Chapter 16

Avian Niche Partitioning

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Introduction

The theory of competitive exclusion was formulated more than 50 years ago by G.F. Gause. The basic premise of the theory is that if two species are competing with one another for the same limited resource, then one of the species will be able to utilize the resource more efficiently, and eliminate the other locally. Foraging place and time are considered important axes along which niches may segregate.One example that demonstrates the principle of competitive exclusion involves two species of barnacles that grew together on the same rocks along the coast of Scotland (Connell, 1961). One of the two species, *Chthamalus stellatus*, lives in a shallower water, where it is often exposed to air. The other species, *Balanus balanoides*, occurs lower down and outcompetes *Chthamalus* by forcing it off the favored area that is usually not exposed to the atmosphere. Another well known example is based on the work of Robert MacArthur (1958). He studied five species of warblers and found that each species spent most of its time feeding in different parts of the trees to avoid competition. This experiment explores niche separation in common avian species in eastern Massachusetts.

Materials

Bird feeders
Binoculars
Seeds: millet and sunflower

Notes for the Instructor

The main objective of this lab is to bring the students out into the field and introduce them to a number of important ecological concepts such as niche partitioning, competition, and the process of speciation. We have found that the best way to convey this information to the students is to meet with the students one week before they go into the field and then again after all the data from all the sections are pooled and distributed. When the data is given back to the students, it is given in tables with Chi-Square analyses already performed. The lab instructors then go over the data and explain how statistics help in analyzing the results. For instance, the appendix shows the preference of species for big or small seeds. The Chi-Square analysis in the appendix shows that the number of observations of birds foraging on large seeds is significantly greater ($p<0.001$) than predicted by chance. We are forced to reject the null hypothesis which is that birds feed equally on large and small seeds and accept the alternative hypothesis that birds prefer large seeds to small seeds. The Chi-Square analysis (already calculated for the students) can be used to confirm that the birds statistically prefer big seeds. We provide similar tables showing a preference for one site over the other, high or low feeders, and preference for time of day.

Good luck and please let me know how it works out.

Student Outline

Study site

The study will be conducted at Hammond Pond Reservation in Newton, Massachusetts. Hammond Pond Reservation is a small mixed-hardwood woodlot dominated by black birch and oak trees. The study will be conducted throughout October - early November. Refer to the Weekly Laboratory Schedule for dates specific to your lab section.

Experimental Design

A series of feeders have been suspended at different heights in two ecologically different areas 20 m apart at Hammond Woods. At each site, two sets of feeders are hung either from trees or from rope strung between two trees. Each set consists of two feeders, one at approximately 3 m (high feeder) and the other at approximately 2 m (low feeder) hung directly below the high feeder. One set of feeders has the high feeder filled with sunflower seeds (large seeds) and the low feeder filled with thistle seeds (small feeder). The other set of feeders has the reverse, the high feeder was filled with small seeds and the low feeder is filled with large seeds. The two sets of feeders were placed approximately 3 m apart.

Pre-Laboratory Field Trip Questions

1. Define the following terms:
   Competition:
   Intraspecific and Interspecific:
   Interference:
   Resource Partitioning:
   Competitive Exclusion:
   Exploitative:
2. Predict what factors will most influence dominance.
   (size, color, etc.…)
3. What conditions might allow birds to eat the same things at the same places and times?

Directions (Location directions specific to your own institution)

Avian Foraging And Niche Partitioning At A Feeder

Modified from Brown, L. and J.F. Downhower (1988); Analyses in Behavioral Ecology: a Manual for Lab and Field. Sinauer Associates, Inc. Sunderland, MA.

Terms

Know the following terms before you come to lab:

Competition	Resource Partitioning
Intraspecific	Competitive Exclusion
Interspecific	Exploitative
Interference	

Purpose

The purpose of this exercise is to help you examine differences in competitive ability among avian species at a feeder. This will include differences in how resources are obtained and in ability to fight and to exclude other species.

Rationale

Animals behave. They move about, make choices, interact with one another, feed, mate, and fight. In this exercise we are interested in questions regarding the behavior and social organization of free-ranging animals. There can be no substitute for using wild animals in the field. Increasing the understanding of the ecology and natural history of animals and plants leads to a vastly increased appreciation of those organisms, their uniqueness, their importance in the ecosystems to which they belong, and perhaps most importantly, their preservation. This experiment will provide basic knowledge, applicable to many different animal species, about how social behavior evolves, and what the role of ecological factors such as food availability is in determining social behavior.

Experimental Design

This experiment has been designed to help you explore avian foraging preferences under field conditions. You will be given the opportunity to observe birds at feeding stations suspended at different heights. You will be evaluating the preferences of different species given a choice between large and small food items at high and low elevations. You will also be investigating the mechanisms used to establish dominance between individuals.

Data Collection and Analyses

We will evaluate the preferences of the different species given a choice between large and small foods at high and low elevations. The number of individuals for each bird species that visited each feeder will be recorded over a 1 hr. period. Data collection will be divided up into morning, afternoon and evening sessions. The data for each session will be pooled. Preference scores for each type of feeder and seed size will be calculated, as well as a dominance aggressive and relative abundance index.

A measure of aggressive dominance will be calculated. All interactions between individuals at the feeders will be scored based on an "intensity of response" scale. The data for each session will be averaged to give a mean aggression score. Expected scores will range from 1 (highly aggressive) to 5 (total avoidance). A score of 3 indicates that both aggression and avoidance occur. A score of 0 indicates that no interactions occur between the species.

A bar graph indicating abundance of each species at each feeder can be constructed. Food and height preference can also be calculated.

You are allowed to attach as many tables and figures (drawings, graphs, etc.) as you need to the end of your final paper. Put each table and figure on a separate page.

Discussion

Interspecific competition refers to competition between members of two different species and will occur to the extent that the two species are ecologically similar. If the two species are very similar in their needs, interspecific competition generally will result in one species being eliminated from the habitat because, almost certainly, one species will be less adept at utilizing the limiting resources. However, if the two species differ somewhat in their needs, they may be able to coexist. Whether or not competitive exclusion occurs will depend upon the degree of resource partitioning.

It also is useful to distinguish between exploitative competition (when the competitors do not confront one another directly but simply deplete the same resource) and interference competition (when direct aggression occurs).

By carefully examining competition and other characteristics of the biology of birds at feeders, we can assess qualitatively the kinds and intensity of interactions among the species. Keep in mind the following questions. Which species interact? How do they interact? Which species are dominant? How is size related to dominance? These are general questions to focus on during the lab. Our observations will allow us to generate some hypotheses concerning the ecological and evolutionary consequences of these behavioral interactions.

Assignment

After you have been out in the field, your section will summarize its data and turn it in to your instructor (these will be returned to you).

In order to answer the questions properly you must calculate the species preferences, relative abundances, and aggressive dominance indices on the worksheets.

Questions

(Answers to the following questions should be incorporated into the final report.)

1. How many bird species occur at each feeder? How abundant was each species?
2. Do the species show any preference for the different food items? Did the birds separate along a height gradient? Did birds favoring the same seed sizes feed at different heights? Explain.
3. Were the same species most common in both areas. If not, do differences among bird species in foraging behavior help to explain these differences?
4. What are the kinds of interactions that you observed? Were there consistent differences in the behavioral dominance of one species over another? If so, did it influence the foraging of either species? Was it the larger or smaller species that was dominant?
5. Was there any evidence that birds feeding at the same height on the same seeds did so at different times of the day?

Behavioral Interactions (Fill in Table 16.1 on the following page.)

Active Aggression

1. *A* actively chases *B* away from the feeding tray following in pursuit beyond the tray.
2. *A* moves toward *B* or pecks toward *B* with enough intensity to cause *B* to leave the feeding tray.
3. *A* moves toward or pecks at *B* but *B* is not forced to leave the feeder.

Table 16.1. Behavioral Interactions. (This data sheet should be handed in to your Teaching Fellow.)

Species A **B**	American Goldfinch	Blue Jay	Downy Woodpecker	Hairy Woodpecker	Dark Eyed Junco	Black-capped Chickadee	White breasted Nuthatch	Purple Finch	Tufted Titmouse
American Goldfinch									
Blue Jay									
Downy Woodpecker									
Hairy Woodpecker									
Dark Eyed Junco									
Black-capped Chickadee									
White breasted Nuthatch									
Purple inch									
Tufted Titmouse									

Date:____________ Site (1 or 2) ______ Feeder (high or low) __________ Seed Size (large or small) ________

Table 16.2. Bird census—summary. (Hand in to your teaching fellow)

Species	**High Feeder Large Seeds**	**Low Feeder Small Seeds**	**Low Feeder Large Seeds**	**High Feeder Small Seeds**
American Goldfinch				
Blue Jay				
Downy Woodpecker				
Hairy Woodpecker				
Dark-eyed Junco				
Black-capped Chickadee				
White-breasted Nuthatch				
Purple Finch				
Tufted Titmouse				
Mourning Dove				
Pine Siskin				
Mockingbird				
Northern Cardinal				
House Sparrow				
White-throated Sparrow				
Evening Grosbeak				
House Finch				
Tree Sparrow				
Starling				
Northern Grackle				

Area ________(1 or 2)
Date: ________________ Temperature: _________________
Time of day: _______________ Weather Conditions: _______________________________

Avoidance

4. *B* avoids *A*, but remains on the feeding tray. Both birds continue to feed but *B* constantly moves away from *A*. *A* never makes an observable aggressive move to cause the avoidance by *B*.
5. *B* avoids *A* by leaving the tray without feeding. *A* never makes an observable aggressive move to cause the departure by *B*, but the avoidance is seen to be caused by the presence of *A*.

Table 16.3. Food Preference. (Hand in to your Teaching Fellow)

Species	**Preference for Large Seeds**	**Preference for Small Seeds**	**Preference for High Feeder**	**Preference for Low Feeder**
American Goldfinch				
Blue Jay				
Downy Woodpecker				
Hairy Woodpecker				
Dark-eyed Junco				
Black-capped Chickadee				
White-breasted Nuthatch				
Purple Finch				
Tufted Titmouse				

Formulas:

$$\text{Preference of Species X for Large Seeds} = \frac{\text{Number of Large Seed Feeders with Species X}}{\text{Total Number of All Feeders with Species X}}$$

$$\text{Preference of Species X for High Feeders} = \frac{\text{Number of High Feeders with Species X}}{\text{Total Number of All Feeders with Species X}}$$

Table 16.4: Relative abundance and dominance. (Hand in to your Teaching Fellow)

Species	Relative Abundance	Aggressive Dominance
American Goldfinch		
Blue Jay		
Downy Woodpecker		
Hairy Woodpecker		
Dark-eyed Junco		
Black-capped Chickadee		
White-breasted Nuthatch		
Purple Finch		
Tufted Titmouse		

Formulas:

$$\text{Relative Abundance of Species X} = \frac{\text{Total Number of Species X Present}}{\text{Total Number of All Birds Present}}$$

$$\text{Aggressive Dominance of Species X} = \frac{\text{Number of Feeders with Only Species X Present}}{\text{Total Number of Feeders where Sp. X is Found}}$$

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Literature Cited

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Connell, J.H. 1961. The influence of interspecific competition and other factors on the distribution of the barnacle *Chthamalus stellatus*. Ecology 42:710-723.

MacArthur, R.H. 1958. Population ecology of some warblers of northeastern coniferous forests. Ecology 39:599-619.

APPENDIX

Bio 007 Behavior Lab

Bird Frequency Data (14:44 Monday, October 30, 1995)

Table of Species by Seed

Frequency (Expected)	**Big Seed**	**Small Seed**	**Total**
Black-capped Chickadee	1594 (1670.3)	350 (273.67)	1944
Tufted Titmouse	1242 (1202.9)	158 (197.09)	1400
White-breasted Nuthatch	860 (830.87)	107 (136.13)	967
Woodpecker	129 (118.57)	9 (19.427)	138
Dark-eyed Junco	69 (71.316)	14 (11.684)	83
Total	3894	638	4532

Statistics for Table of Species by Seed

Statistics	**DF**	**Value**	**Probability**
Chi-Square	4	48.102	0.000
Likelihood Ratio Chi-Square	4	48.814	0.000
Mantel-Haenszel Chi-Square	1	17.070	0.000
Phi Coefficient		0.103	
Contingency Coefficient		0.102	
Cramer's V		0.103	

Sample Size = 4532