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Sensitivity of understorey bird species in two different successional stages of the lowland Atlantic Forest, Brazil

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ABSTRACT

The Atlantic Forest has a high destruction rate and there is little information available on some aspects of the neotropical bird biology. Changes in environment are important factors that affect the resources available to birds. We compared the species sensitivity level of understorey birds in two areas in distinct successional stages (primary and secondary sections). Two 100 ha plots of lowland Atlantic Forest were analysed between August and December 2006. Among 25 bird species recorded, thirteen had lower abundance in secondary forest, two in primary forest, and ten had not clear tendency. According to the criteria used, the percentages for species with low, and medium and high sensitivity to habitat change were 44% and 56%, respectively. The number of species was not associated with the endemism level or foraging strata. Results show the importance of knowing bird species' sensitivity level with regard to habitat modification, and not only forest fragmentation.

Key words: degradation, neotropical birds, point counts, South America, tropical forest.

INTRODUCTION

Many studies have been developed on the effects that area size or fragment isolation has on neotropical birds (Willis 1979, Bierregaard and Stouffer 1997, Boscolo et al. 2008, Lees and Peres 2008). Recently, analyses regarding to habitat modification effects on the forest birds or specific functional groups have increased (Haugaasen et al. 2003, Harris and Pimm 2004, Barlow et al. 2006), although little information is available on the Atlantic Forest (Aleixo 1999, Maldonado-Coelho and Marini 2000, Anjos 2006).

Only 11.26% of the original area covered by the Atlantic Forest – one of the richest biomes on Earth – remains (Morellato and Haddad 2000, Myers et al. 2000, Ribeiro et al. 2009). Despite the establishment of a lot of small isolated fragments, many have lost their original characteristics (Viana et al. 1997). Timber extraction, forest fires, introduction of exotic animals (cattle), and hunting are the main factors that cause this degradation (Ranta et al. 1998, Thiollay 1999, Marsden et al. 2005). Forest fragments tend to lose their capacity to harbour several sensitive species, mainly the forest specialists (Goerck 1997, Anjos 2006, Harris and Pimm 2008). Analyses of these effects on bird communities may have important uses in more efficient management and conservation activities for bird species and their respective habitats (Jones 2004).

Here, we studied the occurrence of understorey birds along two stretches of forest at different vegetation successional stages. More specifically, our objectives

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were: (1) to evaluate the encounter rates of understorey bird species in primary and secondary forests; (2) to verify whether features of life history, such as endemism or foraging strata, predict the species sensitivity in a bird group.

METHODS

Study Area

The current research was undertaken in the Rio Doce State Park (RDSP), one of the largest forest reserves (*ca.* 36,000 ha) in the lowland Atlantic Forest, Brazil. It is located in the Marliéria municipality (19°48′18″-19°24′29″S, 42°38′30″-42°28′18″W), in the middle of the Rio Doce basin, eastern Minas Gerais State (Fig. 1). Its vegetation coverage is composed of a seasonal semideciduous lowland forest, at different successional stages, and features a significant system of natural lakes (approximately 40). It is about 350 m high with the annual average rainfall of 1,480 mm and the mean annual temperature of 22°C. The dry season is between May and September, and the rains occur from November to March (Brito et al. 1997).

The sampling was undertaken in two forest sections of 100 ha each. The first sampled plot (control area) was located in a primary forest, in which several plant species, typical of the climax stage, may be found. These species include *Ficus gomelleira* (Moraceae), *Lecythis pisonis* (Lecythidaceae), *Euterpe edulis* (Arecaceae), and *Virola gardneri* (Miristicaceae). The mean height of the forest canopy is approximately 20 m, although emergent trees reach a height of 40 m. The other forest section has suffered forest fires, mainly surface, ones with the last one occurring some 14 years ago. The plants found in this plot include *Cecropia* sp. (Cecropiaceae), *Typha* sp. (Typhaceae), *Carex* sp. (Cyperaceae), and *Astrocaryum aculeatissimum* (Arecaceae), which are typical of the initial successional stages. The mean height of the forest canopy is approximately 16 m. There are plains in both plots that flood, especially in the rainy season.

Sampling and Data Analyses

We collected data between August and December 2006. Each plot had 36 point counts, but two points in the primary forest were lost by flooding during the rainy season. The points were spread throughout six linear transects with a spacing of 200 m, the same distance as among the points. Each morning we collected 12 points (05h45-09h30). In total, each one of the 36 points in each forest section was sampled six times. All samples were obtained by point counts without any distance restrictions (Bibby et al. 2000). Sampling at each point lasted 10min, and all birds seen or heard were considered. Each bird was registered only once at each point. Simultaneously to the detection of the birds by the chief researcher, an assistant recorded the bird sounds with a Sony TCM 5000 recorder and a Sennheiser ME66 directional microphone. Only the understorey bird species detected, according to the criterion classification of Parker III et al. (1996), were analysed.

The Index of Point Abundance (IPA) was used as an index of relative abundance of species (Aleixo and Vielliard 1995, Anjos and Boçon 1999). The IPA was determined by dividing the total number of contacts of each species by the total number of points sampled in each forest section. This analysis method has been used broadly, especially in bird studies of the Brazilian Atlantic forest (Aleixo and Vielliard 1995, Anjos and Boçon 1999, Vielliard 2000, Anjos 2001, Anjos 2007). The use of this methodology allows us to compare the encounter rate among distinct habitats to same species, but not among distinct species (Aleixo and Vielliard 1995).

In our analyses, only the understorey birds were selected, considering mainly the habitat modification of understorey forests after the occurrence of surface fire. We also classified the species according to its sensitivity level (high, medium, and low), considering the total number of contacts in each plot, as follows: (i) high, when the species was not recorded or when its recordings were bellow 10% in disturbed areas; (ii) medium, when the recordings were between 10-30% in the disturbed plot; (iii) low, when species recordings were over 30% in the disturbed plot. This criterion follows the number of contiguous points of the secondary forest plot to the surroundings of the primary forest (30%). Although arbitrary, we believed that 30% would be adequate to mitigate the effects of the influence of the near primary forest stretches.

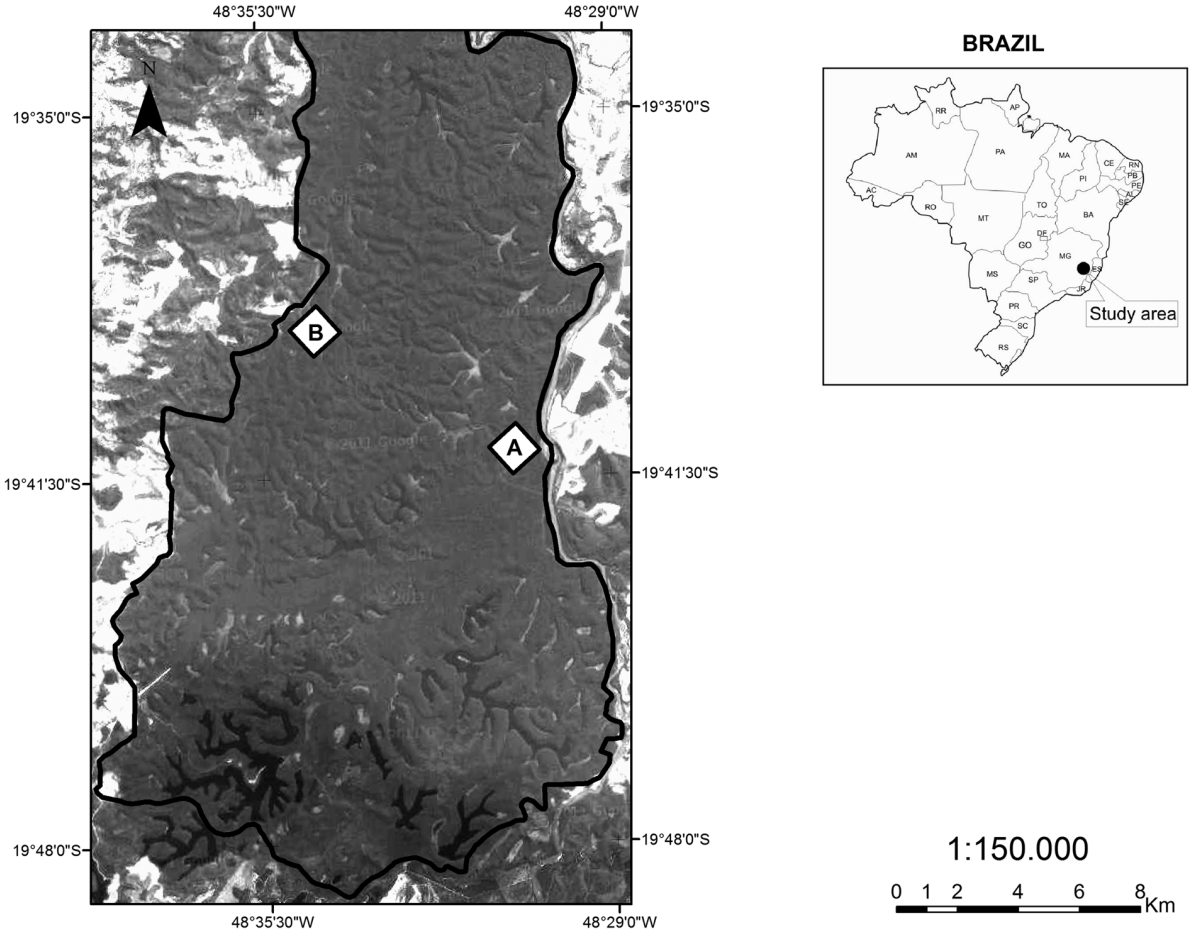

Fig. 1 – Two plots (A – primary forest plot; B – disturbed plot) of the Rio Doce State Park, Minas Gerais State, southeastern Brazil.

In the literature, we consider the high and medium sensitivity levels of species to be similar since both are more prone to extinction. So, to facilitate the comparisons with other authors, we grouped the two classifications (high and medium levels). Data on endemism, foraging strata and conservation priority level followed Parker III et al. (1996). The threat level of the species was based on the "List of threatened species in Minas Gerais State" (Fundação Biodiversitas 2008), and on the Red List of the International Union for Conservation of Nature (IUCN 2008).

We tested the null hypothesis of no difference in the contacts number of the species between the primary and secondary forests by G-test ($P < 0.05$). We also verified whether the endemism level or foraging strata affected species sensitivity in the two different successional stages. Species were thus divided into two groups (high/medium *versus* low sensitivities). Whereas the G-test was employed for all comparisons ($P < 0.05$), the Williams correction factor was used to obtain the adjusted G-value (Fowler et al. 1998). Only species with "n" higher than five were compared in the above-mentioned analyses, coupled to at least one individual in the two plots.

RESULTS

A total of twenty-five understorey bird species were recorded in the present study, totalling 935 contacts (Appendix). Moreover, 32% showed high and medium conservation priority levels, and three species (*Crypturellus noctivagus*, *Dysithamnus plumbeus* and *Neopelma aurifrons*) were highlighted as presenting a very high level. Of all detected understorey species, six are threatened in regional or global lists (*Tinamus solitarius*, *Crypturellus noctivagus*, *Odontophorus capueira* and *Schiffornis turdina*, regional list; *Dysithamnus plumbeus* and *Neopelma aurifrons*, global list).

Fifteen out of twenty-five sampled species occurred in different proportions in the two plots. In fact, thirteen species had the lowest IPA in the disturbed area, namely, *Tinamus solitarius*, *Baryphthengus ruficapillus*, *Dysithamnus plumbeus*, *Neopelma aurifrons*, *Drymophila squamata* and *Dendrocincla turdina*. Two species, *Penelope superciliaris* and *Lathrotriccus euleri*, were more frequent in the disturbed plot. No significant differences occurred among other species with regard to IPA between the plots, or they could not be compared due to the low number of detected individuals (see Appendix).

About 56% of species had high and medium sensitivity, whereas 44% showed low sensitivity. Endemic species did not show higher sensitivity to the secondary forest than the non-endemic ($G = 0.951$; df $= 1$; $P > 0.05$). No relationship has been established among the foraging strata of species and their response to the distinct successional stages ($G = 0.319$; df $= 2$; $P > 0.05$).

DISCUSSION

Human disturbances cause serious damage to the forest biota (Laurance et al. 1997). Changes in the original characteristics of forest remnants in the Atlantic Forest affect the richness and composition of the bird community, especially insectivorous and understorey bird species (Aleixo 1999, Maldonado-Coelho and Marini 2000). Furthermore, increases in forest edge areas change the movements of the understorey birds, especially of those living in their interior (Hansbauer et al. 2008), which then tend to avoid forest edges and clearings. Laurance et al. (2004) have also detected changes in the avifauna movement next to roads in the Amazon region. Forest-dependent insectivorous birds, mixed bird flocks, some solitary terrestrial species and understorey birds were the most affected.

Our data suggest that changes in local conditions may have been preponderant concerning the distribution of some birds. Many bird species are intolerant to high levels of light and tend to avoid edge areas (Laurance et al. 2004). In our study area, terrestrial species, such as *T. solitarius*, *C. noctivagus* and *O. capueira*, were only found in the forest interior, and, even so, not in forest clearings. Moreover, typical understorey species, such as *D. plumbeus*, *D. squammata* and *S. turdina*, may have a preference for areas with low light levels. Among Amazonian understorey birds, factors, such as the evolutionary history of species, structural change of environment and traffic-related disturbances, are determinants of edge avoidance (Laurance et al. 2004). Regarding the two woodcreeper species (*D. turdina* and *X. fuscus*), both showed the lowest number of contacts in the area of the disturbed forest coinciding with the northern Paraná (Poletto et al. 2004, Anjos 2006). However, *X. fuscus* did not show the same sensitivity level (low sensitivity) in the upper of the Rio Doce basin (Ribon et al. 2003).

Forest fires may also greatly affect fauna and flora (Barlow and Peres 2004). Studies undertaken in the Amazon region have reported that terrestrial and understorey birds are highly affected by them (Peres et al. 2003, Barlow et al. 2006). In our case, a forest fire in the 1990s caused habitat modification in the area under analysis. The low IPA of some bird species may have occurred due to initial successional stages; thus, several forest specialist species and/or specific functional groups may be more vulnerable to the habitat modification. Moreover, the effects of a forest fire may be prolonged for a longer period of time since these environments undergo a gradual process of recovery. While these arguments may have some validity, we have no data prior to the occurrence of fires in the area. Thus, any attempt to relate the changes in the habitat to fire would be unfortunately speculative.

Although current data are not related to some aspects of forest fragmentation (e.g., isolation or edge effects), bird species similar to those from other areas had the same response to environmental change. In the upper Rio Doce (Ribon et al. 2003), for instance, ten out of thirteen common species in our investigation were relatively similar regarding their sensitivity levels. Three species (*T. solitarius*, *O. capueira* and *D. turdina*) were considered extinct in the upper Doce River areas, and have been classified as of medium sensitivity in our study area. No similarity of sensitivity occurred in another three species (*G. montana*, *M. rufiventris* and *X. fuscus*). Marsden et al. (2001) studied thirty-one forest fragments in the southeast of Brazil. Although these authors did not use the same methodology of this research, we understand that species detected exclusively in the

Linhares Forest Reserve (*ca.* 40,000 ha) can be classified as extremely sensitive. Nine out of thirteen species registered in the middle Doce River were also similar to our results.

In most cases, the process of environmental modification may be less drastic than that related to habitat loss (Turner 1996). Furthermore, the greater the forest remnants, the higher the chances of conservation of viable populations (MacArthur and Wilson 1967, Marsden et al. 2005). In this case, it is expected that the current sensitivity levels of the species are less drastic when compared with those related to fragmented areas and with different degrees of isolation. In spite of the above, sensitivity levels of certain terrestrial and understorey bird species showed an average concordance rate of over 69% with the level converted from Marsden et al. (2001), Ribon et al. (2003), Anjos (2006) and Uezu (2006).

Anjos (2006) contrasted the sensitivity of seventy-five species between an area of Paraná State, southern Brazil, and another in Minas Gerais, southeastern Brazil. This study suggested that the location of species within their geographical distribution area may be determinant concerning the differences in their vulnerability. However, regional characteristics may greatly affect biological communities (Laurance et al. 1997, Ribon et al. 2003). For instance, current data indicate low sensitivity for *P. superciliaris*, which is very similar to the level found by Anjos (2006) in the northern region of Paraná State, and by Uezu (2006) in the western region of São Paulo State. However, in the upper Rio Doce, about 100 km from our area, this species was considered critically endangered (Ribon et al. 2003) probably due to hunting activities. Reports on the hunting of *P. superciliaris* have arisen in unprotected areas along the middle course of the Rio Doce.

Species sensitivity indexes may also be related to ecological and evolutionary factors (Goerck 1997), such as endemism (Ribon et al. 2003) or ecological similarities among species (Gray et al. 2007). Nevertheless, no association between endemism or foraging strata and the abundance index was found. Anjos (2006) has also observed a weak relation between sensitivity level and foraging strata.

Although the RDSP has an efficient fire-fighting system, it has become necessary to pay more attention to this disturbance. In fact, the RDSP is one of the last well-preserved conservation units in the Brazilian lowland Atlantic Forest. Our results show the importance of habitat conservation for some understorey bird species of the Brazilian Atlantic forest. Although there are protected areas at the government, the effective preservation of these areas is essential. Fires, illegal timber extraction, hunting, and other disturbances are a threat to the local biodiversity not only in unprotected areas, but also in areas that are Conservation Units.

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RESUMO

A Floresta Atlântica apresenta uma alta taxa de destruição e pouca informação disponível de alguns aspectos da biologia da avifauna neotropical. Alterações do ambiente são fatores importantes que influenciam nos recursos disponíveis para as aves. Nós comparamos o nível de sensibilidade das espécies de aves do sub-bosque de dois trechos em diferentes estágios sucessionais (trechos de floresta primária e secundária). Dois trechos de 100 ha cada de Floresta Atlântica de baixada foram analisados entre agosto e dezembro de 2006. Entre as 25 espécies de aves analisadas, treze tiveram menor abundância no trecho de floresta secundária, duas na floresta primária, e dez não mostraram qualquer tendência. De acordo com os critérios adotados, as porcentagens de espécies que apresentaram sensibilidades baixa, e média e alta às alterações de habitat foram de 44% e 56%, respectivamente. O número de espécies afetadas não esteve associado ao grau de endemismo ou estrato de forrageamento. Os resultados indicam a importância do conhe-

cimento do grau de sensibilidade das espécies de aves quanto à modificação dos habitats e não apenas aos efeitos da fragmentação florestal.

Palavras-chave: degradação, aves neotropicais, pontos de escuta, América do Sul, floresta tropical.

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APPENDIX

Number of detections (n), Index of Point Abundance (IPA), sensitivity level (S), endemism (End) and foraging strata (FOR) of twenty-five terrestrial and understorey bird species of a stretch of the lowland Atlantic Forest, southeastern Brazil.

Species	IPA[a]		S[b]	End	FOR[c]	*G*-test[d]
	PF	SF				
Tinamus solitarius	0.111	0.018	medium	yes	T	<0.001
Crypturellus obsoletus	0.171	0.064	medium	no	T	<0.001
Crypturellus noctivagus	0.638	0.055	high	yes	T	<0.001
Penelope superciliaris	0.037	0.083	low	no	T	0.049
Odontophorus capueira	0.064	0.013	medium	yes	T	0.006
Aramides saracura	0.013	0.041	low	yes	T	0.082
Geotrygon montana	0.111	0.111	low	no	T	—
Glaucis hirsutus	—	0.018	low	no	U	—
Phaethornis idaliae	0.148	0.190	low	yes	U	0.293
Phaethornis ruber	—	0.027	low	no	U	—
Baryphthengus ruficapillus	0.236	0.041	medium	yes	UM	<0.001
Dysithamnus plumbeus	0.175	0.055	medium	yes	U	<0.001
Myrmotherula axillaris	0.148	0.190	low	no	UM	0.198
Drymophila squamata	0.055	0.004	high	yes	U	0.001
Conopophaga melanops	0.083	0.018	medium	yes	U	0.002
Dendrocincla turdina	0.120	0.037	medium	yes	UM	0.001
Xiphorhynchus fuscus	0.092	0.013	medium	yes	UM	0.001
Automolus leucophthalmus	0.083	0.083	low	yes	U	—
Xenops minutus	0.037	0.013	medium	no	UM	0.133
Mionectes rufiventris	0.013	0.023	low	yes	UM	0.490
Leptopogon amaurocephalus	—	0.037	low	no	UM	—
Lathrotriccus euleri	0.078	0.260	low	no	U	<0.001
Neopelma aurifrons	0.185	0.070	medium	yes	U	<0.001
Schiffornis turdina	0.130	0.051	medium	no	U	0.005
Habia rubica	0.064	0.004	high	no	UM	<0.001

[a]Index of Point Abundance in the: PF – Primary Forest; SF – Secondary Forest. [b]Sensitivity (see Methods). [c]Strata Foraging: U – Understorey; UM – Understorey/Midstory; T – Terrestrial. [d]Significance level.