

Molecular phylogeny and taxonomic revision on the moss genera *Leptobryum* and *Bryum* from Syowa Station area, Antarctica

The moss taxonomy in Syowa Station area has a half-century history that started from the first Japanese Antarctic Research Expedition (JARE). Though five taxa were listed in the first publication at 1961, even for now only eight taxa have been listed as the moss flora of the area. Despite the low diversity, the taxonomy of some species, especially that of two aquatic moss species and terrestrial *Bryum* species, have been confused through the past examination based on the morphological features. It is considered that the confusions on these species attributed mainly to the morphological plasticity and poor growth of the plants caused by the submersion or the severe environmental conditions of Antarctica. In this study, therefore, the taxonomic revisions of the confused species are performed using the molecular phylogeny based on the DNA sequences (the chloroplast regions and/or the nuclear ribosomal ITS region) that are immune to the environmental stresses.

In the chapter 3, the taxonomy of an aquatic moss species (referred to as *aquatic moss* there) that had been firstly described as *Bryum* cf. *korotkevicziae* is featured. The *aquatic moss* has a long and confused taxonomic history as examined by some researchers. Though the species had been recently recognized as the species in the genus *Leptobryum* (i.e. *L. pyriforme* or *L. wilsonii*), it has been transferred to the genus *Pohlia* as the new combination *Pohlia wilsonii* in the most recent taxonomic treatment. Then, the taxonomic position of *aquatic moss*, which has been confused not only in the specific level (*L. pyriforme* vs. *L. wilsonii*) but also in the generic level (*Leptobryum* vs. *Pohlia*), is examined by the molecular phylogenetic analysis. Based on the results of the analyses, *aquatic moss* is assigned to *Leptobryum* that distantly related to *Pohlia* and determined to be conspecific with *L. wilsonii* described from South America due to having the complete or close identical DNA sequences with the species. Molecular and geohistorical evidence suggests that immigration of *L. wilsonii* into Antarctic lakes took place during the Holocene via long-distance dispersal from South America. The study gives a clear example of the widespread assumption that most of the Antarctic moss species are post-glacial immigrants.

In the chapter 4, the taxonomy of another aquatic moss species (referred to as *aquatic Bryum* there) that had been firstly described as *Bryum pseudotriquetrum* is featured. Though there has been not the taxonomic investigation any more than the first publication, the identification of the species may be depended on the assumption, which accounts the benthic plants were derived from terrestrial populations surrounding the lakes, rather than the morphological similarity. In this study, then, the taxonomic position of *aquatic Bryum* is examined by the molecular phylogenetic analysis

with comparing to the terrestrial species of the genus in Antarctica. The results show that the specimens of *aquatic Bryum* are assigned to the identical position with those of *Bryum nivale*, quite rare species occurring in maritime Antarctica. Moreover, as well as *aquatic Bryum*, some specimens from the terrestrial habitats in the Syowa Station area (referred to as *terrestrial Bryum* there) have close or completely identical DNA sequences with those from maritime Antarctica. Morphologically, the species are characterized by the broad shape and the differentiated basal cells of leaf. These morphological characters can be also observed in the specimens of *terrestrial Bryum* from the Syowa Station area, but not in those of *aquatic Bryum*. Though there are no morphological evidences in the latter specimens, in this study, based on the molecular evidences the identities of both *terrestrial Bryum* and *aquatic Bryum* were concluded as *B. nivale*. As a result, the species is newly added to the list of the moss flora of the Syowa Station area and continental Antarctica. Moreover, though apart from the primary purpose, through the study we found four putative new species only from maritime Antarctica.

In the chapter 5, the phylogenetic relationship among three related species of the genus *Bryum* in Antarctica (i.e. *B. pseudotriquetrum*, *B. archangelicum*, *B. pallescens*) is featured. The theme was mainly brought by the analysis of the chapter 4 where the identity of *B. pseudotriquetrum* in Antarctica (referred to as *Antarctic B. pseudotriquetrum* there) was questioned and moreover suggested the conspecificity with the latter two species. There are almost no genetic variations among the specimens of these species within the chloroplast DNA regions that used in the chapter 4, and then, in the analysis of this chapter, the nuclear ribosomal ITS region that is considered to be the faster evolving locus is used to clarify the relationships among them. As well as the chloroplast regions, the analysis based on the ITS region also shows the separation between the specimens of *Antarctic B. pseudotriquetrum* and those of *B. pseudotriquetrum* out of Antarctica in the phylogenetic tree. As a result, therefore, the conspecificity of Antarctic species with *B. pseudotriquetrum* out of Antarctica, which has been widely accepted for the last two or three decades, is considered to be refuted. However, the identity of the species has been not cleared yet because the phylogenetic relationships among candidate species (i.e. *B. archangelicum*, *B. pallescens*) were not resolved in the analysis. Though the taxonomy of these related species in Antarctica was not cleared, the study in this chapter brought new critical question regarding the taxonomy of the species that has been well known as one of the most dominant plants in Antarctica.

The molecular phylogeny on the bryophyte species in Antarctica have been rarely performed and this is the first comprehensive study using the approach. Though the approach is not necessarily valid as shown in the chapter 5, it must shed new lights on the bryophyte taxonomy through the revisions and the findings of new record and species as also shown in this study.