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BEECH DEAD WOOD INHABITING BRYOPHYTE VEGETATION IN TWO SLOVENIAN FOREST RESERVES

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Abstract

The bryophyte flora and vegetation on dead beech trees in two Slovenian near-natural forest stands is described. A total of 213 trees were investigated, 110 in the Rajhenav Forest Reserve and 103 in the Krokav Forest Reserve. Species richness, frequency, distribution of taxonomic types and ecological categories were estimated. Altogether 103 species were recorded, 96 in Rajhenav and 66 in Krokav, among which several species that are threatened in Europe: *Anacamptodon splagnoides* (Brid.) Brid., *Buxbaumia viridis* Brid. ex Moug & Nestl., *Dicranum viride* (Sull. & Lesq.) Lindb. and *Zygodon forsteri* (Dicks.) Mitt. Their frequency is low except for *Dicranum viride*, a common epiphyte in Rajhenav. According to the species lists, the frequency of rare species and the occurrence of threatened species the near natural forests in southern Slovenia should be considered as hotspots in biodiversity of dead wood living bryophytes in Europe. The species richness is very high, especially in Rajhenav.

Keywords: bryophytes, dead wood, *Fagus sylvatica* L., near-natural forests

MAHOVI NA ODMRLIH LESNIH OSTANKIH BUKVE V DVEH GOZDNIH REZERVATIH V SLOVENIJI

Izveček

Opisana je mahovna flora in vegetacija na odmrlem bukovem drevju v dveh slovenskih sonaravnih bukovih sestojih. Skupno je bilo raziskanih 213 dreves, 110 v gozdnem rezervatu Rajhenavski Rog in 103 v gozdnem rezervatu Krokav. Ocenjena je bila pestrost vrst, njihova pogostost, porazdelitev taksonomskih tipov in ekološke kategorije. Skupno so bile zabeležene 103 vrste mahov – 96 v rezervatu Rajhenavski Rog in 66 v rezervatu Krokav; med njimi je več vrst, ki veljajo v Evropi za ogrožene: *Anacamptodon splagnoides* (Brid.) Brid., *Buxbaumia viridis* Brid. ex Moug & Nestl., *Dicranum viride* (Sull. & Lesq.) Lindb. in *Zygodon forsteri* (Dicks.) Mitt. Njihovo pojavljanje je redko; izjema je vrsta *Dicranum viride*, ki je pogost epifit v rezervatu Rajhenavski Rog. Iz seznama vrst, pogostosti redkih oz. specializiranih vrst in pojavljanja ogroženih vrst lahko sklepamo, da predstavljajo naravni gozdovi JV Slovenije "vročo točko" v Evropi glede biotske pestrosti mahov, ki uspevajo na velikih odmrlih lesnih ostankih. Vrsta pestrost je zelo visoka, kar še zlasti velja za rezervat Rajhenavski Rog.

Ključne besede: mahovi, odmrlo drevje, *Fagus sylvatica* L., sonaravni gozdovi

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1 INTRODUCTION

UVOD

An important feature of natural forests is the high amount of dead wood (PETERKEN 1996). Dead wood is essential for fungi, bryophytes, lichens, invertebrates, amphibians as well as some birds and small mammals (HARMON *et al.* 1986, MASER / TRAPPE 1984, SAMUELSSON / GUSTAFSSON / INGELÖG 1994, CSÓKA 2000). From bryophytes a large number of species occur on dead wood obligatorily (true epixylics) or facultatively (epiphytes, epilithic and epigeic species). A general conclusion of studies comparing managed stands with near-natural forests is that the diversity of bryophytes is much less in managed forests and obligate epixylic liverworts can survive only in stands with a continuous presence of large trees in medium and late decay phases (LESICA *et al.* 1991, GUSTAFSSON / HALLINGBÄCK 1988, ANDERSSON / HYTTEBORN 1991, SÖDERSTRÖM 1988, ÓDOR / STANDOVÁR 2001, RAMBO / MUIR 1998). Unfortunately only few near-natural stands still exist in Europe (PETERKEN 1996, ROSE 1992). Two extensive near-natural forest reserves are Rajhenavski Rog and Krokár in Slovenia. Both reserves contain old beech and fir dominated stands with multi-layered canopies, a mosaic of different development phases and a high amount of dead wood. Phyto-sociological relevés from these reserves include vascular plants, fungi, bryophytes and lichens (HOČEVAR *et al.* 1995). However the bryophyte vegetation on dead wood had not been studied in detail. This study describes the dead wood-inhabiting bryophyte flora of these stands, characterising the local frequencies of the species, their ecological demands and threatened status.

2 SITE DESCRIPTION

OPIS RAZISKOVALNIH OBJEKTOV

Both Rajhenavski Rog and Krokár are located approximately 900 m above sea level in the northern part of the Dinaric mountain range near Kočevje in southern Slovenia. The climate is montane Dinaric with an annual precipitation of over 1500 mm and a mean annual temperature of 7 °C. Both sites are on limestone and are dominated by beech and fir. Both reserves had been virgin forests until 1894, when they were taken out of exploitation with the first forest management plan. Minor fellings were recorded on the

edges of Rajhenavski Rog in 1948, while Krokar was closed to the public until 1990. Stand structure, regeneration, and spatial distribution of forest development phases have been studied, mainly in Rajhenavski Rog (BONČINA 1999). Phyto-sociological relations of ground flora have been studied by PUNCER / WOJTERSKI / ZUPANČIČ (1974) and MARINČEK / PUNCER / ZUPANČIČ (1980). The amount of dead wood is high: 284 m³/ha in Rajhenavski Rog and 153 m³/ha in Krokar.

3 METHODS MÉTODE

Altogether, 213 dead beech trees were selected: 110 in Rajhenavski Rog and 103 in Krokar. Tree selection was independent of their bryophyte vegetation. The selected trees were evenly distributed as much as possible over different decay phases (ÓDOR / STANDOVÁR 2001) and size categories. In September and October 2001, all of the bryophyte species were recorded from the selected trees, per tree differentiated in snag, log, crown, tree base and uprooted part. Nomenclature followed CORLEY *et al.* (1981) and CORLEY / CRUNDWELL (1991) for mosses (acrocarps and pleurocarps), and GROLLE (1983) for liverworts (hepatics). Species richness, frequency, taxonomy type, preference to snag, crown and uprooted parts were estimated. The substrate preference of species, based on field experiences *in situ*, was characterised as follows: epixylic (occurring mainly on soft woody material), epiphyte (occurring mainly on bark of dead trees), opportunistic (no clear substrate preference, occurring on soft woody material but also on bark, on soil or on rock), terricollous (occurring mainly on humus rich soil), uproot species (occurring mainly on mineral soil on the vertical uprooted part of the logs). The threatened status of species on the European level is based on the Red Data Book of European Bryophytes (ECCB 1995) and MARTINČIČ (1992) on the Slovenian level.

4 RESULTS

REZULTATI

Altogether 103 species were recorded, 96 in Rajhenavski Rog and 66 in Krokár. The total number of occurrences was 2445 in Rajhenavski Rog and 952 in Krokár. The mean species richness per tree was $22,23 \pm 0,792$ (standard error) ranging from 2 to 43 in Rajhenavski Rog. The trees in Krokár have 0 to 28 species with an average of $9,24 \pm 0,61$. So species richness in Rajhenavski Rog is much higher than in Krokár. The species lists of both sites do not differ greatly (Appendix). The difference in species richness is very pronounced at the tree level because in Rajhenavski Rog the proportion of species with an intermediate frequency is higher than in Krokár. In other words: Rajhenavski Rog has a more even species frequency distribution.

The distribution of the three taxonomy types is very similar in both sites (Table 1). Pleurocarps are most numerous (between 40 and 50%), but the proportions of acrocarps and hepatics are also considerable (between 25 and 35%).

Table 1. Distribution of different taxonomy types in percentages in Rajhenavski Rog and Krokár based on the species list and on the number of occurrences (A: acrocarps, P: pleurocarps, H: hepatics)

Preglednica 1: Porazdelitev različnih taksonomskih tipov (v %) v gozdnih rezervatih Rajhenavski Rog in Krokár glede na seznam vrst ter pogostost pojavljanja (A: akrokarpni tip, P: pleurokarpni tip, H: jetrnjaki)

Location / Lokacija	Percentage according to presence on the species list / Delež glede na prisotnost vrste na seznamu			Percentage according to occurrences / Delež glede na pojavljanje		
	A	P	H	A	P	H
Rajhenavski Rog	32,3	41,7	26,0	29,6	44,2	26,1
Krokár	34,8	37,9	27,3	20,3	47,8	31,9

According to substrate type, the proportion of epixylics is similar in the two sites, between 18 and 25% (Table 2). With regards to the proportions on the species list, opportunistic ones are more frequent particularly in Krokár, however epiphytes are more common with regards to the proportions in occurrences. The proportions of terricolous uproot and epilithic species are higher in Rajhenavski Rog.

Most of the opportunistic species are common in both sites: *Hypnum cupressiforme* Hedw., *Brachythecium rutabulum* (Hedw.) B., S. & G., *B. salebrosum* (Web. & Mohr.) B., S. & G., *B. velutinum* (Hedw.) B., S. & G., *Bryum subelegans* Kindb., *Plagiochila porelloides* (Torrey ex Nees) Lindenb., *Dicranum scoparium* Hedw. In Rajhenavski Rog *Plagiomnium cuspidatum* (Hedw.) Kop., *Plagiomnium ellipticum* (Brid.) Kop., *Sanionia uncinata* (Hedw.) Loeske, and *Tortella tortuosa* (Hedw.) Limpr. are more common. Often these opportunistic species show the highest cover on dead trees.

Table 2. Distribution of different substrate types in percentages in Rajhenavski Rog and Krokcar based on the species list and number of occurrences (X: epixilics, E: epiphytes, O: opportunistics, T: tericollous species, U: uproot species, L: epilithics)

Preglednica 2: Porazdelitev različnih tipov substrata (v %) v gozdnih rezervatih Rajhenavski Rog in Krokcar glede na seznam vrst ter pogostost pojavljanja (X: epiksilne vrste, E: epifitne vrste, O: oportunistične vrste, T: terikolne vrste, U: vrste na izruvanih koreninah, L: epilitne vrste)

Location / Lokacija	Proportion in species list (%) / Delež glede na seznam (%)						Proportion in occurrences (%) / Delež glede na pogostost pojavljanja (%)					
	X	E	O	T	U	L	X	E	O	T	U	L
Rajhenavski Rog	25,0	31,2	19,8	8,3	6,2	9,4	23,3	34,4	29,3	5,3	2,2	5,5
Krokcar	24,2	34,8	25,8	3,0	3,0	9,1	18,0	48,6	30,6	0,2	0,5	2,1

Isothecium alopecuroides (Dubois) Isov., *Frullania dilatata* (L.) Dum., *Homalothecium sericeum* (Hedw.) B., S. & G., *Lejeunea cavifolia* (Ehrh.) Lindb., *Metzgeria furcata* (L.) Dum., *M. conjugata* Lindb., *Ortotrichum stramineum* Hornsch. ex Brid., *Paraleucobryum longifolium* (Hedw.) Loeske, *Pterigynandrum filiforme* Hedw., *Radula complanata* (L.) Dum. and *Ulota bruchii* Hornsch. ex Brid. are the most common bark living epiphytes in both stands. These epiphytes colonise the bark of living trees and persist on dead trees during earlier decay phases. *Metzgeria conjugata* prefers the leg of snags; *Ortotrichum* and *Ulota* species are more common on branches. Some epiphytes are (almost entirely) restricted to Rajhenavski Rog: *Dicranum montanum* Hedw., *D. viride* (Sull. and Lesq.) Lindb., *Platygyrium repens* (Brid.) B., S. & G., *Zygodon rupestris* Schimp. Ex Lor. and the Atlantic elements: *Antitrichia curtispindula* (Hedw.) Brid.,

Frullania tamarisci (L.) Dum. and *Thamnobryum alopecurum* (Hedw.) Gang. *Orthotrichum affine* Brid. and *O. lyellii* Hook. & Tayl. are more common in Krokavci.

In both sites the most common epixylic species are *Herzogiella seligeri* (Brid.) Iwats., *Lophocolea heterophylla* (Schrad.) Dum. and *Plagiothecium nemorale* (Mitt.) Jaeg. The species richness (diversity and frequency) of obligate epixylic liverworts of well decayed logs is much higher in Rajhenavski Rog as a result of the presence of *Anacamptodon splachnoides* (Brid.) Brid., *Blepharostoma trichophyllum* (L.) Dum., *Buxbaumia viridis* Brid. ex Moug & Nestl., *Calypogeia suecica* (H. Am et J. Press.) K. Müll., *Cephalozia catenulata* (Hüb.) Lindb., *Cephaloziella rubella* (Nees) Warnst., *Dicranodontium denudatum* (Brid.) Britt., *Jungermannia leiantha* Grolle, *Lepidozia reptans* (L.) Dum., *Nowellia curvifolia* (Dicks.) Mitt. in Godman, *Rhizomnium punctatum* (Hedw.) Kop., *Riccardia latifrons* (Lindb.) Lindb., *Riccardia multifida* (L.) S. Gray, *Riccardia palmata* (Hedw.) Carruth. and *Tetraphis pellucida* Hedw.

Terricolous species are also more frequent in Rajhenavski Rog on dead trees, both on humus rich soil (*Eurhynchium angustirete* (Broth.) T. Kop., *E. striatum* (Hedw.) Schimp., *Rhytidiadelphus loreus* (Hedw.) Warnst. and *Thuidium tamariscinum* (Hedw.) B., S. & G.) and on the mineral soil of uprooted parts (*Atrichum undulatum* (Hedw.) Br. Eur., *Plagiothecium cavifolium* (Brid.) Iwats., *Polytrichum formosum* Hedw. and *Weissia condensa* (Voit.) Lindb.).

Epilithic species are rare on dead wood, except *Ctenidium molluscum* (Hedw.) Mitt., which is relatively common in Rajhenavski Rog.

Several threatened species were recorded in Rajhenavski Rog. Those included in the Red Data Book of European Bryophytes (ECCB 1995) are: *Anacamptodon splachnoides* (endangered), *Buxbaumia viridis* (vulnerable), *Dicranum viride* (vulnerable) and *Zygodon forsteri* (vulnerable, not taken for the sample). The Slovenian red list (MARTINČIČ 1992) also mentions *Antitrichia curtispindula* and *Zygodon viridissimus* (Dicks.) Bird. (the authors have found *Z. rupestris*). The frequency of these species is very low except for *Dicranum viride*, which is present on over 50% of the trees in Rajhenavski Rog, especially in early decay phases. Rajhenavski Rog probably holds one of the most important populations of this species in Europe.

5 DISCUSSION

RAZPRAVA

Although obligate epixylic bryophytes (especially liverworts) are broadly distributed in boreal and montane regions, they are usually not very abundant and are, in fact, uncommon. These indicators of old growth forests demand both the continuous presence of logs in intermediate and late decay phases and a continually high air humidity (ANDERSSON / HYTTEBORN 1991, SÖDERSTRÖM 1988). Rajhenavski Rog holds good populations of epixylics. In Krokar these species are missing or very rare, although their substrate (well decayed, large logs) seems available in sufficient quantity and quality. Probably climatic factors limit the occurrence of epixylics in Krokar, the mesoclimate is dryer, the effect of wind is greater and the air humidity consequently lower. It is remarkable that although the species richness is higher in Rajhenavski Rog, the proportions of different taxonomical and substrate types are similar in the two sites, except for a higher proportion of terricolous and uproot species in Rajhenavski Rog and epiphytes in Krokar. Differences in species composition between the two sites can also be caused by differences in forest history. Most of the dead wood-inhabiting bryophytes become locally extinct after stand harvesting caused sudden microclimatic changes. The differences between the two sites show that some species living on dead wood need a long time to re-colonise suitable stands, even when potential habitat is present in the vicinity over a considerable period and the ecological infrastructure is still intact. The distance between Rajhenavski Rog and Krokar is only about 50 km, and both sites are located in a well-forested landscape so their dispersal possibilities appear to be very limited (SÖDERSTRÖM 1990, SÖDERSTRÖM / JONSSON 1992).

According to the species lists, the frequency of rare species and the occurrence of threatened species in the near natural forests in southern Slovenia should be considered as hotspots in biodiversity of dead wood living bryophytes in Europe. The species richness is very high, especially in Rajhenavski Rog. The local populations of rare species create important source populations for the region. Their survival depends on the conservation of these near-natural forest remnants.

6 POVZETEK

V prispevku smo opisali floro in vegetacijo mahov na odmrlih velikih lesnih ostankih bukve v dveh gozdnih rezervatih v Sloveniji. Skupno smo raziskali 213 dreves, 110 v rezervatu Rajhenavski Rog in 103 v rezervatu Krokar. Zabeležili smo pojavljanje 103 vrst mahov – 96 v rezervatu Rajhenavski Rog, 66 v rezervatu Krokar. Povprečna pestrost vrst na drevo je bila 22,23 za Rajhenavski Rog in 9,24 za Krokar. V rezervatu Rajhenavski Rog je pogostnost pojavljanja vrst bolj enakomerno porazdeljena. Na obeh ploskvah znaša delež pleurokarpnih vrst 40 – 50 %; aktokarpnih vrst in jetrnjakov 25 – 35 %; epiksilnih vrst pa 18 – 25 %. Terikolne vrste in vrste, ki rastejo na izruvanem koreninskem sistemu, so bolj pogoste v rezervatu Rajhenavski Rog, epifitne pa v rezervatu Krokar.

V rezervatu Rajhenavski Rog smo evidentirali več ogroženih vrst. Vrste, ki so vpisane v "Rdečo knjigo evropskih mahov" (ECCB 1995), so: *Anacamptodon splagnoides* (Brid.) Brid. (ogrožena), *Buxbaumia viridis* Brid. ex Moug & Nestl. (ranljiva), *Dicranum viride* (Sull. & Lesq.) Lindb. (ranljiva) in *Zygodon forsteri* (Dicks.) Mitt. (ranljiva, ni bila odvzeta za vzorec). Na "Rdeči seznam mahov Slovenije" (MARTINČIČ 1992) sta uvrščeni tudi *Antitrichia curtipendula* (Hedw.) Brid. in *Zygodon viridissimus* (Dicks.) Brid. (najdena je bila *Z. rupestris* Schimp. Ex Lor.). Pogostost teh vrst je zelo nizka; izjema je vrsta *Dicranum viride*, ki je bila zabeležena na več kot 50 % vseh dreves v rezervatu Rajhenavski Rog (predvsem v mlajših fazah razkroja). Sklepamo, da uspeva v tem rezervatu ena najbolj pomembnih populacij te vrste v Evropi.

Obligatni epiksilni mahovi, ki so bolj pogosti v rezervatu Rajhenavski Rog kot na Krokarju, potrebujejo za uspevanje stalno prisotnost srednje in močno razkrojenih velikih odmrlih lesnih ostankov bukve; hkrati je potrebna tudi visoka vlažnost zraka. Klimatski dejavniki so verjetno vzrok bolj omejenemu uspevanju epiksilnih mahov v rezervatu Krokar, kjer je mezoklima bolj sušna; učinek vetra je tu bolj izrazit, vlažnost zraka pa je stalno nižja kot v drugem rezervatu. Razlike v sestavi vrst so lahko tudi posledica različne zgodovine teh sestojev.

Iz seznama vrst, pogostosti redkih oz. specializiranih vrst in pojavljanja ogroženih vrst lahko sklepamo, da predstavljajo naravni gozdovi JV Slovenije "vročo točko" v Evropi

glede biotske pestrosti mahov, ki uspevajo na velikih odmrlih lesnih ostankih. Vrstna pestrost je zelo visoka, kar še zlasti velja za rezervat Rajhenavski Rog.

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8 APPENDIX PRILOGA

Appendix: Appendix: Occurrences of species in Rajhenavski Rog (110 trees) and Krokcar (103 trees); taxonomy types (Tax) are acrocarp (A), hepatic (H), pleurocarp (P); substrate preferences (Sub) are epiphyte (E), epixylic (X), epilithic (L), opportunistic (O), uproot (U), terricolous (T)

Priloga: Priloga: Pojavljanje vrst v gozdnih rezervatih Rajhenavski Rog (110 dreves) in Krokcar (103 drevesa); taksonomski tipi (Tax) so akrokarp (A), jetrnjaki (H), pleurokarp (P); substratne preference (Sub) so epifitna vrsta (na rastlini; E), epiksilna vrsta (na lesu; X), epilitna vrsta (na kamnu; L), oportunistična vrsta (O), vrsta na izruvanih koreninah (U), terikolna vrsta (na zemlji; T)

Species / Vrsta	Rajhenavski Rog	Krokcar	Tax	Sub
<i>Amblystegium riparium</i> (Hedw.) Br. Eur.		1	P	O
<i>Amblystegium serpens</i> (Hedw.) Br. Eur.	32	5	P	O
<i>Anacamptodon splachnoides</i> (Brid.) Brid.	1		P	X
<i>Anomodon viticulosus</i> (Hedw.) Hook. & Tayl.	1		P	E
<i>Antitrichia curtipendula</i> (Hedw.) Brid.	5	1	P	E
<i>Apometzgeria pubescens</i> (Schränk.) Kuwah.	1		H	L
<i>Atrichum undulatum</i> (Hedw.) Br. Eur.	20		A	U
<i>Blepharostoma trichophyllum</i> (L.) Dum.	30	3	H	X
<i>Brachythecium populeum</i> (Hedw.) B., S. & G.	4	4	P	O
<i>Brachythecium rutabulum</i> (Hedw.) B., S. & G.	93	26	P	O
<i>Brachythecium salebrosum</i> (Web. & Mohr.) B., S. & G.	62	16	P	O
<i>Brachythecium velutinum</i> (Hedw.) B., S. & G.	74	52	P	O
<i>Bryum subelegans</i> Kindb.	63	31	A	O
<i>Buxbaumia viridis</i> Brid. ex Moug. & Nestl.	2		A	X
<i>Calypogeia azurea</i> Stotler et Crotz	3	1	H	O
<i>Calypogeia muellerana</i> (Schiffn.) K. Müll.	1		H	O
<i>Calypogeia suecica</i> H. Am et J. Press.) K. Müll.	17		H	X
<i>Cephalozia bicuspidata</i> (L.) Dum.	3	1	H	O
<i>Cephalozia catenulata</i> (Hüb.) Lindb.	17	1	H	X
<i>Cephaloziella hampeana</i> (Nees) Schiffn.	1		H	X
<i>Cephaloziella rubella</i> (Nees) Warnst.	11	4	A	X
<i>Ceratodon purpureus</i> (Hedw.) Brid.	4	1	A	O
<i>Chiloscyphus polyanthos</i> (L.) Corda	3		H	X
<i>Ctenidium molluscum</i> (Hedw.) Mitt.	63	6	P	L
<i>Dicranodontium denudatum</i> (Brid.) Britt.	2		A	X
<i>Dicranum montanum</i> Hedw.	11	1	A	E
<i>Dicranum scoparium</i> Hedw.	30	10	A	O
<i>Dicranum viride</i> (Sull. and Lesq.) Lindb.	60	1	A	E
<i>Encalypta streptocarpa</i> Hedw.	1	1	A	L
<i>Eurhynchium angustirete</i> (Broth.) T. Kop.	26	1	P	T

Appendix: (continuation)

Priloga (nadaljevanje)

Species / Vrsta	Rajhenavski Rog	Krokar	Tax	Sub
<i>Eurhynchium hians</i> (Hedw.) Sande Lac.	2		P	U
<i>Eurhynchium praelongum</i> (Hedw.) B., S. & G.	2		P	O
<i>Eurhynchium striatum</i> (Hedw.) Schimp.	6		P	T
<i>Fissidens dubius</i> P. Beauv	53	1	A	L
<i>Fissidens taxifolius</i> Hedw.	8	4	A	U
<i>Frullania dilatata</i> (L.) Dum.	38	27	H	E
<i>Frullania tamarisci</i> (L.) Dum.	5		H	E
<i>Grimmia hartmanii</i> Schimp.	1		A	L
<i>Grimmia</i> sp.		1	A	L
<i>Hedwigia ciliata</i> (Hedw.) P. Beauv.		1	A	L
<i>Herzogiella seligeri</i> (Brid.) Iwats.	57	30	P	X
<i>Homalothecium philippeanum</i> (Spruce.) B., S. & G.	7		P	L
<i>Homalothecium sericeum</i> (Hedw.) B., S. & G.	47	15	P	E
<i>Homalia trichomanoides</i> (Hedw.) Brid.	2		P	E
<i>Hygrohypnum luridum</i> (Hedw.) Jenn.	1		P	L
<i>Hypnum cupressiforme</i> Hedw.	107	92	P	O
<i>Isothecium alopecuroides</i> (Dubois) Isov.	92	65	P	E
<i>Isothecium myosuroides</i> Brid.	1		P	E
<i>Jungermannia leiantha</i> Grolle	19	3	H	X
<i>Lejeunea cavifolia</i> (Ehrh.) Lindb.	15	15	H	E
<i>Lepidozia reptans</i> (L.) Dum.	28	2	H	X
<i>Leucodon sciuroides</i> (Hedw.) Schwaegr.	20	12	P	E
<i>Lophocolea heterophylla</i> (Schrad.) Dum.	83	60	H	X
<i>Lophocolea minor</i> Nees		1	H	X
<i>Metzgeria conjugata</i> Lindb.	26	16	H	E
<i>Metzgeria furcata</i> (L.) Dum.	74	60	H	E
<i>Mnium marginatum</i> (Dicks) P. Beauv.	9	4	A	X
<i>Mnium stellare</i> Hedw.	3		A	X
<i>Mnium thomsonii</i> Schimp.		1	A	X
<i>Neckera complanata</i> (Hedw.) Hüb.	39	2	P	E
<i>Neckera crispa</i> Hedw.	49	3	P	E
<i>Neckera pumila</i> Hedw.	10	1	P	E
<i>Nowellia curvifolia</i> (Dicks.) Mitt. in Godman	44	11	H	X
<i>Odontoschisma denudatum</i> (Mart.) Dum.	1		H	X
<i>Ortotrichum affine</i> Brid.		2	A	E
<i>Ortotrichum lyellii</i> Hook. & Tayl.	2	8	A	E
<i>Ortotrichum stramineum</i> Hornsch. ex Brid.	37	30	A	E
<i>Paraleucobryum longifolium</i> (Hedw.) Loeske	77	38	A	E
<i>Plagiomnium affine</i> (Bland.) T. Kop.	4		A	T
<i>Plagiothecium cavifolium</i> (Brid.) Iwats.	13	1	P	U
<i>Plagiomnium cuspidatum</i> (Hedw.) Kop.	42	4	A	O
<i>Plagiothecium denticulatum</i> (Hedw.) Br. Eur.	3	1	P	X
<i>Plagiomnium ellipticum</i> (Brid.) Kop.	40	4	A	O
<i>Plagiothecium laetum</i> Br. Eur.	1		P	E
<i>Plagiothecium nemorale</i> (Mitt.) Jaeg.	58	26	P	X
<i>Plagiochila porelloides</i> (Torrey ex Nees) Lindenb.	78	35	H	O
<i>Platygyrium repens</i> (Brid.) B., S. & G.	16		P	E
<i>Plagiomnium rostratum</i> (Schrad.) T. Kop.	1		A	O

Apendix: (continuation)

Priloga (nadaljevanje)

Species / Vrsta	Rajhenavski Rog	Krokar	Tax	Sub
<i>Plagiomnium undulatum</i> (Hedw.) Kop.	40		A	T
<i>Pleurozium schreberi</i> (Brid.) Mitt.	1		P	T
<i>Polytrichum formosum</i> Hedw.	9		A	U
<i>Porella platyphylla</i> (L.) Pfeiff.	10	3	H	E
<i>Pseudoleskeella nervosa</i> (Brid.) Nyh.	2	1	P	E
<i>Pterigynandrum filiforme</i> Hedw.	67	81	P	E
<i>Pylaisia polyantha</i> (Hedw.) Schimp.	4		P	E
<i>Radula complanata</i> (L.) Dum.	61	58	H	E
<i>Rhizomnium punctatum</i> (Hedw.) Kop.	88	17	A	X
<i>Rhytiadelphus loreus</i> (Hedw.) Warnst.	8		P	T
<i>Rhynchostegium murale</i> (Hedw.) B., S. & G.	7	10	P	T
<i>Rhytiadelphus triquetrus</i> (Hedw.) Warnst.	4		P	T
<i>Riccardia latifrons</i> (Lindb.) Lindb.	11		H	X
<i>Riccardia multifida</i> (L.) S. Gray	14		H	X
<i>Riccardia palmata</i> (Hedw.) Carruth.	56	6	H	X
<i>Sanionia uncinata</i> (Hedw.) Loeske	49	2	P	O
<i>Scapania umbrosa</i> (Schrud.) Dum.		1	H	X
<i>Tetraphis pellucida</i> Hedw.	11		A	X
<i>Thamnobryum alopecurum</i> (Hedw.) Gang.	6		P	E
<i>Thuidium tamariscinum</i> (Hedw.) B., S. & G.	40	1	P	T
<i>Tortula ruralis</i> (Hedw.) Gaertn.	1		A	L
<i>Tortella tortuosa</i> (Hedw.) Limpr.	29	6	A	O
<i>Ulota bruchii</i> Hornsch. Ex Brid.	33	16	A	E
<i>Weissia condensa</i> (Voit.) Lindb.	2		A	U
<i>Zygodon rupestris</i> Schimp. Ex Lor.	30	7	A	E