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Long-term avifaunal survey in an urban ecosystem from southeastern Brazil, with comments on range extensions, new and disappearing species

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ABSTRACT

Urban avifaunal surveys in Brazil have been increasing in recent years, despite none of them consisting of long-term studies indicating events of regional colonization and/or missing species. Here, we present an avifaunal survey of an urbanized ecosystem in southeastern Brazil, carried out along 30 years, on the campus of the Pontifícia Universidade Católica de Minas Gerais, municipality of Belo Horizonte, Minas Gerais state. Inside the campus there is a forest reserve adjacent to a small lake. The inventory was mainly based on opportunistic records from the years 1982-2013. We recorded 134 bird species along the past 30 years. However, the present avifauna is composed of 123 species. A total of 97 species was recorded in the reserve, including the forest fragment and the adjacent lake, of which 44 were exclusive to this area. Nevertheless, the majority of the current species found in the study area is forest independent (N = 51) or semi-dependent (N = 46). There is a predominance of insectivorous (N = 43) and omnivorous (N = 29) species. The current avifauna is represented by 15 migratory species, which can be found both in the urbanized area and in the forest remnant. However, the majority of the species (N = 75) is resident in the area, including three invasive species, whereas few others

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(N = 28) are occasional visitors. The remaining species were probably introduced in the area. There were 11 cases of disappearing species, which include typical forest birds, and also species typical of wetlands and rural environments. We also comment on recent colonization and on the possible effects of isolation on birds. Probably, the majority of forest-dependents are on the brink of extinction in the forest fragment. Thus, the species' list provided here can be useful as a database for monitoring long-term effects of urbanization on this bird community.

KEY-WORDS: Avifauna; Colonization; Disappearing species; Urban environment.

INTRODUCTION

In the past century urban ecosystems became the main landscape for billions of people around the world, and concentration of urban population is rising fast (Grimm *et al.,* 2008). In those ecosystems dominated by human activities, biodiversity exerts an important role on human health and welfare and should be managed for improving the quality of life of citizens and the conservation of wildlife (Savard *et al.,* 2000). Birds are important drivers of processes that regulate and support ecosystem function, including pest control, carcass and waste disposal, nutrient deposition, seed dispersal, pollination, and ecosystem engineering by burrow and cavity diggers (Sekercioglu, 2006). Besides the recreational, aesthetic and educational significance of urban birds (Sick, 1997), this highly mobile group is of major importance concerning air traffic collisions (Kitowski, 2011) and the spread of disease (Reed *et al.,* 2003). Urbanization negatively affects bird species richness and composition, selecting against specialized species and favoring synanthropic ones (Chace & Walsh, 2006; Carvalho & Marini, 2007; Ortega-Álvarez & MacGregor-Fors, 2009; Reis *et al.,* 2012). However, even in urban ecosystems, bird species comprise remarkable elements of the biodiversity, and information on community composition can be an important tool for monitoring environmental changes (Fernández-Juricic & Jokimäki, 2001; Chace & Walsh, 2006; Ortega-Álvarez & MacGregor-Fors, 2009, 2011; Fontana *et al.,* 2011; Reis *et al.,* 2012).

The interest of studying bird species composition in urban ecosystems of Brazil exists for decades, which is reflected by the increasing number of studies which have been recently published on this subject (*e.g.,* Rusczyk *et al.,* 1987; Argel-de-Oliveira, 1990, 1995; Matarazzo-Neuberger, 1992, 1995; Monteiro & Brandão, 1995; Alves & Pereira, 1998; D'Angelo-Neto *et al.,* 1998; Borges & Guilherme, 2000; Mendonça-Lima & Fontana, 2000; Guilherme, 2001; Franchin & Marçal-Júnior, 2004; Franchin *et al.,* 2004; Lopes & Anjos, 2006; Scherer *et al.,* 2006; Valadão *et al.,* 2006a, b; Torga *et al.,* 2007; Vasconcelos, 2007; Vasconcelos *et al.,* 2007; Paetzold & Querol, 2008; Pinheiro *et al.,* 2008; Pereira & Silva, 2009; Fontana *et al.,* 2011; Rosa & Blamires, 2011; Dario, 2012; Franco & Prado, 2012; Mafia *et al.,* 2012; Reis *et al.,* 2012; Scherer-Neto *et al.,* 2012; Teles *et al.,* 2012). However, none of these surveys consist of long-term studies that indicate events of regional colonization and/or missing species.

In this paper we present an avifaunal survey of an urbanized ecosystem in southeastern Brazil, carried out along 30 years. Bird species were classified according to occurrence in urban habitats and in the reserve, which includes a native forest remnant and an adjacent lake located within the area. We describe the current bird community in terms of species richness, composition, trophic structure, and the patterns of movement. We also report and comment on range extensions, regional colonization and disappearing species in the bird community during this period.

METHODS

Study area

The *campus* of the Pontifícia Universidade Católica de Minas Gerais (hereafter *campus*) is located in the district of Coração Eucarístico, municipality of Belo Horizonte, the capital of Minas Gerais state, southeastern Brazil, between the coordinates 19°54'58"S and 19°55'35"S, 43°59'19"W and 43°59'44"W (Fig. 1), with elevation ranging from 870 to 930 m above sea level. Belo Horizonte is located in a transitional zone between the Atlantic Forest and the Cerrado.

Until 1926, the area was a farm (Fazenda Gameleira) in the suburbs of Belo Horizonte. It was occupied by the Catholic Church, with the building of the "Seminário Coração Eucarístico" (PBH, 2012). In 1970 the area started to shelter the new *campus* of the Pontifícia Universidade Católica de Minas Gerais (PUC Minas) (Cuadrado, 1987); later, urban areas

rapidly occupied its surroundings, especially in the 1980s (B.J. Teixeira, *pers. com.*).

Inside the *campus* there is a forest reserve known as "Mata da PUC" (hereafter "PUC forest"). This is a fragment of secondary semideciduous forest of *c.* 66,755 m² (Mata da PUC Minas, 2011). Important tree species identified in this fragment (Werneck, 1998) include: "pau-jacaré" (*Piptadenia gonoacantha*), "capixim" (*Mollinedia widgrenii*), "camboatá" (*Cupania vernalis*), "camboatá-branco" (*Matayba elaeagnoides*), "canela-papagaio" (*Endlicheria paniculata*), "maria-faceira" (*Guapira opposita*), "guamirim-chorão" (*Myrcia rostrata*), and "carne-de-vaca" (*Roupala brasiliensis*). Along the forest edges, there are plantations of Asiatic bamboos. In the interior of the forest, it is possible to find other exotic plants, such as: banana (*Musa* sp.), avocado (*Persea americana*), mango (*Mangifera indica*), taro (*Xanthosoma sagittifolium*), "espada-de-são-jorge" (*Sansevieria trifasciata*), salvia (*Salvia splendens*) and "bico-de-papagaio" (*Euphorbia pulcherrima*) (M.F.V., *pers. obs.*).

Based on old aerial photographs available at the university library, it was found that the forest fragment was completely isolated from other forest patches since 1960; part of it, currently covered by secondary forest, was cleared in the past (Fig. 2). This area was reforested with native and exotic trees in the 1970s and the vegetation regenerated (Mata da PUC Minas, 2011). Nevertheless, in the 1960s the entire area of the *campus* was on the outskirts of Belo Horizonte, in a predominantly rural matrix where pastures and swampy areas dominated (B.J. Teixeira, *pers. com.*). Currently, however, this area is completely inserted in an urban matrix, which prevents or impairs the dispersal of several bird species to other city parks and reserves. Furthermore, a small airport (Aeroporto de Carlos Prates), in activity since 1944, is located *c.* 500 m from the *campus.*

Adjacent to the PUC forest is a small lake of about 1,280 m², which was formed by damming a small stream (Landa & Landa, 2001). Upstream, there is another temporary lake, which presents water only during the rainy season (October-March) and becomes a marsh during the dry season (April-September). The rest of the *campus* is characterized by several buildings and gardens, represented by various tree species, most of them exotic.

Despite the importance of the PUC forest as a training site for the undergraduate and graduate students of this institution, there are only three published studies on its fauna: a checklist of butterflies (Silva *et al.,* 2007), a study on the use of space by the White-eared Opossum (*Didelphis albiventris* – Almeida *et al.,* 2008) and a behavioral study of the Flavescent Warbler (*Basileuterus flaveolus* – Perillo *et al.,* 2010). With respect to the *campus,* the only published paper refers to the behavior of the Burrowing Owl (*Athene cunicularia* – Perillo *et al.,* 2011).

Avifaunal survey

The general survey of the *campus* avifauna was conducted between 1982 and 2013. Most of the authors' records were opportunistic, without systematic survey techniques. J.E.S. and B.G. initiated fortuitous bird observations in 1982, working from then until the present as teachers of this institution.

Later, L.G.M., A.P. and R.M. conducted a systematic survey of the avifauna of the PUC forest between 2005 and 2007 using point counts. In that study, 11 points were established in the PUC forest (50 m apart from each other), which were sampled for eight minutes in fortnight campaigns, totaling 160 h of sampling effort.

Another systematic study in this forest fragment was conducted by F.A.V. and D.P. based on MacKinnon lists of 10 species (MacKinnon & Phillips, 1993; Herzog *et al.,* 2002; Ribon, 2010) during monthly observations conducted in the morning (06:00 h-08:00 h) between 2 March 2012 and 8 June 2012, totaling 30 h of sampling effort.

Since April 2010, M.F.V. has taught several field classes in the PUC forest and other areas of the *campus,* including bird observations (*c.* 250 h of sampling effort) and capture with mist-nets (*c.* 20,000 m².h, following Straube & Bianconi, 2002). In those recent surveys, the vocalizations of several species have been recorded with a Sony TCM-5000EV tape recorder and Sennheiser ME-66 microphone. Copies of these vocalizations will be deposited in the Arquivo Sonoro Prof. Elias Coelho (ASEC), at the Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil. Between 2006 and 2012, C.E.R.T.B., J.E.M.D. and B.P.R. also documented the avifauna with photographs, which have been kept in their personal archives.

Additionally, for the general survey of the avifauna, we also checked the bird collection of the Museu de Ciências Naturais da PUC Minas (MCNA), where there are several bird specimens (study skins and skeletons) from the study area and its vicinities.

The systematic order and scientific names follow the Brazilian Committee of Ornithological Records (CBRO, 2011). Classification of endemic birds of the Atlantic Forest was based on Brooks *et al.* (1999b), while those endemic to the Cerrado followed Silva

(1995). Species were classified by forest dependency according to Silva (1995). Birds were also classified in trophic guilds according to Motta Junior (1990), Stotz *et al.* (1996), Sick (1997) and Lopes *et al.* (2005), and according to their migratory status following Sick (1984, 1997) and Chesser (1994). Exotic species were considered invasive, occupying the area with human assistance and, later, establishing populations followed by range expansion (*sensu* Simberloff, 2010). We treated those invasive species differently than introduced species, considering native species that were released in the area; the majority of them common in the pet trade.

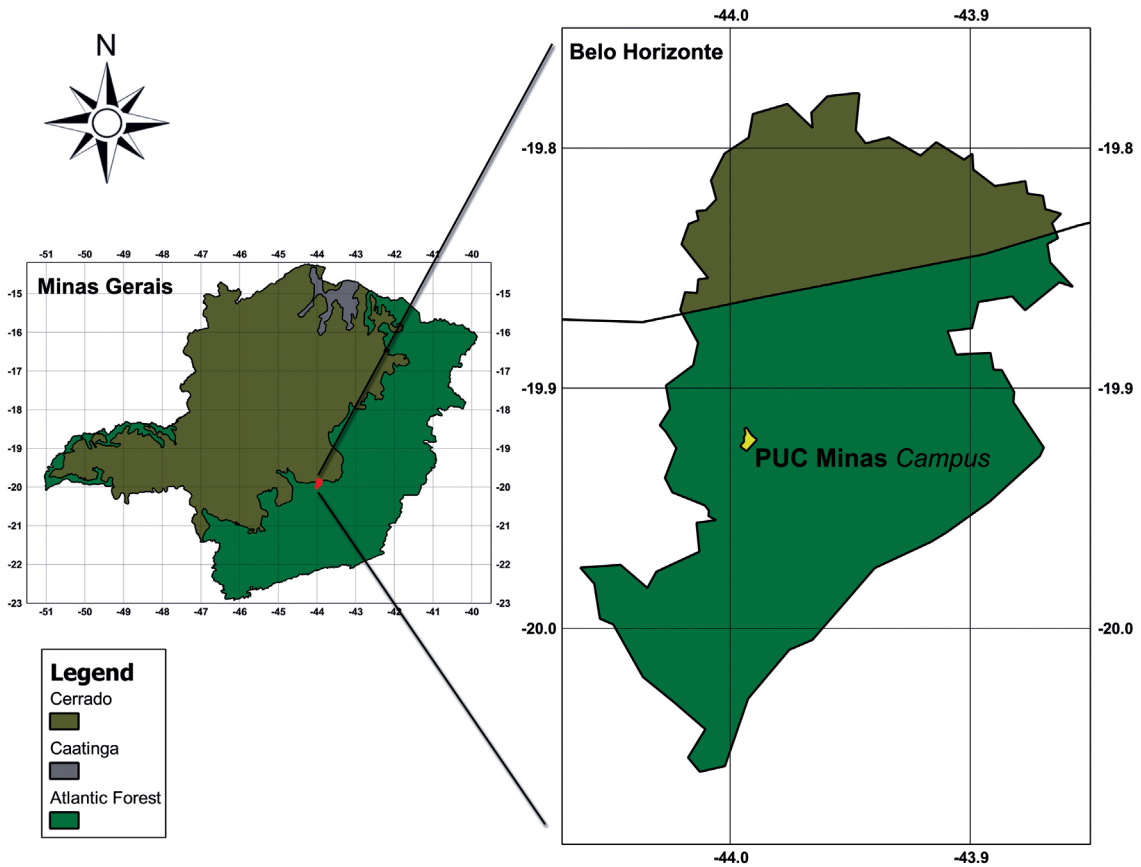

FIGURE 1: Map showing the study area of the *campus* of the Pontifícia Universidade Católica de Minas Gerais (yellow) in the municipality of Belo Horizonte, Minas Gerais, southeastern Brazil. The municipality is in a transitional zone between the Atlantic Forest and the Cerrado.

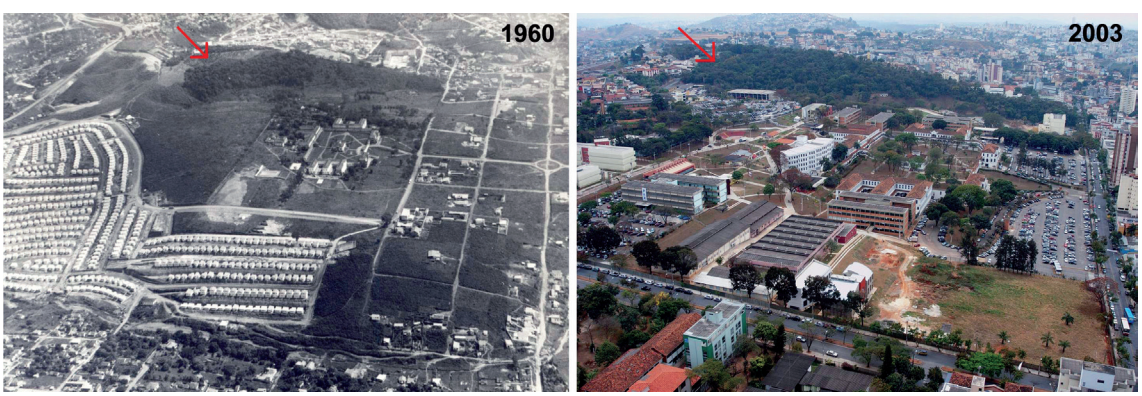

FIGURE 2: Aerial photographs of the *campus* of the Pontifícia Universidade Católica de Minas Gerais in 1960 (left) and 2003 (right). Red arrows indicate the forest fragment (PUC forest).

RESULTS AND DISCUSSION

Avifaunal survey

We recorded a total of 134 bird species belonging to 40 families on the *campus* along the past 30 years (Appendix). However, the present avifauna (recorded between 2005 and 2013) is composed by 123 species from 38 families, mostly native species. Most species (N = 53, 39.6%) were recorded using both urbanized areas and the forest remnant vicinities, but only 37 species (27.6%) were observed exclusively in urbanized area. A total of 97 species (72.4%) was recorded in the forest fragment and its adjacent areas, including the lake. However, 44 species (32.8%) were found exclusively in this habitat, including the Rufous-headed Tanager (*Hemithraupis ruficapilla*), an Atlantic Forest endemic, and the Chestnut-capped Foliage-gleaner (*Hylocryptus rectirostris*), a Cerrado endemic, highlighting the transitional character of the region. Nevertheless, the majority of the current bird species found in the study area is forest-independent (N = 51, 41.5%) or semi-dependent (N = 46, 37.4%). Only 26 species (21.1%) are considered forest-dependent and all of them have populations restricted to small forest fragments, including Plain Antvireo (*Dysithamnus mentalis*), Black-capped Antwren (*Herpsilochmus atricapillus*), Variable Antshrike (*Thamnophilus caerulescens*), Chestnut-capped Foliage-gleaner (*Hylocryptus rectirostris*), Sooty-fronted Spinetail (*Synallaxis frontalis*), Sepia-capped Flycatcher (*Leptopogon amaurocephalus*), Yellow-olive Flycatcher (*Tolmomyias sulphurescens*), Fuscous Flycatcher (*Cnemotriccus fuscatus*), Euler's Flycatcher (*Lathrotriccus euleri*), Rufous-headed Tanager (*Hemithraupis ruficapilla*), Saffron-billed Sparrow (*Arremon flavirostris* – Fig. 3), White-bellied Warbler (*Basileuterus hypoleucus*) and Flavescent Warbler (*Basileuterus flaveolus*).

Considering the current bird assemblage in different trophic guilds, there is a predominance of insectivorous (N = 43, 35%) and omnivorous (N = 29, 23.6%) species, a common pattern found in general Neotropical urban avifauna (Ortega-Álvarez & MacGregor-Fors, 2011). However, we also found some frugivorous (N = 14, 11.4%), granivorous (N = 10, 8.1%), nectarivorous (N = 9, 7.3%), carnivorous (N = 9, 7.3%), piscivorous (N = 6, 4.9%) and detritivorous (N = 3, 2.4%) species. Although birds in most guilds are able to use both the urbanized area and the reserve, the diversity of more specialized insectivorous and piscivorous was higher in the forest remnant and adjacent lake (Fig. 4).

In relation to the pattern of movements and dispersal, the current avifauna is represented by 15 migratory species (see below), nine from Tyrannidae and the remaining distributed among other five families (Appendix). These migratory species can be found both in the urbanized area and in the forest remnant, but few species exclusively used the reserve (Fig. 5). However, most species recorded (N = 75, 61%) can be considered as resident in the area, including three invasive species, whereas few others (N = 28, 22.8%) are occasional visitors. The remaining species were probably introduced in the area, and the majority of them have been recorded in the reserve (Fig. 5).

Also noteworthy are those species of aquatic habitats, which are restricted to the small permanent lake adjacent to the PUC forest. Examples are: Neotropic Cormorant (*Phalacrocorax brasilianus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Striated Heron (*Butorides striata*), Great Egret (*Ardea alba*), Gray-necked Wood-Rail (*Aramides cajanea*), Paint-billed Crake (*Neocrex erythrops*), Ringed Kingfisher (*Megaceryle torquata*) and Amazon Kingfisher (*Chloroceryle amazona*). The piscivorous species are occasional visitors in the study area and feed mainly on Nile Tilapias (*Oreochromis niloticus*) that were introduced in this lake. In the specific case of the Paint-billed Crake, the only species record in the study area is based on a specimen found dead near the Museu de Ciências Naturais, not far from the lake, on 28 September 2010 (Lopes *et al.,* 2012). Its skeleton was prepared and deposited in the bird collection of this institution (MCNA 1757). Sick (1997) reports another record of this species for the city of Belo Horizonte, possibly based on a skin deposited in the collection of the Museu de História Natural and Jardim Botânico da Universidade Federal de Minas Gerais, which was checked by M.F.V.

Disappearing species

Over the course of this 30-year-survey, there were 11 cases of disappearing species in the study area, based on species recorded in the 1980s and 1990s (J.E.S. and B.G., *pers. obs.;* L.F. Silveira, *pers. com.*), but not detected anymore in recent years (2005 onwards). These species are: Small-billed Tinamou (*Crypturellus parvirostris*), Swallow-tailed Kite (*Elanoides forficatus*), Pauraque (*Hydropsalis albicollis*), Rufous-fronted Thornbird (*Phacellodomus rufifrons*), Yellow-chinned Spinetail (*Certhiaxis cinnamomeus*), White-headed Marsh Tyrant (*Arundinicola leucocephala*), White-rumped Swallow (*Tachycineta leucorrhoa*), Black-capped Donacobius (*Donacobius atricapilla*), Pileated Finch (*Lanio pileatus*), Rufous-collared

Sparrow (*Zonotrichia capensis*) and Chopi Blackbird (*Gnorimopsar chopi*).

Those missing species can be divided into three different groups according to their habitats: species typical of forests and forest edges, species typical of wetlands with cattails (*Typha* sp.), and species typical of rural environments. The first group includes *E. forficatus* and *H. albicollis,* which probably disappeared due to the rapid urbanization of the region, which led to the reduction of fragments needed for foraging and perching (*E. forficatus*) or because of the strong pressure of ground-nest predation by domestic cats and dogs (*H. albicollis*), a well known impact on the avifauna of urban areas (Woods *et al.,* 2003; Galetti & Sazima, 2006). Even though both species are absent at PUC Forest currently, they apparently present different extinction levels. *Hydropsalis albicollis* should be considered locally extinct, as it can still be found in larger forest fragments around the city (Vasconcelos *et al.,* 2003; Vasconcelos, 2007). However, *E. forficatus* should be considered regionally extinct, as there are no longer known records of the species in Belo Horizonte, nor in its surroundings (Carvalho & Marini, 2007; L.G.M., M.F.V. and C.E.R.T.B., *pers. obs.*). Birds of the second group include *C. cinnamomeus, A. leucocephala* and *D. atricapilla,* occurring in wetlands with cattails until the 1990s. Subsequently, most of this vegetation was harvested and these three species had no longer been recorded. The third group includes the remaining species, *C. parvirostris, P. rufifrons, T. leucorrhoa, L. pileatus, Z. capensis* and *G. chopi,* which are very common in rural habitats of central and southeastern Brazil (farms, orchards, plantations) that until the late 1970s represented the dominant landscape of the region where the *campus* was located. With rapid urbanization in the region after the 1980s, it is possible that these species were no longer able to maintain viable populations in the *campus* area surrounded by inappropriate urban matrix.

Recent colonization

Two bird species are common in the muddy margins of the small lake adjacent to the PUC forest: the Wing-banded Hornero (*Furnarius figulus*) and the Masked Water-Tyrant (*Fluvicola nengeta*). Both are species with original ranges in northeastern Brazil, but which have been expanding southwards since the last century (Alvarenga, 1990; Willis, 1991; Lo, 1994; Sick, 1997; Krauczuk *et al.,* 2003; Alvarenga *et al.,* 2006; Klavins & Bodrati, 2007; Straube *et al.,* 2007; Melo, 2010; Figueiredo *et al.,* 2010; Quintas-Filho *et al.,* 2011; Straube, 2012). Notwithstanding, *F. nengeta* has been recorded in the area since the earliest surveys (1980s), suggesting an older colonization (see Straube, 2012). On the other hand, *F. figulus* was only recorded in the area after the 1990s (J.E.S., *pers. obs.*).

The Picazuro Pigeon (*Patagioenas picazuro*) was rarely recorded in the *campus* area in the 1980s, as well as in the surroundings of Belo Horizonte city, until the mid-1990s. Currently, it is widespread throughout the city and very common on the *campus.* This species has also expanded its range in the state of São Paulo (Willis & Oniki, 1987; Alvarenga, 1990). Willis (1991) suggested that it would be important to collect specimens of *P. picazuro* in the state of São Paulo in order to determine if the subspecies expanding there was the southern form (*P. p. picazuro*) or the northeastern subspecies (*P. p. marginalis*). Seven specimens that were found dead in the study area (MCNA 726, 1881, 2361, 2362, 2363, 2364, 2922) were identified as the subspecies *P. p. marginalis* (following Pinto, 1949), suggesting that colonization of Belo Horizonte should be occurring from north to south.

The Band-winged Nightjar (*Hydropsalis longirostris*) was previously recorded on the *campus* in 1995 (L.F. Silveira, *pers. com.*). Recently, on 13 October 2011, a young male was found dead near the *campus.* This specimen was prepared as a study skin and has been deposited in MCNA (under the registration number MCNA 1796). Since it is known that *H. longirostris* has the ability to colonize large and medium-sized cities, such as Rio de Janeiro, Porto Alegre and Santo Amaro (Sick, 1959, 1963, 1997; Ingels *et al.,* 1999), it is very possible that this species is colonizing urban areas of Belo Horizonte. In this city, it has also been recorded in recent years in regions where it had not been detected until the last 20 years, such as the districts of Anchieta, Funcionários, Gutierrez, Luxemburgo, Mangabeiras, Santa Lúcia, Santo Antônio and Serra (L.G.M., M.F.V., C.E.R.T.B. and L.P.S.S., *pers. obs.*).

Finally, the record of the Masked Gnatcatcher (*Polioptila dumicola*) on the *campus* represents a range extension of almost 300 km to the east, based on current literature. In Minas Gerais, its known range is concentrated in the extreme west of the state, in the regions of Triângulo Mineiro and northwestern Minas Gerais (Ridgely & Tudor, 1989; Ridgely *et al.,* 2007; Lopes *et al.,* 2008; Faria *et al.,* 2009). Although unpublished, four specimens collected in 2004 by M.F.V. at Fazenda Buriti Grande (18°44'S, 45°20'W), municipality of Morada Nova de Minas, are deposited in the Coleção Ornitológica do Departamento de Ornitologia da Universidade Federal de Minas Gerais

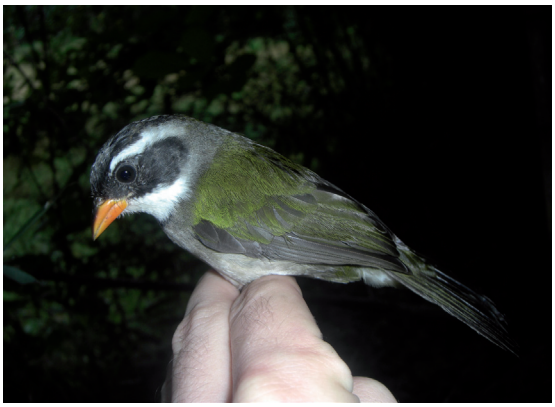

FIGURE 3: Saffron-billed Sparrow (*Arremon flavirostris*) mist-netted in the PUC forest. Photo: J.E.M. Dias.

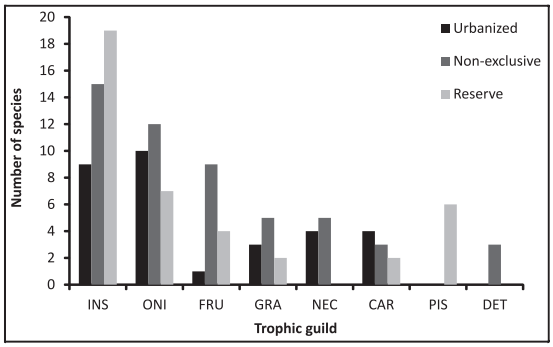

FIGURE 4: Distribution of bird species of different trophic guilds using different habitat on the *campus* of the Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, southeastern Brazil. *Guilds:* CAR = carnivorous; DET = detritivorous; FRU = frugivorous; GRA = granivorous; INS = insectivorous; NEC = nectarivorous; ONI = omnivorous; PIS = piscivorous.

(DZUFMG 4182, 4183, 4248, 5188), which extends the species' range to the central region of the state. Anyway, the record on the *campus* still represents the southeastern border of the range of *P. dumicola* (*c.* 200 km southeast of Fazenda Buriti Grande). The species was first recorded in the study area in 2010. Since *P. dumicola* was not detected during other surveys conducted in other areas of Belo Horizonte (Carnevalli & Rigueira, 1982; Rigueira *et al.,* 1982; Faggioli, 1991; Vasconcelos, 2007; Pedersoli *et al.,* 2010; Mafia *et al.,* 2012), it is possible that the species has been expanding its range as a result of recent environmental changes.

Introduced and invasive species

Some species recorded on the *campus* are commonly appreciated by the human population as pets and can be considered as introduced. Some of them

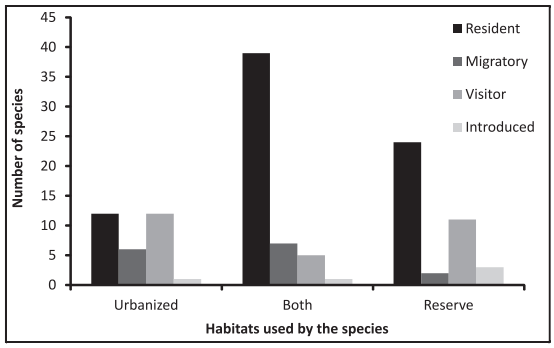

FIGURE 5: Distribution of bird species according to habitat use and patterns of movements and dispersal on the *campus* of the Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Minas Gerais, southeastern Brazil.

FIGURE 6: Individual of Dusky-legged Guan (*Penelope obscura*) in the edge of PUC forest and the garden of Museu de Ciências Naturais. Photo: D. Hoffmann.

FIGURE 7: Individual of Chalk-browed Mockingbird (*Mimus saturninus*) with blackish-brown throat and upper breast. Photo: D. Hoffmann.

have sporadic records in the study area, but do not appear to establish populations there, including Dusky-legged Guan (*Penelope obscura* – Fig. 6), Blue-fronted Parrot (*Amazona aestiva*), Green-winged Saltator (*Saltator similis*) and Hooded Siskin (*Sporagra magellanica*). Probably, these birds escaped from captivity or

have been released. All individuals of the above mentioned species were recorded only once on the *campus,* were not shy (an indication that it is used to humans) and were represented by a single individual.

On the other hand, the introduced Saffron Finch (*Sicalis flaveola*), which has been recently released by the Brazilian environmental agency (IBAMA) and the forest police in Belo Horizonte and several other cities of Minas Gerais state, has a stable and reasonable population in the *campus* area.

Three other common and abundant species, the Rock Pigeon (*Columba livia*), the Common Waxbill (*Estrilda astrild*) and the House Sparrow (*Passer domesticus*) are exotic and considered invasive in Brazil, commonly found in urbanized ecosystems (Sick, 1997).

Migratory species

Despite the fact that we did not attempt to record specific dates of arrival and departure of some migratory species on the *campus,* we were able to note some patterns of occurrence for some of them. The migratory species found were mostly passerines (including several tyrant-flycatchers) and have been generally recorded in the study area between August and December, including: Streaked Flycatcher (*Myiodynastes maculatus*), White-throated Kingbird (*Tyrannus albogularis*), Tropical Kingbird (*T. melancholicus*), Fork-tailed Flycatcher (*T. savana*), Crowned Slaty Flycatcher (*Griseotyrannus aurantioatrocristatus*), Variegated Flycatcher (*Empidonomus varius*), Red-eyed Vireo (*Vireo olivaceus*) and Eastern Slaty Thrush (*Turdus subalaris*).

On the other hand, our records for the Brown-chested Martin (*Progne tapera*) are concentrated during the first months of the year, between January and April. Nevertheless, more detailed investigations are needed to understand the patterns of temporal occurrence of those species in the study area. An example is the Gray Monjita (*Xolmis cinereus*), for which we could not find any clear pattern of seasonal occurrence on the *campus.*

Possible effects of isolation on birds

The *campus* population of the Chalk-browed Mockingbird (*Mimus saturninus*) consists of several individuals possessing a distinct phenotype from the original form. Some of them exhibit, to a greater or lesser extent, a blackish-brown throat, sometimes expanding to the breast (Fig. 7). Probably, this atypical plumage pattern is related to a mutation established in the *campus* population, isolated from others by the urban matrix, where the species is rarely recorded. However, other individuals showing the same atypical plumage pattern have been observed by M.F.V. in two squares of Belo Horizonte city: the Praça do Papa (19°57'22"S, 43°54'54"W) and the Praça Professor Alberto Mazzoni (19°54'31"S, 43°56'11"W). Rapid changes in plumage color and morphology (over a few decades) have been suggested or documented for isolated bird populations (*e.g.,* Fitzpatrick, 1980; Remsen Jr., 1984; Rasner *et al.,* 2004). Thus, detailed genetic studies should be conducted to test whether this mutation is related to the possible isolation of urban populations of this species.

CONCLUSION

The *campus* avifauna is relatively rich and still harbors many native bird species from different functional guilds that must contribute considerably to the health of this urban ecosystem. Nevertheless, the bird community comprises mostly widespread generalists. Yet the forest remnant increases habitat heterogeneity on the *campus,* favoring more specialized species than urbanized areas, and increasing functional diversity of birds on a small scale. Nevertheless, several species have disappeared from the area in a few years, whereas others have been introduced or have invaded this ecosystem, highlighting the pervasive effects of urbanization on bird community turnover. The cases of disappearing species suggest that isolated bird populations are likely to be extirpated in the urban matrix, especially because metapopulations of various species should not be able to recolonize these areas. For example, in the Brazilian Amazon, Borges & Guilherme (2000) found that the loss of understory bird species in an urban fragment of the city of Manaus was stronger than in forest fragments located in rural matrices, such as pastures and plantations. In this respect, within the study area, a single event of harvesting cattails led to the disappearance of three species (see above).

In addition, most forest-dependent species found are represented by small populations in the forest fragment and they are isolated from other populations at least since the 1960s, when the PUC forest was already isolated from other forest fragments (see Fig. 2). Therefore, it is possible that species with small populations are on the brink of extinction in this fragment (Brooks *et al.,* 1999a), since they probably do not present potential abilities for dispersal to other urban or suburban forested areas. Moreover, the gene

flow of these populations is probably interrupted for decades. This isolation of small populations of forest-dependent birds, combined with the risk of predation by domestic cats and dogs that roam in the area, makes it possible to foresee that, in a few decades, the PUC forest will face local extinctions of some bird species (see Christiansen & Pitter, 1997; Willis & Oniki, 2002; Ribon *et al.,* 2003), the last testimonies of the still little known forest avifauna of the municipality of Belo Horizonte.

The species list provided here will be useful as a database for monitoring long term effects of urbanization on this bird community. The continuous effort in surveying the *campus* avifauna will allow us to document new colonization and future local extinctions, especially in the case of forest-dependent species.

RESUMO

Levantamentos da avifauna urbana no Brasil tem aumentado nos últimos anos, embora nenhum deles consista de estudos a longo prazo que indiquem eventos de colonizações regionais ou desaparecimento de espécies. Neste estudo, apresentamos um levantamento da avifauna de um ecossistema urbano do sudeste brasileiro, efetuado ao longo de 30 anos, no campus da Pontifícia Universidade Católica de Minas Gerais, município de Belo Horizonte, estado de Minas Gerais. Dentro do campus há uma pequena reserva florestal adjacente a um pequeno lago. O inventário foi baseado principalmente em registros aleatórios ao longo de 1982-2013. Foram registradas 134 espécies de aves neste período. Entretanto, a avifauna atual é composta por 123 espécies. Um total de 97 espécies foi registrado na reserva, representada pelo fragmento florestal e pelo lago adjacente, das quais 44 foram exclusivas a esta área. Todavia, a maior parte das espécies de aves que ocorrem atualmente na área de estudo é independente (N = 51) ou semi-dependente (N = 46) de florestas. Há um predomínio de espécies insetívoras (N = 43) e onívoras (N = 29). A avifauna atual é representada por 15 espécies migratórias, que podem ser encontradas tanto na área urbanizada quanto no remanescente florestal. Entretanto, a maioria das espécies (N = 75) é residente na área, incluindo três invasoras, enquanto outras (N = 28) são representadas por visitantes ocasionais. O restante das espécies foi possivelmente introduzido na área. Houve 11 casos de desaparecimento de espécies, que incluem espécies típicas de matas, áreas úmidas e ambientes rurais. Também comentamos sobre colonizações recentes e sobre possíveis efeitos do isolamento nas aves. Provavelmente, a maior parte das espécies dependentes de florestas está próxima à extinção local no fragmento florestal. Assim, o presente levantamento pode ser útil como uma base de informações para monitoramentos de longo prazo sobre os efeitos da urbanização sobre esta comunidade de aves.

Palavras-Chave: Ambiente urbano; Avifauna; Colonização; Desaparecimento de espécies.

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APPENDIX

Birds recorded on the *campus* of the Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil. *Status:* † = species disappeared since 2005; * = invasive species; ** = recent colonization. *Guild:* CAR = carnivorous; DET = detritivorous; FRU = frugivorous; GRA = granivorous; INS = insectivorous; NEC = nectarivorous; ONI = omnivorous; PIS = piscivorous. *Movement pattern:* RES = resident; MIG = migratory; VIS = occasional visitor; INT = introduced species. *Evidence:* S = specimen housed at MCNA (study skin and/or skeleton); P = photograph; T = tape-recording; O = observation (sight record); V = record of vocalization. *Area:* C = urbanized area of the *campus.* F = forest remnant including its edges and adjacent lakes. *Forest dependence:* I = independent; S = semi-dependent; D = dependent.

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Tinamidae Gray, 1840					
Small-billed Tinamou *Crypturellus parvirostris* (Wagler, 1827) †	GRA	—	O, V	C	I
Anatidae Leach, 1820					
Black-bellied Whistling-Duck *Dendrocygna autumnalis* (Linnaeus, 1758)	ONI	VIS	V	C	I
Cracidae Rafinesque, 1815					
Dusky-legged Guan *Penelope obscura* Temminck, 1815	FRU	INT	P, O	F	D
Phalacrocoracidae Reichenbach, 1849					
Neotropic Cormorant *Phalacrocorax brasilianus* (Gmelin, 1789)	PIS	VIS	P, O	F	I
Ardeidae Leach, 1820					
Black-crowned Night-Heron *Nycticorax nycticorax* (Linnaeus, 1758)	PIS	VIS	O	F	I
Striated Heron *Butorides striata* (Linnaeus, 1758)	PIS	VIS	O	F	I
Great Egret *Ardea alba* Linnaeus, 1758	PIS	VIS	O	F	I
Cathartidae Lafresnaye, 1839					
Black Vulture *Coragyps atratus* (Bechstein, 1793)	DET	VIS	O	C, F	I
Accipitridae Vigors, 1824					
Swallow-tailed Kite *Elanoides forficatus* (Linnaeus, 1758) †	CAR	—	O	C, F	I
Roadside Hawk *Rupornis magnirostris* (Gmelin, 1788)	CAR	RES	P, O, V	C, F	I
Short-tailed Hawk *Buteo brachyurus* Vieillot, 1816	CAR	VIS	O	C	S
Falconidae Leach, 1820					
Southern Caracara *Caracara plancus* (Miller, 1777)	DET	RES	O, V	C, F	I
Yellow-headed Caracara *Milvago chimachima* (Vieillot, 1816)	DET	RES	P, O, V	C, F	I
Laughing Falcon *Herpetotheres cachinnans* (Linnaeus, 1758)	CAR	VIS	O	F	S
American Kestrel *Falco sparverius* Linnaeus, 1758	CAR	RES	O, V	C	I
Aplomado Falcon *Falco femoralis* Temminck, 1822	CAR	VIS	O, V	C	I
Rallidae Rafinesque, 1815					
Gray-necked Wood-Rail *Aramides cajanea* (Statius Muller, 1776)	ONI	RES	P, O	F	S

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Paint-billed Crake *Neocrex erythrops* (Sclater, 1867)	ONI	VIS	S	F	S
Charadriidae Leach, 1820					
Southern Lapwing *Vanellus chilensis* (Molina, 1782)	ONI	RES	P, O, V	C	I
Columbidae Leach, 1820					
Ruddy Ground-Dove *Columbina talpacoti* (Temminck, 1811)	GRA	RES	S, P, T, O, V	C, F	I
Rock Pigeon *Columba livia* Gmelin, 1789 *	GRA	RES	P, O, V	C	I
Picazuro Pigeon *Patagioenas picazuro* (Temminck, 1813) **	GRA	RES	S, P, T, O, V	C, F	S
White-tipped Dove *Leptotila verreauxi* Bonaparte, 1855	GRA	RES	S, T, O, V	F	S
Psittacidae Rafinesque, 1815					
White-eyed Parakeet *Aratinga leucophthalma* (Statius Muller, 1776)	FRU	RES	P, O, V	C, F	S
Blue-winged Parrotlet *Forpus xanthopterygius* (Spix, 1824)	FRU	RES	S, O, V	C, F	I
Yellow-chevroned Parakeet *Brotogeris chiriri* (Vieillot, 1818)	FRU	RES	P, O, V	C, F	S
Blue-fronted Parrot *Amazona aestiva* (Linnaeus, 1758)	FRU	INT	O, V	C, F	D
Cuculidae Leach, 1820					
Squirrel Cuckoo *Piaya cayana* (Linnaeus, 1766)	ONI	RES	P, O, V	C, F	S
Dark-billed Cuckoo *Coccyzus melacoryphus* Vieillot, 1817	ONI	VIS	P, O	C	S
Smooth-billed Ani *Crotophaga ani* Linnaeus, 1758	ONI	VIS	P, O, V	C	I
Guira Cuckoo *Guira guira* (Gmelin, 1788)	ONI	VIS	O, V	C	I
Strigidae Leach, 1820					
Ferruginous Pygmy-Owl *Glaucidium brasilianum* (Gmelin, 1788)	CAR	RES	O, V	F	S
Burrowing Owl *Athene cunicularia* (Molina, 1782)	CAR	RES	P, O, V	C	I
Striped Owl *Asio clamator* (Vieillot, 1808)	CAR	VIS	O, V	C, F	I
Stygian Owl *Asio stygius* (Wagler, 1832)	CAR	RES	S, O, V	C, F	S
Caprimulgidae Vigors, 1825					
Pauraque *Hydropsalis albicollis* (Gmelin, 1789) †	INS	—	O, V	C	S
Band-winged Nightjar *Hydropsalis longirostris* (Bonaparte, 1825) **	INS	RES	S	C	I
Apodidae Olphe-Galliard, 1887					
White-collared Swift *Streptoprocne zonaris* (Shaw, 1796)	INS	VIS	O, V	C	I
Sick's Swift *Chaetura meridionalis* Hellmayr, 1907	INS	VIS	O, V	C	S
Trochilidae Vigors, 1825					
Planalto Hermit *Phaethornis pretrei* (Lesson & Delattre, 1839)	NEC	RES	O, V	C	S

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Swallow-tailed Hummingbird *Eupetomena macroura* (Gmelin, 1788)	NEC	RES	S, P, O, V	C, F	I
Black Jacobin *Florisuga fusca* (Vieillot, 1817)	NEC	VIS	O	C	D
White-vented Violetear *Colibri serrirostris* (Vieillot, 1816)	NEC	VIS	P, O, V	C	S
Glittering-bellied Emerald *Chlorostilbon lucidus* (Shaw, 1812)	NEC	RES	S, O, V	C, F	S
Fork-tailed Woodnymph *Thalurania furcata* (Gmelin, 1788)	NEC	RES	S, P, O, V	C, F	S
Sapphire-spangled Emerald *Amazilia lactea* (Lesson, 1832)	NEC	RES	S, P, O, V	C, F	D
Amethyst Woodstar *Calliphlox amethystina* (Boddaert, 1783)	NEC	MIG	P, O	C	S
Alcedinidae Rafinesque, 1815					
Ringed Kingfisher *Megaceryle torquata* (Linnaeus, 1766)	PIS	VIS	O, V	F	I
Amazon Kingfisher *Chloroceryle amazona* (Latham, 1790)	PIS	VIS	O, V	F	S
Galbulidae Vigors, 1825					
Rufous-tailed Jacamar *Galbula ruficauda* Cuvier, 1816	INS	RES	O, V	F	S
Ramphastidae Vigors, 1825					
Toco Toucan *Ramphastos toco* Statius Muller, 1776	ONI	VIS	P, O, V	C, F	S
Picidae Leach, 1820					
White-barred Piculet *Picumnus cirratus* Temminck, 1825	INS	RES	S, O, V	C, F	S
Little Woodpecker *Veniliornis passerinus* (Linnaeus, 1766)	INS	RES	V	F	S
Green-barred Woodpecker *Colaptes melanochloros* (Gmelin, 1788)	INS	RES	P, O, V	C, F	S
Campo Flicker *Colaptes campestris* (Vieillot, 1818)	INS	RES	P, O, V	C	I
Thamnophilidae Swainson, 1824					
Plain Antvireo *Dysithamnus mentalis* (Temminck, 1823)	INS	RES	T, O, V	F	D
Black-capped Antwren *Herpsilochmus atricapillus* Pelzeln, 1868	INS	RES	T, O, V	F	D
Variable Antshrike *Thamnophilus caerulescens* Vieillot, 1816	INS	RES	S, O, V	F	D
Great Antshrike *Taraba major* (Vieillot, 1816)	INS	RES	T, O, V	F	S
Furnariidae Gray, 1840					
Wing-banded Hornero *Furnarius figulus* (Lichtenstein, 1823) **	INS	RES	S, P, O, V	C, F	I
Rufous Hornero *Furnarius rufus* (Gmelin, 1788)	INS	RES	P, T, O, V	C, F	I
Chestnut-capped Foliage-gleaner *Hylocryptus rectirostris* (Wied, 1831)	INS	RES	S, O, V	F	D
Rufous-fronted Thornbird *Phacellodomus rufifrons* (Wied, 1821) †	INS	—	O, V	C	S
Yellow-chinned Spinetail *Certhiaxis cinnamomeus* (Gmelin, 1788) †	INS	—	O, V	F	I

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Sooty-fronted Spinetail *Synallaxis frontalis* Pelzeln, 1859	INS	RES	S, P, O, V	F	D
Rhynchocyclidae Berlepsch, 1907					
Sepia-capped Flycatcher *Leptopogon amaurocephalus* Tschudi, 1846	INS	RES	S, O, V	F	D
Yellow-olive Flycatcher *Tolmomyias sulphurescens* (Spix, 1825)	INS	RES	S, T, O, V	F	D
Common Tody-Flycatcher *Todirostrum cinereum* (Linnaeus, 1766)	INS	RES	V	F	S
Tyrannidae Vigors, 1825					
Cliff Flycatcher *Hirundinea ferruginea* (Gmelin, 1788)	INS	MIG	O, V	C	S
Southern Beardless-Tyrannulet *Camptostoma obsoletum* (Temminck, 1824)	ONI	RES	O, V	C, F	I
Yellow-bellied Elaenia *Elaenia flavogaster* (Thunberg, 1822)	ONI	RES	T, O, V	C, F	S
Gray Elaenia *Myiopagis caniceps* (Swainson, 1835)	INS	RES	V	F	D
White-crested Tyrannulet *Serpophaga subcristata* (Vieillot, 1817)	INS	MIG	T, O, V	C, F	S
Short-crested Flycatcher *Myiarchus ferox* (Gmelin, 1789)	INS	RES	S, O, V	C, F	S
Brown-crested Flycatcher *Myiarchus tyrannulus* (Statius Muller, 1776)	INS	RES	T, O, V	F	S
Great Kiskadee *Pitangus sulphuratus* (Linnaeus, 1766)	ONI	RES	S, P, T, O, V	C, F	I
Cattle Tyrant *Machetornis rixosa* (Vieillot, 1819)	INS	RES	P, O, V	C	I
Streaked Flycatcher *Myiodynastes maculatus* (Statius Muller, 1776)	ONI	MIG	P, O, V	C, F	D
Boat-billed Flycatcher *Megarynchus pitangua* (Linnaeus, 1766)	ONI	RES	O, V	C, F	S
Social Flycatcher *Myiozetetes similis* (Spix, 1825)	ONI	RES	O, V	C, F	S
White-throated Kingbird *Tyrannus albogularis* Burmeister, 1856	ONI	MIG	P, O	C	I
Tropical Kingbird *Tyrannus melancholicus* Vieillot, 1819	ONI	MIG	S, P, O, V	C, F	I
Fork-tailed Flycatcher *Tyrannus savana* Vieillot, 1808	ONI	MIG	P, O, V	C	I
Crowned Slaty Flycatcher *Griseotyrannus aurantioatrocristatus* (d'Orbigny & Lafresnaye, 1837)	INS	MIG	P, O	C	S
Variegated Flycatcher *Empidonomus varius* (Vieillot, 1818)	INS	MIG	O, V	C, F	S
Long-tailed Tyrant *Colonia colonus* (Vieillot, 1818)	INS	RES	P, T, O, V	C, F	D
Bran-colored Flycatcher *Myiophobus fasciatus* (Statius Muller, 1776)	INS	RES	O, V	C, F	I
Masked Water-Tyrant *Fluvicola nengeta* (Linnaeus, 1766) **	INS	RES	S, P, O, V	C, F	I
White-headed Marsh Tyrant *Arundinicola leucocephala* (Linnaeus, 1764) †	INS	—	O	F	I
Fuscous Flycatcher *Cnemotriccus fuscatus* (Wied, 1831)	INS	RES	O, V	F	D

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Euler's Flycatcher *Lathrotriccus euleri* (Cabanis, 1868)	INS	RES	S, P, O, V	F	D
Yellow-browed Tyrant *Satrapa icterophrys* (Vieillot, 1818)	INS	VIS	O	C	I
Gray Monjita *Xolmis cinereus* (Vieillot, 1816)	INS	MIG	P, O, V	C	I
Vireonidae Swainson, 1837					
Rufous-browed Peppershrike *Cyclarhis gujanensis* (Gmelin, 1789)	ONI	RES	O, V	F	S
Red-eyed Vireo *Vireo olivaceus* (Linnaeus, 1766)	INS	MIG	V	F	D
Hirundinidae Rafinesque, 1815					
Blue-and-white Swallow *Pygochelidon cyanoleuca* (Vieillot, 1817)	INS	RES	S, P, O, V	C, F	I
Southern Rough-winged Swallow *Stelgidopteryx ruficollis* (Vieillot, 1817)	INS	MIG	P, O, V	C, F	I
Brown-chested Martin *Progne tapera* (Vieillot, 1817)	INS	MIG	P, O, V	C, F	I
White-rumped Swallow *Tachycineta leucorrhoa* (Vieillot, 1817) †	INS	—	O	F	I
Troglodytidae Swainson, 1831					
Southern House Wren *Troglodytes musculus* Naumann, 1823	INS	RES	S, P, T, O, V	C, F	I
Donacobiidae Aleixo & Pacheco, 2006					
Black-capped Donacobius *Donacobius atricapilla* (Linnaeus, 1766) †	ONI	—	O, V	F	I
Polioptilidae Baird, 1858					
Masked Gnatcatcher *Polioptila dumicola* (Vieillot, 1817) **	INS	RES	T, O, V	C, F	S
Turdidae Rafinesque, 1815					
Rufous-bellied Thrush *Turdus rufiventris* Vieillot, 1818	ONI	RES	S, P, T, O, V	C, F	I
Pale-breasted Thrush *Turdus leucomelas* Vieillot, 1818	ONI	RES	S, P, O, V	C, F	S
Creamy-bellied Thrush *Turdus amaurochalinus* Cabanis, 1850	ONI	RES	S, P, O, V	C, F	S
Eastern Slaty Thrush *Turdus subalaris* (Seebohm, 1887)	ONI	MIG	S, O, V	F	D
Mimidae Bonaparte, 1853					
Chalk-browed Mockingbird *Mimus saturninus* (Lichtenstein, 1823)	ONI	RES	P, O, V	C	I
Coerebidae d'Orbigny & Lafresnaye, 1838					
Bananaquit *Coereba flaveola* (Linnaeus, 1758)	NEC	RES	S, T, O, V	C, F	S
Thraupidae Cabanis, 1847					
Green-winged Saltator *Saltator similis* d'Orbigny & Lafresnaye, 1837	FRU	INT	V	F	S
Hooded Tanager *Nemosia pileata* (Boddaert, 1783)	ONI	VIS	O, V	F	D
Orange-headed Tanager *Thlypopsis sordida* (d'Orbigny & Lafresnaye, 1837)	ONI	VIS	O, V	F	S
Pileated Finch *Lanio pileatus* (Wied, 1821) †	ONI	—	O	C	S
Sayaca Tanager *Tangara sayaca* (Linnaeus, 1766)	FRU	RES	O, V	C, F	S

Taxa / English Name	Guild[1]	Movement pattern[2]	Evidence	Area	Forest dependence[3]
Palm Tanager *Tangara palmarum* (Wied, 1823)	FRU	RES	P, O, V	C	S
Burnished-buff Tanager *Tangara cayana* (Linnaeus, 1766)	FRU	RES	S, O, V	C, F	I
Swallow Tanager *Tersina viridis* (Illiger, 1811)	FRU	MIG	S, O, V	C, F	D
Blue Dacnis *Dacnis cayana* (Linnaeus, 1766)	FRU	RES	S, O, V	C, F	S
Rufous-headed Tanager *Hemithraupis ruficapilla* (Vieillot, 1818)	FRU	RES	S, O, V	F	D
Chestnut-vented Conebill *Conirostrum speciosum* (Temminck, 1824)	ONI	RES	O	F	D
Emberizidae Vigors, 1825					
Rufous-collared Sparrow *Zonotrichia capensis* (Statius Muller, 1776) †	ONI	—	O, V	C	I
Saffron Finch *Sicalis flaveola* (Linnaeus, 1766)	GRA	INT	P, O, V	C	I
Blue-black Grassquit *Volatinia jacarina* (Linnaeus, 1766)	GRA	VIS	S, O, V	C, F	I
Yellow-bellied Seedeater *Sporophila nigricollis* (Vieillot, 1823)	GRA	VIS	P, O, V	C, F	I
Double-collared Seedeater *Sporophila caerulescens* (Vieillot, 1823)	GRA	VIS	S, O, V	C	I
Saffron-billed Sparrow *Arremon flavirostris* Swainson, 1838	INS	RES	S, P, O	F	D
Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossem, Van Tyne & Zimmer, 1947					
White-bellied Warbler *Basileuterus hypoleucus* Bonaparte, 1830	INS	RES	S, P, O, V	F	D
Flavescent Warbler *Basileuterus flaveolus* (Baird, 1865)	INS	RES	S, P, T, O, V	F	D
Icteridae Vigors, 1825					
Chopi Blackbird *Gnorimopsar chopi* (Vieillot, 1819) †	ONI	—	S, O, V	C	I
Shiny Cowbird *Molothrus bonariensis* (Gmelin, 1789)	ONI	RES	S, O, V	C	I
Fringillidae Leach, 1820					
Hooded Siskin *Sporagra magellanica* (Vieillot, 1805)	GRA	INT	P, O	F	I
Purple-throated Euphonia *Euphonia chlorotica* (Linnaeus, 1766)	FRU	RES	S, T, O, V	C, F	S
Golden-rumped Euphonia *Euphonia cyanocephala* (Vieillot, 1818)	FRU	VIS	O	F	D
Estrildidae Bonaparte, 1850					
Common Waxbill *Estrilda astrild* (Linnaeus, 1758) *	GRA	RES	S, P, O, V	C, F	I
Passeridae Rafinesque, 1815					
House Sparrow *Passer domesticus* (Linnaeus, 1758) *	ONI	RES	S, P, O, V	C	I

[1] Following Motta Junior (1990), Stotz *et al.* (1996), Sick (1997), Lopes *et al.* (2005).
[2] Following Sick (1984, 1997), Chesser (1994).
[3] Following Silva (1995).