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Temporal Dynamics of an Antarctic Riparian Zone Microbial Community

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Introduction

The environment in the McMurdo Dry Valleys, Antarctica, is too extreme for most life, but the wetted margins or riparian zones along glacial streams provide the proper nutrients and moisture for a diverse microbial community. Due to the steep environmental gradient across the riparian zone, communities vary with respect to their position in the zone. We therefore expected that the response of communities to hydrological and biogeochemical changes would also vary. We monitored the diversity of bacterial communities within the wetted sediments along a transect of Green Creek in the Taylor Valley during 8 weeks of the 2005-2006 austral summer. We predicted that diversity would increase with temperature, but perhaps be limited by extreme discharge or disturbance events.

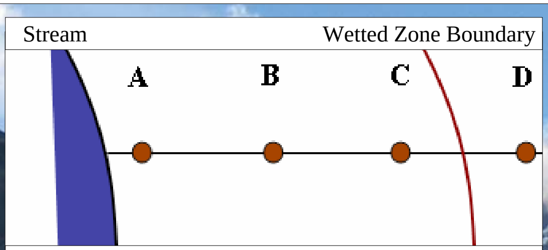

Fig. 1. Sampling scheme across riparian zone transect

Table 1. Physical and biogeochemical characteristics of Green Creek transect from January 2005.

Site	distance from water (m)	soil moisture (%)	pH	Conductivity (µS)	nitrate (µg/g soil)
A	0.2	23.5	7.9	37	0.07
B	2.1	13.1	8.8	130	0.18
C	3.8	6.3	9	118	1.76
D	4.4	2.7	9.6	178	1.1

Methods

- Samples (8) from four sampling positions perpendicular to the stream were collected every 3-7 days during December and January 2005-2006 from Green Creek, located in the Fryxell basin approximately 0.5 km from Canada Glacier.
- The four sampling positions along the transect include three within the riparian zone and one outside (see sampling scheme in Figure 1).
- Community 16S rRNA genes were PCR-amplified from genomic DNA using bacterial-specific primers.
- Denaturing gradient gel electrophoresis (DGGEs) was used to monitor community diversity at each site during the sample period. DGGEs were performed on duplicate DNA extractions.

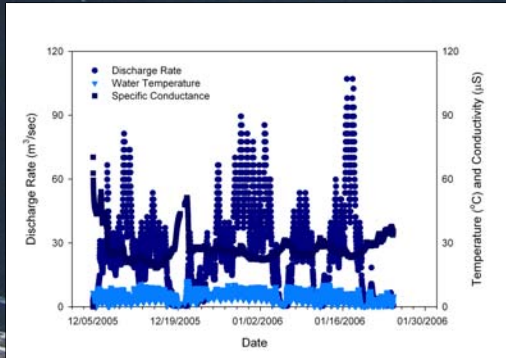

Fig. 2. **Stream data for GreenCreek during the 2005-2006 austral summer**. Measurements were taken every 15 minutes over the two month period, during which time discharge rates fluctuated greatly.

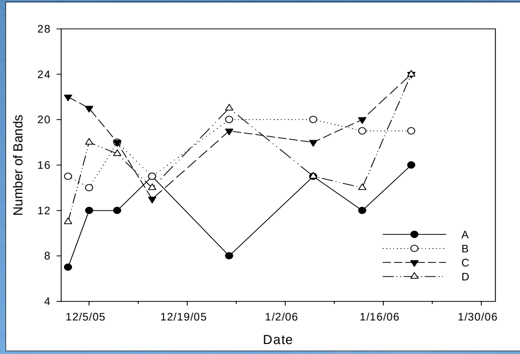

Fig. 3. **Temporal changes** in the community diversity during the sampling period along transect sites A-D. Variations among the sites were similar throughout the sampling period, except at site A, which was submerged during much of the study.

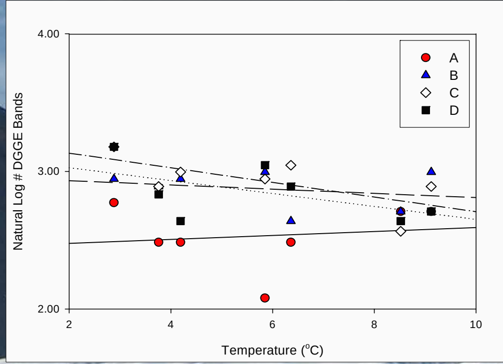

Fig. 4. Metabolic theory (Brown et al. 2004) predicts that **community diversity** should increase with **temperature**, however little work has been done to investigate this relationship at low temperatures. In the Green Creek transect, community diversity at the C and D sites was observed to decrease with increasing temperature (r^2 = 0.45 and 0.35, respectively). Alternatively, the negative correlation could be due to increased discharge or disturbance.

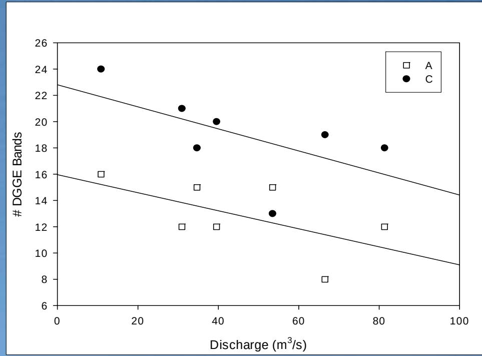

Fig. 5. **Community diversity** decreased with **stream discharge**, especially at sites A and C (r^2 = .35 for both). These data suggest that increased discharge may represent disturbance in the system and limit diversity.

Conclusions

We might expect that metabolic theory holds for the biotic communities near Green Creek, however our data shows that the disturbance due to stream discharge variability has more effect on the communities than temperature. Stream flow affects sites B-D less than A because A is more directly affected by the water level; in fact, on some sample days the site was under water. The reason for a more unstable community at this location can be explained by disturbance theory (Townsend et al.), which treats diversity as a function of instability of environment caused by fluctuating hydrologic level, in this case quantified by stream discharge. While aspects of temporal stream variation such as conductivity had few analyzable effects across the transect, data collected for discharge corresponded well with biotic diversity in terms of intermediate-disturbance hypothesis. The hypothesis predicts that both too much and too little disturbance will have negative effects on community diversity.

References

Brown et al. 2004. Toward a metabolic theory of ecology. *Ecology*. Volume: 85 (7), pp. 1771-1789.

Townsend et al. 1997. The Intermediate Disturbance Hypothesis, Refugia, and Biodiversity in Streams. *Limnology and Oceanography*. Volume: 42, No. 5, pp. 938-949.

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