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BIRDS AS POTENTIAL SEED DISPERSERS OF *CURATELLA AMERICANA* L. (DILLENIACEAE) IN THE BRAZILIAN CERRADO

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Resumo. – Aves como potenciais dispersoras de sementes da lixeira *Curatella americana* L. (Dilleniaceae) em uma área de Cerrado, Brasil. – Espécie típica do Cerrado, a lixeira *Curatella americana* possui frutos com características ornitocóricas, mas sem relatos na literatura sobre a potencialidade das aves na dispersão de suas sementes. Neste trabalho procurou-se investigar a atuação das aves como potenciais dispersores de sementes de *C. americana* em uma área de Cerrado na região leste do Estado de Mato Grosso (15º50'53"S, 50º00'33"W). De setembro a novembro de 2007, foram realizadas 50 h e 30 min de observações e registadas 16 espécies de aves forrageando em dois indivíduos de *C. americana*, das quais 12 foram consideradas potenciais dispersoras de sementes. Em 128 visitas foram consumidos um total de 1373 frutos, sendo *Volatinia jacarina* a espécie que mais visitou *C. americana* com finalidades alimentares. No entanto, foi apenas a quarta espécie que mais consumiu frutos, sendo superada por *Diopsittaca nobilis*, *Patagioenas picazzuro* e *Myiodinastes maculatus*. Nenhuma espécie frugívora foi registrada consumindo frutos de *C. americana*. Espécies onívoras foram responsáveis pelo maior número de visitas, mas superadas pelas granívoras no que se refere às taxas de consumo.

Abstract. – Although *Curatella americana*, a typical species from the Cerrado, produces fruits with ornithochoric characteristics, there are no reports in the literature suggesting that it serves as a food source for birds. This study investigated the behavior of birds as potential seed dispersers for *C. americana* in a Cerrado area in the eastern portion of the State of Mato Grosso, Brazil (15º50'53"S, 50º00'33"W). Between September and November 2007, during 50.5 h of sampling, 16 bird species were observed foraging in *C. americana*, and 12 were considered as potential seed dispersers. During 128 visits, 1373 fruits were consumed. *Volatinia jacarina* was the species that visited *C. americana* for feeding purposes most frequently. However, *Diopsittaca nobilis*, *Patagioenas picazzuro*, and *Myiodinastes maculatus* ingested more fruits than did *V. jacarina*. No frugivorous species were recorded feeding in *C. americana*. Omnivorous birds were represented in the majority of visits, but they were surpassed by granivorous birds with regard to their feeding rates. *Accepted 6 February 2013.*

Key words: *Curatella americana*, Dilleniaceae, Cerrado, feeding behavior, frugivory, potential seed dispersal, Mato Grosso, Brazil.

INTRODUCTION

Seed dispersal by birds is essential to fruiting trees because birds can carry seeds away and deposit them far from the parent plant (Stiles & White 1986). Furthermore, seed dispersal confers additional advantages to plants, such as allowing them to escape from seed predators in habitats with a high density of seeds (Janzen 1970), reducing intraspecific competition (Stiles & White 1986), facilitating colonization of new lands (Nathan 2006), and

increasing the genetic flux of the species into occupied areas, which has been associated with a lowered risk of extinction in those habitats (Soons & Ozinga 2005).

The removal of fruit from the parent plant by the action of frugivores can lead to seed dispersal if it is performed by a legitimate seed disperser, or dispersal can result in seed losses and destruction if the fruit is removed by the activities of frugivorous species that are pulp or aril consumers (Jordano & Schupp 2000). Fruit removal and seed dispersal depend on numerous factors, such as the removal and handling behaviors of the frugivores, the details of fruit processing during mastication and digestion (Jordano & Schupp 2000), the quantity of seeds removed, the time spent foraging, the number of visits to a plant during fruiting, the after-feeding movements of the frugivores (Herrera & Jordano 1981, Levey 1987), the site and distance where the seeds were placed (Wheelwright 1991, Jordano & Schupp 2000, Jordano *et al.* 2007), and the probability of the seedlings reaching an adequate degree of maturity (Jordano *et al.* 2007, Spiegel & Nathan 2007).

Large-sized birds are efficient seed dispersers, similar to mammals, and are able to transport large quantities of seeds for long distances, thereby connecting populations at different sites and/or fragments (Poulsen *et al.* 2001). In contrast, small- to medium-sized birds deposit seeds near the source tree, although they are also capable of delivering seeds at greater distances (Jordano & Schupp 2000, Westcott & Graham 2000).

Although many birds include fruits in their diets, frugivorous birds do not select fruits indiscriminately (Carlo *et al.* 2003). The selection of fruits for feeding depends on morphological characteristics of the birds (e.g., body and bill size) as well as morpho-physiologic properties of the fruits (e.g., fruit and seed size, dehiscence, pericarp hardness, and nutritional content) which strongly influence the birds' preferences (Herrera 1981, Wheelwright *et al.* 1984, Moermond & Denslow 1985, Fleming *et al.* 1987, Carlo *et al.* 2003). In tropical regions, the majority of fruits has a small size (= 1.5 cm diameter) and is accessible to a wide range of frugivores (Pratt & Stiles 1985, Fleming *et al.* 1987). Furthermore, tropical fruits are commonly rich in water and carbohydrates and contain relatively high amounts of indigestible seeds, but they are very low in fats and proteins (Moermond & Denslow 1985).

No research has analyzed birds as potential seed dispersers of *Curatella americana*, despite the common occurrence of this plant in the Brazilian Cerrado, a savanna-like biome considered to be one of the world's biodiversity hotspots (Myers *et al.* 2000). Therefore, this study aimed to determine which bird species eat fruits from *C. americana* and the potential importance of those birds to the dispersal of *C. americana* seeds in an area of the Cerrado.

METHODS

Curatella americana L. (Dilleniaceae) is a deciduous tree ranging from 6 to 10 m in height and possessing grayish and hairy terminal branches in its crown. This tree species is typical of the Cerrado, occurring in almost all of the territories of northern and central Western Brazil, including the southeastern states of Sao Paulo and Minas Gerais. Because of its leathery and rough leaves, *C. americana* is popularly known as "lixeira." Ripe fruits occur from September to December (Lorenzi 1992). The reddish fruits have an average diameter of 1.5 cm and contain from two to five bright seeds of a brown or black color. The seeds are elliptical, with a length of approximately 0.4 cm (Lorenzi 1992). Each seed is covered by a complete or incomplete white aril (Bruniera & Groppo 2010).

Study area. This study was conducted in an area of the Cerrado "*sensu stricto*," in the eastern part of the State of Mato Grosso, Brazil (15º50'53"S, 50º00'33"W), which is well preserved, with occasional prescribed fires. According to Köppen's criteria, the study area has well-defined annual seasons – the dry (May to September) and the rainy (October to April) seasons.

Two individuals of *Curatella americana* with a height of 4 m and 5 m distance from one another were sampled, and they were considered as a unique sample entity because visits to them were not independent. The sampled individuals of *C. americana* were located 50 m from the Cerrado border in a narrow sense, surrounded at approximately 500 m by neighborhood homes of the Pontal do Araguaia. It should be noted that there is no human presence in the study area.

Sampling procedures. The sampling was conducted between September and November 2007, totaling 50.5 h of focused observations. Each observation lasted an average of 1.5 h, during the interval between 06:00 and 18:00 h, and it was always performed by the same two observers. As both observers remained in the sampling area simultaneously, the total time of observation (50.5 h) was the same for both specimens of *C. americana* (one sampling entity).

The methodology employed was described earlier (Pascotto 2006, 2007). The foraging tactics were categorized according to Moermond & Denslow (1985), and the consumption modes were classified according to Schupp (1993): S – swallowers of whole seeds (seed plus aril); AC – aril consumers that discard the seeds; and SD – seed predators, those who damaged the seeds during feeding.

The potential of bird species to be seed dispersers for *C. americana* was determined by analyzing the feeding rates and consumption modes, the time spent foraging and frequency of visits, and the feeding behaviors.

The occurrence of agonistic interspecific and intraspecific interactions was also recorded. According to the feeding guilds, bird species were classified using three robust criteria (Motta-Júnior 1990, Sick 1997, Donatelli *et al*. 2004) (details in Table 1). The classification and taxonomic nomenclature of the bird species were determined according to the Brazilian Committee on Ornithological Registers (CBRO 2011).

Statistical analysis was performed using the Biostat 5.0® program. The Spearman's correlation test was used to verify the correlation between the number of fruits consumed and the frequency of visits by bird species, as well as among the different feeding guilds. The significance level was 1% ($p < 0.01$). To verify the relative significance between the foraging tactics used by birds, a principal components analysis was performed (PCA).

RESULTS

During the first ten sampling days (4–14 September), only Peach-fronted Parakeets (*Aratinga aurea*) were observed eating fruits because the fruits were still immature. Starting with 17 September 2007, the consumption of ripe fruits by birds was recorded. Notably, the Peach-fronted Parakeet was not observed feeding on ripe fruits from *Curatella americana*.

Sixteen bird species belonging to three orders (Table 1) consumed fruits of *Curatella americana*, with a total of 128 recorded visits and a mean of 2.5 visits per hour. In total, 1373 diaspores were eaten, with a mean of 27.9 diaspores per hour. The number of fruits eaten was not positively associated with the length of time that the bird remained on the plant ($r_s = 0.4199$, $p = 0.1053$).

The order Passeriformes was the most well represented for removing the fruits of *Curatella americana*, with seven families. Among

TABLE 1. Bird species that foraged in *Curatella americana* (Dilleniaceae) during 50.5 observation hours in a Cerrado area, eastern of Mato Grosso State, Brazil. [1]NV – number of visits; [2]Mean length and standard deviation of time of visits (seconds); [3]Diet: (FRU) frugivorous, (INS) insectivorous, (GRA) granivorous, (ONI) omnivorous. Diet followed *Donatelli *et al.* (2004), **Motta Junior (1990), and #Sick (1997); [4]Total number of diaspores consumed; [5]CR – consumption rate by the mean and standard deviation of diaspores eaten at each visit; [6]Frequency of visits during one hour of observation; [7]Species here considered as (PD) potential seed disperser or (ND) non-potential seed disperser; [8]Consumption mode: (S) swallower of the whole diaspore, (AC) aril consumer, that eats only the aril and discards the seeds on the parent, (SP) seed predator or seed grinder; [9]Fruits consumed per minute.

Species	NV[1]	V[2]	Diet[3]	DC[4]	CR[5]	Freq[6]	PD/ND[7]	CM[8]	F/min[9]
Columbiformes									
Columbidae									
Patagioenas picazuro	12	153.3 ± 124.1	FRU**	159	13.2 ± 17.1	0.24	PD	S	1.04
Psittaciformes									
Psittacidae									
Diopsittaca nobilis	2	352.0 ± 427.1	FRU*	28	14.0 ± 5.6	0.04	ND	SP	0.08
Aratinga aurea	1	65.0	FRU*	3	3.0	0.02	ND	SP	0.04
Brotogeris chiriri	2	126.0 ± 111.7	FRU*	19	9.5 ± 3.5	0.04	ND	SP	0.15
Passeriformes									
Tyrannidae									
Myiarchus swainsoni	3	166.0 ± 165.4	INS**	22	7.3 ± 4.7	0.06	PD	S	0.13
Myiodinastes maculatus	1	870.0	INS*	14	14.0	0.02	PD	S	0.02
Tyrannus melancholicus	2	57.5 ± 0.7	INS**	10	5.0 ± 1.4	0.04	PD	S	0.17
Vireonidae									
Vireo olivaceus	1	137.0	ONI**	6	6.0	0.02	PD	S	0.04
Corvidae									
Cyanocorax cyanopogon	1	95.0	ONI#	1	1.0	0.02	PD	S	0.01
Mimidae									
Mimus saturninus	5	181.0 ± 239.2	ONI*	56	11.2 ± 6.5	0.10	PD	S	0.31
Thraupidae									
Saltatricula atricollis	1	18.0	FRU*	2	2.0	0.02	PD	S	0.11
Lanio cucullatus	8	177.8 ± 139.4	GRA**	74	9.3 ± 7.4	0.16	ND	S/AC	0.42
Tangara sayaca	5	89.8 ± 56.8	FRU*	29	5.8 ± 5.5	0.10	PD	S	0.32
Tangara palmarum	1	112.0	FRU*	6	6.0	0.02	PD	S	0.05
Emberizidae									
Volatinia jacarina	82	154.9 ± 179.4	GRA**	933	11.4 ± 13.8	1.62	PD	S	6.05
Cardinalidae									
Piranga flava	1	170.0	ONI**	11	11.0	0.02	PD	S	0.65

these, the Thraupidae had the highest number of species consuming fruits from *C. americana* (n = 4), followed by the Tyrannidae (n = 3). The other families were each represented by a single species (Table 1). Among the non-passeriform orders, species from Psittaciformes (n = 3) and Columbiformes (n = 1) were recorded.

The Blue-black Grassquit (*Volatinia jacarina*) demonstrated the highest visiting frequency (1.62 visits/h), but higher feeding rates were recorded by the Red-shouldered Macaw (*Diopsittaca nobilis*), the Picazuro Pigeon (*Patagioenas picazuro*), and the Streaked Flycatcher (*Myiodinastes maculatus*). The Blue-black Grassquit only ranked fourth regarding feeding on diaspores (Table 1). Considering the feeding rate by unit of time, the granivorous species were the most important fruit consumers. Blue-black Grassquit ate 6.05 fruits per minute, followed by Picazuro Pigeon (1.04 fruits/min). The remaining species showed consumption rates lower than one fruit per minute (Table 1).

Among the 16 bird species, 12 (75%) ingested the whole diaspore, being therefore considered to be potential seeds dispersers for *Curatella americana* (Table 1). The remaining 25% were not recognized as potential seed dispersers. In this regard, the three species of Psittacidae were observed grinding the seeds and dropping the fragments over the parent plant, whereas Red-crested Finch (*Lanio cucullatus*) sometimes ingested the whole diaspore, but they were also aril consumers.

The foraging tactics most employed by birds on the *Curatella americana* plants were, reaching (64.3%), picking (23.8%), and hovering (11.9%). None of the species we recorded required the hanging tactic for fruit collection. Reaching was the only tactic used by the Psittacidae, whereas hovering was predominant among the Tyrannidae. The majority of the other species used both picking and reaching while foraging (Table 2). The PCA demonstrated that picking and reaching were responsible for 79.9% of the foraging tactics used on *C. americana*. Principal component 1 (picking) explained 49.7% of the variability among the tactics.

With regards to the consumers of *Curatella americana* fruits, seven species were categorized as primarily frugivorous, four as omnivorous, three as insectivorous, and two as granivorous. In spite of the high representation by frugivorous species, the granivores were responsible for the highest rate of fruit consumption (73.34%), followed by the frugivores (17.91%), the omnivores (5.38%), and the insectivores (3.35%) (Table 1). However, 42.85% of the frugivorous species were responsible for predation of the seeds. When the feeding guilds were analyzed separately, a positive association was not found between the number of fruits consumed and the visiting time for the frugivorous ($r_s = 0.5988$, $p = 0.1554$), insectivorous ($r_s = 0.5000$, $p = 0.6667$), or omnivorous ($r_s = 0.7746$, $p = 0.2253$) species.

While all of the species of birds collected fruits directly from the plant, Blue-black Grassquit and Red-crested Finch were also observed collecting seeds from the ground. This was also true for an individual of tinamou (*Crypturellus* sp.), in only one sample. However, it was not possible to quantify the seeds consumed by this species.

The Blue-black Grassquit was the only species foraging in homospecific groups. None of the observations recorded groups with fewer than eight individuals in this species, and these were always comprised of both males and females. The majority of the time, the group was composed of approximately 30 individuals of both sexes. Despite some group foraging, no agonistic intraspecific or interspecific interactions were noted for any of the species. However, it was noted that the appearance of a Blue-black Grassquit group in the *C. americana* plants often exerted a

TABLE 2. Total number of diaspores consumed by birds on *Curatella americana* (Dilleniaceae) using every foraging tactic.

Species	Picking	Reaching	Hovering
Columbiformes			
Columbidae			
Patagioenas picazuro	76	83	
Psittaciformes			
Psittacidae			
Diopsittaca nobilis		28	
Aratinga aurea		3	
Brotogeris chiriri		19	
Passeriformes			
Tyrannidae			
Myiarchus swainsoni			22
Myiodinastes maculatus			14
Tyrannus melancholicus	3	1	6
Vireonidae			
Vireo olivaceus	1	5	
Corvidae			
Cyanocorax cyanopogon	1		
Mimidae			
Mimus saturninus	31	25	
Thraupidae			
Saltatricula atricollis			2
Lanio cucullatus	45	29	
Tangara sayaca	11	18	
Tangara palmarum	4	2	
Emberizidae			
Volatinia jacarina	159	658	116
Cardinalidae			
Piranga flava	3	6	2

negative effect on other foragers, causing foraging disruption and birds leaving the plant, without defending their food resource.

DISCUSSION

The major finding of this work is that there is great potential for seed dispersal by birds that are consumers of diaspores from *C. americana*. Of the non-predator species, only the Red-crested Finch appears to not contribute to the seed dispersal of *C. americana* in the eastern Mato Grosso Cerrado because it is strictly an aril consumer. Notwithstanding, when comparing our study with others in the Cerrado biome [e.g., Marcondes-Machado 2002 (n = 9), Francisco & Galetti 2002a, b (n = 13 in both works); Francisco *et al.* 2007 (n = 14)], the present work found very significant results regarding birds with high seed dispersal potential. The attraction of a great diversity of frugivores that are allied to the natural occurrence of numerous small fruits seems to be an efficient strategy for a generalist dispersal pathway, available to *C. americana*, which guarantees the ingestion of its seeds by a large number of potential seed dispersers. A generalist strategy favors the settlement of

available glades and edges (Howe 1993), as well as disturbed areas.

The proportion of seeds which are effectively removed from the source plant by frugivores is fundamentally important to seed dispersal (Wheelright & Orians 1982, Jordano & Schupp 2000). The consumption rate of the diaspores in *C. americana* was very meaningful, but it varied among bird species. Among birds that are primarily frugivores, the highest diaspore consumption rates were recorded for members of Columbidae and Psittacidae, but the latter did not contribute to seed dispersal because they were seed predators only. The opportunistically frugivorous species were the most important seed consumers among those represented here by omnivorous, insectivorous, and granivorous species. Except for the Red-crested Finch, the above-mentioned species were swallowers of seeds, performing a very important role in the seed dispersal of *C. americana*.

Beyond the fruit consumption rate, the timing of the visits is another relevant seed dispersal factor. Good dispersers are defined as those who eat large quantities of fruits in a shorter time (Melo *et al.* 2003). By this definition, the Blue-black Grassquit was the most efficient seed disperser for *C. americana*. However, considering only the length of time a bird was on the plant, the great majority of species made short visits to *C. americana*. This behavior classified them as good seed dispersers because the shorter the time of foraging, the higher the probability of spreading seeds far away from the parent plant (Gasperin & Pizo 2012). Our data agree with previous reports, which verify that birds of the Cerrado make short visits, of less than five minutes, during foraging (e.g., Francisco & Galetti 2002a, Francisco *et al.* 2007, Pascotto 2007, Silva *et al.* 2008). One exception was the Streaked Flycatcher which remained for a longer time during foraging, suggesting that this species was not effective at dispersing seeds because lengthy visiting fosters regurgitation and defecation of seeds at the feeding location. Nevertheless, long visits on *C. americana* might be occasional and inconsistent for this bird because for other species of vegetation (e.g., *Rapania lancifolia*, Francisco & Galetti 2001; *Davilla rugosa*, Francisco & Galletti 2002a; *Alchornea glandulosa*, Pascotto 2006; *Rapanea ferruginea*, Pascotto 2007) the mean foraging time for the Streaked Flycatcher did not exceed three minutes.

The number of visits by the consumers to the plant can also influence the efficiency of the dispersers (Wheelwright & Orians 1982). Generally, the number of visits to *C. americana* could be considered low when compared with other studies in the Cerrado (e.g., Francisco & Galetti 2002a, b with 4.0 and 5.8 visits/h, respectively; Francisco *et al.* 2007 with 6.9 visits/h). This observation might be related to many different factors, such as the variety of plant species in the Cerrado, the urban surroundings, and the low bird diversity (pers. observ.).

The order Passeriformes was found to be the primary taxonomic group for *C. americana* seed consumers, a result which is in accordance with many Cerrado studies (Francisco & Galetti 2002a, 2002b; Marcondes-Machado 2002, Melo *et al.* 2003, Francisco *et al.* 2007). It has been suggested that the small-sized Passeriformes, especially the thraupids, are important as seed dispersers in disturbed or urban environments where large-sized frugivores are absent because of limited food supplies (Galetti & Pizo 1996). The same pattern was reported by other authors (Gondim 2001, Jordano *et al.* 2007, Andrade *et al.* 2011). Among the medium-sized frugivores were columbids and psittacids, the last being considered only as seed predators and not associated with the dispersal process in *C. americana*.

Another factor associated with successful dispersal is related to the way that birds treat the diaspores (Pizo 1997). Birds who swallow

whole diaspores are legitimate seed dispersers, whereas the pulp or aril consumers are not so efficient because they can drop some seeds under the parent tree. The majority of the birds who foraged on *C. americana* are seed swallowers represented by the columbids and the bulk of the Passeriformes families. Among the Passeriformes, the thraupids had always been regarded as pulp consumers and inefficient seed dispersers (Moermond & Denslow 1985), but this concept has been recently refuted by numerous studies (e.g., Francisco & Galetti 2002a, Francisco *et al.* 2007, Pascotto 2007). Only the Sayaca Tanager (*Tangara sayaca*) was reported as masticating the diaspores before ingesting them, but the loss of the seeds was not also recorded. The remaining thraupid species were considered to be swallowers and, therefore, legitimate dispersers for *C. americana*. The same behavior was reported by other authors who regarded the thraupids as good dispersers of small-sized seeds, such as those of *Ficus microcarpa* (Figueiredo *et al.* 1995), *Alchornea glandulosa* (Pascotto 2006), *Rapanea ferruginea* (Pascotto 2007), and *Ficus organensis* (Silva 2010). Thus, it appears that the efficiency of the Thraupidae regarding seed dispersal changes according to the plant species, and they cannot always be considered to be inefficient seed dispersers.

Granivorous birds were responsible for the highest consumption rate, although they were represented by only two species. The high consumption of *C. americana* fruits by granivorous birds is associated both with the abundance of Blue-black Grassquit in the area and with their foraging behavior in flocks. The gregarious foraging strategy of the Blue-black Grassquit on *C. americana* seems to be an efficient strategy for avoiding interspecific competition during feeding, but not for avoiding predation. Such an inference is based on the fact that, frequently, the arrival of a flock on a plant provoked the flight of other bird species which had previously been foraging there. Furthermore, all of the Blue-black Grassquit individuals were involved in foraging activities and not on insuring survival against predators. This was also observed in the Yellow-chevroned Parakeet (*Brotogeris chiriri*) by Paranhos *et al.* (2007). Thus, foraging is suggested to be an advantageous feeding strategy for homospecific groups because it enables a large number of individuals from the same species, one that also consumes large quantities of fruits, to feed. The absence of defensive behavior in Blue-black Grassquit could most likely be attributed to the large size of the groups, which naturally induce the flight of other species without any reactive response. This behavior differs from that of the Sayaca Tanager in *Alchornea glandulosa* plants (Pascotto 2006). This species forages in small groups (mean of five individuals), and also actively defends the feeding resource by attacking other species.

The absence of interspecific agonistic interactions in *C. americana* could be related to the lower species diversity among the foraging birds, as well as to the preponderance of generalist species in the area. Notwithstanding, the defense of feeding had been expected because the fruiting period of *C. americana* coincides with a period of food scarcity during the dry season in the Cerrado. This result differs from that previously reported by Pascotto (2006, 2007), which recorded both higher diversity in birds consuming fruits and in aggressive encounters in *Alchornea glandulosa* and *Rapanea ferruginea*. In *A. glandulosa*, a wide defense of feeding resources was observed in the Sayaca Tanager, a frugivorous species that displayed the highest frequency of both intraspecific and interspecific agonistic interactions (Pascotto 2006). In *R. ferruginea* (Pascotto 2007), the Chalk-browed Mockingbird (*Mimus saturninus*) was regarded as the most aggressive species, with 16 recorded interspecific agonistic events.

Often, the evolutionary process engenders a coevolving interdependency between plants and frugivores, which works towards the development of a wide variety of methods of fruit acquisition by birds. Subsequently, to consume the fruits many bird species assume very simple postures for grasping fruits, such as picking or reaching, even approaching true juggling (Sigrist 2006). These fruit acquisition tactics can be associated with the arrangement of branches or with the innate behaviors of the species. In *C. americana*, the fruits are arranged on the extremities of the branches, being slightly pedunculate and dehiscent, the majority of birds collect them using the reaching technique. This pattern contrasts with that found in *Rapanea ferruginea* (Myrsinaceae), on which the fruits form clusters on the branches, with collecting techniques using picking predominating (Pascotto 2007). Another interesting strategy is used by the Tyrannidae, which collect insects in the air as an innate behavior, in the majority of birds from this family. They also employ this foraging tactic for collecting fruits from various plants, as observed in this study and in previous literature (Valente 2001, Francisco & Galetti 2002a, Marcondes-Machado 2002, Gabriel & Pizo 2005, Pascotto 2006, 2007). According to Melo *et al.* (2003), the use of foraging techniques while perching is more productive than foraging while flying because perching provides better opportunities for choosing fruits in less time with less energy expended.

Curatella americana fruits were eaten by granivorous, omnivorous, and insectivorous birds, some of which occasionally include fruits in their diets and are therefore considered to be generalists in the dynamics of seed dispersal. Nevertheless, the large number of diaspores consumed demonstrates the relevance of *C. americana* to the diets of birds in the Cerrado, even for small-sized consumer species and especially during the dry season. In addition, the fruiting period of *C. americana* coincides with the beginning of the birds' reproductive period, which guarantees the birds' more energy to care for their offspring. The advantage for the plants is that the dispersal of their seeds anticipates the rainy season, which potentially increases the survival and settling of their seedlings, thus contributing to their reproductive success.

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