

Nutritional Preferences of Formicidae in Costa Rica

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Abstract: Ant nutrition has been studied across the world and heavily in the United States. The nutritional preferences of Formicidae in tropical environments have little to no research. In order to create the most affective baiting methods for ant colonies, five nutritional treatments were tested among the native ant species of Costa Rica. The transects consisted of 50 vials per transect in three different elevated locations of Pocosol, Soltis, and La Selva. The data yielded significant results of ants preferring different nutritional agents dependent on elevation. The Pocosol location had a p-value of <0.01 and favored the protein treatment. The Soltis location had a p-value of $7.81E-13$ and favored the lipid treatment. The La Selva location had a p-value of 0.0365 and favored the lipid and protein treatment. Due to the results showing the varying nutritional preferences of ants in different elevations, the pest ant colonies can be specifically targeted with appropriate baits.

Keywords: Formicidae, ant nutrition, Costa Rica, nutritional preferences

Introduction

In order to find the proper baiting methods for managing pest ant species, the correct formulas need to be created. By testing the nutritional preferences of ants in transect experiments, the ants are able to show which nutrients they prefer. The ants will forage for the nutrients that are limited in their colony's diet (et. al Dussutour 2009). Ant colonies prefer different nutrients depending on the elevation of their habitat (et. al Kaspari 2008).

Little research exists on the topic of tropical ant nutrition. In order to test the nutrients that Formicidae forage for, transects were used at different elevational sites in Costa Rica. Similar studies have shown that tropical ant colonies inland

prefer to forage for more salt-based nutrients (et. al Kaspari 2008).

Five different agents of sucrose, protein, lipid, protein + sucrose, and protein + lipid were used. The hypothesis was that the ants will prefer the combination agent of protein + lipid because it combines different nutrients that are both essential to the diet of Formicidae. The null hypothesis states that there will be no differences of nutrient preference in relation to habitat elevation.

Materials and Methods

Locations of the Experiment

The nutritional preferences of tropical ants were tested in three different

forested elevations of Costa Rica. The first site tested was the Pocosol Biological Station on August 8th, 2019 which has an elevation of 817 meters above sea level, an average humidity of 85.75%, and an average temperature of 21.8°C. Pocosol receives the most sunlight out the three sites and it is described as a transition from secondary forest to pristine forest with cleared areas for sunlight exposure. The second site tested was the Soltis Center on August 11, 2019 which has an elevation of 445 meters above sea level, an average humidity of 79.5%, and average temperature of 24.1°C. The Soltis Center receives minimal sunlight and it is a secondary forest. The final site tested was the La Selva Biological Station on August 13, 2019 which has an elevation of 59 meters above sea level, an average humidity of 75.25%, an average temperature of 22.3°C. La Selva is an old lowland ecosystem with some spaces for sunlight exposure. All three sites are inland and not coastal ecosystems.

Preparing Nutritional Treatments

Ant transects were used to test the preferences of ants based on five different nutritional treatments. The five different treatments that were used to test the nutritional preferences included: 20% sucrose solution, 30% Whey protein powder, 50/50 Soy and Linseed oil mixture, a 50/50 mixture of sucrose + protein, and a 50/50 mixture of lipid + protein. For each transect a total of 50 Eppendorf tubes were used (Eppendorf AG, Hamburg). Each treatment had ten tubes. The bottom of each vial was filled with cotton to the 0.5 mL mark. Then

the tube was filled halfway with each respective treatment. There was still enough room left for the ants to encounter the substance. The sugar treatment was labelled A, protein was B, Lipid was C, sugar + protein was D, and lipid + protein was E. After all 50 tubes were prepared for each transect, they were closed and placed into a gallon Ziploc bag (S. C. Johnson & Son, Inc.) for randomization.

Transect Data

Ant transects were used to test the nutritional preferences of tropical Formicidae. Six transects were set out at each site location. A single transect consisted of 50 treatment vials, with 10 replicates of each treatment randomly placed approximately one meter apart for a total of 50 meters (in a straight line). As the vials were randomly chosen, the vial caps were opened before placing them on the ground. As soon as the first vial of each transect was placed on the ground, the timer was set for exactly an hour until the vials were picked back up. They were only placed for an hour in order to target Formicidae rather than any unwanted arthropods. Also, all transects were tested during midday, afternoon hours with maximum sunlight exposure.

Collecting Transect Data

When picking up the vials, the lids were shut immediately in order to keep all specimens in their respective tubes. Once all tubes were picked up, they were placed into gallon Ziploc bags (S. C. Johnson & Son, Inc.) and placed in the -20°C freezer in order

to kill the ants. The specimens of each transect were counted underneath a light microscope. Tweezers and 70% ethanol were used to separate and preserve the specimens. Each treatment and transect location were kept separate while counting. All data was inserted into an excel file for further data analysis.

Results

Data was gathered on the nutritional preferences of Formicidae in Costa Rica by sampling with transects of varying nutritional content. Two factors were calculated by the ants found in the treatment vials: hits and recruitment. Hits consisted of whether or not ants were physically in the specific treatment vial. Recruitment consisted of the actual number of ants counted per treatment vial.

The Pocosol hits had a p-value of 0.001984 and an F-value of $(4,29) = 5.76$, with a suggestion of the protein treatment being significantly different from lipids, sucrose + protein, and lipid + protein. The Pocosol recruitment p-value was <0.01 and the F-value was $(4,29) = 14.95$, which also suggested the protein treatments to be significantly different. The Pocosol mean for protein was 40.075 and the SD was 0.65. The Soltis hits p-value was 0.024 and the F-value was $(4,29) = 3.38$. The Soltis recruitment p-value was $7.81E-13$ and the F-value was $(4,29) = 64.86$. Both the hits and recruitment results concluded that proteins + lipids were highly foraged for. The Soltis mean for protein was 34 and the SD was 0.70. The La Selva hits p-value was 0.273

and the F-value was $(4,29) = 1.37$, which indicated no significant differences between hits and baits at this site. The La Selva recruitment p-value was 0.0365 and the F-value was $(4,29) = 3.03$, which indicated a significant difference between recruitment and baits. The La Selva mean for protein was 63.77 and the SD was 0.90.

In comparing all three sites with a Tukey Post-Hoc test, three factors of site, treatment, and interaction were studied. The site factor had a p-value of 0.99 and an F-value of 0.012. The treatment factor had a p-value of 0 and an F-value of 52.44. The interaction factor had a p-value of 0.005 and an F-value of 2.96. The differences of these factors in relation to site locations are seen in Figure 1.

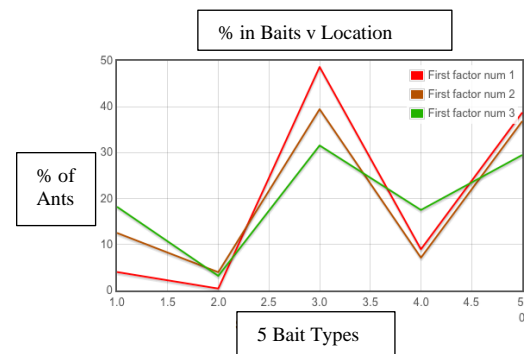


Figure 1. Percent in Baits Compared with Location

Discussion

It was found that Formicidae in Costa Rica prefer different nutrients depending on the elevation in which their habitat lies. The lowest habitat studied was La Selva with an elevation of 59 meters above sea level. The middle habitat studied was the Soltis Center with an elevation of

445 meters above sea level. The highest habitat studied was Pocosol with an elevation of 817 meters above sea level.

Key findings were found as Pocosol showed a large number of ants that were recruited to the lipid mixture, and secondly the lipid + protein mixture. Soltis showed that there was a slightly even favoring between ants recruiting to the lipids and the lipid + protein mixture. However, La Selva showed that the lipid + protein mixture was higher in recruitment than lipids. These findings indicated that ant colonies at different elevations have varying foraging behaviors in relation to fulfilling their nutritional deficits. The ants chose to forage for the nutrients that they are in limitation of.

This study done in Costa Rica testing the nutritional preferences was strong because there are few studies done on studying tropical ant bait types. The limitations may have been that this entire project was conducted in two weeks, and a longer time span would allow for more data to solidify the results.

By studying their forage patterns based on bait type and elevation, it is better understood on how to limit colony growth based on those two factors. Proper baiting

methods could then be used in order to target specific ant pest colonies based on their elevation in the tropics. Future studies can be added to this experiment by testing the bait preferences on the same colony at different times of the year to observe if their nutritional preferences change seasonally. This study is similar to (et. Al Kaspari 2008) in how Kaspari studied the salt limitations between ant colonies with transects in different elevations. It was found that the more inland the colonies are, the more salt they will forage for.

Overall, the hypothesis was supported that the lipid and the lipid + protein mixture would be the most sought-after baits. However, in analyzing the different choices between ants at different locations, it allowed a finding of a nutritional preference based on elevation.

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