The overwintering biology of *Aphelinus certus*, an adventive parasitoid of soybean aphid

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Images: Kelton Welch
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Soybean Aphid
\( (Aphis\ glycines,\ Hemiptera:\ Aphididae) \)
Soybean Aphid Lifecycle
Timeline of soy, soybean aphid, & *Aphelinus certus*

- **2000**: Soybean aphid arrived in North America (WI)
- **2005**: A. certus first detected in North America (PA)
- **2010**: A. certus recognized as important control agent of SBA in Quebec and Ontario
- **2011**: A. certus first detected in MN
- **2015**: Field studies in MN found that A. certus alone can suppress aphids below economic threshold
- **2018**: Overwintering studies addressed today
Genus *Aphelinus*  
(Hymenoptera: Aphelinidae)

- Develop to adulthood in ~3 weeks.
- ~1mm, weak fliers, but long-lived.
- Can parasitize 100-200 aphids in lifetime.
- Can also kill hosts by feeding on them.
What is the overwintering biology of *A. certus*?

- Supercooling point and cold tolerance of diapausing mummies
  - How cold is too cold?
- Overwintering survival of outplanted diapausing mummies
  - What are the effects of latitude and microhabitat?
- Spring emergence trapping of adult wasps
  - Do they overwinter in soy fields?
Supercooling point of diapaus ing mummies

• Decrease from 21°C to -40°C at ~1°C/min.
• Temperature recorded 1x/sec
• SCP = lowest temp prior to release of latent heat of fusion
• N=34
A. certus’ supercooling point is approximately -28°C

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
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</thead>
<tbody>
<tr>
<td>Mid-winter</td>
<td>14</td>
<td>-28.46</td>
<td>2.30</td>
<td>0.61</td>
</tr>
<tr>
<td>Recently mummified</td>
<td>20</td>
<td>-27.62</td>
<td>2.20</td>
<td>0.49</td>
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</tbody>
</table>

$t = -1.0637$, $df = 27.357$, $p$-value = 0.2967
Cold tolerance of diapausing mummies

-30, -28, -25, -22, -20, or 5°C

3 months winter: dark, 5-10°C

Summer, emergence 16:8 L:D and 20°C
Those dissected 1 week after cold-exposure suggest freeze-intolerance.
Wasp emergence after three months of simulated winter further suggests freeze-intolerance and reveals high background mortality.
Logistic regression: Survival was less affected by temperature than whether the insect froze

<table>
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<tr>
<th></th>
<th>Estimate</th>
<th>Std Err</th>
<th>P-value</th>
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</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.570</td>
<td>0.33</td>
<td>0.08</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.024</td>
<td>0.015</td>
<td>0.11</td>
</tr>
<tr>
<td>Supercooled</td>
<td>-2.538</td>
<td>0.77</td>
<td>0.001</td>
</tr>
</tbody>
</table>
\[ LT_{50} = -22.45^\circ C \]
\[ LT_{90} = -33.9^\circ C \]
What are the effects of climate and microhabitat on survival of outplanted diapausing mummies?
2016-17 Woodlot microhabitats near soy fields along NS transect
2016-2017
Survival was higher in the litter and at lower latitudes. The negative effect of foliage was especially strong at high latitudes.

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<tr>
<td>Intercept</td>
<td>0.239</td>
<td>0.08</td>
<td>0.004</td>
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<tr>
<td>MicroHabitat: Foliage</td>
<td>-0.708</td>
<td>0.12</td>
<td>&lt;0.001</td>
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<tr>
<td>Latitude</td>
<td>-0.074</td>
<td>0.02</td>
<td>0.002</td>
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<tr>
<td>Foliage*Latitude</td>
<td>-0.411</td>
<td>0.05</td>
<td>&lt;0.001</td>
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</table>
2017-18
The subnivean zone is warmer and less variable than exposed foliage.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>Foliage</td>
<td>-6.8</td>
<td>7.1</td>
<td>-6.5</td>
<td>-24.2</td>
<td>12.1</td>
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<tr>
<td>Leaf Litter</td>
<td>-3.1</td>
<td>2.6</td>
<td>-2.8</td>
<td>-15.1</td>
<td>12.2</td>
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</table>
2017-18
Appreciable survival only occurred in leaf litter and was greater in woodlots.
2017-18
Post-diapause emergence took 7-8 days longer than expected based on Frewin et al. 2010
Spring Emergence Traps: 2017 & 2018

- 64 bucket traps placed in May and June each year, both tilled and no-till fields
- 21.4 M² of each type covered in each year
- Checked weekly for ~6 weeks.

**Results:**
Many insects trapped, but no *Aphelinus spp.* were recovered either year
Summary of Results

• Supercooling point of diapausing mummies
  • -28°C

• Lower lethal temperature of diapausing mummies
  • Probably freeze intolerant

• Overwintering habitat potential
  • Survival much better under snow than on exposed foliage

• Spring emergence trapping
  • Zero *Aphelinus* captured from soy fields thus far
Further questions

• What are the effects of sustained cold (rather than brief exposures) on survival?
• What are the cues and timing of diapause induction and emergence?
• Does A. certus overwinter in soybean aphid hosts on buckthorn plants?
• Does A. certus overwinter in other aphids?