

A Study of the Interactions of Ants and Caterpillars on *Veratrum californicum* in a California Sierra Meadow: A Test of Two Data Collection Methodologies

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Ants tending aphid clusters on *Veratrum californicum*.

Introduction

On July 12, 2006 we surveyed the presence and diversity of fauna found in association with corn lily, *Veratrum californica*, a widely dispersed plant found throughout the high-elevation Beartrap meadow of Plumas National Forest, California. A preliminary assessment of the invertebrates on the foliage of corn lilies revealed that two species of ants, identified in this paper as large and small, utilize the plants as shelter and a medium for tending aphids to harvest the aphids sugary excrement (Flatt et al. 2000). We also found small caterpillars which we presumed were feeding on the corn lily foliage as evidenced by the presence of characteristic feeding windows. However, in our initial survey we did not observe the presence of both ants and caterpillars on the same plant. There have been several studies conducted in Costa Rica on *Acacia* tree ants where the ants actively remove herbivores from the trees they use/inhabit (Suarez et al. 1998) and (<http://waynesword.palomar.edu/acacia.htm>). This is thought to be a mechanism the ants use to protect the tree they are living in. Our initial survey and the documented behavior of ants on *Acacia* trees lead to our hypothesis that caterpillars, as herbivores, are not found on corn lily plants where ants are tending aphids. If this pattern is found this would lead us to believe that ants may be actively removing the caterpillars from the plants. This paper documents two data collection (survey) strategies we tested to determine a best methodology for conducting a full scale study of the association between ants and caterpillars on corn lily. Data collected in this study on ant presence included plants with ants, aphids, or both together, while caterpillar presence was measured by caterpillar counts, the observation of feeding damage, or both.



Our surveyors in search of ants and caterpillars.

Methods

We took two approaches in looking at ant/aphid colonies and their association with caterpillar abundance. One approach focused on finding corn lily (*Veratrum californicum* var. *californicum*) stems that hosted caterpillars, then looking at surrounding stems for the abundance of ants. The other approach focused on finding corn lily stems that hosted ants, then looking at surrounding stems for the abundance of caterpillars. We performed our abundance counts in Beartrap Meadow, located at N 39° 38.871' W 120° 30.977', approximately 8 km north of highway 49 along Forest Service road 09, at an elevation of 2133m.

We selected a 121m by 54m area, containing a varying density of corn lily, grasses and native forbs. The area was bordered on the north by riparian vegetation consisting primarily of willows (*Salix sp.*), on the east and west by conifers (primarily *Pinus spp.*), and on the south by grasses and forbs. We split into two groups of five people each, with one group conducting a 10-point ant-centric search and the other conducting a 10-point caterpillar-centric search. Starting X, Y search points were chosen from a random number table. Each group marked their 10 sample points using two 100m tapes and colored flags. At each point, the groups looked for the closest (shortest radius from the flag) corn lily stalk hosting one or more ants or caterpillars, as appropriate. On finding the initial stalk with at least one ant or caterpillar, we counted all ants, aphid clusters (not individual aphids) and caterpillars on all stalks, leaves and inflorescences of surrounding plants within a radius of 0.5m. The search radius was determined with a 0.5m piece of string. Details of abundance counts appear in results.

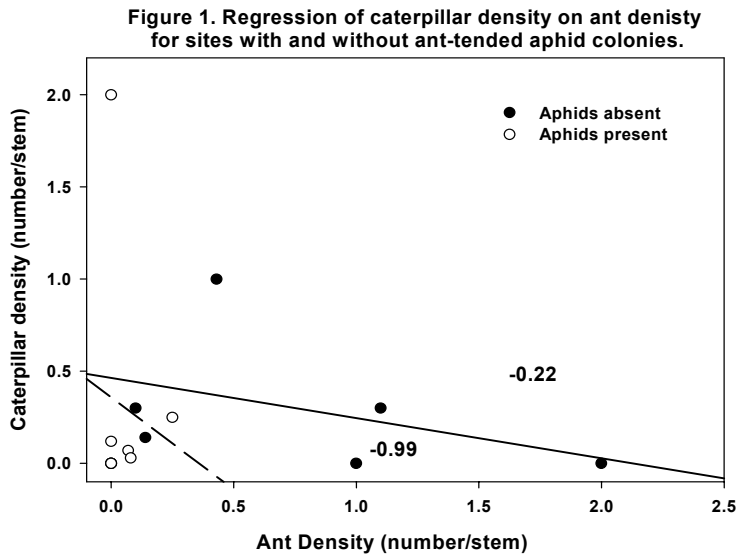
Ants and caterpillars often proved difficult to find. We assumed that ants tended aphid colonies and that the presence of aphids was an indicator for the presence of ants. As caterpillars feed on the leaves of corn lily, we looked on leaves for long, thin patches of leaf damage. These feeding patches resembled “windows” in the leaves. Caterpillars often were found at the base of the leaves near the stem of the corn lily. We assumed that all observers were equally adept at finding ants, aphids and caterpillars and classifying each specimen in the appropriate size category. In reality however, there was probably a great deal of variability between observers.

As the purpose of this study was to determine how many samples an actual study would require, this variability was not an issue.

Midway through our search we encountered an area with a high density of corn lily stalks, which made finding the nearest stalk with ants or caterpillars very difficult. We modified our search methodology slightly by deciding to start the abundance counts at the *first found* stalk containing ants or caterpillars rather than the *nearest* stalk containing ants or caterpillars. This allowed us to use our people more efficiently, and we felt that the new procedure did not significantly alter a stem's chance of being selected at random. Due to time constraints neither group completed their assigned 10 points, but it did give us an idea of the time required to lay out the grid and conduct each search.

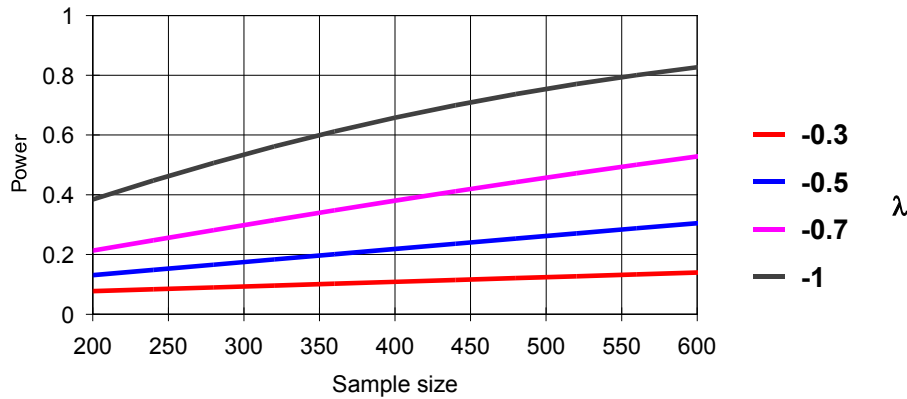
Results

In general, caterpillar densities declined as ant densities increased. However, the rate of decline was much greater at sites where ants were not tending aphids than where they were tending aphids (regression slope = -0.99 when ant are not tending aphids and -0.22 when ants are tending aphids, Figure 1).



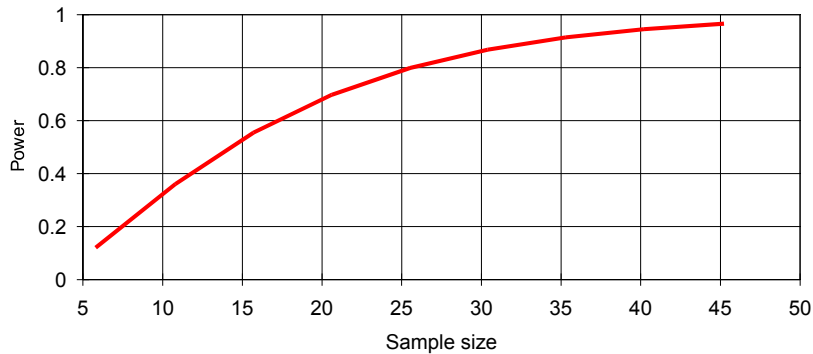
For our sampling method based on caterpillar damage, we estimated the sample size necessary to detect a 30, 50, 70, and 100% decline in caterpillar density as ant density increases at an $\alpha = 0.05$. The sample sizes required are all impractical (Figure 2), suggesting that an alternative method of sampling ants and caterpillars with lower sampling variance is necessary.

Figure 2. Power curves for various effect sizes (λ) of caterpillar density as a function of ant density.



However, using our sampling method based on choosing plants with ants tending aphids, only a sample size of 26 is required to detect a 30% decline in caterpillar numbers as ant density increases.

Figure 3. Power and sample size curve for the test of differences in slope (-0.99 to -0.22).



Discussion

Our study illustrates how preliminary data collection can inform a choice between different observational methods and how an approximate sample size can be determined using preliminary data. Two methods of collecting preliminary data were compared. In one method, ant and caterpillar densities were observed in circular observational units centered on the group of ants tending aphids closest to a randomly generated observation point within the corn lily field ($n = 6$). In the second method, instead of centering density observations on ants tending aphids, observations were centered on the corn lily plant with caterpillar damage nearest to a randomly generated observation point ($n = 8$).

While both methods showed little correlation between the abundance of ants tending aphids and the abundance of caterpillars, there was a difference between the two methods. When ants

farming aphids were used as the center of observational circles, a stronger correlation was seen ($R^2 = 0.18$) than when observations were centered on caterpillar damaged plants ($R^2 = 0.02$). While neither correlation was significant, since more of the variability in caterpillar density was explained using ants tending aphid-centered observations (18% vs 2%), we suggest that ant farming aphid-centered observations would be the better choice of methods to use in a full study. This result is supported by sample size calculation as well. Our results suggest that a sampling program based on caterpillar damage will require enormous sample sizes to detect an effect of ants on caterpillar abundance, but that a sampling program based on ants tending aphids would only require a sample size of 26 plots to detect a 30% decline in caterpillar abundance as ant density increases with $\alpha = 0.05$ and $\beta = 0.2$.

One explanation for this difference in correlation can be explained by the frequent absence of ants in observational circles centered on caterpillar damaged corn lily plants. Had ants tending aphids been more frequent, these methods might have produced more similar regression results.

Our results also suggest that in the presence of aphids, ants do not forage as aggressively for caterpillar prey and hence caterpillar numbers are not as severely suppressed as they are when confronted by ants that are not tending aphids. Perhaps randomly choosing plots and with ants of ants, and plots with ants tending aphids and then recording caterpillar abundance might provide more information about the effects of ants on caterpillar abundance. Furthermore, it appears that a more sensitive study design might involve estimating caterpillar and ant density in a smaller sample quadrat. Our quadrats were 0.5 in radius and we occasionally found ants and caterpillars coexisting at this spatial scale. However, when we examined stems adjacent to ant-tended aphid colonies, no caterpillars were present.

Bibliography

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