long as site hydrology is not actively disturbed. However, neither hydrology distur-

Table 4. Vascular plants and bryophytes most commonly associated with *Hamatocaulis vernicosus* according to the frequency of occurrence in the vegetation samples.

Vascular plants		Mosses	
Associated species	**% samples**	**Associated species**	**% samples**
Potentilla erecta	9	*Sphagnum warnstorfii*	9
Carex rostrata	8	*Sphagnum teres*	8
Cirsium palustre	8	*Aneura pinguis*	5
Equisetum fluviatile	8	*Calliergonella cuspidata*	5
Valeriana dioica	8	*Campylium stellatum*	4
Viola palustris	8	*Sphagnum contortum*	4
Carex panicea	7	*Warnstorfia exannulata*	4
Galium uliginosum	7	*Aulacomnium palustre*	3
Tephroseris crispa	7	*Bryum pseudotriquetrum*	3
Agrostis canina	6	*Scorpidium cossonii*	3
Carex echinata	6	*Sphagnum flexuosum*	3
Carex nigra	6	*Straminergon stramineum*	3
Crepis paludosa	6	*Calliergon cordifolium*	2
Eriophorum angustifolium	6	*Calliergon giganteum*	2
Caltha palustris	5	*Chylosciphus polyanthos*	2
Equisetum sylvaticum	5	*Philonotis fontana*	2
Oxycoccus palustris	5		
Salix aurita	5		
Betula sp.	4		
Cardamine pratensis	4		
Luzula campestris	4		
Pinguicula vulgaris	4		

bances nor eutrophication are presumed due to localization of the sites in I and II zones of the Šumava National Park. It contrasts to most of the localities in other parts of the Czech Republic, where the sites have often been drained and which are surrounded by intensively managed agricultural land (Štechová & Štech, 2009).

Until the mid-20th century, the fens were managed regularly. Today, the sites are not managed except the locality "Zhůří 1", where occasional grazing is made. Due to the high water table at all localities, succession of shrubs and trees has not been very intense, and abandoned areas have remained at least partially without woods. The high water table helps to keep low cover of herbs as well, so the management of regular annual mowing is not necessary. However, preventive occasional cutting of self-seeding shrubs, mowing or grazing once every few years is useful at all localities to prevent . The large populations at the "Zhůří near Křemelná 1 and 2" localities seem to be stable (these populations have been monitored since 2005 and 2006, respectively), forming specific vegetation units. Very small populations ("Jezerní potok", "Slunečná near Prášily", and "Zhůří near Horská Kvilda") are endangered not only by competition with *Sphagnum* species, but also by accidental disturbances. Due to rare sporophytes production of *H. vernicosus* (Štechová et al. 2008), it can be assumed that these very small populations are remnants of formerly larger populations and they have not originated by a recent colonization. For the protection of *H. vernicosus* populations at these sites, manual removing of surrounding *Sphagnum* species would be beneficial, as it would facilitate the growth of the species in free space without competitors (cf. Štechová & Kučera 2007).

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Appendix 1. List of phytosociological samples. Plant covers are listed in percents. Sampled area is 16 m^2. Exact localization of the samples can be found in Table 1.

	Chalupská Slať	Jezerní Potok	Zhůří near Křemelná 1	Zhůří near Křemelná 2	Kvilda	Slunečná near Prášily	Velký Bor	Zhůrské Pláně	Zhůří near Horská Kvilda
E	**90**	**70**	**90**	**95**	**60**	**95**	**80**	**85**	**95**
E0	**80**	**50**	**80**	**90**	**50**	**90**	**70**	**60**	**80**
E1	**50**	**50**	**70**	**40**	**40**	**80**	**50**	**80**	**80**
E2									**1**
E2									
Betula sp.									1
E1								**80**	
Acer pseudoplatanus		0.05							
Agrostis canina	0.2	1		1	0.2		1	0.2	
Andromeda polyfolia	1								
Anthoxanthum odoratum								0.2	0.2
Angelica sylvestris				0.2		0.2			
Betula sp.	3					5	3		5
Bistorta major			0.2		0.2				
Briza media				0.2		0.2	0.2		
Calamagrostis epigejos									0.2
Calamagrostis villosa				0.2					
Caltha palustris			5	0.2		1		3	0.2
Caluna vulgaris	2								
Cardamine pratensis	0.2		0.2					0.2	0.05
Carex canescens			3			1	5		
Carex demissa				0.2					
Carex echinata		5		3	0.2	3	5		25
Carex flava						5			1
Carex nigra	15		10	3		1		5	10
Carex ovalis								0.2	
Carex panicea	1	20	5		1		0.2	5	5
Carex rostrata	20	10	25	3	25	30	3		5
Cirsium heterophyllum				0.2					
Cirsium palustre	0.2	0.2			0.2	0.2	1		0.2
Crepis paludosa			1		5	5	3	40	10
Dactylorhiza fuchsii						0.2			0.2
Dactylorhiza majalis			0.2		0.2			1	
Drosera rotundifolia			0.2	1			0.2		
Epilobium palustre				0.2			0.2	0.2	
Equisetum sylvaticum		1	0.2	3		0.2		0.2	
Equisetum fluviatile	0.2		0.2	3	0.2	0.2	0.2	3	1
Eriophorum angustifolium		5		3	15		40	0.2	3
Eriophorum vaginatum	5			3					
Festuca rubra				1					
Filipendula ulmaria		0.2						10	
Galium uliginosum	0.2	0.2	0.2		0.2		0.2	0.2	1
Geum rivale			0.2						
Chaerophyllum hirsutum								15	0.2
Juncus alpinoarticulatus				1					
Juncus articulatus				5		2			
Juncus effusus		0.2		3					3
Luzula campestris	0.2		1	0.2				0.2	
Lychnis flos-cuculi			3						

Appendix 1. Continued.

Melampyrum pratense	0.2								
Molinia caerulea		5							
Myosotis palustris agg.			1						0.05
Nardus stricta				5		3			2
Oxycoccus palustris	10		0.2	5		10			1
Pedicularis palustris			0.2	1		5			
Picea abies						0.2			
Pinguicula vulgaris				0.2			0.2		
Pinus sylvestris	0.2								
Potentilla erecta	1	1	0.2	5	5	5	3	1	5
Pyrola sp.									0.2
Ranunculus acer						0.2			0.2
Ranunculus auricomus								0.2	
Rumex acetosa								0.2	
Rumex sp.			0.2						
Salix aurita	3	15	10				0.2		5
Salix cinerea						0.2			
Tephroseris crispa	0.2	2	15			5	0.2	2	3
Trientalis europea				0.2					
Vaccinium uliginosum	0.2								
Valeriana dioica	0.2	1	1	3		5	1	0.2	2
Vicia craca						0.2			
Viola palustris	0.2	1	0.2	1	1		1	0.2	1
Willemetia stipitata				2					
E0								**60**	
Aneura pinguis		0.2			0.2		0.2	0.2	0.2
Aulacomnium palustre	1						0.5		5
Bryum pseudotriquetrum		0.2					3	0.2	
Calliergon cordifolium			1			0.2			
Calliergon giganteum				10				0.2	
Calliergonella cuspidata					3	3	1	3	60
Campylium stellatum		1	1	10			0.2		
Climacium dendroides								3	
Hamatocaulius vernicosus	0.2	0.2	15	5	0.2	0.05	2	0.2	0.2
Chiloscyphus polyanthos								0.2	0.2
Pellia sp.								0.2	
Philonotis fontana		0.2	2						
Polytrichum commune				0.2					
Polytrichum strictum				3					
Rhytidiadelphus squarrosus									0.2
Riccardia multifida		0.2					0.2		0.2
Scorpidium cossonii			5	1			1		
Sphagnum contortum		3	15	1			3		
Sphagnum denticulatum					2				
Sphagnum fallax		10							
Sphagnum flexuosum	30			60		40			
Sphagnum magellanicum	1								
Sphagnum squarrosum								3	
Sphagnum subsecundum	1								
Sphagnum teres	40	40	3		10	10	20	25	5
Sphagnum warnstorfii	5	2	35	0.2	30	40	40	25	10
Straminergon stramineum	0.2		1		1				
Warnstorfia exannulata		3			5		1		0.2