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Spatio-temporal changes of soil microbial communities under different land cover types in eastern Madagascar

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Abstract

Soil microorganisms play an important role in nutrient cycling. Understanding how soil microbial communities change across different land cover types and seasons is crucial for identifying the impact of soil microorganisms on ecosystem functioning. This study investigated the spatial and temporal variability of soil microbial community composition associated with vegetation across various land cover types in eastern Madagascar. We collected soil samples from distinct land cover types (tree fallow, shrub fallow, eucalyptus forest, and degraded land) over three sampling seasons (dry season, beginning and end of rainy season). We then quantified total bacteria and fungi, along with gene markers for key functional groups involved in nutrient cycling (*gcd*, *phoD*, *nifD*), using molecular tools. Results showed a significant effect of land cover types on soil microbial community. Shrub fallow exhibited the highest relative abundance of microbial genes compared to degraded land. Shrub fallow also demonstrated greater vegetation species diversity after tree fallow, as indicated by the Shannon diversity index, highlighting the influence of vegetation on soil microbial diversity. Multiple linear regression and Pearson's correlation were applied to microbial parameters combined with soil physicochemical characteristics to investigate the impact of environmental factors on soil microbial composition. The analysis revealed that soil phosphorus (P) availability, after pH, was the primary factor regulating microbial relative abundance, especially for bacteria ($p < 0.001$). Our results, particularly in terms of predicted gene expression, revealed interesting patterns. Samples collected at the beginning of the rainy season generally exhibited the highest mean abundance except for *gcd* and *nifD* genes, which showed higher expression levels at the end of the rainy season. Despite the increased expression of the P-releasing gene in the rainy season, P availability was not correlated to microbial relative abundance. These findings contribute to our understanding of the complex interactions between soil microorganisms, land cover types, and environmental factors, and their impact on ecosystem functioning.

Keywords: Land cover, Madagascar, phosphorus, soil functioning, soil microorganisms