Utilizing the Trophic Interactions of Nematodes as Indicators of Change in Soil Biota Associated with the Loss of *Bouteloua eriopoda* Grasslands

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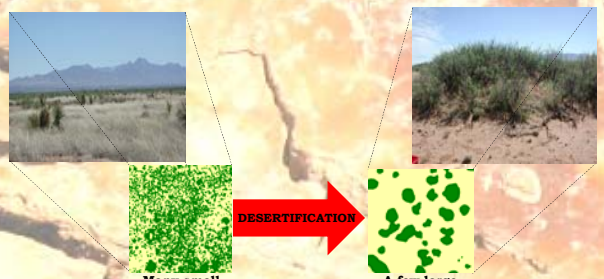
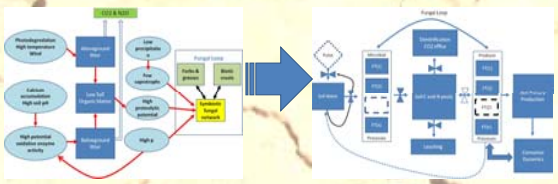
Introduction

A theoretical framework of desertification has been developed on the Chihuahuan Desert within the Jornada Basin that is part of the Long Term Ecological Research Network (LTER). Within this framework, a change in dominant processes through time and patterns across space result in the nonlinear expansion of shrubs across landscapes. Spatial variation in distribution of gap size changes from high connectivity of vegetated patches (many small gaps) in grasslands to low connectivity of vegetated patches and increases in bare ground (mostly large gaps) in shrublands; the importance of wind and water erosion increase as gap size increases. With increased connectivity, increased retention also occurs where soil biotic interactions should be working at a high degree within continuous vegetation.



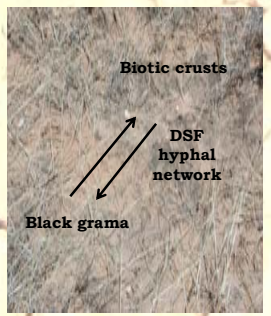
•Emergent research has shown that a whole suite of soil organisms may play integral roles within arid systems and have led to the development of models* that incorporate soil biota and their interactions to ecosystem functioning.



***See the Threshold-delay nutrient dynamics (TDND) Collins et al. 2008; a modification from Ogle & Reynolds 2004 and Reynolds et al. 2004.**

•Biocrusts that serve as an interface between the soil and atmosphere have been described as a "mantel of fertility" because they fix varying amounts of C and N. Historically, bare soil patches and vegetated areas were thought as independent from one another. Accumulating evidence suggests that connectivity between bare soil patches and vegetated areas may occur via hyphal networks that dominate decomposition and N transformation processes through symbiotic associations with producers in a "fungal loop".

•Emerging research has found the existence of at least 7 different species of dark septate fungi (DSF) within *Bouteloua eriopoda* . Because of the ability of DSF's to manage and recycle carbon for the survival and stability of plant communities, as well as inhabiting multiple plant species, this microbe may provide an unexplored source of connectivity between plant species in a single community.



Within black grama grasslands, increased connectivity occurs at the patch scale but also between soil biotic crusts via hyphal networks that:

•Manage N availability and transformations

•Transport and manage C

•Increase soil aggregation and stabilization

•Increase infiltration and water availability

Study Site

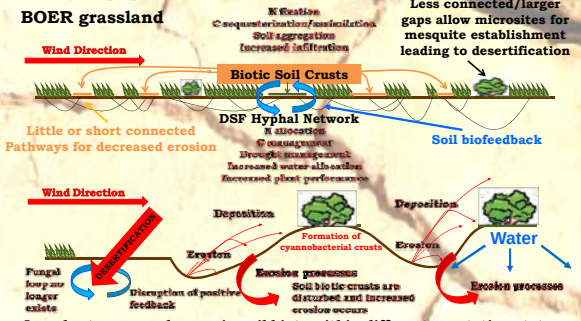
In this study, we are concerned with the upland grasslands that are dominated by black grama (*Bouteloua eriopoda)* Torrey where mesa dropseed (*Sporobolus flexuosus)* Rydb. and various threeawn species (Aristida spp.) sub-dominate that occur on deep loamy sand soils. Over the past century, large areas of the upland grasslands have been converted to shrublands that are dominated by honey mesquite (*Prosopis glandulosa).* To test the hypothesis that increased connectivity results in a more structured, homogeneous soil biotic community, samples were taken and compared across a desertification gradient that involved a remnant black grama grassland, mesquite duneland, and the ecotone between the two vegetation states as described by Bestelmeyer et al. (2006) and was used as the transition zone between the two end members.

Sample locations all occur on the Rio Grande alluvium parent material of the Camp Rice Formation, Fluvial Facies. Wind erosion has been the main sources of sand accumulated on down-wind piedmont slopes and bedrock areas.

The BOER (grassland) sites occur on the eroded Alluvial Plain landform with alluvial plain sediments and exhumed or shallow pertrocalcic horizons of the La Mesa geomorphic surface . The MESQ (mesquite) site occurs on the Alluvial Plain Wind Worked landform consisting of low-relief surfaces of relict fluvial fans of the ancestral Rio Grande. Sediments have been wind-worked and have produced deflational and depositional features with an east-northeast orientation. The ECO (ecotone) sites are a combination of the two soil types

Study Objectives

Based upon pilot study results, we hypothesize that encroachment of mesquite into black grama dominated grasslands has caused a disruption to the positive feedback loop between soil biotic crusts, DSF, and black grama (we collectively call this feedback-loop a soil biofeedback) where a loss of connectivity has occurred and through broad-scale drivers (wind and water erosion) has perpetuated desertification.



•In order to assess changes in soil biota within different vegetation states, this study used nematode diversity and community structure as a proxy for relative soil biotic functional group change. Community structure of nematodes allows for future analysis at the molecular level by aiding in the development of specific primer sets that will provide greater resolution to differentiate changes in soil biota and nematode diversity.

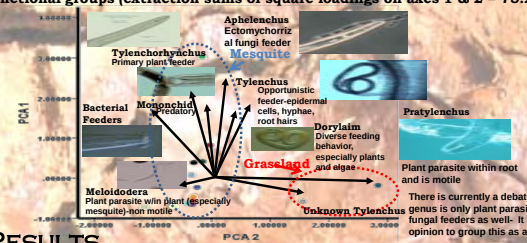
•Utilizing the specificity in feeding behaviors, this study asserts that food web theory plays an integral role in regulating productivity, stability, and structure through the mechanisms of soil biofeedbacks.

Ultimately, this study of nematode diversity will be used to address two main questions:

1) How does the soil biotic consortia of a distinct vegetation state (black grama grasslands vs. mesquite shrublands) change with increased desertification and can this be captured by examining nematode trophic structure?
2) How are these changes in nematodes community structure and subsequently soil biotic communities affected by connectivity of vegetation patches, fungal networks, and soil biotic crusts?

Justification

As the PCA indicates, there are large separations between the trophic groups of nematodes within the two vegetation states and indicates differences in soil biota functional groups (extraction sums of square loadings on axes 1 & 2 = 75.281).

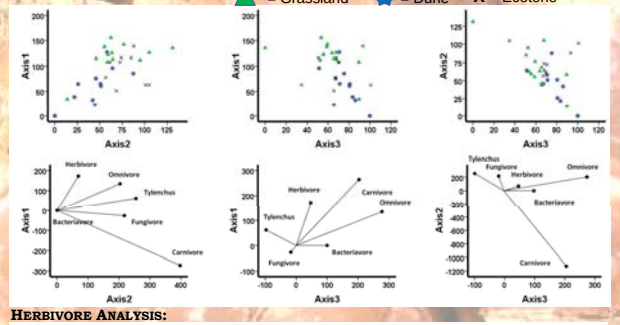


There is currently a debate whether this genus is only plant parasites or includes fungal feeders as well- It is our expert opinion to group this as a fungivore

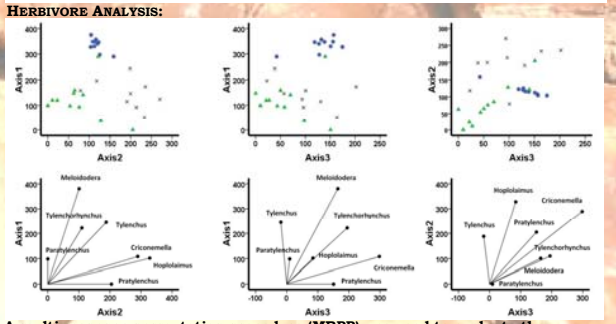
Results

DCA results show that nematode community diversity differs amongst each vegetation type within our desertification gradient. Detrended Correspondence Analyses (DCA) were performed on the different trophic specialists identified within samples and on the different herbivorous nematodes identified down to genus.

Trophic Analysis: = Grassland = Dune X = Ecotone



Herbivore Analysis:



• A multi-response permutation procedure (MRPP) was used to evaluate the differences in nematode community structure for both nematode groupings using each individual "species" DCA score from each of the three axes. The MRPP results in a p value analogous to a significance test. In both analyses, nematode community structure was significantly different among each vegetation state except for the nematode communities found in the dune and ecotone trophic analysis.

Diversity Analysis:

Herbivores Analysis

Simpson's Diversity Index (D)	
Dune	0.39512
Ecotone	0.650122
Grassland	0.359683
Overall	0.4554

Shannon Index (H)	
Dune	0.6498
Ecotone	1.239
Grassland	0.359683
Overall	0.4554

Herbivorous nematode diversity highest in Ecotone that is homogeneously distributed across the landscape

Trophic Analysis

Simpson's Diversity Index (D)	
Dune	0.43375
Ecotone	0.603178
Grassland	0.445625
Overall	0.4843

Shannon Index (H)	
Dune	0.77225
Ecotone	1.106
Grassland	0.767083
Overall	0.861

Overall nematode diversity is highest in ecotone and is dispersed more evenly across the landscape

• The dune and grassland vegetation states have very distinct and significantly different nematode communities, where the number of Paratylenchus found within the grassland samples indicate a possible parasitic infection rate that may be causing top-down pressure on the remnant patches of black grama.