Do the warming effects of climate change affect keystone ants' ability to disperse seeds?

Nicole Price, NR 103, University of Vermont

Background

Ants are incredibly resilient creatures, found on every inhabitable country in the world. They are very intelligent, adaptable, and play a crucial role in ecosystems by aiding in ecosystem services including decomposition, soil turnover, and seed dispersal. The way these insects adapt to climate change can tell us a lot about the future of our ecosystems.

Motivation

Aphaenogaster rudis, native to eastern North American forests, is a keystone species known for mutualistic seed dispersal, or myrmecochory. Their behavior follows an annual cycle that follows the seasons. There is a lack of research about how a warming climate may impact this cycle and essential dispersal for many eastern plant species, as well as how climate change impacts ecological services in general. A controlled experiment is needed to determine how seed dispersal efficiency is influenced by a warmer average temperature.

Hypothesis

There is a relationship between temperature and seed dispersal productivity.

Predictions

An increase in average temperature leads to reduced numbers of seeds dispersed and a lower proportion of seeds taken from distant locations relative to the colony.

http://www.biodiversegardens.com/2017/06/this-week-in-anting-myrmecochory.html
Ants eat the elaiosome on the seed and benefit the plant by dispersing it near the colony.

Study Design

A controlled experiment will be conducted using three large terrariums of Aphaenogaster rudis ants. These environments will mimic those found in Northeastern forests, with controls for moisture, soil, food availability, colony size, etc. Each environment will have differing temperatures, one being a stable climate like that of its natural habitat, the next 1 degree C warmer, and the final 2 degrees C warmer. Dishes of several different species of myrmecochorous seeds will be placed in each of the tanks at varying distances from the colony. The productivity of seed removal (rate of removal from each distance back to the colony) will be measured over one full season for all three colonies.

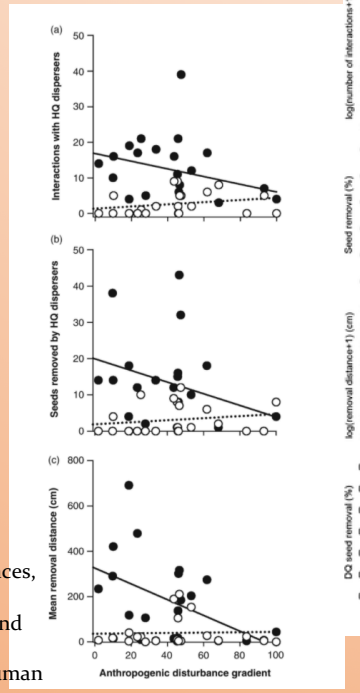

Figure 1. In a study on anthropogenic disturbances, the number of seed interactions, removals, and removal distances were negatively affected by human disturbances on the environment.

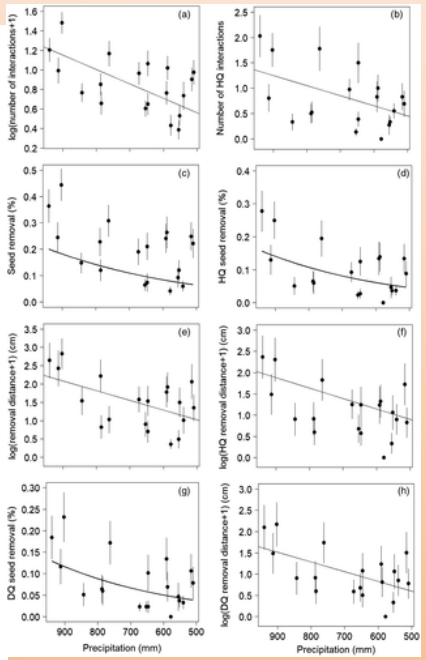

Figure 2. A study of ants in Brazilian Caatinga found a decrease in seed dispersal rate and distance with more arid climate conditions.

Intended Analysis

Given that the response variable (rate of seed removal) is continuous, and the dependent variable (treatment: natural climate, +1ºC , +2ºC) is categorical with >2 groups, we will analyze the data collected using a two-factor Analysis of Variance Analysis (ANOVA). If it proves statistically significant, we can conclude that temperature affects the myrmecochory of A. rudis ants.

Literature Cited

David Lubertazzi, "The Biology and Natural History of Aphaenogaster rudis", Psyche: A Journal of Entomology, vol. 2012, Article ID 752815, 11 pages, 2012. https://doi.org/10.1155/2012/752815.

Del Toro, Israel, Rogério R. Silva, and Aaron M. Ellison. 2015. "Predicted Impacts of Climatic Change on Ant Functional Diversity and Distributions in Eastern North American Forests." Edited by Alan Andersen. Diversity Distrib. 21 (7) (April 13): 781–791. doi:10.1111/ddi.12331.

Leal, I., Leal, L., Oliveira, F., Arcoverde, G., & Andersen, A. (2017). Effects of Human Disturbance and Climate Change on Myrmecochory in Brazilian Caatinga. In P. Oliveira & S. Koptur (Eds.), Ant-Plant Interactions: Impacts of Humans on Terrestrial Ecosystems (pp. 112-132). Cambridge: Cambridge University Press. doi:10.1017/9781316671825.007

Oliveira, FMP, Andersen, AN, Arnan, X, Ribeiro-Neto, JD, Arcoverde, GB, Leal, IR. Effects of increasing aridity and chronic anthropogenic disturbance on seed dispersal by ants in Brazilian Caatinga. J Anim Ecol. 2019; 88: 870– 880. https://doi-org.ezproxy.uvm.edu/10.1111/1365-2656.12979

Warren Ii, R.J., Bahn, V. and Bradford, M.A. (2011), Temperature cues phenological synchrony in ant-mediated seed dispersal. Global Change Biology, 17: 2444-2454. https://doi.org/10.1111/j.1365-2486.2010.02386.x