ENY 6203L Insect Ecology Lab

Module 3 – Herbivory

# Overview

This module will cover the basics of plant-herbivore interactions. This is a practical, field-based lab. Upon completing this lab module, students will be able to:

* Follow standardized, scientific protocols
* Measure herbivory damage to plants using various estimation techniques
* Collect, enter, organize, and analyze ecological data
* Report the findings of an ecological study in a written format

# Outline of laboratory activities

This is a four-week lab module. Plan to conduct one module per week.

1. Observe herbivory on several plant species; develop surveying plan
2. Survey herbivory
3. Process and enter data
4. Analyze data

# Assignments

1. Draft of paper written in a format of a scientific journal
2. Paper written in a format of a scientific journal

# Activity 1: Observe herbivory and develop plan

Objectives:

During the first week of this module, we want to get a sense for the amounts and types of herbivore damage on common plant species in your area. Expect to spend ~30 reading materials, ~1+ hour outside at a field site, ~20 minutes developing a sampling plan. At the end of your time in the field, record a short video describing your sampling plans.

What you need:

* HerbVar Damage Estimation Guidelines
* *iNaturalist* app for a smartphone
* *LeafByte* app for iPhone or *BioLeaf* for Android
* If you don’t have a smartphone, you can still complete this module

Step-by-step instructions:

1. We will use the document “HerbVar Damage Estimation Guidelines” for this activity. Please read this document ahead of time. This document says you should have read the “HerbVar Primary Protocol” document already, but we will come back to this next week.
2. Complete the *LeafByte* or *BioLeaf* tutorial.
3. Find a field site you can work at. Ideally, this would be a natural area (forest, prairie, old field) but could be a lawn or anywhere with at least some weeds. For students in Gainesville we will go over the Natural Areas Teaching Lab.
4. Look around at different plant species at your site. Focus on leafy plants <2m in height (trees are difficult to sample).
5. Examine a few plants of some of the more common species. Take some photos on the *iNaturalist* app on your phone (this can help with ID).
6. Think about steps 1-4 in the “HerbVar Damage Estimation Guidelines” document. For each species, think about the following questions:
   1. How would you estimate plant size?
   2. How long will it take to count the leaves?
   3. How will you subsample leaves, if necessary?
   4. How will you estimate percent damage? Is it easy?
   5. What type of damage do you expect? Mostly chewing? Miners, gallers, etc.?
7. Test our your *LeafByte* or *BioLeaf* app. Next week you will need to bring a white piece of paper with four dots for the *LeafByte* app. So make sure this will work for your species.
8. Develop your sampling plan. This should be a short video (2-3 minutes) shot in the field with a smartphone or digital recording device to submit to canvas. Make sure to answer the following questions via narration in your video:
   1. What is your study site? Describe where you are, what type of habitats, etc.
   2. What species will you select to measure herbivory on? Show us some of you plants, especially some of the damaged leaves.
   3. How will you select your plants?
   4. What measurements will you take? Describe how you will deploy the HerbVar protocol.
   5. Do you see any insects on your plants? What do you suspect is causing any damage you might see?

# Activity 2: Collect herbivory data in the field

Objectives:

Survey herbivory on a minimum of 20 plants but aim for measuring 30+ plants. We will follow he protocol developed by HerbVar, with some modifications. Expect to spend ~20 minutes preparing and ~2 hours in the field collecting data.

What you need:

* Primary protocol for Herbivory Variability Network
* Print off page 3-4 to bring to the field
* Your sampling plan from Activity 1
* Datasheet, clipboard, pencil
* Tape measure
* *LeafByte* app for iPhone or *BioLeaf* for Android

Step-by-step instructions:

1. Read the ‘Primary protocol for Herbivory Variability Network’ document prior to starting this activity. We will only do a subset of the protocol due to time constraints, but it’s important to understand the whole process.
2. Go to your field site and select an area with your focal plant species
3. Follow your sampling plan to randomly (or haphazardly/arbitrarily) select a plant.
4. Collect data follow the instructions for the second bullet point on pg. 3 under the section “Data to record for each selected plant”
5. Collect data on the nearest conspecific neighbor
6. Continue to the next plant
7. For ~5-6 plants, make sure you’re doing a good job by using *LeafByte* or *BioLeaf* to photograph and estimate damage. See pg 8-9 of the “HerbVar Damage Estimation” document for instructions. Photograph 3 leaves per plant (~15 leaves total) for later analysis.
8. Continue sampling until you have sampled ~20+ plants or your 2 hours is up
9. Go home

# Activity 3: Process and enter data

Objectives:

Enter and upload your data and process your digital herbivory data. Expect to spend ~30 minutes process your *LeafByte* or *BioLeaf* data, ~60 minutes entering your herbivory data, and ~30 minutes analyzing comparing your visual herbivory estimates to your *LeafByte* or *BioLeaf* estimates.

What you need:

* Data sheet with data you collected in Activity 2
* Excel file of datasheet to enter data
* *LeafByte* or *BioLeaf* data

Step-by-step instructions:

1. Enter your data into excel using the Datasheet template. Save this file for your use later.
2. Copy and paste your data into the full classes compiled data in google sheets.
3. Enter your *LeafByte* or *BioLeaf* data into a separate excel sheet. You will compare these values with your visual estimates only for the plant species you recorded, so save both files in your personal archives.
4. Compare your visual herbivory estimates to your *LeafByte* or *BioLeaf* estimates.

# Activity 4 – Analyze data

Objectives:

Select questions of interest for your paper and begin data analysis.

Step-by-step instructions:

* Develop a question to address in your paper, based on the conceptual motivation in the HerbVar documents and lecture material. I encourage you to think deeply about the processes that may structure patterns of herbivory within populations, across populations in different habitats, or across species at the same (or similar sites). In part, we are limited by the surveys we are able to have completed but be creative and think of something interesting! Below are some potential questions to get you started (I have some ideas on how to answer them, but this is highly flexible).
  + *Within-population questions:*
    - Is damage spatially structured within a population?
    - Do more apparent (larger) plants experience greater herbivore damage?
    - Does disease presence affect herbivore damage?
  + *Comparing different populations of the same species (requires that multiple surveys were conducted on the same species at different sites):*
    - Do herbivory rates differ among sites with different environmental conditions?
  + *Comparing different species:*
    - Do species differ in herbivory rates based on their life history traits?
    - What predicts the degree of instraspecfic skewness in herbivory across species?
* Develop a plan and begin writing your paper (see rubric)

Literature to get started on your papers:

*Within-population questions:*

Burghardt, K. T. 2016. Nutrient supply alters goldenrod’s induced response to herbivory. Functional Ecology.

Hahn, P.G. and J.L. Orrock. 2016. Ontognetic responses of four plant species to additive and interactive effects of land-use history, canopy structure, and herbivory. Journal of Ecology 104: 1518-1526.

Kim, T.N. and N. Underwood. 2015. Plant neighborhood effects on herbivory: damage is both density and frequency dependent. Ecology 96: 1431-1437.

Underwood, N. and S.L. Halpern. 2012. Insect herbivores, density dependence, and the performance of the perennial herb *Solanum carolinense*. Ecology 93: 1026-1035.

Züst, T., S. Rasmann, and A. A. Agrawal. 2015. Growth-defense tradeoffs for two major anti-herbivore traits of the common milkweed Asclepias syriaca. Oikos 124:1404–1415.

*Comparing different populations of the same species (requires that multiple surveys were conducted on the same species at different sites):*

Anstett, D. N., J. R. Ahern, J. Glinos, N. Nawar, J.-P. Salminen, and M. T. J. Johnson. 2015. Can genetically based clines in plant defence explain greater herbivory at higher latitudes? Ecology Letters 18:1376–1386.

Baskett, C. A., and D. W. Schemske. 2018. Latitudinal patterns of herbivore pressure in a temperate herb support the biotic interactions hypothesis. Ecology Letters 21:578–587.

Hahn, P. G., and J. L. Maron. 2016. A Framework for Predicting Intraspecific Variation in Plant Defense. Trends in Ecology & Evolution 31:646–656.

Kooyers, N. J., B. K. Blackman, and L. M. Holeski. 2017. Optimal defense theory explains deviations from latitudinal herbivory defense hypothesis. Ecology 98:1036–1048.

*Comparing different species:*

Coley, P., J. Bryant, and F. S. Chapin. 1985. Resource availability and plant antiherbivore defense. Science 230:895–899.

Fine, P. V., I. Mesones, and P. D. Coley. 2004. Herbivores promote habitat specialization by trees in Amazonian forests. Science 305:663–665.

Endara, M.-J., and P. D. Coley. 2011. The resource availability hypothesis revisited: a meta-analysis. Functional Ecology 25:389–398.