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

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1- INTRODUCTION

- Soil microorganisms: represent 0.6-1.1% of soil organic carbon and play essential roles in maintaining soil processes and plant development
- Land cover shifts and seasonal variations in environmental factors affect the microbial communities

Understanding microbial distribution is crucial for elucidating the mechanisms that govern microbial composition and regulate ecosystem processes

This research investigates soil bacterial and fungal communities in relation to land cover types and seasonal variability in Madagascar's eastern tropical forest

2- MATERIALS AND METHODS

- Topsoil composite samples from 4 land cover types: Tree fallow (**TSA**), Shrub fallow (**SSA**), Eucalyptus Forest plantation (**EUC**), and Degraded land (TM)
- 3 sampling times across the year: Dry season (**DS**), starting of the rainy season (**SRS**) and ending of the rainy season (**ERS**)
- Vegetation composition diversity (Shannon diversity index) and soil physicochemical properties determined for each land cover type
- Soil DNA extracted (FastDNA SPIN kit for soil), and the abundance of targreted genes quantified by qPCR.: *16S rRNA* (total bacteria), *ITS* (total fungi), *gcd* (inorganic phosphorus[P]-solubilizing bacterial gene), *phoD* (organic P-mineralizing bacterial gene), *betaine* (P-cycling fungal gene), *nifD* (nitrogen-fixation bacterial gene).
- Links between soil physicochemical, microbiological, and vegetation cover in relation to the season, determined.

3- RESULTS

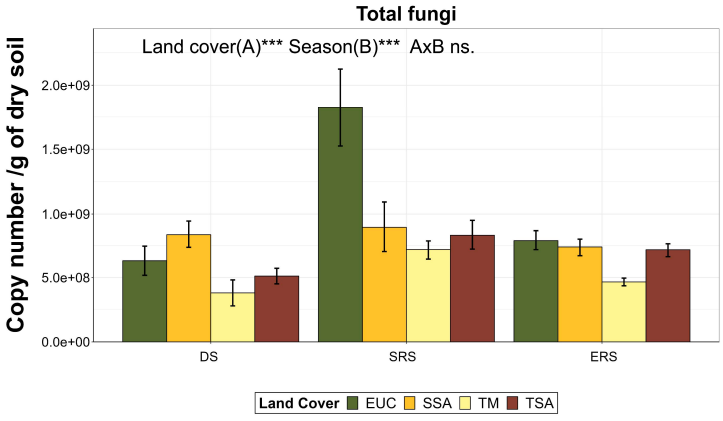
- Fallow land cover type had more diverse vegetation (Table 1)
- Land cover type and sampling season affected soil bacterial and fungal composition.
- Bacterial and fungal community compositions respond differently to environmental factor shifts (Fig. 1), with, for instance, TM generally showing the lowest microbial abundance
- EUC shows a significantly higher number of bacteria and fungi in the soil at SRS
- Soil microbial parameters are more correlated to SSA in contrast with EUC, which has similar characteristics to TM (Fig. 2)
- Soil properties influence the composition of the microbial community: soil bacteria were positively correlated to pH and P availability, while soil fungi were positively correlated to pH and total P (Table 2)
- Soil bacterial relative abundance is influenced by the season (Fig. 1), whereas functional genes (*gcd*, *phoD*, *nifD*) expression was significantly correlated to available P (*gcd*, *phoD*), pH (*nifD*), fine silt (*gcd*), and fine sand (*gcd*, *nifD*) as shown in Table 2

Table 1: Vegetation composition diversity for each land cover

Land cover	Shannon diversity index
TSA	2.99
SSA	2.61
EUC	2.40
TM	0.96

Table 2: Relative importance of soil parameters as predictor variables of microbial relative abundance from multiple linear regression

	Fungi	Bacteria	*gcd*	*phoD*	*nifD*
pH	**23.94**	**36.86**	-	15.72	**26.63**
N_{total}	16.20	8.16	-	5.68	-
C/N	12.41	3.74	-	-	12.77
P_{Olsen}	-	**25.46**	**49.79**	**54.41**	-
P_{total}	**35.83**	17.23	-	7.37	9.25
Fine silt	-	8.55	23.62	16.82	-
Fine sand	-	-	**26.59**	-	**51.36**
Coarse sand	11.62	-	-	-	-
Proportion of variance (%)	**45.81**	**61.39**	**20.92**	**62.75**	**31.9**



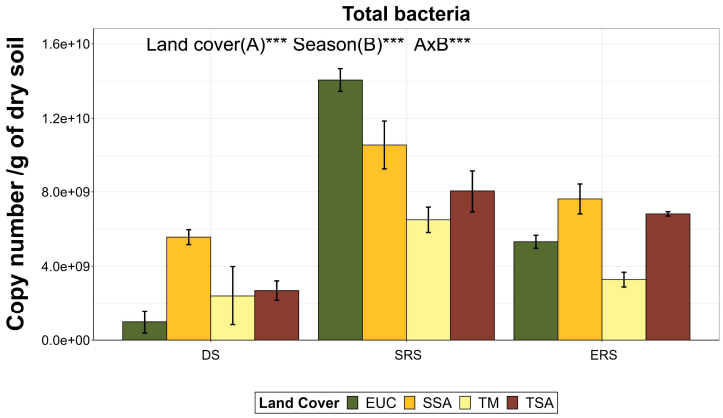


Fig 1: Soil microbial relative abundance as influenced by the land cover type and the season

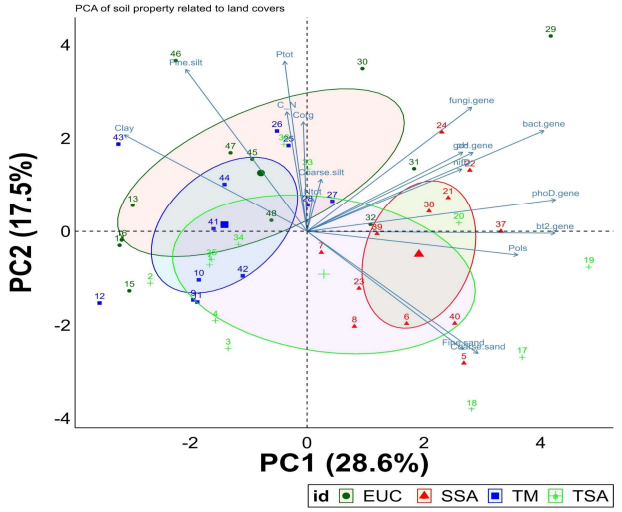


Fig 2: Principal Component Analysis of soil chemical property and microbial community composition related to land covers

DISCUSSION

Soil land cover type influences microbial composition through the diversity of vegetation. Divergent vegetation diversity offers divergent rhizodeposition, which recruits different microbial species. Natural restoration from TM to SSA increases soil microbial composition. Plant-soil microorganisms association is a specific association; it is the case of ectomycorrhizal association with Eucalyptus, explaining the highest relative abundance observed in the EUC. Increasing soil moisture activates soil microbial activity, which explains the increase of soil microbial relative abundance during the wet season. However, water saturation at the end of the rainy season reduces microbial community composition. During the wet season, plants and microorganisms compete for available nutrients. Other mechanisms may inhibit the functional traits of microorganisms that help upcycle nutrients.

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