

PH,D PROGRAM IN BIOLOGY - THE CITY UNIVERSITY OF NEW YORK  
FIRST EXAMINATION - ECOLOGY AND EVOLUTIONARY BIOLOGY  
FALL 1987

Session I. Short factual questions. Answer 10 of the following 12 questions. One brief paragraph should be used to answer each question.

- 1- Define Homology.
- 2- What is polarity with respect to character data?
- 3- What is the difference between clade and grade?
- 4- What is character displacement?
- 5- What is the neutral gene hypothesis?
- 6- What is balanced polymorphism?
- 7- What is meant by r- and K- selection?
- 8- What is meant by density-dependent and density independent factors in terms of population growth?
- 9- Define the term "Niche Breadth".
- 10- What is reciprocal altruism?
- 11- Define ESS.
- 12- What is an optimality theory?

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Session II. Longer factual essays. Answer two of the four questions.

- 1- Careful morphological and biochemical analyses have shown that most populations are characterized by a significant degree of genetic variation.
  - a) Discuss some methods by which variation can be measured.
  - b) In general, discuss the mechanisms by which such variation is increased and maintained in natural populations in spite of factors acting to reduce genetic variations (such as selection, inbreeding, etc.)
  - c) Discuss the significance of genetic variation in relation to adaptation, speciation, and extinction.
- 2- State and contrast center-of-origin, vicariance and ecological determinism. Give examples of each.
- 3- Body size is a variable which often differs significantly among closely related taxa, even within a particular geographic area. Choose any taxon familiar to you in which size variability among species occurs, and discuss the ecological implications of body size (e.g. demographic, reproductive, dispersal, physiological, competitive costs and benefits etc.) While this discussion is likely to be speculative, suggest experiments or observations which might be used to test hypotheses regarding the significance of body size.
- 4- Most bird species are monogamous while many, but not all, mammals are polygamous. What is the theoretical significance of these facts? Discuss a few exceptions for both birds and mammals, and state why these exceptions seem to occur.

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Session III. Data analysis. Select one of three questions.

- I- There are five taxa (1-5) and nine characters (A-I). - means the presence of a character, - its absence. Construct branching diagrams for the five taxa according to the criteria of cladistic, phenetic, and compatibility analysis.

Taxa	Characters								
	A	B	C	D	E	F	G	H	I
1	+	+	+	+	+	-	+	+	+
2	-	+	-	+	-	-	-	+	-
3	-	-	-	+	-	+	-	+	-
4	-	-	-	-	-	+	-	-	-
5	-	-	-	-	-	+	-	-	-

\*Note For phenetic analysis, assume simple matching.

Explain Your Answer

- 2- Given the five figures (1-5) generally titled "Ladybug Removal Experiments," answer the following:

In a field study in Rhode Island, Kareiva (1986) studied the effect of prey patchiness on the ability of a predator ladybug (*Coccinella septempunctata*) to control population density of an aphid (*Uroleucon* sp.). Aphids of this species feed on the stems of Goldenrod (*Solidago*). Patchiness was manipulated experimentally by mowing fields of goldenrod in various arrays (Fig. 1). The effects of patchiness on aphid density are shown in Figure 2. Figure 3 illustrates the response of the prey population to predator removal; Figure 4 shows the subsequent density of aphids in predator removal and control plots. Figure 5 summarizes Some demographic data for the aphid colonies.

Interpret these data and discuss these results within the context of the concept that species interactions structure communities. The author also discovered that the rate of aphid reproduction increased with increasing aphid density. Given this extra information, discuss the interaction of predation and competition in affecting prey density.



Fig. 11.2 Arrangements of patches and dispersal barriers used in goldenrod experiments. Actual linear strips or arrays of patches often curved slightly to conform to preexisting stands of goldenrod monoculture. Arrays within fields were separated by a minimum of 3 m. Although there was some movement by insects between arrays or strips, most movement was along the linear axis of each array or strip.

1

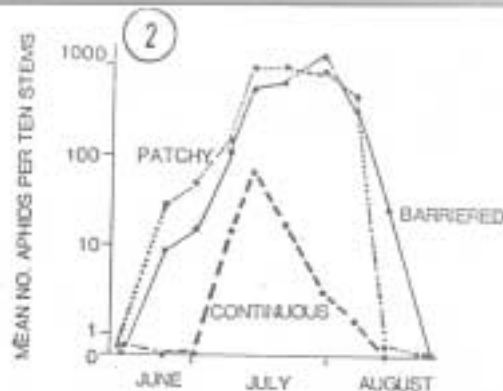


Fig. 11.3 The influence of patchiness manipulations on the density of the aphid *Uroleucon nigrotuberculatus* in 1982. Each point represents a mean from censusing 10 patches. Similar results were obtained in two other fields, although the mean densities differed between fields.

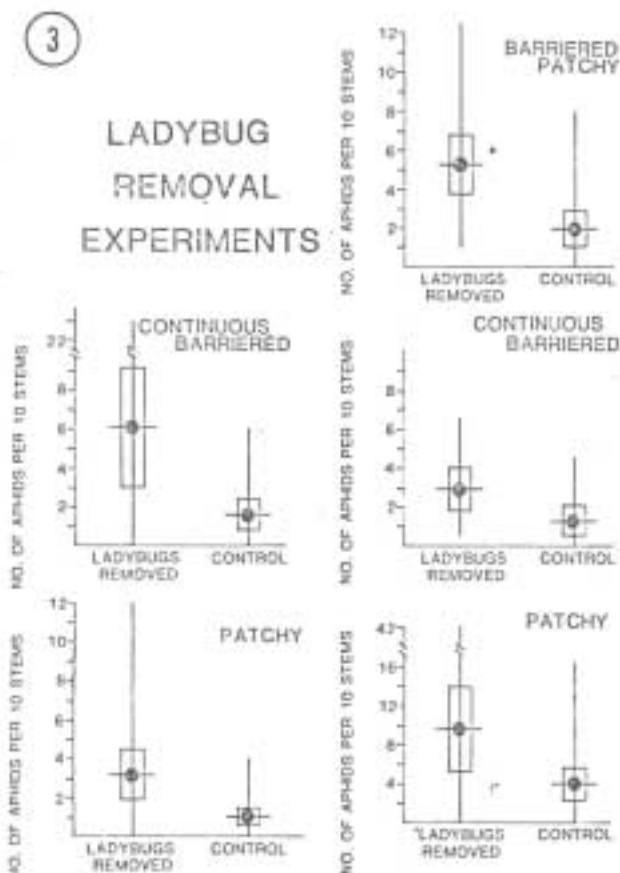
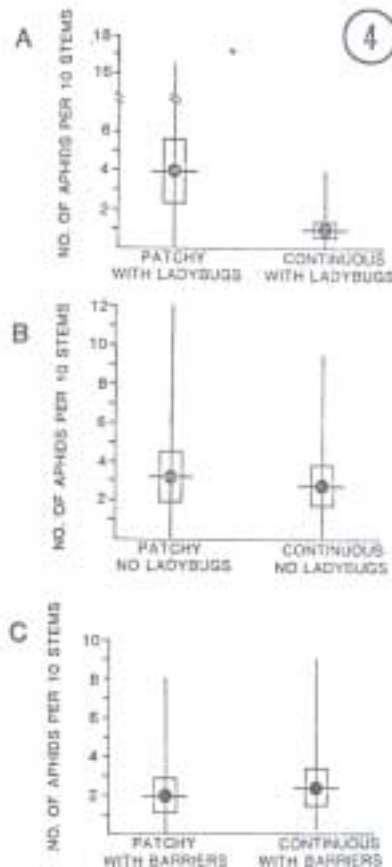


Fig. 11.4 The increase in *Uroleucon nigrotuberculatus* density with the removal of ladybugs in five pairs (ladybug removal and control) of goldenrod strips: two patchy, two continuous barriers, and one barriers patchy. The data shown are the mean, standard deviation, and range of the peak density of aphids during the



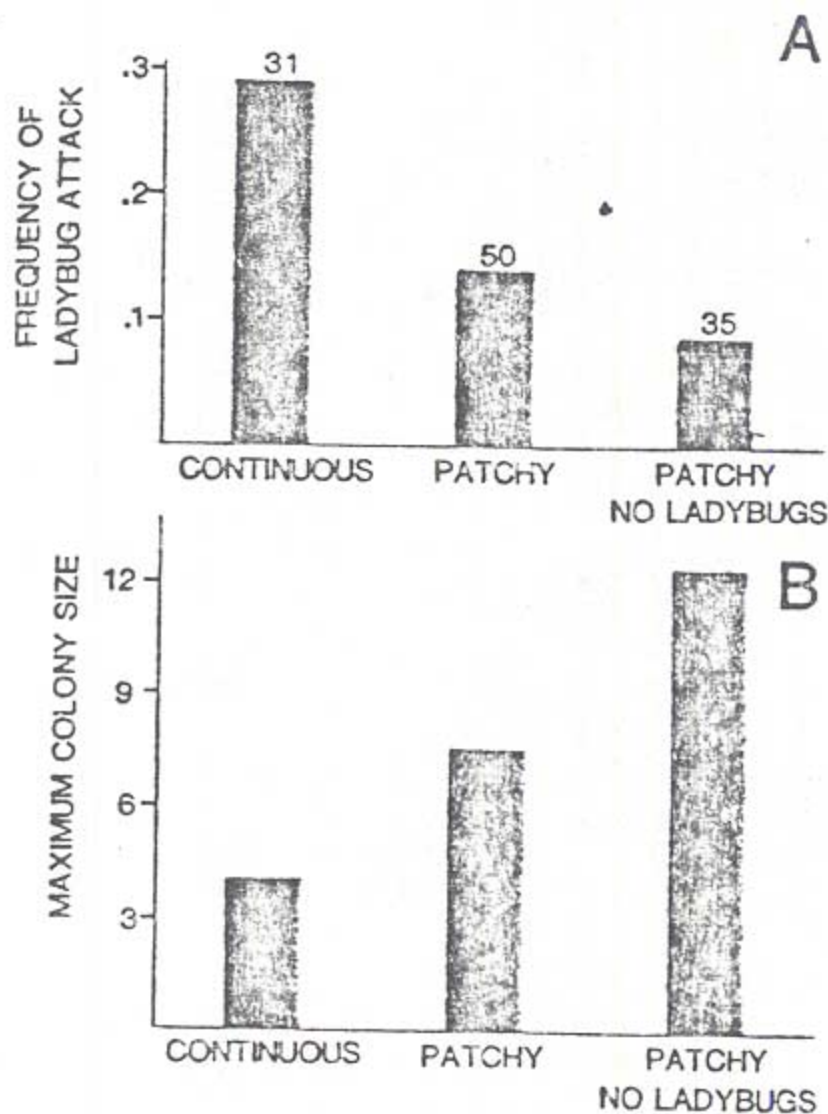


Fig. 11.7 Demographic data on the fate of randomly selected aphid colonies within continuous, patchy, and patchy with no ladybugs (ladybug removal) treatments. The colonies were censused three to five times weekly throughout the summer of 1983 or until the colony went extinct, that is, until all the aphids on a goldenrod ramet disappeared. (A) Proportion of colonies that, at any time during their existence, were discovered being attacked by ladybugs. Differences between treatments are significant. The attack rate is not zero for the ladybug removal treatment because, in fact, it was impossible to remove and keep removed *all* ladybugs. Numbers above bars represent the numbers of aphid colonies that were followed in each treatment. (B) Maximum size attained by colonies in the various treatments. All differences are statistically significant. The numbers of colonies observed were the same as in A.

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Session III. Data analysis continued.

Explain each graph in Figure 7-1, pointing out specific costs and benefits of territoriality. What would happen if temporal variation were introduced to the models parameters so that neither cost nor benefit was constant through time.

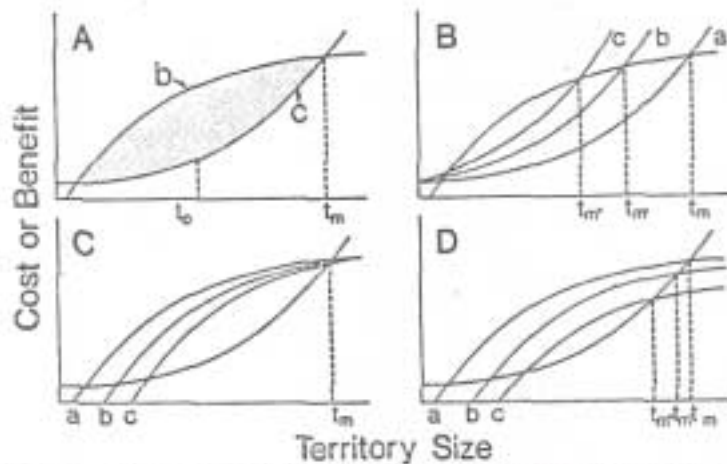


Figure 7-1. A model of optimal territory size based on the relationships between costs or benefits of territorial defense and the size of area defended. (See text.) A. The basic model: b, benefit curve; c, cost curve;  $t_o$ , optimum territory size;  $t_m$ , maximum defensible territory size. Shading defines region within which benefits exceed costs and therefore the range of economically defensible territory sizes given a particular set of cost and benefit curves. B. The effects of changing the cost curve. Small a,b,c identify three cost curves with the slopes increasing from a to b to c. C. A change in the benefit curve with maximum benefit held constant. D. A change in the benefit curve with maximum benefit decreasing from a to b to c.

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Session IV. Research Proposal.

Choose one of the following topic areas for your research and carefully develop each of the following in your proposal:

- a) What are the critical questions you are asking?
- b) What field and/or lab methodologies would you use to examine the question? What are your assumptions in using these techniques?
- c) What sort of data do you anticipate collecting?
- d) How would you organize and analyze the data?

1-Design a study to evaluate the proposition that acid precipitation has had a significant effect on the biota of lakes in upstate New York.

2-Many kinds of ants travel great distances from their nests in search of food. Design a study to discover how they find their way back to the nest.

3-Design a study to demonstrate that coevolution has occurred between a plant and an insect.