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Strieder Philippsen, Juliana; Benedito, Evanilde; Zawadzki, Cláudio Henrique
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Species composition and richness of avifauna in an urban area of southern Brazil

Juliana Strieder Philippsen, Evanilde Benedito* and Cláudio Henrique Zawadzki

*Universidade Estadual de Maringá, Av. Colombo, 5790, 87020-900, Maringá, Paraná, Brazil. *Author for correspondence. E-mail: eva@pesquisador.cnpq.br*

ABSTRACT. The urban environment has become an object of study by ornithologists, who seek to understand the relationships between this new habitat and the birds that survive within it. Aiming to investigate the composition and richness of the avifauna present at the State University of Maringá and identify temporal changes in species composition, the obtained results were compared to the study accomplished by Krügel (1998) in this same location. Thus, we performed field samplings from August 2007 to July 2008, using transects, with visual and auditive identification. We recorded 74 species belonging to 27 families from 12 orders, during 72 hours of observation. Most species were constant in the study area. The predominant trophic categories were insectivores (46%) and omnivores (20%). Comparing the analyzed periods, we verified a reduction in the number of species, besides the record of new species for the studied location.

Key words: avifauna, temporal changes, urban environment, trophic categories.

RESUMO. Composição de especies e riqueza avifauna numa área urbana no sul do Brasil. O ambiente urbano vem se tornando objeto de estudo de ornitólogos que buscam entender as relações entre esse novo habitat e as aves que nele sobrevivem. Com o objetivo de determinar a composição e riqueza específica da avifauna presente no Campus sede da Universidade Estadual de Maringá, e de identificar alterações temporais na composição específica dessa comunidade, os resultados obtidos foram comparados com estudos realizados anteriormente por Krügel (1998) na mesma área amostrada. Para tanto, foram realizadas amostragens mensais entre agosto/2007 e julho/2008, utilizando-se o método de transecção, com identificação visual e auditiva. Totalizou-se 72 horas de observação, com o registro de 74 espécies, pertencentes a 27 famílias de 12 ordens. A maioria das espécies foi classificada como constante no local investigado. As categorias tróficas predominantes foram insetívoras (46%) e onívoras (20%). Comparando-se os períodos analisados, constatou-se redução do número de espécies, além do registro de novas ocorrências para o local estudado.

Palavras-chave: aves, alterações temporais, ambiente urbano, categorias tróficas.

Introduction

The colonization process in Paraná State led to strong environmental degradation and a loss of extensive forest areas. The type of soil from the North and Northwest regions (Dystrophic Purple Latosol) called the attention of the agricultural sector and the semideciduous seasonal forest was replaced by coffee plantations, artificial pastures and cotton and grain cultivations (MAACK, 2002). Along with agricultural growth, urban centers also developed. The city of Maringá is located in this region, and currently, its forest coverage is better represented in the urban area, with small forest reserves and many trees in the streets, avenues and public squares (GARCIA, 2006).

The urban landscape, in spite of not presenting the resources provided by a native forest, may also undergo ornithofauna colonization. According to Sick (1997), birds capable of adapting to the conditions created by humans are called synantropic species. The same author argues that extreme changes in landscape, carried out by humans, implicate that the rest of the natural environment may become too small to support species of animals that require a wide space to survive, threatening them with extinction.

The urban environment offers opportunities to investigate the interactions between the bird community and the changes in the original environment. These changes are the result of the urbanization process, which is responsible for alterations in the vegetation, due to the invasion of opportunistic or exotic species, and also from constant anthropogenic influences (MATARAZZO-NEUBERGER, 1995). Furthermore, the author emphasizes that this habitat, despite being 'synthetic',

presents conditions and resources that may be used by any bird able to explore this new environment.

The avifauna from urbanized areas has become a habitual subject of studies (ANJOS; LAROCA, 1989; HÖFLING; CAMARGO, 1993; ARGEL-DE-OLIVEIRA, 1995; VALADÃO et al., 2006a), which mainly discuss the composition and relative abundance of species, trophic structure, and relationship between forestation and avifauna. University campuses are also objects of ornithology studies (MONTEIRO; BRANDÃO, 1995; VOLPATO; ANJOS, 2001; LOPES; ANJOS, 2006; VOTO et al., 2006). In Maringá, studies on the ornithofauna of green areas (woods and parks) were accomplished by Krügel and Anjos (2000) and by Galina and Gimenes (2006) and at the campus of State University of Maringá (UEM) by Krügel (1998).

In this context, this study investigated species composition and richness, seasonal and temporal changes of avifauna in the campus of the State University of Maringá (UEM), through comparisons with the results obtained by Krügel (1998).

Material and methods

Study area

The city of Maringá, situated in the northwest region of Paraná State, is located in the altitude zone between 500 and 600 m above sea level and is crossed by the Tropic of Capricorn, with a latitude of 23°25'S and longitude of 51°57'W. The predominant climate is subtropical; the mean temperature during the coldest month is below 18°C, and the mean annual temperature is above 20°C, with rainy summers and dry winters (GARCIA, 2006). The original vegetation was composed by a semideciduous seasonal forest that, has been reduced to small and acattered Forest fragments since 1920 (ANJOS, 1998).

The campus of the State University of Maringá (UEM) is located in the urban perimeter of the city of Maringá, occupying an area of 100 ha. To the north, the campus is about 6 km away from plantations, and the neighborhood is occupied by residences (Figure 1).

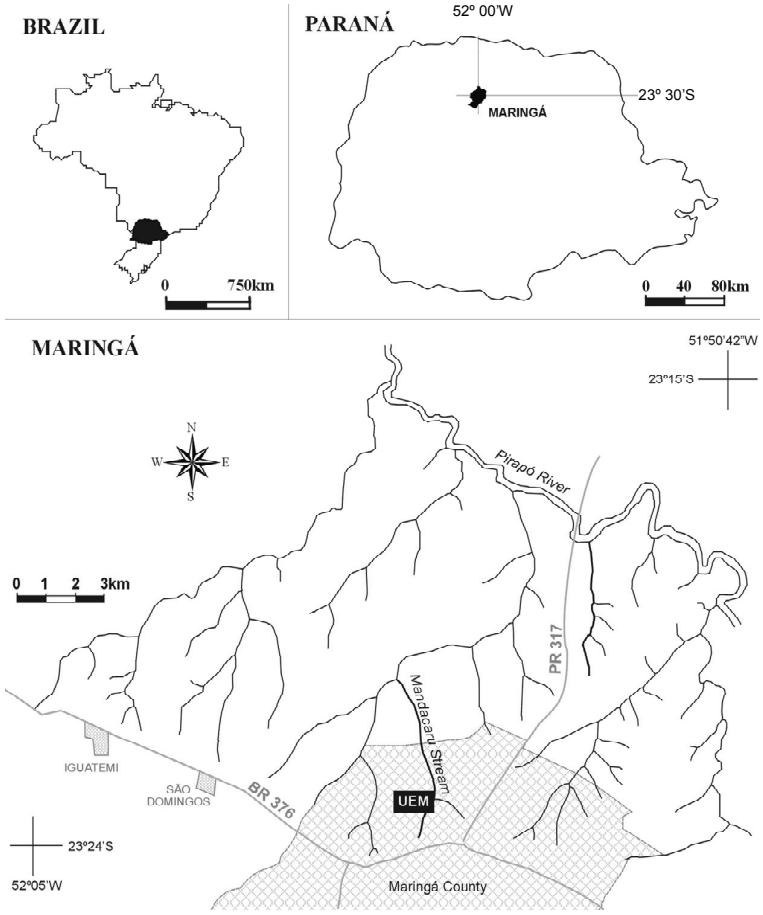

Figure 1. Location of the UEM campus, in the urban area of Maringá, northern Paraná State, southern Brazil.

Methods

Throughout the campus, four environments were considered in accordance to the structure and composition of vegetation: Open Area – OA: scattered trees, gardens, constructions and pavement; Woods I – WI: ornamental and arboreal species; Woods II – WII: beds of medicinal plants and arboreal species; and Riparian Forest – RF: narrow stretch of riparian vegetation, rather degraded, along Mandacaru stream. The environments were sampled using transects. The timeframe used in each transect was two hours, beginning soon after dawn. Samplings were made every month, with one day for each environment. The study was developed from August 2007 to July 2008. The identification of the birds was visual and auditory, using binoculars (8 x 40), field guides (DEVELEY; ENDRIGO, 2004; HÖFLING; CAMARGO, 1993; NAROSKY; YZURIETA, 2006; SIGRIST, 2007) and a portable recorder (AIWA TA153). The species nomenclature follows the Brazilian Bird List from the Brazilian Ornithological Records Committee (CBRO, 2008). The constancy of bird species was determined using the equation C = P x 100/Q (DAJOZ, 1983), where C = occurrence constancy of species; P = number of samples where the species occurred; Q = total number of samples taken. The species was considered constant (C) in a given environment when C was greater than 50%, accessory (A) between 25 and 50%, and accidental (a) when lower than 25%. The Sorensen similarity index (IS) (IS = 2Sab/Sa+Sb, where Sab is the number of species common to environments A and B, Sa corresponds to the number of species in location A, and Sb to the number of species in location B) was used to analyze the similarity, regarding species composition, among the environments and between the results from the present study and those obtained by Krügel (1998). The feeding habits were defined through field observations and literature data (SICK, 1997; KRÜGEL, 1998), considering the predominant food item: carnivores (CAR), necrophages (NEP), frugivores (FRU), granivores (GRA), insectivores (INS), nectarivores (NEC) and omnivores (ONI).

Results and discussion

A total of 74 bird species was recorded, distributed in 27 families and 12 orders, corresponding to about 46% from the entire number of species observed for the city of Maringá, compared to the data obtained by Krügel (1998). The order Passeriformes was the most representative, with 39 species (54%), highlighting the families Tyrannidae (n = 13) and Thraupidae (n = 5). Among non-Passeriformes, the order Apodiformes comprised eight species (11%), followed by Falconiformes with six species (8%) and Columbiformes with five species (7%) (Appendix A). Great part of the species recorded in the present study is commonly found in urbanized environments, according to other studies in parks, public squares, university campi and green areas (MATARAZZO-NEUBERGER, 1995; FRANCHIN; MARÇAL JUNIOR, 2004; SCHERER et al., 2005; VALADÃO et al., 2006b; TORGA et al., 2007). These species may also be considered as 'urban exploiters', i.e., they are very capable of exploiting the changes resulting from urban development and, consequently, they should reach the highest densities in these locations (BLAIR, 1996).

Regarding the feeding habits (Figure 2), there was a predominance of insectivores 46% (n = 34) and omnivores 20% (n = 15). Nectarivores and granivores represented 12% (n = 9) and 8% (n = 6), respectively. Frugivores (8%), carnivores (4%) and necrophages (1%) presented the lowest percentages. According to Scherer et al. (2005), the high rate of insectivores was due to food resource availability throughout the year, and in the case of omnivores, to the wide range of foods they use according to conditions. Adding the species that are dependent on the bottom of the food chain (frugivores, granivores and nectarivores), we can obtain a higher percentage (28%) than that of omnivores, however lower than insectivores.

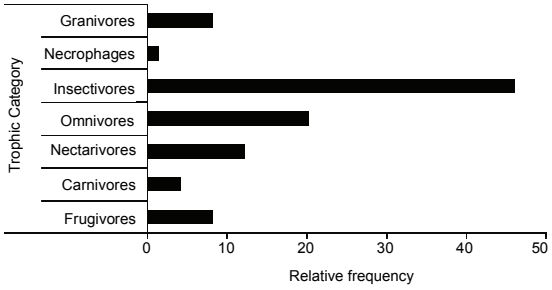

Figure 2. Relative frequency of bird fauna, by trophic category, sampled in the State University of Maringá campus.

The highest species richness was observed in September and November. Otherwise, the lowest value of this attribute was verified during April and May (Figure 3).

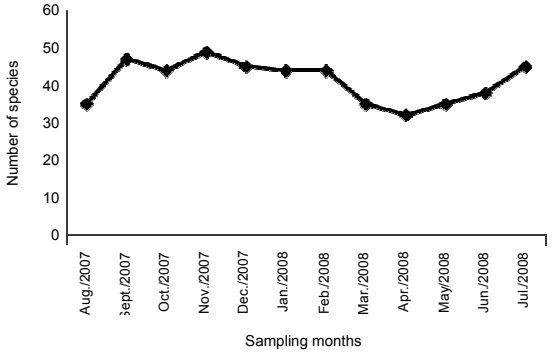

Figure 3. Number of species recorded during each sampling month.

In relation to the seasonal variation in species number, we verified higher species richness in the spring (64) and winter (59), and lower during the summer (54) and autumn (49). The end of the winter and the beginning of the spring (September, October and November) is the time when the birds begin to vocalize more intensely and increase their activities, due to the reproductive period, which facilitates the visualization and species recording (SICK, 1997). Moreover, this variation in species richness may be ascribed to the arrival of migratory species (*Empidonomus varius*, *Molothrus bonariensis*, *Myiodynastes maculatus*, *Tyrannus melancholicus* and *Tyrannus savana*) in the end of the winter, permanence during the spring and departure in the summer. In this period, *Myiodynastes maculatus* and *Tyrannus melancholicus* were observed feeding nestlings of *Molothrus bonariensis*, which indicates that these species use the study area in the reproductive period. *Tyrannus savana*, species with wide habitat tolerance, frequently uses disturbed habitats (ALVES, 2007), besides it was also observed seeking insects in the canopy of trees in order to feed two nestlings. Therefore, the presence of these migratory species indicates that the study location is important during such period, as a nesting location or as food source.

The most similar environments were OA-WI (IS = 0.77), followed by RF-OA and OA-WII (both with IS = 0.68) (Table 1). BI and BII were the most different regarding species composition, in relation to RF (IS = 0.60 and IS = 0.63, respectively). Fifteen exclusive species were recorded in RF, and they were typical of forest edges or occurring near water, such as *Aramides saracura*, *Leptotila verreauxi* and *Tapera naevia* (SICK, 1997). This environment presented the highest number of exclusive species. In accordance to Matarazzo-Neuberger (1995), this exclusivity reflects the presence of original, more dense and ancient vegetation, compared to the vegetation from the other environments. In the OA environment, were recorded migratory Falconidae (*Elanoides forficatus* and *Ictinia plumbea*), and species typical of open areas, such as *Athene cunicularia*, *Machetornis rixosa*, *Mimus saturninus* and *Vanellus chilensis* (SICK, 1997), which occupy grassy areas for food and/or reproduction.

Table 1. Sorensen similarity coefficients obtained for the sampled environments.

	OA	WI	WII	RF
OA	-	0.77	0.68	0.68
WI	0.77	-	0.74	0.60
WII	0.68	0.74	-	0.63
RF	0.68	0.60	0.63	-

Considering the constancy of species in the study area, 45% of them are constant, 24% are accessory and 31% are accidental (Figure 4).

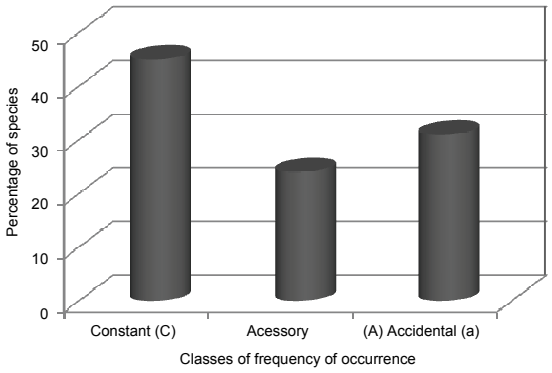

Figure 4. Percentage of species at each frequency of occurrence class.

Comparing the results from the present study to those found by Krügel (1998), we recorded a decrease in the number of species, from 78 to 74. The similarity index applied to the species composition recorded between the two study periods presented IS = 0.74. Fifty-six species are common to both studies, 18 are new records for the Campus area, and 22 were only verified by Krügel (1998) (Appendix B). Among them, 15 species were accidental in that period, thus, we may not consider as losses in specific composition from the studied area. This observation may be related to the sporadic uses of the area by the species and/or to the sampling effort, in the present study, may be not enough to detect these species. Regarding the new records, 11 of them were also just accidental (FO = 8.3%), indicating that these species use the Campus, but they do not occur regularly in the area. Toledo (2007) suggests the hypothesis that the presence of a certain species in an urban green area does not indicate that the same lives into this area; probably this species uses green areas close to them.

Some species presented frequency of occurrence nearly duplicated in comparison to the data obtained by Krügel (1998), such as *Colaptes melanochloros*, *Patagioenas picazuro* and *Veniliornis spilogaster*. *Eupetomena macroura* presented frequency of occurrence of 92% in the present study, while Krügel (1998) recorded this species only at Parque do Ingá (about 3 km from the Campus) and with frequency of occurrence of 8.3%. This result supports the growth in the distribution of this species in southern Brazil, discussed by Straube et al. (2006), who mention records of the species in the region of Londrina. *Coereba flaveola* also presented an increase in the frequency of occurrence (50%) in comparison to the previous study (16.6%), where this species was only recorded at Parque do Ingá. Nevertheless, other birds had a reduced frequency of occurrence in contrast to the above-mentioned research, such as *Falco sparverius* – from 83.3% (1998) to 25% (2008) – and *Colaptes campestris* – from 66.6% (1998) to 25% (2008). This result suggests that the increase in the built area within the Campus, which totaled 2,732.14 m^2 in 1998 and now is 12,159.56 m^2 (data from Campus management), consequently decreased the rural area, and may be responsible for this result, considering that these species occur mainly in that type of habitat (SICK, 1997). The rural species *Ammodramus humeralis* and *Anthus lutescens* may also have suffered with the reduction in rural area, both inside the university and surroundings, since they were not recorded in 2008.

Columba livia and *Columbina picui* are species that presented frequency of occurrence of 100% in the study made by Krügel and were not recorded in the present study. According to Nunes (2003), *C. livia* is frequently found in urban centers due to three factors that allow its high reproductive ability: absence of predators, large supply of food and shelter. It is possible to suppose that some of these factors suffered changes over time, and probably this is responsible for the disuse of available habitats inside the Campus, because this species was recorded in the university neighborhood (personal observation). *Columbina picui* was not recorded in the study accomplished by Galina and Gimenes (2006) at Parque do Ingá. These results indicate a decline in the abundance of this species, requiring confirmation through further studies on population dynamics.

Several factors may be related to the appearance or disappearance of species in a given environment. Among them, we highlight the phylogenetic and evolutionary traits, ecological requirements, as well as species biology. Thus, studies performed not only in the Campus but also in other green areas of the city are important to evaluate the actual situation of the avifauna in Maringá County and which are the main causes of loss of species that may be associated to the changes in floristic composition, increase in pedestrian and automobile traffic and paved areas, i.e., with the urbanization process. It is important to emphasize that not only one factor but a set of factors may be responsible for the increase in some species and the decrease of others; and other studies with this approach are immediately necessary. From that, it is possible to accomplish measures to mitigate the impacts of urbanization on birds, promoting the conservation of part of local biodiversity.

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Appendices

Appendix A. List of species recorded at the UEM campus. Species Constancy★★★ recorded at each sampled environment. Feeding habit (FH). Months when the species were recorded and frequency of occurrence (FO)★.

Family/Species	Environments				FH	Months												FO	FO
	AA	BI	BII	MR		J	F	M	A	M	J	J	A	S	O	N	D	(2008)	(1998)
Ardeidae Leach, 1820																			
Butorides striata (Linnaeus, 1758)				a (8%)	CAR		x											8.3	8,3
Cathartidae Lafresnaye, 1839																			
Coragyps atratus (Bechstein, 1793)	a (8%)			a (16%)	NEP									x	x			16.6	75
Accipitridae Vigors, 1824																			
Elanoides forficatus (Linnaeus, 1758)★★	a (8%)				INS										x			8.3	0
Ictinia plumbea (Gmelin, 1788)★★	a (8%)				INS										x			8.3	0
Rupornis magnirostris (Gmelin, 1788)	A (33%)	a (16%)	a (25%)	C (58%)	INS	x	x	x		x	x	x	x	x	x	x	x	91.6	83,3
Falconidae Leach, 1820																			
Caracara plancus (Miller, 1777)	A (50%)			a (25%)	ONI	x	x			x		x			x	x	x	58.3	41,6
Milvago chimachima (Vieillot, 1816)★★	a (8%)				CAR			x										8.3	0
Falco sparverius Linnaeus, 1758	a (25%)				CAR	x										x	x	25	83,3
Rallidae Rafinesque, 1815																			
Aramides saracura (Spix, 1825)★★				a (8%)	ONI											x		8.3	0
Charadriidae Leach, 1820																			
Vanellus chilensis (Molina, 1782)	C (100%)				ONI	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Columbidae Leach, 1820																			
Columbina talpacoti (Temminck, 1811)	C (83%)	C (66%)	A (33%)	C (58%)	GRA	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Columbina squammata (Lesson, 1831)★★				a (8%)	GRA											x		8.3	0
Patagioenas picazuro (Temminck, 1813)	C (100%)	C (75%)	A (42%)	C (92%)	FRU	x	x	x	x	x	x	x	x	x	x	x	x	100	41,6
Zenaida auriculata (Des Murs, 1847)	C (100%)	C (100%)	C (100%)	C (100%)	GRA	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Leptotila verreauxi Bonaparte, 1855				C (92%)	FRU	x	x	x	x	x	x	x	x		x	x	x	91.6	66,6
Psittacidae Rafinesque, 1815																			
Aratinga leucophthalma (Statius Muller, 1776)★★				a (8%)	FRUG	x												8.3	0
Brotogeris chiriri (Vieillot, 1818)★★	a (8%)			a (8%)	FRUG									x				8.3	0
Cuculidae Leach, 1820																			
Piaya cayana (Linnaeus, 1766)	a (8%)			A (42%)	INS		x				x	x		x	x	x		50	33,3
Crotophaga ani Linnaeus, 1758	C (100%)	C (58%)	A (33%)	C (92%)	INS	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Guira guira (Gmelin, 1788)	C (75%)	a (25%)		a (16%)	INS	x	x	x	x	x	x	x	x	x	x		x	91.6	91,6
Tapera naevia (Linnaeus, 1766)				A (42%)	INS		x				x	x	x		x			41.6	0
Strigidae Leach, 1820																			
Athene cunicularia (Molina, 1782)	C (58%)				INS			x		x	x	x	x	x			x	58.3	100
Trochilidae Vigors, 1825																			
Phaethornis pretrei (Lesson & Delattre, 1839)				C (75%)	NEC	x	x	x		x	x	x	x			x		66.6	41,6
Eupetomena macroura (Gmelin, 1788)★★	C (83%)	C (66%)	C (66%)	a (25%)	NEC	x		x	x	x	x	x	x	x	x	x	x	91.6	0
Florisuga fusca (Vieillot, 1817)★★	a (16%)				NEC							x		x				16.6	0
Anthracothorax nigricollis (Vieillot, 1817)			a (16%)	A (33%)	NEC	x		x						x			x	33.3	33,3
Chlorostilbon lucidus (Shaw, 1812)	A (33%)	A (33%)	A (42%)	a (25%)	NEC	x	x	x	x	x	x	x	x	x	x	x	x	91.6	75
Hylocharis chrysura (Shaw, 1812)	C (100%)	C (66%)	C (83%)	C (92%)	NEC	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Amazilia lactea (Lesson, 1832)	A (50%)	C (66%)	A (42%)	A (42%)	NEC	x	x	x	x	x	x	x	x	x	x	x	x	100	75
Heliomaster sp. (Shaw, 1812)			a (16%)		NEC					x	x							16.6	8,3
Picidae Leach, 1820																			
Picumnus cirratus Temminck, 1825★★				a (25%)	INS					x		x			x			25	0
Melanerpes candidus (Otto, 1796)	A (33%)	a (8%)	a (8%)	a (8%)	INS			x	x	x	x	x		x				50	25
Veniliornis spilogaster (Wagler, 1827)	a (16%)	a (8%)		a (16%)	INS					x	x		x	x				33.3	16,6
Colaptes melanochloros (Gmelin, 1788)	a (16%)	a (8%)	a (8%)	a (16%)	INS		x	x			x	x	x		x			50	25
Colaptes campestris (Vieillot, 1818)	a (16%)			a (8%)	INS		x						x		x			25	66
Thamnophilidae Swainson, 1824																			
Thamnophilus doliatus (Linnaeus, 1764)	a (8%)	C (58%)	A (50%)	C (92%)	INS	x	x	x	x	x	x	x	x	x	x	x	x	100	83,3
Thamnophilus caerulescens Vieillot, 1816				C (66%)	INS	x	x		x	x	x	x		x			x	66.6	100
Dysithamnus mentalis (Temminck, 1823)★★				a (8%)	INS										x			8.3	0
Furnariidae Gray, 1840																			
Furnarius rufus (Gmelin, 1788)	C (100%)	C (92%)	a (8%)	A (42%)	INS	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Synallaxis frontalis Pelzeln, 1859			C (66%)	A (50%)	INS			x		x	x	x	x	x	x	x	x	66.6	100
Tyrannidae Vigors, 1825																			
Todirostrum cinereum (Linnaeus, 1766)	C (66%)	C (92%)	C (92%)	C (75%)	INS	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Elaenia flavogaster (Thunberg, 1822)	C (66%)	C (58%)	a (25%)	C (66%)	ONI	x	x	x	x	x	x	x	x	x	x	x	x	100	91,6
Serpophaga subcristata (Vieillot, 1817)	A (33%)	A (33%)			INS			x	x		x	x		x				41.6	100
Myiophobus fasciatus (Statius Muller, 1776)				A (33%)	INS	x		x					x			x	x	41.6	83,3
Pyrocephalus rubinus (Boddaert, 1783)	a (25%)	a (8%)	a (16%)		INS					x	x	x	x					33.3	25
Machetornis rixosa (Vieillot, 1819)	C (66%)				INS	x		x		x	x		x		x			58.3	83,3
Pitangus sulphuratus (Linnaeus, 1766)	C (100%)	C (100%)	C (100%)	C (100%)	ONI	x	x	x	x	x	x	x	x	x	x	x	x	100	100
Myiodynastes maculatus (Statius Muller, 1776)	A (42%)		a (8%)	a (16%)	INS	x	x								x	x	x	41.6	50
Megarynchus pitangua (Linnaeus, 1766)	C (92%)	A (25%)	a (16%)	C (66%)	INS	x	x	x	x	x	x	x	x	x	x	x	x	100	33,3
Empidonomus varius (Vieillot, 1818)	A (33%)	A (33%)	A (33%)	a (8%)	INS	x	x								x	x	x	41.6	50
Tyrannus melancholicus Vieillot, 1819	A (42%)			a (25%)	INS	x	x	x								x	x	41.6	66,6
Tyrannus savana Vieillot, 1808	A (33%)	A (42%)	a (16%)	a (25%)	INS	x	x								x	x	x	50	58,3
Myiarchus ferox (Gmelin, 1789)★★		a (8%)		a (16%)	INS				x							x	x	25	0
Tityridae Gray, 1840																			

Continue...

...continuation

Tityra inquisitor (Lichtenstein, 1823)**				a (8%)	FRU			x	8.3	0
Vireonidae Swainson, 1837										
Cyclarhis gujanensis (Gmelin, 1789)**				A (33%)	INS	x		x x x	33.3	0
Hirundinidae Rafinesque, 1815										
Progne chalybea (Gmelin, 1789)	a (8%)				INS			x	8.3	16,6
Pygochelidon cyanoleuca (Vieillot, 1817)	C (58%)			a (16%)	INS		x x x	x x x	50	91,6
Troglodytidae Swainson, 1831										
Troglodytes musculus Naumann, 1823	C (83%)	C (92%)	C (83%)	C (92%)	ONI	x x x x x x x x x x x x			100	100
Turdidae Rafinesque, 1815										
Turdus leucomelas Vieillot, 1818	C (83%)	C (58%)	C (92%)	C (66%)	ONI	x x x x x x x x x x x x			100	83,3
Turdus amaurochalinus Cabanis, 1850	a (16%)	a (25%)	a (25%)	a (25%)	ONI		x x x	x x	41.6	41,6
Mimidae Bonaparte, 1853										
Mimus saturninus (Lichtenstein, 1823)	C (66%)	a (8%)			ONI	x	x x x x x x	x x	75	75
Coerebidae d'Orbigny & Lafresnaye, 1838										
Coereba flaveola (Linnaeus, 1758)**	A (42%)	A (33%)	a (16%)		NEC	x x	x	x x x	50	0
Thraupidae Cabanis, 1847										
Nemosia pileata (Boddaert, 1783)		a (8%)	a (8%)		ONI			x x	16.6	25
Thraupis sayaca (Linnaeus, 1766)	C (100%)	C (100%)	C (100%)	C (100%)	ONI	x x x x x x x x x x x x			100	100
Tersina viridis (Illiger, 1811)**	a (16%)		a (16%)		ONI	x	x		16.6	0
Dacnis cayana (Linnaeus, 1766)**	a (25%)	a (8%)	a (25%)	a (16%)	ONI		x x x x x	x x	50	0
Conirostrum speciosum (Temminck, 1824)	A (50%)	A (50%)	a (8%)	a (16%)	ONI	x x x x x	x	x x x	75	58,3
Emberizidae Vigors, 1825										
Volatinia jacarina (Linnaeus, 1766)	a(8%)		a(8%)	A (50%)	GRA	x x		x x x x	50	58,3
Sporophila caerulescens (Vieillot, 1823)	a (16%)	a(8%)		A (33%)	GRA	x x	x	x x	41.6	83,3
Coryphospingus cucullatus (Statius Muller, 1776)**			A (50%)		GRA	x	x	x x x x	50	0
Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossem, Van Tyne & Zimmer 1947										
Geothlypis aequinoctialis (Gmelin, 1789)				a (25%)	INS	x x	x		25	25
Icteridae Vigors, 1825										
Molothrus bonariensis (Gmelin, 1789)	C (58%)	a (25%)	a (16%)	a (16%)	INS	x x		x x x x	50	66,6
Fringillidae Leach, 1820										
Euphonia chlorotica (Linnaeus, 1766)	C (100%)	C (66%)	C (83%)	C (100%)	FRU	x x x x x x x x x x x x			100	83,3
Passeridae Rafinesque, 1815										
Passer domesticus (Linnaeus, 1758)	C (66%)	a (25%)			ONI		x x x x x x x x x		83.3	100

*FO – corresponding to the number of months when the species was recorded; ** Species only recorded during 2008 at the study location; *** Constancy: a – accidental (C < 25%); A – accessory (25% > C < 50%); C – constant (C > 50%).

Appendix B. List of species recorded only by Krügel (1998) and their respective frequencies of occurrence. The following nomenclature was used by this author.

Species	FO (%)
Elanus leucurus	8.3
Columba livia	100
Columbina picui	100
Coccyzus melacoryphus	16.6
Nyctidromus albicollis	16.6
Caprimulgus sp.	25
Chaetura cinereiventris	16.6
Aphantochroa cirrochloris	8.3
Chloroceryle americana	16.6
Satrapa icterophrys	25
Myiarchus swainsoni	8.3
Empidonax euleri	8.3
Myiopagis viridicata	16.6
Tachycineta leucorrhoa	16.6
Alopochelidon fucata	16.6
Stelgidopterix ruficollis	8.3
Anthus lutescens	41.6
Vireo olivaceus	16.6
Leistes superciliares	58.3
Thraupis bonariensis	8.3
Saltator similis	16.6
Myiospiza humeralis	58.3
Estrilda astrild	58.3