Previous Lecture

Population Dynamics
D. Intraspecific Competition

Lecture 7

Interspecific Competition: Exploitation

Exploitation competition -

plants - Deschampsia antarctica and Colobanthus quitensis (and moss) using water or nutrients from the same soil patch, and shading each other.
Lecture 7
Exploitation Competition
- animals - goldfinches and house finches both eating thistle seeds in the same field.

Lecture 7
Interspecific Competition
- Interference competition -

wolf  grizzly bear

Lecture 7
Lotka-Volterra Model
- Premise: Adding individuals of another species is the same kind of density-dependent effect as adding individuals of the same species. But the magnitude may be greater ($\alpha > 1$) or less ($\alpha < 1$) than with interspecific competition.

\[ \frac{dN_1}{dt} = r_1 \left( \frac{K_1 - N_1 - \alpha N_2}{K_1} \right) N_1 \]
Competition Coefficient ($a_{12}$)

- If $\alpha = 1$, then species 2 = species 1
- If $\alpha < 1$, sp. 2 has a smaller effect than sp. 1
- If $\alpha > 1$, sp. 2 has a greater effect on 1 than 1
- Note: if $\alpha = 0$, then sp. 2 has no effect on sp. 1.

- Note: in some sample exam problems, you may see $a_{12} (= \alpha)$ and $a_{21} (= \beta)$ for the competition coefficients

Review: Lotka-Volterra Competition

For two species, L-V is two equations:

\[
\frac{dN_1}{dt} = r_1 \left( \frac{K_1 - N_1 - \alpha N_2}{K_1} \right) N_1
\]

\[
\frac{dN_2}{dt} = r_2 \left( \frac{K_2 - N_2 - \beta N_1}{K_2} \right) N_2
\]

Determining The Outcome of Competition

"Zero-growth isolines" determined for each species
Determining the Outcome of Competition

If a 2-species community started at $N_1=20$, and $N_2=20$, how would $N_1$ change? (A) $N_1$ would increase, (B) $N_1$ would decrease, (C) $N_1$ would stay the same, (D) It is impossible to tell.

Draw an arrow showing this change.

If a 2-species community started at the asterisk, how would $N_1$ change? (A) $N_1$ would increase, (B) $N_1$ would decrease, (C) $N_1$ would stay the same, (D) It is impossible to tell.

Draw an arrow showing this change.

Draw arrows in all 3 spaces defined by the lines.

What is the ENDPOINT???
Outcome of Competition

- Species 1 WINS!!! (where $K_1 > K_2 / \beta$ AND $K_1 / \alpha > K_2$)
- Endpoint: $N_1 = K_1$, $N_2 = 0$
- Endpoint is the same regardless of starting $N$.

Why are we doing this?

- New parameters important: $K$, $\alpha$
- Defines:
  - conditions for coexistence,
  - the limiting similarity
- Predicts character displacement in zones of sympatry for competing species

Graphical analysis - Case 1

Species 1 Wins

Conditions:
Case 2
Species 2 wins

Case 3 - Try One Yourself!

Result? A. Species 1 wins  B. Species 2 wins  C. The two species coexist  D. The outcome depends on the starting point.

Case 3 - Try One Yourself!

Starting from the red asterisk, draw the two-species population trajectory to the “endpoint” of competition.
Case 3 - Try One Yourself!

If competition started at the *, where would it eventually end up? Does any species end up at its carrying capacity?

Case 4 - Conditional competitive exclusion

Graphical analysis - conclusions
- There are four possible outcomes of competition
- Qualitative outcome = f(K, α)
- r does not influence the outcome (exc. Case 4)
- Initial N does not influence the outcome (exc. Case 4)
- We can define the boundary conditions of stable coexistence - VERY IMPORTANT!
Summary

- Competition theory emphasizes the importance of competitive ability and carrying capacity in determining the outcome of competition.

- Next time: The theory predicts the conditions required for coexistence, defines the limiting similarity, and predicts character displacement in zones of sympatry for competing species.