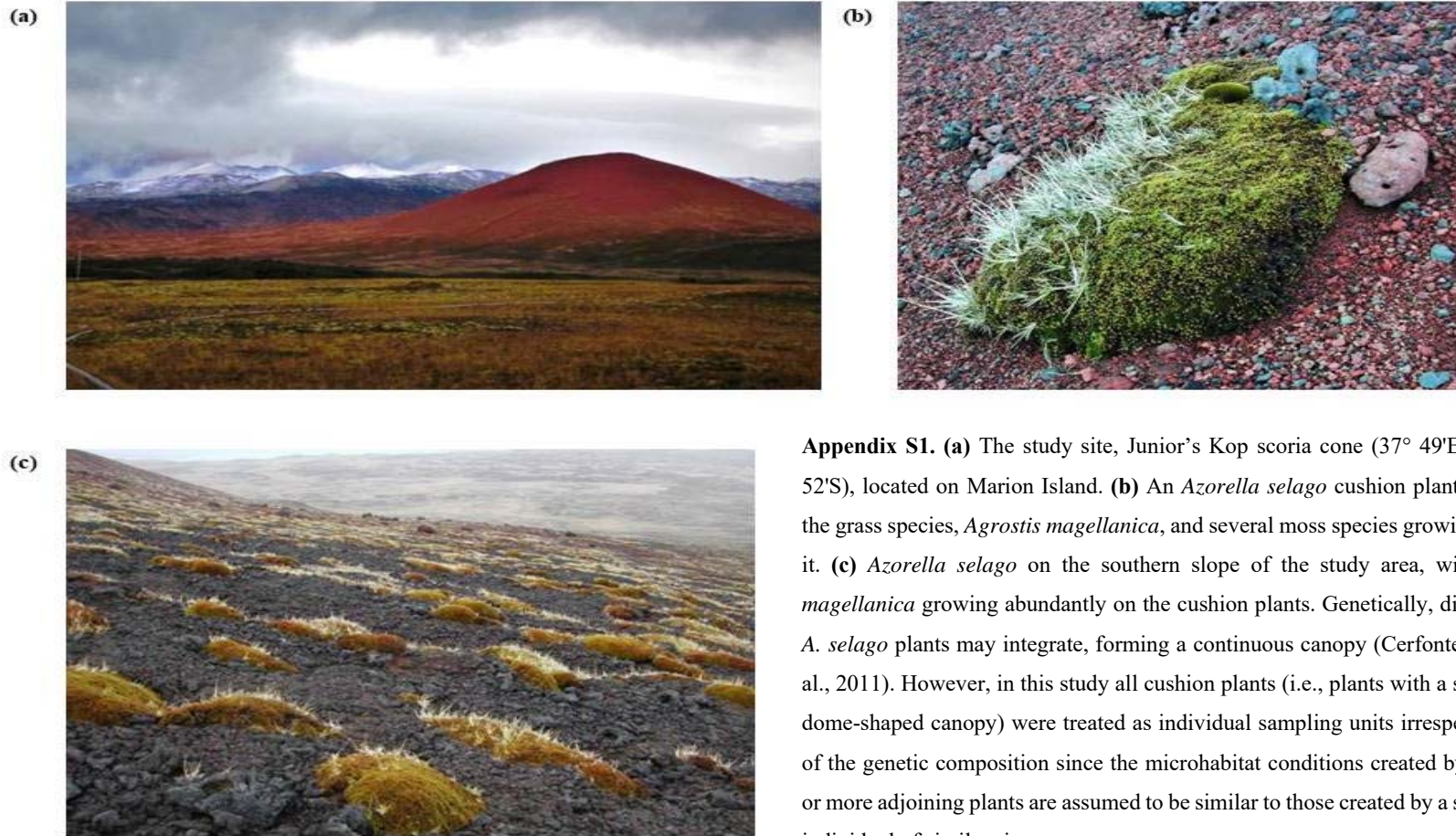


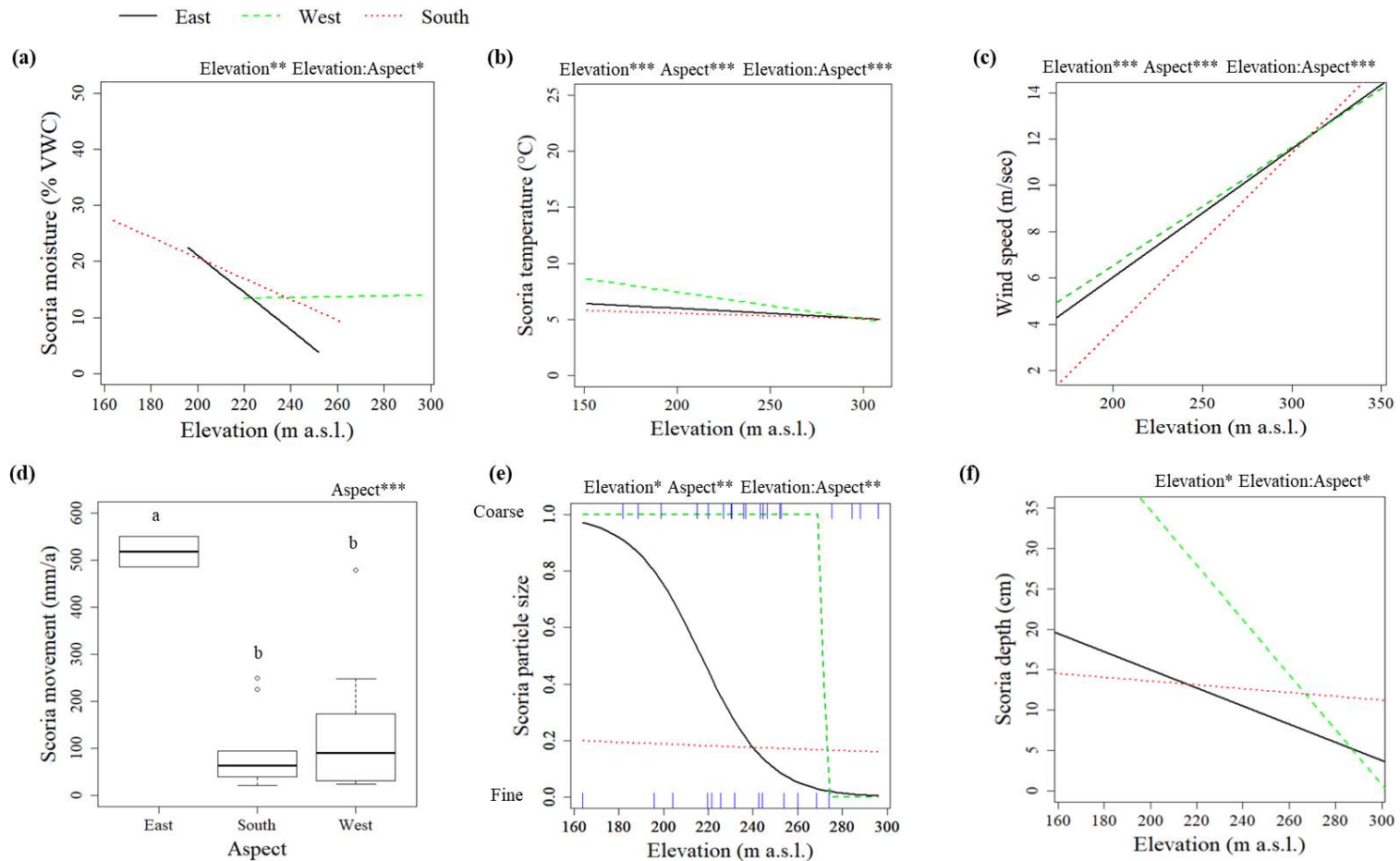
## Supporting information to the paper

Buyens, I. P. R. et al. Fine-scale variation in the effect of the cushion plant *Azorella selago* on vascular plants, mosses, hepatics and lichens in the sub-Antarctic. *Journal of Vegetation Science*.



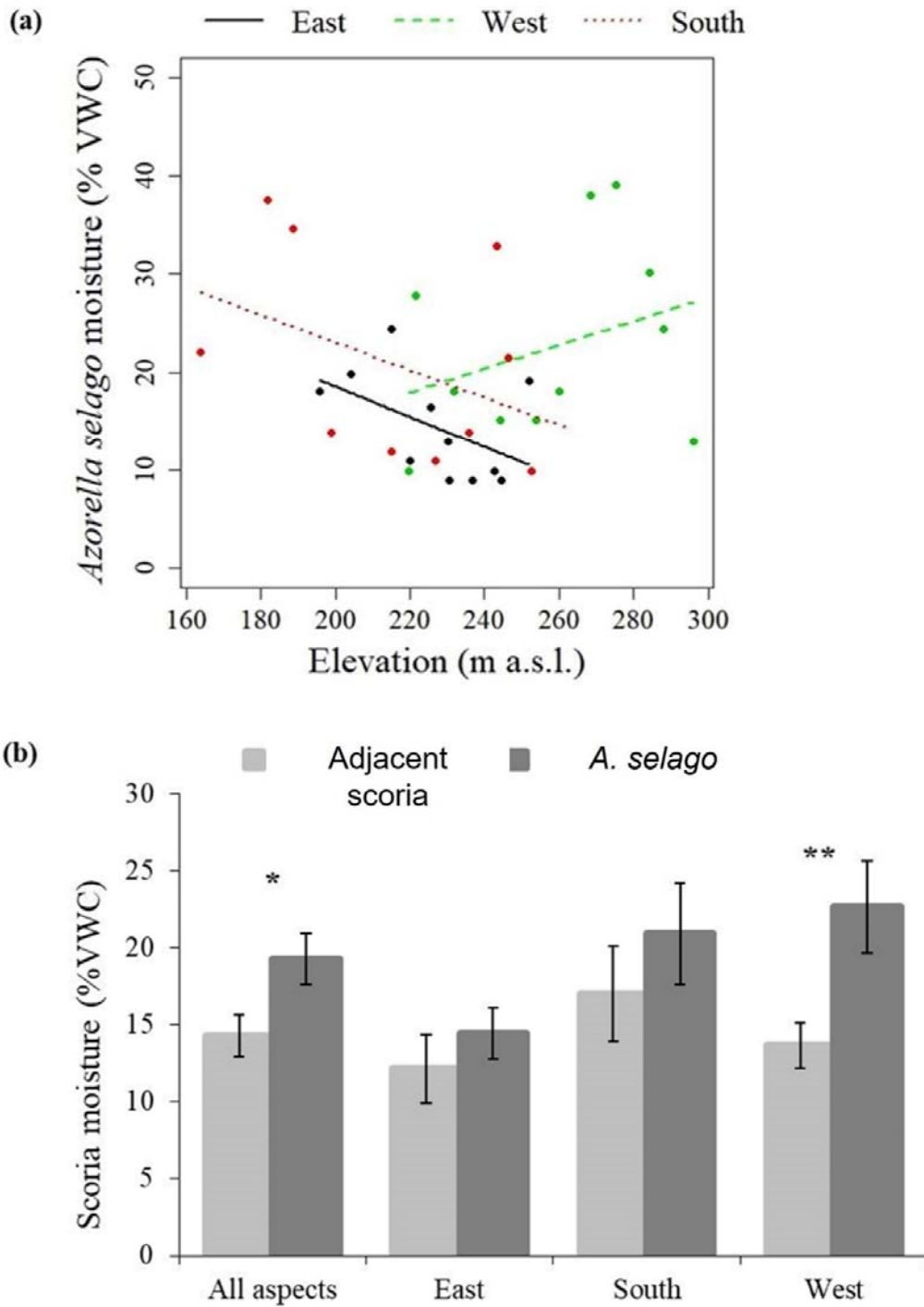
**Appendix S1.** (a) The study site, Junior's Kop scoria cone (37° 49'E; 46° 52'S), located on Marion Island. (b) An *Azorella selago* cushion plant with the grass species, *Agrostis magellanica*, and several moss species growing on it. (c) *Azorella selago* on the southern slope of the study area, with *A. magellanica* growing abundantly on the cushion plants. Genetically, distinct *A. selago* plants may integrate, forming a continuous canopy (Cerfonteyn et al., 2011). However, in this study all cushion plants (i.e., plants with a single dome-shaped canopy) were treated as individual sampling units irrespective of the genetic composition since the microhabitat conditions created by two or more adjoining plants are assumed to be similar to those created by a single individual of similar size.

**Reference:** Cerfonteyn, M.E., le Roux, P.C., van Vuuren, B.J., & Born, C. (2011) Cryptic spatial aggregation of the cushion plant *Azorella selago* (Apiaceae) revealed by a multilocus molecular approach suggests frequent intraspecific facilitation under sub-Antarctic conditions. *American Journal of Botany*, 98, 909–914.



**Appendix S2.** Variation of abiotic variables with elevation and aspect. **(a)** Scoria volumetric water content ( $n = 66$ ). **(b)** Scoria temperature ( $n = 5394$ ). **(c)** Wind speed ( $n = 474$ ). **(d)** Scoria movement ( $n = 24$ ). **(e)** Scoria particle size ( $n = 33$ ; varying from fine [0] to coarse [1]). **(f)** Scoria depth ( $n = 33$ ). Significant model terms using general linear models (elevation, aspect and their interaction) are indicated above each graph. \*\*\* =  $p < 0.001$ ; \*\* =  $p < 0.01$ ; \* =  $p < 0.05$ . In panel **(d)** different letters indicate significant differences between aspects, while the thick horizontal line represents the median, the box represents the interquartile range, the whiskers represent the range of the data, and the empty circles represent outliers.

**Appendix S3. (a)** Scoria volumetric water content below *Azorella selago* ( $n = 66$ ). **(b)** Mean ( $\pm$  SE) scoria moisture beneath *A. selago* and adjacent sites. Data are presented for all aspects combined and for the east ( $n = 33$ ), south ( $n = 33$ ), and west ( $n = 33$ ) aspects separately. \* =  $p > 0.01$ ; \*\* =  $p > 0.001$  (paired t-test).



**Appendix S4.** Vascular plant, hepatic, lichen and moss species occurrences on *Azorella selago* and adjacent sites. A  $\chi^2$  test was used to test if the proportion of occurrences of species differed significantly between *A. selago* and adjacent sites ( $p \leq 0.05$  indicated in bold).

Taxon group	Species	<i>A. selago</i>	Adjacent	$\chi^2$	<i>p</i> -value
<b>Vascular plant species</b>	<i>Acaena magellanica</i>	13	8	1.12	0.29
	<i>Agrostis magellanica</i>	23	14	3.94	<b>0.047</b>
	<i>Blechnum penna-marina</i>	6	6	0.00	1
	<i>Colobanthus kerguelensis</i>	3	1	0.27	0.606
	<i>Montia fontana</i>	2	3	0.00	1
	<i>Poa cookii</i>	1	2	0.00	1
	<i>Ranunculus biternatus</i>	3	0	1.40	0.237
	<i>Sagina procumbens</i>	3	1	0.27	0.606
<b>Hepatic species</b>	<i>Cephaloziella sp.</i>	9	4	1.53	0.216
	<i>Clasmatocolea humilis</i>	0	1	0.00	1
	<i>Fossombronia sp.</i>	12	0	12.32	<b>&lt; 0.001</b>
	<i>Herzogobryum sp.</i>	0	14	15.32	<b>&lt; 0.001</b>
	<i>Jensenia pisicolor</i>	0	1	0.00	1
	<i>Jungermannia sp.</i>	4	0	2.40	0.122
	<i>Lepidozia laevifolia</i>	3	3	0.00	1
	<i>Liverwort morphospecies 1</i>	5	9	0.82	0.366
	<i>Metzgeria sp.</i>	2	2	0.00	1
	<i>Plagiochila crozetensis</i>	0	1	0.00	1
	<i>Plagiochila heterodonta</i>	4	13	5.07	<b>0.024</b>
	<i>Schistochila carnosa</i>	2	0	0.52	0.473
	<i>Syzygiella colorata</i>	0	1	0.00	1
	<i>Syzygiella sonderi</i>	0	5	3.46	0.063
<b>Moss species</b>	<i>Andreaea flabellata</i>	0	23	32.30	<b>&lt; 0.001</b>
	<i>Andreaea acutifolia</i>	0	21	27.94	<b>&lt; 0.001</b>
	<i>Bartramia patens</i>	10	13	0.27	0.605
	<i>Brachythecium rutabulum</i>	1	3	0.27	0.606
	<i>Brachythecium paradoxum</i>	3	10	3.45	0.063
	<i>Breutelia integrifolia</i>	0	1	0.00	1
	<i>Bryum sp. 1</i>	3	10	3.45	0.063
	<i>Bryum sp. 2</i>	5	6	0.00	1
	<i>Bryum sp. 3</i>	10	0	9.55	<b>0.002</b>
	<i>Bryum sp. 4</i>	3	3	0.00	1
	<i>Bucklandiella sp. 1</i>	0	1	0.00	1
	<i>Bucklandiella sp. 2</i>	0	1	0.00	1
	<i>Bucklandiella sp. 3</i>	2	25	30.34	<b>&lt; 0.001</b>
	<i>Campylopus austrostramineus</i>	3	3	0.00	1
	<i>Campylopus cavifolius</i>	0	2	0.52	0.473
	<i>Campylopus clavatus</i>	0	1	0.00	1
	<i>Campylopus introflexus</i>	1	1	0.00	1
	<i>Campylopus polytrichoides</i>	4	1	0.87	0.352
	<i>Catagonium politum</i>	7	11	0.69	0.407
	<i>Cratoneuropsis chilensis</i>	1	6	2.56	0.11

	<i>Ditrichum sp. 1</i>	1	1	0.00	1
	<i>Ditrichum sp. 2</i>	0	1	0.00	1
	<i>Ditrichum sp. 3</i>	2	9	3.93	<b>0.048</b>
	<i>Ditrichum strictum</i>	0	6	4.58	<b>0.032</b>
	<i>Grimmia kidderi</i>	0	14	15.32	<b>&lt; 0.001</b>
	<i>Holodontium pumilum</i>	0	13	13.79	<b>&lt; 0.001</b>
	<i>Hypnum cupressiforme</i>	0	1	0.00	1
	<i>Moss morphospecies 1</i>	1	0	0.00	1
	<i>Moss morphospecies 2</i>	9	5	0.82	0.366
	<i>Moss morphospecies 3</i>	0	2	0.52	0.473
	<i>Moss morphospecies 4</i>	8	8	0.00	1
	<i>Notoligotrichum australe</i>	0	3	1.40	0.237
	<i>Philonotis scabrifolia</i>	1	10	6.98	<b>0.008</b>
	<i>Racomitrium valdonsmithii</i>	5	5	0.00	1
	<i>Racomitrium lanuginosum</i>	0	7	5.75	<b>0.016</b>
	<i>Sanionia uncinata</i>	4	8	0.92	0.338
	<i>Verrucidens microcarpus</i>	0	2	0.52	0.473
	<hr/>				
	<i>Amandinea subplicata</i>	0	26	39.66	<b>&lt; 0.001</b>
	<i>Cladonia sp. 1</i>	1	14	12.42	<b>&lt; 0.001</b>
	<i>Cladonia sp. 2</i>	6	3	0.51	0.473
	<i>Cladonia sp. 4</i>	0	1	0.00	1
	<i>Lichen morphospecies 1</i>	0	2	0.52	0.473
	<i>Lichen morphospecies 2</i>	0	13	13.79	<b>&lt; 0.001</b>
	<i>Lichen morphospecies 3</i>	0	5	3.46	0.063
	<i>Lichen morphospecies 4</i>	0	1	0.00	1
	<i>Lichen morphospecies 5</i>	0	1	0.00	1
	<i>Lichen morphospecies 6</i>	0	2	0.52	0.473
	<i>Lichen morphospecies 7</i>	0	1	0.00	1
<b>Lichen species</b>	<i>Lichen morphospecies 8</i>	0	2	0.52	0.473
	<i>Lichen morphospecies 9</i>	0	6	4.58	<b>0.032</b>
	<i>Lichen morphospecies 10</i>	0	5	3.46	0.063
	<i>Lichen morphospecies 11</i>	0	2	0.52	0.473
	<i>Lichen morphospecies 12</i>	3	9	2.55	0.111
	<i>Lichen morphospecies 13</i>	9	6	0.35	0.557
	<i>Lichen morphospecies 14</i>	0	13	13.79	<b>&lt; 0.001</b>
	<i>Lichen thallose cf. parmelia</i>	0	1	0.00	1
	<i>Orceolina kerguelensis</i>	0	23	32.30	<b>&lt; 0.001</b>
	<i>Peltigera sp. 1</i>	2	3	0.00	1
	<i>Peltigera sp. 2</i>	0	2	0.52	0.473
	<i>Pertusaria sp.</i>	0	1	0.00	1
	<hr/>				

**Appendix S5.** The correlation between the competitive importance index ( $C_{imp}$ ) and the relative interaction intensity index (RII) for species richness and cover of vascular plant, hepatic, moss and lichen species ( $p \leq 0.05$  indicated in bold).

		<b>Correlation</b>	<b><i>p</i>-value</b>
$C_{imp}$ for vascular plant richness	RII for vascular plant richness	0.764	< <b>0.001</b>
$C_{imp}$ for vascular plant cover	RII for vascular plant cover	0.676	< <b>0.001</b>
$C_{imp}$ for hepatic richness	RII for hepatic richness	0.547	< <b>0.001</b>
$C_{imp}$ for hepatic cover	RII for hepatic cover	0.282	<b>0.022</b>
$C_{imp}$ for moss richness	RII for moss richness	0.700	< <b>0.001</b>
$C_{imp}$ for moss cover	RII for moss cover	0.391	<b>0.002</b>
$C_{imp}$ for lichen richness	RII for lichen richness	0.318	<b>0.009</b>
$C_{imp}$ for lichen cover	RII for lichen cover	0.308	<b>0.012</b>

**Appendix S6.** Competitive importance index ( $C_{imp}$ ) from distal models for a) the richness and b) the cover of vascular plant, hepatic, moss and lichen species from  $n = 33$  paired samples ( $n = 11$  per aspect). No individual predictor variables (far right column) or full models (far left column) significantly ( $p < 0.05$ ) explained variation in RII. Significance and percentage deviance explained (% DE) of full model given in the first column. For categorical predictor variables the ranking of the factor levels is shown.

Response variable	Coefficient	Estimate $\pm$ SE	<i>p</i> -value
<b>a) <math>C_{imp}</math> for richness</b>			
Vascular plant	(Intercept)	0.218 $\pm$ 3.163	0.945
$p = 0.994$	Aspect	East > South > West	0.918
% DE = 4.0	Elevation	0.001 $\pm$ 0.014	0.952
Hepatic	(Intercept)	-4.165 $\pm$ 3.401	0.221
$p = 0.807$	Aspect	East > South > West	0.490
% DE = 36.0	Elevation	0.019 $\pm$ 0.015	0.194
Moss	(Intercept)	-2.866 $\pm$ 3.773	0.448
$p = 0.920$	Aspect	East > West > South	0.718
% DE = 25.3	Elevation	0.010 $\pm$ 0.016	0.548
Lichen	(Intercept)	1.123 $\pm$ 3.744	0.764
$p = 0.956$	Aspect	East > West > South	0.747
% DE = 27.9	Elevation	-0.008 $\pm$ 0.016	0.630
<b>b) <math>C_{imp}</math> for cover</b>			
Vascular plant	(Intercept)	-3.742 $\pm$ 3.329	0.261
$p = 0.929$	Aspect	South > East > West	0.830
% DE = 35.2	Elevation	0.016 $\pm$ 0.014	0.277
Hepatic	(Intercept)	-1.586 $\pm$ 3.180	0.618
$p = 0.995$	Aspect	East > South > West	0.898
% DE = 20.3	Elevation	0.007 $\pm$ 0.014	0.610
Moss	(Intercept)	-2.541 $\pm$ 3.236	0.432
$p = 0.968$	Aspect	South > East > West	0.904
% DE = 21.5	Elevation	0.010 $\pm$ 0.014	0.486
Lichen	(Intercept)	1.147 $\pm$ 3.738	0.759
$p = 0.956$	Aspect	East > West > South	0.753
% DE = 28.1	Elevation	-0.008 $\pm$ 0.016	0.625

**Appendix S7.** Competitive importance index ( $C_{imp}$ ) from proximal models for the a) richness and b) cover of vascular plant, hepatic, moss and lichen species from  $n = 33$  paired samples ( $n = 11$  per aspect). No individual predictor variables (far right column) or full models (far left column) significantly ( $p < 0.05$ ) explained variation in RII. Significance and percentage deviance explained (% DE) of full model given in first column. For categorical predictor variables the ranking of the factor levels is shown.

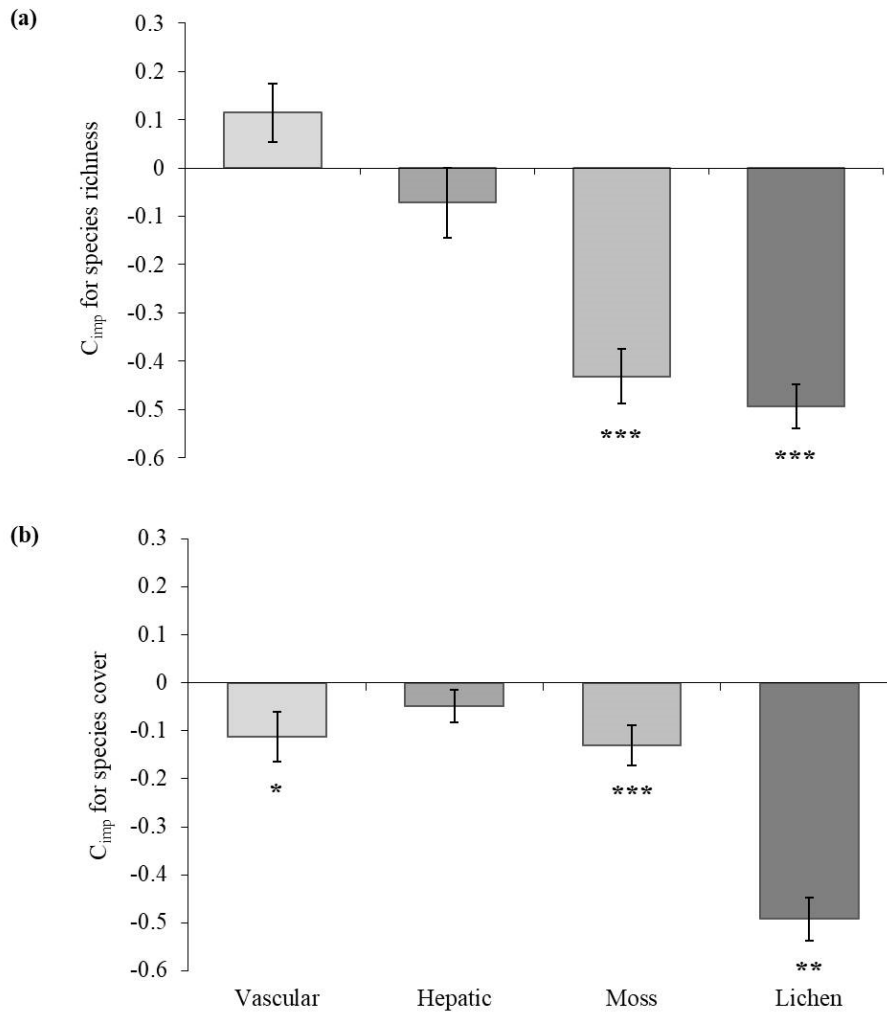
Response variable	Coefficient	Estimate $\pm$ SE	<i>p</i> -value	
<b>a) <math>C_{imp}</math> for richness</b>				
Vascular plant  <i>p</i> = 0.991 % DE = 61.6	(Intercept)	12.780 $\pm$ 23.990	0.594	
	Elevation	-0.013 $\pm$ 0.035	0.700	
	Aspect	West > East > South	0.817	
	Scoria particle size	Coarse > Fine	0.998	
	Scoria depth	0.009 $\pm$ 0.054	0.870	
	Organic material	Absent > Present	0.219	
	Wind speed	-0.126 $\pm$ 0.304	0.680	
	Scoria moisture	-0.007 $\pm$ 0.080	0.928	
	Scoria temperature	-1.385 $\pm$ 2.743	0.613	
	<i>Azorella selago</i> length	0.010 $\pm$ 0.031	0.613	
	<i>Azorella selago</i> height	0.024 $\pm$ 0.103	0.818	
	Hepatic  <i>p</i> = 0.974 % DE = 61.3	(Intercept)	-3.646 $\pm$ 27.408	0.894
		Elevation	0.029 $\pm$ 0.431	0.184
Aspect		West > East > South	0.958	
Scoria particle size		Coarse > Fine	0.783	
Scoria depth		-0.042 $\pm$ 0.057	0.455	
Organic material		Present > Absent	0.941	
Wind speed		-0.240 $\pm$ 0.425	0.573	
Scoria moisture		0.004 $\pm$ 0.085	0.966	
Scoria temperature		0.400 $\pm$ 3.093	0.897	
<i>Azorella selago</i> length		0.001 $\pm$ 0.031	0.977	
<i>Azorella selago</i> height		-0.013 $\pm$ 0.106	0.906	
Moss  <i>p</i> = 0.997 % DE = 48.0		(Intercept)	4.201 $\pm$ 26.994	0.876
		Elevation	0.012 $\pm$ 0.041	0.768
	Aspect	West > East > South	0.826	
	Scoria particle size	Fine > Coarse	0.763	
	Scoria depth	0.030 $\pm$ 0.059	0.615	
	Organic material	Present > Absent	0.849	
	Wind speed	-0.152 $\pm$ 0.339	0.654	
	Scoria moisture	-0.048 $\pm$ 0.106	0.650	
	Scoria temperature	-0.651 $\pm$ 3.009	0.829	
	<i>Azorella selago</i> length	-0.016 $\pm$ 0.034	0.645	
	<i>Azorella selago</i> height	-0.013 $\pm$ 0.113	0.908	
	Lichen  <i>p</i> = 0.999 % DE = 53.6	(Intercept)	-5.120 $\pm$ 27.999	0.855
		Elevation	0.002 $\pm$ 0.040	0.664
Aspect		East > South > West	0.972	
Scoria particle size		Fine > Coarse	0.597	
Scoria depth		-0.029 $\pm$ 0.065	0.653	
Organic material		Absent > Present	0.998	
Wind speed		-0.026 $\pm$ 0.336	0.938	
Scoria moisture		-0.008 $\pm$ 0.091	0.928	
Scoria temperature		0.784 $\pm$ 3.200	0.806	
<i>Azorella selago</i> length		0.007 $\pm$ 0.036	0.845	
<i>Azorella selago</i> height		-0.008 $\pm$ 0.116	0.942	

**Table S4 cont.**

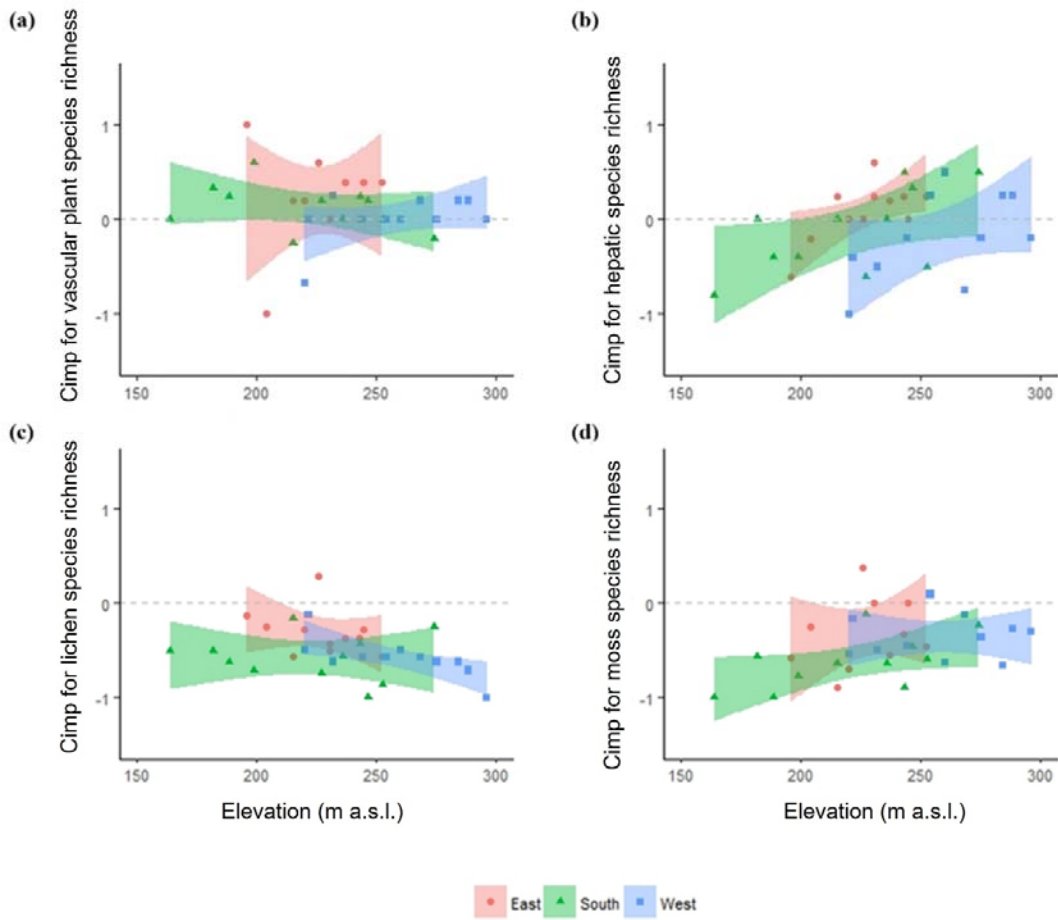
<b>b) <math>C_{imp}</math> for cover</b>			
Vascular plant  <i>p</i> = 0.995 % DE = 74.4	(Intercept)	2.667 $\pm$ 23.890	0.911
	Elevation	0.007 $\pm$ 0.035	0.852
	Aspect	East > West > South	0.965
	Scoria particle size	Fine > Coarse	0.957



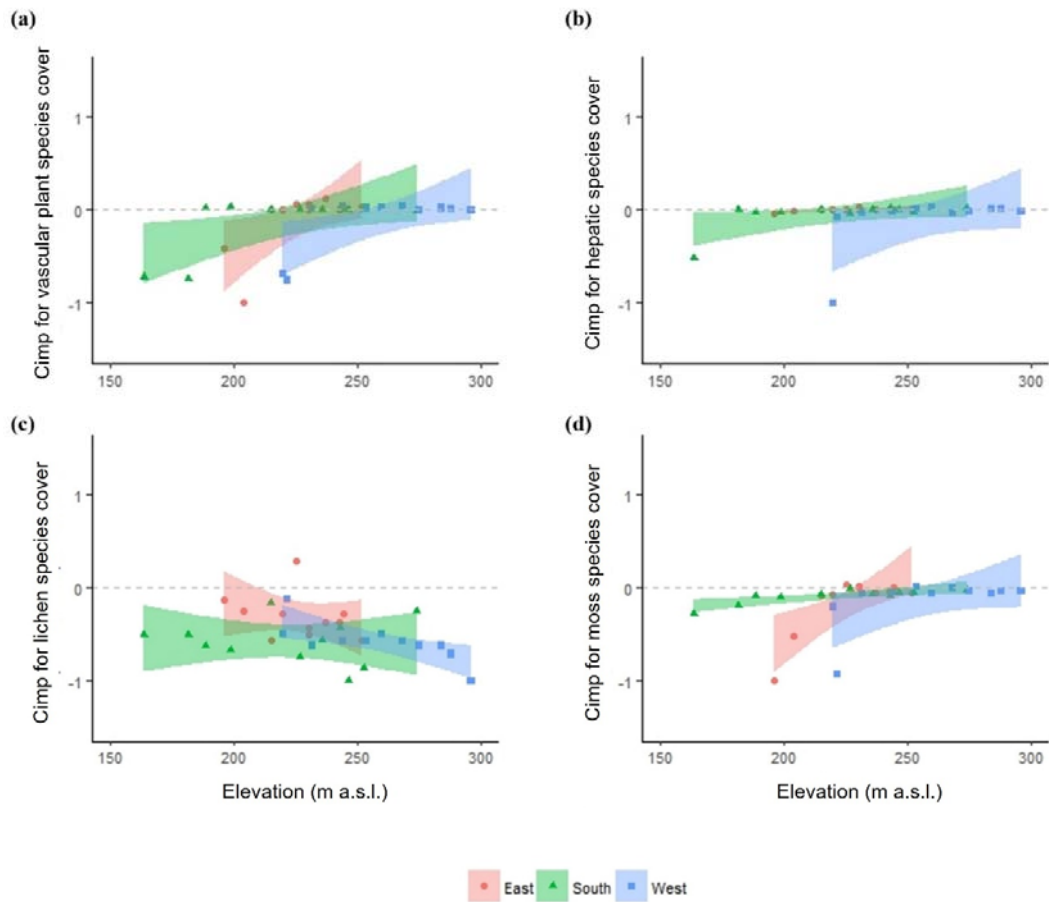
	<i>Scoria depth</i>	-0.010 ± 0.054	0.853
	<i>Organic material</i>	Absent > Present	0.420
	<i>Wind speed</i>	-0.031 ± 0.319	0.923
	<i>Scoria moisture</i>	-0.025 ± 0.083	0.768
	<i>Scoria temperature</i>	-0.496 ± 2.752	0.857
	<i>Azorella selago length</i>	-0.010 ± 0.030	0.745
	<i>Azorella selago height</i>	0.017 ± 0.104	0.874
Hepatic	(Intercept)	10.778 ± 24.842	0.664
	<i>Elevation</i>	0.002 ± 0.034	0.955
<i>p</i> = 1.00	<i>Aspect</i>	West > East > South	0.796
% DE = 63.8	<i>Scoria particle size</i>	Coarse > Fine	0.851
	<i>Scoria depth</i>	0.007 ± 0.054	0.893
	<i>Organic material</i>	Present > Absent	0.934
	<i>Wind speed</i>	-0.240 ± 0.352	0.495
	<i>Scoria moisture</i>	-0.013 ± 0.079	0.870
	<i>Scoria temperature</i>	-1.142 ± 2.820	0.685
	<i>Azorella selago length</i>	-0.006 ± 0.030	0.840
	<i>Azorella selago height</i>	0.008 ± 0.101	0.940
Moss	(Intercept)	0.401 ± 23.418	986.000
	<i>Elevation</i>	-0.001 ± 0.035	0.973
<i>p</i> = 1.00	<i>Aspect</i>	South > East > West	0.950
% DE = 44.4	<i>Scoria particle size</i>	Fine > Coarse	0.853
	<i>Scoria depth</i>	-0.018 ± 0.054	0.747
	<i>Organic material</i>	Absent > Present	0.894
	<i>Wind speed</i>	0.109 ± 0.307	0.722
	<i>Scoria moisture</i>	-0.022 ± 0.080	0.786
	<i>Scoria temperature</i>	-0.301 ± 2.721	0.912
	<i>Azorella selago length</i>	-0.007 ± 0.030	0.805
	<i>Azorella selago height</i>	0.014 ± 0.106	0.897
Lichen	(Intercept)	-4.971 ± 27.999	0.859
	<i>Elevation</i>	0.001 ± 0.040	0.978
<i>p</i> = 0.999	<i>Aspect</i>	East > South > West	0.976
% DE = 54.0	<i>Scoria particle size</i>	Fine > Coarse	0.596
	<i>Scoria depth</i>	-0.030 ± 0.065	0.647
	<i>Organic material</i>	Present > Absent	0.995
	<i>Wind speed</i>	-0.026 ± 0.336	0.939
	<i>Scoria moisture</i>	-0.009 ± 0.091	0.918
	<i>Scoria temperature</i>	0.774 ± 3.192	0.808
	<i>Azorella selago length</i>	0.008 ± 0.036	0.831
	<i>Azorella selago height</i>	-0.010 ± 0.116	0.932



**Appendix S8.** Mean ( $\pm$  SE) competitive importance index ( $C_{imp}$ ) for **a)** the richness and **b)** cover of vascular plant, hepatic, moss and lichen species.  $C_{imp}$  values range from  $-1$  to  $1$ , where positive values indicate net facilitation and negative values indicate net competition and larger absolute values indicating increasing strength of the competitive importance. \* =  $p < 0.05$ , \*\* =  $p < 0.01$ , \*\*\* =  $p < 0.001$  (one sample t-test).



**Appendix S9.** Changes in the competitive importance index ( $C_{imp}$ ) for species richness (mean  $\pm$  SE) with elevation (m a.s.l.) for **a)** vascular plants, **b)** hepatics, **c)** lichens and **d)** mosses.  $C_{imp}$  values range from  $-1$  to  $1$ , where positive values indicate net facilitation and negative values indicate net competition and larger absolute values indicating increasing strength of the competitive importance.



**Appendix S10.** Changes in the competitive importance index ( $C_{imp}$ ) for species cover (mean  $\pm$  SE) with elevation (m a.s.l.) for **a)** vascular plants, **b)** hepatics, **c)** lichens and **d)** mosses.  $C_{imp}$  values range from  $-1$  to  $1$ , where positive values indicate net facilitation and negative values indicate net competition and larger absolute values indicating increasing strength of the competitive importance.