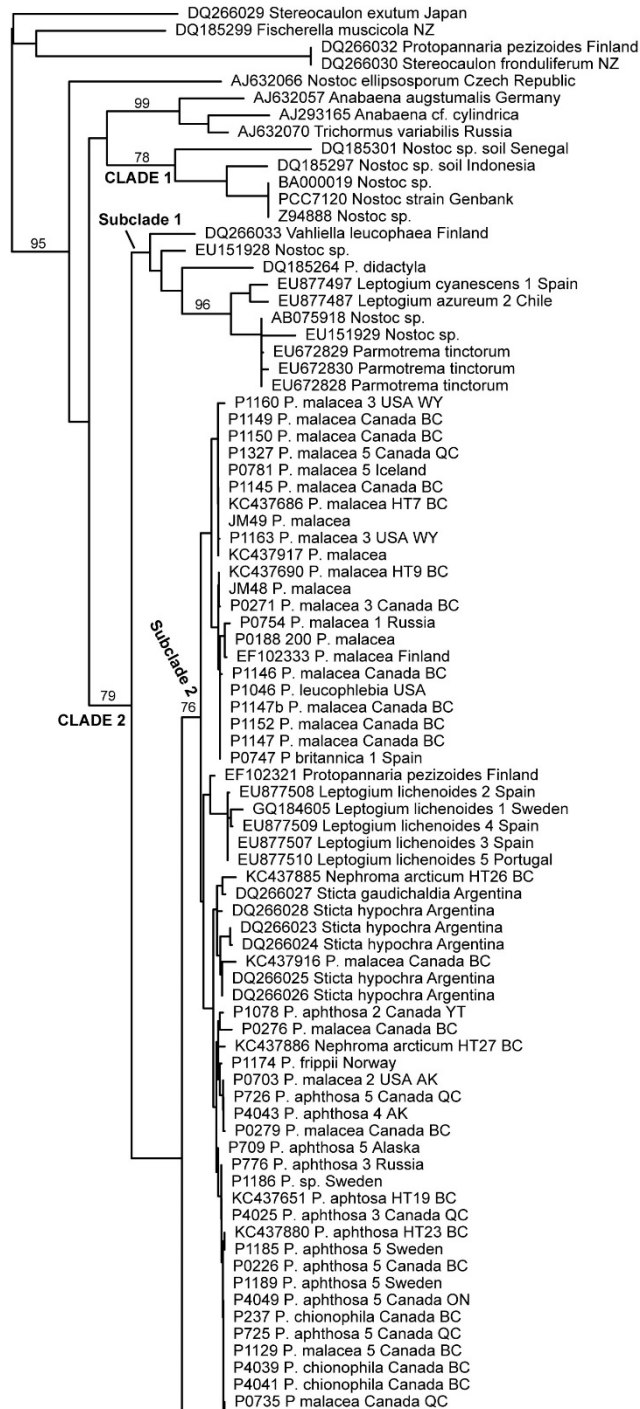
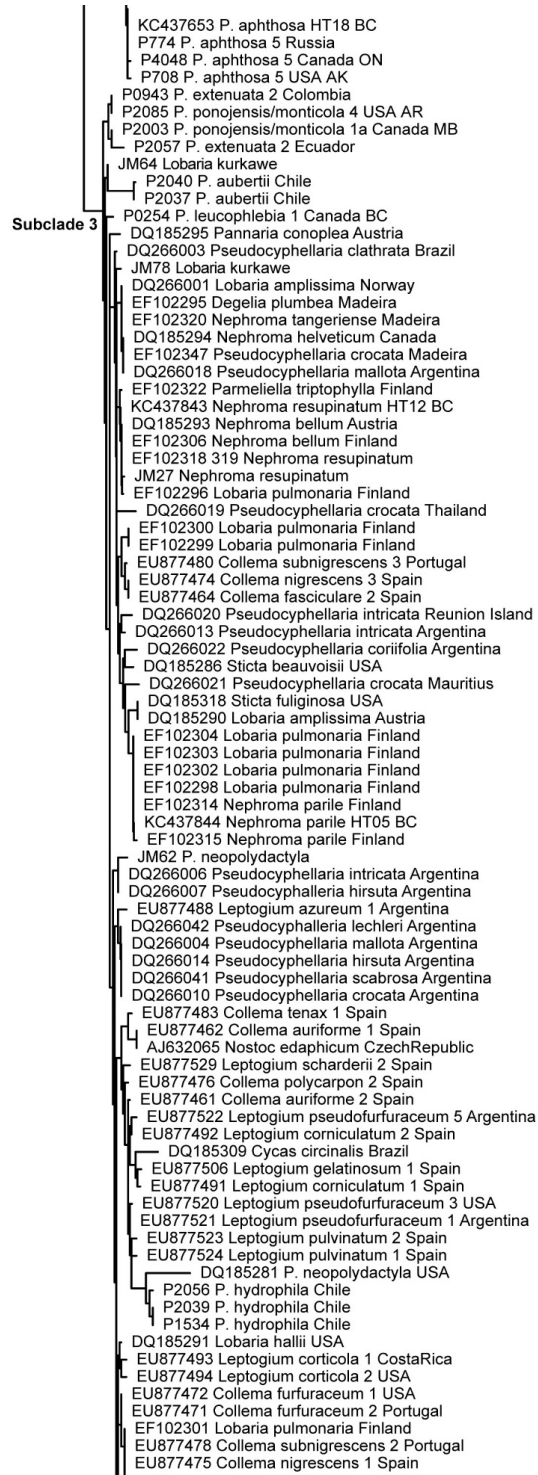


Supplementary Material Figure 2. Phylogenetic relationships inferred from maximum likelihood (ML) analyses of the *rbcLX* locus for 504 representatives of free-living and symbiotic *Nostoc* based on a data set modified from Pardo-De la Hoz *et al.* (2018) and Magain *et al.* (2018). Bootstrap support values > 70% are provided for major clades. Only one representative per terminal is shown, although many terminals are represented by multiple individuals (identical haplotypes) isolated from different lichen species and localities. Phylogroup XL is shown in a grey box. The scale represents nucleotide substitutions per site.





EU877463 *Collema fasciculare* 1 Spain
 DQ266008 *Pseudocyphellaria scabrosa* Argentina
 DQ266015 *Pseudocyphellaria crocata* Argentina
 DQ266005 *Pseudocyphellaria coriifolia* Argentina
 DQ266009 *Pseudocyphellaria crocata* Argentina
 DQ266012 *Pseudocyphellaria crocata* Argentina
 DQ266016 *Pseudocyphellaria coriifolia* Argentina
 DQ266017 *Pseudocyphellaria pilosella* Argentina
 EF102305 *Lobaria scrobiculata* Finland
 DQ266002 *Pseudocyphellaria crocata* Canada
 EF102312 313 *Nephroma laevigatum* Finland
 DQ266000 *Lobaria amplissima* Norway
 P1477 P. sp. 17 Peru
 DQ185292 *Massalonia carnosa* USA
 DQ185289 *Leptogium gelatinosum* 2 USA
 DQ266036 *Massalonia carnosa* Finland
 DQ266031 *Stereocaulon tomentosum* Argentina
 P1495 *P. hydrothyria* Canada NB
 P430 *P. hymenina* H83 Canada NL
 P1493 *P. hydrothyria* Canada QC
 P1494 *P. hydrothyria* Canada QC
 P1420 *P. gowardii* Canada BC
 P1422 *P. gowardii* Canada BC
 P1418 *P. gowardii* Canada BC
 P1423 *P. gowardii* Canada BC
 P1417 *P. gowardii* Canada BC
 EU877495 *Leptogium cyanescens* 3 Panama
 EU877489 *Leptogium brebissonii* 2 Spain
 EU877469 *Collema furfuraceum* 3 Spain
 KC437835 *P. neopolydactyl* HT14 BC
 DQ185307 *P. membranacea* Canada
 P1322 *P. neopolydactyla* 2 Norway
 P1241 *P. pacifica* H74 Canada BC
 EF102336 *P. neopolydactyla* Finland
 P1183 *P. neopolydactyla* 2 Japan
 P0201 *P. apthosa* Canada BC
 KC437874 *P. membranacea* HT15 Canada
 EF102337 *P. neopolydactyla* Finland
 DQ266034 *P. degenii* Finland
 EF102334 *P. membranacea* Finland
 DQ185303 *P. degenii* Canada
 P0523 *P. degenii* 1 Norway
 Z94893 *Nostoc flagelliforme*
 P2066 *P. sp.* 6 Chile
 P0072 *P. phyllidiosa* HT62 USA
 AJ632064 *Nostoc calcicola* Czech Republic
 AJ632063 *Nostoc calcicola* Czech Republic
 EU877484 *Leptogium azureum* 3 Brazil
 EU877484 *Leptogium austroamericanum* 2 Colombia
 EU877485 *Leptogium austroamericanum* 1 Argentina
 EU877505 *Leptogium gelatinosum* 3 Spain
 EU877496 *Leptogium cyanescens* 2 USA
 P2093 *P. cichoracea* India
 EU877504 *Leptogium furfuraceum* 3 Portugal
 EU877498 *Leptogium furfuraceum* 4 Spain
 EU877502 *Leptogium furfuraceum* 1 Croatia
 EU877499 *Leptogium furfuraceum* 5 Spain
 EU877503 *Leptogium furfuraceum* 2 Portugal
 DQ185316 *Geosiphon pyriforme* Germany
 DQ185268 *Blasia pusilla* Germany
 DQ185315 *Gunnera manicata* Germany
 DQ185269 *Blasia pusilla* Germany
 P245 *P. leucophlebia* 4 Canada BC
 KC437699 *P. canina* HT06 BC
 P0291 *P. leucophlebia* Canada BC
 P0214 *P. macilentata* Canada BC
 P0570 *P. praetextata* Norway
 P6061 *P. leucophlebia* 1 USA AK
 P0006 *P. neocanina* 4 Iceland
 P1808 *P. cinnamomea* Canada BC
 EF102332 *P. leucophlebia* Finland
 EF102330 *P. leucophlebia* Finland
 P0408 *P. austroamericana/fibrilloides* 1 Colombia
 P2035 *P. friesiorum* Brazil
 P2010 *P. austroamericana/fibrilloides* 5 Brazil
 P2009 *P. friesiorum* Brazil
 P1405 *P. neocanina* 3 Russia
 P2001 *P. neocanina* 1 Canada MB
 P2023 *P. degenii* 3c Japan
 EF102345 *P. praetextata* Finland
 P0420 *P. praetextata* Serbia
 N2069 *P. polydactylon* Norway
 DQ185260 *P. membranacea* Canada
 P2022 *P. degenii* 3b Russia
 KC437745 *P. horizontalis* HT11 BC

EU877463 *Collema fasciculare* 1 Spain
 DQ266008 *Pseudocyphellaria scabrosa* Argentina
 DQ266015 *Pseudocyphellaria crocata* Argentina
 DQ266005 *Pseudocyphellaria coriifolia* Argentina
 DQ266009 *Pseudocyphellaria crocata* Argentina
 DQ266012 *Pseudocyphellaria crocata* Argentina
 DQ266016 *Pseudocyphellaria coriifolia* Argentina
 DQ266017 *Pseudocyphellaria pilosella* Argentina
 EF102305 *Lobaria scrobiculata* Finland
 DQ266002 *Pseudocyphellaria crocata* Canada
 EF102312 313 *Nephroma laevigatum* Finland
 DQ266000 *Lobaria amplissima* Norway
 P1477 P. sp. 17 Peru
 DQ185292 *Massalonia carnosa* USA
 DQ185289 *Leptogium gelatinosum* 2 USA
 DQ266036 *Massalonia carnosa* Finland
 DQ266031 *Stereocaulon tomentosum* Argentina
 P1495 *P. hydrothyria* Canada NB
 P430 *P. hymenina* H83 Canada NL
 P1493 *P. hydrothyria* Canada QC
 P1494 *P. hydrothyria* Canada QC
 P1420 *P. gowardii* Canada BC
 P1422 *P. gowardii* Canada BC
 P1418 *P. gowardii* Canada BC
 P1423 *P. gowardii* Canada BC
 P1417 *P. gowardii* Canada BC
 EU877495 *Leptogium cyanescens* 3 Panama
 EU877489 *Leptogium brebissonii* 2 Spain
 EU877469 *Collema furfuraceum* 3 Spain
 KC437835 *P. neopolydactyl* HT14 BC
 DQ185307 *P. membranacea* Canada
 P1322 *P. neopolydactyla* 2 Norway
 P1241 *P. pacifica* H74 Canada BC
 EF102336 *P. neopolydactyla* Finland
 P1183 *P. neopolydactyla* 2 Japan
 P0201 *P. aphthosa* Canada BC
 KC437874 *P. membranacea* HT15 Canada
 EF102337 *P. neopolydactyla* Finland
 DQ266034 *P. degenii* Finland
 EF102334 *P. membranacea* Finland
 DQ185303 *P. degenii* Canada
 P0523 *P. degenii* 1 Norway
 Z94893 *Nostoc flagelliforme*
 P2066 *P. sp.* 6 Chile
 P0072 *P. phyllidiosa* HT62 USA
 AJ632064 *Nostoc calcicola* Czech Republic
 AJ632063 *Nostoc calcicola* Czech Republic
 EU877484 *Leptogium azureum* 3 Brazil
 EU877484 *Leptogium austroamericanum* 2 Colombia
 EU877485 *Leptogium austroamericanum* 1 Argentina
 EU877505 *Leptogium gelatinosum* 3 Spain
 EU877496 *Leptogium cyanescens* 2 USA
 P2093 *P. cichoracea* India
 EU877504 *Leptogium furfuraceum* 3 Portugal
 EU877498 *Leptogium furfuraceum* 4 Spain
 EU877502 *Leptogium furfuraceum* 1 Croatia
 EU877499 *Leptogium furfuraceum* 5 Spain
 EU877503 *Leptogium furfuraceum* 2 Portugal
 DQ185316 *Geosiphon pyriforme* Germany
 DQ185268 *Blasia pusilla* Germany
 DQ185315 *Gunnera manicata* Germany
 DQ185269 *Blasia pusilla* Germany
 P245 *P. leucophlebia* 4 Canada BC
 KC437699 *P. canina* HT06 BC
 P0291 *P. leucophlebia* Canada BC
 P0214 *P. macilentata* Canada BC
 P0570 *P. praetextata* Norway
 P6061 *P. leucophlebia* 1 USA AK
 P0006 *P. neocanina* 4 Iceland
 P1808 *P. cinnamomea* Canada BC
 EF102332 *P. leucophlebia* Finland
 EF102330 *P. leucophlebia* Finland
 P0408 *P. austroamericana/fibrilloides* 1 Colombia
 P2035 *P. friesiorum* Brazil
 P2010 *P. austroamericana/fibrilloides* 5 Brazil
 P2009 *P. friesiorum* Brazil
 P1405 *P. neocanina* 3 Russia
 P2001 *P. neocanina* 1 Canada MB
 P2023 *P. degenii* 3c Japan
 EF102345 *P. praetextata* Finland
 P0420 *P. praetextata* Serbia
 N2069 *P. polydactylon* Norway
 DQ185260 *P. membranacea* Canada
 P2022 *P. degenii* 3b Russia
 KC437745 *P. horizontalis* HT11 BC

P1410 P. neocanina 3 Russia
DQ185306 P membranacea Russia
EF102327 P leucophebia Finland
DQ185284 P. membranacea USA
P2032 P. canina 1 Russia
P2025 P. praetextata Russia
P2000 P. ponojensis/monticola 10a USA CA
P6052 P. leucophebia Austria
DQ185275 P. rufescens Germany
P6050 P. leucophebia Austria
P711 P. leucophebia USA AK
KC437665 P. aphthosa HT08 BC
P240 P. leucophebia 3 Canada BC
P0014 P. canina 1 Iceland
P1309 P. aphthosa 2 US AK
P6080 P. latiloba Canada Nunavut
P6076 P. leucophebia 1 Canada BC
P290 P. leucophebia 5 BC
P1292 P. kristinssonii Canada QC
P1340 P. aphthosa 1 Canada QC
P1341 P. aphthosa Canada
P2053 P. neorufescens 2 Peru
P1085 P. leucophebia China
P2046 P. neorufescens 2 Bolivia
JM58 P. leucophebia BC
P2187 P. ponojensis/monticola 10a USA CA
P1336 P. aphthosa 4 Canada QC
P2030 P. sp. 19 USA OR
KC437711 P. praetextata HT03 Canada BC
P0241 P. leucophebia 3 Canada BC
P264 P. leucophebia 1 Canada BC
P0249 P. leucophebia Canada BC
DQ185312 P. aphthosa Switzerland
P0270 P. leucophebia 3 Canada BC
P253 P. leucophebia 3 Canada BC
P6074 P. leucophebia 4 USA WY
P267 P. leucophebia 4 Canada BC
P238 P. leucophebia 3 Canada BC
P1112 P. kristinssonii Canada BC
P1110 P. fuscopraetextata Canada BC
P6066 P. leucophebia 3 USA CO
P6062 P. leucophebia 6 Iceland
P0017 P. leucophebia HT55 Iceland
P6064 P. leucophebia 4 Iceland
P1332 P. aphthosa 1 Canada QC
P287 P. leucophebia 2 Canada QC
P6077 P. leucophebia 5 China
P239 P. leucophebia 1 Canada BC
P1114 P. aphthosa 5 Canada AB
P286 P. leucophebia 2 Canada BC
P1066 P. britannica 2 USA WY
P0427 P. frigida Argentina
P2036 P. sp. 4 Chile
P2012 P. fuscopraetextata Argentina
P0422 P. frigida Chile
P2067 P. fuscopraetextata Chile
Z94890 Nostoc sp.
P1342 P. britannica Canada QC
P6059 P. leucophebia 1 USA AK
P1343 P. latiloba Canada QC
P1330 P. aphthosa 1 Canada QC
P1349 P. latiloba Canada QC
P705 P. leucophebia 2 USA AK
P1330 P. aphthosa Canada
P609 P. nana 2 NZ
P6063 P. leucophebia 6 Iceland
P1476 P. sp.17 Peru
P2086 P. neorufescens 5 Canada YT
KC437900 P. neocanina HT29 BC
EU877518 Leptogium pseudofururaceum 2 USA
EU877519 Leptogium pseudofururaceum 4 USA
EU877470 Collema fururaceum 4 Croatia
EU877468 Collema undulatum 1 Spain
KC437638 P. collina HT13 BC
EU877490 Leptogium brebissonii 1 Spain
P0663 P. canina 2 USA NC
P1287 P. ponojensis/monticola 5a China
P1108 P. ponojensis/monticola 1a Canada BC
DQ185308 P. rufescens Poland
DQ185279 P. canina Germany
P0015 P. neckeri HT52 Iceland
P890 P. pulverulenta H52 Bolivia
P0863 P. fibrilloides Costa Rica
P0054 P. austroamericana/fibrilloides 4 Costa Rica

79

P0054 *P. austroamericana/fibrilloides* 4 Costa Rica
 P2071 *P. rufescens* 2 Costa Rica
 DQ185270 *Anthoceros* sp. Germany
Sinuicella denisonii
 P0026 *P. laciniata* 1 Costa Rica
 P0040 *P. laciniata* 1 Costa Rica
 P2051 *P. laciniata* 2 Bolivia, Ecuador, Gambia
 P0432 *P. sp.* 15 Ecuador
 P2068 *P. soredians* Costa Rica
 P0003 *P. membranacea* 1 Iceland
 N2054 *P. hymenina* Norway
 P0007 *P. hymenina* Iceland
 P871 *P. hymenina* var. *dissecta* H83 Portugal
 EF102335 *P. membranacea* Finland
 P6065 *P. leucophlebia* 1 Iceland
 P0563 *P. degenii* 1 Norway
 P515 *P. melanorrhiza* H3D Portugal
 P16 *P. britannina* Iceland
 EU877473 *Collema nigrescens* 2 Spain
 EU877460 *Collema crispum* 1 Spain
 GQ184606 *Collema flaccidum* 5 USA
 EU877466 *Collema flaccidum* 4 Spain
 EU877465 *Collema flaccidum* 3 Spain
 DQ26040 *Collema flaccidum* 1 Finland
 DQ268039 *Collema flaccidum* 2 Finland
 P6088 *P. leucophlebia* 2 China
 P2087 *P. ponojensis/monticola* 8 USA UT
 DQ185313 *Nostoc muscorum* soil France
 P2072 *P. neorufescens* 2 Costa Rica
 P0444 *P. ponojensis/monticola* 4a USA KS
 DQ185287 *P. canina* USA
 P2027 *P. ponojensis/monticola* 4 USA MO
 P2090 *P. canina* 2 USA OK
 P1483 *P. canina* 2 USA MO
 P2029 *P. ponojensis/monticola* 4 USA AR
 P2083 *P. rufescens* 1 USA NC
 P2028 *P. ponojensis/monticola* 1a USA MO
 P0084 *P. ponojensis/monticola* 1a USA PA
 P2045 *P. friesiorum* Bolivia
 P2076 *P. austroamericana/fibrilloides* 3 Colombia
 P2073 *P. austroamericana/fibrilloides* 3 Peru
 P2055 *P. austroamericana/fibrilloides* 6 Peru
 P2061 *P. neorufescens* 1 Mexico
 P1201 *P. austroamericana* s.l. Mexico
 Z94892 *Nostoc commune*
 DQ185314 *Blasia pusilla* Germany
 DQ185266 *Anthoceros* sp. Italy
 Z94889 *Nostoc* sp.
 EU877477 *Collema polycarpon* 1 Spain
 DQ185273 *Collema crispum* 2 Germany
 DQ185267 *Encephalartos natalensis* Italy
 EU877481 *Collema tenax* 3 Spain
 DQ185280 *Nostoc commune* soil USA
 EU877482 *Collema tenax* 2 Spain
 EU877467 *Collema undulatum* 2 Spain
 EU877513 *Leptogium magnusonii* 4 Denmark
 EU877516 *Leptogium magnusonii* 6 Spain
 EU877517 *Leptogium magnusonii* Sweden
 EU877512 *Leptogium magnusonii* 3 Sweden
 EU877514 *Leptogium magnusonii* 1 Spain
 P2059 *P. austroamericana/fibrilloides* 2 Mexico
 P1817 *P. evansiana* USA PA
 P0630 *P. evansiana* USA NC
 P2005 *P. friesiorum* Brazil
 P0025 *P. austroamericana/fibrilloides* 4 Costa Rica
 P1554 *P. friesiorum* Brazil
 P2047 *P. andensis* Bolivia
 P0940 *P. austroamericana* s.l. Colombia
 P0043 *P. ulcerata* 1 Costa Rica
 P1190 *P. ulcerata* Colombia
 P0048 *P. ulcerata* 1 Costa Rica
 P29 *P. dolichorhiza* H78 Costa Rica
 P0027 *P. austroamericana/fibrilloides* 1 Costa Rica
 P0082 *P. frigida* Chile
 P1810 *P. continentalis* Russia
 P2077 *P. sp.* 22 Colombia
 P2060 *P. austroamericana/fibrilloides* 4 Mexico
 P0038 *P. austroamericana/fibrilloides* 4 Costa Rica
 P2070 *P. austroamericana/fibrilloides* 4 Costa Rica
 P0033 *P. ulcerata* 1 Costa Rica
 P2048 *P. austroamericana/fibrilloides* 3 Peru
 P2019 *P. austroamericana/fibrilloides* 5 Ecuador
 P0059 *P. leucophlebia* 5 Russia
 P6072 *P. leucophlebia* 1 Russia
 DQ185305 *P. lepidophora* Canada
 DQ185262 *P. rufescens* England

Phylogroup XL

P6073 *P. leucophlebia* 5 Russia
 P0004 *P. P. canina* 2 Iceland
 KC437873 *P. praetextata* HT17 BC
 P0081 *P. extenuata* 1 Russia
 P2031 *P. wulingensis* Russia
 P2064 *P. extenuata* 1 Chile
 P1839 *P. retifoveata* USA
 KC437743 *P. neckeri* HT16 BC
 P0074 *P. retifoveata* Russia
 P0211 *P. latiloba* Canada BC
 P6091 *P. leucophlebia* 1 Canada
 P6078 *P. leucophlebia* 2 Canada AB
 P6085 *P. leucophlebia* 2 Canada AB
 P1030 *P. retifoveata* Norway
 EF102329 *P. leucophlebia* Finland
 P6082 *P. leucophlebia* s.str. Canada AB
 P0294 *P. leucophlebia* Canada BC
 AJ632030 *Nostoc* sp. Finland
 DQ185310 *Stangeria paradosa* England
 EU877528 *Leptogium saturninum* 5 USA
 DQ266037 *Leptogium saturninum* 2 Finland
 EU877527 *Leptogium saturninum* 4 Spain
 EU877526 *Leptogium saturninum* 3 France
 DQ266038 *Leptogium saturninum* 1 Finland
 P0073 *P. monticola/monticola* 9 Austria
 DQ185317 *Nostoc punctiforme* soil France
 P2004 *P. ponojensis/monticola* 2 Germany
 P1107 *P. neocanina* 1 Canada BC
 SSM55a *P. islandica*
 P2034 *P. antarctica* Argentina
 DQ185274 *P. rufescens* Germany
 DQ185276 *P. rufescens* Germany
 P0419 *P. ponojensis/monticola* 9 Russia
 DQ185271 *P. rufescens*
 EU877530 *Leptogium schraderi* 1 Spain
 P1812 *P. didactyla* 1 Belgium
 P2097 *P. canina* 1 China
 DQ185283 *P. membranacea* USA
 DQ185282 *P. canina* USA
 P0652 *P. canina* 2 USA NC
 P2026 *P. canina* 2 USA NC
 P0655 *P. canina* 2 USA NC
 P1319 *P. canina* 2 USA NC
 P1111 *P. rufescens* 1 Canada BC
 P1106 *P. ponojensis/monticola* 1a Canada BC
 KC437817 *P. leucophlebia* HT04 BC
 P6079 *P. leucophlebia* 2 Canada BC
 P6092 *P. leucophlebia* 2 Canada QC
 P250 *P. leucophlebia* 1 Canada BC
 P6075 *P. leucophlebia* 1 USA WY
 P258 *P. leucophlebia* 4 Canada BC
 P2089 *P. neocanina* 2 USA CO
 P1844 *P. lepidophora* 1 Canada BC
 P0068 *P. neocanina* 2 USA NM
 P241 *P. leucophlebia* 3 Canada BC
 P1486 *P. ponojensis/monticola* 1a USA ME
 P1109 *P. extenuata* 1 Canada BC
 P1827 *P. kopenhagenii* Papua New Guinea
 P1831 *P. papuana* Papua New Guinea
 P0192 *P. ponojensis/monticola* 5a India
 P1514 *P. praetextata* China
 P2096 *P. praetextata* India
 Z94891 *Nostoc* sp.
 P0208 *P. leucophlebia* Canada BC
 DQ185278 *P. rufescens* Germany
 P2002 *P. rufescens* 1 Denmark
 P2044 *P. antarctica* Chile
 DQ185272 *P. rufescens* Germany
 DQ185277 *P. didactyla* Germany
 KC437801 *P. leucophlebia* HT20 BC
 1947polasH45gamma
 JM66 *P. neopolydactyla*
 P1472 *P. sp.* 17 Peru
 1545PNGH77gamma
 P1853 *P. fimbriata*
 P2020 *P. soledians* Ecuador
 P2049 *P. patagonica* Argentina
 P2013 *P. patagonica* Chile
 P0076 *P. patagonica* Chile
 P2065 *P. antarctica* Chile
 P2038 *P. frigida* Chile
 P0433 *P. tereziana* Australia
 P2021 *P. tereziana* Australia

- 0.005 length units

References

- Pardo-De la Hoz CJ, Magain N, Lutzoni F, Goward T, Restrepo S and Miadlikowska J** (2018) Contrasting symbiotic patterns in two closely related lineages of trimembered lichens of the genus *Peltigera*. *Frontiers in Microbiology* **9**, 2770.
- Magain N, Truong C, Goward T, Niu D, Goffinet B, Sérusiaux E, Vitikainen O, Lutzoni F and Miadlikowska J** (2018) Species delimitation at a global scale reveals high species richness with complex biogeography and patterns of symbiont association in *Peltigera* section *Peltigera* (lichenized Ascomycota: Lecanoromycetes). *Taxon* **67**, 836–870.