Assessment of Soil Microarthropod Abundance & Diversity Below, Above, and Between the Mt. Saana Tree Line

Guillermo Ortiz & Tiffany Gibbs

New College of Interdisciplinary Arts & Sciences, Arizona State University – West Campus, Phoenix, AZ 85069

Introduction:

- The rate at which temperatures in the Arctic change is faster than in any other place in the world.
- One of the products of climate change in the Arctic is the tree line moving higher because higher elevations that normally are cold, become warmer and are more favorable for tree growth.
- Microarthropods recycle nutrients back into ecosystems and play a vital role in making nutrients available for more vegetation.
- As you move up in elevation the soil is not developed like soil from lower elevations.
- A good indication of soil health is the amount of microarthropods in the soil that work to reinstitute nutrients back into the soil

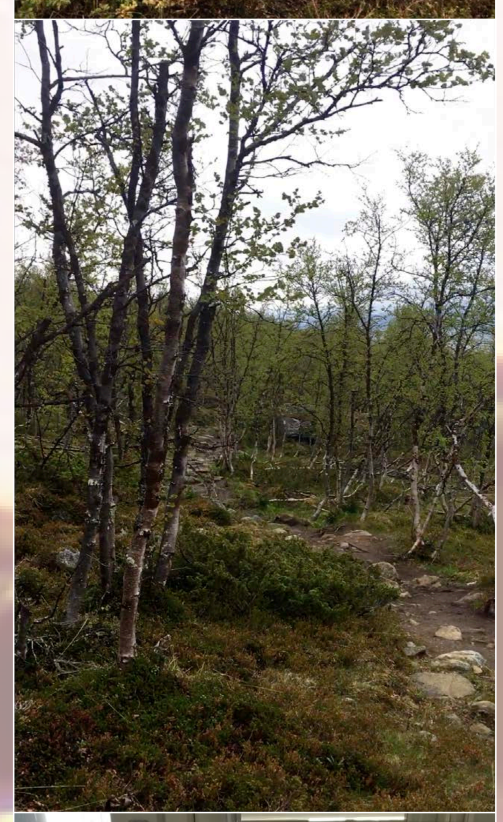
Research Questions and Hypotheses:

Question: In the Arctic, where climate change is occurring rapidly, how does microarthropod diversity and abundance change as you move further up in elevation?

Hypothesis: Since soil development decreases with higher elevations, it is expected that soil microarthropod taxa abundance and diversity will decrease above the tree line.

Methods:

1. We collected 3 soil core samples, below the treeline, at the treeline, and above the treeline on Mt. Saana.
2. The temperature above-ground at each sample site along with soil temperatures at 6cm and 13 cm deep were recorded.
3. A Tullgren Funnel was constructed using cardboard, plastic funnels, reflective metal cans, gauze, small incandescent light bulbs, small plastic vials, and ethanol.
4. The soil core samples were then weighed prior to being inserted into the Tullgren Funnel.
5. Once inserted, the soil samples were dried by using a small incandescent light bulb that was made brighter every 12 hours.
6. Small plastic vials filled with ethanol were attached to each funnel where microarthropods would be collected and preserved.
7. After 4 days, the microarthropods in each sample were identified by taxa, counted, transported and preserved in a labeled vial.
8. The dried soil samples were then weighed and percent water content was calculated. The soil pH was calculated by mixing 10 g of the dried soil sample and 20 mL of deionized water and allowing them to sit for 1 hour prior to testing soil pH



Results:

We found microarthropod taxa abundance and diversity decreases as the elevation increase above the tree line. The Below Treeline samples had the greatest abundance and diversity of soil microarthropods, while the Above Treeline samples had the lowest abundance and diversity of microarthropods, and the At Treeline samples were in between (Fig. 1). The Below Treeline elevation samples were found to be the lowest in soil pH, highest in percent water content, and warmest in above-ground temperature (Table 1). The Above Treeline elevation samples were found to be the highest in soil pH, lowest in percent water content, and coldest in above-ground temperature (Table 1).

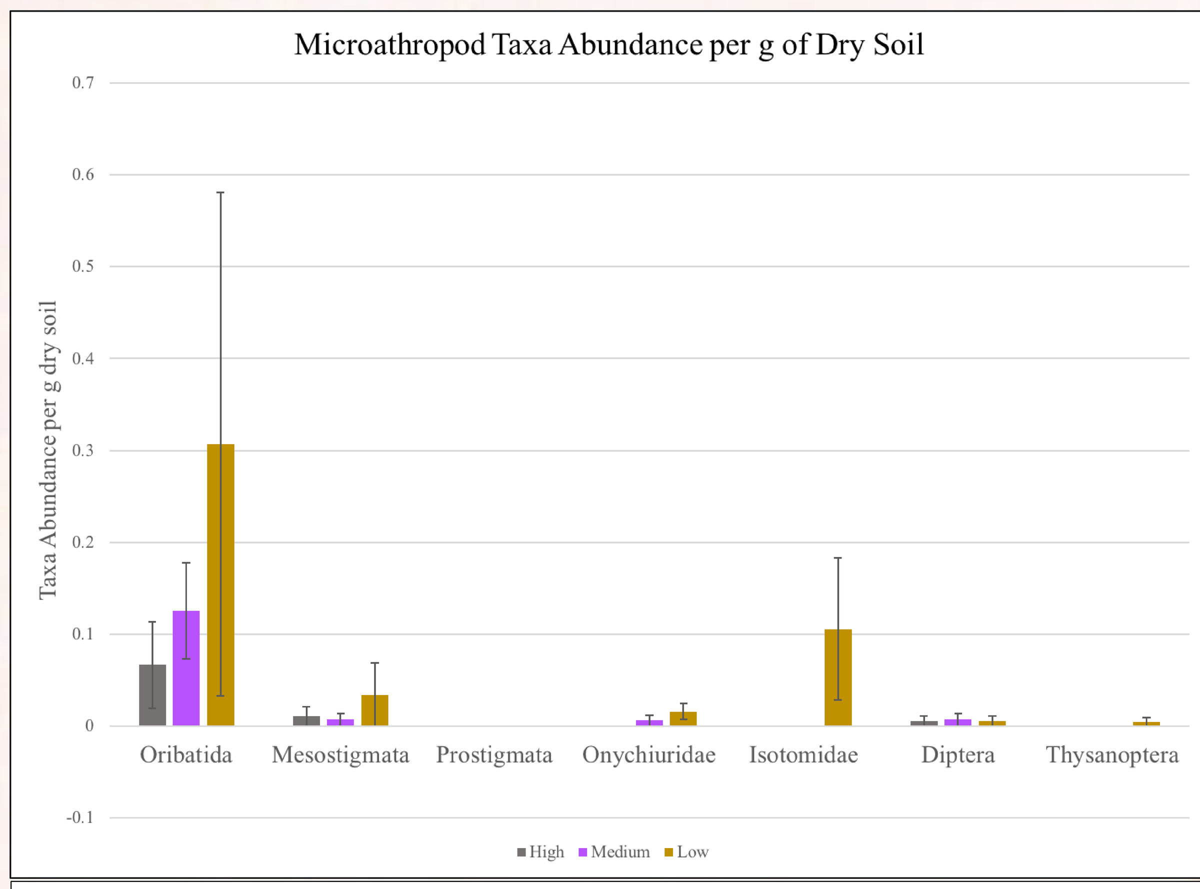


Figure 1. *Microarthropod taxa abundance per gram(g) of dry soil of soil samples from low, medium, and high elevations.*

	Below Treeline	At Treeline	Above Treeline	R^2
Avg pH	4.3 (0.2)	4.5 (0.3)	4.4 (0.0)	0.46
Avg % g/g	50.4 (20.71)	44.9 (11.8)	40.8 (1.7)	0.01
Avg Above-ground Temp (ºC)	9.9 (0.0)	8.7 (0.0)	8.3 (0.0)	0.22
Avg 6cm Temp (ºC)	5.6 (0.2)	6.1 (0.0)	4.7 (0.2)	0.00
Avg 13cm Temp (ºC)	4.9 (0.1)	5.2 (0.2)	3.6 (0.1)	0.02

Table 1. *Average values of pH, percent water content, above-ground temperatures (ºC), 6 cm deep soil temperatures (ºC), and 13 cm deep soil temperatures (ºC) for low, medium, and high elevation samples. Each numerical data has its Standard Error (SE) alongside it determined by regressions made by comparing microarthropod taxa abundance per g of dry soil with each independent factor of the experiment (Avg pH, avg % g/g, etc.).*

References:

1. Chikoski, J. M., Ferguson, S. H., & Meyer, L. (2006). Effects of water addition on soil arthropods and soil characteristics in a precipitation-limited environment. *Acta Oecologica,30*(2), 203-211. doi:10.1016/j.actao.2006.04.005
2. Hågvar, S., & Klanderud, K. (2009). Effect of simulated environmental change on alpine soil arthropods. *Global Change Biology,15*(12), 2972-2980. doi:10.1111/j.1365-2486.2009.01926.x

Discussion:

Of the 3 different sample sites, the samples from below the tree line had the highest soil microarthropod abundance and diversity. Comparisons between the different elevation samples indicated that conditions below the tree line are the most favorable for maintaining such a high abundance and diversity of soil microarthropods. Such a high abundance and diversity in low elevation samples likely resulted from a combination of warmer temperatures, higher percent water content in the soil, and better soil development . In a study done to determine the effects of water addition and soil characteristics on soil arthropods in a precipitation-limited environment (Chikoski et al., 2006) soil arthropod abundance, specifically that of Collembola, grew as moisture content increased; in comparison, soil samples with the highest percent water content were also highest in Collembola abundance and lower in elevation. Mite abundance in this study was also found to increase in soil with a low pH value (Chikoski et al., 2006); in comparison, the lowest pH value (Average pH = 4.2) was also the most abundant in Oribatid mites and lowest in elevation. These results are in agreement with Chikoski's results (2006) that presents data that suggests high water content and low soil pH as factors that increase soil arthropod abundance, specifically that of collembola and mites. Climate change changes microarthropod dominant species and can potentially disturb the roles of each taxa in their environment as warm temp equals more plants and more plant litter and more nutrients available which was seen in the 4 year science study in Norway. In a 4 year study done to determine the effects of simulated climate change on alpine soil arthropods (Hågvar and Klanderud, 2009) the effects of warming and nutrient addition led to distinct changes in the Collembola community by decreasing richness and expanding abundance of generalist species. This study suggested that these responses amongst soil microarthropods are likely the result of changes in soil chemistry and competition (Hågvar and Klanderud, 2009). As the Arctic becomes warmer, the tree line of Mt. Saana and similar areas will move up in elevation; this phenomena would likely result in changes in soil chemistry because an increase of plant litter would provide a greater amount of nutrients in microarthropod communities that were once limited in nutrient availability. In conclusion, this assessment serves as a means of understanding the current state of soil microarthropod abundance and diversity at various elevations, however, as the Arctic warms and the treeline gradually increases, it is likely these changes will result in profound changes in microarthropod taxa abundance and diversity. Since data collected contained outliers and had low R^2 values, the lack of confidence in the accuracy of the data is suggested to have come from a lack of a large sample size. Although the data cannot confidently provide a strong relationship between taxa abundance and independent variables (pH, %g/g, etc.) a future assessment with a larger population would likely establish the true relationship between microarthropod taxa abundance and the tested independent variables.

Acknowledgements: This material is based upon work done in ENV/IAP/LSC 394: BioArt – Sonoran & Arctic Environments. Student research & communication was supported by the National Science Foundation under grant number NSF OPP-1707867. We thank Kilpisjärvi Biological Station for their field and laboratory support.