Intraspecific diversity in a spore-dispersed species with limited distribution range

Systematics and Biodiversity

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ONLINE SUPPLEMENTAL MATERIAL: TABLES S1-S3, FIGURES S1-S5, REFERENCES TO ONLINE MATERIAL

Supplementary Online Table S1 Geographical location of the 33 study plots of the Baltic study, all in Sweden.

Öland. **1:** Råpplinge, Alvaret E of Strandtorp, 56° 49.776' N, 16° 37.688' E, Periodically wet depression, 3 May 2011. **2:** Råpplinge, Alvaret E of Strandtorp, 56° 49.878' N, 16° 37.793' E, Periodically wet depression, 3 May 2011. **3:** Råpplinge, Alvaret E of Strandtorp, 56° 49.867' N, 16° 37.797' E, Periodically wet depression, 3 May 2011. **4:** Vickelby, 500 m E of Lilla Vickelby, 56° 34.064' N, 16° 28.087' E, Periodically wet depression, 4 May 2011. **6:** Resmo, 2 km NNE of Resmo, 56° 33.366' N, 16° 27.986' E, Periodically wet depression, 4 May 2011. **7:** Resmo, 1.5 km N of Resmo, 56° 33.311' N, 16° 27.396' E, Periodically wet depression, 4 May 2011. **8:** Torslunda, S of Gamla Skogsby, 56° 36.878' N, 16° 29.715' E, Periodically wet depression, 5 May 2011. **9:** Torslunda, S of Gamla Skogsby, 56° 36.789' N, 16° 29.685' E, Periodically wet depression, 5 May 2011. **10:** Stenåsa, E of middle portion of Möckelmossen, 56° 32.111' N, 16° 31.983' E, Periodically wet depression, 6 May 2011. **11:** Stenåsa, 200 m NE of N end of Möckelmossen, 56° 32.409' N, 16° 32.151' E, Periodically wet depression, 6 May 2011. **12:** Resmo, 400 m W of N end of Möckelmossen, 56° 32.316' N, 16° 31.368' E, Periodically wet depression, 6 May 2011. **Gotland.** **1:** Boge, N portion of Gyle, E of forest rd near shore, 57° 40.362' N, 18° 47.924' E, Periodically wet depression, 24 May 2011. **2:** Boge, E shore of Lake Sudervik, 57° 39.968' N, 18° 47.732' E, Lake shore fen, 24 May 2011. **3:** Boge, C portion of Gyle, N of forest rd from Klinte, 57° 40.328' N, 18° 47.874' E, Periodically wet depression, 24 May 2011. **4:** Othem, Filehajdar, ca 150 m S of Högstensvät, 57° 43.567' N, 18° 40.226' E, Periodically wet depression, 25 May 2011. **5:** Othem, ca. 800 m E of Barshage, 57° 44.663' N, 18° 41.359' E, Periodically wet depression, 25 May 2011. **6:** Othem, ca. 1 km E of Stora Pus Smyr, at forest rds, 57° 45.495' N, 18° 42.258' E, Periodically wet depression, 25 May 2011. **8:** Rute, Bräntings hajd, large temporary wet depression NW of main rd, 57° 50.999' N, 18° 57.837' E, Large periodically wet depression, 26 May 2011. **9:** Bunge, SE of Bunge airfield, 57° 50.780' N, 19° 2.577' E, Periodically wet depression, 26 May 2011. **10:** Fleringe, ca. 700 m WSW of Hau farm, 57° 53.377' N, 18° 58.151' E, Old, shallow ditch; many shoots in poor condition, 27 May 2011. **11:** Fleringe, ca. 500 m E of S portion of Lake Sändeträsk, 57° 54.400' N, 19° 1.268' E, Periodically wet depression, 27 May 2011. **12:** Fleringe, E portion of Trälgar, 57° 54.810' N, 19° 0.428' E, Periodically wet depression, 27 May 2011. **Uppland (Stockholm archipelago).** **1:** Djurö, Runmarö, 100-150 m SE of Nästräsket, 59° 17.179' N, 18° 48.532' E, Periodically wet depression, 8 June 2011. **2:** Djurö, Runmarö, Storsten, 59° 16.923' N, 18° 48.054' E, Periodically wet depression, 8 June 2011. **3:** Djurö, Runmarö, between Storsten and Nore, 59° 16.761' N, 18° 47.889' E, Periodically wet depression, 8 June 2011. **4:** Djurö, Runmarö, near forest rd 200 m N of Noreträsk, 59° 16.734' N, 18° 47.009' E, Periodically wet depression, 8 June 2011. **5:** Djurö, Runmarö, 150 m N of W portion of Noreträsk, 59° 16.710' N, 18° 46.966' E, Periodically wet depression, among high *Carex*, 8 June 2011. **7:** Blidö, Svartlöga, E side of Lake Storfladen between Stora and Lilla Enskär, 59° 34.425' N, 19° 1.602' E, Phragmites shore fen, 10 June 2011. **8:** Djurö, Runmarö, E shore of Lake Vitträsk, slightly S of mid-lake, 59° 15.979' N, 18° 45.878' E, Flat calcareous rock just inside lake shore, 14 June 2011. **9:** Djurö, Runmarö, W of N portion of Stordalen, 59° 16.309' N, 18° 46.759' E, Periodically wet depression, 14 June 2011. **10:** Djurö, Runmarö, just N of Långstrand, 59° 16.293' N, 18° 47.074' E, Periodically wet depression, 14 June 2011. **11:** Djurö, Runmarö, between Långstrand and Nore, 50 m from the sea, 59° 16.445' N, 18° 47.386' E, Periodically wet depression, 14 June 2011. **12:** Djurö, Runmarö, 100-150 m E of Lake Noreträsk, 59° 16.484' N, 18° 47.236' E, Periodically wet depression, 14 June 2011.

Supplementary Online Table S2 Specimen data and GenBank accession numbers for the studied *Drepanocladus lycopodioides* specimens included in the European study plus representative specimens for those haplotypes that were only found in the detailed Baltic study (BA). All found variants of the studied markers are thus represented in GenBank, but it was considered redundant to deposit additional duplicates among the generated sequences for the 330 shoots sampled in the plots. The format for each specimen is as follows: **Sample No. {BA = representative specimen for haplotypes that were found only in the Baltic study}: {Haplotype};** Locality; {Coll. date}, *Collector* {collector's No.} (*LH* = L.Hedenäs, *WM* = Wirkungskontrolle Moorbiotope); Herbarium or herbarium acronym {; registration No.} (*WSL* = Swiss Federal Institute for Forest, Snow and Landscape Research); GenBank accession numbers for ITS, *gpd*, *rpl16* (*NA* = Not available).

P01: 111; Sweden. Gotland, Stenkyrka; *LH*; S: B62354; FJ535773, KF993740, FJ535791. **PT104:** 121; Sweden. Västergötland, Dala; *LH* & *A.Kooijman*; S: B104861; KF993893, KF993741, KF993818. **PT119:** 121; Sweden. Närke, Kumla; *N.Hakelien*; S: B63760; KF993894, KF993742, KF993819. **PT120:** 121; Sweden. Västergötland, Högstena; *N.Hakelien*; S: B25513; KF993895, KF993743, KF993820. **PT121:** 111; Finland. Kittilän Lappi, Kittilä, Mustavaara; *T.Ulvinen*; S: B111329; KF993896, KF993744, KF993821. **PT122:** 121; Sweden. Uppland, Vaddö; *K.Hylander*; S: B6328; KF993897, KF993745, KF993822. **PT123:** 141; Sweden. Uppland, Singö; *LH*; S: B20466; KF993898, KF993746, KF993823. **PT124:** 121; Sweden. Uppland, Åland; *LH*; S: B25606; KF993899, KF993747, KF993824. **PT127:** 111; Switzerland. Ct. Zürich, Niederglatt; 13 Jul 2005, *N.Schnyder*; herb. Schnyder; KF993900, KF993748, KF993825. **PT128:** 112; Switzerland. Ct. Zürich, Neerach; 15 Jun 2006, *N.Schnyder*; herb. Schnyder; KF993901, KF993749, KF993826. **PT129:** 111; Switzerland. Ct. Zürich, Mönchaltorf; 30 Oct 1992, *N.Schnyder*; herb. Schnyder; KF993902, KF993750, KF993827. **PT131:** 112; Switzerland. Ct. Fribourg/Vaud, La Grève; 15 Jun 1998, *WM*; WSL; KF993903, KF993751, KF993828. **PT151:** 111; Switzerland. Ct. Zürich, Schwerzenbach; *E.Urmi 5178*; herb. Urmi; KF993904, KF993752, KF993829. **PT152:** 111; Switzerland. Ct. Zürich, Uster; 13 Apr 1992, *N.Schnyder*; herb. Schnyder; KF993905, KF993753, KF993830. **PT154:** 121; Switzerland. Ct. Bern. Twann; *WM Obj. 13, Fl. 365*; WSL; KF993906, KF993754, KF993831. **PT155:** 111; Switzerland. Ct. Fribourg, Chabrey & Delley; *WM Obj. 22, Fl. 187*; WSL; KF993907, KF993755, KF993832. **PT157:** 111; Switzerland. Ct. Graubünden, Lai Nair; *WM Obj. 33, Fl. 458*; WSL; KF993908, KF993756, KF993833. **PT158:** 111; Switzerland. Ct. Zürich, Greifensee; *WM Obj. 102, Fl. 80012*; WSL; KF993909, KF993757, KF993834. **PT161:** 111; Sweden. Uppland, Gräsö; *K.Hylander 13*; herb. Hylander; KF993910, KF993758, KF993835. **PT167:** 111; Sweden. Öland, Sandby; *LH*; S: B174718; KF993911, KF993759, KF993836. **PT169:** 122; Sweden. Öland, Resmo; *LH*; S: B174614; KF993912, KF993760, KF993837. **PT174:** 111; Sweden. Gästrikland, Orarna; *H.Sjörs & C.Rune*; S: B25647; KF993913, KF993761, KF993838. **PT175:** 111; Sweden. Dalarna, Boda; *L.Bratt*; S: B25646; KF993914, KF993762, KF993839. **PT176:** 141; Sweden. Uppland, Djurö; *LH*; S: B25602; KF993915, KF993763, KF993840. **PT180:** 111; Denmark. Jylland, Tornby; *G.Een*; S: B108162; KF993916, KF993764, KF993841. **PT185:** 121; Sweden. Västergötland, S. Kyrketorp; *LH & A.Kooijman*; S: B1101; KF993917, KF993765, KF993842. **PT186:** 121; Sweden. Västergötland, Högstena; *LH & A.Kooijman*; S: B1102; KF993918, KF993766, KF993843. **PT187:** 164; Sweden. Skåne, Trolle-Ljungby; *LH & A.Kooijman*; S: B1103; KF993919, KF993767, KF993844. **PT190:** 123; Sweden. Gotland, Bunge; *LH*; S: B31901; KF993920, KF993768, KF993845. **PT194:** 111; Sweden. Gotland, Boge; *LH*; S: B1114; KF993921, KF993769, KF993846. **PT199:** 111; Sweden. Södermanland, Utö; *LH*; S: B177889; KF993922, KF993770, KF993847. **PT200:** 111; Sweden. Skåne, Lerhamn; *LH*; S: B181700; KF993923, KF993771, KF993848. **PT206:** 111; Sweden. Halland, Ås; *K.Georgson*; S: B117802; KF993924 (ITS1), KF993772, NA. **PT207:** 111; Sweden. Västmanland, Sala; *LH*; S: B184548; KF993925, KF993773, KF993849. **PT208:** 111; Estonia. Kingissepa, Koinastu; *LH E-50*; S: B20920; KF993926, KF993774, KF993850. **PT209:** 111; United Kingdom. Scotland, North Uist; *D.G.Long 19677*; S: B21024; KF993927, KF993775, KF993851. **PT210:** 121; Poland. Silesia, Jaworzno-Jeziorski; *K.Jedrzejko et al. (M. Macr. Merid. Pol. Exs 140)*; S: B186019; KF993928, KF993776, KF993852. **PT211:** 121; Hungary. Comit. Veszprém, Nyírad; *T.Pócs (Crypt. exs. Mus. Hist. Nat. Vindob. 4578)*; S: B186024; KF993929, KF993777, KF993853. **PT212:** 121; France. Deux-Sèvres, Lezay; *Biget*; S: B36953; KF993930, KF993778, KF993854. **PT2006:** 111; Sweden. Öland, Råpplinge; *LH & I.Bisang*; S: B195559; KF993931, KF993779, KF993855. **PT2016:** 221; Sweden. Öland, Råpplinge; *LH & I.Bisang*; S: B195560; KF993932, KF993780, KF993856. **PT2033:** 211; Sweden. Öland, Råpplinge; *LH & I.Bisang*; S: B195561; KF993933, KF993781, KF993857. **PT2056:** 111; Sweden. Öland, Vickelby; *LH & I.Bisang*; S: B195562; KF993934, KF993782, KF993858. **PT2074:** 121; Sweden. Öland, Resmo; *LH & I.Bisang*; S: B195563; KF993935, KF993783, KF993859. **PT2087:** 111; Sweden. Öland, Resmo; *LH & I.Bisang*; S: B195564; KF993936, KF993784, KF993860. **PT2103:**

122; Sweden. Öland, Torslunda; *LH & I.Bisang*; S: B195565; KF993937, KF993785, KF993861.
PT2123: 122; Sweden. Öland, Torslunda; *LH & I.Bisang*; S: B195566; KF993938, KF993786,
 KF993862. **PT2142**: 131; Sweden. Öland, Stenåsa; *LH & I.Bisang*; S: B195568; KF993939,
 KF993787, KF993863. **PT2161**: 122; Sweden. Öland, Resmo; *LH & I.Bisang*; S: B195569; KF993940,
 KF993788, KF993864. **PT2181**: 111; Sweden. Gotland, Boge; *LH*; S: B195570; KF993941,
 KF993789, KF993865. **PT2188 BA**: Sweden. Gotland, Boge; *LH*; S: B195571; NA, KF993790,
 KF993866. **PT2197**: 122; Sweden. Gotland, Boge; *LH*; S: B195573; KF993942, KF993791,
 KF993867. **PT2211**: 121; Sweden. Gotland, Othem; *LH*; S: B195574; KF993943, KF993792,
 KF993868. **PT2232**: 311; Sweden. Gotland, Othem; *LH*; S: B195575; KF993944, KF993793,
 KF993869. **PT2250**: 111; Sweden. Gotland, Othem; *LH*; S: B195576; KF993945, KF993794,
 KF993870. **PT2269**: 111; Sweden. Gotland, Rute; *LH*; S: B195577; KF993946, KF993795, KF993871.
PT2290: 121; Sweden. Gotland, Bunge; *LH*; S: B195578; KF993947, KF993796, KF993872. **PT2291**
BA: Sweden. Gotland, Bunge; *LH*; S: B195579; NA, KF993797, KF993873. **PT2307**: 111; Sweden.
 Gotland, Fleringe; *LH*; S: B195580; KF993948, KF993798, KF993874. **PT2327**: 121; Sweden.
 Gotland, Fleringe; *LH*; S: B195581; KF993949, KF993799, KF993875. **PT2346**: 121; Sweden.
 Gotland, Fleringe; *LH*; S: B195582; KF993950, KF993800, KF993876. **PT2366**: 122; Sweden.
 Uppland, Djurö; *LH*; S: B195584; KF993951, KF993801, KF993877. **PT2390**: 141; Sweden. Uppland,
 Djurö; *LH*; S: B195585; KF993952, KF993802, KF993878. **PT2398**: 221; Sweden. Uppland, Djurö;
LH; S: B195586; KF993953, KF993803, KF993879. **PT2420**: 121; Sweden. Uppland, Djurö; *LH*; S:
 B195587; KF993954, KF993804, KF993880. **PT2437**: 121; Sweden. Uppland, Blidö; *LH*; S: B195588;
 KF993955, KF993805, KF993881. **PT2454**: 121; Sweden. Uppland, Djurö; *LH*; S: B195589;
 KF993956, KF993806, KF993882. **PT2473**: 121; Sweden. Uppland, Djurö; *LH*; S: B195590;
 KF993957, KF993807, KF993883. **PT2484 BA**: Sweden. Uppland, Djurö; *LH*; S: B195591; NA,
 KF993808, KF993884. **PT2500**: 221; Sweden. Uppland, Djurö; *LH*; S: B195592; KF993958,
 KF993809, KF993885. **PT2504**: 221; Sweden. Uppland, Djurö; *LH*; S: B195593; KF993959,
 KF993810, KF993886. **PT2519**: 121; Sweden. Uppland, Djurö; *LH*; S: B195594; KF993960,
 KF993811, KF993887. **PT2528**: 111; Sweden. Öland, Stenåsa; *LH & I.Bisang*; S: B195567;
 KF993961, KF993812, KF993888. **PT2544**: 111; Sweden. Gotland, Boge; *LH*; S: B195572;
 KF993962, KF993813, KF993889. **PT2555**: 111; Sweden. Uppland, Djurö; *LH*; S: B195583;
 KF993963, KF993814, KF993890. **OUTGROUP**: *Drepanocladus turgescens* (T.Jensen) Broth.: **P07**:
 Sweden. Gotland, Stenkyrka; *LH*; S: B62357; FJ535774, KF993815, FJ535792. *Drepanocladus*
aduncus (Hedw.) Warnst.: **D409**: United States. Nevada, Jarbidge Mountains; *J.R.Shevock &*
A.Glazer 26069; S: B102942; EU216412, KF993816, KF993891. **D411**: Italy. Süd-Tirol: Brenner,
 Pflerschtal; *LH*; S: B103417; EU216414, KF993817, KF993892.

Supplementary Online Table S3 Number of effective ITS haplotypes (Ne) and ITS haplotype diversity (H) for *Drepanocladus lycopodioides* (in bold) and eleven other pleurocarpous moss species in southern Scandinavia / continental Europe. n, number of samples; NA, not available. Data were extracted from Hedenäs (2008a, b, 2009a, b, 2010a, b, c, 2012a, b, 2014) and Hedenäs & Eldenäs (2007, 2008).

Species	n	Ne	H
<i>Antitrichia curtipendula</i> (Hedw.) Brid.	29 / 17	2.452 / 1.710	0.592 / 0.415
<i>Cratoneuron filicinum</i> (Hedw.) Spruce	15 / 15	3.082 / 1.316	0.676 / 0.240
<i>Drepanocladus aduncus</i> (Hedw.) Warnst.	22 / 19	5.042 / 6.333	0.802 / 0.842
<i>Drepanocladus lycopodioides</i> (Brid.) Warnst.	54 / 11	1.252 / 1.000	0.201 / 0.000
<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs	20 / 15	4.651 / 3.358	0.785 / 0.702
<i>Kindbergia praelonga</i> (Hedw.) Ochyra	21 / NA	1.652 / NA	0.395 / NA
<i>Palustriella falcata</i> (Brid.) Hedenäs	NA / 18	NA / 2.492	NA / 0.599
<i>Rhytidium rugosum</i> (Hedw.) Kindb.	29 / 25	4.226 / 3.453	0.763 / 0.710
<i>Sanionia uncinata</i> (Hedw.) Loeske	30 / 22	3.191 / 1.467	0.687 / 0.318
<i>Sarmentypnum exannulatum</i> (Schimp.) Hedenäs	36 / 37	7.624 / 4.374	0.869 / 0.771
<i>Scorpidium cossonii</i> (Schimp.) Hedenäs	32 / 41	2.573 / 2.681	0.611 / 0.627
<i>Scorpidium scorpioides</i> (Hedw.) Limpr.	29 / 13	2.910 / 3.314	0.656 / 0.698

Supplementary Online Fig. S1 The first two coordinates resulting from a Principal Coordinate Analysis (PCoA) based on the pair-wise Φ_{PT} values among all 33 plots. The first axis explains 47.9% of the variation in the data and the second 26.8%. The samples are divided into the two groups A and B along coordinate 1. Individual plots are identified by their acronyms for regions and numbers (cf. Fig. 1). Plots indicated by 'm' include only males and filled circles appear in group A in the left half of the diagram if only female shoots are included in the analysis.

Supplementary Online Fig. S2 Jackknife tree for 72 *Drepanocladus lycopodioides* samples from different parts of Europe, based on ITS, *gpd*, and *rpl16* and using *D. aduncus* and *D. turgescens* as outgroups. Only branches with a support of at least 60 are shown. When a branch was supported only in one of the corresponding trees based on individual markers, this is indicated. In the tree based on *rpl16* only (not shown), the underlined samples form a clade with a Jackknife support of 84. Specimen numbers correspond with those in Supplementary Online Table S2 and haplotype numbers with those in Supplementary Online Table S2 and Fig. S3.

Supplementary Online Figs S3-S5 (S3) Haplotype network for European *Drepanocladus lycopodioides* based on ITS, *gpd*, and *rpl16*. Circle size is proportional to the number of sampled populations of a certain haplotype. Circles connected by a line differ in a single mutational difference; black dots indicate 'missing' haplotypes. Hatched lines between haplotypes indicate which of the three markers differentiate the haplotypes from each other. (S4, S5) The distribution of the haplotypes among 72 sampled specimens of *D. lycopodioides* in Europe; S5 displays the South Swedish Baltic Area at a larger scale, indicating the location of the sampled regional populations of Öland (OEL), Gotland (GTL) and the Stockholm archipelago (SAR). The species distribution is indicated by gray shading, and is based on studied specimens and the literature (especially Augier, 1966; Hill *et al.*, 1994; Cortini Pedrotti, 2006; Ignatov *et al.*, 2006; Meinunger & Schröder, 2007; Sabovljević *et al.*, 2008). The haplotype numbers correspond with those indicated for the respective specimens in Supplementary Online Table S2.

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