（様式３）

学 位 論 文 内 容 の 要 旨

博士の専攻分野の名称： 博 士（食資源学） 氏名 大東孝充

学 位 論 文 題 名

Impacts of anthropogenic disturbances on the community structures and functions of soil microorganisms
（人為的攪乱が土壌微生物群集の組成や機能に及ぼす影響）

Anthropogenic disturbances such as land-use changes, pollution, and introductions of exotic species have impacted the original natural ecosystems, causing changes in the balance of ecosystem functions. Soil microbial communities, which have various life-supporting ecosystem functions, have also been influenced by such disturbances. However, despite the importance of soil microbes, little is known about whether the disturbed microbial commutes further accelerate the loss of functionality. In addition, previous microbiome studies mostly focused on the Global North (i.e., North America, Europe, and East Asia) while knowledge of the microbiome in other regions is lacking especially in Africa. Although the loss of soil carbon (C) and nitrogen (N) due to excess farming management in Africa is prominent, how such soil degradation affects soil microbial diversity and nutrient cycling functions, which can contribute to further soil degradation, is not clear. Besides, the recent globalization has led to a rapid movement of exotic animals or plants to other local areas with human activities. In the former glacier northern hardwood forests in North America, native earthworms were thought to be cleared out during the last ice age. However, European people introduced non-native earthworms to that area, causing an alteration of ecosystem services such as nutrient availability. Hence, the objectives of this research were: (1) to evaluate changes in a N-cycling activity and the microbes facilitate the function by comparing natural lands and farmlands in Zambia, (2) to investigate the relationship between a location-scale microbial diversity and their multi-functionality in Kenya and Malawi, and (3) to study the mechanism behind decrease in N availability by invasion of non-native earthworms in Minnesota, USA.

The first experiment measured the changes in nitrification potential and its relationship with soil nitrifying microbial communities altered by farming management, targeting three sites where all had neighboring natural lands and farmlands. The nitrification potential was increased in all farmlands than in the natural lands. The abundance of ammonia-oxidizing bacteria (AOB) also tends to increase in farmlands, but it did not correlate with the nitrification potential. On the contrary, the abundance of ammonia-oxidizing archaea (AOA) was lower in the farmlands than in the natural lands. Species in AOB clusters 3a.2 and 3b relatively increased in the farmlands most likely due to an increase in soil pH and ammonium addition by farming. This suggests that not only the total abundance of AOB but also the internal changes in their community structure can upregulate nitrification potential possibly leading to further N loss.

The second experiment performed a microbial ecological investigation on the changes in microbial diversity through forest-to-farmland conversion at the sample scale, the location scale (e.g., within one farmland in Kenya), and the metacommunity scale (e.g., among multiple farmlands across Kenya and Malawi). The heterogeneity of soil prokaryotic and fungal communities was lower in the farmlands than in the natural lands, indicating a community homogenization was caused by farming management. Additionally, the microbial taxonomic heterogeneity was correlated with the heterogeneities of C cycle- and N cycle-related functions and fungal lifestyles at the location scale. Moreover, the homogenization of fungal communities at both location and metacommunity scale was correlated with the relative abundance of pathogenic fungi. Overall, farming management in sub-Saharan Africa might lead to a homogenization of microbial taxa, passively leading to a loss of heterogeneous functions and a rise of pathogenic fungi.

Finally, the third experiment conducted a field investigation of earthworms, gas, and soil biochemical properties and incubation in a laboratory to conduct a stable isotope DNA probing, targeting a northern hardwood forest in Minnesota, where a gradation in invasion level of non-native earthworms is observed (Minimally invaded site, Site M; Highly invaded site, Site H). The abundance of AOA was larger in Site M than in Site H. In addition, the shallow soil in Site H exhibited a slow nitrification activity than that in Site M, most likely as the result of decrease in the AOA abundance. However, not AOA, but AOB and nitrite-oxidizing bacteria (NOB) were detected as they actively facilitate nitrification in all the soils except for the shallow soil in Site H. This may be because the ammonium concentration used in the incubation was too high for AOA that prefers low ammonium environments. These results suggest that nitrification activity of the shallow soil in Site H is slow regardless of the original field nitrifiers' abundances.