

An Evaluation of Indirect Interactions Between Herbivore Guilds: Effects of Meristem Miners on Flower Head Feeders

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Abstract. In the study of biological control of weeds, effects of insect herbivores that attack different plant organs have long been assumed to be independent events. Emerging research indicates stronger interactions between herbivore guilds than was expected historically. My research focuses on damage to apical meristems of tall thistles (*Cirsium altissimum*) by stem mining insects and the indirect, plant-mediated effects of this damage on flower head feeding insects. Two questions were addressed: 1) how does mining of the apical meristem affect tall thistle architecture, including number of branches and flower heads produced? 2) what influence does apical meristem mining have on the intensity of damage to the plant by flower head feeding herbivores? Forty adult tall thistles at two different sites (80 plants total) were assigned to levels of a “meristem-herbivore exclusion treatment” in April, 2008. Insecticide was applied to the apical meristem of treatment plants. Control plants were sprayed with water or were not sprayed. Apical meristem mining had significant effects on; flower heads ($F_{2,2}=45.97$, $p=0.021$), primary stems ($F=11$, $p<0.001$) and plant height over-all ($F_{2,4}=26.39$, $p=0.004$). There was a marginally significant effect on flower head damage, further work will be needed to understand the biological significance of this finding.

1. Introduction

A long-standing, dominant paradigm in insect community ecology has been independence between different guilds of insects feeding on a plant, illustrated by the ideal free distribution hypothesis (1). This hypothesis states that resources in an ecosystem are divided up to decrease inter-specific competition. For example, the ideal free distribution hypothesis would suggest that a folivore removing leaf tissue would have little or no effect on a pollen feeder. It is becoming increasingly clear that there is non-independence between phytophagous insect guilds. There are diverse mechanisms by which non-independence of phytophagous insect guilds can arise. One is direct competition where damage to a plant by one insect species deprives a second insect species of limiting resources. Another mechanism of non-independence could be plant-mediated indirect effects. This includes morphological or chemical changes in a plant in response to damage by one herbivore guild that either increases or decreases the plant's attractiveness to a different guild. Root herbivory often causes physiological and/or morphological changes in a plant (2). Masters et al (2001)(3) used *Cirsium palustre* for a study of indirect interactions between different feeding guilds of insects. They found that a root feeding herbivore changed the chemistry of the plant making it more attractive to a seed-feeding Tephritid fly. Increased tephritid fly densities, in turn, led to an increase in abundance of a parasitoid wasp, illustrating a non-independence of three insect guilds; two herbivorous and one parasitoid.

My research focuses on damage to apical meristems of tall thistle (*Cirsium altissimum*) by stem mining insects and the indirect, plant-mediated effects of this damage on flower head feeding insects. Two hypotheses were addressed; 1) Apical meristem mining has no effect on tall thistle architecture, including number of branches and flower heads produced. 2) Apical meristem mining has no impact on the intensity of damage to the plant from flower head feeding herbivores.

2. Experiment, Results, Discussion, and Significance

For my experiment, I am using three sites; the WSU Biological Field Station, Chisholm Creek Park, and Pawnee Prairie Park. Apical meristem damage was prevented by insecticide treatment. Insecticide was carefully applied to the center of thistle rosettes before they produced a reproductive stalk. Every effort was made to avoid applying insecticide to rosettes' leaves, so as to not incur confounding effects of reduced damage to the leaves. The insecticide was Bifen IT (Control solutions INC). This insecticide is non-systemic, so it is not taken into the plant,

and will only deter insects that use plant parts where the insecticide was applied. Insecticide was applied repeatedly to the apical meristem once rosettes produced reproductive shoots. The controls consisted of no treatment and an application of water in an equivalent amount to the insecticide sprayed, to account for the extra water added to the plant when insecticide is applied.

Measurements of plant architectural complexity, size and flower head production were taken three times during the growing season for WSU Biological Field Station and Chisholm Creek. Pawnee Prairie received only two rounds of measurements. Early season measurements (April) included stem length, root crown diameter and rosette diameter. Measurements at onset of flowering and end of flowering included number of flower heads per plant, number of primary branches, stem length, plant height, root crown diameter, plant diameter and presence/absence of the terminal flower head on the reproductive shoot flower head. Flower heads were collected from thistles in the experiment and are being dissected to quantify damage by flower head feeding insects. Statistical analysis will consist of two-way ANOVA's with insecticide application as the fixed effect, and site as a random effect. Dependent variables for describing plant architecture include stem height, number of flower heads, number of primary branches, total plant height. After flower head dissections are completed, indices of flower head damage by insects also will be analyzed.

Preliminary results show that the application of insecticide to the apical meristem and the resulting reduction in damage by apical meristem-feeding insects changes; total plant height, stem height and total number of flower heads produced. The primary stem of plants sprayed with insecticide were taller ($F_{2,2}=11.01$, $p=0.0228$) than water control and control plants (mean 77.125 cm, se 5.498, mean 56.81 cm, se 2.84, mean 61.21 cm, se 3.899 respectively). Total plant height was greater ($F_{2,4}=26.39$, $p=0.0039$) with insecticide than water control and control (mean 94.88 cm, se 4.047, mean 81.516 cm, se 3.226, mean 84.273 se 3.685). The total number of flower heads produced was lowest ($F_{2,2}=45.97$, $p=0.0213$) with insecticide than water control and control.

3. Conclusions

Preliminary results provide experimental evidence that meristem mining insects can result in changes in plant morphology as well as reproductive organ development. These architectural changes provide a mechanism that may drive plant-mediated effects of meristem-feeders on flower head feeders.

Data will be collected throughout the summer of 2009 in the same manner.

4. Acknowledgments

This project is funded in part by NSF DEB 0532018 to FL Russell and S Louda. I would like to thank my advisor, Dr. Leland Russell, and committee members, Dr. Chris Rogers and Dr. John Greiss, my colleagues Erin White, Halley Terry, Amber Dunham, Ashley Dunham, Shubha Shrestha, Lorna Harder and all members of the biology department.

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