Ant Foraging Behavior: A field exercise for student groups studying leaf cutter ant behavior at BFREE

Author, Amy Treonis, Department of Biology, University of Richmond, Richmond, VA

Introduction:

Leaf cutter ants are unmissable denizens of the rainforest, and a visit to BFREE is not complete without spending some time observing their activities. Leaf cutter ants live in complex, agrarian societies. They harvest leaves, bring them back to their underground nests, which can host millions of ants, and feed the leaves to a cultivated, specialized fungus. The ants feed on the swollen tips of fungal hyphae, called gonglydia. The fungi live in obligate mutualism with the ants. Bacteria are also cultivated on the ants that produce antibiotics that help that keep foreign microbes out of the fungus culture.

Leaf cutter ants are represented by 47 species from the genera *Atta* or *Acromyrmex*, including the widely-distributed, neotropical *Atta cephalotes*. There are four size classes of workers in a leaf cutter ant society: minims, minors, midiae, and majors. Each tends to perform different tasks, with minims taking care of the fungus garden, minors protecting the foragers, midiea being the primary foragers and leaf cutters, and majors acting as soldiers to defend the nest from intruders and also cleaning the foraging path of debris. While the activities of these ants are a key aspect of rain forest ecosystem functioning, particularly with respect to soil building, these ants are also pests in agriculture. It is important to note that there are many species of ants in Belize, but not all of them are leaf cutters.

Leaf cutter ants do not feed indiscriminately. They harvest from only a subset of plant species in their environment, and they may travel good distances (several hundred meters) to forage on a specific plant. After foraging for a few days on one plant, the ants may switch to a new individual or a new species, possibly due to an uptick in plant defense compound production.

Leaf cutter ants are a particularly amenable system for student-led research projects. With just a little observation, students can generate their own hypotheses and experiments. In this curriculum packet, ideas are offered for areas of experimentation and an example experiment is provided.

Principal Ecological Question Addressed: What factors influence the foraging behavior of leaf cutter ants?

Required Class Time: If students are designing their own experiments at BFREE, time should be allocated for students to observe the ants, generate hypotheses, and design experiments. The example experiment described below required about two hours of time in the field to collect leaves, measure their thickness, and imaging. Additional class time is required for image analysis, data processing and interpretation.

Experimentally testable ideas:

Do leaf cutter ants have different foraging behavior on different plant species?

- Are the leaf fragments cut by the ants uniform or do they vary with factors such as tree species and distance from mound?
- Does the weight, thickness, geometry, or cut edge length vary?
- Do ants have specific preferences for plant species, if given a choice of leaves to collect?

Does ant foraging behavior vary seasonally or diurnally, with temperature or when it's raining?

- How do conditions affect the number of ants on a set linear distance of trail at any given time?
- Do conditions affect the properties of leaf fragments carried by ants?

Is there a relationship between ant body size and the size (area, density, thickness) of harvested leaf pieces?

Does the size of a harvested leaf piece influence the rate of movement along a trail by an ant?

Can natural products (garlic extract, hot pepper, etc.) be used to deter foraging leaf cutter ants?

- What concentrations, formulations or natural products work the best?

Experiment Example:

March 2015, a group of five students from the University of Richmond conducted an experiment on leaf cutter ants at the BFREE field station.

Hypothesis: Leaf fragment properties vary when harvested from different plant species.

Experimental Design:

Using a leaf cutter ant mound adjacent to the main trail, leaf cutter ants were followed to where they were harvesting on three different tree species (wax apple, mango, and mamme apple). Using forceps, 15-20 leaf fragments were taken from ants on each tree and placed into plastic bags.

For each fragment, the following measurements were collected:

- Leaf thickness (digital micrometer)
- Surface area & perimeter: Fragments were placed on the sticky side of a piece of masking tape using forceps and then photographed. Each image included a ruler to use for calibrating ImageJ measurements. Using ImageJ, area and perimeter values were collected from the fragments (For a useful ImageJ tutorial, see: http://www.radford.edu/~jmwojdak/ia.html)

Materials and Supplies needed:

- Forceps
- Small plastic bags
- Wide masking tape
- Field notebooks, writing implements
- Small ruler (may be inside field notebook)
- Digital camera
- Digital micrometer
- Laptop with ImageJ, Excel

Results:

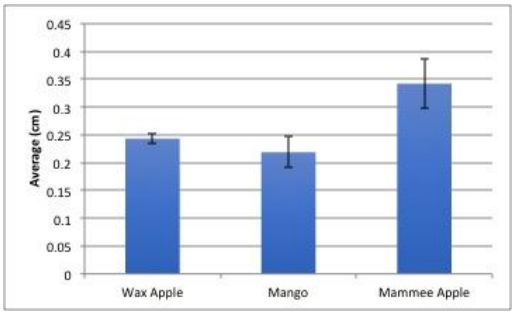

Fig. 1: Relationship between leaf thickness and tree species. $P = 0.009$

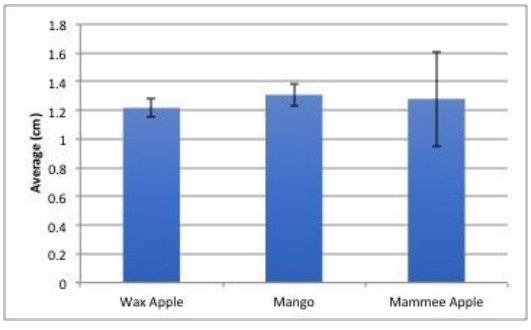

Fig. 2: Relationship between surface area and tree species. $P = 0.708$

Literature Consulted and Additional Resources:

AIMS: Analyzing Images to Learn Mathematics and Statistics: http://www.radford.edu/~jmwojdak/ants.html

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