Effectiveness of pathogens in reducing populations of invasive plants: The Australian bridal creeper case study

Louise Morin, CSIRO Ecosystem Sciences, Australia

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Outline

• Introduce the case study

• Effectiveness:
  • Before and after release comparisons
  • Fungicide exclusion experiments

• Conclusions

Coast Swainson Pea after bridal creeper biocontrol
Bridal creeper (*Asparagus asparagoides*)

- a scrambling vine native to South Africa.
- introduced in Australia in the mid 1800’s as an ornamental.
- became a major invasive plant across temperate regions, smothering large areas of native vegetation.
- extensive below-ground rhizomes and tubers.
- senesces in summer.
Pathogen agent released

Rust fungus *Puccinia myrsiphylli*
- Introduced in 2000
- Macroyclic and autoecious
- Released at > 2000 sites

Releases as of July 2008
Insect agents released

Undescribed Erythroneurini leafhopper
- Introduced in 1999
- Previously *Zygina* sp.
- Released at ≈900 sites

Impact on bridal creeper

[Graph showing above-ground and tuber biomass RGR (day⁻¹) with data from Turner et al. 2010. *Biological Control* 54: 322-330.]
Insect agents released

**Crioceris** sp. leaf beetle
- Introduced in 2002
- Released at 82 sites
- Confirmed established at only 3 sites
Before and after release: photo points

Reduction of bridal creeper density following biological control at Yanchep NP, WA

2000 + 2003

Leafhopper
Methods

- 15 sites across Australia.
- 3-4 permanent plots (3X3m) with trellises (1X2m) per site.
- Growth and reproductive parameters of bridal creeper measured in mid-spring:
  - in a 1 m² quadrat within each plot and climbing on the trellis.
  - 1 to 3 years before release and up to 8 years after release.
- Incidence of rust and leafhopper also measured.

Before and after release: quantitative comparisons

Incidence / m² (%)

<table>
<thead>
<tr>
<th>Sites</th>
<th>WA</th>
<th>SA</th>
<th>Vic</th>
<th>NSW</th>
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<td>Bold Park</td>
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<td>Yanco</td>
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* = leafhopper not released at that site.
Before and after release: quantitative comparisons

- Bridal creeper foliage dry weight (g) or seedling or shoot number / m²
- Monitoring period:
  - Before release
  - 3-year period immediately after release
  - Late after release

<table>
<thead>
<tr>
<th>Monitoring period</th>
<th>Foliage</th>
<th>Seedlings</th>
<th>Shoots</th>
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<td>3-year period immediately after release</td>
<td>4.4</td>
<td>5.4</td>
<td>7.3</td>
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<tr>
<td>Late after release</td>
<td>6.4</td>
<td>19.1</td>
<td>53.6</td>
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Back-transformed scale
Before and after release: quantitative comparisons

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<th>Yanco</th>
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<tbody>
<tr>
<td>Foliage dry weight (g) / trellis</td>
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<td>2.2</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* = significant difference between ‘Before release’ and ‘Late after release’ measurements for that site.
Fungicide exclusion experiments

Methods
- Conducted over 4 years.
- 6 sites in NSW and WA.
- 3 treatments: control, water and fungicide monthly applications.
- 30 permanent quadrats (1m²) per treatment at each site (5 blocks)
- Measurements taken:
  - Bridal creeper above-ground growth and reproductive parameters each year.
  - Cover of associated vegetation each year.
  - Rust incidence and severity each year.
  - Bridal creeper below-ground biomass at the end of experiments.

H = Foliage harvested in early October each year
Fungicide exclusion experiments

Bridal creeper measurements at time of harvest each year

Above-ground biomass dry weight (g)

No. of stems

No. of fruits

Control
Water
Fungicide

+ Rust
− Rust

2005 2006 2007 2008
Fungicide exclusion experiments

### 'Old' tubers dry weight (g)

- **Control**
- **Water**
- **Fungicide**

### 'New' tubers dry weight (g)

- **Control**
- **Water**
- **Fungicide**

Above-ground biomass **harvested** each year
Above-ground biomass **NOT harvested** each year
Fungicide exclusion experiments

% bridal creeper cover

- Rust

+ Rust
Fungicide exclusion experiments

Significant increase in bare ground and leaf litter across all sites
Small increase in both native and invasive plant species

Leaf litter
Clematis glycinoides
Asparagus scandens
Conclusions

Did we achieve our goal?

Modified from Briese 2000
Conclusions

Why has this rust fungus been so effective?

• A single genotype of bridal creeper present in Australia
• Rust fungus isolate released:
  • Perfectly ‘matched’ to the invasive genotype.
  • Sourced from the Western Cape Province of South Africa, which climatically matched bridal creeper-infested regions in Australia.
  • Infect all foliage, irrespective of age.
  • Well-synchronised with its host.
• Both plant and pathogen are active in winter:
  • Good rainfall and almost daily dew formation.
• CSIRO, CRC for Weed Management, various funding schemes from the Australian Government and the respective organisations of our collaborators.
• Adele Reid, Mick Neave, Bob Forrester, Paul Yeoh, Katherine Batchelor, John Scott (CSIRO).
• Peter Turner (DECC, NSW).
• John Virtue and colleagues (DWLBC, South Australia), John Hosking and Royce Holtkamp (I&I NSW), Greg Lefoe and colleagues (DPI Victoria).