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Composition and structure of bird communities in vegetational gradients of Bodoquena Mountains, western Brazil

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ABSTRACT

The informations of bird species distribution in different habitats and the structure of their communities are crucial for bird conservation. We tested the differences in composition, richness and abundance of birds in different phytophysiognomies at Bodoquena Mountains, western Brazil, and we demonstrated the variations in richness and abundance of birds between different trophic groups. Sampling was conducted between July 2011 and June 2012 in 200 point counts arranged in the study area. A total of 3350 contacts were obtained belonging to 156 bird species. Woodland savannas, seasonal forests and arboreal savannas had higher bird abundance and richness, while riparian forests, clean pastures and dirty pastures had smaller values of these parameters. The bird community was organized according to local vegetational gradient, with communities of forests, open areas and savannas, although many species occurred in more than one vegetation type. The insectivorous, omnivorous, frugivorous and gramnivorous birds composed most of the community. These data showed how important environmental heterogeneity is to bird communities. Furthermore, the presence of extensive patches of natural habitats, the small distance between these patches and the permeability of pastures, with high arboreal and shrubby cover, are indicated as important factors to maintain the bird diversity.

Key words: Cerrado, habitat use, point counts, Private Reserves, trophic groups.

INTRODUCTION

The Cerrado is the second largest Brazilian phytogeographic domain, occupying almost 25% of the country, especially in central Brazil (Eiten 1993). Its landscape is caracterized by a mosaic of vegetation types with forests (riparian and seasonal forests), woodland savannas (*cerradão*), arboreal savannas (*cerrado stricto sensu*), natural grasslands (*campo cerrado*, *campo sujo* and *campo limpo*) and wetlands, which include swamps and formations of Buriti palms (*Mauritia flexuosa*, Arecaceae) locally called *veredas* (Eiten 1993, Ribeiro and Walter 1998). The great habitat diversity provides high bird richness in the Cerrado domain, comprising

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45% of Brazilian avifauna or 856 of the 1900 species registered in Brazil (Silva and Santos 2005, CBRO 2014).

The Cerrado domain is one of the most endangered biodiversity hotspots (Myers et al. 2000) and about 60% of its original vegetation has been converted into pastures, plantations and urban areas, creating a landscape formed by great extensions of anthropogenic matrices with isolated fragments of native vegetation (Machado et al. 2004). However, some mountain regions still maintain large extensions of native vegetation due to the relief and the poor quality of the soil reducing their agriculture capability. In central Brazil these areas are extremely important for avifauna conservation, and in the state of Mato Grosso do Sul there are two of these regions, the Maracaju Mountains (Nunes et al. 2013) and Bodoquena Mountains (Pivatto et al. 2006).

The Bodoquena Mountains are located in the southwestern of Cerrado, and presents biogeographic influences of the Pantanal, the Chaco and of the Atlantic Forest. The biogeographic influences of different domains, the great extensions of natural areas and the habitat diversity of the landscape provide the region with a high animal and plant diversity, making them a priority area for the conservation of the biodiversity of the Cerrado (MMA 1999). In relation to the bird diversity, in Bodoquena Mountains 353 species were recorded, showing that this region has high bird richness in comparation to other areas studied in the Cerrado (Pivatto et al. 2006).

At Bodoquena Mountains the efforts towards to the conservation of biodiversity have been conducted especially by the establishment of protected areas. The Serra da Bodoquena National Park is the most important protected area of the region, maintaining 77.021,58 ha of natural areas which include the main vegetational types regionally presents. However, other types of protected areas are important too, as Natural Monuments, Environmental Protected Areas (or APA - Área de Proteção Ambiental) and Private Reserves (or RPPN's - Reservas Particulares do Patrimônio Natural). The Private Reserves, for example, protect almost 1770 ha of natural areas in the Bodoquena Mountains, showing their importance for the regional system of protected areas and to the biodiversity conservation (ICMBIO 2013). These areas are generally small, but are very important to complement the efforts of public conservation. They are fundamental for conservation on a regional scale because they protect populations of different animal and plant species in their natural habitats and function as ecological corridors that contribute to the biological connectivity in fragmented landscapes (Oliveira et al. 2010).

The information about composition and structure of bird communities, as well as on distribution of species in different vegetational types present in a region, are very important for the scientific knowledge and conservation of birds, especially when we consider how quickly the natural environments have been reduced, disturbed and fragmented (Dias 1990).

The objective of this study was to test the differences in composition, species richness and abundance of birds between different phytophysiognomies, showing the importance of the vegetation gradient for the conservation of birds in a protected area located in Bodoquena Mountains, state of Mato Grosso do Sul, Brazil, and additionally present the variations in species richness and abundance of birds between different trophic groups.

MATERIALS AND METHODS

Study Area

The Bodoquena Mountains, located in southwestern of Mato Grosso do Sul state, western Brazil, comprise 2 million ha, ranging 300 km long in a north-south direction and 20-50 km wide from east to west (Boggiani et al. 1993) (Figure 1). The medium altitude in the region varies from 400 to 600 m above sea level, with maximum values of altitude around 770 m in their northern portion and minimum values just below 300 m (ICMBIO 2013). Bodoquena Mountains have many headwaters, functioning as extensive watersheds between the Paraguay River basin, located on the west, and the sub-basins of Apa river, located on the south, and the Miranda river, located on the east (ICMBIO 2013).

The climate of the region is Aw, or tropical sub-warm, according to Köppen classification, with medium annual temperatures between 22 °C and 26 °C, maximum temperatures around 35 °C and 40 °C, and minimal which could reach near 0 °C. The relative air umidity is low, rarely reaching 80%, and the medium annual precipitation is 1400 mm, with a hot and rainy season from November to March, and a dry season from April to October (IBGE 2006).

The Bodoquena Mountains are located in transitional areas under influence of Cerrado and Pantanal domains (Veloso et al. 1991), but they are also influenced by Atlantic Forest and Chaco. The regional landscape is a complex mosaic of vegetation types, dominated by decidual and semidecidual seasonal forests, especially in mountainous areas, riparian forests, woodland savannas (*cerradão*), arboreal savannas (*cerrado stricto sensu*), grasslands, swamps, artificial pastures and disturbed areas in different stages of natural regeneration (Brasil 1997, Pott and Pott 2003).

In Bodoquena Mountains the area chosen for this study was a private protected area called RPPN Estância Mimosa and some areas around it (20°58’57.70”S; 56°30’58.40”O; 390 m above sea level). The study area (referred hereinafter as EM) is located 18 km north of Bonito municipality, state of Mato Grosso do Sul, Brazil (Figure 1). The EM has a total of 800 ha, of which 278.42 ha belonging to RPPN Estância Mimosa.

In the study area there is a vegetation gradient formed by riparian forests associated to the Mimoso river, extensive patches of seasonal forests and arboreal savannas (*cerrado stricto sensu*), in addition to patches of woodland savannas (*cerradão*) and pastures with different levels of arboreal and shrubby cover (clean and dirty pastures). The cattle ranching in this area is developed into silvopasture system, maintaining trees in pastures, which are usually small and are surrounded by large patches of natural habitats.

The riparian forests are always associated to watercourses. These forests are generally evergreen, have continuous canopy (coverage of 70 to 90%) and have trees ranging from 20 to 25 m in height, possible reaching 30 m. Seasonal forests occur in interfluvial areas, generally on rich soils. Their trees range from 15 to 25 m in height and form a continuous canopy with 70 to 95% of arboreal cover, although there is a drastic reduction in this cover during the dry season due to the deciduousness of many plant species. The woodland savannas (*cerradão*) are forest formations of the Cerrado domain which have relatively continuous canopy (50 to 90% of cover) and tree layer with 8 to 15 m in height. The lower height of the trees and the deciduousness of many plant species in the woodland savannas allow better luminosity and consequently major density of understory, with great density of small schrubs. The arboreal savannas (*cerrado stricto sensu*) are savanic formations with tree, shrub and herb layers well defined. Their trees are small (3 to 8 m in height), twisted, formed a discontinuous canopy (20 to 70% of cover) and generally present burn evidences. The schrub and herb layers are dense, especially in rainy seasons (Eiten 1993, Ribeiro and Walter 1998).

Field Methods

The study area was delimited in a rectangle with 800 ha divided into 280 grids of 200 x 200 m, of which 200 were randomly selected. In the center

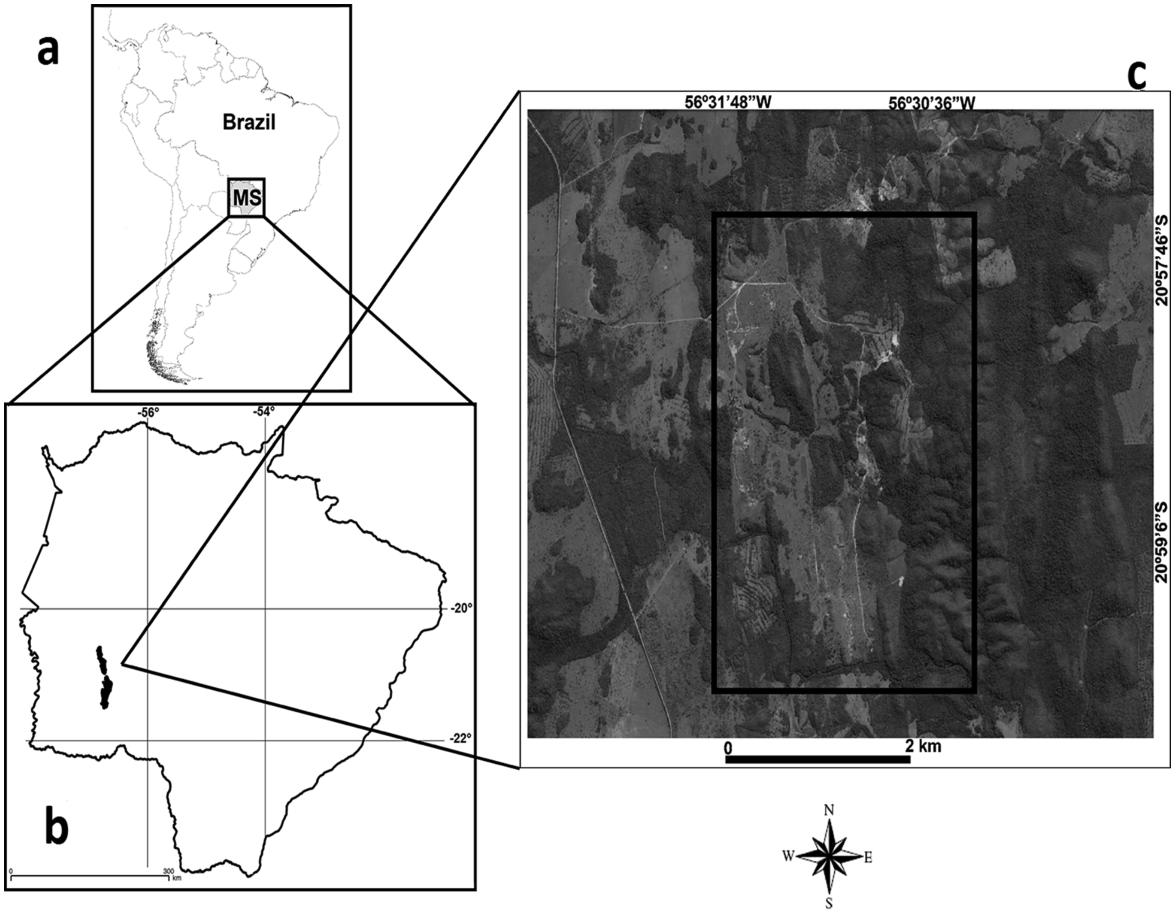

Figure 1 - Localization of Bodoquena Mountains and the study area (black rectangle), Bonito municipallity, state of Mato Grosso do Sul (MS), Brazil.

of each grid a point count was established, with a fixed radius of 50 m and 200 m of minimal distance from any other point (Develey 2004, Anjos et al. 2010, Vielliard et al. 2010). Each point count was established in one vegetation type, avoiding ecotones. By this method, areas of riparian forests (n = 9), seasonal forests (n = 49), woodland savannas (n = 18), arboreal savannas (n = 39), dirty pastures (n = 45) and clean pastures (n = 40) were sampled during 12 consecutive months, between July 2011 and June 2012, equally covering the wet and dry seasons.

Each point count, which represents a sample unit, was visited only once during the study for 15 minutes in the earling morning, between 06:00 and 08:30, when most bird species were active. The points were sampled randomly, and on each day we sampled the drawned point and the four nearest points.

Data Analysis

For each point count we recorded composition, richness and number of contacts per species. The species abundance was expressed by total number of contacts and Punctual Abundance Index (PAI), which is a ratio between the total number of specie´s contacts by total number of samples used in the study (Anjos et al. 2010, Vielliard et al. 2010). The PAI of each species was calculated for all study area and for each vegetation type, separately.

To evaluate if the sampling effort applied was enough to capture a non-biased sample of the entire community, a randomized collector curve was made. This curve was made with the cumulative number of species sampled by the number of samples (point counts) used. The species richness was also estimated using the Bootstrap estimator (Colwell and Coddington 1994).

The differences in avifauna abundance and richness between the vegetation types were tested by Analysis of Variance (ANOVA). The community ordination in relation to composition and abundance of species was performed by Non-Metric Multidimensional Scaling (NMDS) with two dimensions using distance indices of Bray-Curtis. Additionally, an Analysis of Similarity (ANOSIM) with the sequential Bonferroni test was calculated to verify the level of similarity between the bird communities of different vegetation types.

The representation of each trophic group in the community was determined by species richness and bird abundance (number of contacts) in each group. The species classification in trophic groups was based on classifications commonly used in scientific literature (Karr et al. 1990, Motta-Junior 1990, Sick 1997) and on records of bird feedings obtained in field expeditions. The bird species were classified according to principal food itens consumed: insectivores (arthropods), frugivores (fruits), omnivores (arthropods, fruits and small vertebrates), gramnivores (seeds), nectarivores (nectar), carnivores (terrestrial vertebrates captured alive), piscivores (fishes), malacofagous (molluscs) and necrofagous (dead vertebrates).

The taxonomic classification and nomenclature adopted in this study followed the Brazilian Comitee of Ornithological Records (CBRO 2014). All analyses used in this study were made on software R (R Core Team 2013) and "VEGAN" package (Oksanen et al. 2009).

RESULTS

In this study were obtained 3350 records of 156 bird species, belonging to 41 families and 19 orders (Table SI – Supplementary Material). The randomized collector's curve, which considers the cumulative number of bird species as a function of samples used, showed trends of stabilization. The observed richness corresponded to 92.8% of the estimated richness (168.8 species ± 3.2). These results showed that the number of samples used was sufficient for sampling most bird species of the study area (Figure 2).

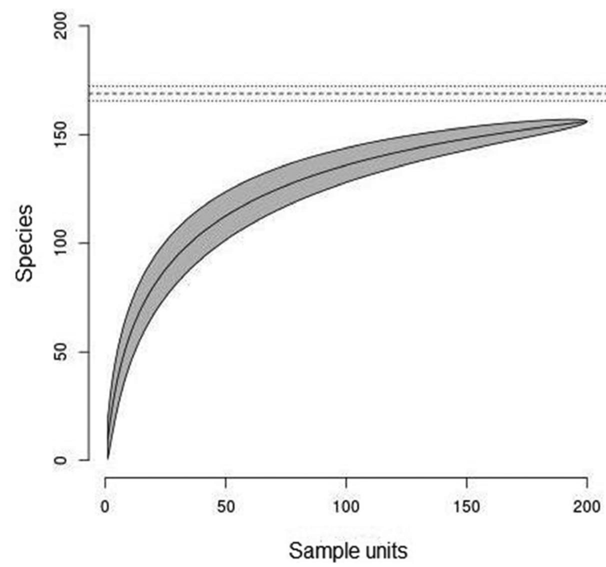

Figure 2 - Randomized collector curve with average and standard deviation of observed (continuous line) and estimated richness (dashed line) of the bird communities at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil.

The greatest values of species richness were obtained in the woodland savannas (13.1 ± 4.9; n = 18), seasonal forests (12.6 ± 3.9; n = 49) and arboreal savannas (10.9 ± 3.9; n = 39), with the smallest richness in clean pastures (7.8 ± 3.3; n = 40), dirty pastures (7.6 ± 4.3; n = 45) and riparian forests (6.8 ± 5.08; n = 9) (Figure 3). The vegetation types which showed the highest bird abundance were also the woodland savannas (20.8 ± 7.1; n = 18), seasonal forests (19.8 ± 6.9; n = 49) and arboreal savannas (17.3 ± 6.4; n = 39), and those with smaller abundances were clean pastures (15.2 ± 8.3; n = 40), dirty pastures (13.3 ± 7.7; n = 45) and riparian forests (12.5 ± 6.8; n = 9) (Figure 4). The vegetational types were significantly different in relation to species richness ($F_{5, 194} = 12.93$, $p \leq 0.0001$) and bird abundance ($F_{5, 194} = 5.74$, $p < 0.001$).

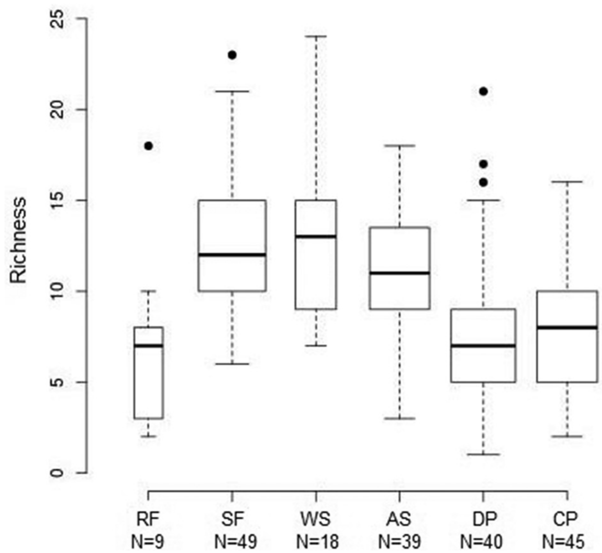

Figure 3 - Bird species richness in riparian forests (RF), seasonal forests (SF), woodland savannas (WS), arboreal savannas (AS), dirty pastures (DP) and clean pastures (CP), at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil. N = number of samples.

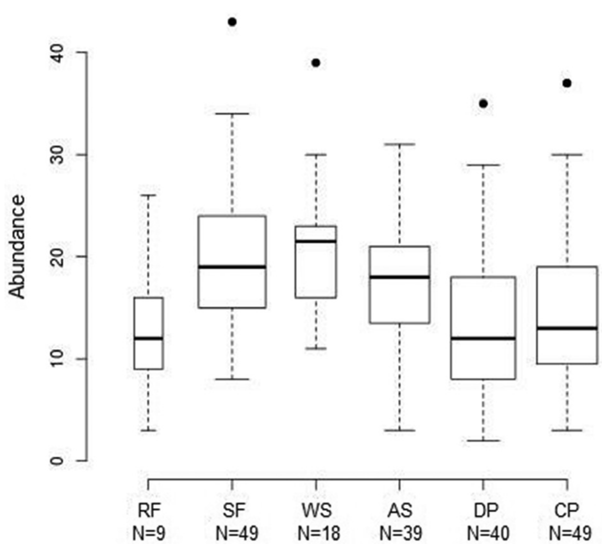

Figure 4 - Bird abundance in riparian forests (RF), seasonal forests (SF), woodland savannas (WS), arboreal savannas (AS), dirty pastures (DP) and clean pastures (CP), at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil. N = number of samples.

The ordination analysis showed there is a trend to separation the bird community at EM between forest formations (seasonal and riparian forests) and open areas (clean pastures), with communities of dirty pastures, arboreal and woodland savannas being intermediate in this vegetational gradient (NMDS, stress: 0.23; $R^2 = 0.759$) (Figure 5). The similarity analysis indicated differences in bird community composition between the vegetation types (Anosim, R = 0.327, $p \leq 0.0001$), but just woodland savannas and dirty pastures (R = 0.002, p = 0.45) and woodland savannas and arboreal savannas (R = 0.01, p = 0.33) presented similar bird communities.

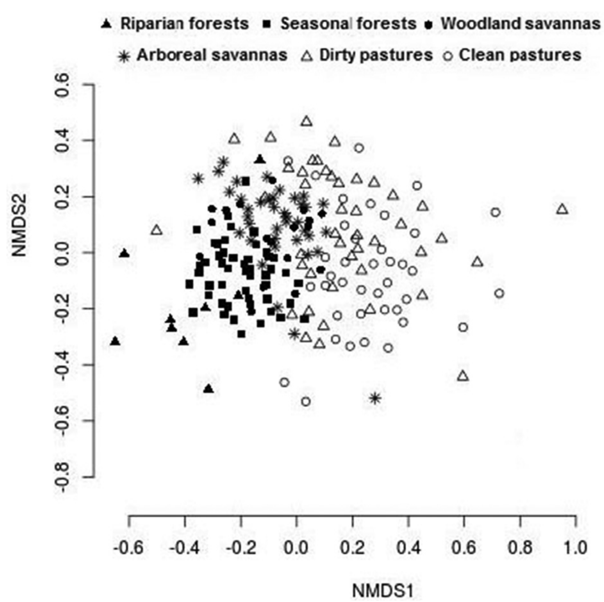

Figure 5 - Non-Metric Multidimensional Scaling (NMDS, Bray-Curtis distance) (Stress = 0.23; $R^2 = 0.759$) of bird community in different vegetation types at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil.

The insectivores, omnivores, frugivores and gramnivores were the most abundant and rich guilds in the bird community (Table SI; Figure 6). We obtained 1213 contacts of 67 insectivorous species, 1390 contacts of 46 omnivorous species, 349 contacts of 13 frugivorous species and 257 contacts of 12 gramnivorous species. The other trophic groups presented smaller abundance and species richness (Table SI; Figure 6).

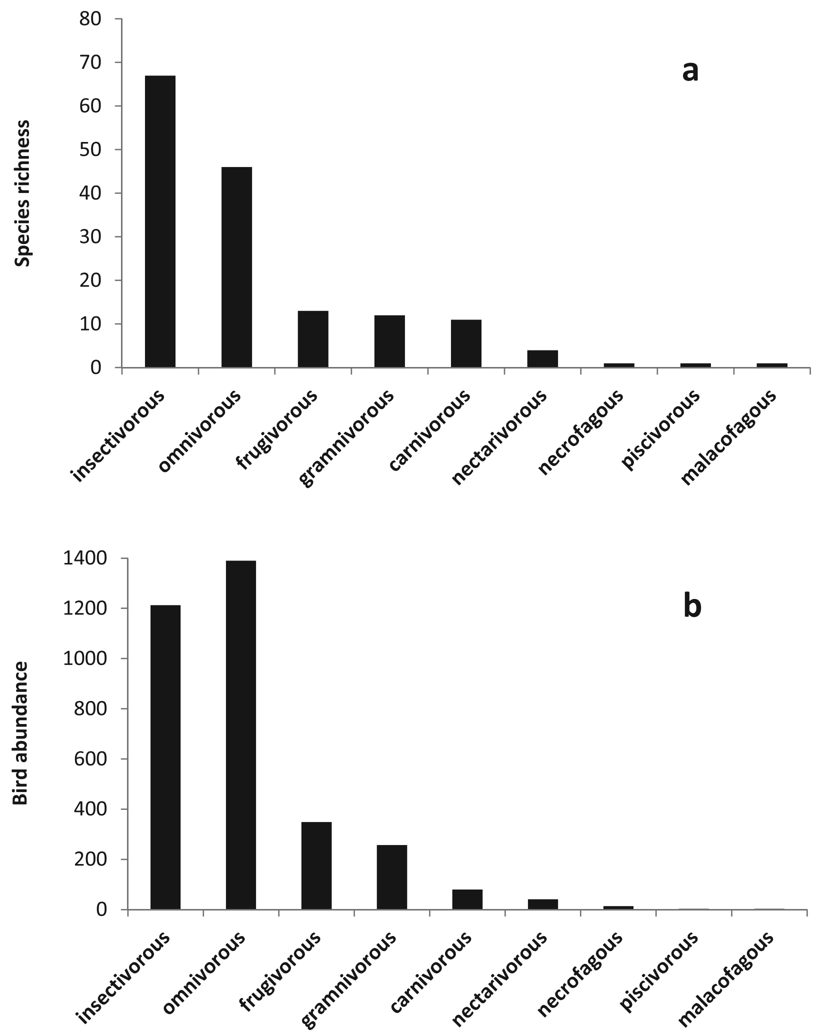

Figure 6 - Species richness (**a**) and bird abundance (**b**) of different trophic groups at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil.

DISCUSSION

We recorded 247 bird species at EM by joint application of qualitative and quantitative sample methods (Godoi et al. 2014). The bird species richness observed in this study by point counts (156 species) represented 63.2% of the known bird richness for all study area, showing the efficiency of this method to record the most bird species of a region (Develey 2004, Anjos et al. 2010, Vielliard et al. 2010). Additionally, the method of point counts is very suitable when the objective is to provide controlled data on the bird abundance, being widely used in studies on bird community structure (Aleixo and Vielliard 1995, Aleixo 1999, Almeida et al. 1999, Pozza and Pires 2003, Donatelli et al. 2004, 2007, Lyra-Neves et al. 2004, Telles and Dias 2010).

The bird abundance and richness varied in the different vegetational types at EM. The mean values of richness and abundance were larger in seasonal forests, woodland savannas and arboreal savannas, and lower in pastures. This result agrees with studies conducted in other Cerrado localities, where bird communities were normally more diversified in seasonal forests, patches of woodland savannas and arboreal savannas, when compared with natural and anthropogenic open areas (Fry 1970, Tubelis and Cavalcanti 2000, 2001, Santos 2001, Piratelli and Blake 2006, Faria et al. 2009).

In this context, it was expected that riparian forests at EM would also present high bird abundance and species richness, because they have structurally heterogeneous environments and are usually mentioned as very rich formations in bird species in the Cerrado domain (Silva 1996, Silva and Bates 2002, Faria et al. 2009, Valadão 2012). However, the riparian forests at EM presented low bird abundance and species richness, which may be attributed to the small area occupied by this physiognomie in the study area and the small number of samples utilized in them.

Vegetational formations which have greater heterogeneous structures, such as greater vertical stratification, for example, usually have higher richness and abundance of birds, a pattern that has been explained by the hypothesis of environmental heterogeneity. This hypothesis assumes that structurally more heterogeneus habitats may provide more ecological niches, allowing major diversification in resource exploitation, which would cause an increase in the species diversity (MacArthur and MacArthur 1961, Tews et al. 2004). The heterogeneity may be provided, for example, by vegetation structure, which in turn is determined by vegetational communities (MacArthur and MacArthur 1961, MacArthur et al. 1962). Thus, even in small spatial scales, the vegetation structure seems to determine the distribution and abundance of species, promoting changes in the composition and structure of bird communities between different habitat types (Blake and Loiselle 2000, Tews et al. 2004).

Despite the differences in bird abundance and richness between the vegetational types, one should highlight the importance of habitat diversity at EM with regard to the local bird conservation. The birds of the Cerrado domain need a mosaic of vegetation types to maintain their populations, since most of them perform daily and seasonal movements between these areas to forage. Thus, it is important to maintain the habitat diversity in the Cerrado domain to provide resource availability for the birds throughout the year (Tubelis et al. 2004).

In relation to composition and structure, the different vegetation types at EM presented particular bird communities, especially seasonal and riparian forests, which had species exclusively sampled in these areas. Seasonal forests, for example, had bird species which are most commonly found in the Atlantic Forest domain, like *Ramphastos dicolorus* and *Melanerpes flavifrons* (Goerck 1997, Brooks et al. 1999). These results showed seasonal forests allow that different Atlantic species may expand their distributions to the west, for regions of Cerrado domain (Straube et al. 1996, Pivatto et al. 2006). The seasonal forests at EM also seem to be the main habitat for some species that need relatively large forests to maintain their populations, like large forest birds such as *Penelope superciliaris*, *Micrastur ruficollis* and *Pulsatrix perspicillata*, and small insectivorous birds which depend on forest understory, like *Herpsilochmus atricapillus*, *Thamnophilus caerulescens*, *Corythopis delalandi* and *Cantorchilus guarayanus*.

The riparian forests at EM also presented bird species which only occur or were more abundant in these areas, like *Aramus guarauna*, *Crotophaga major*, *Chloroceryle amazona*, *Momotus momota*, *Myiozetetes cayanensis* and *Myiarchus ferox*. These forests usually have high species richness and particular bird communities, with species strongly associated with these formations (Fry 1970, Silva and Vielliard 2004, Piratelli and Blake 2006, Faria et al. 2009, Posso et al. 2013). These forests also function as refuges to birds of adjacent savannas (Silva and Bates 2002, Tubelis et al. 2004) and as corridors that allow the expansion of Amazon and Atlantic forest species to the interior of the Cerrado (Silva 1996).

The clean pastures at EM also presented distinct bird communities in relation to other vegetation types. In these pastures many birds typical of open areas occurred, like *Theristicus caudatus*, *Caracara plancus*, *Cariama cristata*, *Vanellus chilensis*, *Eupsittula aurea*, *Athene cunicularia*, *Colaptes campestris*, *Furnarius rufus*, *Sicalis flaveola* and *Gnorimopsar chopi*. These species usually occur in natural and anthropic open areas of the Cerrado and other phytogeographic domains, even in disturbed areas by deforestation in forest regions (Silva 1995, Sick 1997).

The arboreal savannas (*cerrado stricto sensu*) and woodland savannas (*cerradão*) of the EM presented great similarity in bird community composition, such as in areas of the Cerrado located in the east of the state of Mato Grosso do Sul (Piratelli and Blake 2006). These formations, together with the dirty pastures, formed an intermediary group between the bird communities of forests and clean pastures. The arboreal and woodland savannas presented 61 species in common, which represents 82.4% and 80.2% of their communities, respectively.

The arboreal savannas usually present many particular species, but can also be inhabited by grassland and forest bird species (Tubelis et al. 2004, Piratelli and Blake 2006, Posso et al. 2013). The most abundant birds in arboreal savannas at EM were species typically found in these areas, such as *Euphonia chlorotica*, *Myiarchus tyrannulus*, *Hemithraupis guira*, *Lepidocolaptes angustirostris*, *Ramphastos toco*, *Hemitriccus margaritaceiventer*, *Hylocharis chrysura* and *Nystalus striatipectus*. But in these areas also occur forest species which have great movement capacity at landscape, such as *Pyrrhura devillei*, *Cyanocorax cyanomelas*, *Turdus leucomelas* and *Pteroglossus castanotis*. A few grassland species occurred in the arboreal savannas at EM, like *Cariama cristata* and *Sicalis flaveola*, recorded especially in more open arboreal savannas or on the edge of these environments.

The woodland savannas is a forest physiognomy of the Cerrado domain which is habitat for many bird species that also occur in seasonal and riparian forests (Piratelli and Blake 2006, Valadão 2012, Posso et al. 2013). However, at EM the birds of these savannas were more similar to birds of arboreal savannas. Thus, the bird communities of woodland savannas were formed especially by species capable of inhabiting both forest and savanna formations. Some species which were usually most common in forests occurred in woodland savannas at EM (*Cyanocorax cyanomelas*, *Turdus leucomelas*, *Sirystes sibilator*, *Myiothlypis flaveola*, *Casiornis rufus*), such as some species which were most common in arboreal savannas (*Euphonia chlorotica*, *Pitangus sulphuratus*, *Lepidocolaptes angustirostris*, *Ramphastos toco*, *Myiarchus tyrannulus*).

The dirty pastures at EM presented bird communities more similar to those of woodland savannas. These formations presented 54 species in common, which comprises 58% of the birds of dirty pastures and 72.9% of the community of woodland savannas. Thus, dirty pastures indicated being capable of harboring many bird species present in surrounding forests and savannas. This was possible because dirty pastures have many trees and schrubs, which can be used as stepping stones, making pastures more permeable for foraging and movement of bird species between patches of native vegetation (Silva et al. 1996, Estrada et al. 2000). In addition, some plant species which colonize pastures offer a large abundance of fruits, making them more permeable to the birds. This is the case of *capororoca* (*Rapanea guianensis*, Myrsinaceae), a common tree found in savannas and dirty pastures of the study area and belonging to a genus of plants known to be important in the diet of some birds (Pineschi 1990, Francisco and Galetti 2001, Pascotto 2007).

Insectivorous, omnivorous, frugivorous and gramnivorous birds were dominant at EM and in each particular vegetation type. These groups are usually dominant in the Cerrado domain (Motta-Junior 1990, Donatelli et al. 2004, Piratelli and Blake 2006, Manica et al. 2010, Telles and Dias 2010, Vieira et al. 2013) and other Brazilian phytogeographic domains (Willis 1979, Aleixo 1999, Anjos 2001, Silveira et al. 2003, Santos 2004, Olmos et al. 2005, Telino-Júnior et al. 2005, Roos et al. 2006, Donatelli et al. 2007, Silveira and Machado 2012).

The dominance of insectivorous birds could be related to the great abundance of arthropods and the relatively regular supply of these resources. Thus, maintaining a diet of arthropods may be a safer strategy for the birds than the consumption of fruits, which usually have more irregular availability in space and time, especially in vegetational mosaics of forests and grasslands with seasonal precipitation regime, like in Bodoquena Mountains (Reys et al. 2005), as well as throughout the Cerrado domain (Batalha and Mantovani 2000, Batalha and Martins 2004). The adoption of an omnivorous diet, with a regular consumption of fruits, arthropods and vertebrates, often makes the species less sensitive to habitat degradation and fragmentation, since a varied diet allows the birds to forage in different vegetation types and grants them regular food supply throughout the year. Because of this, some omnivorous birds become abundant in disturbed habitats at the same time more specialized birds, both insectivorous and frugivorous, become rare in these areas (Willis 1979).

The gramnivorous birds were most common at EM in pastures and arboreal savannas because the seeds of grasses, which are the main food item for some common bird species, like *Volatinia jacarina* and *Sicalis flaveola*, are more abundant in grasslands and savannas of the Cerrado domain (Motta-Junior 1990). Although nectarivorous birds have been poorly observed, they seem to be more common in arboreal savannas, corroborating data from other areas of the Cerrado in central Brazil (Piratelli and Blake 2006, Vieira et al. 2013). Malacofagous and piscivorous birds only occurred in riparian forests, since these are the only areas with rivers and streams where their food resources could be found. Finally, carnivorous birds were represented by few species, just like in other studies (Motta-Junior 1990, Donatelli et al. 2004, Manica et al. 2010), since top predators occupy large territories and are naturally rare.

In relation to conservation, two main groups of species should be highlighted: insectivorous birds that live in forest understory and forest frugivorous birds, especially large species. The understory insectivorous birds are very sensitive to the loss and fragmentation of forests (Willis 1979, Bierregaard Jr and Lovejoy 1989), since many species cannot maintain viable populations in small and isolated forest fragments or cross open areas to move between fragments (Stouffer and Bierregaard Jr 1995, Canaday 1997, Marini 2001, Sekercioglu et al. 2002, Martensen et al. 2008). Large forest frugivorous birds (*Crax fasciolata*, *Aburria cumanensis*, *Penelope superciliaris*, *Ramphastos dicolorus*, *Pteroglossus castanotis*) are very sensitive too (Willis 1979, Price et al. 1999), because they need large patches of native vegetation or well connected remaining areas to forage on fruiting trees. The conservation of frugivorous birds is extremelly important for the natural ecossystems because they act as seed dispersers, promoting the reproduction of many plant species and the regeneration of natural environments (Levey 1988, Silva et al. 1996, Pizo 2001).

The high species richness observed at EM, with many birds dependent or semidependent on forests (Godoi et al. 2014), the presence of endangered species and species sensitive to loss and fragmentation of forests, as the large frugivorous and understory insectivorous birds, can be atributted to some main factors. Firstly, the maintenance of fragments near areas which still retain large extensions of natural environments, mainly seasonal forests and arboreal savannas. The proximity of large areas of native vegetation certainly contributed to increase the bird species diversity in disturbed areas in addition to increasing the presence of sensitive species in fragmented landscapes (Aleixo 1999, Marsden et al. 2001, Faria et al. 2006).

Another important issue related to the bird conservation is the permeability of the anthropogenic matrix to the birds dependent and semidependent of forests, especially in the dirty pastures. Production systems which allow the maintenance of structurally complex habitats increase the permeability of the landscape to local biodiversity, when compared to other systems that simplify the environment by cutting trees, for example (Pimentel et al. 1992, Estrada et al. 1993a, b, 1994, Perfecto et al. 1996, Greenberg et al. 1997, Rice and Greenberg 2000, Sherry 2000, Faria et al. 2006). Thus, maintaining part of the shrub and arboreal strata in pastures certainly contributes to the local bird conservation, since it increases the area of available habitat and facilitates the movement of bird species in the landscape.

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RESUMO

As informações de distribuição das espécies de aves em diferentes habitats e a estrutura de suas comunidades são cruciais para sua conservação. Nós testamos as diferenças na composição, riqueza e abundância de aves em diferentes fitofisionomias da Serra da Bodoquena, oeste do Brasil, e demonstramos as variações na riqueza e abundância de aves entre diferentes grupos tróficos. As amostragens foram conduzidas entre Julho de 2011 e Junho de 2012 em 200 pontos de escuta distribuídos na área de estudo. Foram obtidos 3350 contatos pertencentes a 156 espécies de aves. Savanas florestadas, florestas estacionais e savanas arborizadas tiveram maior riqueza e abundância de aves, enquanto florestas ripárias, pastos limpos e pastos sujos tiveram menores valores destes parâmetros. A comunidade de aves foi organizada de acordo com o gradiente local de vegetação, com comunidades de florestas, áreas abertas e savanas, embora muitas espécies tenham ocorrido em mais de um tipo de vegetação. As aves insetívoras, onívoras, frugívoras e granívoras compreenderam a maioria da comunidade. Estes dados demonstraram quão importante é a heterogeneidade ambiental para as comunidades de aves. Além disso, a presença de extensas manchas de habitats naturais, a pequena distância entre estas manchas e a permeabilidade das pastagens, com alta cobertura arbórea e arbustiva, são apontadas como importantes fatores para a manutenção da diversidade de aves.

Palavras-chave: Cerrado, uso do habitat, pontos de escuta, Reserva Particular, grupos tróficos.

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SUPPLEMENTARY MATERIAL

TABLE SI - Bird species sampled at Estância Mimosa, Bodoquena Mountains, state of Mato Grosso do Sul, Brazil. Trophic groups: I – insectivorous; O – omnivorous; F – frugivorous; G – gramnivorous; NT – nectarivorous; C – carnivorous; N – necrofagous; P – piscivorous; M – malacofagous. PAI (Punctual Abundance Index): EM (Estância Mimosa or all the study area), RF (riparian forests or *mata ciliar*), SF (seasonal forests or *mata estacional*), WS (woodland savannas or *cerradão*), AS (arboreal savannas or *cerrado stricto sensu*), DP (dirty pastures or *pasto sujo*), CP (clean pastures or *pasto limpo*); n = number of samples.