Lindbergia

L1046

Kyrkjeeide, M. O., Stenøien, H. K., Flatberg, K. I. and Hassel, K. 2014. Glacial refugia and post-glacial colonization patterns in European bryophytes. – Lindbergia 37: 47–59.

Appendix 1

χ^2-tests and ANOVA

χ^2-tests were performed to test if different bryophyte regions in Europe (southern, western, boreal and arctic) are associated with specific life-history characteristics, i.e. frequency of sporophyte production (Table S1 and A2) and spore size (Tables A3 and A4). One test was performed for frequency of sporophyte production and spore size, respectively, including all species recorded for each geographic region they occur. For all χ^2-tests, spore sizes were divided in two categories, small and large, with the limit between small and large spores being set to 20 µm (During 1979). There are too few species occurring in only one element to do a separate test including only these species (Table A2 and A4). In addition, one-way ANOVA was performed to test if the four floristic elements are characterized by different levels of genetic structuring as measured by overall F_{ST} values (log transformed), including all species' F_{ST} recorded for each of the elements the species occur in.

There is no significant association between floristic elements in Europe and frequency of sporophyte reproduction (χ^2 = 0.32, DF = 3, p-value = 0.96), spore size (χ^2 = 5.02, DF = 3, p-value = 0.17), or F_{ST} (DF = 42, R^2 = 0.02, p = 0.87, Table A5).

Table A1. Number of species producing sporophytes frequently and rarely of four floristic elements in Europe.

Region	Reproduction frequent	Reproduction rare
southern	10	7
western	11	11
boreal	13	12
arctic	10	9

Table A2. Frequency of sporophyte reproduction in species occurring in only one floristic element.

Region	Reproduction frequent	Reproduction rare
southern	0	1
western	0	1
boreal	0	1
arctic	0	2

Table A3. Number of species having small or large spores in four floristic elements of Europe.

Region	Small spores	Large spores
southern	16	2
western	15	8
boreal	16	10
arctic	11	8

Table A4. Spore size of species occurring in only one floristic element.

Region	Small spores	Large spores
southern	1	0
western	0	1
boreal	0	1
arctic	0	2

Table A5. Degrees of freedom (DF), sum of squares (SS), mean of squares (MS), F-value, and p-value for the ANOVA analysis of floristic elements and F_{ST} values.

	DF	SS	MS	F-value	p-value
Elements	3	0.32	0.11	0.24	0.87
Residuals	42	18.60	0.44		

Model testing

To find which variables best explain distribution ranges in bryophytes, different models were compared using likelihood ratio tests. The models include distribution range (calculated as number of regions in which a species is found) as the response variable and spore size (mean spore diameter) and frequency of sporophyte production (rare or frequent) as explanatory variables. The different models are listed below.

Model 1: Regions~Spore size × Sporophyte production

Model 2: Regions~Spore size + Sporophyte production

Model 3: Regions~Spore size

Model 4: Regions~Sporophyte production

There is no significant difference between model 1, 2 and 3, but model 4 is significantly worse than model 2 (Table A6). The simplest model (model 2) of the two best ones was thus chosen for further analysis of distribution range.

Table A6. Likelihood ratio test between different models explaining distribution ranges in bryophytes. For model explanation see text. Only model 3 and 4 is significantly worse than the others.

Source	DF	*F*	p
Model 1 vs model 2	26	0.38	0.545
Model 2 vs model 3	27	4.13	0.052
Model 2 vs model 4	27	6.79	0.015

Analyses of phylogenetic relationship

Figure A1 shows the spore size of species included in the meta-analyses performed in this review (see main text for details on statistical methods employed). Species that belong to the same genus tend to cluster regarding spore sizes, indicating that the data points are not independent from one another. However, there are several non-related species having the same spore size as the two largest genera included here. There is no clear clustering of related species in frequency of sporophyte production (Fig. A2) and F_{ST} (Fig. A3). We did the meta-analyses again using estimates at the genus level, i.e. the mean of all species in one genus, to compare the results with results found in the main text. The relationship between range size and spore size is not significant when considering data at the genus level (DF = 16, MS = 0.92, F = 1.43, $R^2 = 0.08$, p = 0.25), but the non-significant result could be due to low sample size. Also, F_{ST} is not significantly higher in species rarely producing sporophytes (mean = 0.34) compared to species with frequent spore production (mean = 0.18, $t = -2.25$, DF = 7.42, p = 0.057, Fig. 3) using the genus level. The relationship between spore size and F_{ST} was not tested again, as this relationship was non-significant at the species level.

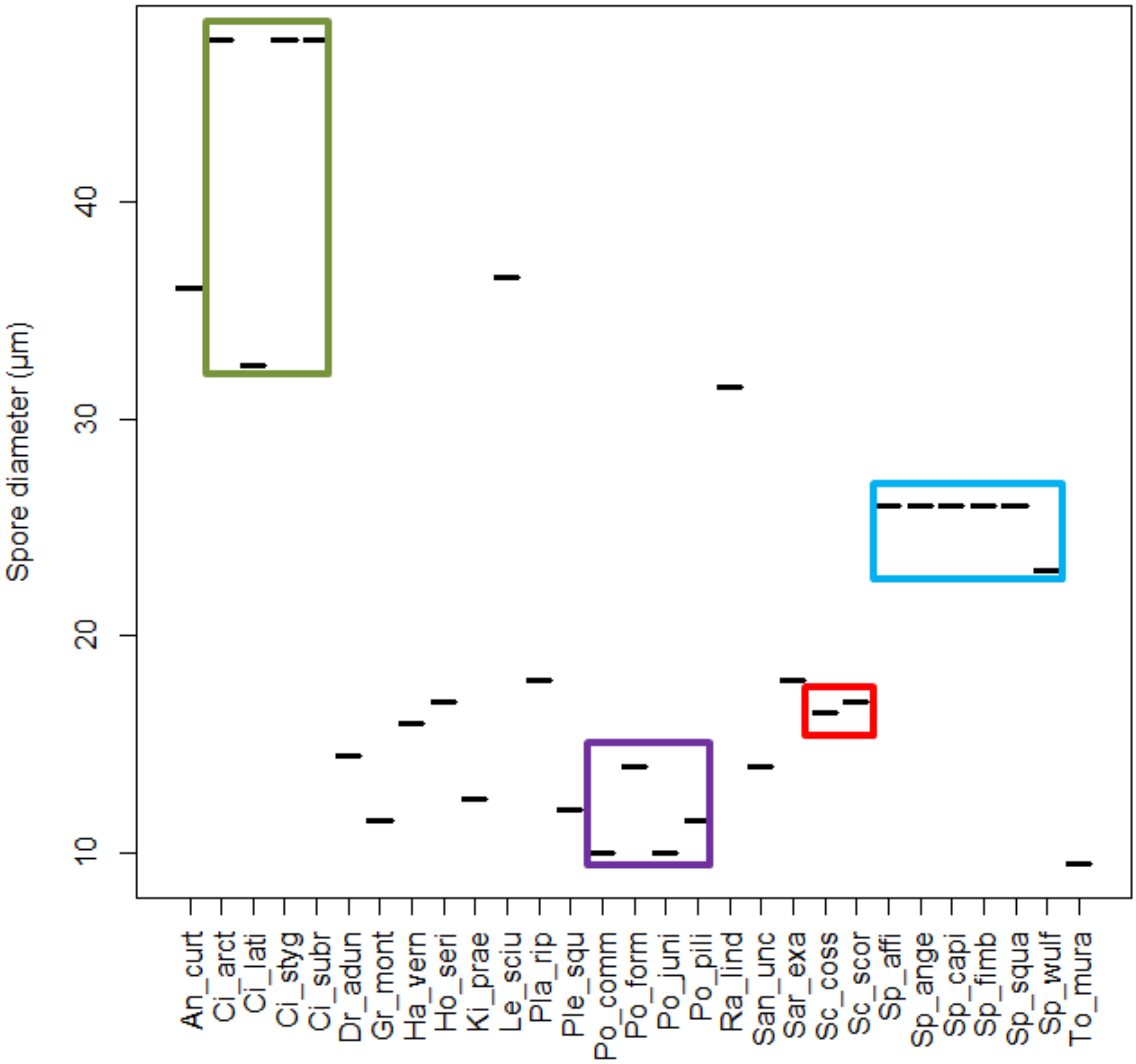

Figure A1. The graph shows the spore size (mean spore size) of all bryophyte species mentioned in the main text. Genera with two or more species are encircled with colour (*Cinclidium* – green, *Polytrichum* – purple, *Scorpidium* – red, and *Sphagnum* – blue). Species in the same genus cluster together around the same spore size.

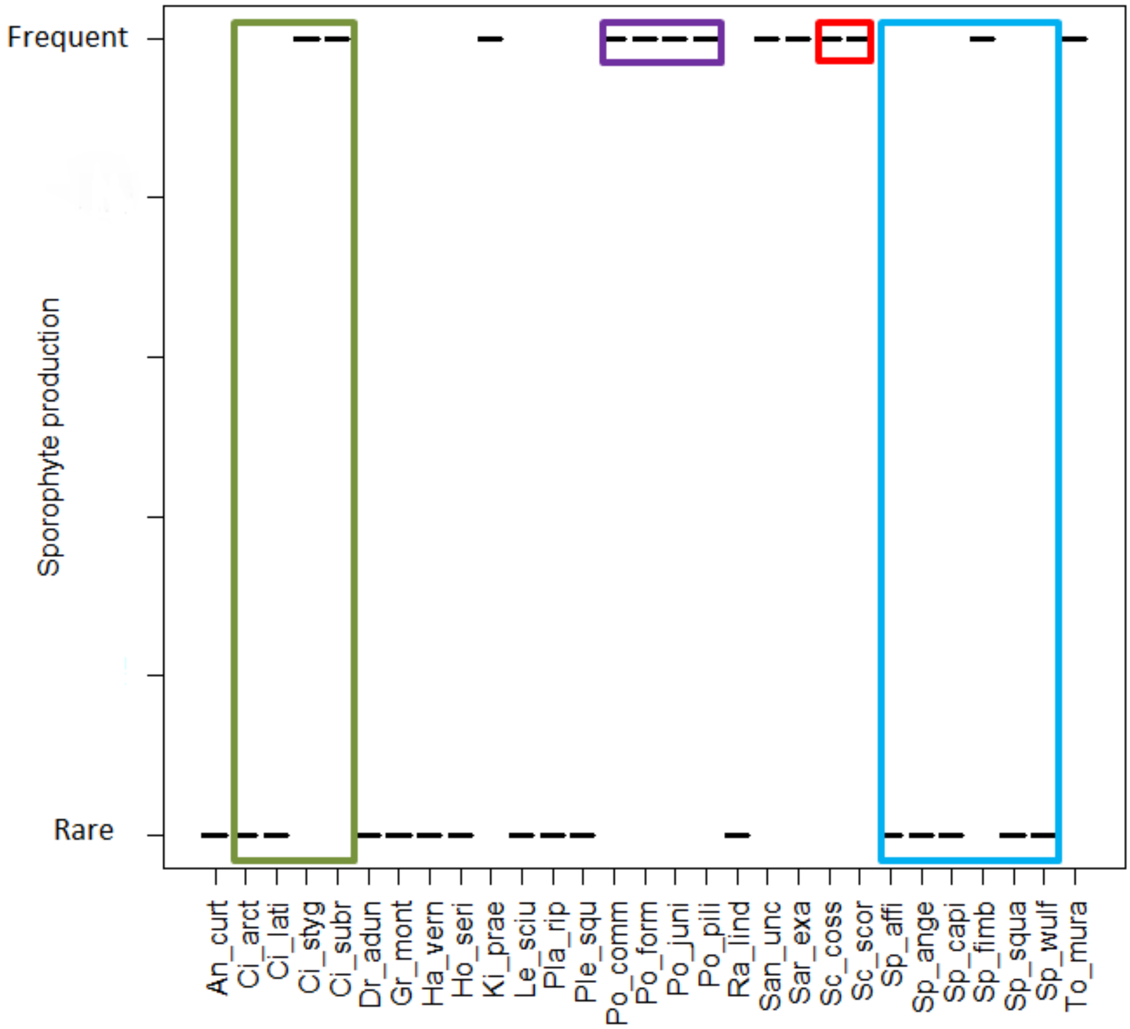

Figure A2. The graph show frequency of sporophyte production, rare or frequent, for all bryophyte species mentioned in the main text. Sporophyte production differs within genera (colours as in Fig. A1).

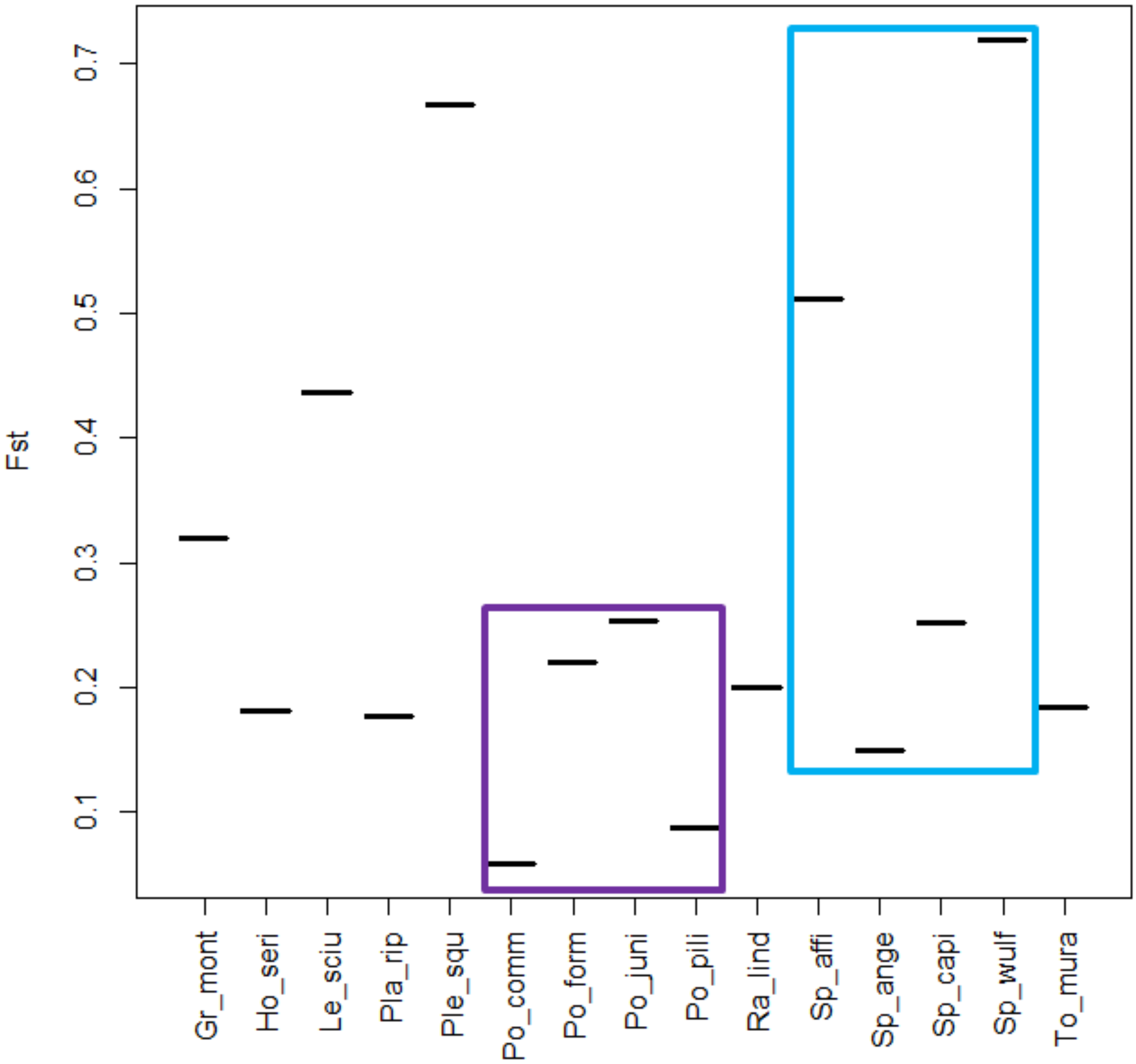

Figure A3. The scatterplot shows F_{ST} values for all bryophyte species included in the meta analyses in the main text. There are only two genera (*Polytrichum* – purple and *Sphagnum* – blue) represented by more than one species and F_{ST} varies greatly within both genera, i.e. phylogeny has no influence on F_{ST}.