An Exploration of Soil Movement Effects on Leaf Litter Decomposition in a Chihuahuan Desert Grassland

Daniel B. Hewins[1], Heather L. Throop[1] , Steven R. Archer[2], Greg S. Okin[3]

[1] Biology Department, New Mexico State University, Las Cruces, NM 88003

[2] School of Natural Resources, University of Arizona, Tucson, AZ 85721

[3] Department of Geography, University of California Los Angeles, CA 90095

Introduction

- Encroachment by woody shrubs has been documented in many of the worlds drylands.
- Shrub encroachment may be accompanied by a loss. This shift in vegetation alters patterns of soil erosion by wind and water.
- Models of decomposition are not particularly accurate in predicting decomposition in arid lands, because there are unique drives of decomposition that have yet to be explored. At present, however, these generally models under-predict decay in arid systems.
- Recent studies suggest that additional drivers of decomposition may operate in drylands. These drivers include photodegradation from UV light and soil deposition. Soil deposition may enhance litter decay by causing physical damage to litter or provide altering the microclimate for decomposers.
- The classical decomposition framework (Fig 1)has been expanded (Fig 2) to incorporate unique mechanisms that may be important mediating decomposition in drylands. Though this framework has not been tested explicitly it may explain the inaccuracy of existing decomposition models.
- Our study aims to assess the relationship between soil flux, vegetation cover and decomposition. We expect that grass losses associated with shrub encroachment will allow for increased soil erosion, which will catalyze decomposition.

Classical Decomposition Framework

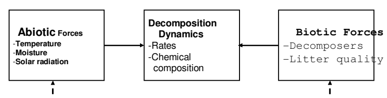

Fig 1. Direct and indirect drivers of decomposition assessed historically (Throop and Archer 2008).

Expanded Decomposition Framework for Drylands

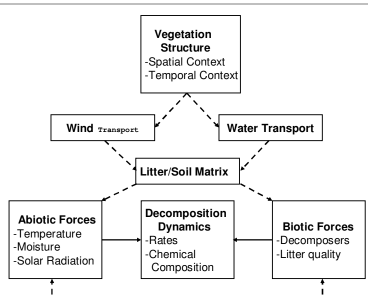

Fig 2. An expanded framework proposed by Throop and Archer (2008). This framework includes erosion-based drivers, and proposes that development of the litter/soil matrix is a key but overlooked component of dryland decomposition. It is hypothesized this matrix is controlled by wind/water transport of soil which, in turn, is controlled by vegetation structure. Furthermore as the litter/soil matrix develops, biotic and abiotic drivers, including UV photodegradation, are strongly mediated.

Methods

- Our study site is located at the Jornada Basin LTER (JRN), Las Cruces, NM, USA. The location of our study is in a mixed Chihuahuan Desert grassland.
- Litter bags were deployed in wind manipulation plots (Fig. 3; Li et al. 2007). These plots consist of upwind treatment plots in which 100 %, 75%, 50% or 0% of grass cover has been removed and downwind, unmanipulated response plots
- Litter material: naturally senescing *Prosopis glandulosa* leaflets were collected at the JRN in the autumn of 2007.
- Mesh litter bags were filled with 2g of air-dried, naturally senescing *Prosopis glandulosa* leaflets. This mass provided a mono-layer of litter, thus limiting leaflet overlap.
- Litter bags were deployed in late April 2008 at the start of the "windy season" at our study site. Bag collections at 0, 1, 3 months have taken place, while 6, 12, 24, 36, and 48 month collections are planned.
- Litter has been analyzed for ash free dry mass loss, % ash (as an index of soil deposition), and C:N content, arthropod sampling and phospholipid fatty acid extraction (PLFA) to assess microbial communities is in progress.

Field Design

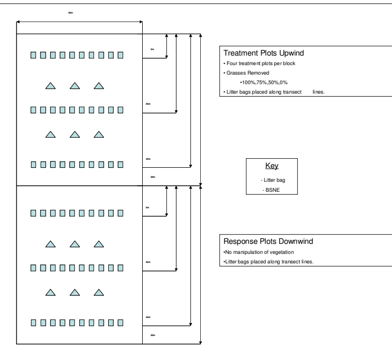

Fig 3. Each field plot is 100m x 25m and has a 50m treatment subplot and 50m response subplot. Within both subplots are litterbag transects at 5m, 25m and 45m. Litter bags have been placed at randomized locations along these transects. There are four different grass removal treatments (100%, 75%, 50%, 0%) and each treatment is replicated three times. Litter bag collections take place on 0, 1, 3, 12, 24, 36, and 48 months.

Preliminary Data

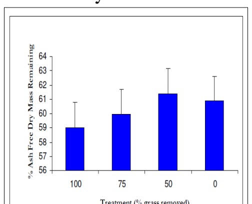

Fig 4. % Remaining ash free dry mass was calculated for the means of the grass removal treatments. Though not statistically significant (P>F= 0.7796, F= 0.3634) there is a trend of mass loss and treatment as shown by the above figure.

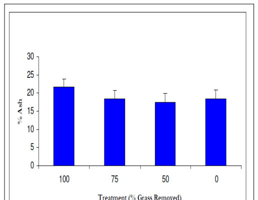

Figure 5. The % ash among plots was analyzed (P>F= 0.5674, F=0.6384) as an index of soil deposition into the bags. Mesquite leaflets collected in the field contain 8% inorganic matter, additional inorganic matter may attributed to soil deposition.

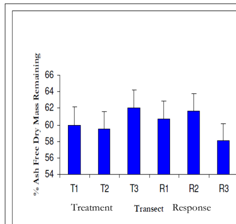

Fig. 6. The ash free dry mass remaining shows no among-transect differences after three months (P>F= 0.7887, F=0.4816). To clarify, the above figures plot responses in transects within field plots. Bars marked "T" are in the upwind treatment half of the plot, while bars marked "R" are in the downwind response half of the plot.

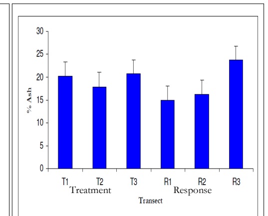

Fig 7. Mean % Ash among transects shows no statistically significant differences (P>F= 0.3085, F= 1.2233) or trend between transects after three months.

Results

After three months, there is evidence of a relationship between vegetation removal, % Ash and decomposition (Figs. 4 & 5). Although there is a correlation, this relationship is still not statistically significant. If this relationship becomes stronger it would suggest that soil deposition facilitates decomposition in arid systems.

Discussion & Future Directions

- To explore the relationship between soil deposition and decomposition further, litter bag collections will continue for remainder the planned 48 month experiment at 6, 12, 24, 36 and 48 months.
- Because data presented here are from the 3 month collections it is not surprising to see a lack of statistical significance. It is, however interesting to see a trend in decomposition and % ash with relation to the grass removal.
- We will also aim to conduct experiments in controlled environments manipulating UV, soil flux and microbial communities.
- The goal of this project is to help untangle a portion of the decomposition conundrum in arid lands and use the results along with results of other studies to aid in the parameterization of specialized drylands decomposition models.
- Understanding the drivers of decomposition in drylands will help us understand how nutrients and carbon are cycling in these changing ecosystems.
- Additional projects that explore influences of vegetation structure and a soil-litter matrix will be conducted at both the Santa Rita Experimental Range and the JRN

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Literature Cited

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