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Introduction

Insect herbivores play an important role in shaping the selection environment for plant populations. Environmental changes, such as habitat fragmentation, alter the interactions between plants and insects in ways that carry consequences for plant fitness.

Ant-aphid interactions are a keystone interaction for plant and insect communities⁴. Aphids feed on plant phloem, thus removing nutrients while leaving tissue intact. Ants tend aphids for their sugary secretions, thus protecting them against predators.

Studies have documented both net-positive and net-negative effects of aphids on host plants. Effects of aphids include, 1) reducing growth and fecundity², and 2) reducing damage from other herbivores⁴. This may occur directly, through aphids reducing plant nutritional quality or indirectly through defensive behavior by aphid-tending ants¹.

Hypothesis:

Aphid infestation influences the frequency of foliar herbivore damage in the purple coneflower, *Echinacea angustifolia*.

Study organisms:

Echinacea angustifolia



- Serves as a model organism for studying the consequences of habitat fragmentation for prairie flora.
- Long-lived, pollinated by multiple insects, and incapable of self-fertilization or fertilization by close relatives.
- Hosts a variety of herbivores, including leaf-chewers and sap feeders.

Aphis echinaceae



- Identified in 2009 as a new species
- Specializes to *E. angustifolia*³.
- Is the only known aphid species to feed on *E. angustifolia*.
- Adults come in both winged and non-winged morphs (Fig. 1).
- Tended by ants.
- Ants sometimes built dirt structures on plants in order to cultivate aphids.

Figure 1. Morphs of *Aphis echinaceae*



winged aptera

nymph

non-winged aptera

Results

- The aphid addition and exclusion treatments were effective at manipulating aphid infestation (table 1).
- Aphid infestation decreased the frequency of foliar herbivore damage (Fig. 2).
- There was a strong association between aphids and ants:
Between July 21st and Sep. 9th, ants occurred on **75%** of observations where aphids were present and **1.6%** where aphids were not present (n = 1200 observations of 100 plants).

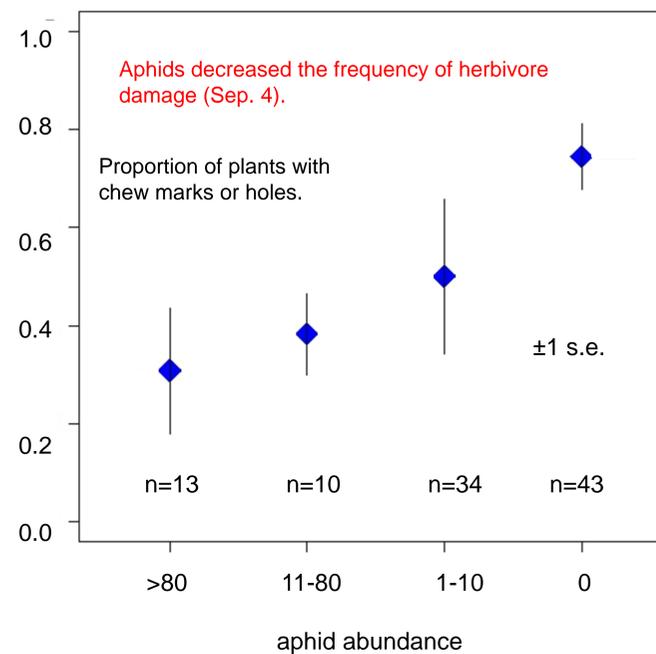


Figure 2: The effect of aphid abundance on foliar herbivore damage

Plants that did not host aphids had a greater incidence of herbivore damage (74%) than those with abundances of >80 (31%), 11-80 (38%), or 1-10 aphids (50%) (GLM with binomial response, Residual deviance = 124 on 96 degrees of freedom, n=100, p= 0.002). Abundances refer to the highest aphid abundance recorded on each plant between Jul. 21 and Sep. 9th. This analysis comes from data recorded on Sep. 4th.

Table 1: Effectiveness of aphid addition/exclusion treatments

Only 8 plants in the exclusion treatment hosted any aphids during the field season, compared with 49 plants in the addition treatment (n=50 for each treatment). Abundances refer to the highest aphid abundance recorded on each plant between Jul 21st and Sep. 9th.

Aphid addition and exclusion treatments were effective at manipulating aphid infestation

Aphid abundance	Addition	Exclusion
>80	13	0
11-80	31	3
1-10	5	5
0	1	42

Methods

- Aphid addition/exclusion experiment on 100 non-flowering plants in an experimental prairie restoration.
- I performed treatments 12 times between July 21st and September 9th, 2011.
 - **Addition treatment** (n=50): Transferred 2-10 adult aphids to the undersides of leaves.
 - **Exclusion treatment** (n=50): Inspected leaves and manually removed aphids.
- On each visit I recorded the aphid and ant abundance present before addition/exclusion.
- Foliar herbivore damage : I recorded the presence of chew marks and holes on Aug. 10 and Sep. 4th.
- In mid-July I recorded vegetative characteristics in order to examine year-to-year changes in vegetative growth (leaf count, length of longest leaf, mm). In June 2012 I will revisit plants to record vegetative characteristics and plant status (flowering, non-flowering, absent).
- **Analysis:** I compared the proportion of plants with foliar herbivore damage between treatments using generalized linear models with binomial response.

Discussion

This study found a decrease in the incidence of foliar herbivore damage associated with aphid infestation. Although there was a strong association between the presence of aphids and ants, it is unclear whether these results were due to antagonistic behavior of aphid-tending ants or changes in plant nutrient quality due to aphid feeding.

Aphids may provide an indirect benefit to plants by reducing damage from other herbivores. Whether or not this represents a net benefit depends on the severity of herbivore damage relative to aphid damage⁵. Therefore, changes in insect community composition due to fragmentation may influence the net effects of aphids on *E. angustifolia*.

Next summer I will revisit these plants to examine effects of aphid infestation on year-to-year vegetative growth.

Projects for 2012

- Examine effects of aphid infestation on seed production.
- Continue a two-year survey on spatial and temporal variation in aphids and ants in an experimental prairie restoration.
- Compare aphid and ant populations among *E. angustifolia* in prairie remnants in Douglas County, MN.

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For more information:

To read about this and other projects related to habitat fragmentation in prairies, visit our website:

echinaceaProject.org

Be sure to check out the field log for updates on current research.



Literature cited

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