

# Microbial Distribution in Streams: A Meta-ecosystems Approach

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# What Is a Meta-Ecosystem?

- A Meta-ecosystem is “a set of ecosystems connected by spatial flows of energy, materials and organisms across ecosystem boundaries” (*Loreau, et al. 2003*).
- Similar ideas as presented in the River Continuum Concept (*Vannote et al. 1980*), however, microbes were not included when this was first published.

Loreau, M., Mouquet, N. and Holt, R. D. (2003), Meta-ecosystems: a theoretical framework for a spatial ecosystem ecology. *Ecology Letters*, 6: 673–679. doi: 10.1046/j.1461-0248.2003.00483.

Vannote, R.L., G. W. Minshall, K. W. Cummins, J.R. Sedell, and C.E. Cushing. (1980). The river continuum concept. *Can. J. Fish Aquatic Science* 37: 130-137.

# Why Study Microbes?

- Microbes have extremely important roles in nutrient cycling and CZO processes (carbon, nitrogen, iron, etc.).
- They have not been studied to the extent of other organisms.
- Because microorganisms are so small, we can work on a small scale:
  - 1) Studies can be conducted in a matter of weeks or months rather than years or decades.
  - 2) Environments are small and self-sustaining. Little space and resources are needed.

# Project Goals

- One goal of this project was to investigate how streambed substrates enrich different bacterial species.
- A second goal was to develop lesson plans for high school teachers to help educate students about microbes and meta-ecosystems.

# Hypothesis

- Bacterial distribution is influenced by environmental conditions (organic matter, substrate type, light, oxygen, etc).

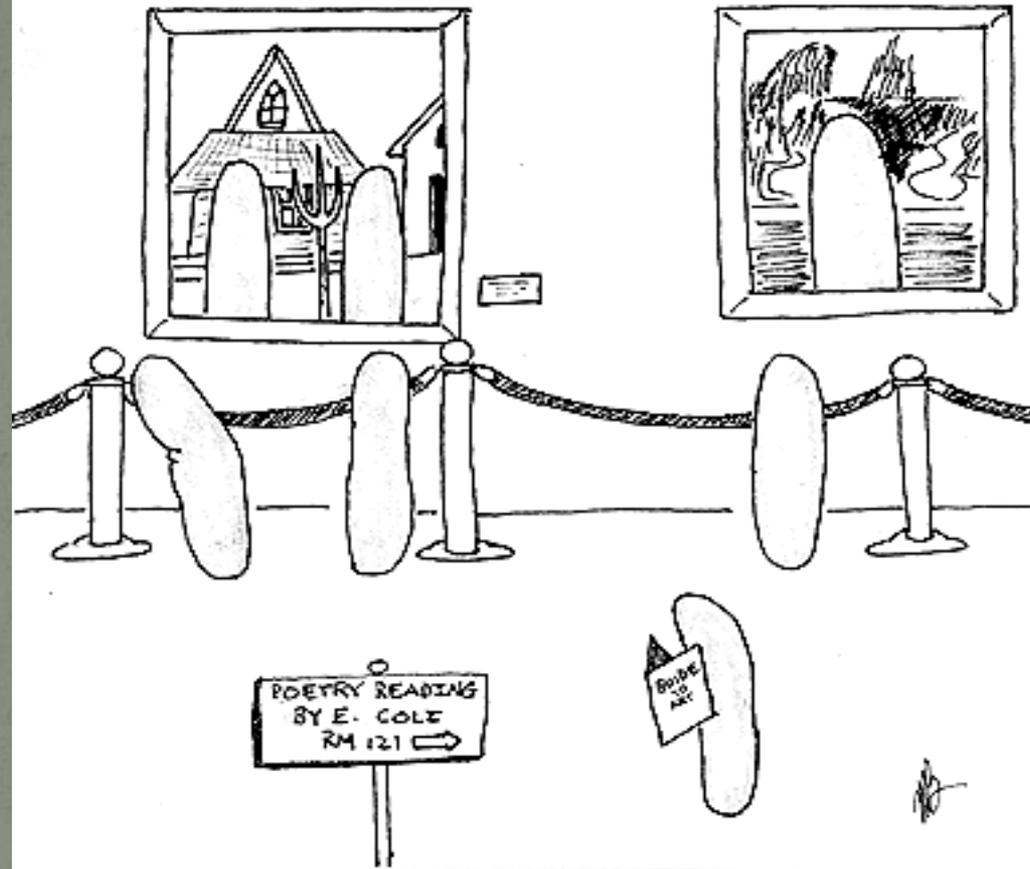
# Setting Up the Aquarium



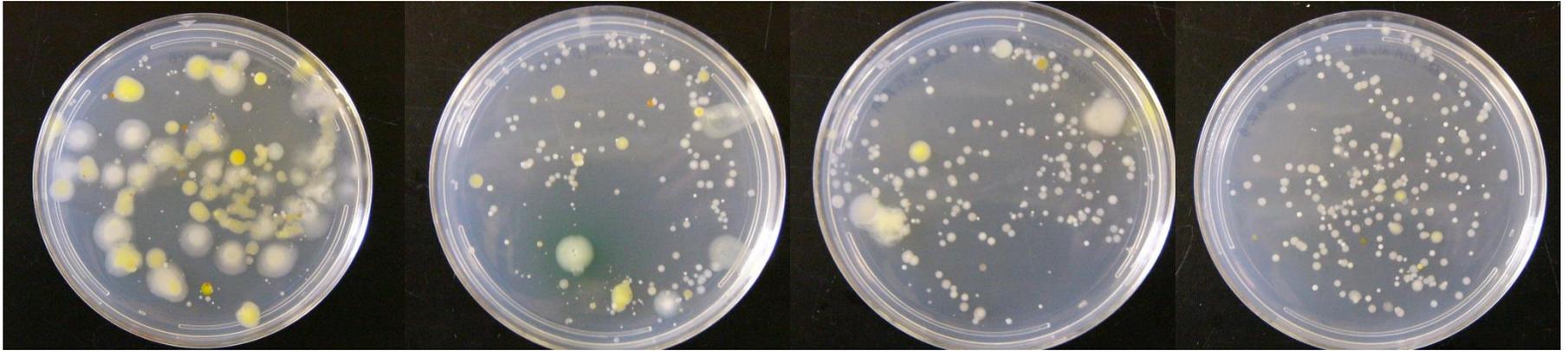
# Collection of Samples for Bacteria Cultivation and DNA Extraction

- Stream Water from White Clay Creek -  $T_0$ 
  - Filter from stream water used to fill the aquarium (6/25/15)
- Water from the Aquarium After 1 month incubation -  $T_{END}$ 
  - Filter from aquarium water (7/24/15)
- Sampling for both Clay and Sediment
  - Used a plastic syringe to take a core
  - Section the top (aerobic) and bottom (anaerobic)
- Rocks
  - Scraped biofilm from the rocks
  - Rinsed the biofilm into a Petri dish
- Leaves
  - Randomly selected leaves

# Bacteria Cultivation



BACTERIA CULTURE



Clay, Top

Clay, Bottom

Sediment, Top

Sediment, Bottom

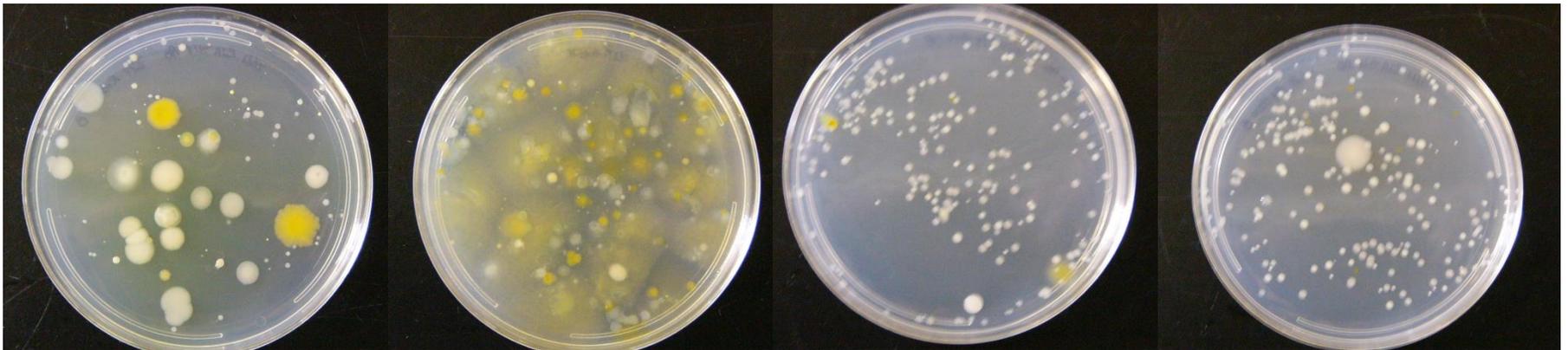
82 hours After Streaking

Rock

Leaves

$T_o$

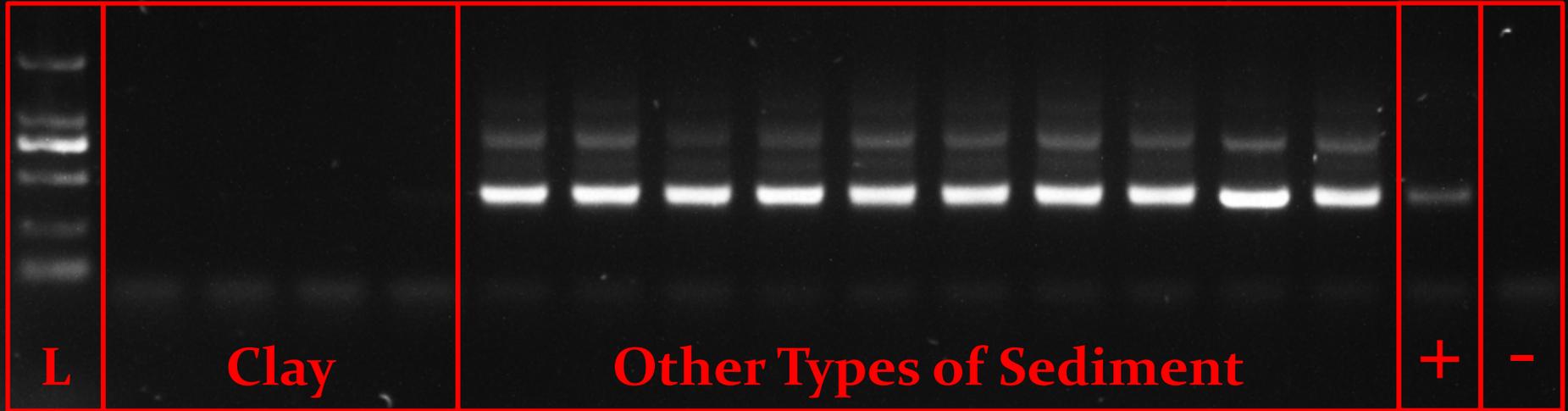
$T_{END}$

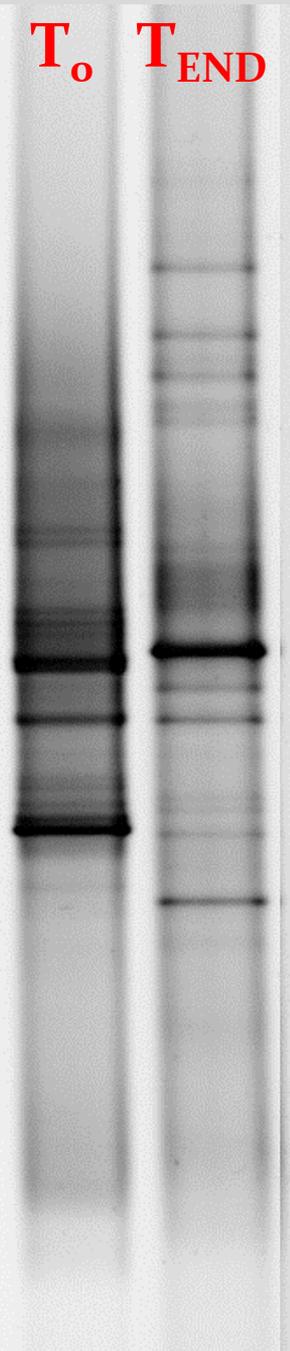
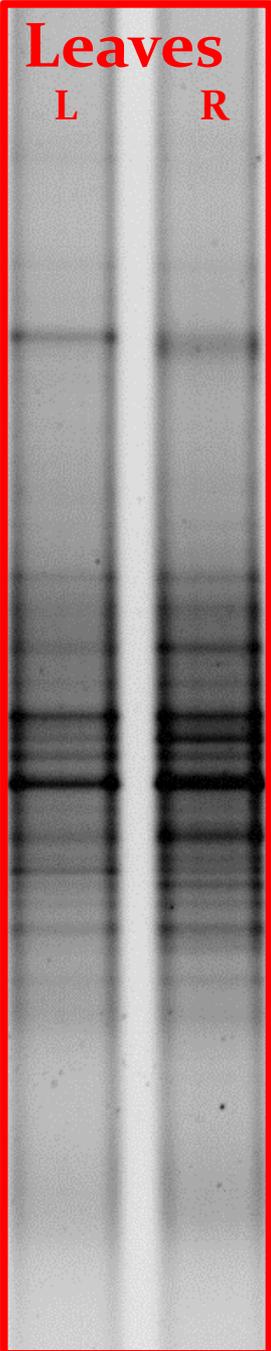
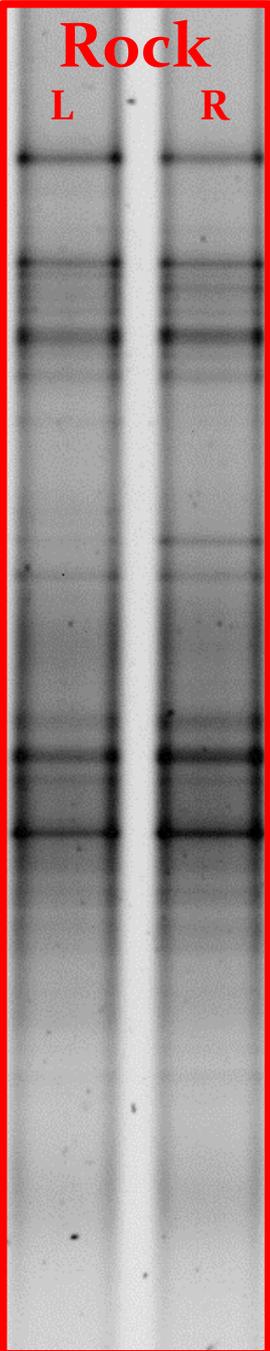
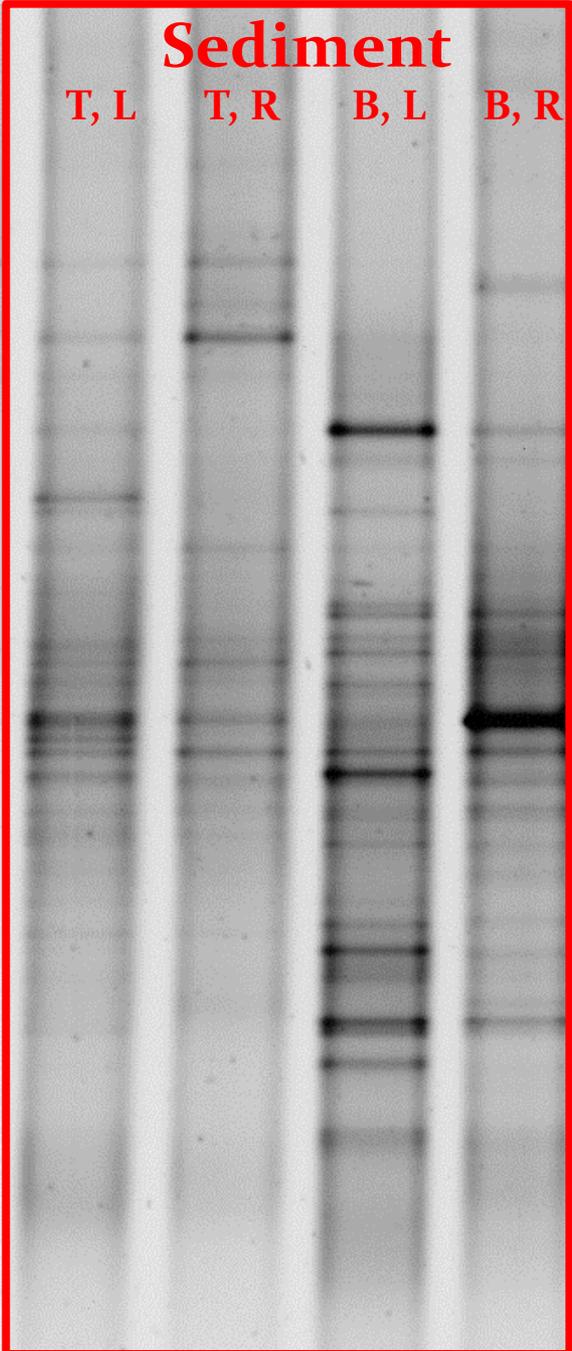


# PCR and DGGE

- What is PCR?
  - PCR stands for Polymerase Chain Reaction. This method is widely used to amplify targeted genes.
- What is DGGE?
  - DGGE stands for Denaturing Gradient Gel Electrophoresis. This approach provides quick fingerprinting profiles for microbial communities (presence/absence and relative abundance).

# PCR Products

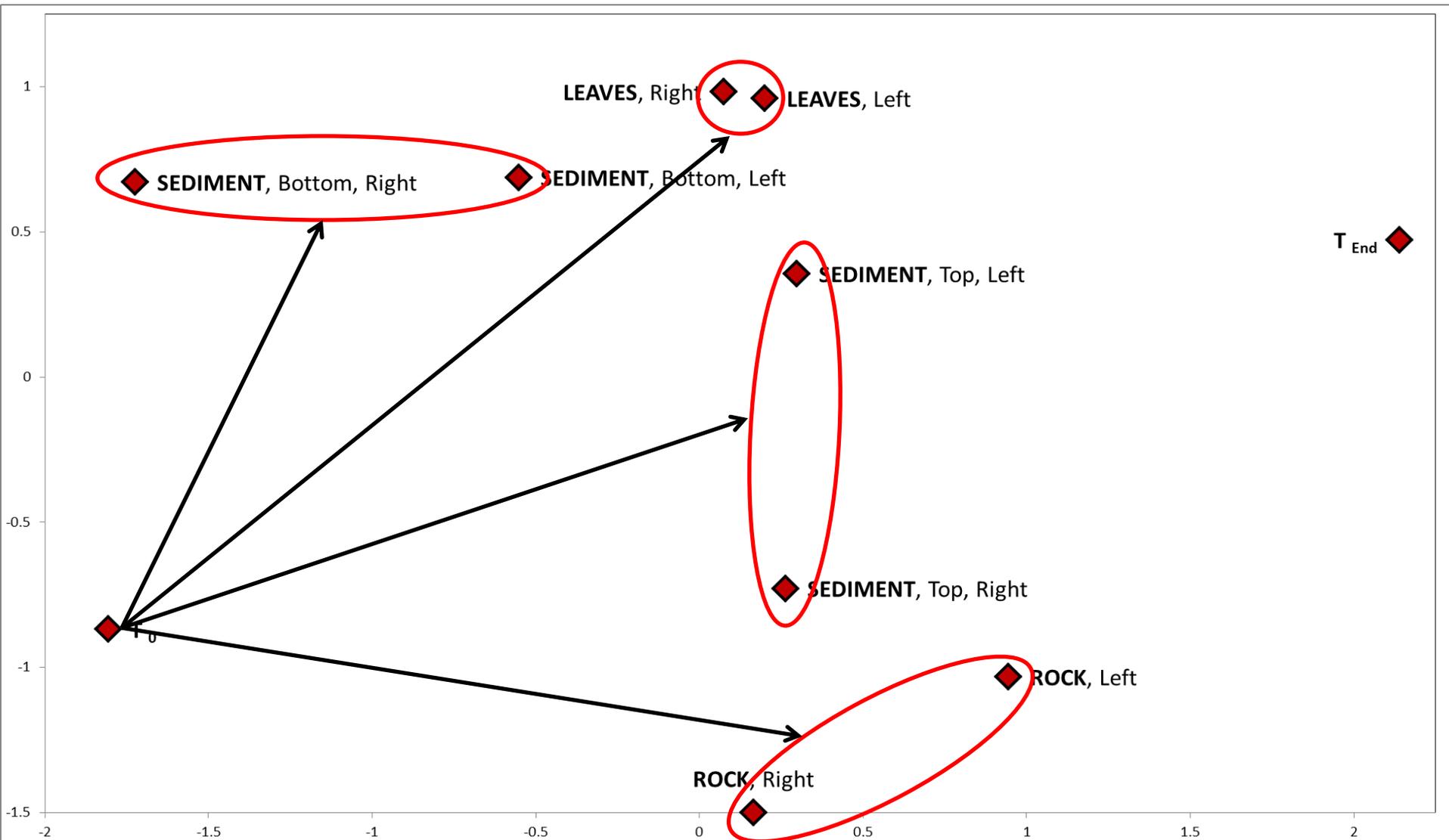




**DGGE**

- Key  
T - Top  
B - Bottom  
L - Left  
R - Right

# NMDS analysis of bacterial fingerprints



# Discussion

- The data supported our hypothesis: Different substrates enriched distinct bacterial communities. For example, bacteria found in aerobic conditions differed from those found in anaerobic ones.
- Questions for further investigation:
  - Why did the clay interfere with the PCR reaction?
  - What is the impact of temperature on the bacterial colonies? Temperature in the aquarium could run as much as 12°C higher than natural stream conditions.

# In the Classroom

- Created three lessons using bacteria and the aquarium.
- Students will learn cultivation techniques and hypothesize which type of substrate they think will show the most bacterial growth based on their knowledge of bacteria and its role in nutrient cycling.
- Students will streak plates to cultivate bacteria and make observations about the phenotypic features of microbes (abundance, size, shape, color, etc.)

# Acknowledgements

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