POPULATION AND COMMUNITY STRUCTURE

INTRODUCTION: Habitat Variation: Ecotone Analysis.

MATERIALS:

Field Equipment (1st day): Pitfall traps (25 minimum; Figure 1), trowels (at least 1 per group), meter tapes (one per group), preservative (9 parts 70% ethanol to 1 part glycerol or automotive antifreeze), thermometers, sling psychrometer(s), psychometric tables or slide rules, anemometer(s), photometer(s), meter sticks, distilled water.

Laboratory Equipment (2nd day): Collection vials (one per trap), forceps, wire strainers, marking pens, plastic Petri dishes, dissecting microscopes, hand lenses.

A habitat's structure is determined largely by local climatic conditions. Thus, most of the fields in your area of the country are similar to one another in the types and number of species they support. However, even though field sites near one another are likely to have similar temperature, rainfall, light, and wind speed attributes, minor variations in their climate can affect community structure. These **microclimate** differences, however small, can encourage the growth of one species over another and ultimately change the species mix in habitats that are located near one another.

In this exercise you will examine the several microclimatic differences among five sites. You will then correlate differences in microclimate with the species composition in each area. The site chosen by your instructor is at the interface between a forest and a field, an area called the **ecotone**. Since the ecotone lies between two disparate habitats, it shares features of both the forest and field sites. Thus, many plants and animals found in the field location will also be seen in the ecotone (the same goes for the forest site). The ecotone is not, however, simply intermediate to the field and forest. Because of microclimate differences, an ecotone also has its own peculiar mix of species, some of which may not be found in either of the other sites.

PROCEDURE:

1. **First Meeting: Setting Up.** Work in groups of three or four, as indicated by your instructor. The class should be divided so that there are at least five groups. If your class is small, you may have to divide up the work so that five **transects** will be made (see below). When you reach the experimental site, your fearless instructor will identify the ecotone. The first group should dig a hole within the ecotone (one meter from the edge of the field). Remaining groups will dig their holes at 10-meter intervals from the first group. The holes should be as wide as the largest of the cups used to construct the pitfall traps (Fig 1). Dig your holes deep enough so the top edge of the funnel is even with the soil surface (Fig 1). If a rock, tree, or other object interferes with the correct placement of the hole, position the trap as close as possible to the preferred site. While others are digging holes and constructing traps, one member of your group should collect the microhabitat measurements near each trap (see step 6 in this section). These results should be shared with other group members.

2. Once a hole is dug, insert the large cup into the hole and check the fit with the soil surface. Since you want animals to easily blunder into the trap, there should be no gap between the cup and surrounding soil. The soil should also be smooth up to the edge of the trap. Smooth the soil, or otherwise adjust the surrounding soil to insure that animals can easily fall into the trap. Fill the smaller cup approximately half way with a preservative and place it in the bottom of the larger cups (Fig 1). Finish your construction by inserting the funnel into the top.

3. Dig a second hole in the forest 10 meters from the first trap. Construct a pitfall trap as above and fill it with preservative. Again, smooth the soil to make it easy for an insect to fall in. The second trap is referred to as the "near forest" trap (it's near the ecotone). Place a third trap deeper in the forest 10 meters from the second (the "far forest" trap).

4. In a similar manner, place a "near field" trap 10 meters from the ecotone in the field. A fifth and final trap is positioned an additional 10 meters from the ecotone trap (this will be your "far field trap").

5. The 5 traps constitute a **transect** from the field through the ecotone and into the forest. Make a note of the position of your transect so you can later identify your group's site during the next class session. At that time you will empty the traps and examine their contents.

6. **Microclimate Measurements.** Perform the following microclimate measurements at each of the trap sites. Air temperature can be measured with a laboratory thermometer. When you take temperature measurements, make sure to hold the thermometer so that it is not affected by your body heat. Temperatures should also be taken in the shade and recorded in °C. Take temperature readings at ground level and at 1, and 2 meters above the surface. Relative humidity is measured with a sling psychrometer. Examine the psychrometer and note that one thermometer bulb is surrounded by a cotton wick. Moisten this wick with distilled water (this is the "wet bulb"). If the nonwicked "dry bulb" gets wet be sure to dry it off. After grasping the psychrometer firmly by its handle and making sure that none of your classmates will get hit, whirl the instrument rapidly in a circular motion. Record the temperature of both the wet and dry bulbs in the Results Section and determine the relative humidity using the psychometric slide rule or tables. Follow these readings with a determination of the light intensity and wind velocity using the methods demonstrated by your instructor.

7. **General Habitat Structure.** Describe the general structure of the habitat surrounding each of the trap sites. Include a description of the vegetation, whether the site receives full sunlight, and other habitat features that you believe may be important. For the plants, pay attention to their height, an estimate of percent coverage, type of plants (grasses, wide or narrow leaf foliage, woody or nonwoody foliage, trees, etc.). Enter these observations in the Results Section.

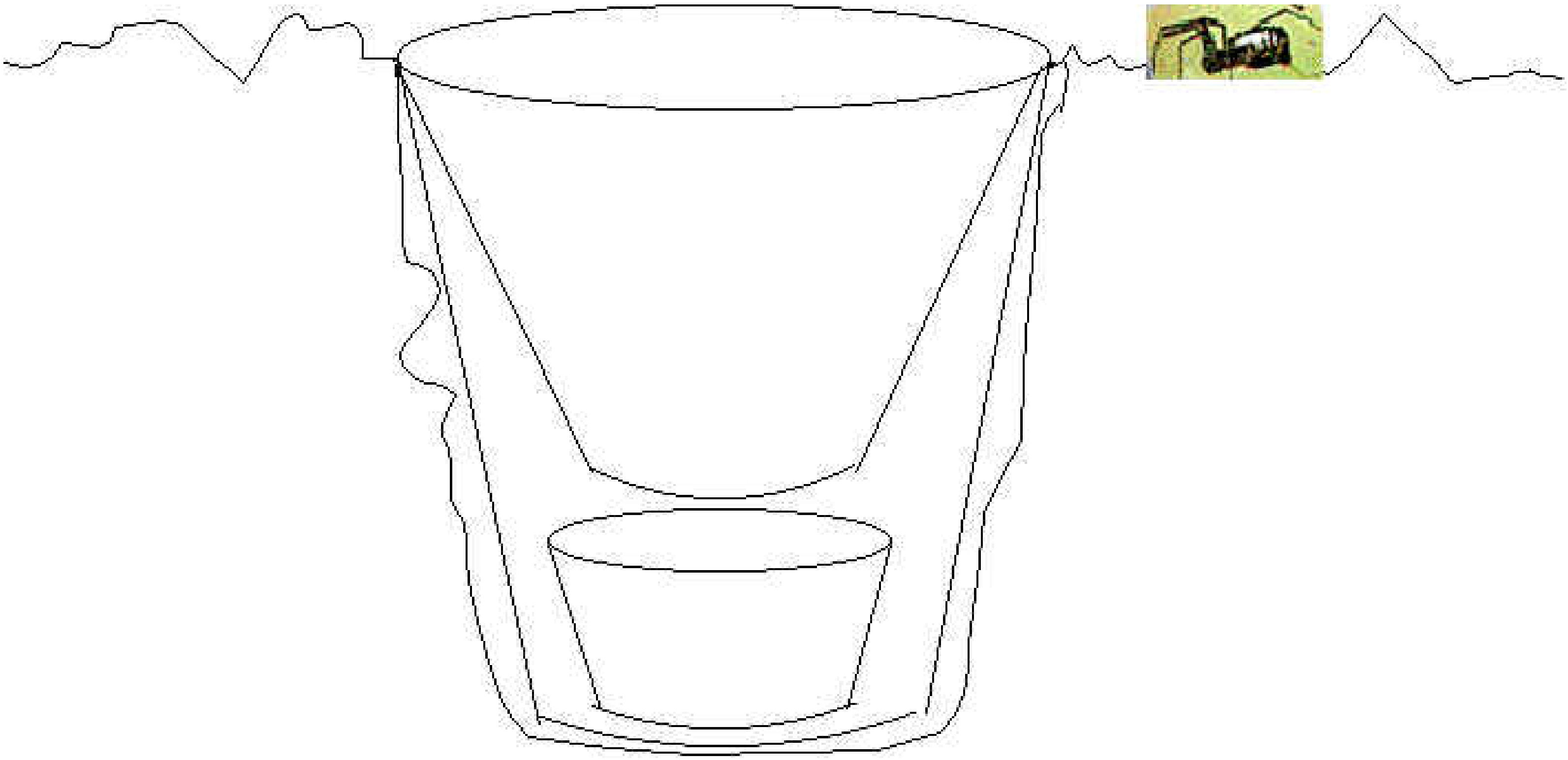

Figure 1. Construction of a Pitfall Trap. A large cup holds a funnel (top) above a smaller cup located at the bottom of the trap. The smaller cup contains a preservative to kill and preserve insects, spiders, and other small creatures that blunder over the edge of the trap.

Second Meeting: Collection and Interpretation of Data. Following a one-week collection period you will return to your site to retrieve the captured animals from your pitfall traps. Label 5 vials with a trap identification ("ecotone," "near forest," etc.). Remove the cups from the center of the trap and pour the contents into the corresponding container. When you return to the laboratory transfer the trapped animals in each vial to a plastic Petri dish (**NOTE:** keep the animals from each trap separate from one another).

9. Pick through your collections and identify and separate the animals as to general type (bees/wasps, ants, beetles, etc.; see the table in the Results Section). If some organism that is not listed in the table makes up a large proportion of your sample, include these in the table. When you have finished collecting your data from the five traps, record your data on the blackboard. When all the groups have entered their data, compute the totals for each species and enter the values in the Results Section. Use the pooled class data for all of your calculations and discussion.

10. Dispose of the animals, Petri dishes, and preservative as indicated by your instructor.

EXERCISE 2 Calculations.

PROCEDURE:

1. Work with the data from exercise 1. For the following sections, work only with the 10 most common species across all habitats (Determine from the last column in the second table in the results section). Perform your calculations only on the class data (not your group data).

2. For each of the habitats ("ecotone," "near field," etc.) determine the relative frequency of the top 10 species (divide the class totals for each species by the total number of organisms caught within a particular habitat). If, for example, 212 ants were found in the ecotone out of a total of 1225 animals in the ecotone, the relative frequency of ants is 212/1225 = 0.1731. Enter these data in the results section. Plot the relative frequency of the top 10 species against habitat (use a different color or line style for each species). What factors (climate, behavior, physiology) could explain the differences in distribution for each species?

3. In addition to descriptions of the relative frequency of each species in a community, ecologists have found it useful to measure the complexity of the species mix. The determination of complexity for a particular habitat is a measure of the **species diversity** for that community. Several methods have been proposed for measuring species diversity. One of the simplest is Simpson's Index of diversity. Again, working only with the 10 most common species, calculate the diversity index for each of the trap sites (Box 1). Record your calculations in the Results Section. Compare the diversity indices among the five sites. Which sites were most diverse? What features of the habitat might explain the differences in diversity?

BOX 3 SPECIES DIVERSITY BY SIMPSON'S INDEX.

The formula for Simpson's Index is:

$D = N(N - 1)/(ni(ni - 1))$ Where: D is the diversity index.

N is the total number of individuals of all species.

ni is the number of individuals of the ith species.

As an example, assume that the following mix of species were collected from a study area:

	Species A	Species B	Species C	Species D
Number of Individuals	20	5	10	45

Individuals: 20 5 10 45 N = 20 + 5 + 10 + 45 = 80

For each species, calculate ni(ni - 1):

Species A: nA(nA-1) = 20(19) =380 Species C: nC(nC-1) = 10(9) = 90

Species B: nB(nB-1) = 5(4) = 20 Species D: nD(nD-1) = 45(44) = 1980

Then calculate the sum: ni(ni-1) = 380 + 20 + 90 + 1980 = 2470

And finish the formula: $D = N(N - 1)/(ni(ni - 1))$ = 80 (80 - 1)/2470 = 6320/2470 = 2.56

Simpson's index varies from a value of 1.0 for a community with only one species to an infinite value for a community with a large number of species, each represented by a single individual. The higher the index, the greater the species diversity. By itself this calculation is of little use since it is intended for comparing diversity among two or more collection sites.

REPORT SECTION ______________________ ________________

Lab 8 (Name) (Date/ Lab Section)

RESULTS AND DISCUSSION

EXERCISE 1 Habitat Variation: Ecotone Analysis. Enter your group's data for the pitfall traps in the following table.

Group Data

Species/ Guild	Far Field	Near Field	Ecotone	Near Forest	Far Fores
Ants					
Bees/wasps					
Butterflies					
Centipedes					
Crickets					
Daddy Long					
Earthworms					
Flies					
Larvae					

Leaf Hopper					
Millipedes					
Moths					
Snails/Slugs					
Spiders					
Rolly polly					
Other insect					

Enter the pooled class counts of species in each of the habitats in the following table. Blanks are provided to add names of species not included in the table.

Class Data (Pooled Results).

Species/ Guild	Far Field	Near Field	Ecotone	Near Forest	Far Fores
Ants					
Bees/wasps					
Butterflies					
Centipedes					
Crickets					
Daddy Long					
Earthworms					
Flies					
Larvae					
Leaf Hopper					
Millipedes					
Moths					
Snails/Slugs					
Spiders					

Rolly polly					
Other insect					

Record your results of the microclimate tests in the following table.

Microclimate Data	Far Field	Near Field	Ecotone	Near Forest	Far Forest
Air Temp (2m)					
Air Temp (1m)					
Surface Temp					
Dry Bulb T					
Wet Bulb T					
Humidity					
Light Intensity					
Wind Velocity					

Provide a short description of each habitat in the following space (Refer to step 7 of Exercise 1. before answering this question).

Far Field: ____

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Near Field: ____

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Ecotone: ____

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Near Forest: ____

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Far Forest: ____

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EXERCISE 2. Calculations. Determine the relative frequencies of the top 10 species for each of the habitats. Record the pooled class counts under the column heading "#". To calculate the relative frequencies, add these up and then divide each species count by the total within each habitat. Record the relative frequencies under the column heading "*F*". As a check on your math, the frequencies should add up to about 1.0 (owing to rounding errors).

Relative Frequencies of the Ten Most Common Species Among Habitats.

Top 10 species	Far Field	Near Field	Ecotone	Near Forest	Far Fores
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total	1.0	1.0	1.0	1.0	1.0

Plot the relative frequency of each species vs. habitat as a line graph. Use different colors and/or line patterns for each species. Identify the species and their line patterns (under legend) in the table to the left of the graph.

Top 10 Species	Legend

What factors (climate, behavior, physiology) might explain the differences in distribution for each species? For the two most common species, discuss in detail aspects of their behavior that could explain why they are more common in one habitat vs. another

Species Diversity. In the space provided below, fill in the habitat descriptions and species diversity as calculated by Simpson's Index. Perform your calculations on the pooled class data.

Habitat	Diversity
Far Field	
Near Field	
Ecotone	
Near Forest	
Far Forest	

Compare the diversity indices among the five sites.

What habitat features could explain the differences in diversity?

Some ecologists have suggested that complex communities (those with high species diversity) are more stable than communities with low diversity. Stable communities maintain species mixes and population numbers in the presence of an external force (such as destruction of the habitat or a key species in the community). Compare the diversity of your samples to predict which communities may be more stable. Why do you think a complex community is more stable (Hint: think about food chains and webs in complex vs. simple communities).