

Species richness of Antbirds (Thamnophilidae) in more central and peripheral sites of *terra firme* forest in the eastern edge of the Amazonia

Riqueza de espécies de chocas e afins (Thamnophilidae) em sítios centrais e periféricos de floresta de terra firme na borda oriental da Amazônia

Carlos Martínez 

Universidade Federal do Maranhão. Departamento de Biologia. São Luís, Maranhão, Brasil

Abstract: Antbirds (Thamnophilidae) comprise many insectivorous, mostly understory birds present in all Neotropical biomas. Many species occur specifically in the Amazonia, so a decline in species richness is expected from central Amazonian sites, to peripheral ones; this pattern is due primarily to the evolutionary history of the taxon. Rapid surveys to state the antbird species richness were performed in six sites of *terra firme* forest in the Belém Center of Endemism, the Easternmost and one of the most threatened regions in the Amazonia. These sites followed a series from more central to more peripheral areas, the latter being located in the edge of the Amazonia. The antbird species richness of every site was stated by presence-absence criteria. Two surveys were made in each site, by walking three transects in each of two trails in every survey. This species richness progressively fell from 19 species in the most central site (Gurupi Biological Reserve) to only two in the most peripheral one (São Luís). Probably, the gradient in the species richness is primarily associated to the evolutionary history of this group, however new studies using methods appropriated to assess the effects of environmental degradation in the regional richness of Thamnophilidae and other forest bird species should be encouraged.

Keywords: Biogeography. Ecosystem fragmentation. Forest degradation. Spatial niche. Understory birds.

Resumo: Chocas e afins (Thamnophilidae) compreendem muitas espécies de aves insetívoras, principalmente de sub-bosque, presentes em todos os biomas neotropicais. Muitas espécies ocorrem especificamente na Amazônia, então é esperado um declínio na riqueza de espécies, dos sítios centrais aos periféricos, tratando-se de um padrão primordialmente decorrente da história evolutiva do táxon. Foram realizadas visitas rápidas em seis sítios no Centro de Endemismo Belém, o mais oriental e um dos mais ameaçados da Amazônia, seguindo uma série, partindo dos mais centrais aos mais periféricos, estando os últimos localizados no limite da Amazônia. A riqueza de espécies de chocas e afins foi determinada por critérios de presença-ausência. Duas visitas foram realizadas em cada sítio, nas quais foram percorridos três transectos em cada uma de duas trilhas, em cada visita. A riqueza de espécies caiu progressivamente de 19 espécies no sítio mais central (Reserva Biológica do Gurupi) até somente duas no mais periférico (São Luís). Provavelmente, o gradiente de riqueza encontrado está primariamente associado à história evolutiva do grupo, mas deveriam ser encorajados novos estudos, com metodologia apropriada para investigar também os efeitos da degradação ambiental na riqueza de Thamnophilidae e outras espécies de aves florestais na região.

Palavras-chave: Biogeografia. Fragmentação de ecossistemas. Degradação florestal. Nicho espacial. Aves de sub-bosque.

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Autor para correspondência: Carlos Martínez. Universidade Federal do Maranhão. Departamento de Biologia. Av. dos Portugueses, s/n – Campus do Bacanga. São Luís, MA, Brasil. CEP 65080-040 (nyctic@yahoo.com).

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The Antbirds (Thamnophilidae) comprise a Neotropical passeriform family, which includes many, mostly undergrowth, insectivorous bird species. Different species occur in all Neotropical biomas, though the local species richness of this family is far higher in tropical forest sites (e.g. Ridgely & Tudor, 2009; del Hoyo et al., 2017).

A broad range of flexibility patterns in ecosystem occupation can be found among antbird species (Stotz et al., 1996; Lees & Peres, 2010; del Hoyo et al., 2017). In the Amazonia, this family includes from highly specialized birds restricted to typical rainforests, to generalistic species occupying a broader or lesser variety of transitional environments.

Silva et al. (2005) identified eight Centers of Endemism for birds in lowland Amazonia. From those, the Belém Center of Endemism (from now on BCE), in the easternmost part of the Amazonia, shows the smallest area and the highest level of deforestation. More than 80% of former tropical forest in BCE has been lost, or seriously degraded (Silva et al., 2005; Celentano et al., 2017). The best-preserved remaining areas in Maranhão correspond to the Gurupi Biological Reserve (from now on GBR) and several Indigenous Lands in the same region, in the southcentral part of BCE, in the State of Maranhão (Celentano et al., 2017). While some relevant information is already available for the GBR in the literature (Lima et al., 2014), the avifauna of the whole region still needs to be more extensively studied.

From the BCE central region, in western Maranhão State, to the East, in central Maranhão, lays a series of transitional habitats between dry forest and *cerrado* woodlands (e.g. Saraiva et al., 2020). Throughout that transition, changes in animal and plant community composition can be found (Carvalho et al., 2017). Those woodlands show lesser diversity of antbird species than tropical rainforest, and further most transitional habitats in central Maranhão have been heavily deforested in the last decades (Celentano et al., 2017).

Indeed, a decline in forest antbird species richness is expected (Lees & Peres, 2010; Rutt et al., 2020) from

the central regions of the BCE to the easternmost areas, independent of their levels of deforestation and fragmentation (Celentano et al., 2017; Silva Junior et al., 2020).

This study aimed to describe the species richness of thamnophilid birds along a geographical series of *terra firme* forest sites; still, the values of species richness would be assessed using qualitative presence-absence field data, easy to obtain and analyze, with simple and rapid field methods. This region in the Amazonia is increasingly threatened so, soon, it could be too late to obtain such data (Celentano et al., 2017), especially as deforestation rates in Brazilian Amazonia have significantly increased since 2018 (Azevedo et al., 2019; Barlow et al., 2019; Silva Junior et al., 2020).

I performed two surveys (one in the rainy season and one in the dry season) in *terra firme* forest remnants in each of six sites in Maranhão, easternmost Amazonia, from 2012 to 2013 (Figure 1). The first site (1) was located in GBR, the most central and well preserved rainforest area in the BCE, inside a forest core area, to be used as a comparison site. Each of the remaining five sites was chosen following a series in the northernmost region of BCE, from more central and preserved western areas, to the most external and highly degraded eastern sites. Those sites were (2) Cururupu, *Nambu Preto* forest, a *terra firme* primary forest fragment of around 5,000 ha, and isolated from Gurupi continuous forest and other large fragments by at least 100 km of unsuitable deforested landscapes; it was connected by some corridors of várzea forest to the following site. (3) Mirinzal, *Rio da Piaba* and *Pantaleão* forest fragments, around than 1,000 ha each, of old second growth forest, with some small plots (at most 100 ha) of primary forest. Both (4) Central do Maranhão, and (5) Alcântara, included old second growth fragments of around 500 ha, weakly connected to each other by secondary *capoeira* woodlands. And (6) São Luís consisted of two fragments of a few hundred ha each, of mixed vegetation (old and recent second growth) separated by several km of urban landscape (Figure 1). Quantitative estimations of forest degradation were not performed, so I avoided to

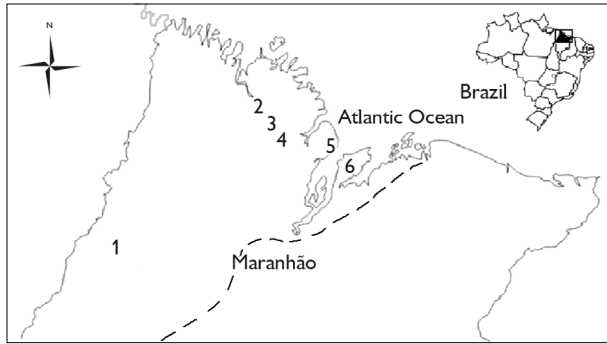


Figure 1. Location of the six sampled sites from the center to the periphery of the Belém Center of Endemism in Maranhão: 1 = Gurupi Biological Reserve (GBR); 2 = Cururupu; 3 = Mirinzal; 4 = Central do Maranhão; 5 = Alcântara; 6 = São Luís. Dotted line: Amazon Rainforest Easternmost Border. Map: Carlos Martínez (2022), adapted from Carmo (2014) and Amor de Papéis (n. d.).

take any conclusions about the effects of forest degradation upon the species richness of Antbirds. They were not only difficult to perform due to the irregularity of the patterns of land cover, but also to the occurrence of continuous and rapid changes in forest cover and quality. For example, almost fifty per cent of *Nambu Preto* large fragment, in Cururupu, was burned up by a forest fire a few months after the last of the surveys performed during the present study. Even GBR is exposed to those threats.

During every survey, and in every site, I walked along six transects of 1 km each, located in two local forest remnant fragments (thus, three transects for fragment). In GBR, the forest is still almost continuous, so two different quadrats of 3 x 3 km (comparable to the size of some forest fragments in the other sites) were chosen in the southernmost region of GBR, laying about 10 km from each other, and three transects were performed in each quadrat. The forest fragments in that region have different sizes, shapes and degradation levels, so I organized the sequence of sites following a geographical series. But, as commented above, even when biogeography could be the central cause for the observed patterns, also degradation and fragmentation could be involved in the final results. However, more adequate methods would have been necessary to assess how the forest fragmentation and degradation is affecting the species richness of this group

along the geographical gradient. Yet the current threatened situation makes it critically important to obtain any data about the regional avifauna as soon as possible.

During the transects, the presence or absence of every species was stated through field identification, either visual or auditive (Erize et al., 2006; Ridgely & Tudor, 2009; van Perlo, 2009; Xeno-canto, 2020). The surveys were part of a more extensive sampling, exceeding the limits of this study, and focusing mostly in the total species richness of every site, for conservation purposes. So, there was an observational emphasis in newly recorded species for a given site, strongly biasing the observation effort. Thus, the total species richness of each site was measured as a simple value, taking in mind that standard deviation could not be appropriately measured when, once previously recorded in the site, the presence of a given species in a given sample was underrecorded.

During the study, 19 antbird species were detected in all sites. The species richness of thamnophilid birds by site ranged from 2 to 19 species, showing a gradient of decline which followed, as expected, from the highest species richness in the Gurupi central forests to the lowest in São Luís remnants.

In site 1, all 19 species were detected, eight of them being restricted only to this site (*Pygiptila stellaris*, *Dysithamnus mentalis*, *Myrmotherula menetriesii*, *Myrmotherula longipennis*, *Isleria hauxwelli*, *Herpsilochmus rufimarginatus*, *Phlegopsis nigromaculata* and *Myrmornis torquata*). In site 2, all the remaining 11 species were found, five of them being restricted only to sites 1 and 2 (*Thamnophilus aethiops*, *Thamnomanes caesius*, *Myrmotherula axillaris*, *Cercomacra cinerascens* and *Willisornis vidua*). It could be said that these 13 species (occurring only in sites 1 and 2) showed the most restricted distribution. In site 3, all the remaining six species were found, two of them (*Cercomacroides laeta* and *Thamnophilus palliatus*) being restricted to sites 1, 2 and 3. An additional species (*Taraba major*) was detected in sites 1, 2, 3 and 4, and another one (*Pyriglena leuconota*) in sites 1, 2, 3, 4 and 5. So the latter four species showed

intermediate to broad distribution ranges. And finally, two species (*Formicivora grisea* and *Thamnophilus amazonicus*), were found in all six sites, showing the broadest distribution along the site series (Table 1; Figure 2).

In the present study, I have not directly assessed the relative importance of each factor, either biogeography or forest preservation, to define the distribution patterns of studied species. For assessing this question, it would be necessary to measure precisely two things: a) to which extent the transition from most central to most peripheral sites is more or less continuous, as it is a patchy and progressively degraded environment, and b) the number, size, shape and preservation levels of forest fragments in every site, which change rapidly along the time.

I found that the total number of Thamnophilid species, as expected, clearly decreased from central forest

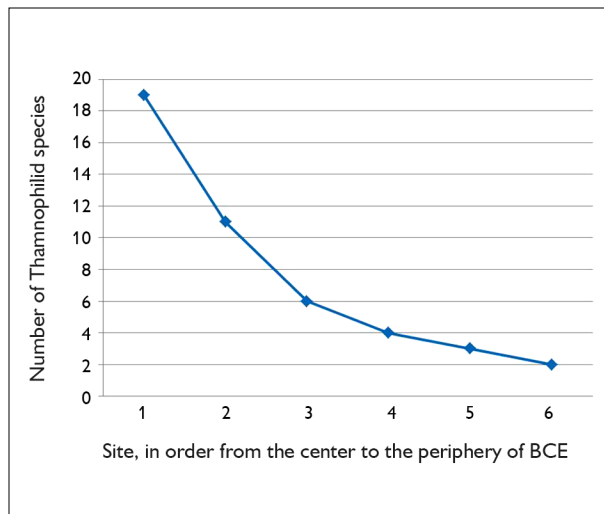


Figure 2. Number of Thamnophilid species found in the six sampled sites from the center to the periphery of BCE in Maranhão. Legends: 1 = Gurupi Biological Reserve (GBR); 2 = Cururupu; 3 = Mirinzal; 4 = Central do Maranhão; 5 = Alcântara; 6 = São Luís.

Table 1. Thamnophilid bird species occurrence in the six sampled sites from the center to the periphery of BCE in Maranhão. Legends: 1 = Gurupi REBIO; 2 = Cururupu; 3 = Mirinzal; 4 = Central do Maranhão; 5 = Alcântara; 6 = São Luís.

Species	1	2	3	4	5	6
<i>Formicivora grisea</i> (Boddaert, 1783)	X	X	X	X	X	X
<i>Thamnophilus amazonicus</i> Sclater, 1858	X	X	X	X	X	X
<i>Pyriglena leuconota</i> (Spix, 1824)	X	X	X	X	X	
<i>Taraba major</i> (Vieillot, 1816)	X	X	X	X		
<i>Cercomacroides laeta</i> (Todd, 1920)	X	X	X			
<i>Thamnophilus palliatus</i> (Lichtenstein, 1823)	X	X	X			
<i>Thamnophilus aethiops</i> Sclater, 1858	X	X				
<i>Thamnomanes caesius</i> (Temminck, 1820)	X	X				
<i>Myrmotherula axillaris</i> (Vieillot, 1817)	X	X				
<i>Cercomacra cinerascens</i> (Sclater, 1857)	X	X				
<i>Willisornis vidua</i> (Hellmayr, 1905)	X	X				
<i>Pygiptila stellaris</i> (Spix, 1825)	X					
<i>Dysithamnus mentalis</i> (Temminck, 1823)	X					
<i>Myrmotherula menetriesii</i> (d'Orbigny, 1837)	X					
<i>Myrmotherula longipennis</i> Pelzeln, 1868	X					
<i>Isleria hauxwelli</i> (Sclater, 1857)	X					
<i>Herpsilochmus rufimarginatus</i> (Temminck, 1822)	X					
<i>Phlegopsis nigromaculata</i> (d'Obigny & Lafresnaye, 1837)	X					
<i>Myrmornis torquata</i> (Boddaert, 1783)	X					

sites, to peripheral fragments in easternmost Amazonia. Probably, the natural biogeographical gradient is essential to define those results, but forest degradation can cause the diversity of birds in peripheral fragments to be lesser than it probably was in the past, in natural conditions. In the future, more complex studies should be conducted to state to which extent this decrease should be attributed to biogeography, habitat conservation status, or both.

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