Comparative Analysis of Soil Metagenomes from North- and South-facing Slopes

Camila Valderrama-Martínez[1], Kimi Swangin[1], Baili S. Popal[1], Josue Navarrete[1], Marisa C. Mendoza[1], Elinne Becket[1], Sergio Nigenda Morales[1], and George Vourlitis[1]

[1]College of Science, Technology, Engineering, and Mathematics, California State University San Marcos, San Marcos, CA

Background

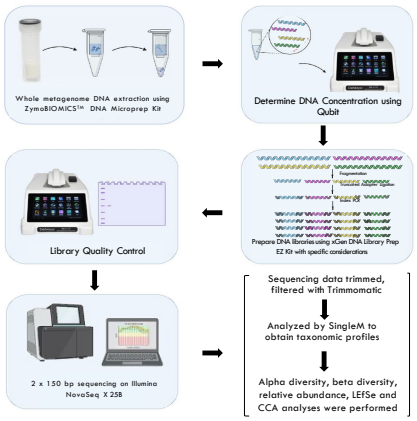
- Microbial communities are crucial for nutrient cycling and promoting stable biodiversity
- Slope aspect in chaparral ecosystems can impact:
  - Temperature, radiation, and moisture levels
  - Plant photosynthesis and function
  - Soil microbial activity and diversity
  - Nutrient cycling
- *Salvia mellifera, Ceanothus tomentosus* grow on both slope types
- Environmental variation and plant colonization may impact soil microbial communities and properties

Hypothesis: Slope aspect directly influences soil microbial community composition and diversity due to the distinct microclimates of north- and south-facing slopes

Methods

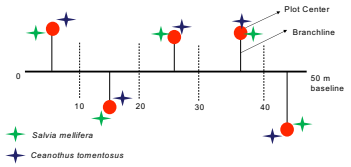
When: January 2025
Location: CSUSM campus

- Soil samples were 1) sieved to remove debris 2) 100-200 mg of soil was aliquoted into Eppendorf tubes
- Chemical and physical analyses were performed on sieved soil
- Metagenomic sequencing was performed on sieved aliquoted soil:



Sampling Site

Sampling Design



Results

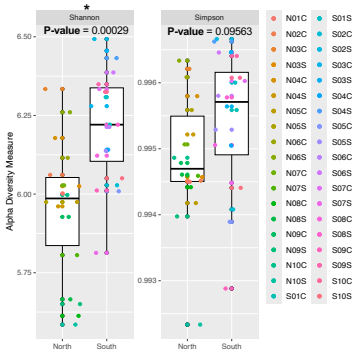


Figure 1. Species alpha diversity of soil metagenomes from North (N) and South-facing (S) chaparral slopes using Shannon and Simpson indices. Points represent individual soil samples from sampled sites, and boxplots show the interquartile range and median.

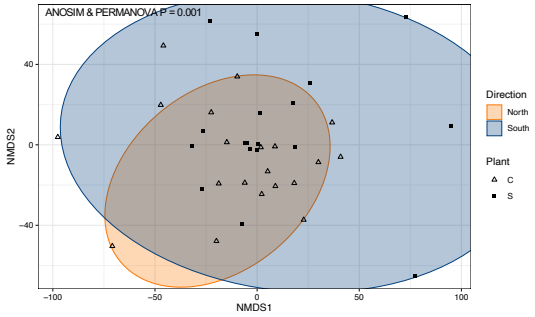


Figure 2. Beta diversity of soil metagenomes across slope aspect and plant type. Points represent samples (triangles = north-facing, squares = south-facing), and color indicates species (orange = *Ceanothus tomentosus*, blue = *Salvia mellifera*). Ellipses represent 95% confidence intervals for species, showing that slope aspect influenced beta diversity.

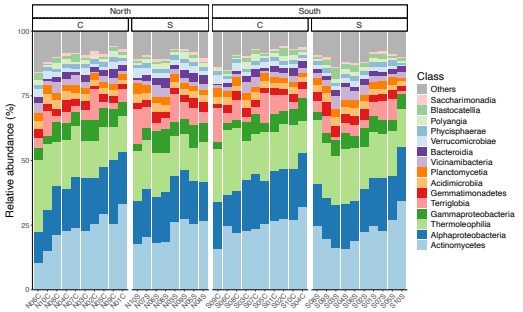


Figure 3. Class-level relative abundance of soil microbial taxa across north- and south-facing slopes, separated by plant species. Taxa beyond top 15 Classes were grouped into "Others". Actinomycetes, Alphaproteobacteria, and Thermoleophilia were the most abundant groups across all samples.

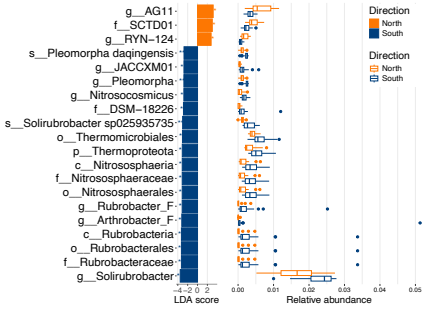


Figure 4. Differentially abundant microbial taxa identified using linear discriminant analysis effect size (LEfSe) between north- and south-facing slopes. The left panel shows taxa with differences in relative abundance, with bar lengths indicating effect size (LDA scores). The right panel presents box plots of relative abundances for each taxon by slope, highlighting slope-enriched microbial groups.

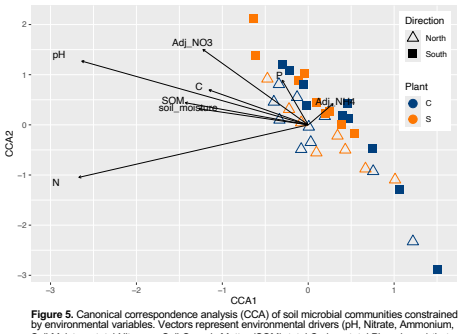


Figure 5. Canonical correspondence analysis (CCA) of soil microbial communities constrained by environmental variables. Vectors represent environmental drivers (pH, Nitrate, Ammonium, Soil Moisture, total Nitrogen, Soil Organic Matter (SOM), total Carbon, total Phosphorus) that shape the distribution of points. Symbols represent slope (triangles = north-facing; squares = south-facing) and species (orange = *Ceanothus tomentosus*; blue = *Salvia mellifera*).

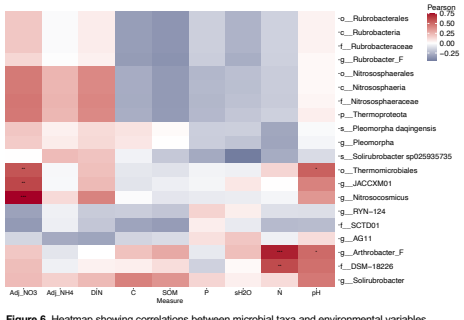


Figure 6. Heatmap showing correlations between microbial taxa and environmental variables across slope and plant groups. Warmer colors represent positive correlations, and cooler colors represent negative correlations, revealing associations between nitrogen- and drought-adapted taxa with specific slope and soil conditions.

Discussion/Conclusions

- Alpha diversity = South slopes had ↑ species richness, but evenness was similar
- Slope aspect significantly influences beta-diversity shifts
- South-facing slopes = ↑ radio tolerant bacteria
- pH & nitrogen most influence compositional shifts: total N (north-facing), ammonia (south-facing)
- Nitrate, ammonia, and pH showed significant correlations with specific taxa

Acknowledgements

Supported by NIEHS Award # R15ES033027, CTREE through Bridges to the Doc T32GM146604 and URISE 5T34GM136481