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JOANDRO PANDILHA DOS SANTOS

DISTRIBUIÇÃO E ECOLOGIA DE AVES EM FLORESTAS DE GALERIA DE SAVANAS AMAZÔNICAS

MACAPÁ, AP
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DISTRIBUIÇÃO E ECOLOGIA DE AVES EM FLORESTAS DE GALERIA DE SAVANAS AMAZÔNICAS

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DEDICATÓRIA

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RESUMO

Pandilha, Joandro. Distribuição De Aves Florestais Em Uma Paisagem De Savana Neotropical. Macapá, 2020. Dissertação (Mestre em Biodiversidade Tropical) - Programa de Pós-graduação em Biodiversidade Tropical – Pró-Reitoria de Pesquisa e Pós-Graduação - Universidade Federal do Amapá.

As florestas de galeria são faixas naturais, estreitas e bem definidas de florestas encontradas ao longo dos rios e córregos de savanas tropicais. As florestas de galeria permitem a colonização de regiões de savana por organismos dependentes de floresta. A maioria dos estudos sobre aves que vivem em florestas de galeria foi realizada no nível local ou regional, mas não no nível da paisagem; portanto, as informações sobre como as espécies florestais são distribuídas em uma paisagem dominada por savanas são escassas. Neste trabalho, estudamos a distribuição de aves da floresta em uma paisagem de savana no Amapá, Amazônia brasileira. Esta paisagem é cercada por dois tipos diferentes de floresta (terras altas e inundadas sazonalmente). Primeiro, avaliamos como a estrutura das florestas da galeria, bem como suas conexões com as florestas adjacentes, influenciam a distribuição das espécies de aves das florestas na paisagem da savana. Em seguida, testamos a hipótese geral de que a riqueza de espécies de aves no nível da paisagem é influenciada por cinco atributos ecológicas de espécies: massa corporal, extensão da ocorrência, grupo trófico, dependência da floresta e uso da floresta. Descobrimos que, embora a estrutura das florestas da galeria não diferisse na paisagem, suas assembleias de aves diferem. A assembleia de aves das florestas de galeria conectadas às florestas de terras altas é mais diversificada e é ecologicamente distinta da assembleia de aves que vive nas florestas de galeria conectadas às florestas sazonalmente inundadas. Além disso, com exceção do grupo trófico, as características ecológicas das espécies não são boas preditoras do tamanho da distribuição geográfica de uma espécie no nível da paisagem. Nossos resultados mostram que os padrões de distribuição de aves de florestas no nível da paisagem se assemelham aos relatados no nível regional. Nos dois níveis, os padrões de distribuição são causados pela dispersão e filtragem ecológica.

Palavras-chave: Amazônia, Neotropical, bacias hidrográficas, ecologia da paisagem, biogeografia, Cerrado.

ABSTRACT

Pandilha, Joandro. Distribution of forest birds in a tropical savanna landscape. Macapá, 2020. Dissertação (Mestre em Biodiversidade Tropical) - Programa de Pós-graduação em Biodiversidade Tropical – Pró-Reitoria de Pesquisa e Pós-Graduação - Universidade Federal do Amapá.

Gallery forests are natural, narrow and well-defined strips of evergreen tall forests found along the rivers and streams of the tropical savanna region. They are mesic corridors that allow for colonization of savanna regions by forest-dependent organisms. Most studies on birds living in gallery forests were carried out at the local or the regional level, but not at the landscape level, so information on how forest species are distributed within a landscape dominated by savannas is scarce. Here we studied the distribution of forest birds in a savanna landscape in Amapá, Brazilian Amazon, that is surrounded by two different types of forest (upland and seasonally flooded). First, we assessed how the structure of the gallery forests as well as their connections to the adjacent forests influence the distribution of the forest bird species in the savanna landscape. Then, we tested the general hypothesis that the range size of the species at landscape level is influenced by five species' ecological traits: body mass, extent of occurrence, trophic group, forest dependence, and forest use. We found that although the structure of the gallery forests did not differ across the landscape, their bird assemblages do. The bird assemblage of the gallery forests connected to upland forests is more diverse and is ecologically distinct from the assemblage of birds living in the gallery forests connected to seasonally flooded forests. In addition, with the exception of trophic group, species' ecological traits are not good predictors of the range size of a species at the landscape level. Our results show that distribution patterns at the landscape level resembles those reported at the regional level. In both levels, distribution patterns are caused by dispersal and ecological filtering.

Keywords: Amazon, Neotropical, watersheds, communities, landscape ecology, biogeography, Cerrado

SUMÁRIO

1. INTRODUÇÃO GERAL 11
2. HIPÓTESES 15
3. OBJETIVOS 16
  3.1. Geral 16
  3.2. Específicos 16
4. REFERÊNCIAS BIBLIOGRÁFICAS 17
  ARTIGO CIENTÍFICO 21
  ABSTRACT 23
  INTRODUCTION 24
  METHODS 26
  RESULTS 32
  DISCUSSION 33
  ACKNOWLEDGMENTS 36
  LITERATURE CITED 36
5. APÊNDICE 42
  5.1. Tables with captions 42
  5.2. Figure captions 45
  5.3. Supplementary Material 48
6. CONCLUSÕES 55
7. ANEXOS 56

1. INTRODUÇÃO GERAL

As savanas cobrem cerca de 20% da superfície terrestre mundial (Lehmann et al. 2014). As savanas tropicais encontram-se localizadas principalmente na América do Sul, África, Austrália e Sul da Ásia. Na América do sul as savanas cobrem uma área de 2 milhões de km², tendo como maiores representantes o Cerrado no Brasil, Bolívia e Paraguai e Llanos na Venezuela e Colômbia (Carvalho and Mustin 2017). Entretanto, existem pequenas ilhas de savanas isoladas dentro do bioma amazônico, intituladas como savanas amazônicas (Silva and Bates 2002, Carvalho and Mustin, 2017). As savanas amazônicas cobrem uma área de 267.164 km², das quais aproximadamente 90% ocorre no Brasil e Bolívia. Os maiores complexos de savanas amazônicas são Beni na Bolívia (~ 127.096 km²); Roraima-Rupununi no Brasil e Guiana (~ 82.382 km²); Sipaliwini-Parú no Brasil e no Suriname (~ 15.453 km²); e as savanas do Amapá no Brasil (~ 13.027 km²) (Barbosa et al. 1997, Carvalho and Mustin 2017).

As savanas amazônicas são consideradas "refúgios" atuais de um ambiente aberto que se expandiu pela Amazônia durante os ciclos climáticos quaternários. Durante períodos frios e úmidos as savanas se expandiram na Amazônia enquanto as formações vegetais úmidas se retraíram. Essas mudanças paleo-climáticas associadas a mudanças vegetacionais são consideradas um dos fatores que levaram à especiação de organismos florestais e savânicos na América do Sul (Silva et al. 1997, Silva and Bates 2002, Vasconcelos et al. 2011).

As savanas possuem uma biota única composta por espécies de vegetação aberta e florestais (Silva and Bates 2002). As espécies florestais são encontradas principalmente nas florestas de galeria, que podem ser caracterizadas como faixas naturais, estreitas e bem definidas de florestas encontradas ao longo dos rios e córregos em savanas tropicais. No Brasil, as florestas galerias de savanas amazônicas são formadas em terrenos mais planos, possuem bacias menores e são conectadas a florestas contínuas, diferentes das florestas de galeria do Cerrado (Silva 1996, Vasconcelos et al. 2011).

As florestas de galeria, apesar de cobrirem uma pequena parte das regiões de savanas (geralmente 10%), são estruturalmente mais complexas que as savanas adjacentes e, com isso, abrigam a maioria das espécies de aves registradas nas regiões de savana. No Cerrado, por exemplo, 72% das espécies de aves são totalmente ou parcialmente dependentes de florestas de galeria (Silva 1995, Silva and Santos 2005, Mittermeier et al. 2010). Além disso, 85% dos mamíferos não-voadores e praticamente todas as espécies de morcegos mantem alguém tipo de associação com as florestas de galeria em estudos realizados no Brasil Central (Marinho and Reis 1989).

As florestas de galerias são ecologicamente importantes pois podem servir como suplementação de recursos para aves de savana (Tubelis et al. 2004), atuam também como corredores ecológicos para colonização das regiões de savana por organismos dependentes de florestas (Redford and Fonseca 1986, Oliveira-Filho and Ratter 1995, Silva 1996, Costa 2003, Mayle et al. 2007). Desta forma, acredita-se que a maioria dessas espécies de aves de florestas de galeria possuem suas distribuições influenciadas pela distância em relação as regiões florestais adjacentes as regiões de savana (Silva 1996). Para expandir e/ou manter suas distribuições dentro das regiões de savana, estas espécies precisam superar vários filtros ecológicos (fatores abióticos e bióticos que restringem o estabelecimento de um grupo de espécies em um determinado habitat), cuja força aumenta com a distância das florestas contínuas (Nekola and White 1999). Como as florestas de galeria estão associadas a rios e os rios são organizados hierarquicamente em bacias hidrográficas, também se espera que a intensidade destes filtros varie entre bacias hidrográficas (Silva 1996).

Poucos estudos tentaram descrever e/ou compreender quais os fatores por trás da distribuição atual da biota das florestas de galeria em áreas de savanas neotropicais. Entre estes podemos destacar alguns estudos com plantas (Felfili 1995, Oliveira-Filho and Ratter 1995), aves (Silva 1995, Silva 1996, Silva et al. 1997, Vasconcelos et al. 2011, Jesus et al. 2018) e mamíferos (Redford and Fonseca 1986, Bernard and Fenton 2002, Costa 2003, Loayza and Loiselle 2009). Dentre estes, apenas Oliveira-Filho and Ratter (1995), Loayza and Loiselle (2009) e Silva (1996) detalharam a distribuição de organismos em florestas de galerias nas regiões de savana.

Oliveira-Filho and Ratter (1995) encontraram que a flora de florestas de galeria a oeste e norte são mais ligadas as florestas amazônicas, enquanto as galerias localizadas ao centro e sul possui mais afinidades com florestas montanas do sudeste brasileiro. Eles sugerem que esses padrões encontrados podem ser fruto de mudanças paleoambientais.

Loayza and Loiselle (2009) realizaram uma pesquisa nas savanas amazônicas de Beni e encontraram que a distribuição de morcegos na região possuía um padrão aninhado, com a composição das espécies nos fragmentos florestais sendo subconjuntos das florestas contínuas.

Estudando somente as aves de florestas de galeria no Cerrado, Silva (1996) descobriu que, em geral, as faixas de distribuição das espécies de aves que vivem em florestas de galeria são pequenas, concentradas principalmente ao longo dos limites das áreas de Cerrado com as regiões adjacentes de floresta, e suas distribuições são influenciadas pela altitude e bacias hidrográficas. Além disso, ele não encontrou nenhuma influência de características ecológicas sobre o tamanho da distribuição das espécies.

Apesar de Silva (1995, 1996) ter detalhado os padrões de distribuição para aves em ambientes de savana, seu estudo se restringiu ao Cerrado. Assim, não há um estudo sequer abrangente sobre a distribuição de espécies de aves em savanas amazônicas. Alguns trabalhos focaram em estudar a riqueza, abundância, composição e descrições biogeográficas de aves em florestas de galeria de savanas amazônicas (Silva et al. 1997, Mees 2000, Sanaiotti and Cintra 2001, Santos and Silva 2007, Aleixo and Poletto 2007, Mittermeier et al. 2010, Vasconcelos et al. 2011), porém, nenhum focalizou exclusivamente na avifaunas das florestas de galeria.

Nas savanas amazônicas amapaenses, Novaes (1974, 1978) listou algumas espécies de aves de florestas. Silva et al. (1997) registraram 179 espécies de aves para região, das quais 104 foram registradas em florestas de galeria. Aguiar and Naiff (2010) registraram para uma área de savana cerca de 60 espécies de aves, e para florestas de galeria adjacentes foram registradas 95 espécies. Boss (2009) realizou um estudo no Campo Experimental de Cerrado da Embrapa, que é um importante sítio de savana protegida do estado no Amapá e catalogou 182 espécies de aves, das quais 101 possui algum tipo de dependência florestal. Por fim, Schunke et al. (2011) realizaram amostragens de aves em duas localidades ao sul do Amapá e registraram 92 espécies em áreas de Cerrado, sendo que 38% possuíam algum tipo de dependência florestal. Estima-se que ocorram cerca de 200 espécies de aves nas savanas amapaenses (Mustin et al. 2017), mas não se sabe exatamente quantas espécies vivem nas florestas de galeria.

As florestas de galeria encontradas nas savanas amapaenses podem ser divididas em duas categorias: florestas de galeria conectadas e/ou influenciadas por florestas de terras altas (floresta de terra firme bem drenadas); e florestas de galeria conectadas e/ou influenciadas por florestas sazonalmente alagadas (IEPA 2008). Até o momento não existe nenhum estudo comparativo entre esses dois tipos de florestas de galeria usando algum grupo faunístico e nem mesmo a respeito da estrutura do habitat. As florestas de terras altas são mais complexas e divergem em composição e riqueza de espécies em relação às florestas sazonalmente alagadas (Montagnini and Muñiz-Miret 1999, Gama et al. 2005). Desta forma, espera-se que as biotas das florestas de galeria das savanas do Amapá sejam diferentes e influenciadas pelas biotas das florestas adjacentes.

Este trabalho é o primeiro estudo abrangente sobre a distribuição de aves em florestas de galeria em uma paisagem de savana amazônica. O objetivo principal do estudo é comparar as assembléias de aves e a estrutura da vegetação de dois tipos distintos de florestas de galeria (um conectado às florestas de terra firma e o outro ligado às florestas de várzea) em uma paisagem de savana amazônica.

2. HIPÓTESES

- As florestas de galeria conectadas às florestas de terras altas são estruturalmente mais complexas que florestas de galeria conectadas a florestas sazonalmente alagadas (Montagnini and Muñiz-Miret 1999, Gama et al. 2005).

- As assembleias de aves de florestas de galeria são influenciadas positivamente pela conexão com as florestas contínuas adjacentes (Silva 1996). Por conseguinte, florestas de galeria conectadas a terras altas serão mais ricas e possuirão maior número de espécies associadas quando comparadas a galerias conectadas a florestas sazonalmente alagadas (Montagnini and Muñiz-Miret 1999, Gama et al. 2005).

- Os tamanhos da distribuição local das espécies florestais em uma paisagem de savana são influenciados pelas características ecológicas das espécies, como peso, uso do habitat, grupo trófico, dependência florestal e extensão de ocorrência.

3. OBJETIVOS

3.1. Geral

Comparar as assembleias de aves e estrutura da vegetação de dois tipos de florestas de galeria em uma paisagem de savana amazônica no estado do Amapá, Brasil.

3.2. Específicos

- Verificar variações na riqueza de espécies de aves entre os dois tipos de florestas de galeria;
- Verificar a variação na composição das espécies associadas entre os dois tipos de florestas de galeria;
- Verificar a influência de características ecológicas no tamanho das distribuições locais das aves que habitam florestas de galeria em uma paisagem de savana amazônica.

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Distribution of forest birds in a tropical savanna landscape

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Distribution of forest birds in a tropical savanna landscape

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ABSTRACT. Gallery forests are natural, narrow and well-defined strips of evergreen tall forests found along the rivers and streams of the tropical savanna region. They are mesic corridors that allow for colonization of savanna regions by forest-dependent organisms. Most studies on birds living in gallery forests were carried out at the local or the regional level, but not at the landscape level, so information on how forest species are distributed within a landscape dominated by savannas is scarce. Here we studied the distribution of forest birds in a savanna landscape in Amapá, Brazilian Amazon that is surrounded by two different types of forest (upland and seasonally flooded). First, we assessed how the structure of the gallery forests as well as their connections to the adjacent forests influence the distribution of the forest bird species in the savanna landscape. Then, we tested the general hypothesis that the range size of the species at landscape level is influenced by five species' ecological traits: body mass, extent of occurrence, trophic group, forest dependence, and forest use. We found that although the structure of the gallery forests did not differ across the landscape, their bird assemblages do. The bird assemblage of the gallery forests connected to upland forests is more diverse and is ecologically distinct from the assemblage of birds living in the gallery forests connected to seasonally flooded forests. In addition, with the exception of trophic group, species' ecological traits are not good predictors of the range size of a species at the landscape level. Our results show that distribution patterns at the landscape level resembles those reported at the regional level. In both levels, distribution patterns are caused by dispersal and ecological filtering.

Keywords: Amazon, Neotropical, watersheds, communities, landscape ecology, biogeography, Cerrado

INTRODUCTION

Gallery forests are natural, narrow and well-defined strips of evergreen tall forests found along the rivers and streams of the tropical savanna region. They have unique bird assemblages that are distinct from the adjacent savannas (Silva 1996; Piratelli and Blake 2006). Because gallery forests are structurally more complex than savannas, they harbor most of the bird species of savanna regions even though they cover a smaller proportion of them. For instance, in the Cerrado, the largest Neotropical savanna, of 778 bird species recorded, 72% are totally or partially dependent on gallery forests and dry forests, which altogether cover less than 17% of the region (Silva 1995; Silva and Santos 2005).

Gallery forests are mesic corridors that allow for colonization of savanna regions by forest-dependent organisms that have their ranges centered in the adjacent forest regions (Redford and Fonseca 1986; Oliveira-Filho and Ratter 1995; Silva 1996; Costa 2003). To expand and maintain their ranges within savanna regions, these species must overcome several ecological filters (i.e., abiotic and biotic factors that constrain the establishment of a group of species in a given habitat). The strength of these filters are predicted to decline with the distance from the continuous forest regions (Nekola and White 1999) and, because gallery forests are associated with rivers and rivers are organized hierarchically in watersheds, these filters are also expected to vary across watersheds (Silva 1996). In general, strong ecological filtering is predicted to favor generalist species (species with ecological traits that allow them to thrive in narrow forest patches) rather than specialist species (Oliveira-Filho and Ratter 1995). Silva (1996) studied the distribution of gallery forests in Cerrado, the largest neotropical savanna region, and found that, in general, the ranges of bird species living in gallery forests are small, concentrated mostly along the boundaries of the Cerrado with the adjacent forest regions, and have their ranges influenced by both altitude and watersheds; moreover, he did not find any influence of ecological traits, such as diet and habitat use, on the range sizes of forest birds within the Cerrado.

Studies on the distribution of gallery forest birds in neotropical savannas to date were carried out mostly at local level (Piratelli and Blake 2006) as well as regional level (Silva 1995, 1996), but not at the landscape level. Because ecological processes (such as dispersal and ecological filtering) operating at regional scales (> 10,000 km^2) can also be relevant at the landscape level (between 1 and 10,000 km^2), it is useful investigating whether the general distribution patterns described for birds of the gallery forests in the Cerrado at regional level can be generalized to the landscape level. This type of research is relevant because scaling (i.e., extrapolating information from one scale to another) continues to be a challenge in ecology as patterns apparent at one spatial level may look quite different when viewed at another level (Wiens 1992; Teng et al. 2020).

In this paper, we present the first comprehensive study on the distribution of bird species associated with gallery forests in a landscape dominated by neotropical savanna. This savanna landscape is located in Amapá, Brazil, in an area that is surrounded by two distinctive types of forests: upland forests to west and seasonally flooded forests to the east. These two types of forests differ in structure, species composition, and species diversity (IEPA 2008). The savanna landscape has two watersheds: one (Matapi) has its gallery forests connected to upland forests whereas the other (Curiaú-Pedreira) has its gallery forests connected to seasonally flooded forests.

We test three general hypotheses. First, we test the hypothesis that the gallery forests of the two watersheds have different structures. Because upland forests are more complex and differ in species richness and composition from seasonally flooded forests (Montagnini and Muñiz-Miret 1999; Gama et al. 2005), we predict that the gallery forests of the two watersheds differ in structure and that this difference influences the distribution of forest species (Wiens

1992). Second, we test the hypothesis that bird assemblages of gallery forests are influenced by their connections with the adjacent continuous forests (Silva 1996). Thus, we predict that the gallery forests connected to the upland forests have more species and a more specialized bird assemblage than the gallery forests connected to the seasonally flooded forest. Finally, we test the hypothesis that the range size of the species at landscape level (hereafter local range) is influenced by five species' ecological traits: body mass, extent of occurrence, trophic group, forest dependence, and forest use. Based on previous studies, we expect that local range increases with both body mass (Gaston and Blackburn 1996) and extents of occurrence (Gaston 2003). Moreover, local ranges are expected to be larger among generalist species (i.e., species that are omnivores, less forest dependent, and use mostly the forest edges) than specialist species (Devictor et al. 2008).

This work, in addition to advancing the understanding on the patterns of distribution of forest species in tropical savanna landscapes, also contributes to basic knowledge on the biota of the Amazonian savannas, a rich and poorly studied ecosystem that is under strong pressure due to the expansion of commercial agriculture across the region (Mustin et al. 2017; Hilário et al. 2017).

METHODS

Study area. The Amapá savannas occupy around 10,000 km^2 (Mustin et al. 2017; Hilário et al. 2017) on a narrow and mainly flat, north-south oriented belt composed of Tertiary sediments ("Barreiras Formation") parallel to the Atlantic coast (Silva et al. 1997). They are bordered on the west by tropical forests on Pre-Cambrian crystalline terrains, and on the east by a combination of seasonally flooded forests, grasslands and mangroves on Holocene sediments (IEPA 2008). Our study area is in a 123,000 hectares savanna (0°12’N, 51°6’ W) located between the municipalities of Porto Grande and Macapá, Amapá, Brazil (Fig. 1).

The climate is hot (average temperature of 27ºC) and humid (average relative humidity of 81%). Average annual precipitation from 1961 to 1990 is around 2,700 mm with a well-marked dry season from August to November, when total monthly rainfall is below 50 mm (Boss and Silva 2015).

The landscape structure of the study area is a matrix composed of different types of open vegetation intersected by corridors of gallery forests. The open vegetations are of two types: upland savannas and flooded grasslands (Silva et al. 1997). The upland savannas cover most of the landscape. They have two layers: a ground layer dominated by grass species dominated by *Rhynchospora*, *Axonopus*, *Paspalum*, *Polygala*, *Bulbostylis* and *Miconia* genera, and a woody layer that includes large shrubs and 3-10 m trees such as *Byrsonina crassifolia*, *Salvertia convallariodora*, *Ouratea hexasperma*, *Curatella americana*, *Himatanthus articulatus*, *Pallicourea rigida* and *Hancornia speciosa* (Sanaiotti et al. 1997; Costa-Neto et al. 2017). In contrast, the flooded grasslands are found only at the bottom of some narrow valleys, where soils are shallow and permanently inundated. These grasslands have narrow belts of *Mauritia* and *Mauritiella* palms (Silva et al. 1997).

Gallery forests are narrow (100-150 m) and found only on cambisols or hydromorphic soils rich in the organic matter along the wide valleys of rivers and streams (Silva et al. 1997). They are evergreen forests with a well-defined canopy composed of 20-30 m tall trees and a humid understory that harbors many ferns, epiphytes, as well as palms. The most common plant species are *Mauritia flexuosa*, *Euterpe oleracea*, *Mauritiella aculeata*, *Desmoncus* sp., *Annona paludosa*, *Coccoloba* sp, *Ficus* sp., *Symphonia globulifera*, *Virola* sp., *Lecythis* sp. and *Hymenaea parvifolia* (Costa-Neto and Silva 2004).

Sample design. Because the proportion of the study area covered by the Curuá-Pedreira is twice as large as the area covered by the Matapi, we set 18 transects in the former and eight transects in the latter (Fig. 1). Transects were 0.5 km long and their locations within each watershed were selected to maximize three criteria simultaneously: accessibility, low levels of human disturbance and physiognomic variation.

Vegetation structure. In each of the 26 transects, we selected three plots measuring 75m × 2m (150m^2) separated by a minimum distance of 100 meters. In each plot, we took ten measurements of vegetation structure: (1) canopy cover, (2) vegetation obstruction, (3) mean diameter at the breast height, (4) average vegetation height, (5) number of palms per hectare, (6) number of lianas per hectare, (7) number of dead trees per hectare, (8) density of trees, (9) basal area, and (10) average litter depth. The canopy coverage was measured using a leaf coverage index ranging from 0% to 100%. This index is estimated through analysis of photographs of the canopy, using the program "Gap Light Analysis Mobile App" - GLAMA (Tichý 2016). We took four photographs at points separated by 25 meters in each plot with the camera vertically positioned at a height of 1.60 m above the ground. The average leaf coverage of the 12 photographs (4 photographs × 3 plots) was used as a measure of the canopy coverage of the sampling transect. The vegetation obstruction was measured as the number of foliage contacts between 0.5 m and 2 m above the ground with an aluminum pole two-meters tall and 5 mm in diameter. The pole was walked in front of the body in the middle of the plot (2 m wide) and all the touches of the three plots were summed up (Mantovani and Martins 1990). In each plot, all trees with a diameter at breast height greater than or equal to 10 mm were measured. In addition, the number of palms, lianas, and dead trees were counted. From these measurements, we calculated the following metrics: average diameter at breast height, the average vegetation height, the number of palm trees per hectare, the number of lianas per hectare, the number of dead trees per hectare, the density of trees and basal area per hectare. The height of the trees was measured using a 4-and-a-half-meter graduated ruler and a Bushnell

Hypsometer (Scout 1000 Arc). The laser was launched on the highest branches, branches or leaves and the hypsometer data recorded. Then, the formula

$$\sin(\text{Angle} \times \pi / 180) * \text{Distance from the object} + 1.59\ (\text{eye height})$$

was used to obtain the height of each tree. Basal area were calculated using the formula (Soares et al. 2006)

$$((((\text{dbh (mm)} / 1000) / 2)^2 \times \pi) \times (10{,}000 / 450)$$

and the number of trees was estimated (Soares et al. 2006) by using

$$\text{number of trees} \times (10{,}000 / 450)$$

The litter depth was measured using a 30 cm graduated ruler every ten meters within each 75m × 2m plot. Thus, seven measurements of litter depth were taken per plot yielding a total of 21 samples. The average of these values was calculated to represent the average litter depth in each plot.

Bird survey. To estimate the distribution of the bird species across the landscape, we choose three count points in each of the 26 transects. Thus, we had 54 count points in the Curuá-Pedreira and 24 in the Matapi. These count points were separated by at least 200 meters to approximate independent sampling (Hutto et al. 1986; Vielliard et al. 2010). We counted birds four times from April to September 2019, twice during the rainy season (April and June) and twice during the dry season (July and September). Thus, our counts included all the critical periods of the region's annual bird cycle (Boss and Silva 2015). We counted birds between 6:00 am and 10:30 am to maximize the detection of species (Hutto et al. 1986). Each count point was sampled for 10 minutes, such as recommended for tropical forests (Wunderle 1994). We recorded the start and end time of the count, the identity of the recorded species (observed or heard) and the number of individuals. When possible, unidentified species recorded during the 10 min census were followed and identified after the census period (Hutto et al. 1986). The counts were made with the aid of Olympus Binoculars (7x32) and Nikon D5100 camera. The vocalizations, when necessary for the identification of the species, were recorded with Zoom H1n recorder and directional microphone Yoga-Ht81.

Local range size and ecological traits. We used the incidence of the species across all point counts as the indicator of local range size. We assumed that species recorded at more point counts would have larger local ranges. To assess if the range size at landscape level is associated with species' ecological traits, we collected data for five ecological traits: trophic group, habitat use, forest dependence, body mass, and extent of occurrence. We recognized four trophic groups based on the most common type of food consumed by the species: (a) herbivorous (eat mostly fruits and/or seeds), (b) insectivores (eat mostly insects and other invertebrates), (c) carnivores (eat mostly vertebrates) and (d) omnivores (combine a herbivore and insectivore diets). We classified each species into one of three categories of habitat use based on where in the forest the species was found most frequently in our observations: (a) forest interior, (b) forest canopy, and (c) forest edge. We used Silva (1995) and our personal observation to classify the species in forest dependent (species that live only in forests) and forest semi-dependent (species that live in forests and other adjacent habitats). Finally, we gathered information about body mass for all species from the literature (Terborgh et al. 1990; Cintra and Naka 2011; Johnson et al. 2011) and data on extent of occurrence from BirdLife International (2020).

Statistical analysis. Principal Component Analysis (PCA) was used to reduce the dimensionality of the ten indicators of vegetation structure, which were scaled to unit variance to allow the calculation of a matrix of variance/covariance to run the PCA. The first three orthogonal axes of PCA composed by scores (representing the distance between sampling points in the multidimensional space) were used to represent vegetation structure. Then, we test the hypothesis that the gallery forests of the two watersheds differ in structure by using the Mann-Whitney *U* non-parametric test.

We restricted our analyses to bird species that are associated with forest habitats. Thus, we excluded all species that were considered as independent of forests by Silva (1995) and our observations. In addition, we excluded all species with nocturnal habits (e.g., Strigidae and Caprimulgidae families) because we did not count birds in the evenings. In total, we excluded 26 species, which represent 18.2% of the total species recorded in all surveys.

To test the hypothesis that the assemblages of forest birds of the two watersheds are distinct, we assessed two indicators: species richness and species composition. We used the number of sampling locations where the species was present in each watershed (incidence-raw data) to estimate species richness. Species accumulation curves, corrected by Hill's numbers, were generated by using the iNEXT package of the R platform (Hsieh et al. 2016), and compared using the 95% confidence interval (Chao and Chiu 2017). To evaluate species composition, we focused on two groups of species: those restricted to a watershed and those that can be considered as indicators of a watershed through a quantitative analysis. The first group of species was identified by mapping their occurences in the landscape. The second group of species was identified by using the indicator species analysis implemented in the package "indicspecies" (De Cáceres et al. 2010) in R Platform (R Core Team 2017). We used 999 permutations to define the statistical significance of the associations between species and watersheds.

We used the Chi-squared test of independence to assess if watershed preference (i.e., number of restricted or indicator species in each watershed) is independent of forest use, forest dependence, and trophic groups. If the Chi-square test for independence was significant, then we tested the statistical significance of the difference between the observed and expected values in each cell to identify where the significance came from. We estimated the exact probability for each cell and its statistical significance with the Holm–Bonferroni correction method using the procedures described by Shan and Gerstenberger (2017).

We used a Poisson regression to evaluate the influence of ecological traits on species' local range sizes. In both regressions, we first examined the variation inflation factors (VIF) to ensure that the predictor variables were independent of one another. Because no variable had VIF> 5 (Dormann et al. 2013), we kept all of them. Because the dependent variable is overdispersed (variance > mean), we used robust standard errors that are more conservative and unbiased(Cameron and Trivedi 2010). We used Stata 15 (StataCorp. 2017) in this analysis.

RESULTS

Forest structure. The principal component analysis (PCA) showed that its first three axes explain 69% of the total variation of the ten variables used to measure the vegetation structure of gallery forests (Table 1). The first component explained 37.7% of the variation and is associated with positive values for the number of palm trees per hectare, basal area, the average diameter of breast height, litter depth and the height of vegetation. This first component was also negatively related with the density of trees and dead trees per hectare. The second component explained 17.7% of the variation and was associated with positive values for the number of lianas per hectare and negative values for the number of dead trees per hectare and the number of palm trees per hectare (Table 1). Finally, the third component explained 13.6% of the variation and had positive loadings for average vegetation height and negative for vegetation obstruction (Table 1).

We recorded 117 forest species of 32 families in the landscape, of which 100 were recorded in Matapi and 98 in Curuá-Pedreira (Supplemental Table S1). The estimated species richness is higher in Matapi than Curiaú-Pedreira (Fig. 3). We found that 50 species are restricted to or can be considered as indicators of one watershed. Of these species 29 are associated with Matapi and 21 with Curuá-Pedreira. Species restricted to one watershed were 36, 19 in Matapi and 17 in Curiaú-Pedreira (Supplemental Table S1). Indicator species were 14, 10 in Matapi and four with Curiaú-Pedreira (Table 2).

Watershed preference and habitat use are associated (Chi-Square = 6.7, df = 2, P = 0.003); Matapi has more and Curiaú-Pedreira fewer interior species than the expected (Fisher exact test, P = 0.041). Similarly, watershed preference and forest dependence are also associated (Chi-Square = 8.2, df = 1, P = 0.004), with Matapi having more and Curiaú-Pedreira fewer dependent species than the expected (Fisher exact test, P = 0.002). On the other hand, Curiaú-Pedreira has more and Matapi has fewer semi-dependent species than the expected (Post hoc exact Fisher test, P = 0.002). Finally, there is a significant association between watershed preference and trophic group (Chi-Square = 7.8, df = 3, P = 0.04). In it, Curiaú-Pedreira has more and Matapi has fewer carnivore species than the expected (Fisher exact test, P = 0.002).

Local range size and ecological traits. The Poisson regression model was significant (Wald Chi-Square = 99.7, $P < 0.000$), indicating that all of the estimated coefficients were different from zero (Table 4). However, the pseudo-R^2 is low (9%) suggesting a limited fit between the actual data and the model. Trophic group was the only significant predictor (Table 4). We found that carnivores had smaller ranges than herbivores (Table 4), omnivores (Chi-Square = 52.3, $P < 0.000$) and insectivores (Chi-Square = 59.4, $P < 0.000$).

DISCUSSION

We presented the first study documenting the patterns of distribution of forest birds in a landscape dominated by tropical savannas. We found that gallery forests associated with different watersheds have similar vegetation structure but distinct bird assemblages. Moreover, we documented that the trophic group is the only significant predictor of a species' local range size. Altogether, these findings provide a more nuanced perspective on the distribution of forest birds in tropical savanna landscapes.

The gallery forests of the two watersheds are connected to different types of forests, but they do not differ in structure. This finding does not support our original hypotheses and therefore requires an explanation. The presence of vertebrate seed dispersers in both continuous and gallery forests (Piña et al. 2019) and existence of upstream and downstream dispersion of seeds by river flow (Cunha et al., 2017) indicates that there is a permanent flow of propagules of different groups of plant species from the continuous forests to the gallery forests. However, there is evidence demonstrating that the establishment of a plant species in a riverine area is constrained by factors such as soil type and depth of the water table (Costa et al. 2009; Schietti et al. 2014; Toledo et al. 2017). If these factors are strong and homogeneous enough, then the structure of the vegetation will converge to a similar state regardless of floristic composition. We predict that structural convergence is pervasive among tropical gallery forests because they are linear, narrow, occur a restricted number of soil types, and are usually subject to waterlogging (Ribeiro and Walter 2001).

The forest bird assemblages of the two watersheds were distinctive even though their habitat did not differ in structure. We suggest that such differences is a consequence of the connections that the gallery forests of each watershed have with the adjacent forests. As predicted, Matapi forests had more species than Curuá-Pedreira forests and that each watershed has a unique set of species. In addition, we found that the sets of species that distinguish the watersheds present different ecological characteristics. The species associated with Matapi are more forest dependent and live in the interior of the forests, but the species associated with Curiaú-Pedreira are more flexible with their habitat requirements. This pattern fits well with the notion that bird species living in seasonally flooded forests are better dispersers and tolerate more habitat changes than birds living in upland forests (Remsen and Parker 1983; Rosenberg 1990).

We found that ecological attributes are not good predictors of the range size of a forest species within a savanna landscape. Against our expectations, we did not find that large birds have large local ranges (Gaston and Blackburn 1996). Moreover, we did not find that birds with large extents of occurrence had large local ranges (Gaston 2003). Finally, we did not find any evidence that generalist species have larger local ranges than specialist species (Devictor et al. 2008). We predicted that omnivores would have larger ranges than the other trophic groups, but our results did not support such a prediction. We did find that the four species of carnivores had smaller local ranges than all other trophic groups. Silva (1996) found that two ecological traits (habitat use and diet) did not influence the ranges of birds living in the gallery forest of the Cerrado. In general, ecological traits are not reliable predictors of the success of a species living in continuous forests galleries at colonizing gallery forests.

In summary, our results show that forest bird species are not homogeneously distributed throughout savanna landscapes. In fact, 42.7% of the forest species that we recorded in our study area showed some type of habitat preference. This distribution pattern at the landscape level resembles the pattern reported by Silva (1996) at the regional level to the Cerrado. We suggest that this common pattern is caused by dispersal and ecological filtering. Thus, species from a large and continuous forest area are always dispersing to savanna landscapes and regions by tracking the expansion of gallery forests due to fluvial erosion (Cole 1986). However, the success of a species in establishing viable populations in gallery forests is determined by the environmental factors operating in the savanna landscape or region during the colonization event. Because species respond to environmental factors in different ways (Peterson et al. 2011), the combination of these environmental factors (filters) are possibly species-specific. In addition, because the factors causing environmental variation at the landscape level are different from the factors operating at the regional level, then filters are also scale-dependent (Forman 1995). If this general model is valid, then we predict that all bird assemblages of tropical gallery forests present a large heterogeneity at both the landscape and the regional levels.

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5. APÊNDICE

5.1. Tables with captions

Table 1. Component loadings of the principal components (PC) of ten variables measuring the vegetation structure of the gallery forests of Matapi and Curiaú-Pedreira watersheds, Amapá, Brazil.

Variables	PC 1	PC 2	PC 3
Mean diameter at the breast height	0.946	-0.096	0.078
Basal area	0.808	-0.232	-0.165
Density of trees	-0.827	-0.039	-0.035
Average vegetation height	0.666	0.306	0.392
Average litter depth	0.704	0.301	0.252
Number of lianas per hectare	-0.205	0.730	0.034
Vegetation obstruction	0.070	0.470	-0.797
canopy cover	0.228	-0.274	-0.626
Number of palms per hectare	0.374	-0.704	-0.103
Number of dead trees per hectare	-0.606	-0.452	0.270

Table 2. Bird indicator species for the gallery forests of two watersheds (Matapi and Curiaú-Pedreira) in an upland savanna in Amapá, Brazil.

Watershed	Species	Permutation test	P
Matapi	*Phaethornis ruber*	0.72	0.02
	Trogon viridis	0.71	0.00
	Cyclarhis gujanensis	0.70	0.02
	Ramphocelus carbo	0.64	0.03
	Cercomacroides tyrannina	0.62	0.00
	Tolmomyias poliocephalus	0.61	0.00
	Myrmeciza longipes	0.48	0.02
	Myiopagis flavivertex	0.44	0.02
	Rhytipterna simplex	0.42	0.03
	Todirostrum pictum	0.42	0.02
Curiaú+Pedreira	*Tolmomyias flaviventris*	0.73	0.02
	Thamnophilus punctatus	0.71	0.00
	Pachyramphus polychopterus	0.51	0.04
	Orthopsittaca manilatus	0.49	0.03

Table 3. Poisson regression model assessing the influence of body mass, extent of occurrence, trophic level, forest use, and forest dependence on the local range size of bird species in gallery forests of an upland tropical savanna, Amapá, Brazil.

	Coefficient	Robust Standard Error	Z	*P*
Intercept	2.66	0.32	8.17	0.000
Body Mass (g)	-0.0006	0.0006	-1.24	0.304
Extent of occurrence (km^2)	0.00	0.00	1.24	0.216
Trophic Level[1]				
Omnivorous	0.25	0.26	0.98	0.329
Insectivores	-0.17	0.27	-0.64	0.522
Vertebrates	-2.24	0.33	-6.88	0.000
Forest Use[2]				
Canopy	-0.19	0.26	-0.72	0.472
Edge	-0.17	0.35	0.50	0.614
Forest Dependence[3]				
Dependent	0.14	0.21	0.63	0.526

1. Compared to primary consumers
2. Compared to forest interior
3. Compared to semi-dependent

5.2. Figure captions

Fig. 1. Study area in Amapá, Brazil, with vegetation types and the distribution of transects across watersheds.

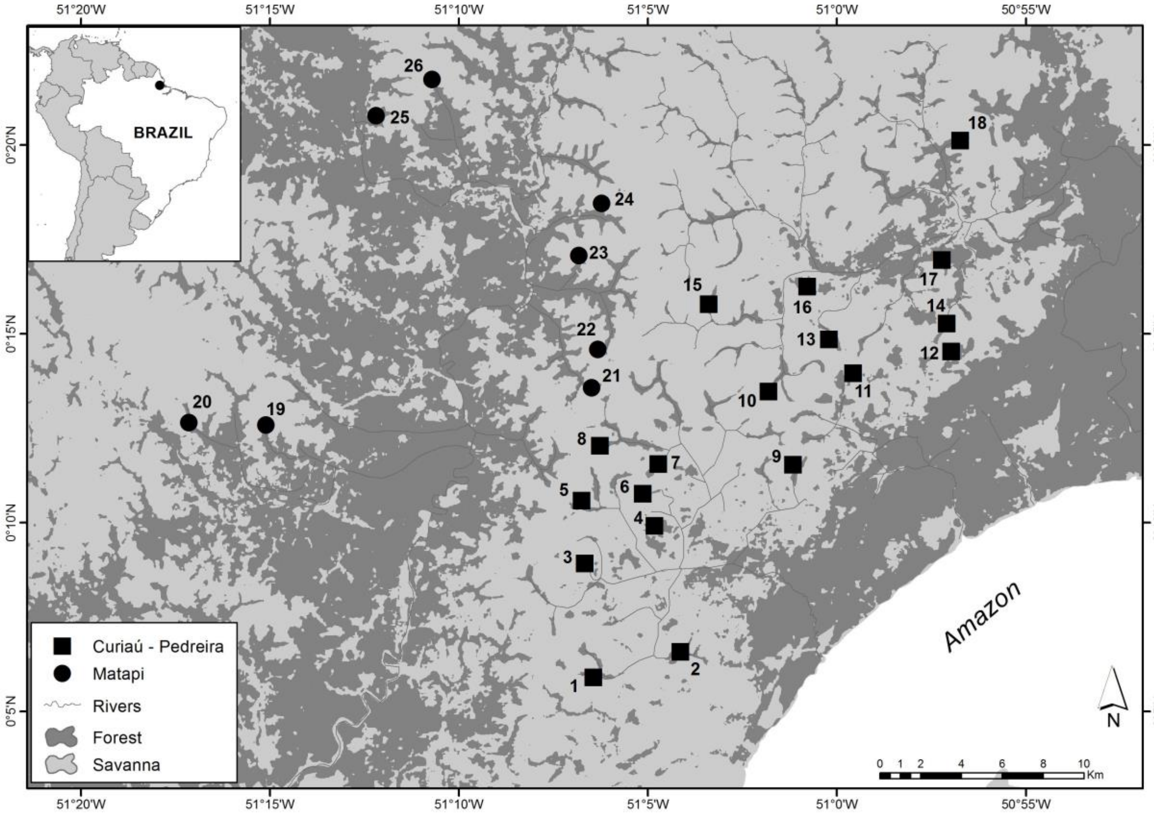


Fig. 2. Comparison of the vegetation structure of the gallery forests in two watersheds in Amapá, Brazil by using the three first principal components that summarize ten different measurements.

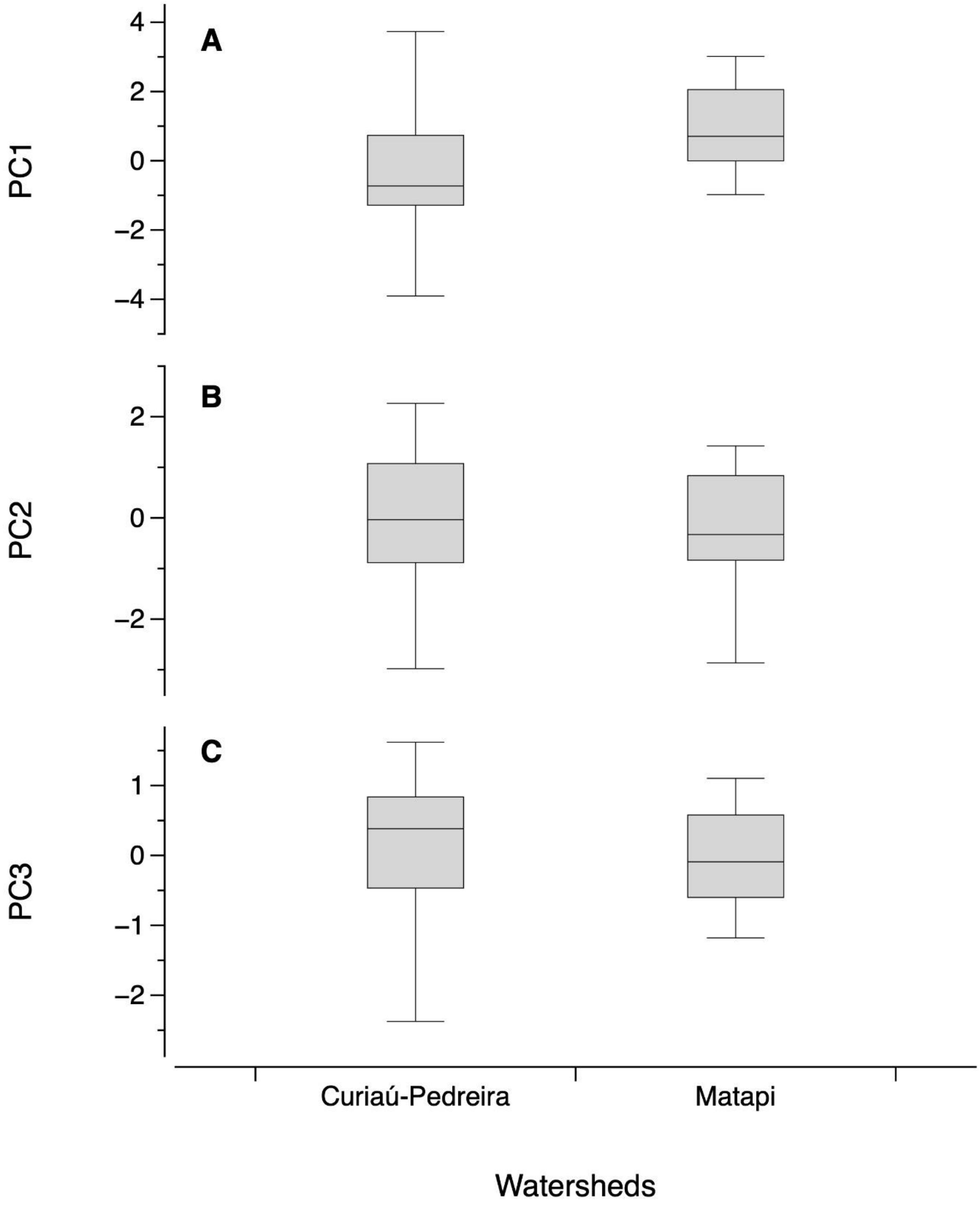
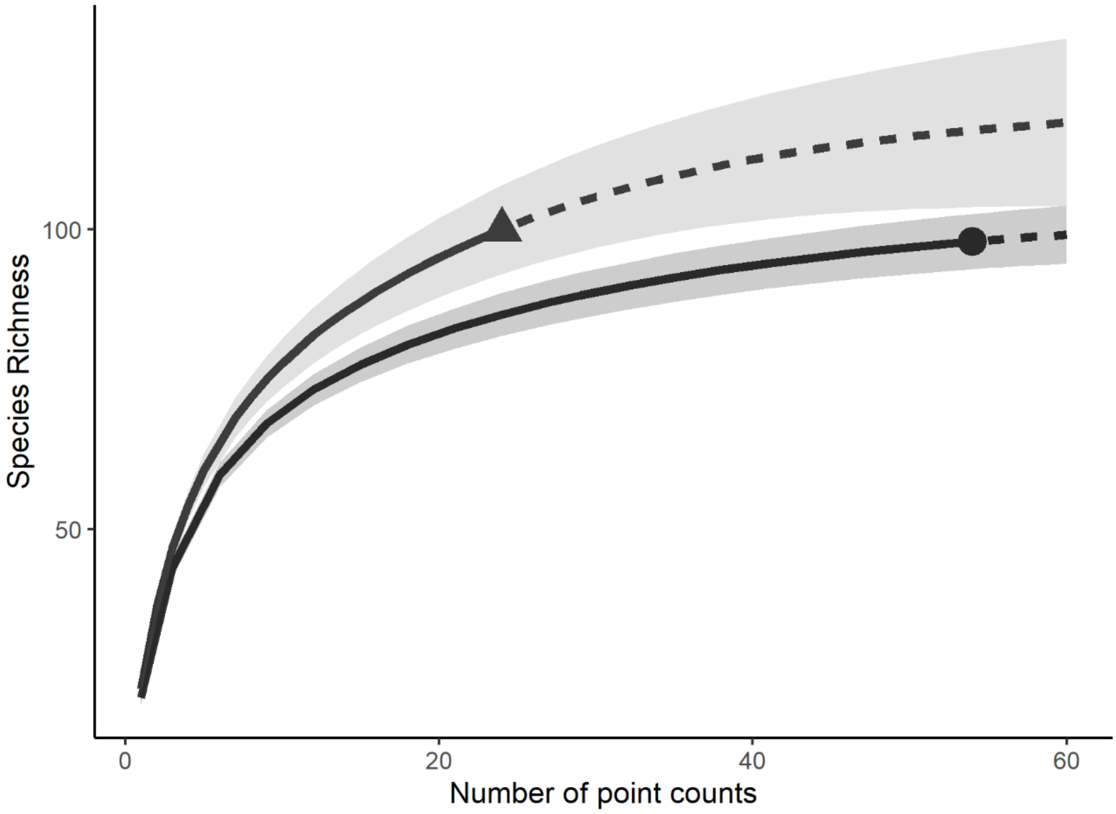


Fig. 3. Species accumulation curves (with 95% confidence interval) for forest bird species recorded in the gallery forests of the Matapi (triangle) and Curiaú-Pedreira (circle) watersheds, Amapá, Brazil.



5.3. Supplementary Material

Table S1 Abundance and life-traits (body mass, diet, extent of occurrence, forest use, and forest dependence) of bird species recorded in the gallery forests of two watersheds (Matapi and Curiaú-Pedreira) in an upland savanna in Amapá, Brazil. Trophic level (H = herbivores, fruits and seeds; O = omnivores; I = insectivores; C = carnivores), habitat use (I = interior; C = canopy; E = edge), forest dependence (D = dependent, SD = semi-dependent).

Táxon	Abundance		Body Mass (g)	Trophic level	Habitat Use	Forest Dependence	Extent of Occurrence (km^2)
	Matapi	Curiaú-Pedreira					
Tinamidae							
Tinamus major	1	0	1112	H	I	D	11,300,000
Crypturellus soui	5	17	206	H	I	D	15,200,000
Crypturellus erythropus	2	3	350	H	I	D	2,750,000
Cracidae							
Ortalis motmot	8	21	502	H	E	D	2,630,000
Accipitridae							
Spizaetus tyrannus	0	1	1005	C	C	D	17,500,000
Columbidae							
Patagioenas speciosa	2	5	261	H	C	D	16,900,000

Patagioenas cayennensis	7	23	260	H	C	SD	18,700,000
Leptotila verreauxi	4	4	154	H	I	SD	26,000,000
Leptotila rufaxilla	7	23	153	H	I	D	14,300,000
Cuculidae							
Coccycua minuta	2	3	30	I	I	D	10,200,000
Piaya cayana	6	15	118	I	C	SD	16,100,000
Trochilidae							
Phaethornis ruber	21	33	2.2	H	I	D	11,300,000
Chlorestes notata	2	4	3.8	H	C	D	10,800,000
Amazilia fimbriata	3	5	4.3	H	C	SD	12,700,000
Trogonidae							
Trogon viridis	18	20	84	O	I	D	11,800,000
Trogon violaceus	1	1	47	O	I	D	12,100,000
Alcedinidae							
Chloroceryle aenea	0	3	14	C	I	SD	14,200,000
Chloroceryle inda	0	1	52	C	I	SD	13,000,000
Momotidae							
Momotus momota	2	7	122	I	I	D	11,300,000
Galbuliformes							
Galbulidae							
Galbula galbula	7	17	29	I	I	D	2,200,000
Bucconidae							
Notharchus tectus	0	2	32	I	C	D	6,720,000
Bucco tamatia	1	9	29	I	I	D	6,240,000

Ramphastidae							
Ramphastos tucanus	14	29	607	H	C	D	3,240,000
Ramphastos vitellinus	1	2	370	H	C	D	2,100,000
Pteroglossus aracari	2	1	280	H	C	D	6,980,000
Picidae							
Picumnus cirratus	0	2	10	I	I	SD	7,630,000
Veniliornis passerinus	0	2	30	I	I	SD	13,200,000
Celeus flavus	2	2	201	O	C	D	10,300,000
Dryocopus lineatus	4	8	205	I	C	SD	21,300,000
Campephilus rubricollis	2	0	231	O	C	D	7,810,000
Campephilus melanoleucos	3	7	220	O	C	D	13,300,000
Falconidae							
Herpetotheres cachinnans	0	2	650	C	3	SD	20,400,000
Psittacidae							
Ara ararauna	0	2	1125	H	C	SD	10,300,000
Ara macao	0	4	1025	H	C	D	10,200,000
Ara severus	1	9	430	H	C	D	8,540,000
Orthopsittaca manilatus	1	15	370	H	C	SD	8,860,000
Psittacara leucophthalmus	4	11	190	H	C	SD	13,200,000
Pyrrhura picta	2	0	67	H	C	D	1,560,000
Brotogeris versicolurus	8	14	60	H	C	SD	2,730,000
Brotogeris sanctithomae	0	1	64	H	C	D	3,870,000
Graydidascalus brachyurus	0	2	400	H	C	D	3,870,000
Amazona amazonica	5	16	460	H	C	D	12,300,000
Amazona ochrocephala	3	14	510	H	C	SD	8,000,000

Thamnophilidae							
Myrmophylax atrothorax	1	1	8	I	I	D	7,150,000
Myrmotherula axillaris	5	10	8	I	I	D	10,400,000
Formicivora grisea	0	12	11	I	I	SD	8,830,000
Herpsilochmus sticturus	3	0	10	I	C	D	786,000
Thamnophilus doliatus	1	7	28	I	E	SD	18,300,000
Thamnophilus punctatus	7	38	19	I	I	D	3,830,000
Taraba major	1	2	60	I	E	SD	18,300,000
Myrmoderus ferrugineus	1	0	25	I	I	D	1,700,000
Sclateria naevia	7	7	22	I	I	D	6,920,000
Myrmeciza longipes	7	4	22	I	I	D	3,190,000
Percnostola rufifrons	13	0	29	I	I	D	2,220,000
Cercomacroides tyrannina	12	8	18	I	I	D	7,000,000
Dendrocolaptidae							
Dendrocincla fuliginosa	9	16	37	I	I	D	12,300,000
Glyphorynchus spirurus	5	9	14	I	I	D	13,500,000
Xiphorhynchus guttatus	12	29	65	I	C	D	5,980,000
Xiphorhynchus obsoletus	1	0	39	I	I	D	7,100,000
Dendroplex picus	6	25	41	I	I	SD	12,500,000
Lepidocolaptes albolineatus	1	0	27	I	C	D	1,780,000
Nasica longirostris	1	0	92	I	E	D	6,830,000
Dendrexetastes rufigula	1	0	70	I	I	D	6,340,000
Dendrocolaptes certhia	1	0	67	I	I	D	8,970,000
Dendrocolaptes picumnus	1	0	79	I	I	D	12,000,000
Xenopidae							

Xenops minutus	0	1	12	I	C	D	1,650,000
Furnariidae							
Berlepschia rikeri	1	3	30	I	E	D	7,070,000
Pipridae							
Pipra aureola	14	28	15	H	I	D	2,340,000
Manacus manacus	2	0	12	H	I	D	13,300,000
Chiroxiphia pareola	7	18	19	H	I	D	10,900,000
Tityridae							
Tityra semifasciata	2	5	88	O	E	D	16,200,000
Pachyramphus polychopterus	1	16	20	I	E	SD	18,200,000
Cotingidae							
Querula purpurata	1	0	125	H	C	D	8,790,000
Rhynchocyclidae							
Tolmomyias poliocephalus	11	6	11	I	C	D	10,000,000
Tolmomyias flaviventris	14	48	14	I	C	D	10,200,000
Todirostrum maculatum	0	1	7	I	C	SD	6,600,000
Todirostrum cinereum	2	3	7	I	C	SD	17,600,000
Todirostrum pictum	5	2	7	I	C	D	1,850,000
Lophotriccus galeatus	14	43	10	I	E	D	4,780,000
Tyrannidae							
Elaenia flavogaster	7	20	20	O	C	SD	19,400,000
Myiopagis gaimardii	13	34	12	I	I	D	12,100,000

Myiopagis flavivertex	5	1	11	I	C	SD	4,590,000
Tyrannulus elatus	1	14	7	O	C	SD	8,700,000
Attila cinnamomeus	5	16	33	I	I	SD	6,400,000
Attila spadiceus	1	1	35	O	I	D	18,100,000
Legatus leucophaius	1	10	24	I	C	SD	18,600,000
Myiarchus ferox	4	2	24	I	E	SD	13,600,000
Myiarchus tyrannulus	6	14	26	I	E	SD	26,400,000
Rhytipterna simplex	5	2	33	I	I	D	11,300,000
Tyrannopsis sulphurea	2	6	30	O	C	D	7,510,000
Megarynchus pitangua	7	15	60	O	C	SD	20,500,000
Myiozetetes cayanensis	5	16	42	O	C	D	11,500,000
Empidonomus varius	0	1	27	I	C	SD	12,900,000
Vireonidae							
Cyclarhis gujanensis	20	32	28	O	C	SD	21,700,000
Hylophilus pectoralis	0	13	11	I	E	D	7,790,000
Vireo chivi	15	25	15	I	C	D	17,300,000
Troglodytidae							
Pheugopedius coraya	3	0	17	I	I	D	5,900,000
Cantorchilus leucotis	10	20	16	I	I	D	11,200,000
Polioptilidae							
Polioptila plumbea	10	25	6	I	C	SD	15,800,000
Turdidae							
Turdus leucomelas	21	46	67	O	I	SD	13,800,000
Turdus nudigenis	0	3	65	O	C	SD	4,300,000

Passerellidae							
Arremon taciturnus	1	0	28	H	I	D	9,910,000
Icteridae							
Psarocolius viridis	4	6	300	O	C	D	6,170,000
Cacicus cela	7	15	85	O	E	D	11,200,000
Icterus cayanensis	2	0	42	O	C	SD	5,320,000
Thraupidae							
Tangara mexicana	6	6	19	O	C	D	7,710,000
Tangara episcopus	11	26	35	O	C	SD	13,100,000
Tangara palmarum	17	35	39	O	C	SD	15,600,000
Nemosia pileata	2	3	14	O	C	D	13,800,000
Conirostrum speciosum	1	0	9	O	C	D	13,200,000
Hemithraupis guira	1	0	10	O	C	D	14,300,000
Ramphocelus carbo	16	22	24	O	E	SD	11,500,000
Cyanerpes cyaneus	1	1	14	H	C	D	16,300,000
Dacnis cayana	4	9	13	O	C	SD	15,700,000
Coereba flaveola	14	23	9	O	C	SD	22,400,000
Fringillidae							
Euphonia chlorotica	5	5	8	H	C	SD	15,100,000
Euphonia violacea	6	10	14	H	C	D	9,350,000

6. CONCLUSÕES

Nossos resultados sugerem que no geral as florestas de galerias das drenagens de Matapi e Curiaú-Pedreira não diferem estruturalmente apesar de serem influenciadas por tipos diferentes de florestas adjacentes. Quanto às aves florestais, nossos dados mostram que as florestas de galeria das duas drenagens não são iguais em número de espécies e que a distribuição de espécies não apresenta um padrão de distribuição homogêneo, pois mais de 40% das espécies apresentam preferências por algum tipo de habitat. As espécies restritas às florestas de galeria do Matapi vivem principalmente no interior das matas e são dependentes florestais. Por outro lado, as espécies restritas as florestas de galeria do Curiaú-Pedreira são semi-dependentes e menos especializadas. De modo geral, as características ecológicas das espécies não são boas preditoras para determinar o tamanho das distribuições das espécies de florestas em regiões de savana.

7. ANEXOS

Journal of
Field Ornithology

Distribution of forest birds in a tropical savanna landscape

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