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Drosophilia ecology: Food resource behavior

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Drosophila Ecology: Food Resource Behavior

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by

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Introduction

Food preference and choice of oviposition (egg laying) site are critical factors for insects such as *Drosophila* and affect many aspects of their lives (Jennings and Seager, 1982). Different species of *Drosophila* fill various niches by making use of a variety of foods, which also affects their seasonal abundances (Shorrocks, 1983). The ability of *Drosophila* to find the location of a certain food type for egg laying and thus for their larvae affects the survival of their species. Breeding sites and substrates of the flies are chosen on the basis of the food available for the larvae of each species.

Beagon and Shorrocks (1978) showed that *Drosophila* preferred food sources with certain types of yeast that are unique in the wild. Carson and Heed (1983) found that almost any fruit serves well as bait for *Drosophila*, especially citrus fruits and apples. Shorrocks (1982) showed that *Drosophila* are attracted to a wide range of baits such as malt, artificially decayed plant matter, sap fluxes, and rotting vegetables. It was found that when *D. melanogaster* and *D. simulans* were captured on various baits, marked with florescent light, and released they showed statistically significant levels ($p < 0.05$) of returning to the same bait on which they were originally caught (Turelli et al., 1984). Food choice is ultimately based on the nutrients and carbohydrates found within them because the *Drosophila* are unable to make all the necessary nutrients they need to survive (Carson and Heed, 1983).

Bobinet (unpublished data) found that *D. robusta* preferred banana bait in the wild at a statistically significant level ($p < 0.05$), while *D. tripunctata* preferred mushroom bait in the wild at a statistically significant level ($p < 0.05$). These data were supported by further trappings done in Cedar Falls, Iowa (Seager et al., unpublished).

The purpose of the following study was done to create a workable laboratory apparatus that replicated the bait preference behavior found in the wild. An apparatus which models the wild would allow for the dissection of the *Drosophila* behavior. *Drosophila robusta* and *D. tripunctata* were chosen because of their distinct bait preference behavior. *D. robusta* had been caught entirely (100%) on banana bait and *D. tripunctata* had been caught primarily on mushroom bait (80%). We tested whether the apparatus we built replicated this behavior.

Methods

The apparatus was 1 cm high, 10 cm wide, and 80 cm long. It was made out of Plexiglas and coated with Teflon. The apparatus was divided into sections that could be partitioned off with gates. Each end section was 20 cm, while the center section was 40 cm long. The lid had eight holes 2.5 cm in diameter evenly distributed along the length of the lid. These holes were covered with nylon netting. The baits were placed on opposite ends of the apparatus. Air was blown onto the bait, and then a tube leaving the bait was placed flush with the netting of the last hole of the apparatus.

The baits used were the same as used in the field study: fermented bananas (100 g) mixed with bakers yeast (1.25 g), and mushrooms (65 g) mixed with water (15 g). Each bait was prepared three days prior to the trial by mashing it with a mortar and pistil.

Nine separate genetic lines of *D. robusta* and *D. tripunctata* were combined within each species for the experiment. Each line was started from a single female that had been inseminated in the wild and captured in Cedar Falls, Iowa. For each species, adults 3 to 5 days old were tested separately through the apparatus, requiring four runs to complete a trial.

For each run 80-100 flies were placed in the center section of the apparatus. Air was run through the bait and into the ends of the apparatus. The flies were allowed to move freely within the apparatus for two hours. Then the gates were lowered, and carbon dioxide was used to knock the flies out. The number of flies in each section of the apparatus was recorded. Between runs the apparatus was wiped down with water and dried to remove any residue left from the baits.

Results and Discussion

This analysis is over five trials (20 runs). The flies could arrange themselves in any number of patterns if they weren't experiencing attraction. A randomization test was used to determine the probability that the flies would behave in the recorded pattern. This statistical test determines whether the observed pattern is significantly different from random. *D. tripunctata* females were significantly more attracted to the mushrooms than *D. robusta* ($p=0.0079$). This was also found in the males, with the *D. tripunctata* significantly more attracted to the mushrooms than the *D. robusta* ($p=0.0079$).

The banana bait didn't provide a clear distinction between the species. *D. tripunctata* females were not found to be statistically different from the *D. robusta* ($p=0.1984$). There was no significant difference in attraction to the banana bait between the *D. tripunctata* males and the *D. robusta* males ($p=0.7937$).

The third category of flies were the flies that didn't change their position in the apparatus. They didn't respond to either the banana bait or the mushroom bait. The male non-responders were found to be primarily the *D. robusta* ($p=0.0079$). There was no distinction between the species with the female non-responders ($p=0.1984$).

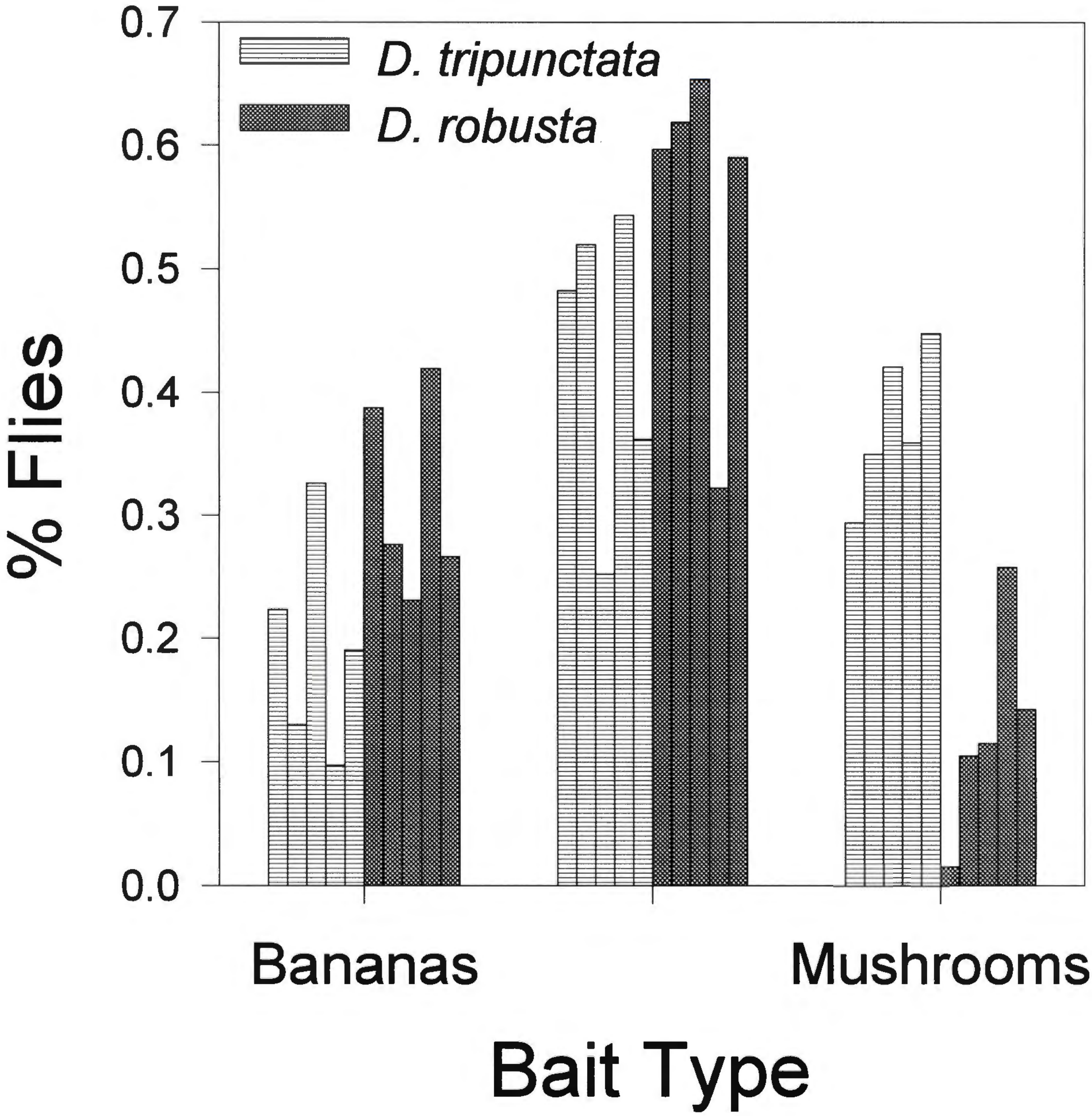
The lack of a statistically significant response to the banana bait among the males could be due to the fact that in the wild, *D. tripunctata* were not caught exclusively on banana bait (Seager et al, unpublished). This means that they will feed on more than one type of food. Therefore, it can be expected that the bananas will attract them. The *D. robusta* were not caught on mushrooms. This lack of attractiveness is still found in both the males and the females.

Our laboratory results are consistent with the field data (Seager et al, unpublished). Thus, the laboratory apparatus can be used to further dissect this bait attractiveness behavior. For example, it is not known why some flies don't respond to the presence of food. It could be that the flies aren't hungry or thirsty. One way to examine this is to desiccate the flies, which is removing them from food and water to make them hungry and thirsty. Then analyze if this alters the non-responder behavior.

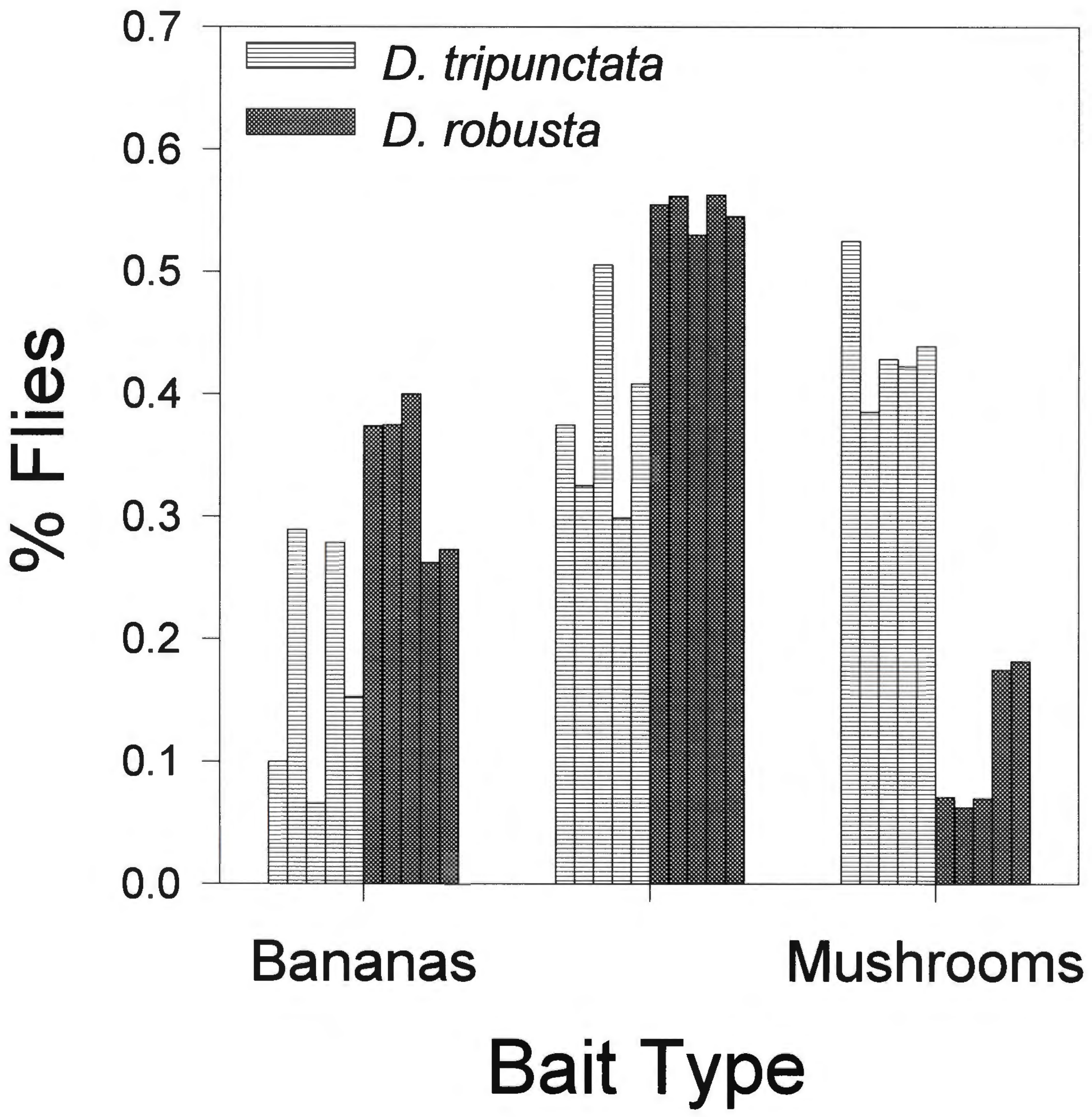
It is also not known whether food attraction is a genetic trait, or if it is a conditioned response. The apparatus could be used to attempt to alter the flies natural tendencies by raising the flies on media that includes either mushrooms or bananas. If the attractiveness can be altered by the environment the flies are raised in, it is at least partly a conditioned response. However, if we are unable to alter the flies behavior it is most likely genetic.

Attractiveness to food plays an integral part in the survival of *Drosophila.* Therefore, the working model that has been developed will help us to better understand the flies and what drives their search for food.

Tripunctata vs Robusta Females



Tripunctata vs Robusta Males



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Senior Thesis Appendix

While working on my senior thesis, I found myself learning more about science than I had in any previous educational experience. Learning about science in any other setting included repeating procedures that had been given to me. I would learn about experiments that clearly showed a basic scientific principle without explaining any difficulties that were incurred reaching the conclusion. What isn't printed in the textbooks is how many times did the setup fail before the experiment gave conclusive results.

As I developed my experiment, I learned to accept science as a creative endeavor. The scientific method gives an outline on how the creativity must be harnessed, but this is far from giving a recipe on how experiments should be run. I can now appreciate the number of pilot tests that go into developing a scientific instrument. I had planned on setting everything up for my research and being done in about half the time that it actually took me. It was good to go through the process of problem solving and being creative in developing my design, because it taught me firsthand how science is really done. The creative nature of scientific problem solving can be read about, but until it is experienced it can't be completely understood.

Acknowledgments

I wish to personally thank Dr. Seager for giving me the freedom to make mistakes, and to figure out how science works. Without his guidance this project would never have gotten past the pilot tests. I would like to thank the Presidential Scholar's Program because without the thesis requirement I would never have had this rewarding experience. Jenny Payton has my gratitude for supporting me and putting up with the odd hours. Most of all I want to thank God, for his wonderful creation that I continually search to understand.