Effects of Coyote Urine on Trappability of

Peromyscus leucopus* and *Peromyscus maniculatus gracilis

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Matthew Bono
Advisor: Michael Cramer
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Abstract

Many factors play into the behavior of mammals. One such factor is the relationship between predator and prey. Prey species will often times alter their behavior in order to increase their chance of survival by avoiding predation. The prey species will use indirect cues from the predator in order to assess the risk of the environment and act accordingly. One such interaction occurs between the group of prey species composed of *Peromyscus leucopus* and *Peromyscus maniculatus gracillis* and the predator species, the coyote (*Canis latrans).* This study investigated how the presence of coyote urine affects *Peromyscus* use of space. *Peromyscus* had the option of visiting traps set on the ground and in trees at two sites. By trapping *Peromyscus* both in the presence of the scent and without it, I was able to examine what ways, if any, *Peromyscus* altered its behavior when presented with cues from a coyote. The data collected revealed that there was no significant decrease in the number of *Peromyscus* captured per trap-interval, however there was a significant decrease in the proportion of *Peromyscus* ground captures both for the overall community and for individual mice.

Introduction

Predation has had a significant impact on all organisms and has shaped the way they behave. Different organisms utilize different strategies in order to avoid predation and successfully obtain energy and nutrients. Thus, the risk of predation can affect foraging decisions of many organisms. Many herbivores are forced to alter foraging behavior in the presence of predators at the cost of foraging on lower quality resources (Macarthur and Pianka 1966). The tradeoffs that make up optimal foraging decisions help shape the evolution of social behavior.

Although traditionally viewed through the lens of prey consumption, predators can also affect their prey through predator induced alterations in foraging, habitat use, morphology, and other traits (Abrams 1984, 1995). The presence of a predator can cause various nonconsumptive effects on a prey species. These nonconsumptive effects play a major role in the ecology of the prey species. Nonconsumptive effects can often times equal or exceed consumptive effects in determining population-level effect of predators on their prey and their prey's resources (Preisser et al. 2005).

In order to avoid predation, mammals must alter their behavior based on the scenario that presents itself. The prey must determine which actions are appropriate given the conditions of a particular situation. One of the major factors influencing the prey organism's actions is the behavior of the predator species. For example, a prey species is less likely to respond to cues from predators that are active hunters, meaning they actively seek their prey, than predators that sit and wait for their prey. Similarly, prey species are less likely to respond to cues from species that have larger habitat domains as opposed to those with narrower domains (Preisser et al. 2007). Other factors influencing the prey's behavior include encounter rate with predators, predator lethality in the absence of vigilance, effectiveness of vigilance in reducing predator lethality, the marginal value of energy to the forager and the forager's survivor's fitness (Brown 1999).

Numerous studies have repeatedly demonstrated the impact of predator cues on the behavior of small mammals. Olfactory cues in particular have produced nonconsumptive effects in various different organisms (Preisser et al. 2007). In general, previous studies have confirmed the trends indicating that the presence of predator urine elicits different effects from the prey species based on the predator's hunting characteristics (Apfelbach et al. 2005).

One set of small mammals of particular interest regarding predator avoidance is the two mouse species *Peromyscus maniculatus gracilis* and *Peromyscus leucopus*. These two similar mouse species have been studies numerous times by other researchers regarding behavioral effects resulting from the presence of predators. In this particular study, I will investigate *Peromyscus* behavioral changes in the presence of urine from a potential predator, the coyote (*Canis latrans*). The coyote represents an active hunter with a broad hunting range and a diet that is less specific to mice than other potential predators of *Peromyscus* (Young et al. 2006). I will test the hypothesis that in the presence of coyote urine, *Peromyscus* will have a higher capture proportion in traps mounted in trees as opposed to ground traps. My hypothesis is based on the fact that the coyote is unable to climb the trees as easily as other predators; therefore *Peromyscus* will seek refuge in the trees. Other studies have shown that predator cues can result in an overall decrease in foraging by some small mammals (Brinkerhoff et al. 2005). However, I do not expect there to be a significant decrease in overall captures in the presence of the predator urine. Since the coyote is an active hunter and has a broad range, I do not expect the increase in tree captures to be large since previous studies have indicated that this particular hunting style does not invoke a large response from prey species (Preisser et al. 2007).

Materials and Methods

Two different trapping sites were selected within the property of the University of Notre Dame Environmental Research Center. Each site contained 50 different Sherman traps. 25 of the traps were on the ground and 25 were in the trees. The ground traps were placed 15m apart along 5 parallel transects, also 15m apart. Tree traps were strapped to a wood platform and the platform was strapped to the tree nearest to the corresponding ground trap, roughly 2m from the ground. The traps were set without any coyote urine for the first five days so as to serve as a control. Traps were set at sundown each day with equal amounts of oats and sunflower seeds in each trap and were checked the following morning at sunrise. All captured *Peromyscus* were given individual marks.

The second five nights of trapping served as the experimental phase of study. In addition to adding the same amounts of food as the control phase, each ground trap held a cotton ball containing 1mL of coyote urine. The cotton balls were replaced every other day.

In order to analyze the data, I tested whether the mean number of *Peromyscus* caught per trap-interval differed during the control phase and the experimental phase. Trap-intervals were adjusted according to a model proposed by Beauvais and Buskirk (1999) which allowed me to account for closed traps that caught other species, were sprung but did not capture anything, and those that caught *Peromyscus*. I also tested whether the mean proportion of tree traps differed between the control phase and the experimental phase. I used SYSTAT 12 to run a paired t-test to compare the difference in proportion of ground captures for each individual between the control phase and the experimental phase. Proportions were determined by dividing the number of ground captures for the 5-day interval by the total captures in tree and ground traps combined in that same time interval. Additionally, I ran a t-test to test for a significant difference in the mean number of *Peromyscus* captured per trap-interval. Only the individuals that were caught at least twice during the control phase were included in the analysis so as to make sure all trends during the control phase were not due to just one capture.

Results

During the 10 nights of trapping, I successfully captured 46 different individual *Peromyscus* for a combined total of 197 captures. 76 of those captures occurred during the control phase and 83 occurred during the experimental phase. Of the 46 individuals captured, 25 occurred during the control phase and 22 of those 25 were captured more than once. With respect to those 22 captured more than once, 20 captures occurred in the tree traps while 33 occurred in the ground traps during the control phase. Those same 22 individuals were captured 33 times in the trees and 44 times on the ground during the experimental phase.

Upon examining the data, I found that there was no significant difference in the mean number of *Peromyscus* captured per trap-interval (control = 0.166 ± 0.019, experimental = 0.193 ± 0.026) (Figure 1). A t-test confirmed this trend for all traps between the two treatments (t = 0.824, df = 8, p = 0.434). The data of proportional ground captures for the 22 individuals had a normal distribution so there was no need to transform the data. The mean proportion of ground captures for the 22 individuals (control = 0.71 ± 0.078, experimental = 0.55 ± 0.081) differed significantly between the two phases of the experiment (Figure 2). The paired t-test confirmed a significant difference in the change for individual *Peromyscus* between ground trap captures in the control phase and the experimental phase (t = 2.196, df = 21, p = 0.039).

Discussion

Statistical tests revealed that there was no significant change in the mean number of *Peromyscus* captures per trap interval between the control and experimental stages of the experiment. This suggests that the *Peromyscus* did not interpret the coyote urine as enough of an indication that coyote presence in the area would pose an immediate threat to their survival. It is possible that the coyote's generally active hunting style and broad range allow the *Peromyscus* to continue foraging in the area as the probability of encountering the coyote is not as great as the probability of encountering other potential predators (Preisser et al. 2007). If cues from actively hunting predators provide less information about local predation risk than cues from sedentary predators, prey may be less responsive to cues from active predators as opposed to sit-and-wait or sit and-pursue predators (Lima and Bednekoff 1999)

Though there was no significant decrease in the mean number of *Peromyscus* per trap-interval, statistical tests indicated a significant decrease in the proportion of ground captures for individual *Peromyscus* in the presence of coyote urine. This suggests that *Peromyscus* altered their behavior so as to avoid the greater potential for predation in ground traps indicated by the coyote urine and they preferred the tree traps. The tree traps not only contained no coyote urine, but they were also high enough to keep any coyotes from being able to prey upon the *Peromyscus*. It is possible that *Peromyscus* is familiar with the coyote's hunting tactics and seeks refuge in trees when it is deemed necessary. However, in order to test this theory more adequately, I would need to run an experiment similar to the one I already conducted. The new experiment could test the effects of urine from different predators such as bobcats (*Felis rufus*) which have the ability to climb trees or weasels (*Mustelidae*) which have a diet more specific to mice. *Peromyscus* should have a greater decrease in its capture rate as both of those predators pose a greater threat than the coyote.

The results from the paired t-test suggest that the decrease in the proportion of ground captures was not a result of the overall population, but rather the trend occurred at the individual level. Though not all of the individuals demonstrated a decreased proportion of ground captures, a large enough majority of the population did in fact alter its behavior in the presence of coyote urine during the second 5-day interval of the study.

Despite the significant trends indicated by the data collected, many questions remain regarding the changes in behavior observed in this experiment. The largest remaining question is whether or not the trends were actually due to the introduction of coyote urine, or whether there were any other factors attributing to the changes in *Peromyscus* behavior. One previous study had results contrary to mine. Orrock et al. (2004) found that mice did not alter their giving up density when presented with cue from coyotes or any other predators. Instead, they were more impacted by microhabitat use including leaf cover, precipitation, and moon illumination. However, the study did suggest that indirect cues provide more easily assessed information regarding the risk of multiple predators.

Because of the time constraints placed on this study, I was only able to test whether there were any differences in behavior after coyote urine was introduced. However, other studies have found other cues that tend to alter *Peromyscus* behavior that do not pertain to the presence of predators. One such factor is the individual's previous encounters with the cue. In a study between lab mice and wild mice, there was data to imply a key role of early experience in certain sensory cue preferences in *P. leucopus* (Barry 1984).Also, other studies have found that the diet of the coyote from which the urine is collected can affect the repellency of the odor based on increased sulfur content resulting from high levels of meat consumption (Nolte 1994).

One of the main potential influences on the *Peromyscus* behavior is olfactory conspecific cues. Previous studies have found that *P. leucopus* is more likely to be captured in traps previously occupied by conspecific individuals of the opposite sex than in traps previously occupied by the same sex (Wolf and Batzli 2002). Most of my captures were males, making it difficult to test this discovery. However, it would be interesting to test whether gender had an impact on trapability in a larger population over an extended period of time. Preferences for odors of conspecifics of the opposite sex may be related to mate finding and reproduction (Mazdzer et al. 1976). Other studies have found that individuals are more likely to go for the cues from the opposite sex during the springtime mating season (Daly et al. 1978). However, this behavior was not limited the opposite sex as males were often times found in traps that previously held other males.

There were a few flaws in my experimental design which might have caused the data to reflect the *Peromyscus* populations less accurately than it could have. The main flaw was the fact that we placed the coyote urine inside the trap, meaning the *Peromyscus* had to physically enter the trap and set it off in order to investigate the source of the scent. It may have been a better idea to place the scent outside the trap so the individuals could investigate it and then decide whether or not they would forage on the ground or seek protection in the trees. Predator fur has been found to be a stronger indicator of predator presence, though it is more difficult to acquire and distribute (Apfelbach 2005). It also would have been better to have gotten a larger sample of the population during the control phase, but time constraints limited me to just 5 days of control trapping. I would suggest repeating this study over an extended period of time on more grids to obtain a better representation of the *Peromyscus* population.

Although I used the trap-interval correction model proposed by Beauvais and Buskirk (1999), it is still possible that *Peromyscus* captures per trap-interval were thrown off as a result of other organisms going into the traps. However, flying squirrel (*Glaucomys volans* and *Glaucomys sabrinus)* activity is limited to about 2 hours after sundown and a few hours before sunrise (Weigl 1974). Therefore, the trap-interval adjustment was most likely able to accommodate for the fact that there were some disturbances from organisms other than *Peromyscus.*

A better way to test whether or not the behaviors observed during my study were a result of the coyote urine would be to conduct the study in a much more controlled setting. In order to do so, I would capture the *Peromyscus* over night and bring them back to the lab during the day before returning them at the end of the day. In the lab, I would put the *Peromyscus* in the middle of a large cage that contained bedding on either side of it. One of the two beddings would contain the scent of coyote urine while the other would not. Observing the mouse's behavior would allow me to find out whether the mouse investigated the scent, avoided it all together, or was not influenced by it at all. This experiment would be much more controlled and would allow for stronger conclusions regarding *Peromyscus* behavior in the presence of coyote cues.

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Appendix

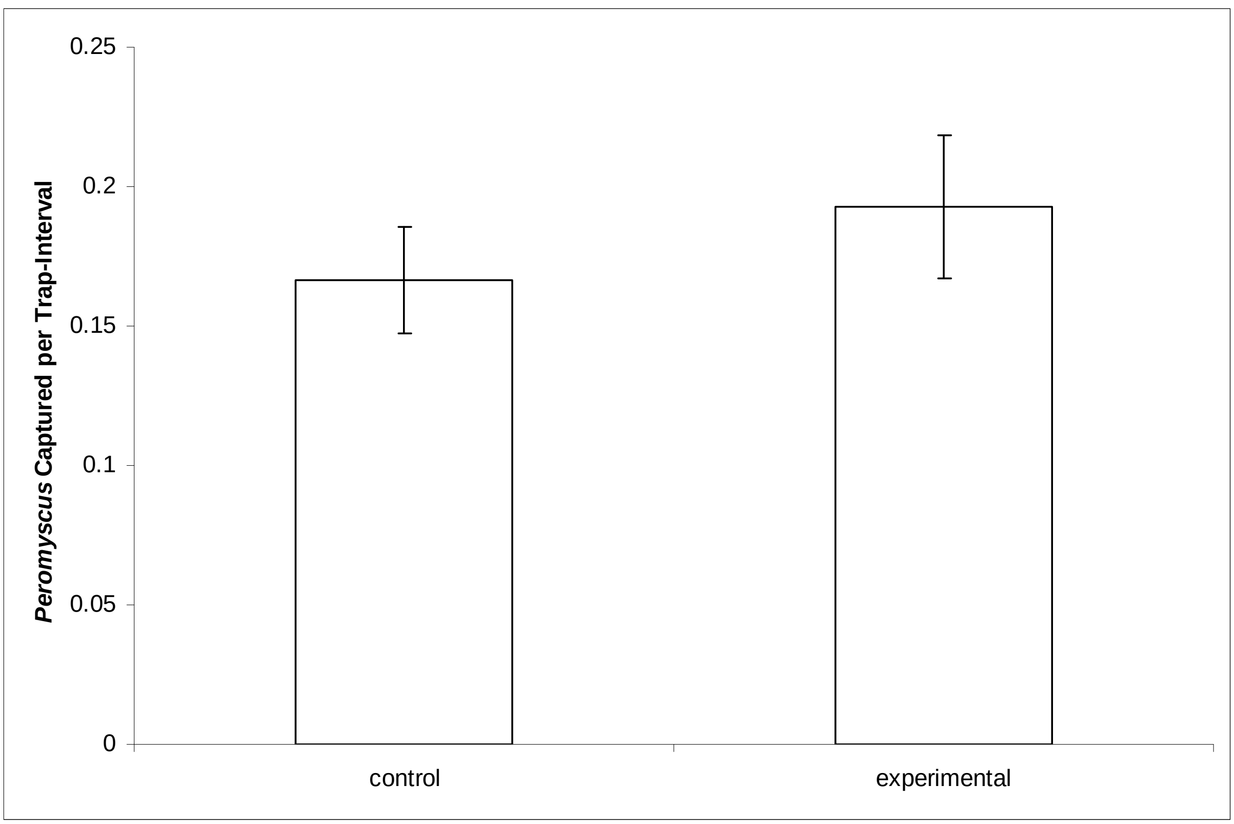

Figure 1 – Comparison of mean number of *Peromyscus* captured per trap-interval in all traps during the control and experimental phases. There was no significant difference in the mean number of captures (control = 0.166 ± 0.019, experimental = 0.193 ± 0.026). Error bars represent standard error.

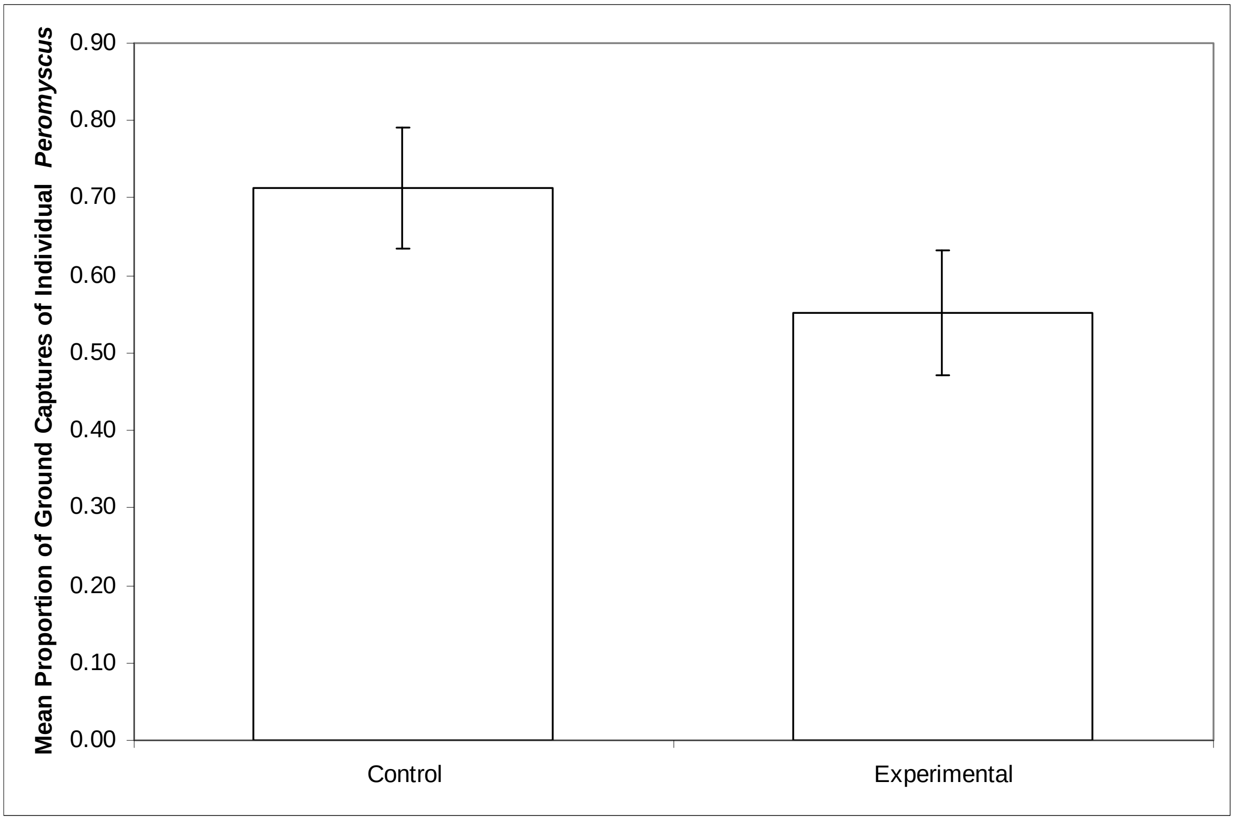

Figure 2 – Comparison of mean proportion of ground captures for individual *Peromyscus* between the control and experimental phases. The control had a significantly greater proportion of ground captures than the experimental phase (control = 0.71 ± .0078, experimental = 0.55 ± 0.081). Error bars represent standard error.