

## **Linking Soil Organic Carbon Source, Microbial Diversity, and Mycorrhiza Abundance to Ungulate Presence in Kruger National Park, South Africa**

Aboveground and belowground biota are interlinked through their effects on community level processes (Bardgett *et al.* 1998; van der Putten *et al.* 2001; Bardgett and Wardle 2003; Wardle *et al.* 2004). Evidence is increasing that large mammalian herbivores substantially influence soil organisms and their activities, and this may significantly influence plant productivity and community structure (Bardgett and Wardle 2003; Wardle *et al.* 2004). Grazing and browsing can directly and indirectly affect the soil biota and ecosystem productivity by modifying feedbacks between dominant plants and belowground properties (Carline and Bardgett 2005) either positively or negatively (Wardle *et al.* 2004). Direct effects include selective foraging of plant material and soil and vegetation trampling. Indirect effects include nutrient recycling via herbivore excretions and improvements in the decomposability of grazed plants (McNaughton *et al.* 1997; Denton *et al.* 1999; Bardgett *et al.* 2001; van der Putten *et al.* 2001). Positive effects of herbivory are predicted for ecosystems with high soil fertility and high rates of consumption by herbivores (Bardgett and Wardle 2003). In contrast, negative effects of herbivory characterize unproductive ecosystems with low plant consumption rates (Bardgett and Wardle 2003).

The effects of browsing and grazing on the aboveground community have been studied abundantly, but linkages to the soil microbial community have been studied relatively little. Much research has focused on the effects of both fire and fauna on the aboveground biota, on the nutritional content and digestibility of the aboveground portions of plants, and on the nutritional content of herbivore fecal matter. Limited attention has been given to the belowground community.

We are interested in how grazing and browsing alter the carbon inputs, diversity of soil microbes, and the abundance of arbuscular mycorrhizal fungi (i.e., Glomeromycota; see Schussler *et al.* 2001) in Kruger National Park (KNP), which supports some of the largest concentrations of free-roaming ungulates in Africa. We hypothesize that herbivory induces a positive feedback on vegetation, mediated through effects on soil microbes and nutrient cycling

in savanna habitats of the KNP. We are investigating two sites, Makhohlola in northern KNP (25°15'50''S, 31°54'50''E) and Shingwedzi in southern KNP (23°06'30''S, 31°23'58''E). Each site consists of a long-term fenced plot (exclosure), which completely restricts entry by large herbivores, and an unfenced plot, which allows large herbivore movement within the plot. We are assessing: 1) the relative contribution of grasses versus shrubs and trees to soil organic matter under different browsing and grazing regimes, 2) the effects of grasses versus trees on soil microbial diversity in grazed and browsed savanna and within exclosures, and 3) the effects of grasses versus trees in grazed and browsed savanna and within exclosures on integrated, long-term mycorrhizal fungus activity in the soil. Such research has never been conducted in KNP and afforded our fellows and teachers a unique opportunity to work in an ungulate-dense environment, conducting novel research and intimately learning about components of the African savanna.

The South Africa SMS team piloted this project in July 2009 along with two of University of Pretoria's graduate students. Together we collected a total of 60 soil samples from the Makhohlola and Shingwedzi research sites. Both areas are characterized as dense to moderate tree savannas with basalt soils. The leaf litter atop the cored point was collected separately, as were fine roots removed from each soil core. Soil samples were then exported to the University of Miami for laboratory analyses. We are currently analyzing the total soil organic carbon, C<sub>4</sub>/C<sub>3</sub>, total nitrogen, and <sup>15</sup>N enrichment with an elemental analyzer connected to an isotope ratio mass spectrometer. The microbial diversity of soils samples is being analyzed using DNA pyrosequencing, and mycorrhizal fungus activity is being analyzed using glomalin as a proxy for hypha abundance.

Photos of this research project can be viewed in the images section of the South Africa link on our SMS website.

## **References**

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