Tested Studies for Laboratory Teaching
Proceedings of the Association for Biology Laboratory Education
Volume 39, Article 27, 2018

Seeing is Believing: Looking at Insect Diversity in a Natural Field, a Playing Field, and Right Outside Your Door

Marsha Fanning[1] and Brian Johnson[2]

[1]Marsha Fanning: Box 7156, Lenoir-Rhyne University, Hickory NC 28601 USA
[2]Brian Johnson[2]: East Gaston High School, Mt. Holly NC and Lenoir-Rhyne University, Hickory NC 28601 USA
(**Marsha.Fanning@LR.edu**; **Brian.Johnson@LR.edu**)

Species diversity is one of the fundamental concepts of ecology, and while students often think they understand what it means, they often don't fully appreciate it. Actually seeing how a small change in habitat can result in huge changes in diversity gives a lasting impression. In this exercise, participants sample insects in two very similar but different habitats, and determine species richness and evenness. Diversity of size, color, as well as kind becomes obvious. Hypotheses about the effect of various biotic and abiotic parameters, as well as the effect of various land uses, can be tested. This exercise can be used in both college and high school biology classes.

Keywords: insect, ecology, species diversity, sampling, hypothesis testing

Introduction

Since insects are some of the world's most abundant organisms, thriving in almost any habitat where there is life, they make good indicators of a community's health. With almost 1,000,000 species of named insects, which is perhaps less than one third of the total number, the chance of finding a variety of insect species in any one area is pretty high.

Species diversity is one of the fundamental concepts of ecology, and while students often think they understand what it means, they often don't fully appreciate it, until they actually see how a small change in habitat can result in huge changes in diversity. In this workshop, participants sample insects in two very similar but different habitats. After sorting and "IDing" the insects to "kind", species richness and evenness can be calculated for insects in each habitat. Diversity of size and color, as well as kind, also becomes obvious.

Species Diversity Indices

Species diversity consists of two components: species richness and species evenness. <u>Species richness</u> is a simple count of the different species found in an area, while <u>Species evenness</u> quantifies how equal the <u>abundances</u> of individuals are among the species.

Hypothesis Testing

Students can easily collect enough data to examine many different hypotheses in a single lab period... Hypotheses about the effect of various biotic and abiotic parameters, as well as the effect of various land uses, can be tested. For example, possible testable hypotheses include:

- Old fields that are "rarely disturbed" will have higher diversity than those "managed" with frequent mowing, watering and fertilizing.
- Wetland areas will have higher diversity than Mesic areas
- South facing slopes will have higher diversity than North facing slopes
- High elevation fields will have higher diversity than those at lower elevations
- Insect diversity will be higher when plant diversity is also high.
- The use of fertilizer will increase diversity in an area
- Areas where there are invasive species will have lower insect diversity than those areas free of invasives.

Student Outline
Seeing Is Believing: Looking at Insect Diversity in a Natural Field, a Playing Field, and Right Outside Your Door

Objectives

- Learn how to use sweep nets to sample insect populations
- Learn how to identify insects to Order
- Test hypotheses regarding insect species diversity

Introduction

Since insects are some of the world's most abundant organisms, thriving in almost any habitat where there is life, they make good indicators of a community's health. With almost 1,000,000 species of named insects, which is perhaps less than one third of the total number, the chance of finding a variety of insect species in any one area is pretty high.

Species diversity is one of the fundamental concepts of ecology, however, to fully appreciate what it means, it helps to see how a small change in habitat can result in huge changes in diversity. In this lab we will sample insects in two very similar but different habitats. After sorting and "IDing" the insects to "kind", species richness and evenness can be calculated for insects in each habitat and any differences in diversity noted. Diversity of size and color, as well as kind, should also become obvious.

Species diversity consists of two components: species richness and species evenness. <u>Species richness</u> is a simple count of the different species found in an area, while <u>Species evenness</u> quantifies how equal the <u>abundances</u> of individuals are among the species. Hypotheses about the effect of various biotic and abiotic parameters, as well as the effect of various land uses, can be tested.

Methods and Data Collection

You will collect data to examine an hypothesis regarding insect diversity in two different habitats using sweep net techniques. Hypotheses about the effect of various biotic and abiotic parameters, as well as the effect of various land uses, can be tested. For example, possible testable hypotheses include:

- Old fields that are "rarely disturbed" will have higher diversity than those "managed" with frequent mowing, watering and fertilizing.
- Wetland areas will have higher diversity than mesic areas.
- South facing slopes will have higher diversity than North facing slopes.
- High elevation fields will have higher diversity than those at lower elevations.
- Insect diversity will be higher when plant diversity is also high.
- The use of fertilizer will increase diversity in an area.
- Areas where there are invasive species will have lower insect diversity than those areas free of invasives.

Methods:

Unroll a tape measure on the ground and walk the tape to determine the number of steps it takes for you to cover 10 meters. Multiply this number by 10 to get the number of steps needed to sweep 100 meters.

- Sweep 100 meters (based on number of steps) in each of your habitats. Remember while sweeping to never stop swinging the net to avoid letting the insects escape. "Flip" the end of the net over when you finish your sampling.
- Transfer insects to a killing jar and wait until the insects stop moving. They can then be transferred to a sealed plastic bag for return to the lab.
- Repeat same procedure in a different habitat.
- Take samples back to lab for sorting. First remove plant material, then sort in petri dishes by kind.
- Identify species (Record Order of each insect and give it a "kind" name). You do not need to determine actual species names.

(Caution: Avoid areas containing poison ivy and plants with thorns. Care should be taken when stinging insects are captured; listen for "buzzing". Always check for ticks after being in the field)

Data Analysis

After sorting and identifying the insects in each of your collections, calculate diversity indices for Species Richness, and Evenness, and also determine percent similarity of the two different communities. Do the results of your calculations support or reject your initial hypothesis?

Discussion

As you write up your lab report on the effect of habitat on insect diversity, be sure to consider the following questions:

- What are the dominant species of each community?
- Which community has the greatest dominance by a few species?
- What % Similarity is there between the different communities?
- Would you expect the season of the year to effect the results of the experiment? How?
- Based on the Shannon index, which community has the most diversity?
- Can you attribute this primarily to a difference in species richness or species evenness?
- Based on the information gathered in the laboratory experience, which community has the possibility for the greatest number of niches, the most complex food web, and the greatest number of feedback loops?
- Which community would you expect to be the most stable?
- What other organisms would you expect to find in the communities, that we have not sampled? Would you expect their addition to change the results of the experiment appreciably?

Materials

Equipment needed includes sweep nets, killing jars, 10 m tape measure, trays, petri dishes, teasing needles, forceps, magnifying glasses or dissecting microscopes, insect keys and/or field guides.

Notes for the Instructor

This exercise can be used at many different levels, from high school students to Ecology students, depending on the amount of time allotted and the degree to which you want students to focus on identification, calculations or habitat parameters. Having a camera hooked up to a microscope that you can project for the students helps them to appreciate the differences among the insects even more.

In the process of doing this exercise, students learn the scientific process by formulating testable hypotheses, doing actual data collection and analysis, including the use of a variety of diversity index calculations. Students may complete the experiment by writing a lab report in the format of a scientific research paper or as a scientific poster or they may present as a scientific PowerPoint presentation.

Sweep nets and killing jars can be purchased from many biological supply houses. Muslin nets will hold up better with repeated use than those from thinner material. Homemade killing jars can be made using a layer of hardened plaster of Paris in the bottom of a large jar. A small amount of Chloroform or Acetone can be poured onto the plaster as a killing agent.

There are many useful websites that might help with identification: A couple of useful resources are:

Bug Guide at http://bugguide.net
and UW-Madison at
http://labs.russell.wisc.edu/insectlab/.

See Appendix A for formulas for several diversity indices.

Acknowledgments

Thank you very much to all of the LR ecology students who have helped improve this laboratory exercise over the years.

About the Authors

Marsha Fanning has been a professor at the Lenoir-Rhyne University in Hickory, NC since 1973, where she teaches both introductory and advanced courses in biology, including general ecology to biology majors.

Brian Johnson teaches AP biology at East Gaston High School and serves as an adjunct professor at Lenoir-Rhyne University where he teaches a course in environmental science

Appendix A: Calculations

A. ***Index of Dominance*** (C)

$C = \Sigma(n_i/N)^2$ where: n_i = # individuals of species i

N = total # of individuals

B. ***Index of Similarity*** (S) where: A = # of individuals of all species in sample A
B = # of individuals of all species in sample B

$S = 2C/(A + B)$ C = lower number of individuals of a given species found in the two samples.

C. ***Indices of Diversity***

1. Species Richness

$d_1 = (S - 1)/\log N$ where: S = # of species

$d_2 = S/N$ N = # of individuals

d_3 = S per 1000 ind.

D_s = Simpson's Index of Diversity = 1-D, where:

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

2. Evenness Indices (e)
$e = \overline{H}/\log S$ where: $\overline{H}$ = Shannon index
S = # of species

3. **Shannon index of general diversity** (H)
$\overline{H} = -\Sigma(n_i/N)\log(n_i/N)$ where: n_i = # individuals of species 1
N = total # of individuals

Mission, Review Process & Disclaimer

Citing This Article

Fanning M and Johnson B 2018. Seeing is Believing: Looking at Insect Diversity in a Natural Field, a Playing Field, and Right Outside your Door Article 27 In: McMahon K, editor. Tested studies for laboratory teaching. Volume 39. Proceedings of the 39th Conference of the Association for Biology Laboratory Education (ABLE). **http://www.ableweb.org/volumes/vol- 39/?art=27**