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FIRST RECORD OF THE RARE BOREO-ALPINE MOSS *HERZOGIELLA STRIATELLA* (BRID.) Z. IWATS. IN THE WESTERN BALKANS

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The rare boreo-alpine moss *Herzogiella striatella* was found on Mt Snježnik (W Croatia) in 2015 and constitutes the first national record. Two populations were recorded inside an old and hardly accessible spruce forest on steep boulders (*Lonicero caerulae-Piceetum*) along the Frankopanski Put hiking path. The markedly cool and humid microclimate ensured by small karst dolines within the forest shapes the specific bryophyte species composition with the elements of snowbed and timberline pine krummholz vegetation and the domination of boreal and arctic taxa. Due to its pronounced isolation from other European populations, the species is certainly of relict origin in Croatian Dinaric Alps.

Key words: boreal taxa, bryophytes, Croatian Dinaric Alps, spruce forests, Mt Snježnik, snowbed vegetation

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Rijetka borealno – alpska mahovina *Herzogiella striatella* pronađena je po prvi put u Hrvatskoj na Snježniku 2015. godine. Zabilježene su dvije populacije unutar stare i teško pristupačne smrekove šume na strmim stijenama (*Lonicero caerulae-Piceetum*) uz Frankopanski put. Izrazito hladna i vlažna mikroklima koju osiguravaju male krške ponikve unutar šume oblikuje specifičan floristički sastav mahovina s elementima vegetacije snježnica i klekovine bora krivulja te dominacijom borealnih i arktičkih svojti. Zbog svoje izrazite izoliranosti od ostalih europskih populacija, vrsta je zasigurno reliktnog podrijetla na području hrvatskih Dinarida.

Ključne riječi: borealne svojte, mahovine, Dinarsko gorje Hrvatske, smrekove šume, Snježnik, vegetacija snježnica

INTRODUCTION

The mainly Northern Hemisphere monophyletic genus *Herzogiella* Broth. (Huttunen *et al*., 2013) traditionally belonging to Hypnaceae, but recently assigned to Plagiotheciaceae (Frey & Stech, 2009) is represented in Europe by three species: *Herzogiella seligeri* (Brid.) Z. Iwats., *H. turfacea* (Lindb.) Z. Iwats. and *H. striatella* (Brid.) Z. Iwats

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(Hodgetts *et al*., 2020). According to recent checklists (Sabovljević, 2006; Sabovljević *et al*.; 2008; Ros *et al*., 2013; Hodgetts & Lockhart, 2020) and Flora Croatica Database (Alegro & Šegota, 2018-onwards), only *H. seligeri* has been recorded in Croatia so far.

Herzogiella striatella is a very small to medium-sized moss with irregularly branched procumbent stems, forming straggling glossy green patches (Smith, 2004; Atherton *et al*., 2010). It is easily distinguishable by its inflated, hyaline, decurrent alar cells, which form distinct auricles (Frahm & Frey, 2004; Smith, 2004). *Herzogiella striatella* has a boreal-alpine distribution, with the major populations across northern parts of North America, Europe and Asia. However, some disjunct populations are known on higher European mountains of lower latitudes, e.g. in the Scottish Highlands, the Pyrenees, the Alps, the Tatra Mountains, the Sudetes, the Carpathian Mountains etc. (Sauer, 2001). It is a woodland species of humid and shaded habitats growing typically on peaty soils in fissures and rocky crevices amongst boulders, and is less common on tree boles (Sauer, 2001; Frahm & Frey; 2004, Smith, 2004; Atherton *et al*., 2010; Guerra, 2018).

Given that *H. striatella* is unknown for the Balkan Peninsula (Hodgetts & Lockhart, 2020), we aimed to search for this species in suitable habitats along the Croatian Dinaric Alps.

MATERIALS AND METHODS

Study area

The field research was focused on two Croatian mountains – Mt Velebit (SW Croatia) in 2014 and 2015 and Mt Snježnik (W Croatia) that took place in 2015 (Fig. 1). The mountains were chosen due to previous studies that detected some potential habitats of this uncommon species (Vukelić *et al*., 2010a, b, 2011; Papp *et al*., 2013a, b). Mt Velebit is the longest Croatian mountain range extending in a typical Dinaric direction from northwest to southeast, with the highest peak (Vaganski Vrh) at 1,757 m a.s.l. (Riđanović *et al*., 1975; Magaš, 2015). It is one of the most extensively researched parts of the country with respect to bryology (Degen, 1938), with recent surveys still revealing new taxa for the area (Papp *et al*., 2013b; Alegro *et al*., 2019; Šegota *et al*., 2020).

Mt Snježnik is situated in the Gorski Kotar Region (western Croatia), between the Adriatic Sea and neighbouring Slovenia. This mountain ridge is 10 km long with several peaks over 1,300 m and the highest one (Snježnik Summit) at 1,506 m a.s.l. Geologically, the area is rather homogeneous with Mesozoic carbonate and dolomite bedrock. Precipitation is high, regularly exceeding 2,000 mm per year, while a maximum of 3,600 mm was recorded on the adjacent mountain ridge of Risnjak (Zaninović, 2008). Mean annual temperature on Mt Snježnik is around 7 °C, with a maximum in July and a minimum in January. The mountain ridge is very steep and covered with forest vegetation, with open grassland habitats developed in the subalpine belt. Although no systematic bryological research has ever been conducted into the area, several valuable contributions are provided by Sendtner (1848), Horvat (1932) and Šegota *et al.* (2020).

Field and laboratory work

A search for the target species was conducted on Northern Velebit and Snježnik during the vegetation season within spruce forests. At the finding places, phytosociological relevés were carried out on a plot size of 100 m^2 using an expanded Bra-

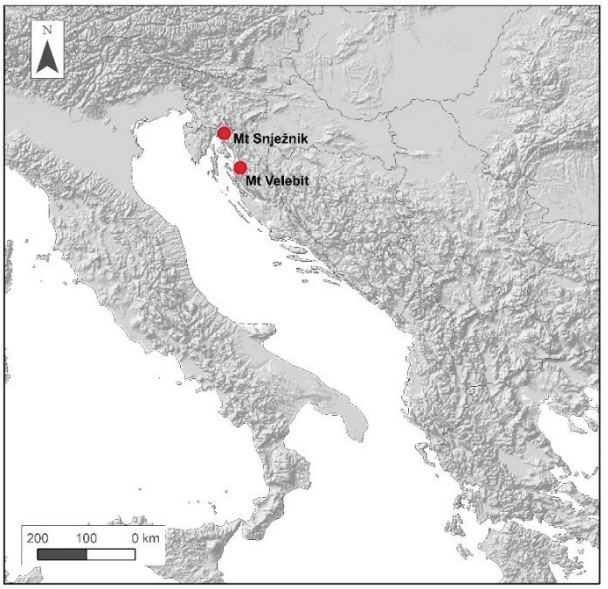

Fig. 1. Geographical position of the study area.

un-Blanquet nine-degree scale (Braun-Blanquet, 1964; Barkman *et al*., 1964; Dierschke, 1994) and including all vascular plants and bryophytes on different substrates (soil, rock, bark and dead wood).

Coverage of the skeletal substrate (i.e. rockiness) and litter was estimated. Sunlight penetration was approximated using the coverage of the tree layer. Soil samples were taken from 5–10 cm depth. Five subsamples were taken and mixed from the same 100 m^2 plot used for vegetation relevés. Soil pH was measured in water (substrate/water=10 g/25 mL) using a WTW pH 330i meter. Calcium carbonate content was measured indirectly using volumetric method with hydrochloric acid (calcimeter method) (Steubing & Fangmeier, 1992). Soil organic content was measured using the method of Steubing & Fangmeier (1992). Bioclimatic variables were derived using climatic data from 1960–1990, obtained from WorldClim (spatial resolution 1 × 1 km) (Hijmans *et al.,* 2005).

The vouchers are deposited in the Bryophyte Collection of the *Herbarium Croaticum*, University of Zagreb (ZA) (specimens 71890, 71891 and 71892). LM photographs were taken with Zeiss AXIO Lab.A1 microscope connected to a Moticam digital camera and Helicon software was used for image processing. The nomenclature of the bryophytes follows Hodgetts *et al.* (2020) (Appendix 1), and for vascular plants Euro+Med PlantBase (Euro+Med, 2006-onwards) (Appendix 2). For bryophyte species, the categories of biogeographic elements according to Hill *et al.* (2007), with respect to major biome element (E1), were assigned.

RESULTS AND DISCUSSION

The field search for *Herzogiella striatella* in Croatia resulted in the identification of two localities on Mt Snježnik (Gorski Kotar Region, NW Croatia). Both localities are situated along Frankopanski Put hiking path which connects Leska Plane and Snježnik

Fig. 2. Finding localities of *Herzogiella striatella.*

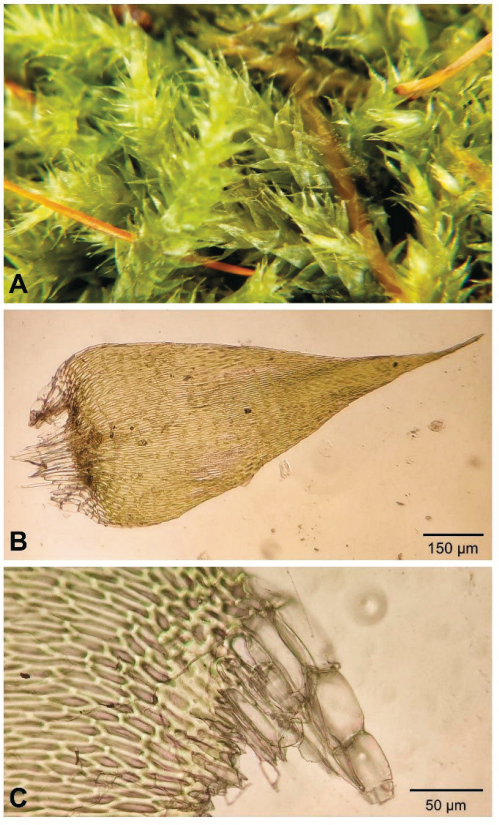

Fig. 3. *Herzogiella striatella,* habitus (A), branch leaves (B) and distinctly deccurent leaf base with inflated, hyaline alar cells (C).

Summit (Fig. 2). The first locality lies at N45° 27' 2.9", E14° 35' 13.5" on 1,239 m a.s.l. and the second at 45° 27' 3.9"N, 14° 35' 4.9"E on 1,267 m a.s.l., both found on 2 September 2015. The specimens exhibit distinctly decurrent leaves with hyaline, abruptly inflated alar cells, which form distinct auricles (Fig. 3).

According to Hill & Preston (1998) *Herzogiella striatella* is a discontinuously circumpolar European-boreal-montane species. Both Croatian populations were found growing in old spruce forests (alliance *Piceion excelsae* Pawlowski *et al*. 1928), in its typical habitat – peaty soil in crevices amongst boulders at high altitudes, which is an extremely rare habitat in Croatia (Fig. 4). Here, the specific cold and humid microclimate is ensured by peculiar forest floor geomorphology – small karst snowbed sinkholes in which cool air is uprising from the karstic underground. Due to the dominance of skeletal substrate (rockiness of the terrain exceeds 80%) on both localities, the spruce stands are not very dense, resulting in rather high light penetration through canopies (40%). The soil reaction is low (4.00 in the first and 5.13 in the second locality), as expected for spruce stands. The litter coverage is rather high in both localities (40%), as is soil organic matter content (68.91 % in the first and 62.28% in the second locality) (Tab. 1).

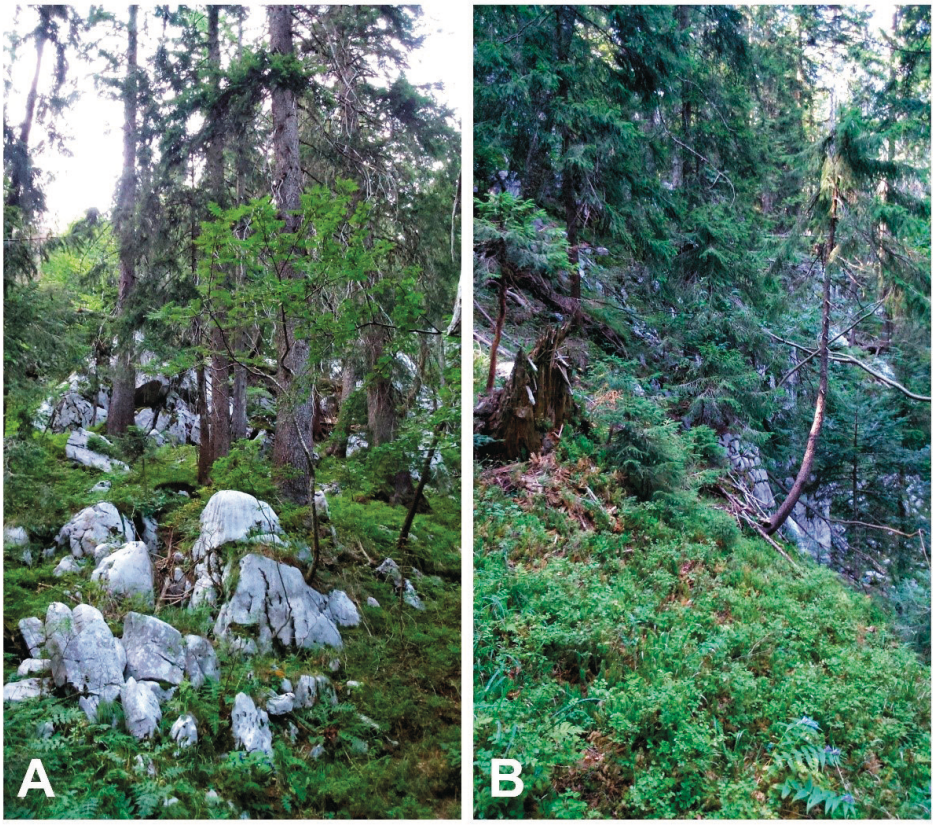

Fig. 4. Habitats of *Herzogiella striatella* on Mt Snježnik.

Tab. 1. Measured and assessed parameters of habitat, soil and climate.

Locality	**1**	**2**
altitude (m)	1239	1267
inclination (°)	40	0
exposure (°)	57.23	103.88
skelet (rocks, stones) (%)	80	80
litter (%)	40	40
light protrusion (%)	40	45
tree layer (%)	60	55
shrub layer (%)	60	60
herb layer (%)	25	30
bryophyte layer (%)	60	60
pH (H_2O)	4.54	5.66
pH (KCl)	4.00	5.13
m (CaCO3) (mg)	0.00	2.82
total soil organic matter (%)	68.91	62.28
mean annual temperature (°C)	5.37	4.68
maximum temperature of warmest month (°C)	19.1	18.0
minimum temperature of coldest month (°C)	-6.1	-6.6
annual precipitation (mm)	1747	1828
precipitation of the wettest month (mm)	201	211
precipitation of driest month (mm)	110	115

The species was found growing on moist soil together with other mosses (*Dicranum scoparium*, *Hylocomiadelphus triquetrus*, *Hylocomium splendens*, *Isothecium alopecuroides*, *Leucobryum glaucum*, *Mnium thomsonii*, *Plagiothecium denticulatum*, *Polytrichum formosum*, *Ptychostomum zieri*, *Rhytidiadelphus loreus*, *R. squarrosus*, *Sanionia uncinata* and *Sphagnum quinquefarium*) and liverworts (*Bazzania trilobata*, *Calypogeia azurea*, *C. muelleriana*, *C. neesiana*, *Cephalozia bicuspidata*, *Chiloscyphus polyanthos*, *Mylia taylorii*, *Plagiochila porelloides* and *Scapania aspera*) (Appendix 1).

The floristic composition and the peculiar geomorphology of the sites clearly put the researched stands into the association *Lonicero caerulae-Piceetum* Zupančić (1976) 1994 corr. 1999 (Vukelić *et al*., 2011). Our researched forest stands embrace the typical spruce forest bryoflora with large pleurocarps, e.g. *Rhytidiadelphus loreus*, *Hylocomiadelphus triquetrus*, *Hylocomium splendens* and saproxylic liverworts, e.g. *Bazzania trilobata*, *Blepharostoma trichophyllum*, *Ptilidium pulcherrimum*, *Riccardia palmata*, accompanied with vascular plants, e.g. *Lycopodium annotinum*, *Huperzia selago*, *Hypericum richeri* ssp. *grisebachii*, *Valeriana tripteris*, *Calamagrostis varia*, *Homogyne sylvestris*, *Maianthemum bifolium*, *Veronica urticifolia*, *Rubus saxatilis*, *Vaccinium myrtillus*, *V. vitis-idaea*, *Rosa pendulina*, *Lonicera nigra*, *Sambucus racemosa* etc. However, due to several small karst sinkholes within the forest, with markedly cooler and humid microclimate, the fragments of snowbed vegetation (*Drepanoclado uncinati-Heliospermetum pusillae* Surina et Vreš 2004) with *Sanionia uncinata* (= *Drepanocladus uncinatus*), *Silene pusilla* (= *Heliosperma pusillum*), *Polytrichastrum alpinum*, *Orthothecium rufescens*, and *Distichium capillaceum*, are present. Snowbed stands are generally rare in Croatia, found only in freezing ravines and dolines of the Liburnian karst and Velebit Mountains (NW Dinaric Alps, NW Croatia),

hosting some rare and often relic plant species (Modrić Surina & Surina, 2010). Besides snowbed vegetation, a considerable number of plants from the uppermost treeline forest belt – dwarf forest vegetation of the alliance *Lonicero borbasianae-Pinion mugi* Čarni et Mucina 2015 (subalpine calcicolous pine krummholz of the Balkan Peninsula) are found in the researched spruce stands: *Clematis alpina, Parnassia palustris, Viola biflora, Rhododendron hirsutum, Salix appendiculata, Lonicera caerulea, Juniperus communis* ssp. *nana, Microhypnum sauteri* and *Pohlia cruda*. The discovery of *Sphagnum quinquefarium* is noteworthy since it is one of the rarest peat mosses in Croatia, living mostly within forests and known only from a few localities (Alegro & Šegota, unpublished). Moreover, this is the only known population of peat mosses on Snježnik Massif.

This bryophyte species composition is remarkable, consisting of as many as 61 bryophyte taxa and belonging to several vegetation types, as underlined with a distinctive biogeographical spectrum dominated by boreal and arctic (41%) and boreo-temperate taxa (41%) (Fig. 5). The most extreme taxa in respect to geographical latitude and altitude are arctic-montane *Brachythecium cirrosum* and boreo-arctic montane *Mnium thomsonii*, *Sanionia uncinata, Pohlia cruda, Scapania aequiloba, Ptychostomum zieri, Blepharostoma trichophyllum, Distichium capillaceum, Mesoptychia collaris* and *Platydictya jungermannioides*.

As a boreal-alpine species, *H. striatella* requires a humid and cold environment, which prevails on the northern exposed mountain slopes of Snježnik Massif with low mean annual temperatures (5.37 °C at the first locality and 4.68 °C at the second), high annual precipitation (1,747 mm; 1,828 mm), sufficient precipitation during the summer (110 mm; 115 mm during the driest month) and long-lasting snow cover (Tab. 1). Thus, the more frequent climatic extremes with longer rainless summer periods and higher air temperatures could severely jeopardise the populations of this relic species. In the European context, *H. striatella* has been assessed as least concern (LC), however, on national levels, it is vulnerable (VU) in Germany and Estonia and endangered (EN) in Andorra, Madeira, Slovakia, Switzerland and Romania (Hodgetts & Lockhart, 2020).

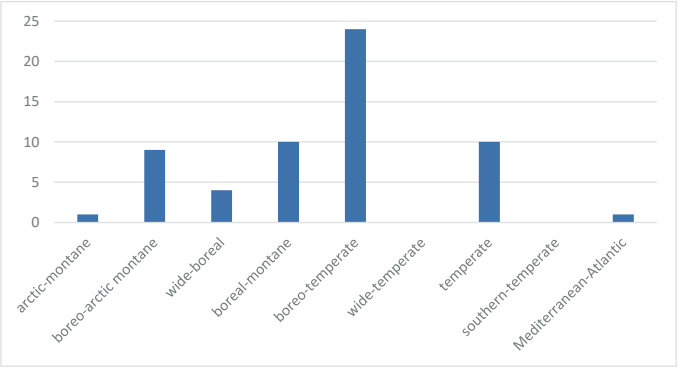

Fig. 5. Spectrum of biogeographic elements regarding major biomes for bryophyte flora of *H.striatella* localities on Mt Snježnik.

CONCLUSIONS

The discovery of *Herzogiella striatella* on Snježnik Massif is of high significance in the wider Southeast European context, since it is known otherwise only from Romania and from several localities in the alpine region of neighbouring Slovenia (Martinčić, 2003; Hodgetts & Lockhart, 2020). Its phytogeographical boreo-alpine affinities, along with the apparent isolation of European populations from different mountains, suggest a relict origin. It shares these affinities with *Myurella sibirica* (Müll.Hal.) Reimers. (Alegro *et al*., 2018), *Syntrichia norvegica* F.Weber. (Ellis *et al*., 2015), *Cyrtomnium hymenophylloides* (Huebener) T. J. Kop. (Blockeel *et al*., 2009), *Drepanium fastigiatum* (Brid.) C. E. O. Jensen (Šegota *et al*., 2020), *Microhypnum sauteri* (Šegota *et al*., 2020) and *Dichodontium flavescens* (Dicks.) Lindb. (Alegro *et al*., 2019), all recently discovered in different mountain refuges along the Croatian Dinarides.

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Appendix 1. Bryophyte taxa and their abundances on two finding sites of *H. striatella* on Mt Snježnik: M – moss, L – liverwort, BE – biogeographic element (1 – arctic-montane, 2 – boreo-arctic montane, 3 – wide-boreal, 4 – boreal-montane, 5 – boreo-temperate, 6 – wide temperate, 7 – temperate, 8 – southern-temperate, 9 – Mediterranean-Atlantic); key for the abundance ranks: + = up to 5 individuals; 1 = up to 50 individuals; 2m = more than 50 individuals; 2a = coverage between 5 and 15%; 2b = coverage between 15 and 25%; 3 = coverage between 25 and 50%; 4 = coverage between 50 and 75%; 5 = coverage over 75%

Locality	1	2	BE
Bryophyte layer			
Ctenidium molluscum (Hedw.) Mitt. **(M)**	2a	2a	5
Fissidens dubius P.Beauv. **(M)**	2a	2a	7
Polytrichum formosum Hedw. **(M)**	2a	2a	5
Dicranum scoparium Hedw. **(M)**	2a	2m	3
Mylia taylorii (Hook.) Gray **(L)**	2m	2a	4
Rhytidiadelphus loreus (Hedw.) Warnst. **(M)**	2a	2m	5
Mnium thomsonii Schimp **(M)**	1	2a	2
Sanionia uncinata (Hedw.) Loeske **(M)**	1	2a	2
Campylium protensum (Brid.) Kindb. **(M)**	1	2m	5
Hylocomium splendens (Hedw.) Schimp. **(M)**	1	2m	3
Brachythecium cirrosum (Schwägr.) Schimp **(M)**	1	1	1
Chiloscyphus polyanthos (L.) Corda **(L)**	1	1	5
Herzogiella striatella Brid.) Z.Iwats **(M)**	1	1	4
Isothecium alopecuroides (Lam. ex Dubois) Isov **(M)**	1	1	5
Schistidium helveticum (Schkuhr) Deguchi **(M)**	1	1	4
Tortella tortuosa (Hedw.) Limpr. **(M)**	1	1	5
Calypogeia fissa (L.) Raddi **(L)**	1	+	7
Exsertotheca crispa (Hedw.) S.Olsson, Enroth & D.Quandt **(M)**	1	+	7
Plagiochila porelloides (Torr. ex Nees) Lindenb. **(L)**	1	+	5
Lophozia ventricosa (Dicks.) Dumort. **(L)**	+	1	3
Plagiothecium laetum Schimp. **(M)**	1	+	4
Pohlia cruda (Hedw.) Lindb. **(M)**	+	1	2
Ptilidium pulcherrimum (Weber) Vain. **(L)**	1	+	4
Rhizomnium punctatum (Hedw.) T.J.Kop. **(M)**	1	+	5
Scapania aspera M.Bernet & Bernet **(L)**	+	1	5
Calypogeia muelleriana (Schiffn.) Müll.Frib. **(L)**	+	+	5
Lophocolea bidentata (L.) Dumort. **(L)**	+	+	7
Plasteurhynchium striatulum (Spruce) M.Fleisch. **(M)**	+	+	9
Radula complanata (L.) Dumort.	+	+	5
Scapania aequiloba (Schwägr.) Dumort. **(L)**	+	+	2
Hylocomiadelphus triquetrus (Hedw.) Ochyra & Stebel **(M)**	2a		3
Leucobryum glaucum (Hedw.) Ångstr. **(M)**	2a		7
Rhytidiadelphus squarrosus (Hedw.) Warnst. **(M)**		2a	5
Bazzania trilobata (L.) Gray **(L)**	2m		7
Sphagnum quinquefarium (Braithw.) Warnst. **(M)**	2m		4
Calypogeia neesiana (C.Massal. & Carestia) Müll.Frib. **(L)**	1		5
Herzogiella seligeri (Brid.) Z.Iwats. **(M)**		1	5
Ptychostomum zieri (Hedw.) Holyoak & N.Pedersen **(M)**	1		2
Isothecium myosuroides Brid. **(M)**	1		5
Orthothecium rufescens (Dicks. ex Brid.) Schimp. **(M)**	1		4

Locality	1	2	BE
Plagiothecium curvifolium Schlieph. ex Limpr. **(M)**		1	7
Polytrichastrum alpinum (Hedw.) G.L.Sm. **(M)**		1	5
Blepharostoma trichophyllum (L.) Dumort. **(L)**	+		2
Brachytheciastrum velutinum (Hedw.) Ignatov & Huttunen **(M)**		+	7
Ptychostomum capillare (Hedw.) Holyoak & N.Pedersen **(M)**	+		5
Ptychostomum elegans (Nees) D.Bell & Holyoak **(M)**	+		4
Calypogeia azurea Stotler & Crotz **(L)**	+		5
Campyliadelphus chrysophyllum (Brid.) R.S.Chopra **(M)**		+	5
Cephalozia bicuspidata (L.) Dumort. **(L)**		+	5
Distichium capillaceum (Hedw.) Bruch & Schimp. **(M)**		+	2
Eurhynchium angustirete (Broth.) T.J.Kop. **(M)**		+	-
Hygrohypnum luridum (Hedw.) Jenn. **(M)**		+	5
Microhypnum sauteri (Schimp.) Jan Kučera & Ignatov **(M)**		+	-
Lepidozia reptans (L.) Dumort. **(L)**	+		5
Lophocolea heterophylla (Schrad.) Dumort. **(L)**	+		7
Mesoptychia collaris (Nees) L.Söderstr. & Váňa **(L)**		+	2
Plagiothecium denticulatum (Hedw.) Schimp. **(M)**	+		5
Platydictya jungermannioides (Brid.) H.A.Crum **(M)**	+		2
Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb. **(M)**		+	4
Rhynchostegium murale (Hedw.) Schimp **(M)**		+	7
Riccardia palmata (Hedw.) Carruth. **(L)**		+	4

Appendix 2. Vascular plants and their abundances on two finding sites of *H. striatella* on Mt Snježnik. Taxa abundances are estimated within three vegetation layers (trees, shrubs and herbs); key for the abundance ranks: + = up to 5 individuals; 1 = up to 50 individuals; 2m = more than 50 individuals; 2a = coverage between 5 and 15%; 2b = coverage between 15 and 25%; 3 = coverage between 25 and 50%; 4 = coverage between 50 and 75%; 5 = coverage over 75%

Locality	1	2
Tree layer		
Picea abies (L.) H. Karst.	4	4
Abies alba Mill.	1	2m
Fagus sylvatica L.	+	1
Acer pseudoplatanus L.	r	
Shrub layer		
Vaccinium myrtillus L.	2a	3
Vaccinium vitis-idaea L.	2a	1
Rosa pendulina L.	2a	1
Lonicera nigra L.	+	2a
Daphne mezereum L.	+	+
Lonicera alpigena L.	+	+
Rubus saxatilis L.	+	+
Salix hastata L.	+	+
Sorbus aucuparia L.	r	+
Rhododendron hirsutum L.	1	
Salix appendiculata Vill.	1	
Erica carnea L.	+	
Juniperus communis L. ssp. *nana* Syme	+	
Lonicera caerulea L.	+	

Locality	1	2
Sambucus racemosa L.		r
Sorbus aria (L.) Crantz	r	
Herb layer		
Lycopodium annotinum L.	2a	1
Valeriana tripteris L.	2m	2m
Calamagrostis varia (Schrad.) Host	1	2m
Homogyne sylvestris Cass.	2m	1
Clematis alpina (L.) Mill.	2a	+
Silene pusilla Waldst. et Kit.	+	2m
Bellidiastrum michelii Cass.	1	1
Huperzia selago (L.) Schrank et Mart.	1	1
Maianthemum bifolium (L.) F. W. Schmidt	1	1
Oxalis acetosella L.	1	1
Anemone nemorosa L.	1	+
Asplenium viride Huds.	1	+
Convallaria majalis L.	1	+
Veronica urticifolia Jacq.	1	+
Cardamine trifolia L.	+	1
Gentiana asclepiadea L.	+	1
Phyteuma spicatum L.	+	1
Asplenium ruta-muraria L.	+	+
Campanula scheuchzeri Vill.	+	+
Carex digitata L.	+	+
Gymnocarpium robertianum (Hoffm.) Newman	+	+
Hypericum richeri Vill. ssp. *grisebachii* (Boiss.) Nyman	+	+
Phegopteris connectilis (Michx.) Watt	+	+
Polygonatum verticillatum (L.) All.	+	+
Polystichum lonchitis (L.) Roth	+	+
Prenanthes purpurea L.	+	+
Veratrum nigrum L.	+	+
Cirsium erisithales (Jacq.) Scop.	r	+
Cyclamen purpurascens Mill.	r	+
Melica nutans L.		2m
Athyrium filix-femina (L.) Roth		+
Carex sylvatica Huds.		+
Circaea lutetiana L.		+
Doronicum austriacum Jacq.		+
Dryopteris expansa (C. Presl) Fraser-Jenk. et Jermy		+
Fragaria vesca L.	+	
Moehringia muscosa L.		+
Paris quadrifolia L.		+
Parnassia palustris L.	+	
Senecio ovatus (P. Gaertn., B. Mey. et Scherb.) Hoppe.		+
Viola biflora L.	+	
Viola reichenbachiana Boreau		+
Cardamine enneaphyllos (L.) Crantz	r	
Melampyrum velebiticum Borbás	r	