Local habitat disturbance increases bird nest predation in the Brazilian Atlantic rainforest

V. B. Rodrigues, F. M. Jesus, R. I. Campos

Abstract

Local habitat disturbance increases bird nest predation in the Brazilian Atlantic rainforest. We evaluated the effect of anthropogenic disturbance on nest predation in Brazilian Atlantic forest. Artificial nests were distributed in fragments with distinct degrees of anthropogenic disturbance. We found a higher proportion of egg predation on the ground and in the fragments classified as 'high' and 'medium' disturbance than in the fragments classified as 'low' degree of disturbance. The higher egg predation is probably linked to low structural complexity of vegetation and high accessibility of these areas to opportunistic predators. We suggest that forest fragments with high vegetation complexity and low human activity should be preserved in order to maintain the biodiversity of bird species.

Key words: Artificial nest, Forest fragments, Habitat conservation, Vegetation structure

Resumen

La perturbación del hábitat local aumenta la depredación de nidos de aves en la pluviselva atlántica del Brasil. Evaluamos los efectos de la perturbación antropógena en la depredación de nidos en el bosque atlántico del Brasil. Se distribuyeron nidos artificiales en fragmentos con distintos grados de perturbación antropógena. Observamos una mayor proporción de depredación de huevos en el suelo y en los fragmentos clasificados como de perturbación alta y media que en los fragmentos con un bajo grado de perturbación. La mayor depredación de huevos está probablemente relacionada con una vegetación de complejidad estructural baja y con la elevada accesibilidad de estas zonas para depredadores oportunistas. Con vistas a mantener la biodiversidad de especies de aves, proponemos que se conserven los fragmentos forestales con vegetación de complejidad estructural elevada y escasa actividad humana.

Palabras clave: Nido artificial, Fragmentos de bosque, Conservación del hábitat, Estructura de la vegetación

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Introduction

The Brazilian Atlantic Forest is considered one of the most important areas in the world for species conservation (Ribeiro et al., 2009). In the case of birds, this biome has the highest conservation priority in the country once it harbors 75.6 % of threatened and endemic bird species of Brazil (Aleixo, 2001). Despite its importance, only 12 % of the original Atlantic rainforest area remains intact and it continues to be disturbed by human activity, such as cattle grazing, monocultures, and urban expansion (Ribeiro et al., 2009).

On a landscape scale, habitat fragmentation has extremely negative effects on biodiversity, even for groups with notorious dispersal abilities, such as birds (Wang et al., 2015). The loss and isolation of natural habitats promoted by fragmentation alters bird movements and consequently decreases gene flow. Previous studies have shown that fragmented landscapes have high rates of bird nest predation and it is probably related to the increased abundance of generalist predators in smaller fragments (Melo and Marini, 1997). Nest predation is considered a major cause of change in abundance, richness, and species composition in bird communities (Evans, 2004). However, the effect of local habitat disturbance on bird nest predation is still poorly studied, especially in the neotropics (but see Borges and Marini, 2010).

We consider local disturbance as any human influence that modifies local habitat conditions. For instance, a change in vegetation structure (e.g. a decrease in foliage cover and/or tree density) and a reduction in distance from areas of intense human activity can increase bird nest vulnerability to predators (Borges and Marini, 2010; Nana et al., 2015). Increased predation, in turn, can also affect the distribution of nest sites among vertical strata (Silvia and Voltolini, 2015). A couple of studies have shown that bird nests on the ground were more vulnerable to predators than nest in low vegetation (Castro–Caro et al., 2014). However, we have not found any studies evaluating the effect of local habitat disturbance and vertical stratification on bird nest predation in Atlantic rainforest.

In the present study we experimentally evaluated the effect of habitat strata (ground and low vegetation) on artificial nest predation in three disturbed Atlantic Forest fragments inside the *Parque Nacional do Caparaó* (PNC). We tested two hypotheses: i) artificial nest predation is higher in habitats with increased disturbance and ii) predation on artificial nests is higher on the ground than in low vegetation strata.

It is important to highlight that an artificial nest will not present the same visual and olfactory signals as a natural nest. Artificial nests, for example, do not include any parental activities and they might present differences in egg size and exposure (Mezquida and Marone, 2003). Although they have a certain degree of bias, quail eggs can be considered a good model owing to their average size and color matching that of other common species of forest birds that lay eggs in open nests (Marini and Melo, 1998), but all potential predators, both introduced and native, can break the quail egg shells (Marini and Melo, 1998). Artificial nests, on the other hand, can provide key information (such as probabilities of predation) that would otherwise be very difficult to obtain in natural conditions (Nana et al., 2015).

Material and methods

The study was conducted in the *Parque Nacional do Caparaó* (PNC), one of the largest reserves of Atlantic Forest (32,000 ha) in southeastern Brazil along the states of Minas Gerais and Espírito Santo (20° 19′–20° 37′ S, 41° 43′–41° 53′ W). The field sampling took place in December 2004. Within the PNC, we selected three forest fragments based on distance from the intensive use area (administrative and touristic centers) and degrees of anthropogenic disturbance (table 1). Based on their past logging history we classified the three fragments according to their degree of disturbance as follows: low (selective logged at least 100 years ago); medium (selective logged at least 30 years ago) and high (completely logged at least 30 years ago). All three forest fragments were around 20 ha in size and are surrounded by roads and other forest fragments. See table 1 for vegetation description.

We handmade 138 artificial nests from filter paper and vegetation materials. We placed a single quail egg (*Coturnix coturnix* L.) in each nest. We chose quail eggs because they are commonly used model in experiments of artificial nest predation (Marini and Melo, 1998). Throughout the experiment, we used rubber boots and gloves to minimize the effect of human scent. Inside each of the three forest fragments (at least 500 m far from the border), we placed 46 artificial nests with a quail egg approximately 3 m from each other, alternating one nest on the ground and one on a tree branch (about 1.8 m high). All the nests were left in the field for four days and after that they were checked for prey marks. When pierced, fragmented, destroyed or missing, the egg was considered as preyed upon.

To determine the effects of the categorical explanatory variables 'forest fragment' (with three levels of disturbance: low, medium and high) and 'habitat strata' (ground and trees) on the response variable 'proportion of eggs prayed' (calculated from a binomial variable: 0 for non–preyed and 1 for preyed eggs), we first built a Generalized Linear Mixed Model (GLMM) (Crawley, 2012). For this model, to deal with our low number of real replicates (one fragment per treatment) the explanatory variable 'forest fragment' was included as a random effect and 'habitat strata' as a fixed factor. To analyze the differences between each pair of disturbance levels (low, medium and high) and 'habitat strata' (ground and trees) we used model selection. This procedure was followed using Akaike's information criterion with second order bias correction (AICc) due to our limitations in sample size (Burnham et al., 2011). In this procedure we first built a global model and then compared this model with all candidate variables. Finally, we selected the best model based on AICc weights (Wagenmakers and Farrell, 2004). All analyses were performed in R using the package MuMIn.

Results

From the 138 eggs placed in artificial nests, 35 were preyed upon, 2 in a low degree of disturbance, 15 in a medium degree, and 18 eggs in a high degree. Regarding the habitat strata, 21 eggs were preyed upon on the ground and 14 on tree branches. Corroborating our first hypothesis, our analysis showed that a higher proportion of eggs were preyed upon in fragments classified under a 'high' and 'medium' degree of disturbance (AICc = 147.4; Δ = 0.00; weight = 0.748)

Table. 1. Degree of disturbance (Dd), description of vegetation (visual estimate), distance to the intensive use area (D, in m, administrative and touristic centers), human activity (H, based on interviews with five rangers) and geographic coordinates from the three forest fragments sampled inside the PNC.

Tabla. 1. Grado de perturbación (Dd), descripción de la vegetación (estimación visual), distancia a la zona de uso intensivo (D, en m, centros administrativos y turísticos), actividad humana (H, basada en entrevistas con cinco guardabosques) y coordenadas geográficas de los tres fragmentos de bosques muestreados dentro del Parque Nacional de Caparaó.

Dd	Vegetation	D	H	Coordinates
Low	Canopy approximately 30 m high with 90 % of foliage cover	620	Rare	20° 25' 7.28 4" S 41° 50' 45.74 4" W
Medium	Canopy approximately 25 m high with 80 % of foliage cover.	340	Low	20° 25' 8.83 2" S 41° 50' 55.42 8" W
High	Canopy approximately 20 m high with 70 % of foliage cover	60	High	20° 25' 13.512" S 41° 51' 7.92" W

when compared to the 'low' degree (AICc = 149.6; Δ = 2.18; weight = 0.252) (fig. 1). As expected, we also found that the proportion of preyed eggs was higher on the ground than in trees (AICc = 149.6; Δ = 0.00; weight = 0.503).

Discussion

We found that artificial nest predation was greater in more disturbed forest fragments. Despite the limita-tions of the artificial nests (Mezquida and Marone, 2003), our result supports the hypothesis that habitat degradation has a negative effect on reproductive success of birds (e.g. Borges and Marini, 2010). The higher predation observed in the disturbed fragments here might be explained by three major factors. First, the smaller tree density and foliage cover found in highly disturbed area (table 1) might enhance the transmission of acoustic, chemical, or visual signals from nests to predators, increasing the predation rate (Hazler et al., 2006). Second, areas with a high
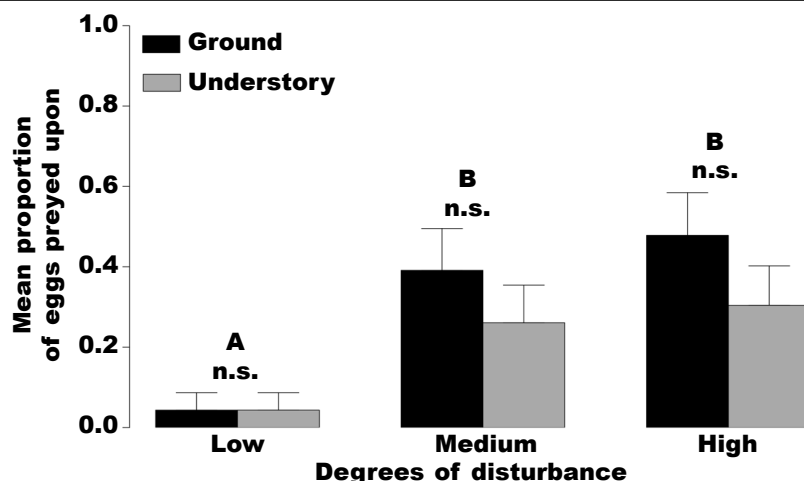

Fig. 1. Mean (+ SE) proportion of eggs preyed upon per fragment and habitat strata (ground and trees), considering non–preyed eggs as 0 and preyed upon eggs as 1.

Fig. 1. Proporción media (+ DE) de huevos depredados por fragmento y estrato del hábitat (suelo y árboles), considerando los huevos no depredados como 0 y los depredados, como 1.

degree of disturbance might have greater accessibility to opportunistic and small predators, such as rodents, lizards, and small mammals (Melo and Marini, 1997). Finally, humans live and work in the park facilities, close to the study area classified as 'high degree of disturbance' and therefore we can speculate that the presence of humans avoids large predators, allowing an increase in the activity of small wild predators, or at least of dogs and feral cats.

We also corroborate our second hypothesis as we found that egg predation was higher on the ground than in trees. The high predation rates on the ground can be related to the greater abundance of terrestrial than arboreal predators (Castro–Caro et al., 2014). It is also plausible that predation of nests by non–avian species, such as rodents and lizards, may increase in fragments near urban areas, as in our forest fragments. Two studies have previously reported that bird nests were more vulnerable to predators on the ground than in low vegetation (Castro–Caro et al., 2014; Silvia and Voltolini, 2015). However, this is the first study that evaluates the effect of local habitat disturbance and vertical stratification on bird nest predation in Atlantic rainforest.

We showed here that local habitat disturbance can increase bird nest predation. Although our findings do not differ from previous studies (Melo and Marini, 1997; Hazler et al., 2006; Borges and Marini, 2010) they should be interpreted with caution due to our low number of true replicates. However, we consider our analytical approach robust enough to remedy this methodological limitation. Since nest predation is considered a key factor affecting bird richness, abundance, and distribution (Evans, 2004), the present study might be considered as a fast and low–cost alternative to indicate high–priority areas for bird species conservation in forest fragments. Based on our results, we suggest that forest fragments with high structural complexity and low human activity should be preserved in order to maintain bird species biodiversity (Nana et al., 2015).

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