学 位 論 文 内 容 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 effect 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 is growing beneath the forest canopy but above the forest floor. Forest understory vegetation is often dominated by herbaceous species in Japanese boreal forests, especially dwarf bamboos. In Hokkaido, which is the area of heavy snowfall, dwarf bamboos *Sasa* spp. can quickly cover forests with vigorously extending rhizomes. Former studies suggested that understory bamboos play an important role in boreal forest through competing for soil resources. To better understand *Sasa* and soil properties, it is necessary to carry out a further survey of structural and functional diversity of microbial populations 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. In the current study, I investigated the microbial community structures of soils with or without understory *Sasa kurilensis* in a *Betula ermanii* stand, by using DGGE and NGS methods. The aim of this study was to observe the relationship between the soil microbial community and soil physicochemical properties in the rhizosphere of *Sasa kurilensis* .

Diversity estimates of microbial communities

In this chapter, I 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, both the results of DGGE and NGS methods rarely told the differences between the SI and SR plots. However, these two methods described different levels of taxonomic classification. NGS provided more detail information of species diversity. More information of taxonomic classification of species is necessary in order to find the differences between the SI and SR plots. Therefore, after comparing the results of the two methods, I carried out a further experiment to indicate the microbial community structures in the SI and SR plots by NGS method.

Microbial community structure and soil properties

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

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. More soil water was retained after *S. kurilensis* was removed. The presence of *S. kurilensis* appeared to promote the colonization of soil mycorrhizal fungi of the family *Pezizaceae* (phylum *Ascomycota*), which may have meditated the amount of soil carbon in the dry soil environment. The present study enriches our understanding of how the presence of understory bamboo affects soil properties and corresponding microbial communities in a boreal forest.