

## Occupancy of different types of forest habitats by tyrant flycatchers (Passeriformes: Tyrannidae)

Gabriel Lima Medina Rosa<sup>1,4</sup>, Luiz dos Anjos<sup>2</sup> & Maurício Osvaldo Moura<sup>3</sup>

<sup>1</sup>Programa de Pós-graduação em Ciências Biológicas, Departamento de Biologia Animal e Vegetal – BAV, Universidade Estadual de Londrina – UEL, Rod. Celso Garcia Cid, PR 445 Km 480, Campus Universitário, CP 6001, CEP 86051-970, Londrina, PR, Brasil. [www.uel.br](http://www.uel.br)

<sup>2</sup>Departamento de Biologia Animal e Vegetal – BAV, Universidade Estadual de Londrina – UEL, Rod. Celso Garcia Cid, PR 445 Km 480, Campus Universitário, CP 6001, CEP 86051-970, Londrina, PR, Brasil. [www.uel.br](http://www.uel.br)

<sup>3</sup>Departamento de Zoologia, Centro Politécnico, Universidade Federal do Paraná – UFPR, CP 1920, CEP 81531-980, Curitiba, PR, Brasil. [www.ufpr.br](http://www.ufpr.br)

<sup>4</sup>Corresponding author: Gabriel Lima Medina Rosa, e-mail: [g\\_rosa\\_bio@hotmail.com](mailto:g_rosa_bio@hotmail.com)

ROSA, G.L.M., ANJOS, L. & MOURA, M.O. **Occupancy of different types of forest habitats by tyrant flycatchers (Passeriformes: Tyrannidae)**. *Biota Neotrop.* 13(4): <http://www.biotaneotropica.org.br/v13n4/en/abstract?article+bn03513042013>

**Abstract:** The abundance distribution of the tyrant flycatchers (Tyrannidae family) was evaluated in three main forest habitats of Mata dos Godoy State Park (PEMG), north of the state of Paraná. We conducted point counts and from the collected data we calculated the Index of Point Abundance (I. P. A.) of each species in the habitats of interior of mature forest (FLI), slope forest (FLE) and reforestation (REF). Among the 22 recorded species, eight occurred in all habitats, while other eight occurred in two habitats and six were exclusive of one habitat. Among the 16 recorded species in more than one habitat, 10 were more abundant in only one. On the contrary to our expectation and despite the clear habitat segregation among species, the abundance distribution was not significantly influenced by the foraging strategies. Maybe, phylogenetic relationships could better explain the found pattern. Some partially frugivorous species were present in REF and FLI. Those species could be considered as potential ecological restoration agents and thus to promote seed dispersal among habitats. Indeed, the greater similarity of tyrant flycatchers abundance distribution in FLI and REF indicates that these two habitats could be part of the same gradient. FLE, however, can be considered a separated habitat by its abundance of bamboo clusters and the six tyrant flycatcher species which are commonly associated with this vegetation type.

**Keywords:** *habitat, foraging, abundance, distribution, frugivory.*

ROSA, G.L.M., ANJOS, L. & MOURA, M.O. **Ocupação de diferentes tipos de habitat florestal por tiranídeos (Passeriformes: Tyrannidae)**. *Biota Neotrop.* 13(4): <http://www.biotaneotropica.org.br/v13n4/pt/abstract?article+bn03513042013>

**Resumo:** Nós avaliamos a distribuição da abundância de papa-moscas (família Tyrannidae) nos três principais habitats florestais do Parque Estadual Mata dos Godoy (PEMG), norte do Paraná. Conduzimos amostragens por pontos de escuta e, por meio dos dados coletados, foi calculado o Índice Pontual de Abundância (I. P. A.) de cada espécie nos habitats de interior de floresta madura (FLI), floresta de encosta (FLE) e reflorestamento (REF). Das 22 espécies registradas, oito ocorreram em todos os habitats, 8 ocorreram apenas dois e seis foram exclusivas de apenas um habitat. Das 16 espécies registradas em mais de um habitat, 10 foram mais abundantes em apenas um. Ao contrário do esperado e apesar da clara segregação de espécies entre habitats, a distribuição da abundância não foi influenciada significativamente pelas estratégias de forrageamento. Algumas espécies são parcialmente frugívoras e foram registradas em FLI e REF, podendo ser consideradas como potenciais agentes de restauração ecológica promovendo a dispersão de sementes entre habitats. A maior similaridade entre a abundância das espécies de tiranídeos em FLI e REF indica que estes habitats podem fazer parte do mesmo gradiente. FLE, em contrapartida, pode ser considerado um habitat distinto pela marcante presença de agregados de bambu e as seis espécies de tiranídeos comumente associados a este tipo de vegetação.

**Palavras-chave:** *habitat, forrageamento, abundância, distribuição, frugivoria.*

## Introduction

Tyrannidae, which is about 430 species, is commonly the family with the highest local richness in several Neotropical ecosystems (Sick 1997, Fitzpatrick et al. 2004). Although some species include fruits in their diet, the Tyrannidae family is primarily insectivorous with an impressive evolutive radiation in foraging strategies. Those foraging strategies are frequently associated with morphological modifications, which increase the efficiency in arthropod capture. Patterns of foraging strategies and morphological adaptations have been the subject of classical studies, as Fitzpatrick (1980, 1985) and Fitzpatrick et al. (2004). The habitat occupancy of Tyrannidae species, known as tyrant flycatchers, should be closely related to the foraging strategy, since efficiency capturing arthropods varies according to phytophysionomy, as for example the density of the foliage (Fitzpatrick 1980). Therefore, forest areas with variations in their phytophysionomy would select different foraging strategies, which could drive to particular flycatchers' assemblies.

In the present study it was evaluated similarities in flycatcher assemblies in different forest habitats that occur in a Reserve in the north of the state of Paraná, Mata dos Godoy State Park (PEMG). Birds were previously study in that Reserve, which allowed to distinguish two basic types of forest (see Anjos et al. 2007): a riparian forest strongly influenced by sloped terrain, called slope forest (FLE) in this study, and an upland forest, called interior of mature forest (FLI) in this study. FLI is dominated by typical semi-deciduous forest, a type of Atlantic Forest covering that extends from southern and southeastern Brazil to northeastern Argentina. In addition, it was included a 30 years restored (REF) area, as a third habitat, adjacent to that Reserve. We argue that the flycatchers occupy differently those forest areas.

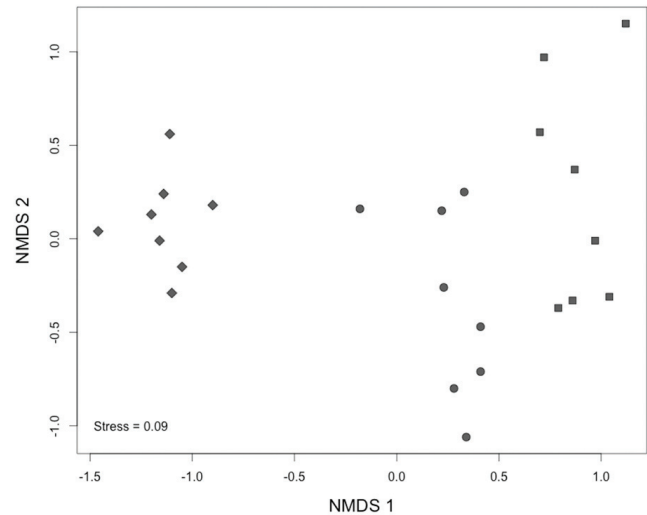
One important aspect of the tyrant flycatchers diet, which is mainly composed by arthropods, is the addition of fruit items by some species that, consequently, act as seed dispersal agents (Howe & De Steven 1979, Fitzpatrick et al. 2004, Brum et al. 2012). In PEMG, some species might be acting as restoration agents when occupying both habitats, the mature forest and the restoration area. We expect to identify which species are potentially restoration agents among tyrant flycatchers.

Therefore, in this study we investigated the habitat occupancy of 22 tyrant flycatcher species that were previously recorded in PEMG (Anjos 2006). We foresee that tyrant flycatchers have different occupancy tendencies in the forest areas of the PEMG, and these tendencies are strongly associated with the foraging strategies used by each species. We also hope to evaluate in particular the occupancy of the frugivorous flycatchers in the restored area due to their potential importance in seed dispersal.

## Material and Methods

### 1. Study Area

Mata dos Godoy State Park (PEMG), 23° 27' S and 51° 15' W, with 656 ha, (Figure 1), is mostly covered by seasonal semi-deciduous forest, forest ecosystem that belongs to the Atlantic Forest Biome (Ribeiro et al. 2009). Beyond the high biotic integrity, there are also corridors that link this Reserve to other well-conserved forest fragments, totalizing near 2,000 ha of continuous forest (Silveira 2006, Anjos et al. 2009). The birds in this Reserve have been studied for several years (Anjos et al. 1997, 2007, Anjos 2001, 2006, 2007). Two original types of habitats have been differentiated at PEMG: one at the north portion, called "plateau", considered as interior of mature forest (FLI) in this study, and another in the southern



**Figure 1.** Map of detailed Mata dos Godoy State Park (PEMG) sampling points in the areas: interior of mature forest (FLI), slope forest (FLE) and reforestation (REF). The reforestation limits are represented as a smooth line (northeastern portion of PEMG) and the other habitats by the thick line.

portion, called "slope area", named slope forest (FLE) in this study. Bird communities have shown to be different among those habitat types (Anjos et al. 2007, Santana & Anjos 2010).

So, in the present study we evaluated the occupancy of tyrant flycatchers in three habitat types: interior of mature forest (FLI), a slope forest (FLE) and a reforestation (REF). FLI is an older growth vegetation area, 200 m apart from the continuous forest edge. Thereby, FLI is not supposed to show border effect, considering recent evaluations from Laurance & Vansconcelos (2009), which consider 200 m as the limit to the edge effect in birds. In FLI the lower growth vegetation is relatively scarce in relation to the medium and high growth vegetations (Figure 1). The dominant species, constituting a dense higher growth vegetation in FLI are *Aspidosperma polyneuron* Müll.Arg. (Apocynaceae), *Euterpe edulis* Martius (Arecaceae), *Croton floribundus* Spreng. (Euphorbiaceae), *Trichilia claussenii* C.DC. (Maliaceae), *Sloanea monosperma* Vell. (Elaeocarpaceae), *Cabralea canjerana* (Vell) Mart. (Meliaceae), and *Ficus glabra* Vell. (Moraceae). Because of the low light incidence in the medium growth and still lower in understory, both strata are sparser, composed mainly by bushes and small trees, as *Eugenia verrucosa* D. Legrand (Myrtaceae) and *Sorocea bonplandii* (Baill.) W.C. Burger, Lanjouw & Boer (Moraceae) (Soares-Silva & Barroso 1992, Bianchini et al. 2001, Silveira 2006). For quantitative data see Appendix A.

As FLI, the habitat type FLE is more than 200 m far from the continuous forest edges, dominating the southern portion of PEMG, along the Ribeirão dos Apertados course. In FLE the slope terrain (20-40°) provides certain features that lead Santana & Anjos (2010) to classify it as a slope forest. This slope turns impossible to most of the higher growth vegetation of FLI to colonize it successfully, turning common the clearing formation by tree falls. Tree species that successfully colonize this slope area are *Chrysophyllum gonocarpum* (Mart.; Eichler) (Sapotaceae) and *Campomanesia xanthocarpa* Berg (Myrtaceae). In the low and medium growth vegetation, the dominant species are *Parapiptadenia rigida* (Benth.) (Fabaceae), *Nectandra megapotamica* (Spreng.) Mez (Lauraceae), *Lonchocarpus muehlbergianus* Hassl. (Fabaceae) e *Cabralea canjerana* (Vell) Mart. (Meliaceae). Areas, where clearings are formed, have a fostering on the development of bamboo clusters, *Chusquea* sp. (Poaceae), and

the herbaceous *Celtis iguanaea* (Jacq.) Sarg. (Ulmaceae) (Silveira 1993, Bianchini et al. 2001). For quantitative data see Appendix A.

The reforestation (REF), with about 21 ha in area, was made only with native species. REF is dominated by medium growth species equally distant from one another as a consequence of the standardized planting (Figure 1). Despite the lack of quantitative data on density, coverage and dominance, it is known that it is happening a slow colonization process by the native species *Croton floribundus* Spreng. (Euphorbiaceae), *Tabernaemontana catharinensis* DC. (Apocynaceae), *Alchornea triplinervea* (Spreng.) Müll. Arg. (Euphorbiaceae), *Parapiptadenia rigida* (Benth.) Brenan (Fabaceae) and *Cedrela fissilis* Vell. (Meliaceae) (Silveira 2006). However, the understory vegetation is still dominated by Grass, probably because of direct sunlight penetration to the level of the understory during the dry season, which slows down the colonization process by typical plant species from FLI (Silveira 2006).

## 2. Sampling Methods

Point counts (Blondel et al. 1970, Bibby et al. 1992) were performed in all the habitat types. In order to apply the point count method, we plotted ten points separated by 100 m along trails. The counts were made by visual aid such as 8×50 binoculars and auditory contacts aid as a digital sound recorder. We called a “sampled habitat” the set of all ten points sampled along a trail. In total, three sites were sampled. Although point counts do not consider differences in detectability or allow calculating actual densities for each species, we believe they are useful as an index to detect significant differences in abundance among populations within species, as well as among different forest types and thus those data provide relevant information to our hypotheses (Bibby et al. 1992). Considering that previous studies showed that four days performing point counts are enough to detect more than 90% of the known local bird species richness (Anjos 2007), we performed 10 days per sampled habitat. The point counts were performed in 10 mornings, equally distributed among the dry and humid seasons. Points along the trails were sampled randomizing the first point at each morning. The samples were made in the early morning when vocal activities of diurnal birds begin. We sampled for five minutes at each point, with 15 minutes standardized interval to move between points. Earlier studies, which applied point counts or evaluated microhabitats of birds in the PEMG (e.g. Anjos 2001, 2007, Poletto et al. 2004), indicate that most species only can be heard up to 40-50 m from the observer and some species were detected up to 70-80 m. However, the radius for detection at each point was estimated to be 30 m to improve visual species detection and identification. Moreover, in a single sampling point, it was counted as one contact each pair or flock. Precaution was taken to avoid counting the same pair or group more than once, particularly for highly mobile species. The point counts were performed by one observer with previous knowledge of the avifauna in the sampled area.

## 3. Data analysis procedures and Additional Comments.

Tello et al. (2009) suggested modifications in the Parvorder Tyrannida Wetmore & Miller, 1926. Among these changes, it is the allocation of some species belonging to the family Tyrannidae Vigors, 1825 in the family Rhynchocyclidae Berlepsch, 1907. However, in the present study we considered the American Ornithologists Union (AOU; Remsen Junior et al. 2013). The tyrant flycatchers foraging strategies was described and studied by Fitzpatrick (1980, 1985). According to the habitat characteristics, where each foraging strategy described by Fitzpatrick (1980, 1985) are more likely to succeed, the species studied could be grouped in three main classes. The first species group catches its prey in or near to the ground (ground foragers) or branches or leaves as they walk or climb in the foraging

strata (perch-gleaners); there are several morphological features of different species that allow them to use this foraging technique e.g. short wings, long tarsus and a narrow bill. The second species group uses upward strikes, without hovering or chasing its prey. There are particular adaptations of these species that use this technique, such as wide bills surrounded by bristles, short tail and round shaped wings. Finally, the third species group catches its prey during the flight (aerial-hawkers, aerial-salliers and hover-gleaners); with long wings, short and wide bills which are morphological features of species that uses this technique. All recorded species could be associated with at least one of those groups. But, in some cases, different species could frequently use more than one strategy, being associated to two or even all groups, in the case of generalists.

The field data allowed us to calculate Index of Point Abundance (I.P.A.) for each species. I.P.A. was calculated according to the expression:  $I.P.A. = Nci/Nta$ . In which *Nci* is the number of contacts with the species and *Nta* is the total number of the sampling points. The Significance of the I.P.A. values for each species in different habitats was evaluated using G test (Fowler & Cohen 1995). Because of the values of I.P.A. which are frequently below zero, we multiplied them by 100 and considered  $\alpha=0.01$ , as recommended by Aleixo (2001).

The relationship between the assembly composition and the sample habitats was individualized in a reduced space composed by two first axis in a non-metric multidimensional scaling analysis (NMDS). The NMDS was constructed with a matrix of dissimilarity among the sample areas based on a Bray-Curtis Index (Legendre & Legendre 1998).

To answer if there are differences in assembly compositions as function of the sample areas (REF, FLI e FLEN) it was used a two-factor similarity analysis (ANOSIM, Clarke 1993, Legendre & Legendre 1998). The ANOSIM tests if the dissimilarities in the assembly composition are larger between groups than inside the groups (Clarke 1993). The ANOSIM values, quantified by the R index, varies between -1 a +1, being close to zero when there is an indication of effect absence (Clarke 1993). The associated probability is generated by resample (Clarke 1993). To access the relative contribution of each species to the assembly composition was used a percent similarity analysis (SIMPER; Clarke 1993).

## Results

A total of 42 species of tyrant flycatchers were recorded in the present study. 20 species were not presented on the point count (Appendix B). Among the 22 species recorded in the sampling points, 8 occurred in three habitats, eight occurred in two habitats and six were exclusive from one habitat. Among the 16 species that occurred in more than one habitat, 10 species had I.P.A. value higher in a single one ( $p>0.01$ ; Table 1).

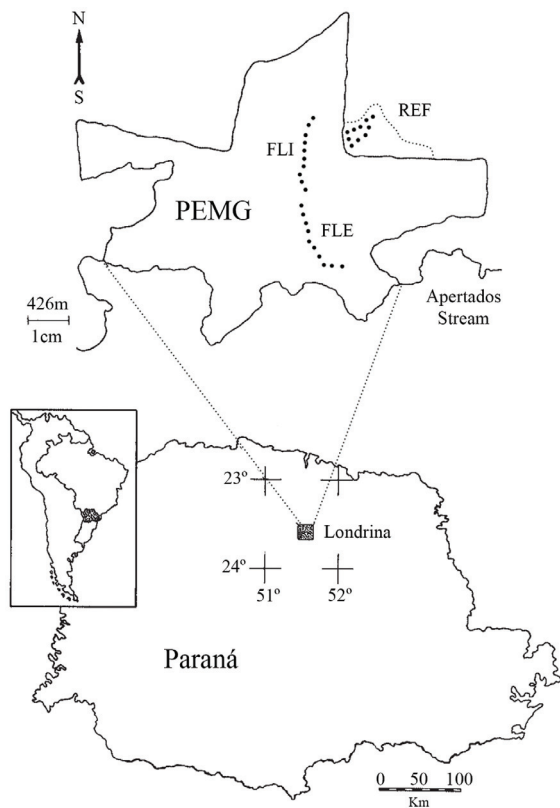
The assembly ordination by the NMDS analysis produced a good fit (0.09 stress; Figure 2). The sampling area position in function of the dissimilarities in the I.P.A., in relation to the two axis of the NMDS analysis which indicates significant variation of the communities among habitats (Table 2). The variation occurs in a gradient where FLI is placed as an intermediate between FLE and REF. The most dissimilar among the communities is FLE, considering the overlapping of FLI and REF (Table 2). Unexpectedly, it was not found an association between foraging strategy and habitat choice, despite the clear assembly ordination among the habitats (Table 3, Figure 2).

The ordination test (Table 2) indicated significant difference between the species and the sampled habitats ( $R=0.97$ ;  $P<0.001$ ). Regarding the spatial variation, all the three tested groups (FLE,

**Table 1.** Values of the Index of Point Abundance (I. P. A.) of each species registered in the habitats of interior of mature forest (FLI), slope forest (FLE) and reforestation (REF). Different cell colors indicate significant difference in the I.P.A. values, darker in higher values. Presented in the table are the p values to the G Test for each species in the distinct habitats.

Species	I.P.A.			p values (G Test)			Foraging Class		
	REF	INT	ENC	FLI x REF	FLI x FLE	REF x FLE	I	II	III
<b>Tyrannidae</b>									
<i>Myiopagis caniceps</i> (Swainson, 1835)*	0.75	1.2	0.5	p<0.01	p<0.01	p>0.01			x
<i>Myiopagis viridicata</i> (Vieillot, 1817)*	0.38	0.2	-	p>0.01	-	-			x
<i>Campostoma obsoletum</i> (Temminck, 1824)	0.38	-	-	-	-	-	x		x
<i>Corythopsis delalandi</i> (Lesson, 1830)	1.63	1.6	-	p>0.01	-	-	x	x	
<i>Phylloscartes ventralis</i> (Temminck, 1824)	0.38	2.5	-	p<0.01	-	-		x	x
<i>Phylloscartes paulista</i> Ihering & Ihering, 1907	0.25	0.1	-	p<0.01	-	-		x	x
<i>Leptopogon amaurocephalus</i> Tschudi, 1846 *	0.13	0.9	1.11	p<0.01	p<0.01	p<0.01		x	x
<i>Myiornis auricularis</i> (Vieillot, 1818)	-	-	0.2	-	-	-		x	
<i>Hemitriccus diops</i> (Temminck, 1822)	-	0.2	1.25	p>0.01	p<0.01	p<0.01	x	x	
<i>Hemitriccus obsoletus</i> (Miranda-Ribeiro, 1906)	0.13	0.1	0.75	p>0.01	p<0.01	p<0.01	x	x	
<i>Hemitriccus nidipendulus</i> (WIED, 1831)	-	0.1	0.75	-	p<0.01	-	x	x	
<i>Poecilotriccus plumbeiceps</i> (Lafresnaye, 1846)	-	-	2.75	-	-	-		x	x
<i>Todirostrum cinereum</i> (Linnaeus, 1766)	0.25	-	0.25	p>0.01	-	-	x	x	
<i>Tolmomyias sulphurescens</i> (Spix, 1825)*	0.25	2	1.25	p<0.01	p<0.01	p<0.01	x	x	x
<i>Platyrinchus mystaceus</i> Vieillot, 1818	-	0.1	0.25	-	p<0.01	-		x	x
<i>Pitangus sulphuratus</i> (Linnaeus, 1766)*	0.13	-	-	-	-	-	x		x
<i>Myiodynastes maculatus</i> (Stadius Muller, 1776)*	1.25	2	-	p<0.01	-	-		x	x
<i>Megarynchus pitangua</i> (Linnaeus, 1766)*	1.13	1.1	0.5	p>0.01	p>0.01	p>0.01		x	x
<i>Empidonomus varius</i> (Vieillot, 1818)*	-	0.2	-	-	-	-	x		x
<i>Sirystes sibilator</i> (Vieillot, 1818)*	0.88	1.6	0.25	p<0.01	p<0.01	p<0.01			x
<i>Myiarchus swainsoni</i> Cabanis & Heine, 1859*	0.13	0.7	-	p<0.01	-	-			x
<i>Myiarchus ferox</i> (Gmelin, 1789)*	0.25	-	-	-	-	-		x	x

\*species that includes fruit in its diet.



**Figure 2.** Graphic ordination of the species according to its abundance in the sampled habitats plotted in the NMDS first two-axis space. The groups are: interior of mature forest (FLI; circle), slope forest (FLE; diamond) and reforestation (REF; square).

FLI and REF) were different in the pair wise comparisons (all with  $p=0.01$ ).

The mean dissimilarity (in percent) between the communities is  $66.6\% \pm 15.2\%$  (Table 3). The lowest percent difference occurs between REF and FLI (50.25%), as the difference between FLI and FLE is intermediate (69.32%) and between REF and FLE is the highest (80.28%).

Three of the four species are responsible for the mean of 50% of dissimilarity between sampled habitats (Table 2). The dissimilarity produced between REF and FLI is about 50%, in general, by the abundance difference of *Tolmomyias sulphurescens* (Spix, 1825), *Phylloscartes ventralis* (Temminck, 1824) and *Sirystes sibilator* (Vieillot, 1818). The differences between FLI and FLE (about 70%) and REF and FLE (about 80%) are produced mainly by species that were present in just one sampled area, most with preference for FLE. The differences related to FLE are the results from *Poecilotriccus plumbeiceps* (Lafresnaye, 1846) and *Hemitriccus diops* (Temminck, 1822) presence.

## Discussion

Despite of our expectation and the clear habitat segregation of the recorded species, we found a weak association between foraging strategy and habitat occupancy. The found habitat choice was best associated with the case of bamboo specialists, present almost exclusively in FLE. In addition, it brought light to what could be a group of potential restoration agents, in the case of partially frugivorous species. Indeed, some recorded species were present both in FLI and in REF.

The foraging strategies used by tyrant flycatcher species can be directly related to the prey capture efficiency in a particular substrate, and habitat type (Fitzpatrick 1980, 1985). However, our data do not

**Table 2.** Species contribution in the mean dissimilarity among the possible pair wise combinations in the three sampled habitats: interior of mature forest (FLI), slope forest (FLE) and reforestation (REF).

Species	Mean Ab.	Mean Ab.	Mean Diss.	Contribution %	Cumulative (Percent)
<b>REF e FLI</b>					
<i>Tolmomyias sulphurescens</i>	2.38	19.88	9.69	19.27	19.27
<i>Phylloscartes ventralis</i>	3.63	24.25	7.92	15.76	35.03
<i>Sirystes sibilator</i>	8.75	16	4.96	9.87	44.91
<i>Leptopogon amaurocephalus</i>	1.38	9.13	3.82	7.61	52.51
<i>Corythopis delalandi</i>	16.5	15.25	3.48	6.93	59.44
<i>Megarhynchus pitangua</i>	11.25	10.88	2.95	5.87	65.31
<i>Myiodynastes maculatus</i>	12.88	20.38	2.91	5.79	71.11
<i>Myiopagis caniceps</i>	7.5	12	2.59	5.16	76.26
<i>Camptostoma obsoletum</i>	3.88	0	1.88	3.74	80
<i>Myiarchus swansoni</i>	1.25	6.88	1.74	3.45	83.45
<i>Myiopagis viridicata</i>	3.88	2	1.23	2.45	85.9
<i>Hemitriccus diops</i>	0	2	1.15	2.28	88.18
<i>Todirostrum cinereum</i>	2.88	0	1.09	2.18	90.36
<b>REF e FLE</b>					
<i>Poecilatriccus plumbeiceps</i>	0	27.38	16.01	19.94	19.94
<i>Corythopis delalandi</i>	16.5	0	9.49	11.82	31.76
<i>Hemitriccus diops</i>	0	12.25	7.05	8.78	40.54
<i>Tolmomyias sulphurescens</i>	2.38	13.13	6.89	8.58	49.12
<i>Leptopogon amaurocephalus</i>	1.38	11.13	5.94	7.4	56.52
<i>Myiodynastes maculatus</i>	12.88	0	5.53	6.89	63.41
<i>Hemitriccus nidipedulus</i>	0	7.5	3.96	4.93	68.34
<i>Sirystes sibilator</i>	8.75	2.5	3.38	4.21	72.56
<i>Hemitriccus obsoletus</i>	1.25	7.5	3.27	4.07	76.63
<i>Megarhynchus pitangua</i>	11.25	5.13	3.21	4	80.63
<i>Camptostoma obsoletum</i>	3.88	0	2.16	2.7	83.33
<i>Phylloscartes ventralis</i>	3.63	0	2.06	2.56	85.89
<i>Myiopagis viridicata</i>	3.88	0	1.93	2.4	88.29
<i>Myiopagis caniceps</i>	7.5	5	1.91	2.38	90.67
<b>FLI e FLE</b>					
<i>Poecilatriccus plumbeiceps</i>	0	27.38	12.18	17.57	17.57
<i>Phylloscartes ventralis</i>	24.25	0	8.85	12.77	30.34
<i>Corythopis delalandi</i>	15.25	0	6.86	9.89	40.22
<i>Myiodynastes maculatus</i>	20.38	0	6.24	9	49.23
<i>Sirystes sibilator</i>	16	2.5	5.91	8.52	57.75
<i>Tolmomyias sulphurescens</i>	19.88	13.13	4.53	6.54	64.29
<i>Hemitriccus diops</i>	2	12.25	4.51	6.5	70.79
<i>Myiopagis caniceps</i>	12	5	3.45	4.98	75.76
<i>Megarhynchus pitangua</i>	10.88	5.13	2.67	3.85	79.62
<i>Hemitriccus obsoletus</i>	1	7.5	2.66	3.84	83.46
<i>Hemitriccus nidipedulus</i>	1	7.5	2.63	3.79	87.25
<i>Myiarchus swansoni</i>	6.88	0	2.1	3.04	90.29

**Table 3.** Values of the pair wise comparisons of the ANOSIM analysis, indicating the R value, the associated probability (P), the number of permutations and the number of observations where the random value is higher than the calculated (N); and percent values of dissimilarity (SIMPER). For comparisons among sampled habitats, the groups are: interior of mature forest (FLI), slope forest (FLE) and reforestation (REF).

Groups	R	P (%)	Permutation	N	SIMPER (%)
REF e INT	0.938	1.2	81	1	50.25
REF e FLE	0.948	1.2	81	1	80.28
FLI e FLE	1	1.2	81	1	69.32

show this relationship so clearly. Regarding the foraging strategy classification, it made grouping strategies according to its efficiency in substrate (Fitzpatrick 1980, 1985), it is possible that we gathered in the same group strategies that could explain different habitat choices. Regarding to the possible similarity between habitats, maybe their differences are not deep enough to further distinct foraging strategies. So, some information on habitat description should be useful. Even a possible evaluation of arthropod availability among strata and habitat could be better predictor of insectivore abundance. In addition, Brum et al. (2012) found that Tyrannidae habitat distribution is strongly affected by phylogenetic relationships, since there is relatively high niche conservatism.

Partially frugivorous species of Tyrannidae could be important to seed dispersal if they are common in both FLI and REF. Our data suggest that this pattern is real. FLI and FLE reached high similarity and they could consider the two habitats as part of the same gradient. The species *Myiopagis caniceps* (Swainson, 1835), *Myiopagis viridicata* (Vieillot, 1817), *Leptopogon amaurocephalus* Tschudi, 1846, *Tolmomyias sulphurescens*, *Myiodynastes maculatus* (Statius Muller, 1776), *Megarhynchus pitangua* (Linnaeus, 1766), *Empidonomus varius* (Vieillot, 1818), *Sirystes sibilator* (Vieillot, 1818) and *Myiarchus swainsoni* Cabanis & Heine, 1859 use both habitats, being considered together, with another frugivorous species of the bird community, as agents of ecological restoration in REF. The highest similarity between FLI and REF assemblies, regarding FLE, indicates that despite the considerable alteration level of REF (Silveira 2006), both seems to be part of the same gradient of conditions and resources in an analogous way to what could be observed as edge and interior gradient.

Also, it is noteworthy that Brum et al. (2012) found that habitat variables that are known influenced by fruit availability are related to frugivorous tyrant flycatchers, but this relation is phylogenetically biased, suggesting niche conservatism among clades (sensu Pillar & Duarte 2010).

Microhabitat variables, as light intensity distribution was showed to play an important role in the distribution of forest interior species, especially those with preferences for low-light conditions (Patten & Smith-Patten 2012). For those species, a light-intense environment can act as a behavioral barrier, inhibiting non-migratory movements through ecotones or habitat matrixes (Harris & Reed 2002). According to Harris & Reed (2002), habitat specialists, understory birds, tropical species, solitary, and non-migrant species are more likely to be inhibited by behavioral barriers than its opposite equivalents. Maybe, the effects of light intensity can be stronger in FLI and FLE than in REF assemblies, given that in FLI and FLE there is a proportionally higher number of species that have dense vegetation as one of their requirements, regardless of the strata they occupy (Fitzpatrick et al. 2004).

The dissimilarity of FLE reflects, as expected, particularities of this habitat, and the presence of bamboo clusters (*Chusquea sp.*). It was confirmed the importance of bamboo clusters to *Hemitriccus diops*, *Hemitriccus obsoletus* (Miranda-Ribeiro, 1906), *Hemitriccus nidipendulus* (Wied, 1831), *Platyrhynchus mystaceus* Vieillot, 1818, *Poecilotriccus plumbeiceps* and *Myiornis auricularis* (Vieillot, 1818), species that are known to show various levels of specialization to this microhabitat (Santana & Anjos 2010).

Our data is important for conservation. Firstly, the fact that FLI and FLE support different bird composition, both should be maintained. Secondly, REF has lower importance as source to FLE's

assembly than to the FLI's. Therefore, FLE seems more vulnerable to disturbance and should have high conservation concern by regarding it as a habitat with conditions and resources different enough to be suitable to a significantly different tyrant flycatcher assembly.

## Acknowledgements

Financial support for this study was obtained from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), by Programa Institucional de Bolsas de Iniciação Científica (PIBIC). We thank Instituto Ambiental do Paraná (IAP) for the permissions to conduct the research in the PEMG. In addition, especially to Santos-Júnior P. C. A., Zaiden T., Boesing A. L., Bochio G. M. and Arakaki B. R. for helping in the work field, and to Kurozawa M. F. for helping in the language revision.

## References

- ALEIXO, A. 2001. Conservação da avifauna da Floresta Atlântica: efeitos da fragmentação e a importância de florestas secundárias. In Ornitologia e Conservação – Da Ciência às estratégias. (J.L.B. Albuquerque, J.F. Cândido Junio, F.C. Straube & Roos A.L., eds). Unisul, Tubarão, p.199-206.
- ANJOS, L. 2001. Bird communities in five Atlantic Forest fragments in Southern Brazil. *Ornitol. Neotrop.* 12:11-17.
- ANJOS, L. 2006. Bird Species Sensitivity in a Fragmented Landscape of the Atlantic Forest in Southern Brazil. *Biotropica*. 38(2):229-234. <http://dx.doi.org/10.1111/j.1744-7429.2006.00122.x>
- ANJOS, L. 2007. A eficiência do método de amostragem por pontos de escuta na avaliação da riqueza de aves. *Rev. Bras. Ornitol.* 15(12):239-243.
- ANJOS, L., SCHUCHMANN, K.L. & BERNDT, R. 1997. Avifaunal composition, species richness, and status in the Tibagi river basin, Paraná State, southern Brazil. *Ornitol. Neotrop.* 8(2):145-173.
- ANJOS, L., VOLPATO, G.H., LOPES, E.V., SERAFINI, P.P., POLETTO, F. & ALEIXO, A. 2007. The importance of riparian forest for the maintenance of bird species richness in an Atlantic Forest remnant, southern Brazil. *Rev. Bras. Zool.* 24(4):1078-1086. <http://dx.doi.org/10.1590/S0101-81752007000400027>
- ANJOS, L., BOCHIO, G.M., CAMPOS, J.V., McCRATE, G.B. & PALOMINO, F. 2009. Sobre o uso de níveis de sensibilidade de aves à fragmentação florestal na avaliação da Integridade Biótica: um estudo de caso no norte do Estado do Paraná, sul do Brasil. *Rev. Bras. Ornitol.* 17(1):28-36.
- BIANCHINI, E., PIMENTA, J.A. & SANTOS, F.A.M. 2001. Spatial and temporal variation in the canopy cover in a tropical semi-deciduous forest. *Braz. Arch. Biol. Technol.* 44:269-276. <http://dx.doi.org/10.1590/S1516-89132001000300008>
- BIBBY, C.J., BURGESS, N.D. & HILL, D.A. 1992. *Bird Census Techniques*. British Trust for Ornithology and the Royal Society for the Protection of Birds.
- BLONDEL, J., FERRY, C. & FROCHOT, B. 1970. La méthode des indices ponctuels d'abundance (I.P.A.) ou des relevés d'avifaune par "stations d'écoute". *Alauda*. 38:55-71.
- BRUM, F.T., KINDEL, A., HARTZ, S.M. & DUARTE, L.D.S. 2012. Spatial and phylogenetic structure drive frugivory in Tyrannidae birds across the range of Brazilian Araucaria forests. *Oikos*. 121(6):1-8. <http://dx.doi.org/10.1111/j.1600-0706.2011.19978.x>
- CLARKE, K.R. 1993. Non-parametric multivariate analyses of changes in community structure. *Aust J Ecol.* 18:117-143. <http://dx.doi.org/10.1111/j.1442-9993.1993.tb00438.x>
- FITZPATRICK, J.W. 1980. Foraging behavior of Neotropical Flycatchers. *Condor*. 82(1): 43-57. <http://dx.doi.org/10.2307/1366784>
- FITZPATRICK, J.W. 1985. Form, foraging behavior, and adaptive radiation in the Tyrannidae. In *Neotropical Ornithology*. (P.A. Buckley, M.S. Foster, E.S. Morton, R.S. Ridgely & F.G. Buckley, eds.) American Ornithologist's Union. Ornithological Monographs, Washington, 36:447-470.

- FITZPATRICK, J., BATES, J., BOSTWICK, K., CABALLERO, I., CLOCK, B., FARNSWORTH, A., HOSNER, P., JOSEPH, L., LANGHAM, G., LEBBIN, D., MOBLEY, J., ROBBINS, M., SCHOLE, E., TELLO, J., WALTHER, B. & ZIMMER, K. 2004. Family Tyrannidae. In Handbook of the Birds of the World. (J. Del Hoyo, A. Elliot, & D. Christie, eds.). Lynx Editions, v.9, p.170-463.
- FOWLER, J. & COHEN, L. 1995. Statistics for ornithologists. 2nd ed. British Trust for Ornithology, Norfolk.
- HARRIS, R.J. & REED, M. 2002. Behavioral barriers to non-migratory movements of birds. *Ann. Zool. Fennici*. 39:275-290.
- HOWE, H.F. & DE STEVEN, D. 1979. Fruit production, migrant bird visitation, and seed dispersal of *Guarea glabra* in Panama. *Oecologia*. 39(2):185-196. <http://dx.doi.org/10.1007/BF00348067>
- LAURANCE, W. & VASCONCELOS, H. 2009. Consequências ecológicas da Fragmentação Florestal na Amazônia. *Oecol. Bras.* 13(3):434-451. <http://dx.doi.org/10.4257/oeco.2009.1303.03>
- LEGENDRE, P. & LEGENDRE, L. 1998. Numerical ecology. 2nd ed. Elsevier, Amsterdam.
- PATTEN, M.A. & SMITH-PATTEN, B.D. 2012. Testing the microclimate hypothesis: Light environment and population trends of Neotropical birds. *Biol. Conserv.* 155:85-93. <http://dx.doi.org/10.1016/j.biocon.2012.06.004>
- PILLAR, V.D. & DUARTE, L.S. 2010. A framework for metacommunity analysis of phylogenetic structure. *Ecol. Lett.* 13:587-596. PMID:20337699. <http://dx.doi.org/10.1111/j.1461-0248.2010.01456.x>
- POLETTI, F., ANJOS, L., LOPES, E.V., VOLPATO, G.H., SERAFINI, P.P. & FAVARO, F.L. 2004. Caracterização do microhabitat e vulnerabilidade de cinco espécies de arapaçus (Aves: Dendrocolaptidae) em um fragmento florestal do norte do estado do Paraná, sul do Brasil. *Rev. Bras. Ornitol.* 12:86-96.
- REMSEN JUNIOR, J.V., CADENA, C.D., JARAMILLO, A., NORES, M., PACHECO, J.F., PÉREZ-EMÁN, J., ROBBINS, M.B., STILES, F.G., STOTZ, D.F. & ZIMMER, K.J. 2013. A classification of the bird species of South America. American Ornithologists' Union: <http://www.museum.lsu.edu/~Remsen/SACCBaseline.html> (último acesso em 20/05/2013).
- RIBEIRO, M.C., METZGER, J.P., MARTENSEN, A.C., PONZONI, F.J. & HIROTA, M.M. 2009. The Brazilian Atlantic Forest: how much is left, and how is the remaining forest distributed?. Implications for conservation. *Biol. Conserv.* 142:1141-1153. <http://dx.doi.org/10.1016/j.biocon.2009.02.021>
- SANTANA, C.R. & ANJOS, L. 2010. Associação de aves a agrupamentos de bambu na porção sul da Mata Atlântica, Londrina, Estado do Paraná, Brasil. *Biota Neotrop.* 10(2): <http://www.biotaneotropica.org.br/v10n2/en/abstract?article+bn00510022010> (último acesso em 21/05/2013).
- SICK, H. 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro.
- SILVEIRA, M. 1993. Estrutura vegetacional em uma topossequência no Parque Estadual "Mata dos Godoy". Tese de mestrado, Universidade Federal do Paraná, Curitiba.
- SILVEIRA, M. 2006. A vegetação do Parque Estadual Mata dos Godoy. In *Ecologia do Parque Estadual Mata dos Godoy*. (J.M.D. Torezan, org). Itedes, Londrina, p.19-27.
- SOARES-SILVA, L.H. & BARROSO, G.M. 1992. Fitossociologia do estrato arbóreo da floresta na porção norte do Parque Estadual Mata dos Godoy, Londrina-PR, Brasil. In *Congresso da Sociedade Botânica de São Paulo*. Sociedade Botânica de São Paulo, São Paulo, 8:101-112.
- TELLO, J.G., MOYLE, R.G., MARCHESE, D.J. & CRACRAFT, J. 2009. Phylogeny and phylogenetic classification of the tyrant flycatchers, cotingas, manakins, and their allies (Aves: Tyrannidae). *Cladistics*. 25:429-467. <http://dx.doi.org/10.1111/j.1096-0031.2009.00254.x>

*Received 07/15/2013*

*Revised 11/27/2013*

*Accepted 12/03/2013*

## Habitat occupancy by tyrant flycatchers

**Appendix A.** Table with values of relative density (DR), relative dominance (DoR), coverage value (VC) and relative frequency (FR) the four most representative species of FLI and FLE.

Species	DR	DoR	FR	VC
FLI*				
<i>Aspidosperma polyneuron</i> Müll.Arg.	5.72	22.81	3.65	22.85
<i>Euterpe edulis</i> Martius	9.74	3.71	3.04	13.45
<i>Croton floribundus</i> Spreng.	5.22	7.4	3.04	12.65
<i>Trichilia clausenii</i> C.DC.	9.81	1.84	3.34	11.65
FLE**				
<i>Parapiptadenia rigida</i> (Benth.)	0.76	22.97	1.11	28.73
<i>Nectandra megapotamica</i> (Spreng.)	7.63	6.78	5.19	14.42
<i>Lonchocarpus muehlbergianus</i> Hassl.	6.62	4.87	5.93	11.49
<i>Cabralea canjerana</i> (Vell)	7.38	4.21	5.19	11.58

\*Soares-Silva & Barroso (1992), \*\*Silveira (1993).

**Appendix B.** List of species of the family Tyrannidae recorded in the intervals or outside the radius of the point counts.

*Elaenia flavogaster* (REF), *Elaenia parvirostris* (REF), *Elaenia obscura* (REF), *Serpophaga subcristata* (REF), *Capsiempis flaveola* (REF), *Euscarthmus meloryphus* (REF), *Pogonotriccus eximius* (REF, FLI, FLE), *Mionectes rufiventris* (FLI, FLE), *Myiophobus fasciatus* (REF), *Lathrotriccus euleri* (REF, FLE), *Cnemotriccus fuscatus* (REF, FLI), *Contopus cinereus* (FLI), *Pyrocephalus rubinus* (REF), *Arundinicola leucocephala* (FLE), *Legatus leucophaeus* (REF), *Myiozetetes similis* (REF), *Conopias trivirgatus* (REF), *Griseotyrannus aurantioatrocristatus* (FLI), *Tyrannus melancholicus* (REF) and *Attila phoenicurus* (FLI).