

August 2007

Going batty : response of foraging glossophagine bats to auditorily perceived predator presence

Hannah Kim Frank

Follow this and additional works at: https://digitalcommons.usf.edu/tropical_ecology

Recommended Citation

Frank, Hannah Kim, "Going batty : response of foraging glossophagine bats to auditorily perceived predator presence" (2007). *Tropical Ecology Collection (Monteverde Institute)*. 297.
https://digitalcommons.usf.edu/tropical_ecology/297

This Text is brought to you for free and open access by the Monteverde Institute at Digital Commons @ University of South Florida. It has been accepted for inclusion in Tropical Ecology Collection (Monteverde Institute) by an authorized administrator of Digital Commons @ University of South Florida. For more information, please contact scholarcommons@usf.edu.

Going Batty: Response of foraging glossophagine bats to auditorily perceived predator presence

Hannah Kim Frank

Department of Organismic and Evolutionary Biology, Harvard University

ABSTRACT

Predator presence is known to alter the foraging behavior of many species leading to decreased resource acquisition and lowered reproductive rate (Werner 1994). Previous studies have examined the effect of predator presence on the emergence of roosting bats and the effect of predator models on foraging bats (Baxter et al. 2006). Only one study, however, has examined the importance of auditory cues in alerting foraging bats to the presence of predators (in this case, owls; Baxter et al. 2006). The study concluded that bats not only avoid perceived owls but also the call of a diurnal woodpecker, leading the authors to question whether the latter finding was the result of novel sound avoidance or acoustic interference. This study, conducted in Monteverde, Costa Rica, investigated whether the findings of the earlier study were due to the effects of a novel sound or acoustic interference. Predator avoidance was quantified by counting number of visits to a hummingbird feeder after playing an owl call, a frog call or no call (a silent control). Significantly fewer visits were detected after the owl call than either the frog call or silence (ANOVA, $F = 11.0203$, $p = 0.0001$, $df = 2$) indicating the results of the previous study were due to novel sound avoidance. This study also reaffirmed the importance of auditory cues as a technique for predator detection in foraging bats, demonstrating a globally significant trait of bats.

RESUMEN

Se sabe que la presencia de depredadores puede cambiar el comportamiento de forrajeo de muchas especies, llevando a una reducción en la adquisición de recursos y bajando la tasa reproductiva (Werner 1994). Estudios anteriores examinaron el efecto de la presencia de depredadores afuera de los sitios de descanso de murciélagos y el efecto de modelos de depredadores en los murciélagos que forrajean (Baxter et al. 2006). Sin embargo, solamente un estudio examinó la importancia de señales auditivas como alerta ante depredadores sobre murciélagos que forrajean (búhos en este caso; Baxter et al. 2006). En este estudio se concluyó que los murciélagos no solo evitan los búhos que perciben sino que también el canto de un carpintero diurno, lo que llevo a los autores a cuestionar si lo encontrado es el resultado de evasión de un nuevo sonido o de evita interferencia acústica. En este estudio, realizado en Monteverde, Costa Rica, se investigó si los resultados del estudio anterior se deben a los efectos de un sonido nuevo o a interferencia acústica. La evasión de depredadores se cuantificó contando el número de visitas a un comedero artificial después del canto (playback) de un búho, una rana y silencio (como control). Había menos visitas después del canto del búho que después del canto de la rana y el silencio, indicando que los resultados de Baxter et al. (2006) fueron debido a la evasión de un sonido nuevo. Este estudio también reafirma la importancia de señales auditivas como una técnica para la detección de depredadores por parte de murciélagos que forrajean.

INTRODUCTION

Glossophagine bats are in the family Phyllostomidae, also known as the American leaf-nosed bats (Nowak 1994). Members of the subfamily Glossophaginae, these bats exhibit similar behaviors to hummingbirds, pollinating many tropical plants. They are specialized to extract nectar from flowers with elongated tongues, a narrow snout with sensory hairs and the ability to hover (LaVal and Rodríguez-H 2002). Still, many species have more

generalized diets that include fruit and insects (Findley 1993). Because of this nectarivorous diet, glossophagine bats are attracted to hummingbird feeders at night, where they can be observed in large numbers (Heuer 2004).

The presence or absence of predators near the feeding site is very important since predation is a major factor in bat mortality. In fact, predator avoidance has been offered as the reason for why bats roost colonially, emerge from these roosts in groups and are nocturnal (Baxter et al. 2006). Risk of predation is especially high during foraging since with increased activity bats are more likely to encounter predators and because predators are often better at detecting moving prey. Still, level of activity is positively related with resource acquisition and it is this tradeoff between obtaining food and the risk of mortality that defines the behavior of many species. Bats generally avoid predators and will avoid food if the predator is nearby (Baxter et al. 2006). This predator presence therefore hinders the foraging success of many species, leading to a lower reproductive rate, making the organism less evolutionarily fit (Werner 1994). Therefore predator presence is a powerful factor in determining not only a bat's short-term feeding but also its lifetime fitness.

A variety of studies have been conducted to determine how roosting bats respond to the presence of predators. These studies have used methods that include using actual predators, visual models of predators and models with playbacks of predator calls near bat roosts with mixed results. However, few researchers have examined the behavior of foraging, not roosting, bats in response to predators (Baxter et al. 2006). Heuer (2004) examined the response of foraging nectarivorous bats to a model snake or owl, known and important predators of bats, positioned at their feeder sites (Altringham 1996). She noted that bats avoided feeders with either model present but not a control without a model. As a follow up, Díaz (2005) tested the hypothesis that bats were avoiding a novel object and not a predator by comparing bats' reactions to a snake model, a novel object (a shoe) and a control, which lacked any object. She found that bats avoided the snake model but not the shoe and concluded that bats only respond to the threat of a recognizable predator.

However, bats do not only use visual and olfactory signals. Bats also use echolocation, which involves the transmittance of sound (Nowak 1994). Additionally, studies with bats and other prey animals have demonstrated that auditory cues are very important in predator detection (Baxter et al. 2006; Berger 1999; Schnitzler and Kalko 1998). Only one study, however, has looked at foraging bats' detection of predators using auditory cues. Baxter et al. (2006) used playbacks of owls, woodpeckers and silence at spatially separated stations to determine whether bats avoid owl calls. The bats they studied did avoid owl calls but also avoided the woodpecker calls. The researchers theorized that the avoidance of woodpeckers was likely due to an avoidance of novel sounds or acoustic interference since the bats of their study were insectivorous bats, which rely heavily on echolocation (Nowak 1994). The woodpecker would indeed be a novel sound because the bats of their study, genus *Myotis*, tend to roost in caves and very rarely in hollow trees where they would be likely to encounter the diurnal woodpecker (Nowak 1994).

This study attempted to clarify the results of Baxter et al. (2006) and to determine whether bats avoid a novel sound or acoustic interference by using playbacks of owl and frog calls. Also, if the bats avoid predator song (owl), it further reinforces the conclusion of Baxter et al. (2006) that acoustic cues are important in detecting predator presence during foraging. This study expected a difference in the number of bat visits to the feeder after the various calls. Also, it was predicted that there would be fewer visits to the

feeder immediately after the predator call than after either the familiar call or silence, as bats should avoid the perceived predator. Since the bats are familiar with the frogs and know they are not harmful, the bats would not avoid the feeder after the frog call unless it is indeed the noise that bothers them.

MATERIALS AND METHODS

Bats were observed on 11 nights between July 14 and July 31, 2007, between 6:40 pm and 9:00 pm. They were observed visiting a hummingbird feeder in the garden at Selvatura Adventure Park, located at 1612 m on the Caribbean slope of the Tilarán mountain range (Millard 2004). The garden contains six feeder stands, each with four feeders. For this experiment, all feeders but the one observed feeder were removed to concentrate the bats and accurately monitor all bat activity.

Three treatments were used in the experiment: the call of the Bare-shanked Screech Owl, the call of the Common Tink Frog (*Eleutherodactylus diastema*) and a silent control. These species were chosen because they are known to live in the region of the study site; this ensures bats would be familiar with both calls (Fogden 1993; Leenders 2001). The silent control trials replaced the call with silence but were otherwise identical. Treatments were performed in a random order by sampling without replacement to control for the variation in visits with time of night. All treatments were run an equal number of times per night, twice a night except for one night in which trials were only once, for nine nights (the first two nights utilized a different procedure). Trials were run a total of 17 times for each call type. Only 15 trials were used in data analysis, however, since the data from July 21 were excluded based on abnormal activity possibly due to aberrant weather and the presence of a screaming animal.

For each trial the call was played and then the numbers of visits were recorded for a five-minute period following the call (or silence). Calls were played, from various locations, for roughly one minute each to allow the bats time to hear the call and react. The frog call lasted 52 seconds, the owl 55 seconds and silence for approximately one minute. A visit was defined as a pause in front of the feeder; repeated visits by the same bat were counted as separate visits as described in Heuer (2004) and Díaz (2005). Visits were observed using a headlamp and small flashlight, both covered in red cellophane to minimize disturbance to the bats. Trials were spaced 20 minutes apart to allow bats to forget the previous call. This period was chosen based on observations of the bats on the first two nights as being adequate recovery time.

Also, based on the first two nights of observations, the most reliable predictor of bat activity appeared to be presence of food in the feeder. On the subsequent nights feeders were refilled with a 20 % sugar solution by volume. Volume of sugar solution in the feeder was measured immediately before the call and after the five-minute period to determine volume eaten by the bats during each trial.

Other data was recorded as well. The amount of moonlight was quantified as no moon, slight moon or nearly full. Weather conditions were recorded in regards to the degree of rain and were quantified as dry, drizzle, rain and downpour. Number of visits per trial was the average of counts by two individuals. Number of visits as a percentage of the nightly average was used in data analysis to control for the fluctuations in numbers of visits each night (between 481 and 922 visits per trial). Visits as a percentage of the nightly average was then analyzed with an ANOVA test to determine whether bats selectively

avoid any treatment. ANOVA tests were also used to determine the effect of weather, moonlight and time of night on the number of visits. A regression was used to relate volume eaten with number of visits. On two nights bats were netted with butterfly nets to identify species using a guide by LaVal and Rodríguez-H. (2002).

RESULTS

Three species of bats were found to visit the feeders. *Anoura geoffroyi*, *Glossophaga commissarisi* and *Glossophaga soricina* were all caught as they visited the feeder. All three species are common in the Monteverde area (LaVal and Rodríguez-H. 2002).

There were significantly fewer visits to the feeder after the owl call than after either the frog call or the silent control (ANOVA, $F = 11.0203$, $p = 0.0001$, $df = 2$; Figure 1). Weather was shown not to affect the number of visits in this experiment (ANOVA, $F = 1.5309$, $p = 0.2090$, $df = 4$). Similarly, the time of night did not affect the number of visits during a trial (ANOVA, $F = 0.3316$, $p = 0.9593$, $df = 9$). Moonlight was significantly related to number of visits within a trial, showing fewer bat visits with no moon (ANOVA, $F = 5.2969$, $p = 0.0083$, $df = 2$; Figure 2). In addition, volume eaten was compared with number of visits and no correlation was discovered ($R^2 = 0.0422$, $p = 0.1483$, $N = 51$; Figure 3).

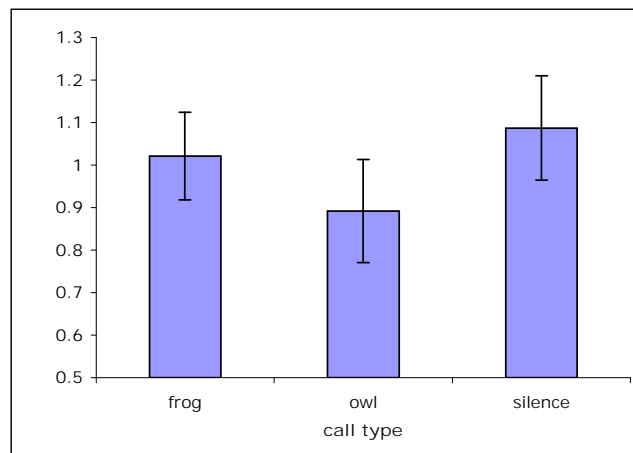


Figure 1. Effect of call type on visits (mean \pm s). Data over all nights except July 21 shows a strong relationship with fewer visits after the owl call (Means for frog, owl, silence: 1.0212 ± 0.1028 ; 0.8918 ± 0.1209 and 1.0870 ± 0.1228) % nightly average is the number of visits in a trial divided by the average number of visits per trial for that night.

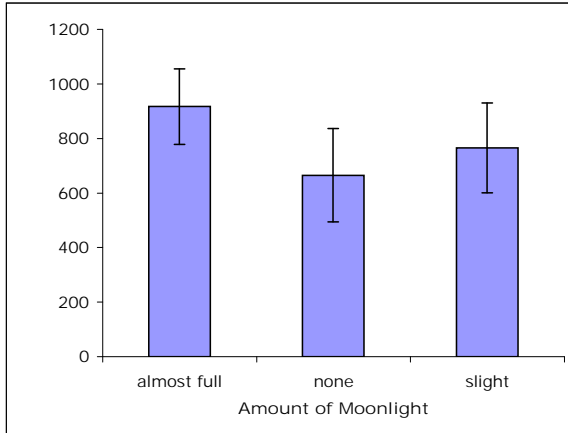


Figure 2. Effect of moonlight on number of visits. There were significantly less visits in the absence of the moon.

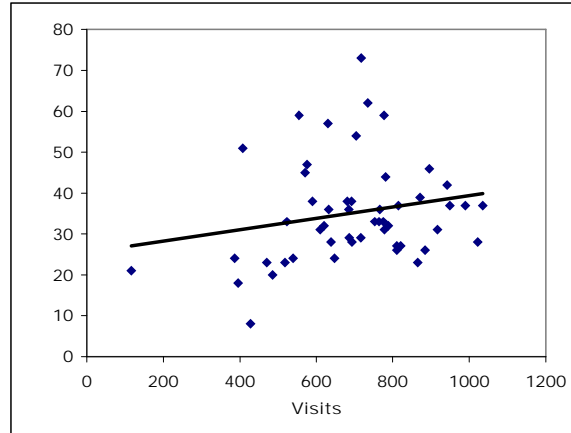


Figure 3. Volume change as a factor number of visits. No significant relationship was found. (Fit line: $Y = 25.3945 + 0.0140 X$)

DISCUSSION

Trials demonstrated that there were fewer visits after the owl call than the frog call or silence, supporting the hypothesis and prediction of this study that bats avoid an auditorily perceived predator. The response to the predator call, reduction in number of visits to the feeder, supports the findings of Heuer (2004), Diaz (2005) and Baxter et al. (2006) that bats respond to the detection of predators with avoidance and that predator presence is an important factor in foraging activities. This is vitally important since in altering foraging behavior to avoid the predator, bats lose an opportunity to gain food and potentially reduce lifetime reproductive success (Werner 1994). The fact that bats accept these costs to avoid predators indicates the importance of predation to these animals. Also, this study confirms the importance of owls as a predator of bats as was found in Heuer (2004) and Baxter et al. (2006). Finally, the relationship confirms the findings of Baxter et al. (2006), emphasizing that auditory cues are important for bats in the detection of predators.

This study also clarifies the conclusions of Baxter et al. (2006) by determining whether their findings of reduced bat activity near woodpecker calls was the result of avoidance of a novel sound or an effect of acoustic interference. Since bats in this study did not avoid the frog call, it can be inferred that the bats in Baxter et al. (2006) were likely avoiding a novel sound and not acoustic interference. There was no novel sound in this trial so if the bats had avoided the feeder after the frog call, it would have been to avoid acoustic interference. Still, since the calls were not played during the five-minute periods in which visits were counted, the role of acoustic interference cannot totally be ruled out. Also, the bats observed in this study are nectarivorous bats in the tropics, visiting a known and consistent feeding source. These bats likely have very different behavioral ecologies than insectivorous bats in British Columbia, the bats observed in Baxter et al. (2006), for which echolocation may play a more important role in foraging and therefore for which acoustic interference would be a larger concern.

Additionally, this study examined the effect of time of night, weather and moonlight on the number of visits to the feeders. Both time of night and weather did not

affect the number of visits indicating that predator avoidance was likely responsible for differences in numbers of visits between trials. Diaz (2005) also noted no significant effects in visitation as a result of weather or time of night; however, she noted that bats are discouraged entirely from visiting the feeder by heavy rain. In contrast, I noted no significant difference in visits over all-weather types, recording upwards of 500 visits in the five-minute periods in which there was torrential rain.

The third effect examined was that of moonlight. Heuer (2004) found a significant relationship indicating that with more moonlight there are fewer visits to the feeder. My study showed the opposite with significantly less bats on nights with no moon or obscured moon. This finding runs contrary to findings with many different species of bats including vampires and insectivorous species, which seem to avoid moonlight presumably to avoid predation (Altringham 1996). It also runs counter to the findings of Elangovan and Marimuthu (2001) who found that the number of feeding visits of an Indian fruit bat to a tree was negatively correlated with percent moonlight. The significance of the current study's finding of fewer bats with less moonlight is that moonlight did not affect the number of visits to the feeder in this experiment. The bats in this experiment may be less affected by the amount of moonlight because of the light conditions of the site. Although the garden is not lit at night and is surrounded by tall trees that block some of the surrounding light, there are buildings near the site with lights that may acclimatize the bats that visit these feeders and make the effect of extra moonlight less relevant.

Lastly, volume measurements were taken as another way to measure potentially the bat activity at the feeder. This variable did not relate to visits, likely the result of a variety of difficulties ascertaining the correct volume of solution in the feeders. As a result, volume measurements were not used in any of the data analysis other than to demonstrate that volume eaten (as well as could be measured) does not seem to correlate with number of visits. If one were able to ensure that they were measuring the correct volume of sugar water consumed by the bats during the trial, it may tell a different story about foraging behavior and may be an interesting future study.

Overall, this study reinforces the conclusions of previous studies that predator avoidance is a major factor in Chiropteran foraging behavior. It also emphasizes the importance of auditory cues in predator detection and their role in affecting foraging behavior, something only previously examined by one study. This previous study was carried out with insectivorous bats in British Columbia. Because the current study shows similar conclusions, but was with nectarivorous bats in Costa Rica, it demonstrates that avoidance of an auditorily perceived owl is a global trait of bats, emphasizing the importance of auditory cues and the role of owls as bat predators. Still, the high numbers of bats visiting after all treatments demonstrates the importance of these feeders as a food resource in the region. Additionally, this study clarified the findings of Baxter et al. (2006), suggesting that confounding results were the result of novel sound avoidance and not acoustic interference. Finally, this study examined the effects of weather and time of night and determined that they were not responsible for the differences in number of visits per trial. The effect of moonlight was also examined with unanticipated results. This was interpreted to mean that, contrary to the literature, moonlight did not significantly affect visitation in this particular experiment. Future studies may consider playing the call throughout the experimental period to look at the role of acoustic interference versus predator avoidance. This may also strengthen the differences between treatments since in this study visitation tended to recover quickly with bats only avoiding feeders for a short

period, approximately one minute, after the owl calls. Future studies may also wish to examine how much food is actually consumed by the bats during each trial as a different measure of risk taking.

ACKNOWLEDGEMENTS

I would like to extend a tremendous thank you to Arturo Cruz for accompanying me for nine nights, enduring extreme boredom and a lot of rain. I am also grateful to him for helping me net and identify the bats (or rather, for identifying the bats). I would also like to thank Tania Chavarría for her guidance and assistance throughout the entire process and especially with the statistics. I am very grateful to the owners of Selvatura for allowing me to use their site. Thanks to Karen Masters for her advice on improving my project, help with statistics and general guidance. Thank you to Camryn Pennington and Pablo Allen for their help with statistics, general paper writing and, in Cam's case, for allowing me to bug her with questions while she studies for the GREs. I am very grateful to Nick Fabeck, Jessica Walthew and Amy Elliott for help with Excel and editing. Lastly, Beth Schlimm has my eternal gratitude for sitting in a thunderstorm to assist me on the wettest data collecting night of them all.

LITERATURE CITED

- Altringham, J.D. 1996. Bats: biology and behavior. pp. 130, 219-221. Oxford University Press. New York, New York.
- Baxter, D. J. M., J. M. Psyllakis, M. P. Gillingham and E. L. O'Brien. 2006. Behavioural response of bats to perceived predation risk while foraging. *Ethology* 112: 977-983.
- Berger, J. 1999. Anthropogenic extinction of top carnivores and interspecific animal behaviour: implications of the rapid decoupling of a web involving wolves, bears, moose and ravens. *Proceedings of the Royal Society of London* 266: 2261-2267.
- Díaz, L. 2005. Effects of novel object versus predator presence on nectarivorous bat foraging behavior. pp. 123-129. *Tropical Ecology and Conservation*. CIEE, Summer.
- Elangovan, V. and G. Marimuthu. 2001. Effect of moonlight on the foraging behaviour of a megachiropteran bat *Cynopterus sphinx*. *Journal of Zoology* 253: 347-350.
- Findley, J. S. 1993. Bats: a community perspective. pp. 25-26. Cambridge University Press. Cambridge, Great Britain.
- Fogden, M. 1993. An annotated checklist of the birds of Monteverde and Peñas Blancas. pp. 17- 30. Michael Fogden. Monteverde, Costa Rica.
- Heuer, R. 2004. The effects of predator presence on nectarivorous bat foraging behavior. pp. 88-95. *Tropical Ecology and Conservation*. CIEE, Summer.
- LaVal, R. K. and B. Rodríguez-H. 2002. Murciélagos de Costa Rica/ bats. pp. 134, 140-141, 144-145, 148-149. Editorial INBio. Costa Rica.
- Leenders, T. 2001. A guide to amphibians and reptiles of Costa Rica. pp. 102. Zona Tropical. Miami, Florida.
- Millard, E. 2004. Foraging strategies and body partitioning of glossophagine bats. pp. 1-11. *Tropical Ecology and Conservation*. CIEE, Spring.
- Nowak, R. M. 1994. Walker's bats of the world. pp. 125-129, 186-190. Johns Hopkins University Press. Baltimore, Maryland.
- Schnitzler, H.-U. and E.K.V Kalko. 1998. How echolocating bats search and find food. *In* H. T. Kunz and P. A. Racey (Eds.). *Bat biology and conservation*. pp. 183-196. Smithsonian Institution Press. Washington, DC.
- Werner, E. E. 1994. Individual behavior and higher-order species interactions. *In* L. A. Real (Ed.). *Behavioral mechanisms in evolutionary ecology*, pp. 300-301. University of Chicago Press. Chicago, Illinois.