

Does ant usage vary the between plants *Ligusticum porteri* and
Helianthella quinquenervis?

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Abstract:

Mutualistic interactions between ants and plants are common. Understanding the effects on ants with different variables can denote what influences the ant abundance. As an observational study, I censused all 10 sites four times in a two week period reporting the number of flowering stalks, the number of ants, and documenting the abiotic factors. The study showed that the site, species of plant, number of flowering stalks, and the effect on ant abundance that is dependent on the number of flowering stalks was significant. Mutualistic relationships are shown between the ants and which plant is preferred.

Keywords: *Ligusticum porteri*, *Helianthella quinquenervis*, ant abundance effects, flowering stalks, extrafloral nectaries, abiotic factors

Introduction:

There are many mutualistic interactions between ants and plants, arthropods, and fungi called myrmecophily. The anatomy and physiology of the ants and the host plants have changed over time with a positive outcome with one another that has derived from natural selection (Holldobler 1990). Within these mutualistic interactions, ants provide protection to the plants from other herbivores and the plants may provide the ants with a home and food resources (Savage 2013). *Ligusticum porteri* (family Apiaceae) is a perennial plant that ranges between the elevations of 1200 feet to 11000 feet in the western United States along ravines, in open fields, and on steep inclines (Terrell and Fennell 2009). Herbivores become present as *L. porteri* matures where umbels develop (Terrell and Fennell 2009). *L. porteri* have these insects, commonly called aphids (family Aphidoidea), that produce honeydew from feeding on *L. porteri*

that ants are drawn to. Since aphids provide food resources for ants in the form of honeydew, ants provide protection to the aphids from predators and parasites (Stadler et al 2001). Honeydew is a high-quality liquid resource which is excreted by the aphids as they feed on the plant's sap.

In contrast, *Helianthella quinquenervis* (family Asteraceae) is a small perennial sunflower that also thrives in the western United States (Kartesz 2013). It produces extrafloral nectaries (EFNs) to provide ants with a food resource, but these plants are not suitable to be a permanent habitat for ants, unlike *L. porteri*. Like they do on *L. porteri*, ants provide *H. quinquenervis* with protection from other herbivores (Inouye 1979). Because honeydew contains more amino acids and complex sugars than the EFNs in plants, it is likely that ants prefer the honeydew over the EFNs (Savage and Rudgers 2013). The number of flowering stalks could be a determinant of ant abundance.

At the Rocky Mountain Biological Laboratory (RMBL), I became interested in this system. This summer I asked the question: Do ants prefer plants with aphids secreting a rich sugary honeydew, (e.g. *L. porteri*) or plants that produce EFNs (*H. quinquenervis*)? I want to know (1) How does ant use of plants vary between the species of plants *L. porteri* and *H. quinquenervis*? (2) How does weather effect ant abundance on plants? (3) How does the number of EFNs effect ant abundance on *H. quinquenervis*?

Methods:

To test the question of what plant species ants prefer, I conducted an observational study where I sampled 10 plants in 10 different sites around the Rocky Mountain Biological Laboratory in Gothic, Colorado. Each site there was five *L. porteri* plants and five *H. quinquenervis* plants. At each site I randomly generated 10 points along a 15 meter transect line

and observed plants closest to each point. Each site can be seen in Map 1. I collected census data four times within two weeks during July in 2013. I observed each site at different times of the day to see if abiotic factors (e.g. cloudiness, etc.) influence ant abundance. For each plant, I recorded the species of plant, the number of flowering stalks, the number of ants, and the presence of abiotic factors: cloudy, windy, rain, and dew on plants. I quantified ant preference by measuring ant abundance. I totaled the ant abundance and calculated the average number of ants for each site. For each *H. quinquenervis* plant I counted each EFN along with the other florets on the same stalk to see whether or not the presence of EFNs had an influence on ant abundance.

Data Analysis:

The main effects on ant abundance on each species of plant were as follows: site, species of plant -- *L. porteri* or *H. quinquenervis* --, the number of flowering stalks on a plant, and the effect of species on ant abundance that is dependent on the number of flowering stalks. I transformed my dependent variables whenever the residuals were not normally distributed. I ran an ANCOVA to test whether the sites, the species of plants, *L. porteri* and *H. quinquenervis*, the number of flowering stalks, and the effect of species on ant abundance that is dependent on the number of flowering stalks. To detect whether weather was dependent on ant abundance a One-way ANOVA was conducted. By completing a Linear Regression I was able to detect if the number of EFNs was dependent on the ant abundance. All analyses were conducted using SAS JMP (SAS Institute Inc. 2012).

Results:

The numbers of flowering stalks are a confounding factor on whether or not ants are present on the plants. The effect of site on the total ant abundance was significant ($F= 11.1878$,

$P = <0.0001$) (Figure 2). The effect of species on the total ant abundance was significant ($F = 40.9483$, $P = <0.0001$) (Figure 1). The effect of flowering stalks on the total ant abundance was significant ($F = 8.0896$, $P = 0.0055$) (Figure 4). The effect of species on ant abundance that is dependent on the number of flowering stalks was significant ($F = 7.9866$, $P = 0.0058$). The effect of site on the average ant abundance was significant ($F = 10.1276$, $P = <0.0001$). The effect of species on the average ant abundance was significant ($F = 29.5690$, $P = <0.0001$). The effect of flowering stalks on the average ant abundance was significant ($F = 5.7549$, $P = 0.0186$) (Figure 3). The effect of species on ant abundance that is dependent on the number of flowering stalks was significant ($F = 6.2932$, $P = 0.0140$). The effect of abiotic factors on the total ants observed was not significant ($F = 1.1393$, $P = 0.3463$). The effect of the average EFNs on the *H. quinquenervis* on the average ant abundance was not significant ($F = 0.8821$, $P = 0.3523$). The variance between the number of EFNs and the ant abundance is minor (RSquare = 0.018045).

Discussion:

The primary goal was to see which type of mutualism ants prefer by looking at ant abundances on two species of plants—*Ligusticum porteri* and *Helianthella quinquenervis*. Ants interact with *H. quinquenervis* because the plant produces extrafloral nectaries (EFNs), and in return the ants provide the plant with protection from other herbivores. According to some studies (De la Fuente 1999), without ant mutualism on plants that have EFNs, there is an increase in plant herbivory and as a result, a decrease on plant fitness. The ant-plant mutualisms can be dependent on abiotic factors (e.g. temperature, rain, sun, snowfall) as well as biotic factors (e.g. food resources) but the ants tend to be more generalized and do not have specific needs as to where the food source comes from (Rosumek et al 2009). Ants have this relationship with aphids on *L. porteri*, where the aphids produce their sugary honeydew that the ants feed on, and in

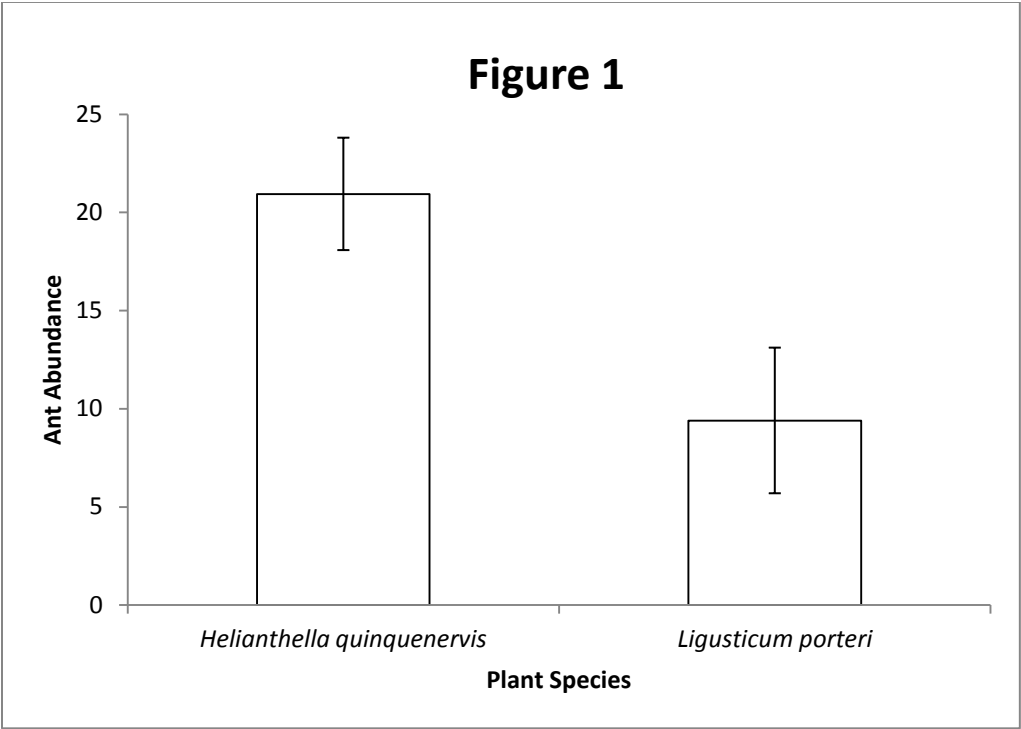
return, the ants protect the aphids from predators like ladybugs (family Coccinellidae) and mirids to parasites like red spider mites (family Tetranychidae) and parasitic wasps (order Hymenoptera). *L. porteri* and *H. quinquenervis* both share positive mutualisms with ants by providing different food sources in exchange for protection against other herbivores. Over time, ants have changed their course of action and created mutualism with plants where ants provide protection to plants against herbivory and against parasitism on aphids (Rosumek et al 2009). Aphids provide ants with a sugary honeydew whereas ants decrease predation on aphids from other insects (Rosumek et al 2009). Without ants tending to aphids on plants (e.g. *L. porteri*), aphid predators may extirpate aphid populations before the aphid colony can become established; this explains how ant-aphid mutualisms are important to study (Wimp and Whitham 2001).

Abiotic factors including shade and cloud cover were noted because it is known that insects are ectothermic and it was noted that insects (e.g. ants) were not present in high numbers during the times of observation. Myrmecophillic plants (e.g. *H. quinquenervis*) contribute food resources to ants (Webber et al 2007) as EFNs (Rosumek et al 2009). Interacting species like ants and plants, such as the interaction between ants on *H. quinquenervis* have a mutualism where the plant will have reproductive success because the ants are controlling seed predation (Breton and Addicott 1992). According to Inouye (1979), the greater EFN secretions the greater the herbivory on *H. quinquenervis* by its natural enemies. However, when more EFNs are present, more ants feed on these EFNs and provide protection to the plant. Species that have a large effect on the local community structure, such as ants and their effect on arthropod communities, are keystone species. For example, aphid-tending ants on *L. porteri* where insects can exist on the same plant but are using different resources offered by the plant (Crutsinger and Sander 2005).

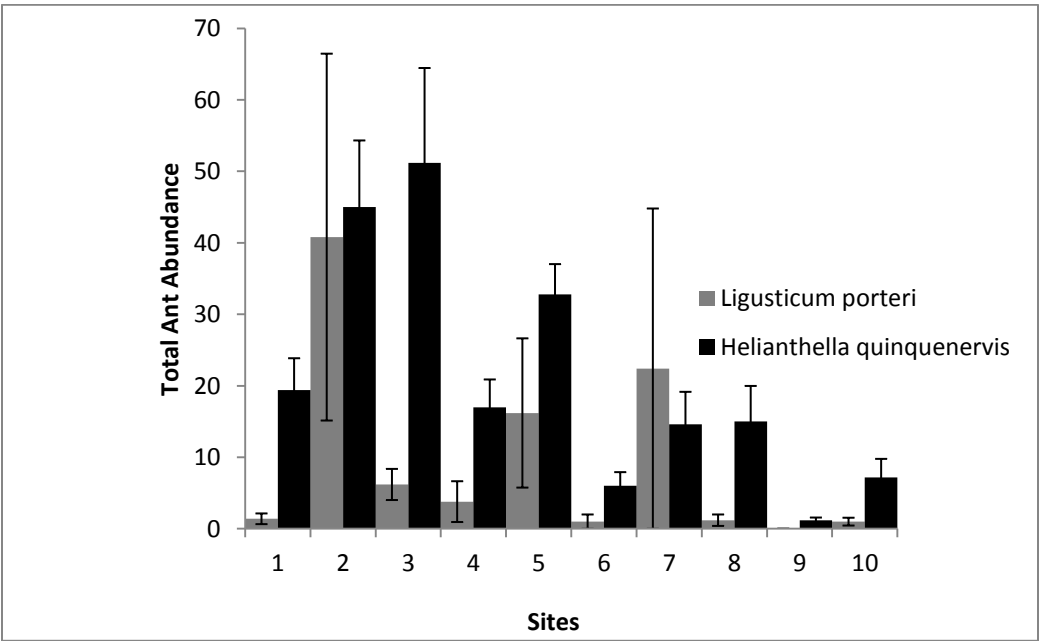
The analyses show that either effect were significant on total ant abundance. On the other hand, the abiotic factors (e.g. cloudy, windy, rain, and dew on plants) were thought to have an impact on observing the ant abundances. Also, I hypothesized that EFNs would increase ant abundance but the data shows the EFNs had no effect. I noted that the number of flowering stalks on each may have affected ant abundance.

The species of plant is a determinant of ant preference. *H. quinquenervis* has a greater number on ant abundance than *L. porteri* (Figure 1). Each site was different from one another and Figure 2 shows that ant abundance is varied. As the number of EFNs increase on *H. quinquenervis*, the ant abundance had no significance with the number of EFNs. If there is at least one flowering stalk ants will be present (Figure 3 & 4). As the number of flowering stalks increase on *L. porteri*, the ant abundance increases more dramatically than the *H. quinquenervis* (Figure 3 & 4). The number of flowering stalks plays an important role in how much room aphids have to colonize, therefore there are more aphids for ants to tend to on *L. porteri*.

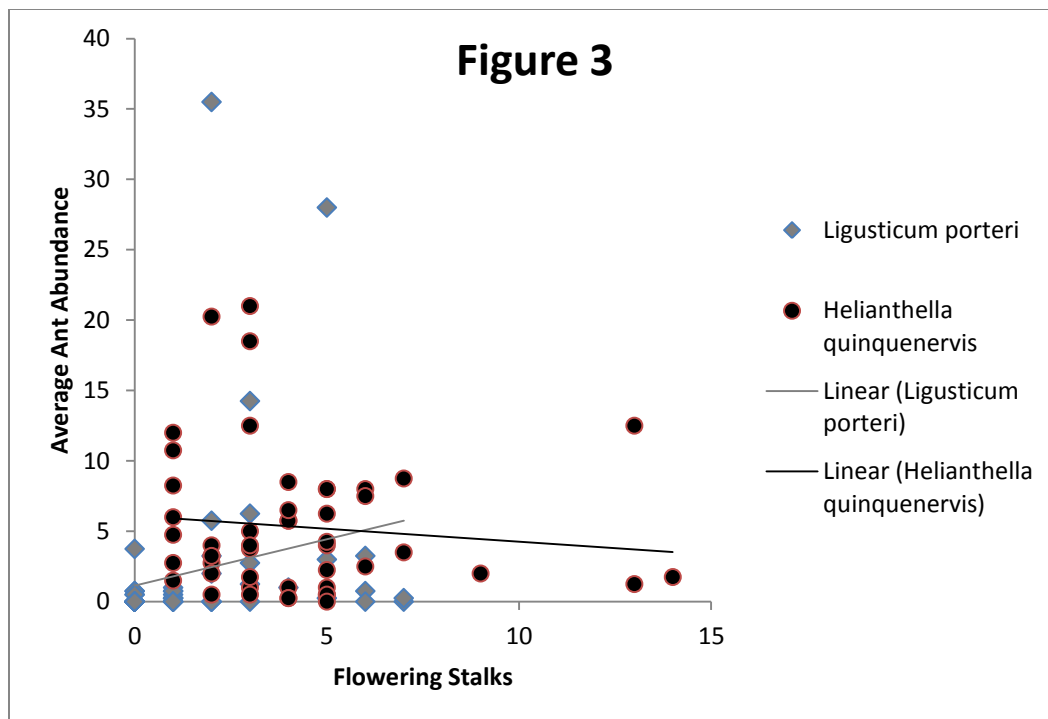
Figures:



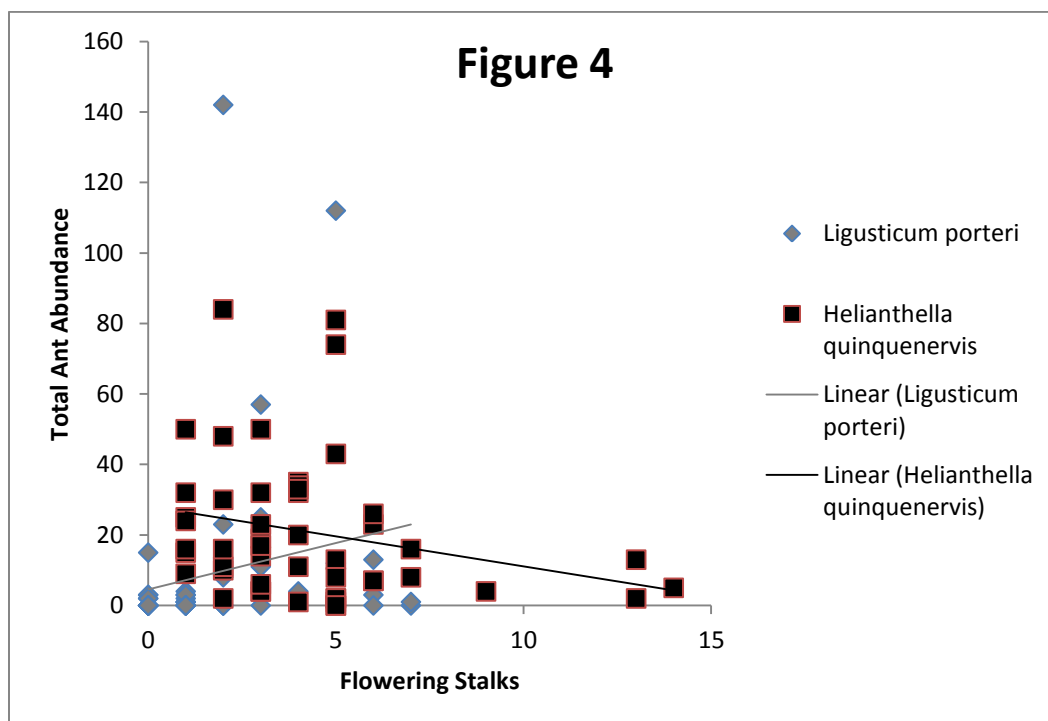
Plant species influence ant abundance. (above)



Site influence on ant abundance (above)

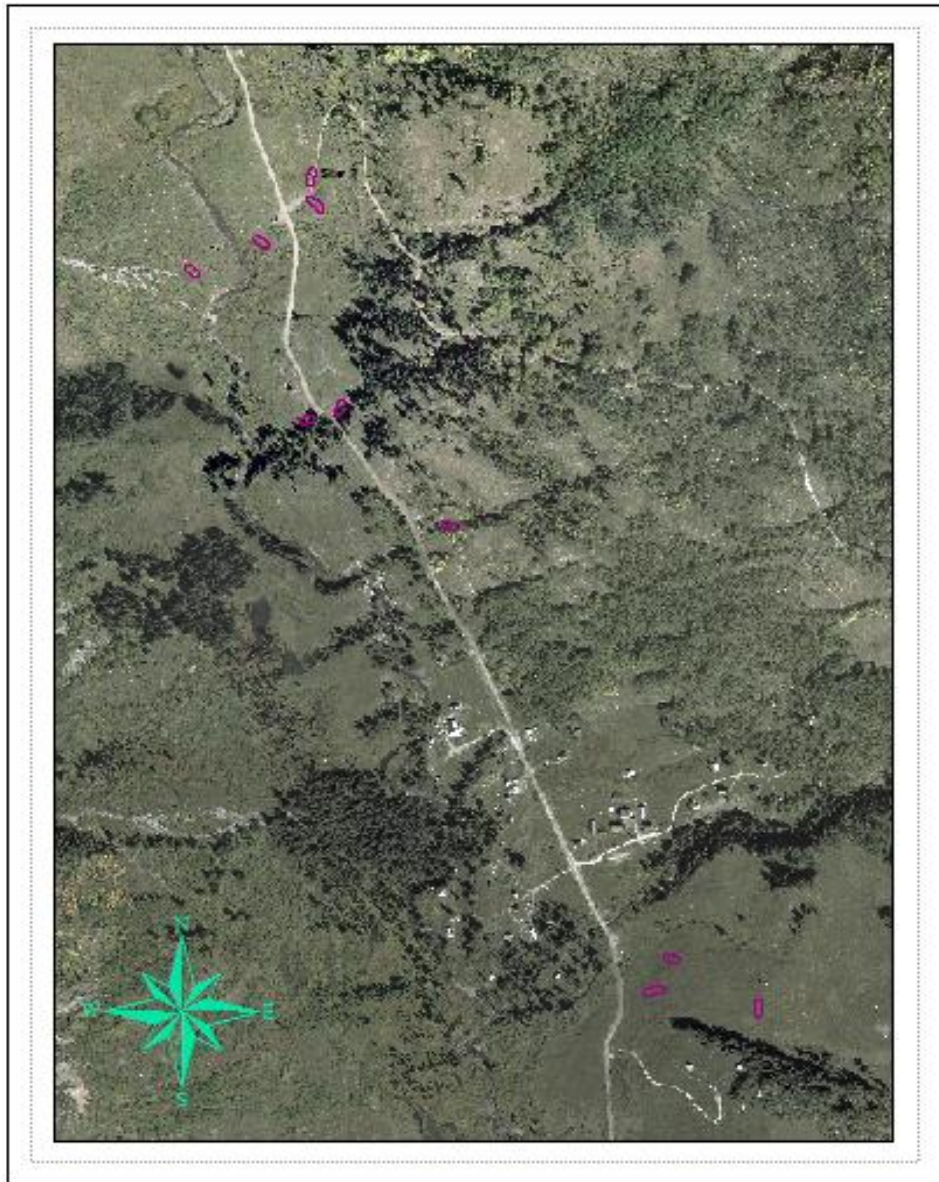


Influence of number of flowering stalks on average ant abundance (above)



Number of flowering stalks influencing the total ant abundance (above)

Map 1 (below)



This map shows each site throughout the town of Gothic, CO with 5 meter buffers around each site.

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