学 位 論 文 審 査 の 要 旨

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学 位 論 文 題 名

Study of the microbial community structure in the rhizosphere of understory dwarf bamboo (*Sasa kurilensis*) in a *Betula ermanii* forest, northern Japan
（日本北方林のダケカンバ林における下層ササ根圏の微生物群集の構造に関する研究）

Boreal forest refers to the forest in a low temperature zone, and comprises about 25% of the world's forest land, which has an influence on the global climate through release of its large store of soil carbon. In northern Japanese boreal forests, Erman's birch (*Betula ermanii* Cham.) is an early-successional tree species, which may be sensitive to environmental changes among various boreal ecosystems. Understory plants grow on the forest floor beneath the forest canopy. Forest understory vegetation is often dominated by herbaceous species in Japanese boreal forests, especially by dwarf bamboos. In Hokkaido, which is the area of heavy snowfall, dwarf bamboos *Sasa* spp. can quickly cover forest floors with vigorously extending rhizomes. Former studies suggested that understory bamboos play an important role in boreal forests through competition for soil resources. To better understand the role of *Sasa* and soil properties, it is necessary to carry out a further survey of structural and functional diversity of microbial communities in the rhizosphere of *Sasa*. Owing to the complexity of microbial communities in forest habitats, it is difficult to determine the species structure of soil microorganism communities under natural conditions. However, rapid advances in molecular ecological approaches have made it possible to analyze whole microbial communities in a relatively short time. This study investigated the microbial community structures of soils with or without understory *Sasa kurilensis* in a *Betula ermanii* forest by using DGGE and NGS methods. The aim of this study was to investigate the relationships between soil microbial communities and soil physicochemical properties in the rhizosphere of *Sasa kurilensis* .

Diversity estimates of microbial communities: This chapter analyzed soil microbial communities in the presence of *S. kurilensis* (SI) and absence of *S. kurilensis* (SR) by comparing their microbial species diversity. Species richness in both the SI and SR plots was lower when using DGGE method than when using NGS method. According to the

banding patterns on the DGGE gels, there were some specific species of fungal communities. As for calculating Shannon and Simpson indices, the results of both DGGE and NGS methods rarely showed the differences between the SI and SR plots. However, these two methods showed different levels of taxonomic classification. NGS provided more detailed information of species diversity. More information of taxonomic classification of species is necessary to find the differences between the SI and SR plots. Therefore, after comparing the results of the two methods, a further experiment was carried out to investigate the microbial community structures in the SI and SR plots by NGS method.

Microbial community structure and soil properties: In this chapter, Illumina MiSeq was used to analyze the microbial community structures, and soil properties were measured in both the SI and SR plots. The relationships between the microbial community structures and soil physicochemical properties were investigated. The presence of understory *S. kurilensis* strongly affected soil properties, including total carbon, total nitrogen, nitrate, and C:N ratio as well as relative soil moisture. It was found that the abundance of *Pezizaceae*, known to act as mycorrhizal fungi, was related to the amount of soil total carbon in the SI plot. Furthermore, the results of the number of OTUs suggested that some species of phylum *Planctomycetes* were more likely to occur in the SI plot.

The overall results indicated that the presence of *S. kurilensis* in a *B. ermanii* boreal forest affected the structure of soil microbial communities and the corresponding soil properties. Less soil water was retained in the presence of *S. kurilensis*. The presence of *S. kurilensis* appeared to promote the colonization of soil mycorrhizal fungi of family *Pezizaceae* (phylum *Ascomycota*), which may have increased the amount of soil carbon in the dry soil environments. This study enriches our understanding of how the presence of understory bamboo *S. kurilensis* affects soil properties and corresponding microbial community structures in the boreal forest.

The examination committee recognized that this study provides new insights into ecological phenomena in boreal forests from microbial, ecological and physiological points of view and contributes to the development of environmental studies of boreal forests. The committee thereby concluded that the applicant is eligible for the degree of Doctor of Philosophy (Environmental Science).