The Influence of Soilborne Pathogens on Seedling Mortality

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Diversity

• One of the fundamental questions of ecology

• Proposed contributors:
  – Habitat complexity
  – Niche differentiation
  – Specialized predators and pathogens
Janzen-Connell Effect

(Janzen, 1970)
Janzen-Connell Effect

Canopy

“Dead Zone”

Likely Successful Recruitment
The “Dead Zone” of species A opens a gap for species B
How do emergent patterns at the population level affect patterns of seedling recruitment?
Emergent Patterns
Emergent Patterns
Emergent Patterns
Emergent Patterns
Emergent Patterns
How does an extreme spatio-temporal life cycle mismatch between consumer and producer affect Janzen-Connell patterns?
Model Tree Life Cycles

- Mature trees disperse seeds once a year according to a dispersal kernel

(Janzen, 1970)
Model Pathogen Life Cycles

- **Oomycetes**
- **2 modes of reproduction**
  - Zoospores – flagellated for movement through soil water
  - Oospores – long term dormancy, local hyphal colonization
- **Reproduction several times a year, depending on conditions**
- **Zoospore dispersal on much smaller scale**
- **Long-term colony in roots of parent trees**
Individual-scale Models
Population Models

Black = trees
Green = seeds
Population Models

• A seed survives pathogen infection according to:

\[ P(\text{survival}) = e^{(-\gamma \nu d)} \]

\( \gamma \) = probability a seed will encounter a spore
\( \nu \) = infectivity
\( d \) = density of spores
Hybrid Modeling

\[ P(\text{survival}) = e^{(-\gamma Vd)} \]

Seedling Survival
Outputs

• Demographics of trees
  – Lifespan, age distribution, infection rate
  – Cause of mortality (intraspecific competition vs. pathogen infection)
  – Seedling survival rate

• Spatial distribution of trees
  – Regularity of arrangement
  – Average distance between neighbors
Analysis

• Sensitivity Analysis
  – Test various parameter combinations
  – Which parameters have the biggest effect?
Expected Results

• More active fungi will create larger gaps in tree population because of increased seed mortality
• Density-dependent mortality will increase with decreasing pathogen activity
• Increased lifespan of infected living trees contributes to pathogen mortality
Questions?