

Phylogeography of *Psoroma hypnorum* complex

Soon Gyu Hong^{1*}, Chae Haeng Park¹, Eun Hye Kim¹, Arve Elvebakk²

¹Division of Polar Life Sciences, Korea Polar Research Institute, Get-Pearl Tower, 12 Gaetbeol-ro, Yeonsu-gu, Incheon 406-840, Republic of Korea

²Tromsø University Museum, University of Tromsø, N-9037 Tromsø, Norway

Psoroma is a squamulose tripartite lichen with algae as main photobionts and *Nostoc* in cephalodia. It is classified in Pannariaceae (Peltigerales, Lecanoromycetes) and occurs on bryophytes, soil, and tree barks. It is known as a predominantly Southern Hemisphere genus. From the phylogenetic studies on *Psoroma* and related species, it was revealed that *Psoroma* is closely related with *Psorophorus*, *Xanthopsoroma*, *Pannaria*, *Protopannaria*, *Fuscopannaria*, *Santessoniella*, and *Moelleropsis*, which are members of Pannariaceae s.str. (Ekman and Jørgensen, 2002; Wedin and Wiklund, 2004; Passo et al., 2008; Wedin et al., 2009; Elvebakk et al., 2010). *Psoroma hypnorum*, the type species of the genus *Psoroma*, is a cosmopolitan species recorded in Europe, Asia, North and South America, Australia, New Zealand, and the Antarctic. It occurs on moist bryophytes, on damp gravelly soil and rock ledges (Øvstedal & Lewis Smith, 2001). The species includes morphologically and genetically diverse samples and some of them appeared in phylogenetically diverse lineages (Passo et al., 2008).

To understand relationships among *Psoroma hypnorum* complex from Northern and Southern Hemispheres and relationships among different localities in Southern Hemisphere, we collected samples of *Psoroma hypnorum* and related species from Norway, King George Island, Chile, and Falkland Islands. Phylogenetic relationships were reconstructed based on the sequence information of ITS1-5.8SD-ITS2-LSU rDNA and mitochondrial SSU rDNA. We could detect four major phylogenetic groups, three of which were composed of Southern Hemisphere samples and one was composed of Norway samples. The main group of King George Island samples formed a basal lineage of *P. hypnorum* complex. It was clearly distinguished from other samples from Northern and Southern Hemispheres. The relationship was supported by both of nuclear and mitochondrial rDNA. Considering phylogenetic relationships and morphological characteristics, it is proposed that they are different species from *P. hypnorum* s.str. and endemic to the Antarctic. The second monophyletic group was composed of four samples from Chile and was close to the basal in the phylogeny. The other Southern Hemisphere samples from Chile, Falkland Islands, and King George Island formed the third

monophyletic group. They were genetically very homogeneous and geographical isolation was not evident. It implies that *P. hypnorum* inhabiting in Chile, Falkland Island, and King George Island is transferred between different localities by long distance dispersal mechanisms such as wind or birds (Bailey and James, 1979; Munõz et al., 2004). *Psoroma hypnorum* from Norway formed the fourth monophyletic group. It was genetically more diverse than the other groups. To explain the evolution of *P. hypnorum* complex, it is proposed that one event of long distance dispersal between Northern and Southern Hemispheres and frequent long distance dispersal among different localities in the Southern Hemisphere can explain current distribution of the species.

References

- Bailey, R.H., and James, P.W. (1979) Birds and the dispersal of lichen propagules. *Lichenologist* 11: 105-106.
- Ekman, S. and Jørgensen, P.M. (2002) Towards a molecular phylogeny for the lichen family Pannariaceae (Lecanorales, Ascomycota). *Can. J. Bot.* 80: 625-634.
- Elvebakk, A., Robertsen, E., Park, C.H., Liaimer, A. and Hong, S.G. (2010) *Psorophorus* and *Xanthopsoroma*, two new genera for yellow-green, corticolous and squamulose lichen species, previously in *Psoroma*. *Lichenologist* 42: 563-585.
- Munõz, J., Felicísimo, Á.M., Cabezas, F., Burgaz, A.R., and Martínez, I. (2004) Wind as a long-distance dispersal vehicle in the Southern Hemisphere. *Science* 304: 1144-1147.
- Øvstedal, D. O. & Lewis Smith, R. I. (2001) *Lichens of Antarctica and South Georgia: A guide to their Identification and Ecology*, Cambridge, UK: Cambridge University Press.
- Passo, A., Stenroos, S. and Calvelo, S. (2008) *Joergensenia*, a new genus to accommodate *Psoroma cephalodinum* (lichenized Ascomycota). *Mycol. Res.* 112: 1465-1474.
- Wedin, M. and Wiklund, E. (2004) The phylogenetic relationships of Lecanorales suborder Peltigerineae revisited. *Symb. Bot. Ups.* 34: 469-475.
- Wedin, M., Wiklund, E., Jørgensen, P.M., Ekman, S. (2009) Slippery when wet: Phylogeny and character evolution in the gelatinous cyanobacterial lichens (Peltigerales, Ascomycetes). *Mol. Phyl. Evol.* 53: 862-871.