Ants in your Plants;

Priorities of *Pseudomyrmex* ants when colonized *Acacia collinsii* is approached by foreign objects

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Abstract: We looked at the symbiotic relationship between the *Pseudomyrmex ferruginea* ant, and the *Acacia collinsii*. We carried out a study to see what part of the *Acacia* the *Pseudomyrmex ferruginea* would protect when a foreign object came in contact with a leaf, a leaf with nutrients for the ants, or a pod in which the ants raise their larvae. We found that *Pseudomyrmex,* first aided their larvae, then their food source, and periodically went to check on other parts of the plant being invaded. Our findings suggest that *Pseudomyrmex* ants protects leaves with food for them to a greater degree than the leaves without food.

Introduction

The *Acacia collinsii* plant and the *Pseudomyrmex ferruginea* ant inhibit the Panamanian dry forests and many others in Central America and Mexico. The relationship between these two organisms is a perfect example of mutualism, because the *Pseudomyrmex* provide protection for the *Acacia* tree in exchange for food and protection for their larvae (Armstrong, 2005). Beltian bodies are filled with protein, and grow on the ends of some of the *Acacia*'s leaves; they are food sources for the *Pseudomyrmex*. The bodies grow off of the new leaves anywhere along the tree; they are not limited to a specific part of the tree. The bodies are usually a yellowish color, but can appear with a darker brown color as well.

With Beltian Bodies

Without Beltian Bodies

The *Acacia* trees contain thorns that are hollow and sturdy, which provide protection for the *Pseudomyrmex* to lay their eggs. In exchange for shelter and sustenance, the *Pseudomyrmex* protect the plants by deterring herbivores, killing small insects, and cutting off epiphytes; there is a clear symbiotic relationship between the plant and the animal (Marietta College).

The thorns also allow a place for the larvae to mature. The *Pseudomyrmex* drill small holes near of the top of the thorns for the ability of entering and exiting the thorns. These thorns grow off of the branches of the *Acacia*, giving the *Pseudomyrmex* easy access to their young and shelter. Part of the symbiotic relationship is for the *Pseudomyrmex* to protect the *Acacia* from foreign objects that encounter the plant. We noticed that depending on where a foreign object was placed on the *Acacia*, the *Pseudomyrmex* would interact with the object and try to push it off of the plant. We also noticed that the *Pseudomyrmex* would have a faster reaction time to the foreign object based off of where the foreign object was placed on the plant. This brought up the question of whether the *Pseudomyrmex* prioritize one part of the *Acacia* over other parts. For example, do they move faster to remove a foreign body if it is placed near their food source, their offspring, or just on a normal leave that is part of their habitat. We created our hypothesis around this question, and decided that if a foreign body is placed near the Beltian bodies (food source), thorns (offspring), or on a normal leaf of the *Acacia* (part of their habitat), the *Pseudomyrmex* will prioritize the protection their offspring. In other words, the time it takes for the *Pseudomyrmex* to interact with a foreign body in the hopes of removing it will be quickest when a foreign body is placed near a thorn.

Material and Methods

Our experiment takes place in the dry forest of the Azuero Peninsula in Los Santos, Panama. It required Hibiscus flowers, tweezers, three *Acacia collinsii* plants populated by a colony of *Pseudomyrmex ferruginea*, stopwatches or timers, and a notebook with a writing utensil. In order to compensate for the effect we might have on the *Acacia* and the *Pseudomyrmex*, we chose to experiment on three different plants, and cycle between them. This allows each colony time before being agitated by pieces of flowers again. Starting with the first tree, three members of the group each took a piece of hibiscus flower using tweezers, and prepared to gently place it on their specified location at the same time. One member placed the flower bit on a leaf without Beltian bodies, another paced the flower on one of the thorns containing ant larvae, and finally the third member put their piece of flower on a leaf containing Beltian bodies. A the same time each group member secured their piece of flower onto their specified location, and started their stopwatches. Each member stopped the stopwatch when an *Pseudomyrmex* interacted with the piece of flower. After the fourth member recorded how long it took for the *Pseudomyrmex* to reach the flower in each respective location, the group moved to the next tree, and repeated this process to ensure our data was not influenced by only one tree. We cycled through all three trees four times, for a total of 12 comparable data points per location.

Afterwards, we assessed how the quality of leaves with Beltian bodies versus those without Beltian bodies in order to see if the *Pseudomyrmex* normally protect the leaves that do not contain their food. One member stood at the same level as the tree, then we selected the area of the tree that measured from their knee to the top of their head, and assessed the quality of each leaf clump. We established a rank of quality with 1 as very healthy (no leaves missing, no holes in the leaves, vibrantly green, flourishing) to 5 as very damaged (most leaves missing, leaves are dead, holes in leaves, clump is shriveled up). Three members took turns identifying the quality of a clump and whether it contained Beltian bodies, and shared their findings with the fourth member who marked the clump with either a check for leaves with Beltian bodies or an ex for leaves without Beltian bodies in a box labeled with a number corresponding to the quality of the leaves. After collecting data about each clump of leaves in the cubic area, we went to the next tree, and repeated the process. We did this for all three trees we tested previously.

Results

Table 1: Time taken (in seconds) for a *Pseudomyrmex* to make contact with flower, depending on where the flower was placed. The trials were stopped at 120 seconds. Those that were stopped before contact with an ant are denoted in red.

	Larvae (or near the larvae on the spike)	Leaves with Beltian bodies	Leaves without Beltian bodies
Tree 1	3.48	6.7	22
	1.88	85.83	120
	4.83	16.45	32
	4.05	4.59	11
Tree 2	6.13	9.1	120
	1.83	64.62	120
	2.71	25.97	120
	24.47	27.06	120

Tree 3	9.48	17.19	120
	15.97	56.66	120
	27.5.54	39.54	120
	19.4	99.76	120
Averages	10.1475	37..79	95.42

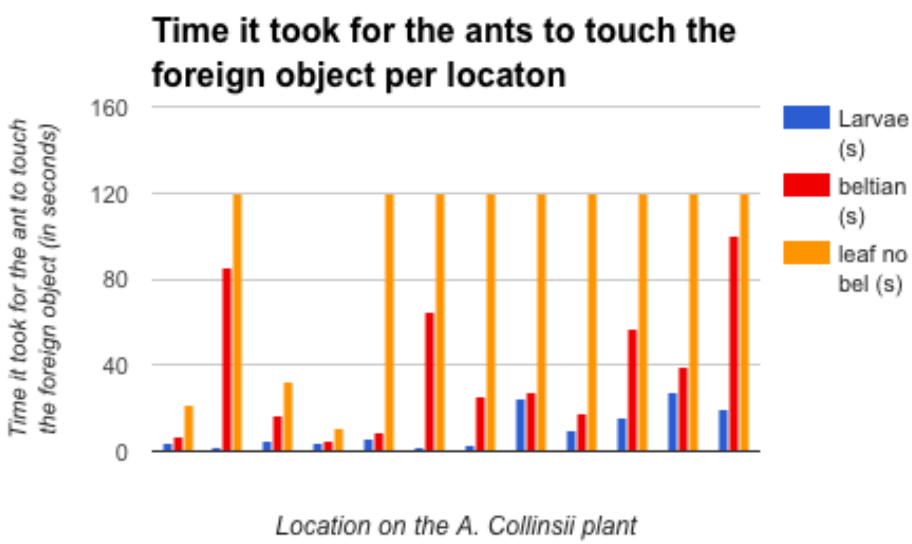

Figure 1: This figure displays the patterns shown in table one. It shows that in each trial the *Pseudomyrmex* first contacted the leaf positioned near the larvae, then the one on the Beltian body, and lastly, the flowers on the leaves with no Beltian bodies.

Table 2: To see if the patterns we found were significant , we did a Mann Whitney U test, the results are shown below. Since all of the p values are less than 0.05, the differences between time are all significant.

compared categories	Larvae and Beltain	Beltian and Leaf	Leaf and Larvae
p value	0.00736	0.0035	0.00016

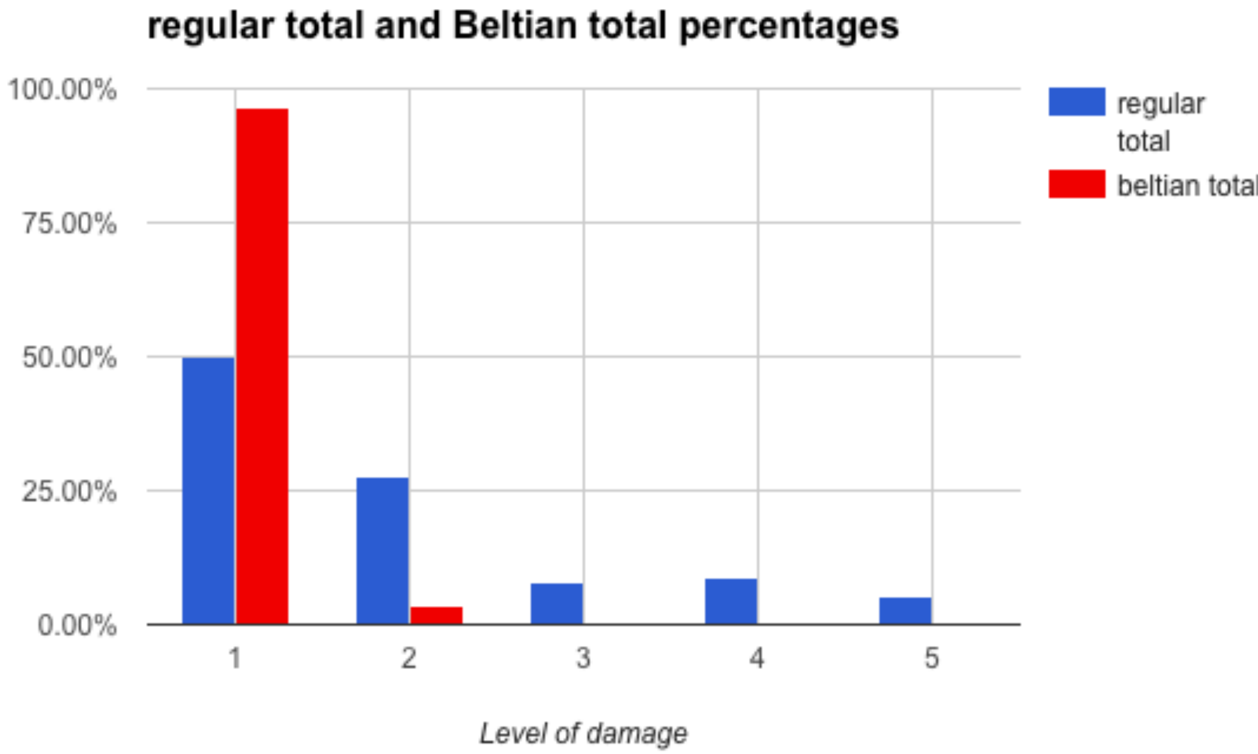

Figure 2: This shows the percentages of leaves and how well they are kept by the *Pseudomyrmex*. The regular leaves are compared to those with Beltian bodies, and ranked on a scale from 1 to 5 quality.

Summary of results: Through analyzing the *Pseudomyrmex* we found that when a foreign body was brought into its habitat, the *Pseudomyrmex* first protected the larvae area, then their food source (Beltian bodies), then the regular leaves. After conducting these tests we also took a section of each of the three *Acacia*, and took note of which leaves were in better condition than others. We found that those with Beltian bodies were very likely to be in the healthiest condition.

Discussion

Our results support our hypothesis; The *Pseudomyrmex* prioritize the protection of their offspring, rather than their food source, or part of their habitat. This discovery relates to an animal's interest in protecting their young. From the second part of our experiment we observed that the *Pseudomyrmex* preserve and protect leaves with Beltian bodies instead of those without Beltian bodies. The leaves without Beltian bodies appear to be unnecessary to the *Pseudomyrmex*, and therefore the *Pseudomyrmex* may not feel the need to maintain those leaves. This means leaves without Beltian bodies are more vulnerable to consumption or destruction from other species. The thorns full of larvae seem to be the most important aspect of the *Acacia* for the *Pseudomyrmex*, and *Pseudomyrmex* appear to be more protective of them. In addition, the *Pseudomyrmex* ants appear to have an easier time traveling to the thorns based on where they are located on the branch. One can infer that the construction of the plant is orientated towards the reproduction of the *Pseudomyrmex* in order to maintain their lasting symbiotic relationship.

Our project did contain some sources of error. One was not being able to efficiently secure the flower when group members placed them on the leaves or branches. This meant that sometimes we would agitate the *Pseudomyrmex* ants before placing the object on the plant. In theory the placement of the object would be the original source of agitation. As we were testing we were also faced with the difficulty of limiting the contact of the plant with our human bodies. If they did become aware of a surrounding threat they appeared to patrol the plant with more urgency. We wanted to create a controlled experiment but our presence might have signaled that there was going to be a threat. The last source of error is derived from our final portion of the experiment where we assigned degrees of decay to leaves on the plant. Each group member identified leaves and our scales and determinations could have been slightly different due to our different opinions.

Conclusion

We are able to conclude that our hypothesis was supported; the *Pseudomyrmex* do seem to prioritize the protection of the thorns containing their young and of the leaves with Beltian bodies over leaves with no Beltian bodies. We suggest that the *Pseudomyrmex* allow the unneeded leaves to decay and become damaged because they are unnecessary to their survival.

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