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# The Effects of Predator Presence on Nectarivorous Bat Foraging Behavior

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## ABSTRACT

For many species, predator avoidance changes normal foraging behavior, altering optimal foraging strategies. In this study, foraging behavior of bats was examined by observing the number of feeding visits to control feeders in comparison to feeders with an artificial snake or owl in close proximity. Trials were also performed between snake and owl treatments to determine if one predator was more strongly avoided during feeding. Nectarivorous bats were found to exhibit predator avoidance behaviors for both snake and owl predators ( $P < 0.0001$ ,  $P < 0.0001$ ). There was no significant difference in trials comparing owl and snake avoidance, suggesting that bats do not fear one more than the other ( $P = 0.947$ ). This study shows that predator presence must be taken into account along with search time, handling time, and caloric reward when evaluating optimal foraging models with nectarivorous bats.

## RESUMEN

Para muchas especies, evitar al depredador cambia el comportamiento normal para forrajear, alterando las estrategias óptimas para forrajear. En este estudio, se examinó el comportamiento para forrajear de murciélagos observando el número de visitas al alimentarse en los comederos control en comparación con los comederos con una serpiente o un búho artificial cerca en proximidad. Se realizaron ensayos también entre los tratamientos con serpiente y con búho para determinar si un depredador fue evitado más fuertemente durante la alimentación. Se encontró que los murciélagos nectarívoros exhibieron comportamientos para evitar los depredadores tanto para el depredador serpiente y el búho ( $P < 0.0001$ ,  $P < 0.0001$ ). No hubo diferencia significativa en los ensayos que comparaban el evitar el búho y la serpiente, sugiriendo que los murciélagos no temen a uno más que al otro ( $P = 0.947$ ). Este estudio demuestra que la presencia del depredador se debe tomar en cuenta junto con tiempo de búsqueda, manejando el tiempo, y la recompensa calórica cuando se evalúa los modelos óptimos con los murciélagos nectarívoros.

## INTRODUCTION

The impacts of predator-prey interactions on population structure and dynamics have been examined for years. Numerous studies have observed the effects of predator presence on the foraging efficiency of prey species (Krebs and Davies 1981). Optimal foraging models have attempted to predict foraging strategies based upon search time, handling time, and caloric reward (Krebs and Davies 1981). It is likely that the presence of predators creates another variable in optimal foraging behavior.

The foraging strategies of hummingbirds, birds, and insects have been found to be affected by predator presence. In a previous study, it was found that hummingbirds visited feeders less frequently if there was an artificial predator in the vicinity, even if higher caloric rewards were found near the predator feeder (Flowers 1998). In another study, small birds were found to decrease their feeding rates after a hawk predator was flown overhead (Alcock 1984). Insect species have also exhibited predator avoidance

behaviors while feeding. In one study, the presence of artificial predators reduced the overall number of insect visitations to *Clibadium leiocarpum* (Asteraceae) (Tomon 1995).

There appears to be a lack of information about the effects of predator presence on the feeding behavior of bat species. Bats have highly developed olfactory and echolocation sensory systems for foraging, allowing them to detect objects as thin as a mist net (Janzen 1983). The complexity of bat sensory systems suggest acute predator sensing ability. If predator presence affects foraging behavior of such a variety of organisms it is possible that bats might exhibit similar behavior.

This study attempted to determine if bats exhibit predator avoidance behavior while foraging, and whether avoidance was stronger with a certain type of predator. An artificial snake and owl were used as predators in this study because they are known to prey upon bats (Altringham 1996). It was hypothesized that higher numbers of bats will feed at control feeders rather than feeders with predators nearby. It was also hypothesized that there would be different responses to each type of predator.

## **METHODS**

Data were collected at feeders located at Selvatura near the Santa Elena Cloud Reserve between the dates of July 14<sup>th</sup> and August 1<sup>st</sup> in Santa Elena, Monteverde, Puntarenas province. Data collection occurred between 6:50 p.m. - 9 p.m. for eight evenings. Selvatura contains 90% primary forest, 3% pasture, and 7% secondary forest and it is located on the Atlantic side of the Tilarán Mountain Range at 1612 meters (Solano pers. comm.).

To imitate a snake both visually and olfactorily, a rubber snake (1.55 m long, 0.03 m thick) was rubbed with snake scent obtained from the Serpentarium in Santa Elena, on July 19<sup>th</sup>, 22<sup>nd</sup>, and 29<sup>th</sup>, 2004. An artificial owl (0.25 m long, 0.10 m wide) was constructed out of clay, chicken wire, and brown felt material in order to imitate the approximate size and shape of an average owl. Bird feathers from wild birds were obtained on July 16<sup>th</sup> and 29<sup>th</sup>, 2004 and attached to the artificial owl in order to imitate bird scent.

For each time trial, two feeders six meters apart were monitored. Three types of treatments were used: snake versus control, owl versus control, and snake versus owl. Artificial predators were hung in the same horizontal level as feeder holes, approximately 0.25 meters from feeders. Other area feeders were removed to increase bat visitation at experimental feeders. Mag-lights were used to spotlight feeders in order to view feeding. Control, snake, and owl feeders were rotated between trials to control for preset feeder preferences or effects of surrounding objects. The order of treatments was also rotated nightly to avoid patterns based upon feeding times.

Eighteen ten minute observation periods were conducted for each treatment. The number of bats visiting each feeder was recorded over the ten-minute intervals. Within each observation period, monitoring was alternated by ten second intervals between the two feeders. A feeding visit was counted as a pause in front of any one of the four feeder holes. Any bats that appeared to revisit a feeder were counted as a new bat. Moonlight conditions were also recorded for each interval.

Means over ten-minute time intervals were compared in order to test for preferred feeding times. Paired t-tests were used to compare feeder visitation at control versus owl, control versus snake, and owl versus snake treatments. An unpaired t-test was used to compare feeder visitations in nights with full moon versus nights with partial moon cover.

## RESULTS

Feeding activity was highest between 8:11-8:21 p.m. and the lowest between 6:54-7:04 p.m. ( $x$ : 188.5 and 65.056) (Figure 1). Lunar cycles were also found to effect bat feeding behavior, with a significantly lower number of overall feeder visits during full moon nights versus partial moon nights (Unpaired t-test:  $t = 6.465$ ,  $P < 0.0001$ ) (Figure 2).

The number of bat visits was significantly higher at control feeders when compared to both owl feeders and snake feeders (Paired t-test:  $t = 5.115$ ,  $P < 0.0001$ ;  $t = 5.446$ ,  $P < 0.0001$ ) (Figure 3). Bats were not found to avoid one predator more than the other (Paired t-test:  $t = 0.067$ ,  $P = 0.9472$ ; Figure 3).

## DISCUSSION

As predicted, bats were found to exhibit less frequent feeding activity in the presence of both owl and snake artificial predators when compared to control treatments. It is clear that predator presence must be taken into account along with search time, handling time, and caloric reward when evaluating optimal foraging models. In order to better understand how predator avoidance fits into foraging strategy, manipulations of feeder sucrose concentrations may be necessary to test for trade-offs between greater caloric rewards and predator avoidance. Comparisons of behavior at feeders and in natural habitats may also determine differences in predator avoidance behavior and optimal foraging strategy.

The lack of a significant difference between avoidance of owl and snake predators suggests that bats do not find one of the predators more threatening than the other. Comparing bat response to predators with response to random objects would be useful to determine if bats avoid specific predators or if foreign objects of any kind near their food source produce a response.

Outside factors could have affected the observed bat foraging behavior. Feeding times were the highest between 8:11-8:21 p.m., suggesting that bats may have an optimal feeding time. There was a decrease in overall feeding behavior with increases in lunar light. This is consistent with a study on frugivorous bats in Mexico where it was found that the number of feeding visits was negatively correlated with percent moonlight (Elangovan and Marimuthu 2001). Throughout data collection, numerous bat vocalizations were heard. Bats are known to make food calls in order to increase group foraging behavior (Altringham 1996). These communications could have contributed to foraging behaviors in the presence of treatment feeders. Bats have been shown to have some memory capacity so it is possible that with successive nights there was less feeding activity due to avoidance of feeding disturbances (Janzen 1983). In addition to predator and control manipulations, mag-lights could have caused overall reduced feeding rates.

Further studies are needed to determine more precise effects of predator presence on optimal foraging strategies. Incorporating a measure of movement into predator treatments may be helpful in more closely mimicking real predators. It is unknown whether predator behavior is learned or a result of previous close encounters. A study on bat memory of predator locations may help further explain the importance of choice in optimal foraging strategy. Furthermore, it is possible that predator avoidance during foraging behavior may be population or geographically specific, and that certain populations may become habituated to different stimuli at the microhabitat level. To fully understand bat foraging behavior, studies on other aspects of feeding would be beneficial. Predator avoidance appears to be one of many complex factors that influence feeding behavior.

## ACKNOWLEDGEMENTS

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## LITERATURE CITED

Alcock, J. 1984. Animal behavior: An evolutionary approach. pp. 270. Sinaur Associates, Inc. Sunderland, Massachusetts.

Altringham, J. D. 1996. Bats: biology and behavior. pp. 182-183, 219-221. Oxford University Press. New York, New York.

Elangovan V. and Marimuthu G. 2001. Effect of moonlight on the foraging behaviour of a megachiropteran bat *Cynopterus sphinx*. Journal of Zoology. 253: 347-350.

Flowers, T. 1998. Trade-offs between caloric gain and anti-predator defense in hummingbirds (Tochilidae). Tropical Ecology and Conservation. CIEE, Spring, pp. 150-162.

Janzen, D. 1983. Costa Rican natural history. pp. 431-435. University of Chicago Press. Chicago, Illinois.

Krebs J. R. and Davies, N. B. 1984. Behavioural ecology: An evolutionary approach. pp. 95-110. Sinauer Associates, Inc. Sunderland, Massachusetts.

Tomon, T. J. 1995. Predator recognition by insects foraging at flowers of *Clibadium leiocarpum* (Asteraceae). Tropical Ecology and Conservation. CIEE, Summer, pp. 236-244.

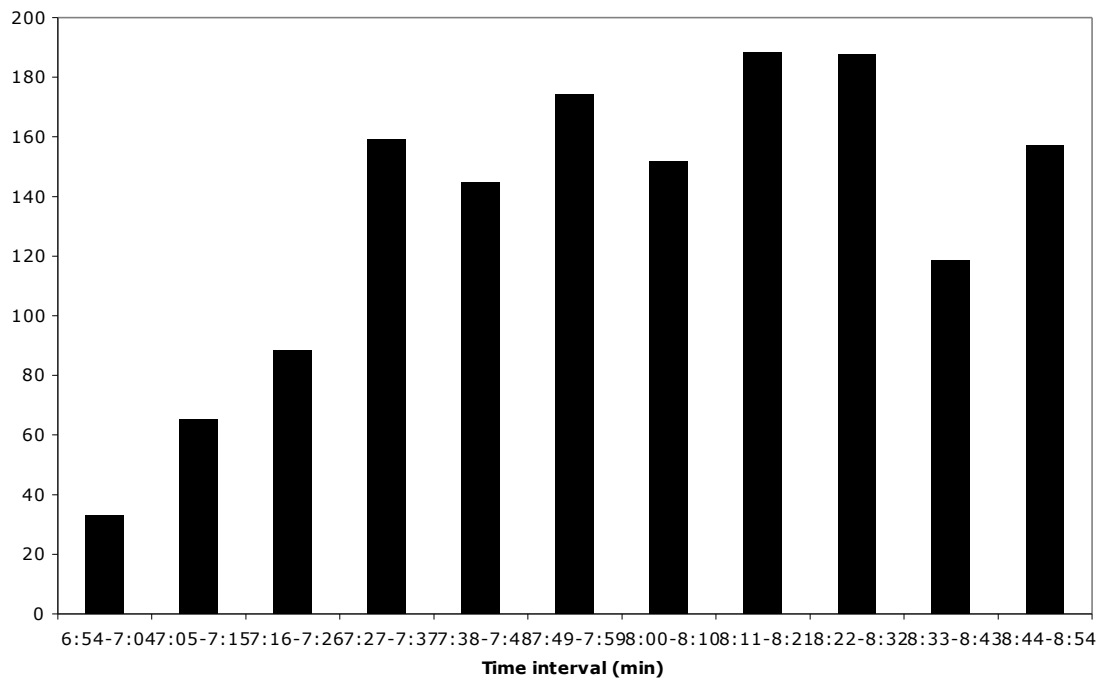
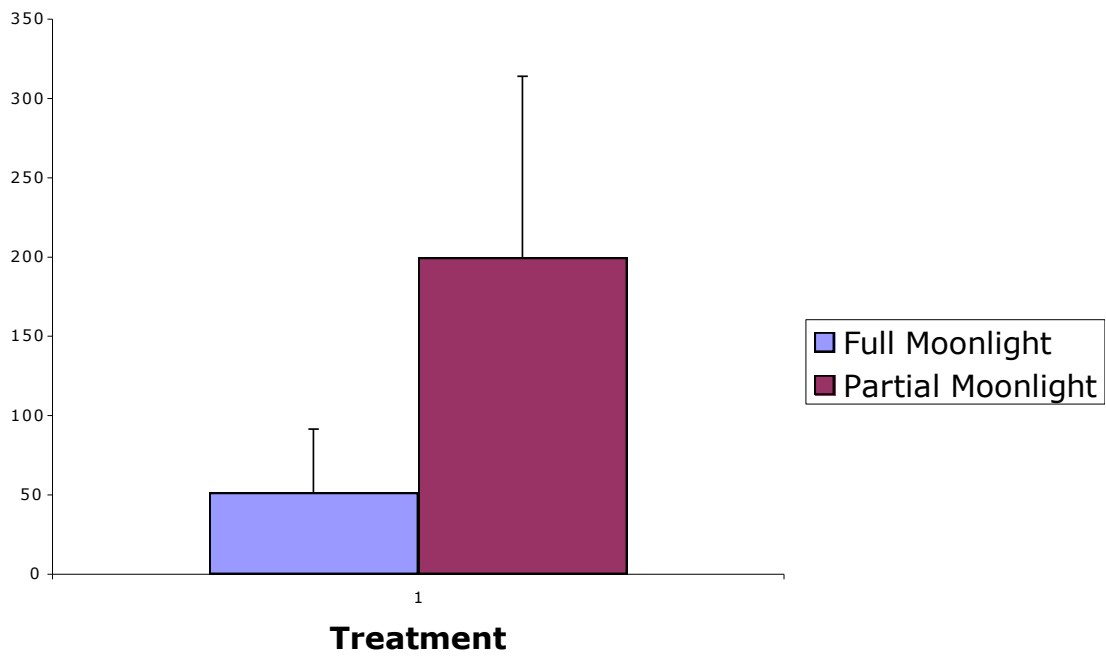


Figure 1: Mean number of bat visits per ten-minute interval at hummingbird feeders. Includes total number of treatments for each time interval averaged over 8 nights.

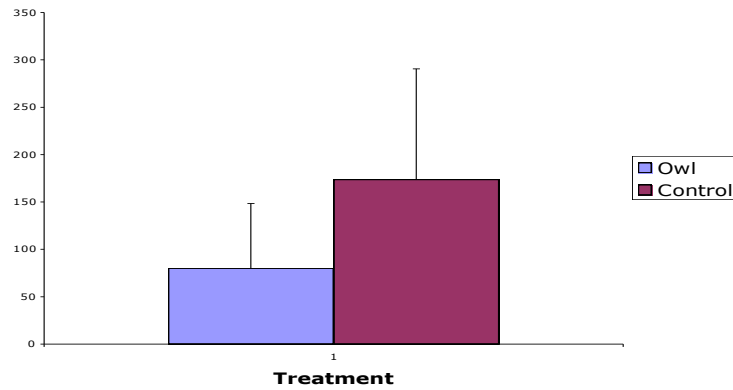


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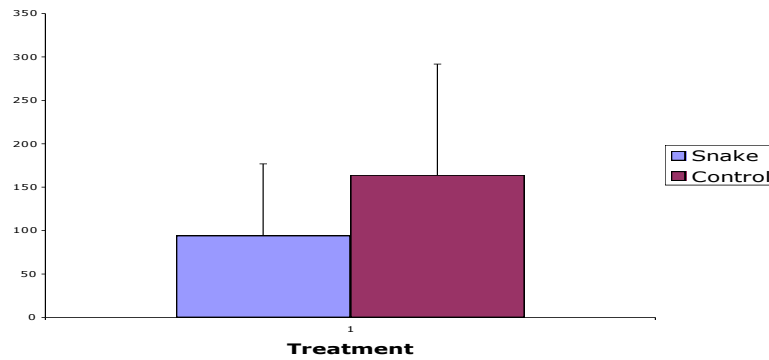
Figure 2: Comparison of mean number of bat visits at hummingbird feeders during full moonlight ( $x = 39.899 \pm 51.57$ ) ( $N = 28$ ) and partial moonlight ( $x = 199.643 \pm 114.284$ ) ( $N = 28$ ) (Unpaired t-test:  $t = 6.465$ ,  $P < 0.0001$ ). Error bars represent one standard deviation.



A



B



C

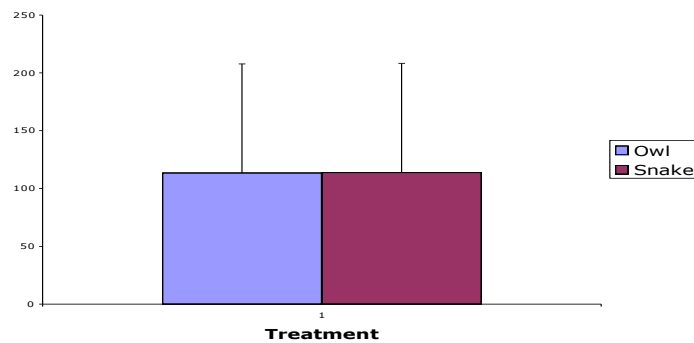


Figure 3: Comparing the mean number of bat visits in treatments of A: owl ( $x = 80.333 \pm 67.973$ ) versus control ( $x = 173.833 \pm 116.662$ ) (Paired t-test:  $t = -5.115$ ,  $P < 0.0001$ ) B: snake ( $x = 94.158 \pm 82.614$ ) versus control ( $x = 164.053 \pm 127.724$ ) (Paired t-test:  $t = 5.446$ ,  $P < 0.0001$ ) and C: owl ( $x = 113.474 \pm 94.306$ ) versus snake ( $x = 113.947 \pm 94.341$ ) (Paired t-test:  $t = 0.067$ ,  $P = 0.9472$ ). Means were taken over 18 ten-minute observation periods for each treatment. Error bars represent one standard deviation.