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Invertebrate Diversity in Taylor Valley Soils and Sediments

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Explaining how ecosystems function across variable landscapes will require knowledge of biodiversity patterns. In particular, biodiversity studies of soils and sediments will help in understanding the linkages between ecosystem processes in both of these habitats (Freckman et al. 1997). Soils and sediments are domains for ecosystem processes such as decomposition and trace gas exchange. There are few studies, however, that have compared abundance and diversity of organisms in adjacent soils and sediments (Freckman et al. 1997). The goal of this study was to increase understanding of how the biotic communities involved in ecosystem processes are organized within an important feature of the Antarctic dry valley landscape—a stream channel and the soils and sediments surrounding it.

Dry valley streams, which flow for 6 to 10 weeks during the austral summer, are links between glaciers, lakes, and soils (Lyons et al. 1998). Glacial meltwater is carried by streams to lakes, and nutrients and salts are accumulated by the water and transported throughout the stream channel. The hyporheic zone is the area of stream sediments and adjacent soils where subsurface stream flow occurs. The hyporheic zone of dry valley streams extends out laterally, rather than deep below the stream, due to a shallow permafrost barrier. Water in the hyporheic zone accumulates salts and nutrients through weathering and atmospheric deposition. At the same time, nutrients may be lost from stream water by microbial uptake, and salts are deposited in soils and sediments when stream waters evaporate or freeze in the hyporheic zone. Inputs of nutrients and water to dry valley lakes are determined by the extent and balance of these stream and hyporheic zone interactions.

We compared invertebrate abundance and diversity in samples collected during the austral summer, 1997-1998, from the soils, benthic sediments, and hyporheic zone of the Harnish/Von Guerard Stream network (Taylor Valley, 77°S 163°E). This stream is approximately 5 km long, has an elevation change of 500 m, and empties into Lake Fryxell. Samples were collected from the top 10 cm along upstream, midstream, and downstream transects (32 m long) beginning in the sediments in the center of stream flow and extending through the channel to the soils. Nematodes, rotifers, and tardigrades were extracted and enumerated, using a sugar flotation/centrifugation technique (Freckman and Virginia 1993), and were the only invertebrates observed in these samples. Three nematode species were found (*Plectus antarcticus, Eudorylaimus antarcticus,* and *Scottnema lindsayae*).

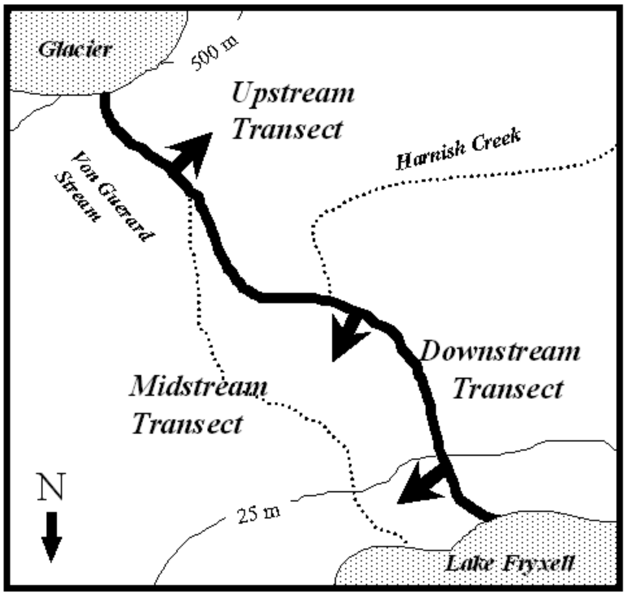

Figure 1a

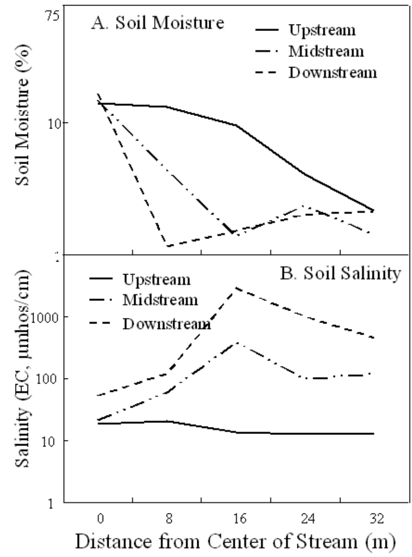

Figure 1b

Figure 1a. Schematic of Von Guerard/Harnish Stream network showing the locations of the transects sampled.

Figure 1b. Moisture content (A) and salinity (B) of soil and sediment samples by location in the stream channel.

At the time of sampling, surface water was generally visible in the center of the stream channel in a 0-5 m wide stream. Moisture content declined moving out from the center to the adjacent soil system (0 to 32 m) (figure 1A). Salinity of sediments was very low in the center of the stream (0 m) (figure 1B). Samples taken 16 m from the stream center in midstream and downstream transects were the most saline. Beyond this hyporheic zone/soil transition, soils are outside the range of direct influence of stream water and associated salts and are therefore drier and less saline.

Nematodes, rotifers, and tardigrades assembled into distinct communities depending on distance from the center of stream flow and the location along the slope, upstream or downstream. Abundance and diversity of invertebrates were associated with the moisture content and salinity levels at the different locations on the stream channel. Where stream waters were flowing, at the center of the channel, the low salinity and high moisture content of the sediments were associated with communities having a high abundance of tardigrades, rotifers, and the nematode species *Plectus antarcticus* and *Eudorylaimus antarcticus* (table, figure 2).

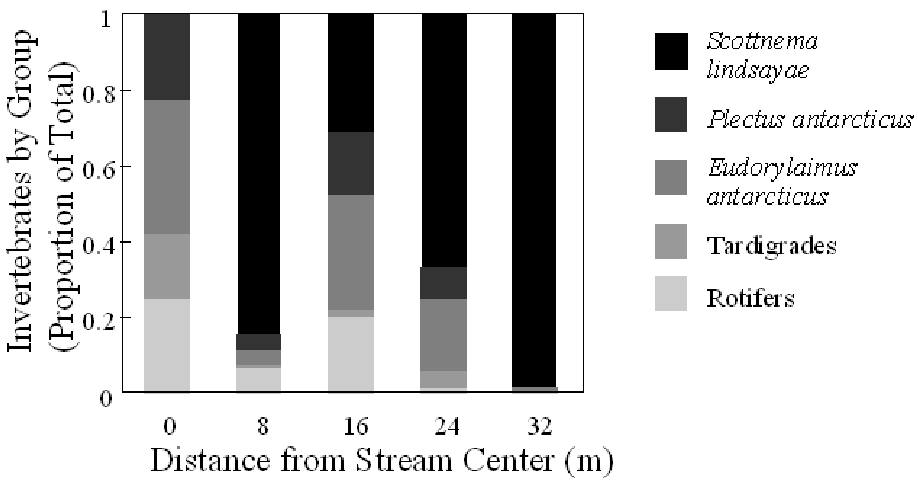

Figure 2. Invertebrate community composition along transects (all three transects are combined

Total invertebrates (nematodes, rotifers, tardigrades) per kilogram of sample at locations along transects crossing a Taylor Valley stream channel.).

Distance from Center of Stream (m)	Total # of Invertebrates
0	3320
8	1596
16	292
24	773
32	1032

The poorest habitat for invertebrates was in the hyporheic zone/soil transition (16 m), where high salinity was associated with reduced organism abundance, although communities were still diverse (table, figures 1 and 2). Outside of the stream, in the dry soils, invertebrate abundance was similar to that of the stream sediments at 0 and 8 m, but the soil communities were the least diverse (table, figure 2). Soils were dominated by a single species of nematode, *Scottnema lindsayae* (figure 2). In the downstream transect, no invertebrates were found at 16, 24, and 32 m, possibly due to excessive salinity (figure 1B).

In this study, the strong contrast between stream channel sediments and soils showed how salinity and moisture both affect the diversity and abundance of invertebrates within this feature of the dry valley landscape. Salinity affected invertebrate abundance, but not diversity. All organisms have increased density with increased moisture except the nematode *Scottnema*, which declines with increased moisture. *Scottnema* abundance is highest in the dry soils, and this organism may be adapted to specialization in the harshest (most arid) environments. Alternatively, the preferred food source for this microbivore may be more abundant in the soils. This research supports the results of previous studies, which have shown that nematodes are absent in high salinity dry valley soils (≈1,000 µmhos/cm), and there is a positive relationship between soil moisture and abundance of *Plectus* and *Eudorylaimus* (Freckman and Virginia 1997; Powers et al. 1998).

In temperate and tropical streams, the diversity of organisms may be related to many complicated factors, including biogeography, stream characteristics, and types of local vegetation (Covich 1988). In this Antarctic stream channel, the simplicity of the ecosystem allows us to draw conclusions about how diversity compares in soils and sediments based on observations of basic habitat properties such as moisture and salinity. We have shown that invertebrates in this Antarctic stream channel are in distinct communities and environments depending on location in the stream. Studies of transitional habitats or across well-characterized environmental gradients, like the stream/soil interface of this study, coupled with measurements of ecosystem processes, should help to resolve questions about the importance of biodiversity in ecosystem functioning.

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