Impact of Allee effects on the establishment of biocontrol agents

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Introduction

Crucial Step: Establishment
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Factors influencing Establishment

• Biocontrol species characteristics
• Host plant characteristics
• Climate and Habitat
• Time of release
• Allee effects
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- Biocontrol species characteristics – Reduced Genetic diversity
- Host plant characteristics
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Crucial Step: Establishment

Factors influencing Establishment

• Biocontrol species characteristics – Reduced Genetic diversity
• Host plant characteristics – Insufficient quality (low nitrogen)
• Climate and Habitat – Mismatch and variability
• Time of release
• Allee effects
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Crucial Step: Establishment

Factors influencing Establishment

- Biocontrol species characteristics – Reduced Genetic diversity
- Host plant characteristics – Insufficient quality
- Climate and Habitat – Mismatch and variability
- Time of release
- **Allee effects**
Introduction: Allee Effects

What is the Allee effect?
- Decrease in per capita growth rate with a decrease in population size
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Typical signs:

- Reduced probability of Establishment at smaller population sizes
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- Reduced probability of Establishment at small population sizes
- Reduced per capita growth rate at small population sizes
- Threshold below which negative growth rate is experienced
Objectives

• Theoretical population models indicate Allee effect to be a major factor
• Field evidence scarce
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**Invasive Weed:** *Tradescantia fluminensis*

**Biocontrol agent:** *Neolema ogloblini*
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We asked:
- Allee effect present?

Invasive Weed: *Tradescantia fluminensis*

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We asked:

- Allee effect present?
- Which driving mechanisms?

Invasive Weed: *Tradescantia fluminensis*

Biocontrol agent: *Neolema ogloblini*
Methods: Detecting Allee effect

- Made several small replicated releases
  - Release sizes: 2, 4, 8, 16, 32, 64
  - 5 replicates per release size
Methods: Detecting Allee effect

- Manipulate initial population size of replicated releases
  - Release sizes: 2, 4, 8, 16, 32, 64
  - 5 replicates per release size

- Evaluated impact of release size on:
  - Probability of establishment
  - Per capita population growth rate
Results: Detecting Allee effect

- Allee effect present
  - Probability of establishment increased with increasing release size

\[ X^2 = 2.191; \text{df} = 1.25; P = 0.028 \]
Results: Detecting Allee effect

- Allee effect present
  - Probability of establishment increased with increasing release size
  - Per capita population growth rate increased with increasing release size

\[ X^2 = 2.191; df = 1.25; P = 0.028 \]
\[ X^2 = 3.369; df = 1.25; P = 0.003 \]
Methods: Determining Driving Mechanism No 1
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Mate limitation?
Methods: Driving Mechanisms

1) Mate limitation
• Made several small replicated releases
  − Release sizes: 2, 8, 16
  − 6 replicates per release size
  − Used new, unmated adults
1) Mate limitation

- Made several small replicated releases
  - Release sizes: 2, 8, 16
  - 6 replicates per release size
  - Used new, unmated adults

- Evaluated impact of recovered male density on:
  - Mating status of recovered females
Results:  Driving Mechanisms

1) Mate limitation

Probability of being mated increased with increasing number of live males recovered

\[ X^2 = 2.138; df = 1.49; P = 0.0325 \]
Methods: Driving Mechanism No2
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Generalist predation?
Methods: Driving Mechanisms

2) Generalist predation
   • Noted high levels of larval predation during release size field trials
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2) Generalist predation

- Noted high levels of larval predation during release size field trials

- Predator exclusion field trials
  - Cages:
    - Total exclusion (Closed)
    - Partially open (Sham)
    - Open to predators (Open)
  - Two densities:
    - High (50 eggs)
    - Low (22 eggs)
Results: Driving Mechanisms

2) Generalist Predation

• Proportion of larvae surviving highest in total exclusion cage
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- *Tested* larval densities had no significant influence on survival
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- Proportion of larvae surviving highest in total exclusion cage
- *Tested* larval densities had no significant influence on survival
- Additional testing with higher populations is needed
Conclusions

• Establishment of small populations of *N. ogloblini* is affected by Allee effects.
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• Preliminary results indicating predation and mate limitation as driving mechanisms.
Conclusions

• Establishment of small populations of *N. ogloblini* is affected by Allee effects.
• Preliminary results indicating predation and mate limitation as driving mechanisms.
• Allee effect potentially impacting establishment and spread of many biocontrol agents.
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