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Interactions between frugivorous birds and plants in savanna and forest formations of the Cerrado

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Abstract: We recorded interactions between frugivorous birds and plants in the Cerrado and we assessed the role and importance of birds as potential seed dispersers. We analyzed the distribution of recorded feeding events, bird-plant interactions, and bird species composition between savanna and forest formations and between the dry and rainy seasons. Samplings were carried out from August 2009 to October 2010 and from November 2011 to August 2012 by means of line transects and focal observations. We recorded 348 feeding events and 187 interactions involving 44 plant species and 60 bird species. Most of the feeding events were observed in the forests and during the dry season (χ^2 = 39.529; gl = 1; $p < 0.001$). However, no significant difference was found in the number of interactions (χ^2 = 15.975; gl = 1; p = 0.06) between the two vegetation formations and between seasons. The bird species composition differed between savanna and forest formations (ANOSIM, R = 0.238; $p < 0.001$) and between the dry and rainy seasons (ANOSIM, R = 0.223; $p < 0.001$). Most of the potential seed dispersers were generalist birds that preferentially occupy forests during the dry season. Records of feeding events in forest formations increased in the dry season, indicating that birds use these sites as foraging areas during this period. We suggest that the preservation of forests in predominantly savanna-like ecosystems such as the Cerrado is extremely important for frugivorous birds and for frugivore-plant interactions.
Keywords: *Mutualistic interactions, Neotropical savanna, seasonality, seed dispersal.*

PURIFICAÇÃO, K.N., PASCOTTO, M.C., PEDRONI, F., PEREIRA, J.M.N., LIMA, N.A. **Interações entre aves frugívoras e plantas em formações savânicas e florestais do Cerrado.** Biota Neotropica. 14(4): e20140068. http://dx.doi.org/10.1590/1676-06032014006814

Resumo: Registramos interações entre aves frugívoras e plantas no Cerrado e avaliamos o papel e a importância das aves como potenciais dispersoras de sementes. Observamos como números de registros de alimentação e de interações e composição de espécies de aves se distribuem entre formações savânicas e florestais e entre as estações seca e chuvosa. Realizamos amostragens entre agosto/2009 e outubro/2010 e entre novembro/2011 e agosto/2012 por meio de transecções e observações focais. Observamos 348 registros de alimentação e 187 interações envolvendo 44 espécies de plantas e 60 espécies de aves. A maioria dos registros de alimentação foi observada nas florestas e durante a estação seca (χ^2 = 39,529; gl = 1; $p < 0{,}001$). Já em relação ao número de interações não encontramos diferença significativa (χ^2 = 15,975; gl = 1; p = 0,06) entre as duas formações vegetacionais e entre as estações. A composição de espécies de aves diferiu entre formações savânicas e florestais (ANOSIM, R = 0,238; $p < 0{,}001$) e entre as estações seca e chuvosa (ANOSIM, R = 0,223; $p < 0{,}001$). A maioria das espécies potencialmente dispersoras foi aves generalistas que ocupam preferencialmente florestas durante a estação seca. Durante a estação seca há aumento de registros de alimentação nas formações florestais, indicativo de que as aves usam estes locais como área de forrageio nesse período. Sugerimos que a manutenção de florestas em ecossistemas predominantemente savânicos como o Cerrado é extremamente importante para a avifauna frugívora e para as interações frugívoro-planta.
Palavras-chave: *Interações mutualísticas, savana Neotropical, sazonalidade, dispersão de sementes.*

Introduction

One of the main positive interactions between plants and animals is seed dispersal by frugivores. Plants benefit from the dispersal of their propagules away from the parent plant because this reduces competition and predation (Howe & Smallwood 1982) and increases gene flow between populations. In return, animals that consume fruits receive nutritional benefits (Howe & Primack 1975, Snow 1981).

The interactions between fruiting plants and frugivorous birds in a community define a pattern comprising a few bird species that interact with many plant species and a few plants that interact with many birds. This makes the dependence between bird and plants species essential to the stability of the ecological processes of a community (Fadini & De Marco 2004).

Birds stand out as seed dispersers due to the high abundance and frequency with which they feed on fruits and their great ability to move between environments (Jordano 1994). Frugivorous birds represent 56% of the world's avian families and, in Neotropical forests, 25 to 30% of the avifauna includes fruits in their diet (Pizo & Galetti 2010). According to Jordano (1987), studies of frugivory by birds in tropical forests are relatively well reported (e.g., Snow 1981, Jordano 1987, Galetti & Pizo 1996, Medellín & Gaona 1999, Silva & Tabarelli 2000, Bascompte et al. 2003, Saracco et al. 2005, Galetti et al. 2013). It is estimated that 50 to 90% of tree species in tropical forests produce zoochorous fruit (Howe & Smallwood 1982). In contrast, in tropical savannas, despite the wide geographical distribution and rich biodiversity, few studies have addressed the frugivory and seed dispersal by birds (e.g., Dean et al. 1999, Hovestadt et al. 1999, Wütherich et al. 2001, Faustino & Machado 2006, Christianini & Oliveira 2009, Pascotto et al. 2012, Maruyama et al. 2013).

Savannas are defined primarily by their seasonal climate and fire regime, with vegetation characterized by an herbaceous stratum dominated by grasses and a discontinuous woody shrub stratum (Skarpe 1992). The Brazilian Cerrado, the largest savanna in the world, is represented by a mosaic of phytophysiognomic formations such as Fields, Cerrado *sensu stricto*, Semideciduous Forests and Gallery Forests (Silva & Bates 2002). The climate is represented by two well-defined seasons (one warm and wet and the other cool and dry), due to the changes in temperature and precipitation over the year (Eiten 1972).

With about 12000 plant species (Mendonça et al. 2008) and 837 bird species (Myers et al. 2000) catalogued, it is estimated that about half of the plant species in the Cerrado need animals to disperse their seeds, and birds are the main group of dispersers (Gottsberger & Silberbauer-Gottsberger 1983, Pinheiro & Ribeiro 2001, Kuhlmann 2012). The proportion of zoochorous plant species is high in both savanna and forest physiognomies of the Cerrado. In the Cerrado *sensu stricto* of Central Brazil, for example, the proportion of zoochorous plant species ranges from 51 to 68% (Vieira et al. 2002). On the other hand, in the Gallery Forests of Central and Southeastern Brazil, 63 to 89% of the plants have zoochorous dispersion and more than half of them are *ornithochorous* (Pinheiro & Ribeiro 2001, Motta-Junior & Lombardi 2002).

The fruit production of most Cerrado *sensu stricto* zoochorous species follows a seasonal pattern, with a peak in fruit ripening in the rainy season (Silberbauer-Gottsberger 2001, Lenza & Klink 2006, Pirani et al. 2009, Camargo et al. 2013). The same pattern has been observed in Gallery Forests (Oliveira & De Paula 2001). However, the fruit of most abundant species in the two phytophysiognomies ripen in the dry season (Gouveia & Felfili 1998).

Knowing that seed dispersal is an important ecological process that acts in the maintenance of diversity and that frugivory is the first step in studying this event (Cordeiro & Howe 2001), our objectives were (i) to identify the interactions between frugivorous birds and plants and the most important species in the community (*sensu* importance Murray 2000), and (ii) to evaluate the potential of seed dispersal, number of feeding records, number of interactions and composition of frugivorous bird species in savanna and forest formations of the Cerrado, considering the dry and rainy seasons. We tested the hypothesis that forest formations have higher numbers of feeding records and interactions, since most of the zoochorous plants of the Cerrado are concentrated in forests (Pinheiro & Ribeiro 2001, Kuhlmann 2012), and that the records of feeding and interactions show higher values during the rainy season, because there is greater availability of ripe fruit in the Cerrado during this season (Silberbauer-Gottsberger 2001, Lenza & Klink 2006, Pirani et al. 2009, Camargo et al. 2013). Our second hypothesis is that the composition of frugivorous bird species does not differ between savanna and forest formations or between the dry and rainy seasons, since most of the bird species of the Cerrado occur in both vegetation formations (Silva 1997, Bagno & Marinho-Filho 2001).

Material and Methods

Study area – This study was conducted in Serra Azul State Park (15°52'S and 51°16'W), located in the municipality of Barra do Garças, in the region of the Araguaia Valley, in the eastern part of the state of Mato Grosso. With an area of about 11,000 ha, this is an important Conservation Unit in the Cerrado containing a variety of phytophysiognomies typical to this biome, including savanna and forest formations (Ribeiro & Walter 2008). The average altitudes in the region range from 600 to 700 m and its soils are classified as clayey dystrophic red-yellow latosol (oxisol) (Pirani et al. 2009).

According to the Köppen classification the region has an Aw type climate, hot and humid, with two well-defined seasons, a rainy summer (October to March) and dry winter (April to September). The average annual temperature is 25.5°C and annual average rainfall is 1,528 mm (Pirani et al. 2009).

Data collection – Sampling was conducted from August 2009 to October 2010 (first period) and from November 2011 to August 2012 (second period). In the first period, we used four preestablished trails, each approximately 2 km in length, two of which passed through savanna formations (rocky outcrop Cerrado - *Cerrado Rupestre* and Typical Cerrado - *Cerrado Típico*) and two through forest formations (Gallery Forest and Semideciduous Forest). In the second period we sampled the module that follows the RAPELD model (Magnusson et al. 2005), in which two parallel 5-km-long trails, one kilometer apart from each other, pass through different Cerrado phytophysiognomies, such as Shrubby Grassland Cerrado (*Cerrado Ralo*), Typical Cerrado, Semideciduous Forest and Gallery Forest (*sensu* Ribeiro & Walter 2008).

The interactions were recorded using the line transect method (Bibby et al. 2000), with adaptations for frugivory studies (Pizo & Galetti 2010). In addition to the line transect method, focal observations were made involving twelve plant species chosen mainly because of their large individual fruit production and the easy visibility of the crown (*Byrsonima sericea* DC. – Malpighiaceae, *Cecropia pachystachya* Trécul – Urticaceae, *Copaifera langsdorffii* Desf. – Fabaceae, *Lasiacis ligulata* Hitchc. & Chase – Poaceae, *Miconia staminea* (Desr.) DC. – Melastomataceae, *Myrcia multiflora* (Lam.) DC. – Myrtaceae, *Myrsine umbellata* Mart. – Primulaceae, *Norantea guianensins* Aubl. – Marcgraviaceae, *Rudgea viburnoides* (Cham.) Benth. – Rubiaceae, *Schefflera morototoni* (Aubl.) Maguire et al. – Araliaceae, *Xylopia aromatica* (Lam.) Mart. e *Xylopia sericea* A. St.-Hil. – Annonaceae). Focal observations of the same plant were made on non-consecutive days, with an average of three observers per sampling. Three hours of focal observations were made for each plant species and only complete observations were considered, in which a frugivore was observed from its arrival on the plant until its departure, without losing sight of the bird during its entire visit (Silva et al. 2002).

Each time a bird was observed eating fruit the feeding event was recorded, regardless of the number of fruits consumed and the duration of the visit. In the case of flocks of birds foraging at the same time on the same plant, an individual feed record was made of the fruit consumed by each bird in the flock (Pizo & Galetti 2010). Records of feeding events by a bird species on a plant species corresponded to an interaction. Thus, an interaction indicated that a particular bird species consumed fruits of a particular plant species, regardless of the number of recorded feeding events.

In each recorded feeding event, we noted the consumer bird species, the plant species whose fruits were consumed, the phytophysiognomy and the date of the record. The mode of fruit consumption by the birds was also evaluated, including the portion of fruit consumed (pulp, aril, seed, and/or entire fruit) and the fruit's ripeness. Birds observed consuming whole propagules or taking them away from the parent plant were considered potential seed dispersers. The species that ate unripe fruits or that shredded the seeds were considered seed predators (Howe & Smallwood 1982, Moermond & Denslow 1985).

Weekly visits to the field were made in the first period, so that each phytophysiognomy was sampled at least once a month by the line transect method. Two to three weekly field visits were made in the second period, so that each vegetation type would also be sampled at least once a month by the line transect method, ensuring that the number of samplings in savanna and forest formations would be as similar as possible. Samplings were conducted between 6:00 AM and 1:00 PM., totaling 284 hours of sampling work by the line transect (248 hours) and focal methods (36 hours).

A frugivore was considered based on the criteria of Moermond & Denslow (1985), according to which a frugivorous bird is one that includes fruits in its diet at least during some season or stage of life, but does not feed exclusively on fruits. To separate the frugivorous birds into feeding guilds, we used the criteria adopted by Vieira et al. (2013) for the avifauna of Serra Azul State Park. The taxonomic classification and nomenclature of bird species was based on the proposal of the Brazilian Ornithological Records Committee (CBRO 2014) and of plant species on the List of Brazilian Flora Species (2014).

Data analysis – The importance index (*I*) was calculated for each bird species considered a potential seed disperser. This index denotes the contribution of a bird species compared with the other bird species to each of the plants with which it interacts. The index is characterized by assigning a weight to the species with many interactions, which include many exclusive interactions (Murray 2000), and is given by the following formula: $I_j = \Sigma[(C_{ij}/T_i)/S]$ where T_i is the total number of bird species that fed on the fruit of plant *i*, *S* is the total number of sampled plants species, and C_{ij} is equal to 1 if the bird species *j* consumed the fruits of the plant species *i* or 0 if it did not. The value of *I* varies between 0 and 1, with 0 corresponding to avian species that did not interact with any plant and 1 corresponding to those that consumed fruits from all the plants contained in the sample. The same index was use to calculate the plant species whose fruits were eaten by the birds. In this case, *i* corresponded to the bird species and *j* to the plant species.

We used the chi-square test (χ^2) by means of contingency tables (Zar 1999) to test our first hypothesis, i.e., to ascertain if there are more records of feeding events and interactions (consumed/did not consume) in forest formations than in savanna formations, and to determine how these values are distributed between the dry and rainy seasons. The composition of frugivorous bird species between savanna and forest formations and between the dry and rainy seasons (second hypothesis) was compared based on a multivariate analysis of similarity (ANOSIM) (Clarke & Green 1988), using the Jaccard similarity coefficient. The significance of the test (*p*) was obtained after 9,999 permutations and sequential Bonferroni correction (Legendre & Legendre 1998). The analyses were performed using the R-2.13.0 software program (R Development Core Team 2011).

Results

A total of 348 feeding events were recorded (average of 1.22 events per hour) and 187 interactions involving 44 plant species (26 families) and 60 bird species (19 families). Of the 60 bird species observed consuming fruit, 47 belong to the order Passeriformes, and are distributed in 12 families. Among them, the most numerous in terms of species were Thraupidae (16) and Tyrannidae (11). Among the non-passerines (13 species), the Psittacidae family was the most well represented (5 species) (Figure 1A). The plant families with the highest species richness were Myrtaceae (4), Melastomataceae (3) and Malpighiaceae (3) (Figure 1B).

The bird species that interacted with the largest number of plants were *Turdus leucomelas* Vieillot, 1818 (15 interactions) and *Dacnis cayana* (Linnaeus, 1766) (n = 12), followed by *Tangara cayana* (Linnaeus, 1766) (n = 9) and *Cyanocorax cyanopogon* (Wied, 1821) (n = 9). Considering only forest formations, *Turdus leucomelas* (n = 12), *Dacnis cayana* (n = 8) and *Saltator maximus* (Statius Muller, 1776) (n = 8) were the bird species that interacted with the largest number of plant species. In the savanna formations, *Dacnis cayana* and *Tangara sayaca* (Linnaeus, 1766) stood out with five interactions each, and *Hemithraupis guira* (Linnaeus, 1766) and *Elaenia chiriquensis* Lawrence, 1865, with four interactions each.

The plant species that interacted with the largest number of bird species were *Miconia staminea* (23 interactions), *Cecropia pachystachya* (n = 12) and *Dilodendron bipinnatum* Radlk. (n = 12). In the forest formations, 35% of the observed interactions involved *Miconia staminea* (n = 23), *Dilodendron bipinnatum* (n = 12) and *Schefflera morototoni* (n = 10). On the other hand,

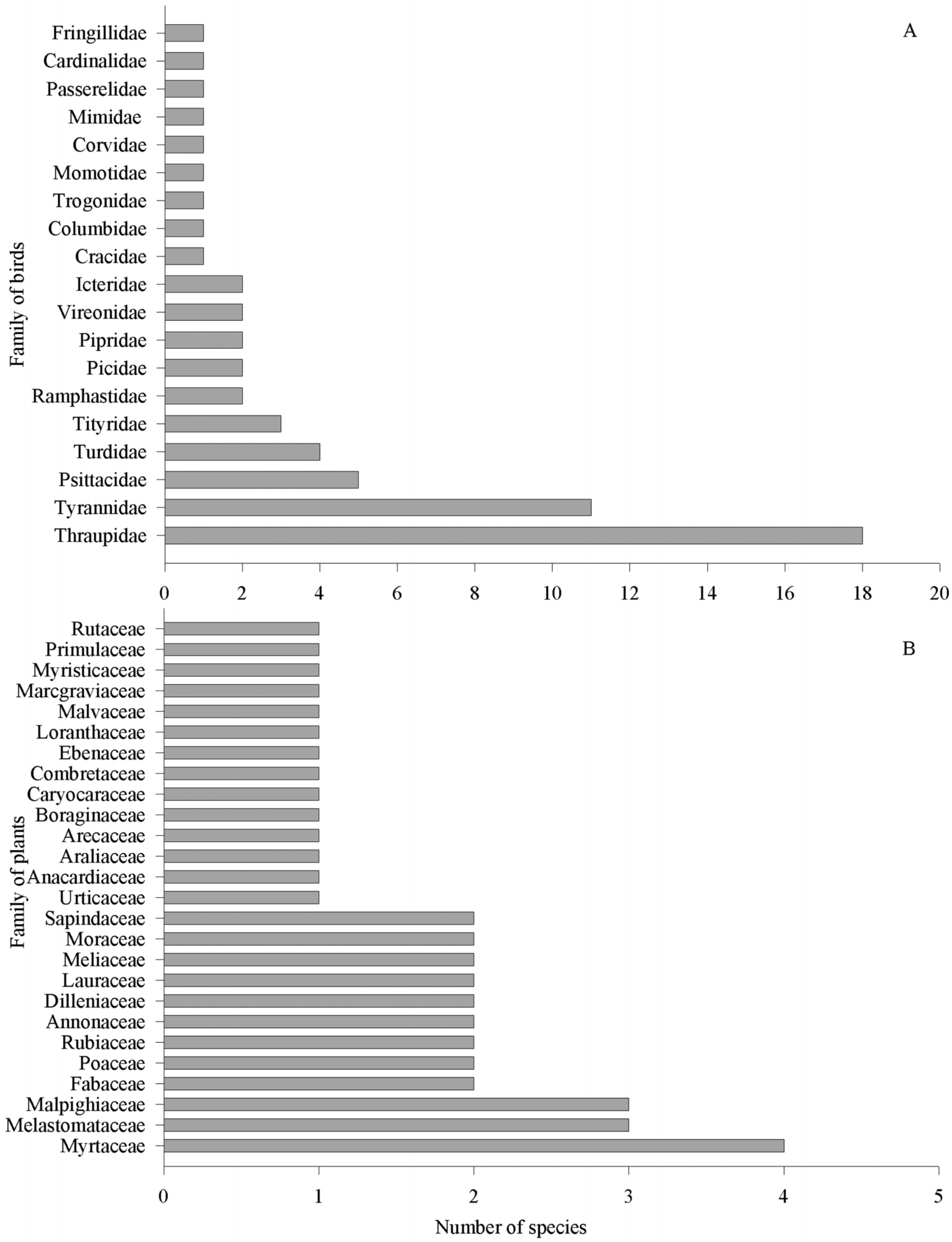

Figure 1. Specific richness of the avian (A) and plant (B) families that presented interactions in frugivory events in Serra Azul State Park, Mato Grosso, Brazil.

about 40% of the interactions in the savanna formations involved *Cecropia pachystachya* (9 interactions), *Curatella americana* L. (n = 9) and *Copaifera langsdorffii* (n = 7).

As for the importance index, *Turdus leucomelas* (*I* = 0.107), *Cyanocorax cyanopogon* (*I* = 0.066) and *Trogon curucui* Linnaeus, 1766 (*I* = 0.054) were the most important bird species in the entire community (Figure 2A). The most important bird species in the forests were *Turdus leucomelas* (*I* = 0.116), *Trogon curucui* (*I* = 0.078) and *Saltator maximus* (*I* = 0.071). In the savanna formations, the bird species with the highest levels of importance were *Volatinia jacarina* (Linnaeus, 1766) (*I* = 0.080), *Turdus leucomelas* (*I* = 0.065), *Tangara sayaca* (*I* = 0.065) and *Myiodynastes maculatus* (Statius Muller, 1776) (*I* = 0.065).

Among plants, *Miconia staminea* (*I* = 0.162), *Cecropia pachystachya* (*I* = 0.083) and *Rudgea viburnoides* (*I* = 0.063) were the most important in the community (Figure 2B). The plants that stood out in the forest formations were *Miconia staminea* (*I* = 0.255), *Rudgea viburnoides* (*I* = 0.089) and *Xylopia sericea* (*I* = 0.084). The most important plants in the savanna formations were *Cecropia pachystachya* (*I* = 0.170), *Curatella americana* (*I* = 0.165) and *Copaifera langsdorffii* (*I* = 0.111).

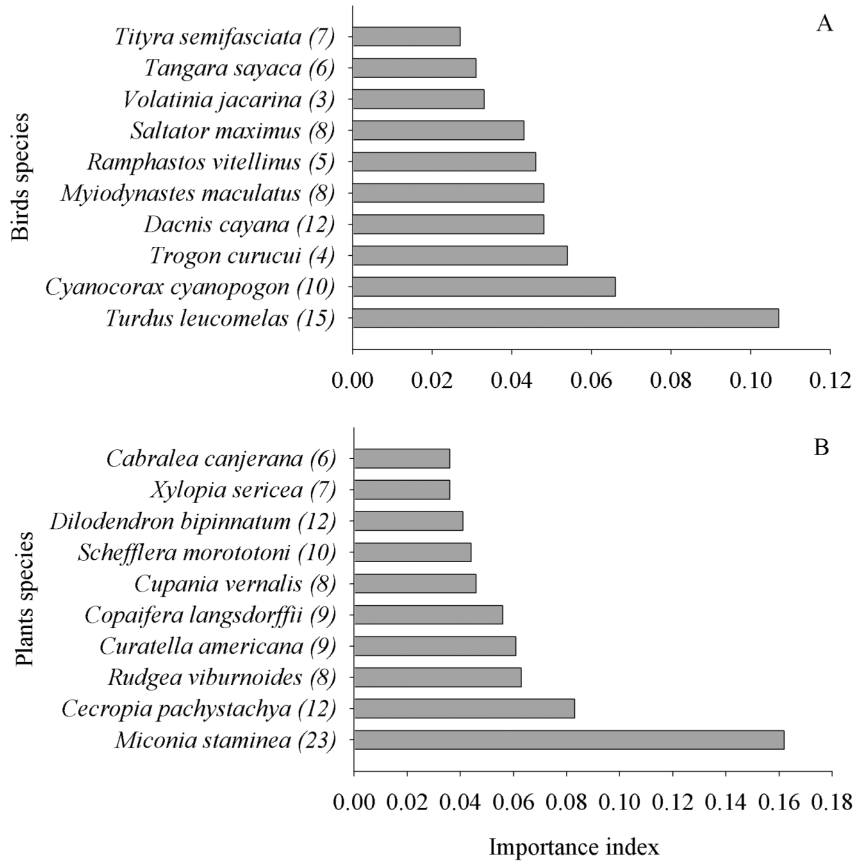

Figure 2. Indices of importance of the ten avian (A) and plant (B) species that presented the highest values in Serra Azul State Park, Mato Grosso, Brazil. The number of recorded interactions are shown in parentheses.

Among the observed interactions, 77% showed a potential for dispersal. Of the 60 bird species, 49 (82%) were considered potential dispersers of all the plant species with which they interacted. Seed predators, represented mainly by species of the Psittacidae family, accounted for 12% of the observed bird species. Besides parrots, only *Cyclarhis gujanensis* (Gmelin, 1789), *Nemosia pileata* (Boddaert, 1783), *Neothraupis fasciata* (Lichtenstein, 1823), *Tersina viridis* (Illiger, 1811), *Zonotrichia capensis* (Statius Muller, 1776) and *Gnorimopsar chopi* (Vieillot, 1819) were not considered potential seed dispersers of any plant species (Table 1).

The seeds of nine plant species were not dispersed by any bird species. The seeds of four of these plant species [*Brosimum gaudichaudii* Trécul, *Caryocar brasiliense* Cambess., *Cordia sellowiana* Cham. and *Pseudobombax tomentosum* (Mart. & Zucc.)] were shredded by parrots. Added to these plant species, the fruits of *Mezilaurus crassiramea* (Meisn.) Taub. ex Mez and Indeterminate 1 were consumed only in the unripe stage. The consumption of pulp was observed only in *Buchenavia tomentosa* Eichler, *Diospyros brasiliensis* Mart. ex Miq. and *Mangifera indica* L. (Table 1).

Most of the feeding events (70% of total) were recorded in forest formations and during the dry season (73%) ($\chi^2 = 39.529$; $gl= 1$; $p < 0.001$). As for the number of interactions (consumed/did not consume), about 70% of them were recorded in the forest formations and also during the dry season (75%). However, this result was not significant ($\chi^2 = 15.975$; $gl = 1$; $p = 0.06$). Of total number of frugivorous birds recorded, 75% occurred in forest formations and 52% in savanna formations, indicating that the composition of frugivorous bird species differed between the two types of vegetation (ANOSIM, $R = 0.238$, $p < 0.001$). The bird species composition also differed between seasons (ANOSIM, $R = 0.223$, $p < 0.001$). About 80% of the species were recorded during the dry season, while approximately 50% were recorded eating fruits in the rainy season. Twenty- nine bird species were recorded consuming fruits exclusively in forests, 15 exclusively in savanna formations, and 16 in both environments (Table 1).

Discussion

Bird species of the Thraupidae and Tyrannidae families (Passeriformes) were found to be the main potential seed dispersers. In frugivory studies conducted in the Cerrado (Francisco & Galetti 2002, Cazetta et al. 2002, Melo et al. 2003, Marcondes-Machado & Rosa 2005, Pascotto 2006, 2007, Francisco et al. 2007, Christianini & Oliveira 2009, Allenspach & Dias 2012, Pascotto et al. 2012, Maruyama et al. 2013), species of the aforementioned families also stood out as the main potential seed dispersers, with *Tangara sayaca*, *Tangara cayana* (Thraupidae), *Pitangus sulphuratus* (Linnaeus, 1766) and *Myiodynastes maculatus* (Tyrannidae) standing out as the most frequently recorded species.

Species of the tanager family are very important to seed dispersal in the Cerrado, as well as throughout the Neotropics (Snow & Snow 1971). According to Francisco & Galetti (2002),

Table 1. Avian species observed consuming fruit during 284 hours of observations in forest and savanna formations in Serra Azul State Park, municipality of Barra do Garças, Mato Grosso, Brazil. [1]**Dispersal potential (DP):** (PD) Potential disperser, (ND) Non-disperser. [2]**Diet (D)** (Vieira et al. 2013.): (Fru) Frugivorous, (Omn) Omnivorous, (Ins) Insectivorous, (Nec) Nectivorous, (Gra) Granivorous. [3]**Vegetation formation (VF):** (F) Forest, (S) Savanna. [4]**Season (S):** (D) Dry, (R) Rainy. *Seed shredder species. §Species carrying fruit in their beak/nails.

Birds	Plants	DP[1]	D[2]	VF[3]	S[4]	Portion consumed
Cracidae						
Penelope superciliaris Temminck, 1815	*Rudgea viburnoides* (Cham.) Benth (Rubiaceae)	PD	Fru	F	D	Whole fruit
Columbidae						
Patagioenas speciosa (Gmelin, 1789)	*Schefflera morototoni* (Aubl.) Maguire *et al.* (Araliaceae)	PD	Fru	F	D	Whole fruit
	Indeterminada 1	ND		F	R	Unripe fruit
Trogonidae						
Trogon curucui Linnaeus, 1766	*Byrsonima* sp. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Byrsonima sericea DC. (Malpighiaceae)	PD		F	R	Whole fruit
	Dilodendron bipinnatum Radlk. (Sapindaceae)	PD		F	D	Seeds
	Guarea guidonia (L.) Sleumer (Meliaceae)	PD		F	D	Seeds
Momotidae						
Momotus momota (Linnaeus, 1766)	*Cabralea canjerana* (Vell.) Mart. (Meliaceae)	PD	Omn	F	D	Seeds
	Xylopia aromatica (Lam.) Mart. (Annonaceae)	PD		F	D	Seeds
Ramphastidae						
Ramphastos toco Statius Muller, 1776	*Cecropia pachystachya* Trécul (Urticaceae)	PD	Fru	S	D	Pulp/Seeds
Ramphastos vitellinus Lichtenstein, 1823	*Calyptranthes* cf. *lucida* Mart. *ex* DC. (Myrtaceae)	PD	Fru	F	D	Whole fruit
	Campomanesia eugenioides (Cambess.) D.Legrand *ex* Landrum (Myrtaceae)	PD		F	R	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		F	R	Pulp/Seeds
	Ocotea corymbosa (Meisn.) Mez (Lauraceae)	PD		F	R	Whole fruit
	Myrsine umbellata Mart. (Primulaceae)	PD		F	D	Whole fruit
Picidae						
Celeus flavescens (Gmelin, 1788)	*Xylopia aromatica* (Lam.) Mart. (Annonaceae)	PD	Ins	F	D	Seeds
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
Dryocopus lineatus (Linnaeus, 1766)	*Myrcia multiflora* (Lam.) DC. (Myrtaceae)	PD	Ins	S	R	Whole fruit
Psittacidae						
Ara chloropterus Gray, 1859	*Caryocar brasiliense* Cambess. (Caryocaraceae)	ND	Fru	S	D	Pulp/Seeds*
Diopsittaca nobilis (Linnaeus, 1758)	*Cordia sellowiana* Cham. (Boraginaceae)	ND	Fru	F	R	Pulp/Seeds*
Psittacara leucophthalmus (Statius Muller, 1776)	*Cordia sellowiana* Cham. (Boraginaceae)	ND	Fru	S	R	Pulp/Seeds*
Eupsittula aurea (Gmelin, 1788)	*Brosimum gaudichaudii* Trécul (Moraceae)	ND	Fru	S	D	Pulp/Seeds*
Brotogeris chiriri (Vieillot, 1818)	*Brosimum gaudichaudii* Trécul (Moraceae)	ND	Fru	S	D	Pulp/Seeds*
	Pseudobombax tomentosum (Mart. & Zucc.) A.Robyns (Malvaceae)	ND		F	D	Pulp/Seeds*
Pipridae						
Pipra fasciicauda Hellmayr, 1906	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Fru	F	D	Whole fruit
Antilophia galeata (Lichtenstein, 1823)	*Rudgea viburnoides* (Cham.) Benth (Rubiaceae)	PD	Fru	F	D	Whole fruit
Tityridae						
Tityra inquisitor (Lichtenstein, 1823)	*Rudgea viburnoides* (Cham.) Benth (Rubiaceae)	PD	Ins	F	D	Whole fruit

Continued on next page

Table 1. Continued.

Birds	Plants	DP[1]	D[2]	VF[3]	S[4]	Portion consumed
Tityra semifasciata (Spix, 1825)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Ins	F	R	Whole fruit
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Ocotea corymbosa (Meisn.) Mez (Lauraceae)	PD		F	D	Whole fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
	Virola sebifera Aubl. (Myristicaceae)	PD		F	D	Seeds/Aril
	Xylopia aromatica (Lam.) Mart. (Annonaceae)	PD		F	D	Seeds
Pachyramphus viridis (Vieillot, 1816)	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Omn	F	D	Whole fruit
Tyrannidae						
Camptostoma obsoletum (Temminck, 1824)	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Ins	F	D	Whole fruit
Elaenia flavogaster (Thunberg, 1822)	*Byrsonima pachyphylla* A.Juss. (Malpighiaceae)	PD	Omn	S	D	Whole fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Xylopia aromatica (Lam.) Mart. (Annonaceae)	PD		S	D	Seeds
Elaenia mesoleuca (Deppe, 1830)	*Xylopia sericea* A.St.-Hil. (Annonaceae)	PD	Omn	F	D	Seeds
Elaenia chiriquensis Lawrence, 1865	*Brosimum gaudichaudii* Trécul (Moraceae)	ND	Omn	S	D	Pulp
	Byrsonima pachyphylla A.Juss. (Malpighiaceae)	PD		S	D	Whole fruit
	Byrsonima sericea DC. (Malpighiaceae)	PD		S	R	Whole fruit
	Cupania vernalis Cambess. (Sapindaceae)	ND		F	D	Aril
	Miconia albicans (Sw.) Triana (Melastomataceae)	ND		S	D	Unripe fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
Myiarchus swainsoni Cabanis & Heine, 1859	*Cabralea canjerana* (Vell.) Mart. (Meliaceae)	PD	Ins	F	D	Seeds
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Virola sebifera Aubl. (Myristicaceae)	PD		F	D	Seeds/Aril
Sirystes sibilator (Vieillot, 1818)	*Cabralea canjerana* (Vell.) Mart. (Meliaceae)	PD	Ins	F	D	Seeds
Pitangus sulphuratus (Linnaeus, 1766)	*Copaifera langsdorffii* Desf. (Fabaceae)	PD	Omn	F	D	Seeds/Aril
Myiodynastes maculatus (Statius Muller, 1776)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Byrsonima sp. (Malpighiaceae)	PD		F		Whole fruit
	Cabralea canjerana (Vell.) Mart. (Meliaceae)	PD		F	D	Seeds
	Copaifera langsdorffii Desf. (Fabaceae)	PD		F/S	D	Seeds/Aril
	Cupania vernalis Cambess. (Sapindaceae)	PD		F	D	Seeds/Aril
	Curatella americana L. (Dilleniaceae)	PD		S	D	Seeds/Aril
	Davilla elliptica A.St.-Hil. (Dilleniaceae)	PD		S	D	Seeds/Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
Megarynchus pitangua (Linnaeus, 1766)	*Byrsonima* sp. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Cabralea canjerana (Vell.) Mart. (Meliaceae)	PD		F	D	Seeds
	Curatella americana L. (Dilleniaceae)	PD		S	R	Seeds/Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
Empidonomus varius (Vieillot, 1818)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Ins	F	R	Whole fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit

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Table 1. Continued.

Birds	Plants	DP[1]	D[2]	VF[3]	S[4]	Portion consumed
Cnemotriccus fuscatus (Wied, 1831)	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Ins	F	D	Whole fruit
Vireonidae						
Cyclarhis gujanensis (Gmelin, 1789)	*Cupania vernalis* Cambess. (Sapindaceae)	ND	Ins	F	D	Aril
Vireo chivi (Linnaeus, 1766)	*Cupania vernalis* Cambess. (Sapindaceae)	PD	Omn	F	D	Seeds/Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Zanthoxylum rhoifolium Lam. (Rutaceae)	PD		F	D	Seeds
Corvidae						
Cyanocorax cyanopogon (Wied, 1821)	*Acrocomia aculeata* (Jacq.) Lodd. *ex* Mart. (Arecaceae)	PD§	Omn	F	R	Pulp
	Buchenavia tomentosa Eichler (Combretaceae)	ND		S	D	Pulp
	Copaifera langsdorffii Desf. (Fabaceae)	PD		S	D	Seeds/Aril
	Diospyros brasiliensis Mart. *ex* Miq. (Ebenaceae)	ND		F	D	Pulp
	Mangifera indica L. (Anacardiaceae)	ND		F	R	Pulp
	Miconia albicans (Sw.) Triana (Melastomataceae)	PD		F	C	Whole fruit
	Miconia macrothyrsa Benth. (Melastomataceae)	PD		F	D	Whole fruit
	Tocoyena formosa (Cham. & Schltdl.) K.Schum. (Rubiaceae)	PD		S	D	Seeds/Pulp
	Virola sebifera Aubl. (Myristicaceae)	PD		F	D	Seeds/Aril
Turdidae						
Turdus leucomelas Vieillot, 1818	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Cabralea canjerana (Vell.) Mart. (Meliaceae)	PD		F	D	Seeds
	*Calyptranthes*cf. *lucida* Mart. *ex* DC. (Myrtaceae)	PD		F	D	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		S	R/D	Pulp/Seeds
	Copaifera langsdorffii Desf. (Fabaceae)	PD		S	D	Seeds/Aril
	Lasiacis ligulata Hitchc. & Chase (Poaceae)	PD		F	D	Whole fruit
	Miconia macrothyrsa Benth. (Melastomataceae)	PD		F	D	Whole fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Myrcia tomentosa (Aubl.) DC. (Myrtaceae)	PD		S	R	Whole fruit
	Indeterminada 2	PD		F	D	Whole fruit
	Rudgea viburnoides (Cham.) Benth (Rubiaceae)	PD		F	D	Whole fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
	Xylopia aromatica (Lam.) Mart. (Annonaceae)	PD		F	D	Seeds
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
	Zanthoxylum rhoifolium Lam. (Rutaceae)	PD		F	D	Seeds
Turdus amaurochalinus Cabanis, 1850	*Copaifera langsdorffii* Desf. (Fabaceae)	PD	Omn	S	D	Seeds/Aril
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Turdus subalaris (Seebohm, 1887)	*Cupania vernalis* Cambess. (Sapindaceae)	PD	Omn	F	D	Seeds/Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Turdus albicollis Vieillot, 1818	*Myrsine umbellata* Mart. (Primulaceae)	PD	Omn	F	D	Whole fruit
	Rudgea viburnoides (Cham.) Benth (Rubiaceae)	PD		F	D	Whole fruit

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Table 1. Continued.

Birds	Plants	DP[1]	D[2]	VF[3]	S[4]	Portion consumed
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Mimidae						
Mimus saturninus (Lichtenstein, 1823)	*Copaifera langsdorffii* Desf. (Fabaceae)	PD	Omn	S	D	Seeds/Aril
Passerelidae						
Zonotrichia capensis (Statius Muller, 1776)	*Curatella americana* L. (Dilleniaceae)	ND	Gra	S	D	Unripe fruit
Icteridae						
Icterus pyrrhopterus (Vieillot, 1819)	*Cecropia pachystachya* Trécul (Urticaceae)	PD	Omn	S	D	Pulp/Seeds
Gnorimopsar chopi (Vieillot, 1819)	*Curatella americana* L. (Dilleniaceae)	ND	Oni	S	D	Aril
Thraupidae						
Coereba flaveola (Linnaeus, 1758)	*Cecropia pachystachya* Trécul (Urticaceae)	PD	Nec	S	D	Pulp/Seeds
Saltator maximus (Statius Muller, 1776)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		F	D	Pulp/Seeds
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Lasiacis ligulata Hitchc. & Chase (Poaceae)	PD		F	D	Whole fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Pterodon pubescens (Benth.) Benth. (Fabaceae)	PD		F	D	Seeds
	Rudgea viburnoides (Cham.) Benth (Rubiaceae)	PD		F	D	Whole fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Saltator similis d'Orbigny & Lafresnaye, 1837	*Cupania vernalis* Cambess. (Sapindaceae)	PD	Omn	F	D	Seeds/Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Zanthoxylum rhoifolium Lam. (Rutaceae)	PD		F	D	Seeds
Nemosia pileata (Boddaert, 1783)	*Copaifera langsdorffii* Desf. (Fabaceae)	ND	Omn	F	D	Aril
	Davilla elliptica A.St.-Hil. (Dilleniaceae)	ND		S	D	Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
Tachyphonus rufus (Boddaert, 1783)	*Byrsonima pachyphylla* A.Juss. (Malpighiaceae)	PD	Omn	S	D	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		S	D	Pulp/Seeds
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Rudgea viburnoides (Cham.) Benth (Rubiaceae)	PD		F	D	Whole fruit
Ramphocelus carbo (Pallas, 1764)	*Cupania vernalis Cambess. (Sapindaceae)*	ND	Omn	F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	*Xylopia aromatica (*Lam.) Mart. (Annonaceae)	PD		F	D	Seeds
Lanio cristatus (Linnaeus, 1766)	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Omn	F	D	Whole fruit
Lanio penicillatus (Spix, 1825)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Fru	F	R	Whole fruit
	Cupania vernalis Cambess. (Sapindaceae)	ND		F	D	Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
Tangara sayaca (Linnaeus, 1766)	*Brosimum gaudichaudii* Trécul (Moraceae)	ND	Omn	S	D	Pulp
	Cecropia pachystachya Trécul (Urticaceae)	PD		S	D	Pulp/Seeds
	Copaifera langsdorffii Desf. (Fabaceae)	ND		S	D	Aril

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Table 1. Continued.

Birds	Plants	DP[1]	D[2]	VF[3]	S[4]	Portion consumed
	Norantea guianensis Aubl. (Marcgraviaceae)	PD		S	R	Pulp/Seeds
	Psittacanthus robustus (Mart.) Mart. (Loranthaceae)	PD		S	D	Whole fruit
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
Tangara palmarum (Wied, 1823)	*Miconia albicans* (Sw.) Triana (Melastomataceae)	PD	Omn	S	R/D	Whole fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Tangara cyanicollis (d'Orbigny & Lafresnaye, 1837)	*Miconia staminea* (Desr.) DC. (Melastomataceae)	PD	Fru	F	R	Whole fruit
Tangara cayana (Linnaeus, 1766)	*Campomanesia eugenioides* (Cambess.) D.Legrand *ex* Landrum (Myrtaceae)	PD	Omn	F	R	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		F	D	Pulp/Seeds
	Copaifera langsdorffii Desf. (Fabaceae)	ND		S	D	Aril
	Davilla elliptica A.St.-Hil. (Dilleniaceae)	ND		S	D	Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Indeterminada 2	ND		F	D	Unripe fruit
	Norantea guianensis Aubl. (Marcgraviaceae)	PD		S	R	Pulp/Seeds
	Rudgea viburnoides (Cham.) Benth (Rubiaceae)	PD		F	D	Whole fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
Neothraupis fasciata (Lichtenstein, 1823)	*Byrsonima pachyphylla* A.Juss. (Malpighiaceae)	ND	Omn	S	D	Pulp
Tersina viridis (Illiger, 1811)	*Davilla elliptica* A.St.-Hil. (Dilleniaceae)	ND	Omn	S	D	Aril
Dacnis cayana (Linnaeus, 1766)	*Byrsonima sericea* DC. (Malpighiaceae)	PD	Omn	F	R	Whole fruit
	Curatella americana L. (Dilleniaceae)	PD		S	R/D	Seeds/Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril
	Ficus sp. (Moraceae)	PD		F	D	Whole fruit
	Mezilaurus crassiramea (Meisn.) Taub. *ex* Mez (Lauraceae)	ND		S	R	Unripe fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Norantea guianensis Aubl. (Marcgraviaceae)	PD		S	R	Pulp/Seeds
	Psittacanthus robustus (Mart.) Mart. (Loranthaceae)	ND		S	R	Unripe fruit
	Schefflera morototoni (Aubl.) Maguire *et al.* (Araliaceae)	PD		F	D	Whole fruit
	Xylopia aromatica (Lam.) Mart. (Annonaceae)	PD		F/S	R/D	Seeds
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
	Zanthoxylum rhoifolium Lam. (Rutaceae)	PD		F	D	Seeds
Cyanerpes cyaneus (Linnaeus, 1766)	*Curatella americana* L. (Dilleniaceae)	PD	Fru	S	R/D	Seeds/Aril
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Norantea guianensis Aubl. (Marcgraviaceae)	PD		S	R	Pulp/Seeds
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
Hemithraupis guira (Linnaeus, 1766)	*Byrsonima pachyphylla* A.Juss. (Malpighiaceae)	PD	Omn	S	D	Whole fruit
	Byrsonima sericea DC. (Malpighiaceae)	PD		F	R	Whole fruit
	Cecropia pachystachya Trécul (Urticaceae)	PD		S	D	Pulp/Seeds
	Curatella americana L. (Dilleniaceae)	ND		S	R/D	Aril
	Dilodendron bipinnatum Radlk. (Sapindaceae)	ND		F	D	Aril

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Table 1. Continued.

Birds	**Plants**	**DP**[1]	**D**[2]	**VF**[3]	**S**[4]	**Portion consumed**
	Mezilaurus crassiramea (Meisn.) Taub. *ex* Mez (Lauraceae)	ND		S	R	Unripe fruit
	Miconia staminea (Desr.) DC. (Melastomataceae)	PD		F	D	Whole fruit
	Xylopia sericea A.St.-Hil. (Annonaceae)	PD		F	D	Seeds
Volatinia jacarina (Linnaeus, 1766)	*Brachiaria* sp. (Poaceae)	PD	Gra	S	R	Seeds
	Curatella americana L. (Dilleniaceae)	ND		S	R/D	Aril
	Miconia albicans (Sw.) Triana (Melastomataceae)	PD		S	R	Whole fruit
Cardinalidae						
Piranga flava (Vieillot, 1822)	*Cecropia pachystachya* Trécul (Urticaceae)	PD	Omn	S	D	Pulp/Seeds
	Curatella americana L. (Dilleniaceae)	PD		S	R	Seeds/Aril
Fringillidae						
Euphonia chlorotica (Linnaeus, 1766)	*Cecropia pachystachya* Trécul (Urticaceae)	PD	Omn	S	D	Pulp/Seeds
	Norantea guianensis Aubl. (Marcgraviaceae)	PD		S	R	Pulp/Seeds

tanagers stand out especially in the dispersal of seeds from plants with small fruit (< 0.4 cm). In the case of larger fruits, seed dispersal is compromised because the seeds fall under the parent plants (Levey 1987, Sick 1997, Francisco & Galetti 2002). Despite the importance of tanagers as potential seed dispersers in this study, we observed that in the case of larger seeds (> 0.5 cm, personal observation), the potential for seed dispersal was really compromised, confirming the findings of Francisco & Galetti (2002). Tanagers also were less efficient in the dispersal of arilled seeds (Table 1). According to Sick (1997), species of this group commonly eat only the aril and discard the seeds under the plant.

On the other hand, tyrant flycatchers, which are known for their predominantly insectivorous diet, include many species that feed on a mixed diet of insects and fruits (Sick 1997). Some studies have shown that species that supplement their diet with fruits, as in the case of this family, have stood out as major seed dispersers in forest (Melo et al. 2003, Pascotto 2006, 2007) and savanna formations (Faustino & Machado 2006, Pascotto et al. 2012, Maruyama et al. 2013) in the Cerrado. Generally, bird species with non-specialized diets also lack habitat specificity, making them important in seed dispersal among different environments (Melo et al. 2003). Thus, in environments characterized by a mosaic of vegetation types, such as the Cerrado (Silva & Bates 2002), opportunistic frugivores are extremely important from the standpoint of seed dispersal potential, at least with regard to plants that are little specialized and to the quantitative component (Schupp 1993). However, it is worth investigating how seeds are treated after being ingested by these birds.

Miconia staminea and *Cecropia pachystachya* stood out as the most important plants. These species are characterized by their abundant production of small fruits and seeds (Kuhlmann 2012). Like most of the plant species observed here, they belong in the low investment model (Howe & Smallwood 1982). In this model, plants produce copious amounts of fruits which are not very nutritious and small seeds, attracting a large variety of opportunistic birds willing to take advantage of a super-abundant resource, but of little nutritional value. Based on the bird species observed consuming fruits (Table 1), we suggest that our results strongly fit this model, since most of the interactions were performed by opportunistic frugivores.

We found that 82% of the frugivorous bird species were considered potential seed dispersers. This was expected, since ornithochory is the main seed dispersal syndrome of tree species in the Brazilian Cerrado, in both forest and savanna environments (Gottsberger & Silberbauer-Gottsberger 1983, Pinheiro & Ribeiro 2001). Species of the Psittacidae family, widely known as predators of seeds, which are usually shredded when ingested, stood out among the bird species that did not act as seed dispersers (Sick 1997). Plants with larger fruits (> 2.5 cm), such as *Buchenavia tomentosa* and *Diospyros brasiliensis*, were only visited by pulp-eaters or seed predators (Table 1).

An analysis of the records of feeding events, number of interactions and composition of frugivorous bird species indicated that higher numbers were recorded in forested areas, confirming our hypotheses. A recent study by Kuhlmann (2012) in the central portion of the Cerrado, involving 150 plant species with fruit attractive to fauna, revealed that about 80% were dispersed by birds and about 60% occurred in forested areas. Seed dispersal by animals in forest environments is more advantageous for plants than dispersal by abiotic processes, since animals, particularly birds, are more likely to disperse seeds over longer distances (Hovestadt et al. 1999).

Kuhlmann (2012) states that the majority of fruiting plants of the Cerrado ripen predominantly in the rainy season. Oliveira & De Paula (2001) reported a similar finding, stating that the fruit of most zoochorous plant species of gallery forests in central Brazil ripen in the rainy season. The same phenomenon has been observed in savanna formations (Silberbauer-Gottsberger 2001, Lenza & Klink 2006, Pirani et al. 2009, Camargo et al. 2013). Based on this information about fruiting phenology, we expected to record more numerous feeding events and interactions during the rainy season since, according to the above cited authors, more fruits ripen during this period. However, our assumption was not confirmed.

We believe that the large number of records of feeding events and of interactions during the dry season stems from the high production of fruits by species such as *Rudgea viburnoides*, *Schefflera morototoni* and *Miconia staminea*. According to Snow (1981), species of these three genera are very important in the diet of frugivorous birds in the Neotropics, because their fruits are eaten by specialist and generalist frugivores. Firstly, the three species have small fruits (< 1 cm), which enables them to be eaten by frugivores of all sizes. *Rudgea viburnoides* and *Miconia staminea* belong to the two most important families of plants for tropical frugivorous birds (Rubiaceae and Melastomataceae, respectively) and, because their fruits are succulent, they are appreciated by a variety of frugivorous birds, especially the small ones that feed in the lower strata of the vegetation (Snow 1981, Maruyama et al. 2013). On the other hand, the fruit of *Schefflera morototoni* is rich in lipids and proteins (Snow 1971), and therefore also attracts a wide variety of frugivores ranging from the smallest to the largest (Saracco et al. 2005, Parrini et al. 2013).

It should also be noted that highly abundant species such as *Turdus leucomelas*, which alone accounted for 25% of the recorded feeding events, may have influenced the high number of feeding events recorded in the forests during the dry season, which may explain the fact that we found no difference in the qualitative matrix of interactions. Thus, we emphasize that it is important to consider the abundance of frugivores, as well as the number of recorded feeding events, and not only the presence/absence of interactions. During the dry season, for example, the number of feeding events recorded for *Turdus leucomelas* in forest areas was about 90% higher than in the rainy season. Most of the species recorded in forests also showed a remarkable increase in recorded feeding events in the dry season. This may be due to temporal and spatial variations in food resources, such as lower abundance of invertebrates and ripe fruits in open areas in the dry season (Macedo 2002). These factors are extremely important and can influence the movement of birds between forest and savanna habitats.

We observed that the composition of frugivorous birds differs between savanna and forest formations. This contradicted our hypothesis since, according to Bagno & Marinho-Filho (2001), most bird species in the Cerrado occur in both savanna and forest formations. However, this does not seem to apply when only frugivorous birds are involved (Vieira et al. 2013), probably due to the dependence of mandatory frugivores [e.g., *Ramphastos vitellinus* Lichtenstein, 1823 and *Antilophia galeata* (Lichtenstein, 1823)] on forest environments.

Based on the composition of avian frugivores (Table 1), it was found that the diet of approximately 80% of the recorded bird species is not based on fruits, but that they simply complement their diet with this type of resource. Thus, we believe that during the dry season, when there is a scarcity of other food items [such as small arthropods (Macedo 2002, Manhães 2003)], there is an increase in fruit consumption. Moreover, in situations of water deficit, consuming fruit is one of the main ways to obtain water (Argel-de-Oliveira 1998). Thus, species that do not usually consume fruits begin to use this resource in the dry season, which may explain the increase in the records of feeding events and bird-plant interactions during this period.

Our findings suggest that there is a shift of frugivorous bird species and particularly of individuals between savanna and forest formations in response to fluctuations in food resources, which are influenced by the strong climate seasonality of the Cerrado (Macedo 2002, Manhães 2003). Future studies to evaluate temporal and spatial fluctuations in the composition and abundance of bird species in the different vegetation formations of the Cerrado, as well as the availability of food resources, may complement and strengthen our findings. However, we already have strong evidence that forests represent important foraging areas for frugivorous birds during the dry season. Thus, the conservation of forest areas in predominantly savanna-like ecosystems such as the Cerrado is extremely important for frugivorous birds, thus ensuring the preservation of frugivore-plant interactions.

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