Do Trees Respond to Insect Attack?

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Introduction

- Insects and microbes could consume all the plant material on earth, yet the world remains green.
- **Why does the world remain green?**
- Plants can produce defense compounds in response to insect feeding.
- These inducible defenses decrease insect growth and may reduce the growth of subsequent insect generations.
- Inducible defenses are beneficial to plants because they use resources only when the plant is under attack and therefore maximize the resources available to plant growth.
- Inducible defenses create short term changes in leaf chemistry that may explain the large fluctuations seen in forest caterpillar abundance.
- Short term inducible defenses may influence caterpillar feeding behaviors.
- Leaf damage will be more uniform in trees displaying inducible defenses and more clumped in trees without inducible defenses.

Hypotheses

H1 Understory tree species can produce inducible defense compounds.

- A feeding caterpillar can induce short term defense compounds.
- Application of defense compounds can induce short term defenses.

H2 Caterpillars fed leaves from the same short shoot as leaves damaged by herbivory, mechanical tearing and jasmonic acid will have low growth performance.

H3 The presence of inducible defenses can affect the feeding behavior of foraging caterpillars.

Methods

- I conducted field work on Mt. Moosilauke in the White Mountains of New Hampshire.
- The study included three understory tree species:
  - Striped maple (*Acer pensylvanicum*)
  - Sugar maple (*Acer saccharum*)
  - American Beech (*Fagus grandifolia*)

- I applied five treatments to forty trees of each species:
  1. **Jasmonic Acid –** JA dissolved in 10% ethanol in water was sprayed onto the surface of mechanically torn leaves.
  2. **Solution control –** 10% ethanol in water was sprayed onto leaves.
  3. **Herbivory** - Third instar white marked tussock moth caterpillars were placed in mesh bags on individual leaves.
  4. **Control –** Untreated leaves from trees that received treatments 1, 2, and 3.
  5. **True control –** Untreated leaves from trees that did not receive treatment.
- I conducted lab growth trials to test the influence of changes in leaf chemistry on caterpillar growth performance.
- Third instar white marked tussock moth caterpillars were fed leaves from the same short shoot as each treatment leaf.
- I compared the relative growth rates of caterpillars across treatments.

Above: White marked tussock moth caterpillar.

Right: Mesh bags were used to enclose caterpillars on individual leaves in order to simulate a herbivory response. This bag is shown on a sugar maple short shoot.

Feeding Behavior

- I surveyed ten trees of each species for signs of caterpillar feeding damage.
- Every leaf on each tree was categorized by the percent of leaf material eaten by herbivores.

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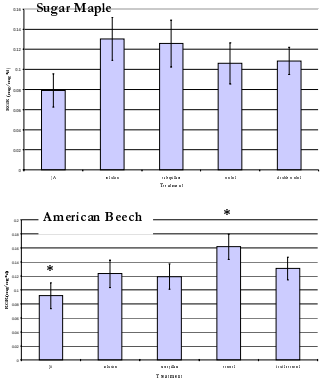
Above: Caterpillar feeding damage found on sugar maple leaves during feeding behavior survey.

Preliminary Findings and Further Study

Striped Maple: White marked tussock moth caterpillars did not have positive growth rates when fed striped maple leaves. Treatments had no affect on caterpillar growth because striped maple is a poor food choice for white marked tussock moth caterpillars.

Sugar Maple: No statistically significant differences were evident between treatments in the sugar maple growth trial. Jasmonic acid application displayed a marginally significant reduction in relative growth rate.



Top: The relative growth rates of caterpillars showed no significant response to the five treatments in sugar maple.

Bottom: The application of jasmonic acid statistically reduced the relative growth rate of caterpillars fed adjacent short shoot leaves compared to control leaves in american beech.

Right: American beech leaf with no apparent feeding damage.

American Beech: The difference between the jasmonic acid treatment and control were statistically significant in the beech growth trial.

- Leaves on the same short shoot as leaves sprayed with jasmonic acid provided less palatable food for caterpillars than control leaves.
- This result supports the hypothesis that the application of jasmonic acid will induce short term changes to leaf chemistry, and shows that beech may be capable of inducing defense compounds in leaves under attack.
- To further support this data, patterns of feeding damage can be quantified in beech and maple to check for the presence of inducible defenses.

New Hypothesis

H1 In feeding behavior surveys, beech will display a uniform distribution of feeding damage and sugar maple will have more clumped areas of extensive damage.

- Future analytical analysis of feeding behavior data will lead to results that either support or falsify the results of the induced defense growth trials.