

Occurrence of thrushes in an urban fragment of Araucaria forest in southern Brazil

Huilquer Francisco Vogel^{1,4}, Cláudio Henrique Zawadzki² & Rafael Metri³

¹Programa de Pós-graduação em Ecologia de Ambientes Aquáticos Continentais, Departamento de Biologia, Universidade Estadual de Maringá – UEM, Av. Colombo, 5790, G90, S16A, CEP 87020-900, Maringá, PR, Brasil

²Departamento de Biologia, Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura, Universidade Estadual de Maringá – UEM, Av. Colombo, 5790, G90, S18B, CEP 87020-900, Maringá, PR, Brasil

³Departamento de Ciências Biológicas, Faculdade Estadual de Filosofia, Ciências e Letras de Paranaguá – FAFIPAR, Rua Comendador Correia Junior, 117, CEP 83203-280, Paranaguá, PR, Brasil

⁴Corresponding author: Huilquer Francisco Vogel, e-mail: huilquer@hotmail.com

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Abstract: Seasonal segregation among syntopic species can be viewed as one of the available strategies for coexistence, reducing competitive process. The present work therefore aimed to interpret the assemblage structures comprising birds of the genus *Turdus* (Turdidae), through the analysis of seasonal variation in the species occurrence in a forest remnant located in the southcenter State of Paraná. Mist-netting was employed twice a month for capturing birds, totalling an annual effort of 7488 h.m². The frequency of occurrence, constancy and class of species dominance was determined, together with the parameters generally used in studies of ecological communities (richness, abundance, diversity and evenness). A total of 162 individuals were captured, representing five species. *Turdus rufiventris* was the most constant and frequent species. *Turdus amaurochalinus* and *Turdus leucomelas* were captured with variable constancies and frequencies along the seasons. *Turdus amaurochalinus* was also very common and may present an overlapping process between migrant and non-migrant individuals during spring. *Turdus albicollis* was considered accessory, whereas *Turdus subalaris* was only registered during the reproductive period. Hence, it was possible to observe that seasonal modifications occurred both in the frequency of occurrence and in the constancy and dominance of species. These results indicated the possibility of a lower use of the environment during the breeding season, as well as the presence of a higher number of individuals in summer and increased abundance of *Turdus rufiventris* and *T. leucomelas* during autumn and winter.

Keywords: passeriformes, seasonal segregation, Turdidae, *Turdus*.

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Resumo: Segregações sazonais entre espécies sintópicas podem ser interpretadas como táticas utilizadas para a coexistência, diminuindo processos competitivos. Neste contexto, o presente trabalho buscou interpretar a estrutura da assembléia formada por aves do gênero *Turdus* (Turdidae) para averiguar a possibilidade de padrões distintos de ocorrência em função da variação sazonal em um fragmento florestal situado no Centro-sul do Estado do Paraná. Foram utilizadas redes ornitológicas para a captura das aves, com um esforço amostral anual de 7488 h.m². Por meio das capturas quinzenais foi possível a obtenção do índice de frequência de ocorrência, constância e classes de dominância das espécies, bem como, de parâmetros ecológicos utilizados em estudos de comunidades. Um total de 162 indivíduos pertencentes a cinco espécies foram capturados. *Turdus rufiventris* foi a espécie mais frequente e constante durante o estudo. *Turdus amaurochalinus* e *T. leucomelas* foram capturadas com frequências e constâncias variáveis entre as estações do ano, sendo que, para *T. amaurochalinus* houve evidências de sobreposição de populações migrantes e não migrantes durante a primavera. *Turdus albicollis* foi considerada acessória, enquanto *T. subalaris* foi registrada somente durante a temporada reprodutiva. Desta forma, foi possível observar que ocorrem modificações sazonais, tanto na frequência de ocorrência, quanto na constância e dominância das espécies. Tais resultados indicam a possibilidade de menor intensidade do uso do ambiente durante o período reprodutivo, assim como a presença de um maior número de espécies no verão e aumento da abundância de *T. rufiventris* e *T. leucomelas* durante o outono e inverno.

Palavras-chave: passeriformes, segregação sazonal, Turdidae, *Turdus*.

Introduction

The Turdidae family occurs worldwide, representing 162 species (Clement 2000). In this family, the genus *Turdus* is prominent as a passerine group with a higher level of species richness, with 65 to 70 species (Clement 2000, Voelker et al. 2007). In Brazil, 17 thrush species are currently recorded among three genera: *Cichlopsis* (one species), *Catharus* (three) and *Turdus* (13), according to Clement (2000), Collar (2005) and CBRO (Comitê... 2011).

In Brazil, although studies focusing on *Turdus* species are not incipient, the issue is still seldom explored (Vogel 2012). Many studies aimed to establish the natural history parameters of species and we can cite studies concerning aspects of migration e.g. *Turdus subalaris* (Seeböhm, 1887) (Alves 2007) and occurrence patterns of *T. amaurochalinus* Cabanis, 1851 (Capllonch et al. 2008). More recently, there are works highlighting some predation aspects of *T. rufiventris* Vieillot, 1818 (Leite et al. 2010) and feeding habits of *T. leucomelas* Vieillot, 1818 (Sazima & D'Angelo 2011). In the field of parasitology there have been contributions, such as some studies involving mites (Storni et al. 2005) and plumicolous insects (Enout et al. 2009) associated with *T. albicollis* Vieillot, 1818 and *T. leucomelas*, respectively.

Studies on interactions that allow the coexistence of turdid species have been conducted by Gasperin & Pizo (2009) and Vogel et al. (2011a). These studies suggest a high level of overlap in the feeding habit of these species, which may enhance competition processes. Alves (2007), evaluating the research of Maia-Gouvêa et al. (2005), suggests that there is a segregation pattern among the nine syntopic species of Turdidae recorded at Parque Nacional de Itatiaia, in Rio de Janeiro. They note that nesting of *Turdus flavipes* (Vieillot, 1818) was limited to vegetation on slopes between 800 and 1800 m above sea level, whereas *T. leucomelas* and *T. amaurochalinus* were registered from 400 to 1200 m. This observation provides evidence of an altitudinal segregation among species that nest locally.

Additionally, Maia-Gouvêa et al. (op. cit.) observe segregation in the abundance of *T. albicollis* between the dry and rainy seasons, providing evidence that, in addition to the known altitudinal migrations of the group (Clement 2000, Alves 2007, Capllonch et al. 2008), there are also processes of seasonal segregation occurring in the occupational structure of the environment for such assemblages. Cody (1974) suggests that temporal segregation is a strategy for niche partitioning, decreasing direct competition for the environmental resources, and therefore enabling coexistence.

Research dealing with the Turdidae family has shown a tendency for the substitution of natural landscapes by agricultural fields (Burfield & Brooke 2005), nest predation and environmental effects on reproductive success (Kurucz 2010, Robinson et al. 2010). However, to achieve better conclusions from surveys focusing on such parameters it is necessary to have a thorough understanding of basic aspects of the species' ecology. Such information, in the Brazilian scenario, is still scarce, local and little discussed. Therefore, studies dealing with the seasonal dynamic occurrence of the species are also important as a trigger to future research.

In this context, the purpose of the present study was to evaluate whether the thrush species occurring in the same habitat vary seasonally in abundance, constancy and frequency of occurrence. If variations in these parameters are encountered, this provides indications of alternative usage of the environment that can be related to strategies for reducing competition.

Materials and Methods

1. Study area

The Parque Municipal das Araucárias (PMA) is located in the city of Guarapuava, state of Paraná, $\approx 25^{\circ} 21' S$ and $51^{\circ} 28' W$. It

is an area of environmental protection, according to the municipal law number 198/91, dated June 5th 1981 (Cordeiro & Rodrigues 2007). It comprises 104 ha, including 41 ha of Araucaria moist forest (Figure 1).

The park surrounding area is composed by an agricultural area in the north and by an urban area in the south. The regional climate is under the influence of the extratropical zone, resulting in temperatures of mesothermic type (Maack 1981). The annual average temperature is about 17 °C, with cold winters and moderated summers due to the altitude, and annual average evaporation is about 850 mm (Thomaz & Vestena 2003). Rainfall is evenly distributed throughout the year (mean annual rainfall is close to 2000 mm), without a dry season (Thomaz & Vestena 2003). The rainiest month is January and the driest month is August (Maack 1981). The mean altitude in the PMA is 1,040 m. The mean temperature of the hottest months (summer) is about 25°C, with 10 to 20 frosts occurring during winter (Maack 1981).

According to Cordeiro & Rodrigues (2007), five plant species (*Araucaria angustifolia* (Bertol.) Kuntze, *Campomanesia xanthocarpa* Berg., *Casearia decandra* Jacq., *Capsicodendron dinisii* Schwanke and *Allophylus edulis* (St. Hil.) Radlk.), together comprise a phytosociological index of importance value of 65% in the structure of the forest remnant. Exotic species within the local flora are also present, representing 12% of the arboreal species richness. Among the species with zoocoric potential are *Hovenia dulcis* Thunberg and *Ligustrum lucidum* W. T. Wait.

2. Fieldwork

The study was performed from December 2008 to November 2009. In order to investigate the structure of the assemblages, surveys on the understorey were performed using mist nets. We used six nets (three of 35 mm mesh and another three of 20 mm mesh), each 6.0 m long by 3.0 m high, arranged from 50 to 150 cm above ground level. During implementation of the pilot project, the complete randomization of the network was found to be inefficient for the capture of specimens. Thus, the net sites were chosen after analysis on the day preceding each survey, with locations where the highest activity of the studied species being selected in order to maximize captures. The captures took into account the need to sample both edges and interior environments. The nets were opened at 07:00 and remained open until sunset. The nets were checked each 30 minutes. The field effort comprised four days sampling per month, with a duration of 12 hours per day (48 hours per month), totalling 3456 h/net/year in a sampling effort of 7488 h.m², calculated from Straube & Bianconi (2002). The captured individuals were banded with numbered metal rings supplied by CEMAVE (Centro Nacional de Pesquisa e Conservação de Aves Silvestres).

3. Data analysis

The Shannon–Wiener index was applied to obtain the diversity values for the structural analysis of the assemblages among the seasons. This index is suitable for irregular sampling, which was used because the intervals between samples were not always equal, due to bad weather conditions.

Dominance and equitability indexes were also used. The Berger-Parker index was used to estimate dominance. Pielou's equitability was used because samplings were undertaken in the same place. Additional estimations were performed based on the similarity of seasons through the Bray–Curtis index and proportional capturability for 1.000 h.m². Calculations of ecological indexes were performed with recaptures that occurred in different seasons only.

The species dominance classes were calculated based on Palissa et al. (1977), $D\% = (i/t) \times 100$, where i = total number of

individuals of a species, and t = total of sampled individuals, being: $D = > 10\%$ Eudominant; $D = > 5 \div 10\%$ Dominant; $D = > 2 \div 5\%$ Subdominant; $D = 1 \div 2\%$ Recessive; and $D = < 1\%$ Rare. This index was applied to the annual results in order to establish the type of dominance of a species along the sampling year. This calculation did not take recaptures into account.

Constancy was found with the index $C = p \times 100/N$ according to Gimenes & Anjos (2000), where p is the number of surveys containing the analysed species and N the total number of surveys. The following grouping categories were proposed: $C = > 50\%$ Constant; $C = 25 \div 50\%$ Accessory; and $C = < 25$ Accidental. This index was applied both for each season and annually in order to diagnose a possible shift in the species occurrence along the seasons.

Results

A total of 162 specimens were captured and 13 were recaptured during the study, totalling 175 captures. *Turdus rufiventris* accounted for 57 captures and four recaptures. *Turdus leucomelas* ($n = 51$) totalled eight recaptures. Of the eight specimens of *T. albicollis*, there was only one recapture. Specimens of *T. amaurochalinus* and *T. subalaris* were not recaptured from a total of 42 and four specimens, respectively (Table 1). The annual variation in abundance of species showed that *T. amaurochalinus*, *T. leucomelas* and *T. rufiventris* are present throughout the year, with an increase in abundance during autumn and winter (Figure 2).

Concerning the abundance of species among seasons, there was a considerable similarity in the thrush assemblages between autumn and winter (0.93), while the lowest similarity was observed between autumn and spring (0.51). Summer and autumn and spring and summer seasons presented similarities of 0.60 and 0.63, respectively. The data summary is shown in Table 2. The highest diversity ($H' = 1.32$) was found in summer for five species, while the lowest occurred in spring ($H' = 0.96$), with three species. A high equitability was observed in winter ($j' = 0.90$) and major dominance of *T. amaurochalinus* was identified in spring (0.55), representing a total of 162 captures in a year (not taking into account recaptured

Table 1. Total of thrush captures and recaptures in the Parque Municipal das Araucárias, southern Brazil.

Tabela 1. Total de capturas e recapturas de turdídeos no Parque Municipal das Araucárias, Sul do Brasil.

Species	Total per year	Recaptured	Capture rate
	<i>N</i>	<i>N</i>	Birds/1000 h.m ²
<i>Turdus rufiventris</i>	57	4	7.61
<i>Turdus leucomelas</i>	51	8	6.81
<i>Turdus amaurochalinus</i>	42	0	5.60
<i>Turdus albicollis</i>	8	1	1.06
<i>Turdus subalaris</i>	4	0	0.53

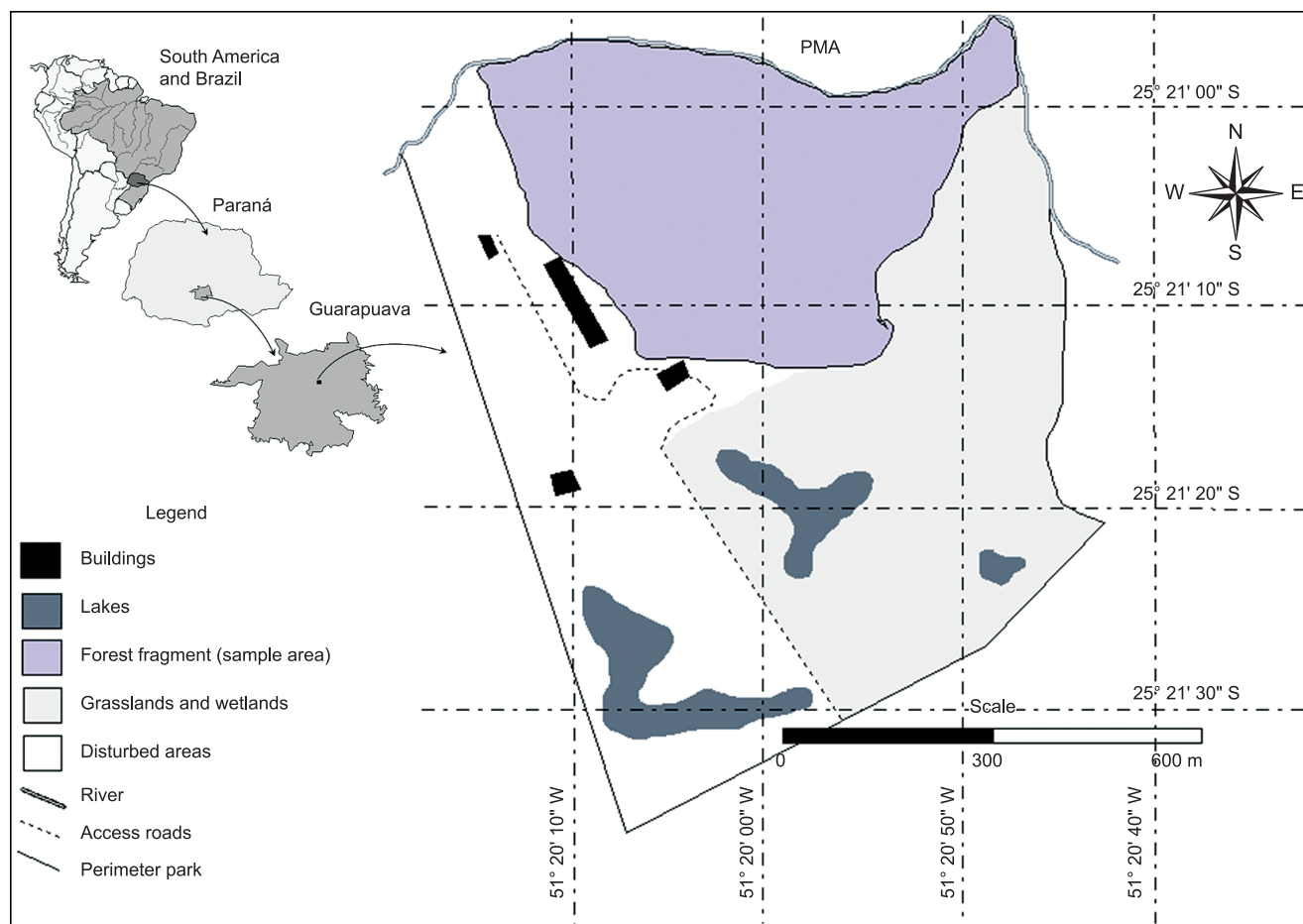


Figure 1. Location of the Parque Municipal das Araucárias in the municipality of Guarapuava, Southern Brazil.

Figura 1. Localização do Parque Municipal das Araucárias no Município de Guarapuava, Sul do Brasil.

species in different seasons), and 175 when recaptures were taken into account.

Data shown in Table 3 suggest that *Turdus rufiventris* was constant throughout the four sampled seasons, being more frequent in winter ($C = 75.0\%$). *Turdus leucomelas* was considered accessory during summer and accidental in spring, being constant in the remaining seasons. *Turdus amaurochalinus* was accessory only in summer, but constant in the remaining seasons with a relative increase in spring in comparison to the remaining seasons ($C = 84.6\%$). In its turn, *T. albicollis* was taken as accessory ($C = 30.4\%$) only in winter,

being accidental in summer and autumn and not occurring in spring. Finally, *T. subalaris* was accidental in summer and autumn and did not occur in the remaining seasons.

Discussion

The Turdidae family is commonly found in urban areas in southern Brazil (Gasparin & Pizo 2009). More specific studies also demonstrate that the genus *Turdus* is commonly captured using mist nets, as in Efe et al. (2007), which found a higher abundance of *T. rufiventris*. However, Gasparin & Pizo (2009) stated that the second most abundant *Turdus* species was *T. amaurochalinus*, differing from the present study that indicated *T. rufiventris* in the first place and *T. leucomelas* in the second place, what shows that the most abundant species positions must reflect local conditions more than the higher geographical scale.

In the survey performed at the Parque Municipal das Araucárias the highest similarity index was found between autumn and winter (0.93), which may be related to the fructification in this period of the exotic species *Ligustrum lucidum*, a frequent food resource for birds. Scheibler & Melo-Junior (2003) note that *L. lucidum* is often utilized as food by thrushes during winter. It is thus postulated that these species were more dependent on this resource in milder periods, resulting in a higher assemblages similarity between autumn and winter.

Table 2. Ecological indices related to the samplings performed at the Parque Municipal das Araucárias, southern Brazil.

Tabela 2. Índices ecológicos relacionados com as amostragens realizadas no Parque Municipal das Araucárias, Sul do Brasil.

Indexes	Seasons			
	Summer	Autumn	Winter	Spring
Richness	5	5	4	3
Individuals	28	61	57	29
Diversity H'	1.32	1.31	1.24	0.96
Evenness J'	0.82	0.81	0.90	0.87
Dominance	0.50	0.40	0.38	0.55

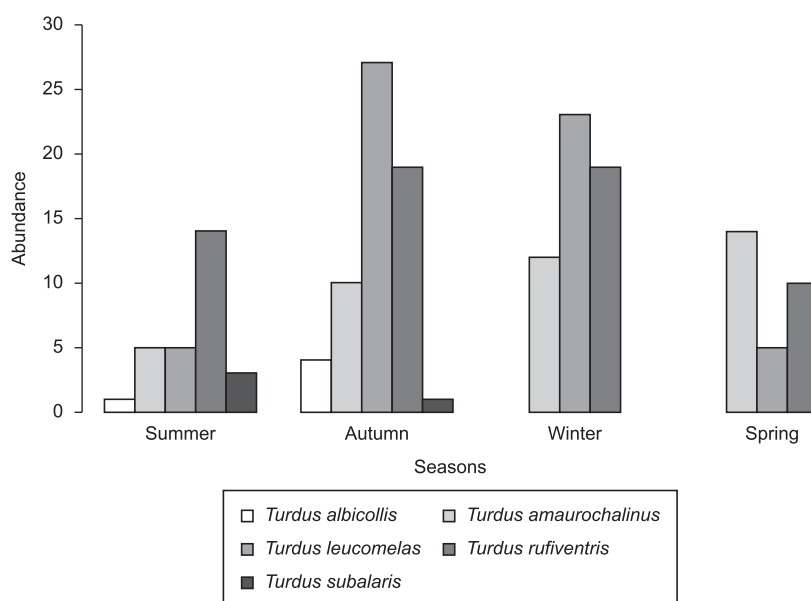


Figure 2. Seasonal variation in abundance of five *Turdus* species in the Parque Municipal das Araucárias, southern Brazil.

Figura 2. Variação sazonal na abundância de cinco espécies de *Turdus* no Parque Municipal das Araucárias, Sul do Brasil.

Table 3. Constancy (C) and dominance (D) of five *Turdus* species at the Parque Municipal das Araucárias, southern Brazil.

Tabela 3. Constância (C) e dominância (D) de cinco espécies de turdídeos no Parque Municipal das Araucárias, Sul do Brasil.

Species	Seasonal constancy ($C\%$)				Total overall	
	Summer	Autumn	Winter	Spring	($C\%$)	($D\%$)
<i>Turdus rufiventris</i>	53.80	75.00	84.60	53.80	66.60	35.18
<i>Turdus leucomelas</i>	30.40	91.60	76.90	23.00	54.90	31.48
<i>Turdus amaurochalinus</i>	38.40	50.00	53.80	84.60	56.80	25.93
<i>Turdus albicollis</i>	7.60	1.60	30.40	0.00	13.70	4.94
<i>Turdus subalaris</i>	1.50	1.60	0.00	0.00	7.80	2.47

Diversity in summer was higher ($H' = 1.32$) due to the presence of *Turdus subalaris*. This species occurred exclusively in summer and in early autumn (a single individual in the last season). According to Antas & Valle (1987), this species breeds in southern South America and uses the southern border of the Amazon as wintering areas. Alves (2007) suggests that there should be a lack of fidelity to return areas by *T. subalaris*, which might explain why the species, which occurred in summer 2008, was not sampled in spring 2009, despite it being concomitantly visually registered in neighbouring areas.

Turdus albicollis, which presented constancy values of 7.6% in summer and 1.6% in autumn, showed a relative increase in occurrence frequency during winter (30.4%), becoming an accessory species. This bird is considered sensitive to processes of forest fragmentation (Sick 1997, Collar 2005, Gasperin & Pizo 2009) and its presence may indicate the capacity of this forest fragment to support small populations of this bird. In the present study, *T. albicollis* was more frequent than reported by Lopes & Anjos (2007), who reported its presence only in winter at the campus of Universidade Estadual de Londrina (northern state of Paraná).

Turdus rufiventris is considered a common species in studies in the vicinity of the study area (Vogel et al. 2011b). The species, as expected, was constant throughout the study due to its non-migratory behaviour, as described by Sick (1997) and Collar (2005). Its annual constancy ($C = 66.6\%$) establishes its resident status. In the present study, despite the few recaptures of *T. rufiventris* at PMA, it was found to be constant throughout two seasons (autumn and spring), which infers the permanence of at least some individuals throughout the breeding and non-breeding periods. Ludvig et al. (1994) verify that adults of *Turdus merula* (Linnaeus, 1758) in an urban park in Budapest (Hungary) stayed or returned to the studied fragment in spring. That work described how in the spring season pairs presented a more evident agonistic defensive behaviour, displaying the territorial pattern for the genus. Lomáscolo et al. (2010) demonstrate that *T. rufiventris*, although tolerant to altered habitats, suffers high nest predation in relation to natural areas, which is compensated by choosing safer microhabitats for nest building. Therefore, these data emphasize the importance of urban fragments in the maintenance of some anthropophilic bird species. Despite the majority of bird species inhabiting urban environments having characteristics that allow them to use such unnatural habitats, small fragments are, for example, as important as nocturnal shelters (Lomáscolo et al. 2010).

The decrease in the constancy of *Turdus leucomelas* in spring and summer could be related to factors emphasized by Alves (2007) as a means of intraspecific spatial segregation during breeding periods, as it coincides with the pattern described for the south region of Brazil (Sick 1997). Additionally, in this period, sexual activity in the field was also verified. Cohen & Lindell (2004) observed that specimens of *Turdus assimilis* Cabanis, 1850, commonly return with their offspring to the forests immediately after breeding in adjacent areas, providing evidence for the employment of a distinct habitat during the breeding season. In the same way, many individuals of *T. leucomelas* are perhaps using urban environments for reproduction, as verified in the field, and returning to PMA in the autumn and winter for feeding.

On the other hand, the increase in the frequency of occurrence of *Turdus amaurochalinus* in spring can be seen as an overlapping of migrant individuals over resident individuals. Such a phenomenon is cited by Sick (1997) because not all individuals migrate. This observation is similar to results of a study conducted by Capllonch et al. (2008). They observe that, in the preferred breeding habitat in areas of Argentina, there is an overlap of migrant thrushes over local resident specimens from September to October. Gonzaga et al. (2000) mention capturing the species in Maricá Restinga in Rio de Janeiro between

April and July. Alves (2007) reports two samples in two periods of the year in the Cerrado near to Brasília city (Central Brazil) in May and between August and October. Although *T. amaurochalinus* has been frequent in the sampled forest fragment, its occurrence at the site should be related to temporary use, resting, or simply as shelter during displacements through the landscape, since the species is common in open habitats (Ridgely & Tudor 2001).

The pattern of occurrence found for the thrush assemblages that comprises the site shows that *T. subalaris* is the less abundant species and only occurs in summer and early autumn, an occurrence pattern that, according to Clement (2000), is coincident with the breeding season. In theory, such an occurrence could be related to the period, given its increased average temperatures in southern Paraná State (Maack 1981). Such heating periods culminate in increased food resources (e.g. insects and fruits), favouring the occurrence of breeding sites for this species (Sick 1997). The abundance of resources reduces competition pressure and allows species to coexist (Putman 1996). However, with dwindling resources, the optimum tactic is to make seasonal movements in search of better environmental conditions (Alves 2007). The species included in this study are perceived to be very similar, both morphologically and functionally (Sick 1997), mainly in terms of trophic guilds (Clement 2000, Gasperin & Pizo 2009). The morphological proximity among the species can provide a convergence in habitat occupation and therefore a niche overlap (Cody 1974, Putman 1996). According to Vogel et al. (2011a) there is some possibility of competitive edge between *T. rufiventris* and *T. leucomelas* due to the higher trophic niche breadth of *T. rufiventris*. Therefore, studies taking into account the sharing of breeding sites are essential to explain the dynamics of species abundance throughout the seasons.

As noted by Remsen Junior & Good (1996), many studies have failed to consider any attempt to correct the deviations caused by the several factors that influence the capture of birds. Among these factors are changes in the seasonal activity patterns of birds (Malizia 2001), in daily environmental parameters (Mallet-Rodrigues & Noronha 2003), and in the habitat type and size (Lövei et al. 2001). However, due to morphological similarities among these species and similar behavioural habits, it is reasonable to infer that our estimates could function as a parameter between catch rates and abundance of species (Table 1). Nonetheless, due to the relatively low quantity of available data, this conclusion need to be treated with caution.

In summary, thrush assemblages at PMA is dynamic, variable and possibly related to seasonal factors, once the variation in constancy and abundance values of species along seasons are taken into account. A monitoring study could confirm this pattern, since the rate of capture is a complex index. *Turdus rufiventris* was the most constant and abundant species in this study. *Turdus leucomelas* presented patterns of decrease in its occurrence frequency in the spring samplings, possibly indicating a local population reduction as individuals search for specific areas for nidification. The occurrence patterns of *T. albicollis* at PMA might be associated with altitudinal displacement movements, a phenomenon already referred to in relation to the congeneric species. In turn, for *T. amaurochalinus* the occurrence of an overlap of migrant individuals or populations over the resident ones is possible, and the occurrence of *T. subalaris* was only observed during its migratory passage in summer. Although not the ultimate aim of this paper, we agree with the works of Galina & Gimenes (2006) and Catian & Aranda (2009), who draw attention to the relevance of urban-forested ecosystems in the maintenance of several bird species. There is a frequent use of these habitats not

only by the resident species but also by migratory birds which use the sites as resting areas when in migration, obtaining food, shelter and reproductive sites.

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