Microbial Diversity Across Landscape Units In The McMurdo Dry Valleys, Antarctica

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Introduction

The McMurdo Dry Valleys of Antarctica (MCM) comprise the largest ice free area in Antarctica and are considered to be the driest and coldest desert on Earth. The landscape of the MCM consist of a mosaic of bare soils, perennially frozen lakes, ephemeral streams and glaciers . Despite the harshness of the environment, microorganisms persist in soils, lakes, streams and on glacier surfaces. Preliminary evidence implies that microbial diversity in MCM is extremely low (e.g. Priscu et al. 1999) allowing relationships between ecosystem function and diversity to be characterized more readily than is possible in more diverse ecosystems.

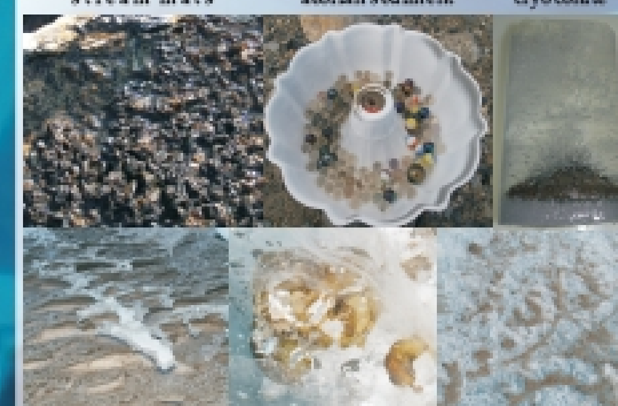
Strong katabatic winds that transport sediment composed of sand (50 to 1000 μm) and silt/clay (< 50 μm) is an important transport feature of MCM environment (Lancaster 2002). Wind is believed to be the main process redistributing organic matter in the MCM soils and for depositing sediment and associated organic matter to the permanent ice surface of the lakes (Fritsen et al. 2000). Studies of lake-ice microbial assemblages (Priscu et al. 1998, Gordon et al. 2000) and cryoconites (Christner et al. 2003) within the MCM have shown that the stream mats provide the biological seed to these environments (Priscu and Christner 2004). Recent studies also revealed the importance of wind dispersal of invertebrates in MCM soils (Nkem et al. 2006).

Despite the apparent importance of wind dispersal as a factor controlling the distribution and diversity of life in the MCM ecosystem no comprehensive research effort has been made to study the role of aeolian processes on microbial diversity and function in polar desert ecosystems.

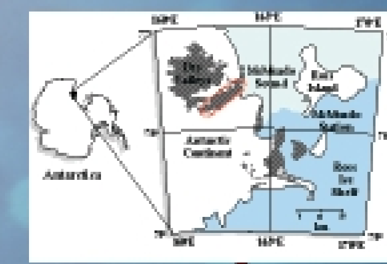
Materials & Methods

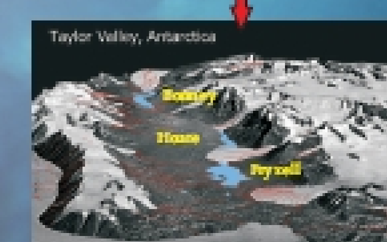
- collection of samples from soils, cryoconites, glacier ice, glacier sediment, lake sediment, lake and stream mats and aeolian sediment
- Diversity of photosynthetic microorganisms using spectral fluorescence of chl-a
- Elemental stoichiometry
- Prokaryotic diversity assessment using DGGE
- Statistical evaluation: Cluster + Redundancy analysis

stream mats aeolian sediment cryoconite



glacier sediment lake mats lake sediment





Research Questions

- **Is the biodiversity among the landscape units of MCM (glaciers, lakes, streams and soils) controlled by aeolian transport of organisms?**
- **Do particulate C:N:P ratios change across landscape units in MCM?**
- **Are stream and lake microbial mats an exception where bulk liquid water during the summer allows growth rates that exceed the rate of aeolian dispersal**

Diversity is controlled by habitat selection

aeolian sediment
soils
glacier and lake sediments
cryoconites
lake and stream mats
lake water

Diversity is controlled by physical processes

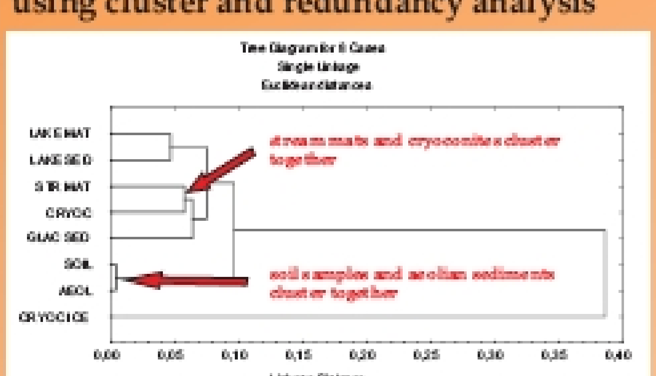
Results

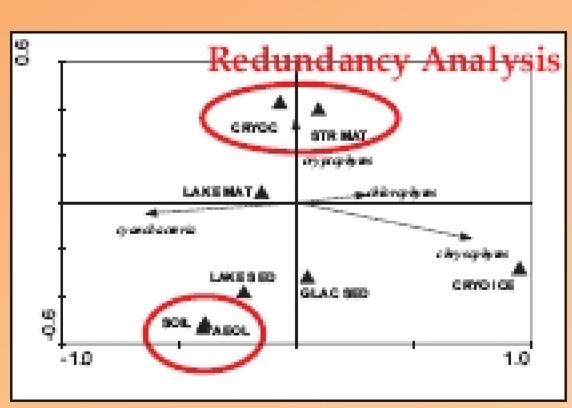
The diversity of photosynthetic microorganisms

Determined using spectral fluorescence of chl-a: allow us to place organisms into functional groups (cyanobacteria, cryptophytes, chrysophytes and chlorophytes) based on assessory pigment distribution. Similarity in the distribution of these functional groups among different MCM environments was determined using cluster and redundancy analysis

Fluoroprobe

http://www.bbe-moldaenke.de



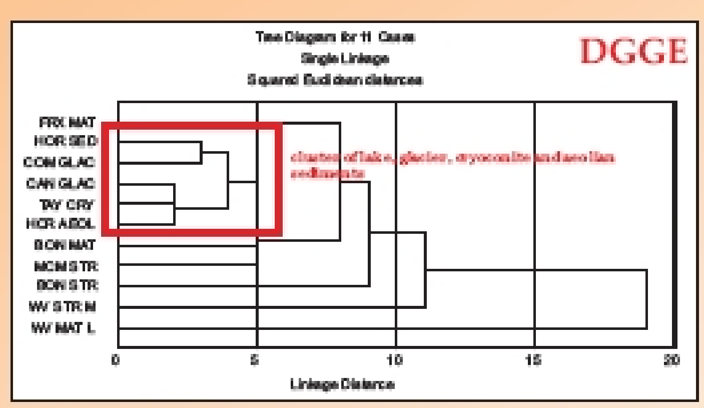


Prokaryotic diversity

PCR product amplified using 16 S primers was separated using Denaturating gradient gel electrophoresis (DGGE)
Cluster analysis used to compare samples from different habitat and localities

Legend:

LAKE MAT = lake mats
LAKE SED = lake sediment
STR MAT = stream mats
CRYOC = cryoconite sediment
GLAC SED = glacier sediment
SOIL = soils
AEOL = aeolian sediment
CRYOC ICE = cryoconite ice
FRX MAT = mats from lake Fryxell
HOR SED = sediment from lake Hoare
COM GLAC = surface sediment from Commonwealth glacier
CAN GLAC = surface sediment from Canada glacier
TAY = cryo = cryoconite sediment from Taylor glacier
HOR AEOL = aeolian sediment collected around lake Hoare
BON MAT = mats from lake Bonney
MCM STR = mats from stream around McMurdo station
BON STR = mats from streams around lake Bonney
WV STR M = mats from streams in the Wright Valley
WV MAT L = mats from ponds and lakes in the Wright Valley



Conclusions

- **Similar microorganisms inhabit soils, aeolian sediments, sediments on the lake ice and glacier surface inferring that these systems may be linked via wind dispersal**
- **Resemblance in photosynthetic microbial composition among cryoconite sediments and stream mats**
- **DGGE data show similar diversity patterns across environments supporting the notion that wind dispersion plays an important role in the distribution of microorganisms in the MCM Dry Valleys.**

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