Effects of habitat on avian antipredator behavior

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ABSTRACT

A variety of antipredator behaviors have evolved in birds because of the far-reaching effects of predation risk. The use of antipredator behavior is a tradeoff, as it can dissuade a predator, but it also depletes time and energy from foraging and other activities. Forests provide better protection from predators than do open field habitats. Birds were tested in both forest and open habitat to determine if habitat type had an effect on frequency or aggressiveness of antipredator behavior. Calls of two different predators were played at different sites in each habitat type, where reactions of birds were observed and recorded. More birds exhibited antipredator behavior in the open than in the forest (χ^2 = 4.27, df = 1, p = 0.04). Birds that inhabited the open areas also reacted more aggressively (χ^2 = 13.28, df = 4, p = 0.01). This study showed that the continual conversion of land from forest to non-forest may have serious impacts on bird populations as predation risk will continue to rise. Habitat fragmentation may ultimately cause suitable habitat patches to become too small and too isolated for viable populations to sustain themselves.

RESUMEN

Una variedad de comportamiento antidepredador ha evolucionado en aves en respuesta a los efectos del riesgo de depredación. El uso de los comportamientos antidepredador puede disuadir un depredador, pero a la vez toma tiempo y energía la cual puede utilizarse en otras actividades. El bosque provee mejor protección ante los depredadores que hábitats como los campos. Examiné aves en el bosque y en áreas abiertas para determinar si el tipo de hábitat tuvo un efecto en la frecuencia o la agresividad del comportamiento antidepredador. Puse reclamos de dos depredadores diferentes en cada tipo de hábitat, donde observé las reacciones de las aves ante este estimuló. Una mayor cantidad de aves exhibieron comportamiento antidepredador en áreas abiertas más (χ^2 = 4.27, df = 1, p = 0.04). Pájaros en áreas abiertas reaccionaron más agresivos, también (χ^2 = 13.28, df = 4, p = 0.01). Este estudio mostró que la conversión de la tierra de bosque a zonas abiertas tendría impactos serios en las poblaciones de pájaros al riesgo de depredación.

INTRODUCTION

Predation is an interaction between predator and prey, in which one species consumes the other. Predation can have far-reaching effects on biological communities as it provides the links to move energy throughout the food web (Dame and Patten 1981). Not only does predation link species through interactions, it has also been implicated as a selective force in evolving morphological and behavioral adaptations of many species (Lima and Dill 1990). Antipredator responses are both widespread and variable. Predators are more likely to prey on individuals that show little or no defense and do nothing to discourage an attack (Stoffer and Sih 1998). Because most species are preyed upon by a number of others, they have been forced to evolve protective responses. Therefore, predation can be an agent of natural selection, as easily captured prey are eliminated, and prey with effective defense mechanisms dominate the population. Because of this, inadequate antipredator defenses could have significant impacts on the future success of certain species. Birds are a good medium by which to study antipredator responses because they are vocal, relatively easy to detect, and many birds have fairly well developed responses to a direct threat or predator. In the presence of a predator, behavioral changes such as notably enhanced vigilance, alarm calling, investigating, mobbing, or flight are common (Alcock 2005).

The ability for antipredator behavior to function correctly relies heavily on being able to first, recognize a predator, and second, to assess the risks involved. Learning plays an important role in the development of antipredator responses, and much of the learning relies on the recognition and assessment of the threat (Kelley and Magurran 2003). Without the ability to recognize friend from foe, one is likely to either expend unnecessary amounts of energy in antipredator behavior, thereby decreasing foraging time, or put insufficient energy into defenses, thereby becoming more vulnerable to predation.

Habitat complexity directly influences risk of predation, and as complexity declines, risk of predation increases (Tupper and Boutilier 1997). As humans degrade and simplify habitats around the world, effects on birds and other species continue to intensify. The struggle between predator and prey is one that no species can escape. Because of this, knowing how land conversion and the associated increase in predation actually impact bird species is essential to our understanding of consequences at the population level. In a study by Martin (1988), density of foliage minimized the risk of predation, making closed forests safer than open areas. From this it is clear that landscapes become more homogeneous, the effects on bird species and their susceptibility to predation will become a necessary area of study. It has been observed that fragmented landscapes are more attractive to predators, supporting the theory that risk of predation increases in simplified habitats (Chalfoun et al. 2001). In a larger context, habitat fragmentation may cause suitable habitat patches to become too small and too isolated for viable populations of species to continue to be successful (Johnson 2001).

The purpose of this study was to examine the difference in bird behavior to predator calls depending on habitat type, and to test the possibility of recognition and reaction to a familiar predator. I predicted that birds will respond more frequently and more strongly to predators in open habitats, as they have higher risks of predation. Secondly, I expected that birds would react more strongly to a familiar call in comparison to an unfamiliar one.

MATERIALS AND METHODS

Study Species

Two bird predators, the Barred Forest Falcon (*Micrastur ruficollis*) and the Least Pygmy Owl (*Glaucidium minutissimum*) hunt in different areas. The Forest Falcon is a closed forest species that hunts in the canopy. It is found in tropical and sub-tropical forest throughout Central America and into South America. It subsists mainly on birds and small lizards (Stiles and Skutch 1989). In contrast, the Pygmy Owl is an open area hunter and frequents edge and pasture lands. There it scans for prey both day and night from a semi-protected perch. This species eats insects, lizards and small birds, and is found throughout Central America and into central South America (Stiles and Skutch 1989).

Study Site
I conducted my study in and around the property of Jim Wolfe in La Cruz, Costa Rica during April and May of 2007. The site contains both open fields and closed forest, and lies in premontane wet forest. This life zone is found from 800-1500 m, and is characterized by a largely evergreen forest with a few deciduous species (Haber 2000). The elevation of the area is around 1400 m, and many bird species are known to forage there.

Data Collection
I played calls of two different predatory birds, the Barred Forest Falcon and Least Pygmy Owl, in open pasture land and covered forest. Using an Apple iPod with a JBL iPod speaker attachment, both playback calls were played in each habitat type 36 different times, for a total of 72 playback calls. I had six different sites, three in each habitat type, in which one of the two callbacks was played each day. I played the call for five minutes; two minutes on, one minute off, and another two minutes on. During this time, I identified all birds in sight to species (if possible), then proceeded to monitor and record which reactions and behaviors were exhibited by each individual. I only recorded one reaction per individual. I continued to identify birds that came into view throughout the five minutes. I then waited 15 minutes, walked to the next site, and played the other call, repeating the same process. Calls of the predators alternated for a total of six callbacks per day, three of each species. Recorded reactions included (in order from most aggressive to least): coming toward the noise while calling, start calling from current perch, coming toward the noise silently, increased vigilance or more alert, and retreating from the noise. I recorded increased vigilance only if the individual stopped its current activity and looked around. All but one of the trials took place between 6:00 and 11:00 a.m.

I conducted a Chi-squared goodness-of-fit test to determine differences of bird reactions according to habitat type, and another to look for differences in the number of birds that reacted to the predators in the open compared to in the forest. A third Chi-squared goodness-of-fit test was performed to determine if the observed bird species reacted differently to an unfamiliar predator call in comparison to that of a familiar one. That is, birds in the open react more to the pygmy owl, and birds in the forest, to the forest falcon.

RESULTS

Thirteen identified species of birds reacted to the predator calls. Six occurred only in the open, five occurred only in the forest, and two species occurred in both habitats (see Appendix 1). I found that birds in open habitats exhibit antipredator behavior more frequently in the presence of predators than birds in closed forest habitats. Birds in the open reacted 38 times, compared to 20 times in the forest (Chi-squared goodness-of-fit test, $\chi^2 = 4.27$, df = 1, p = 0.04, Fig 1).

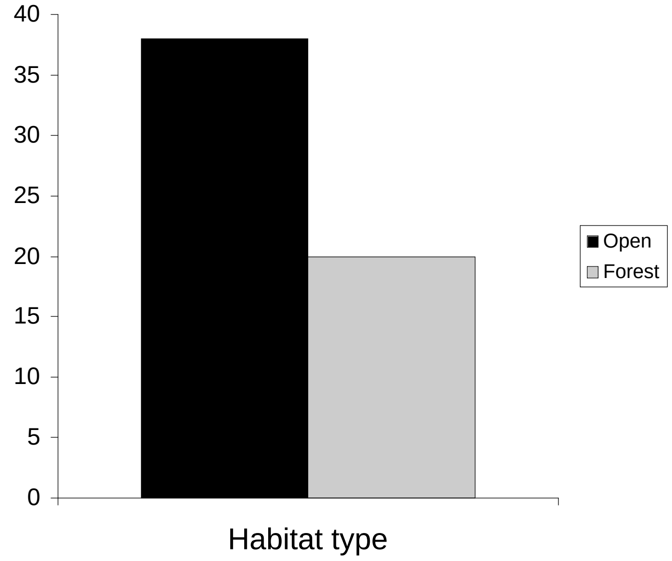

Fig. 1: Number of birds exhibiting antipredator reactions to predator callbacks according to habitat in La Cruz, Costa Rica. In the open, 38 birds reacted compared to in the forest, 20 birds reacted.

Birds in open habitats also reacted more strongly to the predators than birds in the forest. Open habitat birds exhibited a higher frequency of coming toward the noise silently and while calling than forest birds, while increased vigilance and retreating where only observed in open habitats. Birds in the forest started calling from perch more often than birds in the open (Chi-squared goodness-of-fit test, χ^2 = 13.28, df = 4, p = 0.01, Fig 2).

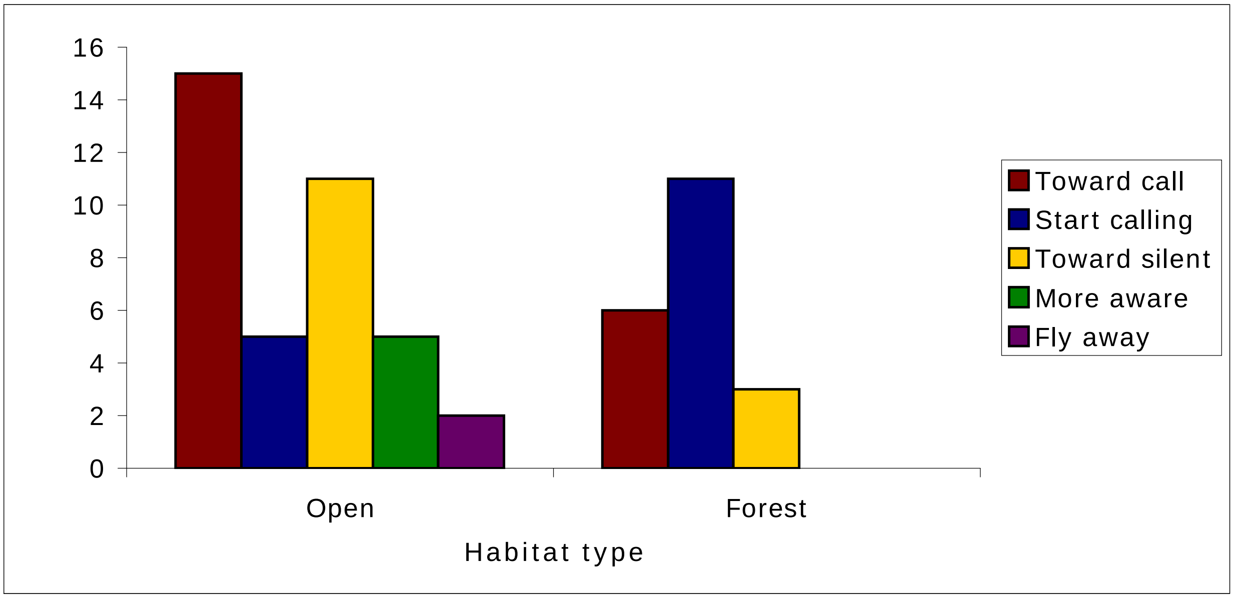

Fig 2: Frequency of bird reactions to two different predator callbacks, sorted by reaction type. Calls were played in open and closed forest habitats in La Cruz, Costa Rica. Reaction types differed between habitat types. In the open, birds often came toward the noise calling, or came toward silently, whereas in the forest, birds were more likely to begin calling from current perch.

During many trials, no birds responded to the predator callback. This occurred more frequently in forest habitats than in open habitats; 53% and 39%, respectively. Birds showed no discernible recognition to the predator more common in their habitat (Chi-squared goodness-of-fit test, $\chi^2 = 0.29$, df = 1, p = 0.59). In the open, birds reacted only slightly more to owl calls than falcon calls, 20 to18, respectively. In the forest, birds also reacted more to the owl than the falcon; 12 and 8, respectively.

DISCUSSION

My primary objective was to discern if habitat type played a role in the frequency and aggressiveness of antipredator behavior of birds. Results showed that birds in open habitats reacted more frequently and more aggressively to a threat than birds in the cover of the forest. Further, the data indicated that birds showed no apparent recognition of one predator more common in their given habitat.

Forests are diverse, structurally complex systems that provide many opportunities for cover from predation, whereas open habitats with scattered trees provide much less shelter, and thus, it is more difficult to avoid detection in these areas (Martin 1988). When faced with a threat, birds will assess the situation, and depending on the risk, might begin mobbing, flying toward the intruder, start calling, or simply hide (Alcock 2005). Because antipredator behavior consumes energy and takes away from other activities such as foraging, one would expect that a bird would only enlist in such behaviors if there was a real threat. A study conducted by Ives and Dobson (1987) demonstrates that as prey increase their investment in antipredator behavior, thereby decreasing their chance of being captured by the predator, they pay for this protection by a cost exacted through decreased fecundity or increased mortality caused by factors other than predation. Therefore, a balance needs to be found between time spent exhibiting antipredator behavior, and time spent doing other things such as foraging. As birds are more exposed in open habitats, and therefore more susceptible to predation, their health and reproductive success may be compromised as they are forced to invest more energy in defenses. Because of the habitat complexity of the forest, birds are often difficult to detect, and birds of prey may have trouble navigating through the dense foliage, giving the prey more time to escape. Hence, fleeing from predation is facilitated in a forest, and birds need to exhibit antipredator defenses less often. It is also possible that the sound of the predator call was carried further in the open because there were less obstructions and sound barriers than in the forest (Richard and Wiley 1980). Because of this and reasons stated above, it is logical that more birds would have reacted to calls of predators in the open habitats. It should be noted, however, that open habitats inherently contain more birds.

I predicted that birds would react more frequently to the predator that hunted predominantly within their habitat (Least Pygmy Owl in the open, and Barred Forest Falcon in the forest). However, observations showed that birds did not react differently to either predator. The forest patch used was only a ten hectare plot, meaning that edge species would be common throughout. Because of the high number of edge species, it is likely that they would recognize both calls, and would not exhibit more aggression to one over the other. Additionally, the pygmy owl and forest falcon have somewhat similar calls, as they are both a series of high-pitched staccato notes. It is probable that birds are more likely to recognize the sound of a generic predator than a specific species or genus (i.e. owl vs. hawk). This ability to recognize the sound of an aerial predator may have evolved through natural selection, as an individual is more likely to survive if it is able to recognize a whole suite of predator sounds rather that one or two specific ones.

Perception of predation risk by birds living in habitat fragments may moderate movement behaviors, potentially influencing the connectivity of degraded landscapes (Sieving, et al. 2004).

Because habitats continue to be simplified, this may be significant in the future management of connectivity in fragmented landscapes. As stated above, habitat affects risk, and species are attacked and captured more frequently in the open (Longland and Price 1991). Increased risk of predation could cause habitat specializations and force birds that currently reside in open areas into the safety of the forest. Additionally, as forests are degraded into more open areas, forest specialist species will be forced to adapt to higher predation risks associated with open habitats. Deforestation around the world is happening at an alarming rate, which may have strong implications for bird populations, as they seek forest and shelter. Knowing how land conversion and the associated increase in predation will impact individual birds is essential to the understanding of consequences to bird populations around the world.

Birds are a well-studied taxa, but how bird populations will react to human induced habitat changes has not been fully explored. Future studies might focus on competition between forest and edge specialists, as their interactions will increase as habitats are depleted. Additionally, it may be useful to explore reactions to a number of different auditory cues to determine if birds can, in fact, recognize the sound of a predator versus non-predator.

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APPENDIX 1: List of species and in which habitat they were found in La Cruz, Costa Rica. Six species were only found in the open, five birds were only found in the forest, and two species were found in both habitats.

Species	Open	Forest
Cyanocorax morio	x	x
Wilsonia pusilla	x	
Tityra semifasciata	x	
Chlorospingus ophthalmicus		x
Myioborus miniatus	x	x
Thryothorus rufalbus		x
Micrastur ruficollis		x
Campylopterus hemileucurus		x
Empidonax flavescens		x
Contopus cinereus	x	
Turdus assimilis	x	
Myiozetetes similis	x	
Thraupis episcopus	x	