

I. Short Answer Questions (4-16 points each) DO ALL QUESTIONS

SAQ #1. Please state and BRIEFLY explain the two major objectives of community ecology. Please use a diagram for each, AND write an explanation.

diagram and explain objective 1, and explain the key “emergent properties” that this objective aims to explain – (4 pts)

diagram and explain objective 2, and explain the key “emergent properties” that this objective aims to explain – (4 pts)

Consider the simplest possible model of two species **competition** below:

for species 1:

for species 2

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = r_1 - a * N_2$$

$$\frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = r_2 - b * N_1$$

SAQ #2. (a). Describe this model. What do the terms to the left and right mean, and what are the principal assumptions of this model? (5 pts)

(b). On the axes at right plot the change in the population size of **N₁** using four little arrows corresponding to when **N₁** and **N₂** are common and rare. (4 pts)

(c). On the axes at right plot the change in the population size of **N₂** using four little arrows corresponding to when **N₁** and **N₂** are common and rare. (4 pts)

SAQ #3. On the axes at right combine the arrows from the two plots above (SAQ #2) and explain in a phrase in the space below what is the MAIN PREDICTION of this model: (6 pts)

SAQ #4. What did Joe Connell (1961) observe about the distribution of two barnacle species in the Scottish rocky inter-tidal? What exactly did Joe Connell (1961) do to understand what caused the barnacle distribution pattern in the Scottish rocky inter-tidal? What were the causes of the distribution pattern observed? Please use diagrams, sketches, etc., in your answer and explain the experimental design and experimental results. (8 pts)

SAQ #5. Consider the simplest possible model of two species **predator/prey interaction** below:

for prey:

for predator:

$$\frac{1}{\text{Prey}} * \frac{\Delta \text{Prey}}{\Delta t} = r_1 - a * \text{Predator}$$

$$\frac{1}{\text{Predator}} * \frac{\Delta \text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

a. In the graph at right, plot the change in the population size of **Predators** using four little arrows corresponding to when Prey and Predators are common and rare. (4 pts)

b. In the graph at right, plot the change in the population size of **Prey** using four little arrows corresponding to when Prey and Predators are common and rare. (4 pts)

c. In the graph at right, combine the arrows from the two plots above... (4 pts)

Consider again the simplest possible model of two species **predator/prey interaction** below:

for prey:

for predator:

$$\frac{1}{\text{Prey}} * \frac{\Delta \text{Prey}}{\Delta t} = r_1 - a * \text{Predator}$$

$$\frac{1}{\text{Predator}} * \frac{\Delta \text{Predator}}{\Delta t} = -r_2 + b * \text{Prey}$$

SAQ #6. Does this model lead to stable predator prey coexistence? **Yes or No ???** (1 pt)
And, briefly explain why or why not. (3 pts)

SAQ #7. What are the biological interpretations of higher alpha (α) and higher beta (β)?
higher alpha (α) - (3 pts)
higher beta (β)? - (3 pts)

- SAQ #8. Explain the effect that a higher alpha (α) and higher beta (β) would have on the chances of long term predator prey coexistence according to the model from the previous page. (4 pts)
- SAQ #9. When is it coevolution versus ordinary evolution? In your answer, please offer a definition of coevolution and describe exactly how this phenomenon differs from evolution. (5 pts)
- SAQ #10. If competition is not observed in a particular two species study system, despite considerable taxonomic and resource similarity, how valid is the conclusion that competition is unimportant in structuring this system? Please explain your reasoning. (4 pts)

I. Longer Answer Questions (15 points each) CHOOSE ANY 2 QUESTIONS and put a big “X” across the pages of the questions you do not want.

LAQ#1. What was the take home message of John Matter’s seminar on “Physiological Ecology of Reproduction in *Sceloporus*: a Lizard for All Seasons” at Widener University on Monday 23 November 1998? Please explain what, according to the speaker, were the principal research questions he was interested in answering, and explain why *Sceloporus* was a model system to study?
 principal research questions he asked – (5 pts.)
 why *Sceloporus* was a model system to study – (5 pts.)
 take home message – (5 pts.)

LAQ #2. This question will asses your understanding of the conditions for stable coexistence from the 2 species competition equations:

species 1:

species 2:

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = r_1 * \left(1 - \frac{N_1}{K_1} - \frac{a * N_2}{K_1} \right) \quad \frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = r_2 * \left(1 - \frac{N_2}{K_2} - \frac{b * N_1}{K_2} \right)$$

- (a). Please explain in words without using any symbols or notation what is the principal prediction of the 2 species competition model above.
- (b). It can be shown that stable competitive coexistence will always occur if two inequalities are true:

$$\frac{1}{K_2} > \frac{a}{K_1} \quad \text{and} \quad \frac{1}{K_1} > \frac{b}{K_2}$$

Show how EITHER ONE of these inequalities results directly from the 2 species competition equations above.

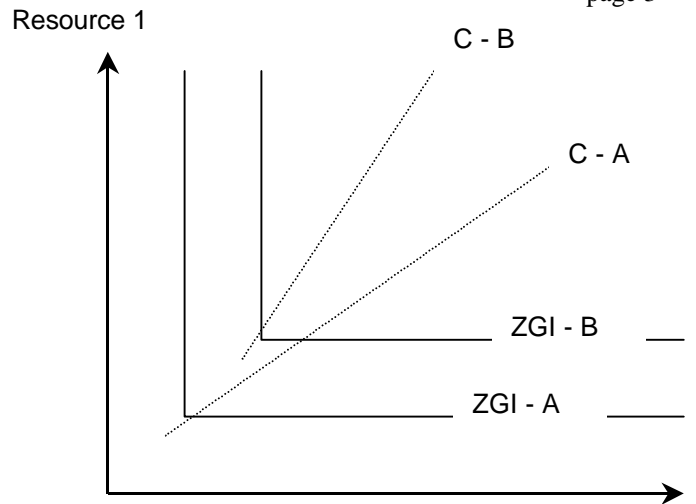
- (c). Please briefly explain how the conditions for stable coexistence (stemming from the inequalities above) validate the “competitive exclusion principle” which states simply that "complete competitors cannot coexist."

LAQ #3. This question will assess your understanding of David Tilman’s model of two species competition.

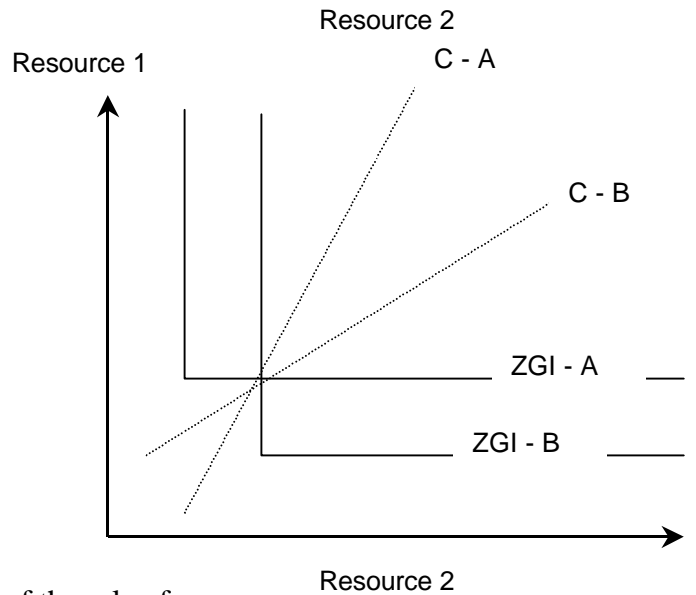
- (a). According to Stiling, a drawback to the Lotka-Volterra competition equations (appearing in LAQ #2) is that “no mechanisms are specified.” How does Tilman’s model address this drawback? Exactly what “mechanism” for competition does Tilman’s model explicitly assume?

- (b). According to Tilman’s model in the case for which the “zero growth isoclines” (ZGI-A and ZGI-B) and “consumption curves” (C-A and C-B) for species A and B appear in the figure at right, explain why this situation will always lead to exclusion of one of the two competitors?

Which one wins and why? (Hint: the C’s are unimportant)



- (c). According to Tilman’s model in the case for which the “zero growth isoclines” (ZGI-A and ZGI-B) and “consumption curves” (C-A and C-B) for species A and B appear in the figure at right, explain why this situation will always lead to coexistence of both competitors?



LAQ #4. This question will assess your understanding of the role of coevolutionary mutualisms in the origin of biological diversity.

- (a). Please briefly explain what is a coevolutionary mutualism. (5 pts)
 (b). According to a simple model of two species **mutualism** such as:

for species 1:

$$\frac{1}{N_1} * \frac{\Delta N_1}{\Delta t} = -r_1 + a * N_2$$

for species 2:

$$\frac{1}{N_2} * \frac{\Delta N_2}{\Delta t} = -r_2 + b * N_1$$

...recall that it is not possible for these species to regulate each other – either they go to extinction or infinity.

What does this finding imply about the mechanisms of regulation for these species, and why does this implication lead to the argument that tight obligatory mutualisms, for which essential needs of each species are met by the other, might directly lead to rapid speciation of both lineages in phylogenetic parallel (their phylogenetic trees perfectly overlap)? (10 pts)

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