Effectiveness of Ant Baits and Their Relationship with the Species of Ants Attracted

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Abstract: Insect infestations caused by a single species require control techniques that take advantage of the target's natural instincts and passively lure them out of hiding. Bait traps commonly mimic the odor of food with chemical substitutes that trick an insect's senses to passively guide it to the trap. The purpose of this experiment was to test Texas ant species preferences for a carbohydrate or protein food source. Furthermore, comparisons were made of the data collected from different environments to test for preference differences between isolated populations of the same species. Data collection required three sticky traps; an unchanged control lacking a source of bait, and two others containing either a carbohydrate or protein-rich food source. Placing the traps in varying habitats allowed the testing for an environmental influence on a particular species' food preference. The results suggest that, among the ant species collected, a majority prefer a carbohydrate food source. While the numbers favor carbohydrates, the specimen collected from the protein and control traps demonstrates an ability to utilize multiple food sources to attract a species and that food attractants improve the success of trapping. This experiment supports the benefit of bait trapping with carbohydrate attractant in ant pest management plans, but also shows that a combination of protein and carbohydrate attractant serves best.

Keywords: ants, macronutrient, bait, attractant

Due to stinging, biting, and spraying techniques, a plethora of ant species are medically relevant (Touchard et al. 2016). Chemicals within ant venom can result in adverse allergic reactions, including anaphylaxis and neuropathy (Stablein et al. 1987). Additionally, a variety of ant species maintain the ability to vector diseases and contaminate food and water sources (Simothy et al. 2018). With the prevalence of ant populations around the country, the importance of control methods is essential to the safety of various environments (Fields et al. 2007; Holway et. al 2002). Because ant species in a geographical location differ based on the type of ecosystem they are present in, this study utilized different habitat types to conduct experimentation.

Previous research has proven ants maintain preferences for certain habitat types. A study concerning ant habitats was conducted in an ecologically diverse area of Mississippi, and determined that forest-type habitats of oak-hickory and flatwoods contained more ant sites and a greater variety of ant species compared to grassland-type habitats of pastures and prairies. The research also concluded that the higher number of ant sites reflected a higher total number of ants present. Although the forest-type habitats of oak-hickory and flatwoods were relatively similar in their quantity of species and number of ant sites, oak-hickory habitats displayed the greatest diversity and quantity of ant species and mounds. Oak-hickory and flatwoods habitats had an average of approximately 25 different species. In contrast, the prairies had an average of 17.1

species, while pastures had an average species variation of 5.2 species (Hill et al. 2008).

Using the Principal Component Analysis (PCA) tool, the most significant characteristics of an environment were determined to be land cover type and soil pH. Terrains with fewer trees, higher soil pH, and reduced shading, as seen in pasture and prairie habitats, had lower species variation and lower ant quantities. However, terrains with low pH, or acidic soil, higher amounts of trees and shading, such as flatwoods and oak-hickory habitats, displayed greater amounts of species variation and abundance. Overall, oak-hickory habitats were more abundant in ant sites and species than flatwoods and other habitats due to more shading by coarse woody debris and more acidic soil (Hill et al. 2008).

As aforementioned, previous research has proven different ant species can adapt and thrive in a plethora of ecosystems. These ecosystems often contain great diversity of flora and fauna species. To protect the biodiversity of ecosystems and minimize environmental pollution, ant baits are often used as an alternative to insecticide sprays to eradicate ant pests from unwanted areas (Allen et al. 1994; Bradberry et al. 2005). Foods differing in macronutrient ratios are often presented as ant bait that attract worker ants to the site. For example, a previous study in the Galapagos Islands cited that the ant bait, Amdro, composed primarily of corn grit and soybean meal, was most effective in attracting workers of the *Wasmannia auropunctata* species in the field, while peanut butter and honey were the most attractive food substances in the laboratory (Williams and Whelan 1992). Furthermore, a yearlong study on Barro Colorado, an island of Panama, observed the attraction of different ant species to protein versus carbohydrate-based baits. It was noted that arboreal ants were mostly attracted to protein-based bait, while terrestrial ants were primarily attracted to carbohydrate-based bait. However, these ant baits were tested during different seasons (dry and wet seasons), so ant attraction may have reflected the environment's lack of resources during certain seasons. Thus, this information may only be highlighting the nutritional requirements of ants, not food preferences (Hann and Wheeler 2002). While ants generally prefer foods abundant in carbohydrates, other factors, such as ant species, availability of food resources, and recent nutritional history also play a role in uptake of baits. In fact, previous research has demonstrated ants intentionally balance their intake of macronutrients to maintain a nutritional homeostasis (Lach et al. 2019). In this experiment, the level of attraction of different ant species to baits varying in macronutrients was tested in different ecological habitats.

Materials and Methods

Experimental Dates and Location

Three locations around the College Station, TX area were chosen as the experimentation sites. The following locations were selected for the experiment: the Winnie Carter Wildlife Center, Janice and John G. Thomas Honey Bee Facility, and the backyard of a local resident near Wellborn Rd. and Navarro Dr. These locations were chosen because they are representative of different environmental conditions within the local area and presented opportunities to obtain different species of ants. The Winnie Carter Wildlife Center is working site for many students and the home to an assortment of wild animals. The land is mainly a grassy environment with trees lightly populated in some areas, but heavily untouched in others.

In contrast, the Honey Bee Facility is located in a region currently being developed. Thus, there are ongoing ecological disruptions in the area; however, the majority of nearby land constitutes an isolated and rural environment. The area is also abundant in wildlife, yet these animals are free-roaming, unlike those of the Winnie Carter Wildlife Center. Finally, the residential location in South College Station is surrounded by a neighborhood with brick and stone houses on concrete foundations. The outdoor area in this region is mainly comprised of trimmed grass, small and well-kept gardens, and some sparsely scattered trees. This location is representative of a stable, suburban area with paved roads and established houses. Therefore, the main disruption of insect habitats is the changing weather and yard upkeep.

Because certain ant species occupy subterrestrial habitats during the winter season, this experiment was conducted in early November to obtain the greatest number and diversity of ants. Studies were conducted simultaneously for a two-week interval between 4.XI.2019 and 18.XI.2019.

Materials

To test the effectiveness of ant baits based on their macronutrient content, two attractants and a negative control were used for each location. Foods rich in protein or carbohydrates served as the bait. For the protein source, a raw sausage was used. The carbohydrate attractant was represented as solid sugar. In addition to these baits, the negative control lacked any attractant. Finally, commercial sticky pads were used in conjunction with each bait in order to trap ants approaching food baits.

Design and Procedure

Eight ounces of each macronutrient were spread on two separate sticky pads. The negative control was comprised of only a sticky pad and lacked a food bait. The different traps were laid two feet apart at each individual location. The pads were placed under shaded areas to prevent potential damage from weather. Each pad was checked for ants twice a week for two weeks. During each checkpoint, collected ants were carefully removed from the sticky pad and preserved in vials of 95% ethanol. Ants were identified using dichotomous keys from Cokendolpher and Francke (1990).

Results

A total of 51 specimens were collected, all representing Hymneoptera:Formicidae. Table 1. and Fig. 1 display the number and species of ants obtained for each trap by macronutrient and respective location. The Winnie Carter Wildlife Center and Janice and John G. Thomas Honey Bee Facility collected a total of 19 ants, while the residential area location collected 13 ants.

The vast majority of ants collected were *Solenopsis invicta*, the red imported fire ant. For both the Winne Carter Wildlife Center and the Janice and John G. Thomas Honey Bee Facility, only red imported fire ants were collected. However, other species of ants were obtained, including the pharaoh ant, *Monomorium pharaonis*, the ghost ant, *Tapinoma melanocephalum*, and the carpenter ant, *Camponotus rasilis*, as depicted in Fig 2. These ants were collected at the residential area, which failed to capture any red imported fire ants.

Finally, the carbohydrate macronutrient observed the greatest number of ants and species, as seen in Fig 1.

Location	Macronutrient	*S. invicta*	*M. pharaonis*	*T. melanocephalum*	*C. rasilis*
Winnie Carter Wildlife Center	Carbohydrate	9	0	0	0
	Protein	6	0	0	0
	Control	4	0	0	0
Honey Bee Facility	Carbohydrate	13	0	0	0
	Protein	2	0	0	0
	Control	4	0	0	0
Residential Area	Carbohydrate	0	3	2	2
	Protein	0	1	0	1
	Control	0	1	1	2

Table 1. The quantity and species of ants at each experimental location with respect to the macronutrient present.

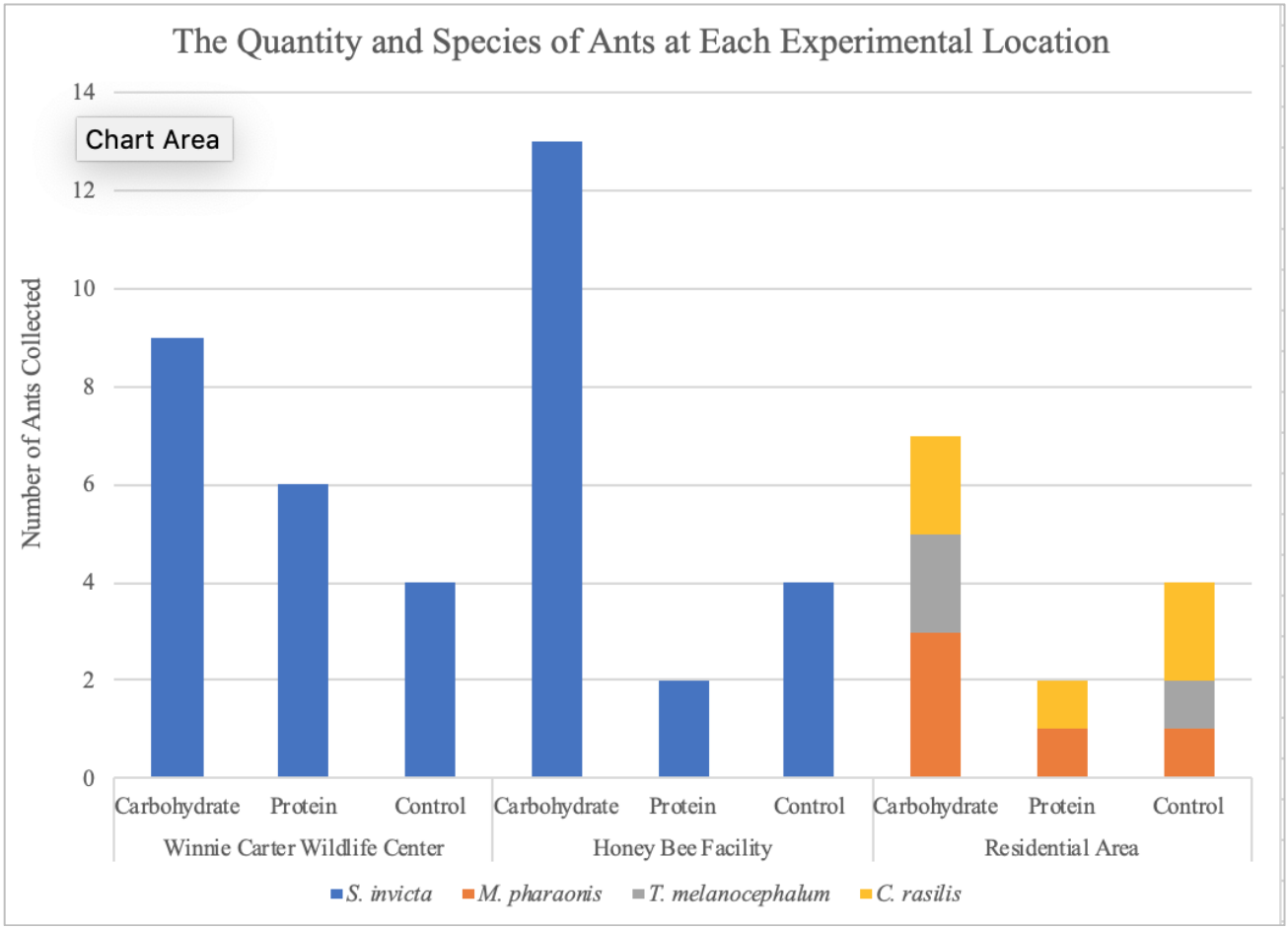

Fig. 1. A graphical depiction of the quantity and species collected by respective location and macronutrient.

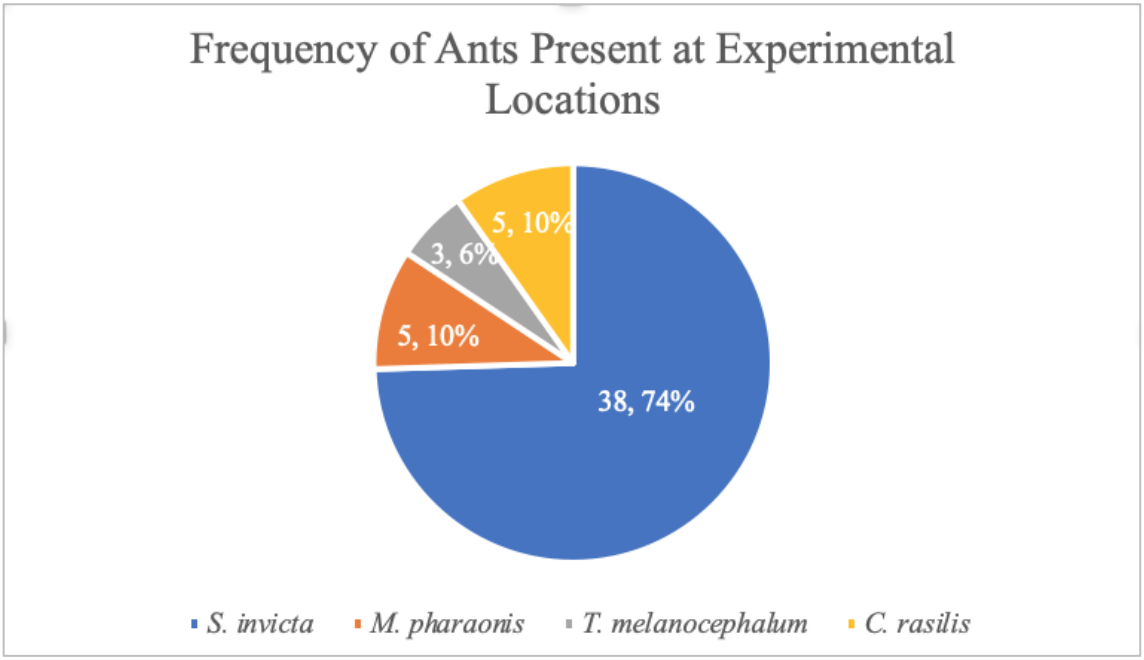

Fig. 2. The distribution of ant species from all experimental locations.

Discussion

The prevalence of different ant species in varying ecological habitats was evident throughout this study. Within the Winnie Carter Wildlife Center and the Janice and John G. Thomas Honey Bee Facility, all ants collected were *S. invicta*, the red imported fire ant. The abundance of *S. invicta*, particularly in disrupted ecosystems, is seen throughout the southwestern United States because of this species' ability to adapt their foraging behaviors and due to their opportunistic, omnivorous diet (Kaakeh and Dutcher 1992). In contrast, the residential area collection reflected a greater diversity of ant species. A possible explanation for this trend is the relative stability of suburban areas in comparison to developing areas; established suburbs lack the construction and stress levels that accompany developing areas, as seen in the other two locations described (Hackett et al. 2014). Ants, such as the ghost ant, collected at this residential site, may lack the traits and skills required in order to adapt rapidly to such environmental stresses. Previous research depicting the growing geographical distribution of the red imported fire ant shows this species of ant has the tools, such as aggressive defense behaviors, necessary to flourish in developing areas (Kemp et al. 2000). In contrast, the other species of ants obtained exhibit different foraging behaviors that may hinder their ability in comparison to the red imported fire ant. For instance, the pharaoh ant has been proven to search and defend resources only within close proximity of its mound (McGlynn 1999).

The success of the carbohydrate macronutrient serving as a bait can possibly be explained by environmental conditions and resource availability. Previous research has demonstrated ants can alter their foraging behaviors in order to adapt to the availability of food resources, which is often a product of weather (Cook et al. 2011). During this

experiment, the average temperature maintained was 55.03° F. Most species of ants are active at temperatures ranging between 50° F and 80° F (Jayatilaka et al. 2011). Thus, the uncharacteristically cold weather for Texas may have played a role in diminutive number of ants collected.

Furthermore, this weather may have affected the nutritional requirements of the mound and thus, foraging behaviors (MacLean et al. 2017). Although ants typically are predisposed to carbohydrates, the lower temperatures could have led ants to seek more carbohydrates in order to store energy for upcoming foraging trips and lipid reserves (Cook et al. 2010; Arrese and Soulages 2010). Additionally, only larval stages of ants can digest protein because of a sieve-like filter within adult ant mouths (Dussutour and Simpson 2012). Consequently, foragers may seek macronutrients beneficial to all ant life stages, especially given the colder environmental conditions.

Despite the conclusion that carbohydrates were the most attractive macronutrient to ants within this study, further research is needed to observe how external conditions can affect a bait's ability to attract different species of ants.

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