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Article

Germination of fruits eaten by the maned wolf *Chrysocyon brachyurus* (Illiger, 1815) (Carnivora, Canidae)

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Abstract: Zoochory is a fundamental process that can be the main mechanism for seed and plant dispersal for many species. Mammals of the Carnivora order are among the most important dispersing agents; however, little is known regarding the role of canids as seed dispersers. Although the maned wolf (*Chrysocyon brachyurus*) has a potentially important role in seed dispersal, given its relatively high consumption of fruits, few studies have investigated the germination rate of ingested seeds. Here, we used seeds removed from the feces of two captive specimens (maned wolf treatment) and those directly collected from unconsumed fruits (control) in germination essays to evaluate the germination rate and emergence velocity index (IVE). We used mature fruits from five species of trees in the Cerrado and Atlantic Forest in a 5 (species) × 2 (method of seed collection) factorial arrangement. The passage of seeds through the digestive tract of the maned wolf favored the germination of *Genipa americana* and *Psidium guajava,* delayed germination of *Psidium cattleianum*, and maintained the germination of *Plinia cauliflora* and *Ficus obtusifolia*. Our results revealed that germination occurred for all tested plant species consumed by the maned wolf; therefore, this canid species has high dispersal potential and can be an important ally in the restoration of the Cerrado and Atlantic Forest-Cerrado contact zone ecosystems.
Keywords: *Frugivory; germination; maned wolf; seed dispersal; zoochory.*

Germinação de frutos consumidos pelo lobo-guará *Chrysocyon brachyurus* (Illiger, 1815) (Carnivora, Canidae)

Resumo: A zoocoria é um processo fundamental para muitas espécies vegetais, podendo ser o principal mecanismo de dispersão de sementes e plantas. Os mamíferos da ordem Carnivora estão entre os agentes dispersores mais importantes, contudo, pouca atenção tem sido dada ao papel dos canídeos como dispersores de sementes. Embora o lobo-guará (*Chrysocyon brachyurus*) tenha um papel potencialmente importante na dispersão de sementes dado o seu consumo relativamente elevado de frutos, poucos estudos investigaram a taxa de germinação de sementes ingeridas. Aqui utilizamos sementes retiradas de fezes de dois exemplares em cativeiro (tratamento do lobo-guará) e diretamente retiradas de frutos não consumidos (controle) em ensaios de germinação para avaliar a taxa de germinação e o índice de velocidade de emergência (IVE). Utilizamos frutos maduros de cinco espécies de árvores que ocorrem no Cerrado e Mata Atlântica formando um arranjo fatorial de 5 (espécie) × 2 (forma de coleta de sementes). A passagem das sementes pelo trato digestivo do lobo-guará favoreceu a germinação de duas espécies, *Genipa americana* e *Psidium guajava*, atrasou a germinação de uma espécie, *Psidium cattleianum* e não afetou a germinação de duas espécies, *Plinia cauliflora* e *Ficus obtusifolia*. Com base nos nossos resultados, particularmente a descoberta de que todas as espécies vegetais testadas consumidas pelo lobo-guará germinaram, concluímos que esta espécie de canídeo tem um elevado potencial de dispersão, sendo um importante aliado na restauração de ecossistemas do Cerrado e da zona de contato entre Cerrado e Mata Atlântica.
Palavras-chave: *Frugivoria; germinação; lobo-guará; dispersão de sementes; zoocoria.*

Introduction

Seed dispersal is an important mechanism for many plant species because it allows for the transport of offspring to areas distant from the parent plant, contributing to a decreased competition for resources, reduced density-dependent seedling mortality, and increased ability to finding suitable microhabitats for the establishment and colonization of new areas (Howe & Smallwood 1982, Hämäläinen et al*.* 2017, Souza et al. 2021). Zoochory (dispersal by animals) is the main form of seed dispersal in tropical forests, and birds and mammals are the main dispersing agents (Bascompte & Jordano 2013). This process usually involves fruit consumption followed by regurgitation or defecation of the seeds, whereby some of the ingested seeds maintain their viability after transit through animal digestive tracts (Traveset et al*.* 2007).

However, passage through digestive tracts can alter parameters such as the percentage, speed, and synchronization of seed germination (Paulino-Neto et al. 2016). Thus, germination can be increased, decreased, or unaltered during passage through the digestive system due to mechanical or chemical scarification of the seed tegument, rendering it more permeable to gases and water, and the loss of germination inhibitors when the fruit pulp is removed (Traveset et al. 2007).

Species of the order Carnivora are among the most important dispersing agents (Willson 1993), because they move great distances and consume various plants (Jordano et al. 2007). However, few studies have investigated the role of canids as seed dispersers (Spennemann 2021). Canids are medium to large animals that tend to be highly mobile and have long digestion times; therefore, these mammals are equipped to transport seeds over long distances (Price et al. 2015). The maned wolf (*Chrysocyon brachyurus* Illiger 1815) is a good example of a dispersal agent, as it is the largest South American canid, has an extensive home range (Dietz 1984, Jácomo et al. 2009), and maintains an omnivorous diet composed of small mammals, birds, and fruits that varies according to the seasonal availability of resources (Rodrigues et al. 2007, Queirolo et al. 2011). The maned wolf was historically widely distributed in the grassland and Cerrado areas of central South America (Paula et al. 2018), and its geographical distribution in Brazil was limited by the Amazon Forest in the north and the Caatinga and Atlantic Forest biomes in the northeast (Queirolo et al. 2011). However, the number of maned wolf records in the Atlantic Forest biome has been increasing in the states of São Paulo, Rio de Janeiro, Minas Gerais, and Paraná, particularly in deforested, agricultural, pastural, and urban areas (Bereta et al. 2017; Muscat et al. 2021). Despite this recent expansion toward the Atlantic Forest (Xavier et al. 2017), the disorderly growth of urban centers and consequent loss and alteration of the Cerrado (Coelho et al. 2008), which is the main habitat of this species, has caused a considerable reduction in suitable environments for the maintenance of maned wolf populations (Paula et al. 2018). Therefore, the species is considered "vulnerable" in Brazil (Brasil 2022, p. 74) and "near threatened" globally (Paula & DeMatteo 2015).

The Cerrado has a great wealth of native fruit plants that are essential for wildlife sustainment, ecological balance, and environmental services (Kuhlmann & Ribeiro 2016). Seed-dispersing fauna are also fundamental for the balance of this biome because seeds influence the vegetation structure and forest dynamics and are the basis of plant diversity maintenance (Estrada & Fleming 2012, Villar et al. 2019, Lautenschlager et al. 2022). Despite its richness, approximately 50% of the original Cerrado has been converted to pastures and agricultural fields (Souza et al. 2020). Environmental laws and international commitments stipulate that Brazil should restore approximately 12 million hectares of its natural habitat, of which 5 million hectares are within the Cerrado region (Federal Decree 8.972/2017) (Schmidt et al. 2019). To meet these conditions, cost-effective, practical methods that are effective on a large scale are required (Schmidt et al. 2019). Seed-dispersing canids have the potential to assist in the ecological restoration of degraded environments, thereby perpetuating and favoring the conservation of plant species (Estrada & Fleming 2012).

Animal and vegetal material is equally represented in the feces of maned wolves, with variations according to season and location (Motta-Junior & Martins 2002, Rodrigues et al. 2007, Michalski et al. 2013). Fruits are important in the maned wolf diet, and a consistently high ingestion rate is present, even in animals from disturbed landscapes (Queirolo & Motta-Junior 2007, Massara et al. 2012, Kotviski et al. 2019). The most complex and heterogeneous agroecosystems, such as permanent preservation areas and legal reserves, provide resources for carnivores (Gheler-Costa et al. 2012) and can be used as dispersal corridors amid fragmented landscapes occupied by monocultures (De Castro & Fernandez 2004, Ferreira et al. 2018). Thus, considering the long distances traveled (Carvalho & Vasconcellos, 1995), fruit consumption by this canid can aid in the restoration of agroecosystems through the distribution of seeds over new areas, where they colonize and contribute to plant diversity in these locations.

Although studies on maned wolf diets are readily attainable (Dietz 1985, Motta-Junior et al. 1996, Aragona & Setz 2001, Motta-Junior & Martins 2002, Rodrigues et al. 2007, Massara et al. 2012, Kotviski et al. 2019), few have assessed the effectiveness of this animal species as a seed dispersal agent (Motta-Junior & Martins 2002, Santos et al*.* 2003, Santos et al*.* 2013). Motta-Junior and Martins (2002) evaluated the germination parameters of seeds from plant species consumed by maned wolves at different locations in the Cerrado, while Santos et al. (2003) and Santos et al. (2013) evaluated seed germination parameters of a single plant species, *Solanum lycocarpum* (the wolf fruit). Despite these studies, knowledge on this important topic is limited, because the effectiveness of a dispersing agent in contributing to the reproductive success of plants is determined not only by diet, but also by the germination potential of seeds after passing through the digestive tract and the spatial pattern of deposition of the defecated seeds (Schupp et al. 2010).

Based on the preceding factors, and considering a diet consisting of a high consumption of fruits, as well as a wide home-range, we investigated the potential role of the maned wolf as a seed-dispersing agent of the Cerrado and Cerrado-Atlantic forest contact zone ecosystems. Accordingly, we tested the hypothesis that the effects of seed passage through the digestive tract of the maned wolf favor germination parameters (increased percentage of germinated seeds and increased speed of germination) over those of unconsumed seeds, thus indicating the importance of this species as a seed disperser in natural habitats.

Materials and Methods

1. Study area

This study was conducted at the Ilha Solteira Wildlife Conservation Center (CCFS-ISA) (20º25'58" S, 51º20'33" W), where we provided

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food (fruits) and collected feces from captive maned wolves. The CCFS-ISA, as well as the sites where fruits were collected, are located in a transition zone between the Cerrado and Atlantic Forest in the northwest of São Paulo State, Brazil.

2. Choice of plant species, fruit offering, and collection of feces/seeds

To evaluate the effect of passage through the digestive tract of *C. brachyurus* on the percentage and speed of fruit seed germination, we selected plant species from the Cerrado and a semideciduous seasonal forest, which is a sub-type of the Atlantic Forest, in the northwest region of the state of São Paulo. According to Motta-Júnior and Martins (2002) and Kotviski et al. (2019), the selected species are representatives of botanical families that are part of the natural diet of the maned wolf. The following plant taxa were chosen: *Genipa americana* L. (Rubiaceae family); *Psidium guajava* L., *Psidium cattleianum* Sabine, and *Plinia cauliflora* (Mart.) Kausel (Myrtaceae family); and *Ficus obtusifolia* Kunth (Moraceae family). *Genipa americana* and *F. obtusifolia* are widely distributed throughout Brazil, and occur in several biomes, including the Cerrado (Gomes 2020, Pederneiras et al. 2020). *Psidium guajava* is a commonly found naturalized species (Proença et al. 2020), while *P. cattleianum* occurs in the Cerrado and Atlantic Forest (Proença et al. 2020) and *P. cauliflora* is located in the Atlantic Forest (Stadnik et al. 2020). These taxa have specimens on the premises of the CCFS-ISA and on the Teaching, Research, and Extension Farm of UNESP (FEPE – UNESP Ilha Solteira), where we collected fruits according to their availability throughout the year. For *G. americana, P. guajava, P. cauliflora,* and *F. obtusifolia*, fruits were collected from a single specimen to avoid variations related to individual plant genetics. This method was not feasible with *P. cattleianum*; therefore, the fruits were collected from a population of plants and homogenized to constitute the treatments.

Fruits of the selected taxa (*P. cattleianum*, *G. americana*, *P. cauliflora, P. guajava, and F. obtusifolia*) were offered separately to one female and one male maned wolf in captivity (Authorization SISBIO 72225–1, Certificate CEUA/FEIS-UNESP 13/2019, and Certificate SisGen A9A3783)*,* to avoid possible co-occurrence of seeds of different species in the feces collected. Since the wolves used in the study lived in the same enclosure, it was implausible to separate the feces by individual. The fruits were offered to the animals after 24 h of fasting. This procedure is part of the food management of carnivorous animals that the CCFS-ISA applies once a week; thus, there was no change in the feeding routine. This methodology prevented contamination of the samples by species not related to this study that were used in the daily management of the animals.

The feces were collected no more than two days after the fruit offering, considering the time for the animals to digest the food, and then packed in plastic bags and taken to the laboratory. In the laboratory, feces (maned wolf treatment) and fruit pulp (control treatment) were washed with running water over plastic sieves, and the seeds were removed with tweezers and dried in trays on absorbent paper at room temperature (~25 ºC). Only whole seeds were used for the germination tests to obtain homogeneous lots.

3. Germination trials

Seeds collected from the feces of maned wolves (maned wolf treatment) and directly from the fruits (control treatment) formed two treatments with 50 seeds for each plant species and four repetitions (2 treatments × 4 repetitions × 50 seeds × 5 plant species, totaling 200 seeds of each species per treatment, 400 seeds per plant species and of 2000 total seeds), in a 5 × 2 factorial (species × method of seed collection).

The seeds were sown in propylene boxes (internal dimensions: 12.0 × 13.5 × 28.0 cm), using sand as the substrate. Fifty seeds were sown in each box (five columns with ten seeds in each column), with four repetitions for each treatment. For all species evaluated, the seeds from the control treatments were sown together with the seeds from the maned wolf treatment. Seeds of *P. cauliflora* and *G. americana* were sown on the same day that the stools were sorted and seeds were separated; because they were recalcitrant or intermediate and thus sensitive to desiccation and storage (Panza et al. 2007, Bonjovani & Barbedo 2008, Galetti et al. 2013). Sowing of *P. guajava, P. cattleianum,* and *F. obtusifolia* occurred after drying at room temperature for a maximum of 96 h, as these are orthodox seeds that are tolerant to desiccation and storage (Medeiros & Eira 2006). After sowing, all germination boxes were stored in a greenhouse without control of environmental variables.

The treatments were monitored daily for irrigation requirements, and irrigated when necessary until they were sufficiently moist. Fungal control in the germination boxes was performed by applying a solution of the fungicide Vitavax®-Thiram diluted to 1 mL.L^{-1} of water.

For the germination evaluation, daily quantification was performed for all treatments, with germination established when the seedlings emerged from the soil surface. The germination tests began at sowing, and if new seedlings did not emerge after 30 consecutive days, the tests were terminated. Germination tests were conducted from December 2020 to April 2021 for *G. americana*, January to May 2021 for *P. cauliflora*, January to April 2021 for *P. guajava*, January to May 2021 for *P. cattleianum*, and March to June 2021 for *F. obtusifolia*. The periods for the germination tests differed among the species due to the dates of sample collection and fruit offering to the maned wolves, as well as the natural germination period of each plant species.

4. Data analysis

The germination parameters used were germination percentage and germination speed, according to Maguire (1962). The germination percentage expresses the total number of germinated seeds in relation to the total number of seeds in the treatment, and is given by the formula:

$$\%G = (\sum ni * N^{-1}) * 100.$$

Equation 1: $\sum$ni = total number of seeds germinated; N = number of seeds sampled

The speed of seedling emergence was determined by the emergence velocity index (IVE), estimated using the following formula:

$$\text{IVE} = \frac{G_1}{N_1} + \frac{(G_2 - G_1)}{N_2} + \frac{(G_3 - G_2)}{N_2} + \dots + \frac{(G_f - G_n)}{N_f}.$$

Equation 2: G_1, G_2, G_3, G_n, and G_f are the number of normal seedlings counted on the first, second, third, and remaining days, and at the last count, respectively, and N_1, N_2, N_3, N_n, and N_f are the number of days from sowing to the first, second, third, remaining, and last counts, respectively, with daily evaluations of germination. Higher IVE values indicate greater germination speeds and a stronger vigor of the batch.

The values obtained in the germination tests were compared with those of the maximum tolerance table for the germination of forest species (Mapa 2009). Differences greater than the maximum tolerance allowed between the largest and smallest mean germination from repetitions were observed for the following species in the maned wolf feces: *G. americana*, *P. cauliflora*, *P. guajava*; and in the controls: *P. guajava*, *P. cattleianum*, and *F. obtusifolia*. Thus, for each of these treatments, the repetition batch that differed from the other three (considerably higher or lower value) was replaced by the average value calculated from the other repetitions. This procedure was used because we did not have a sufficient number of seeds to repeat the experiments with all species.

Possible differences in germination rates between the control and maned wolf treatments for each fruit species were tested using the chi-squared test. Differences between emergence velocity indexes (IVE) were tested using the *t-test* for normally distributed data and the Mann–Whitney test for non-normally distributed data, after checking normality with the Kolmogorov-Smirnov test. All statistical analyses were performed using Bioestat software version 5.3 (Ayres et al. 2007), and a 5% significance level was adopted.

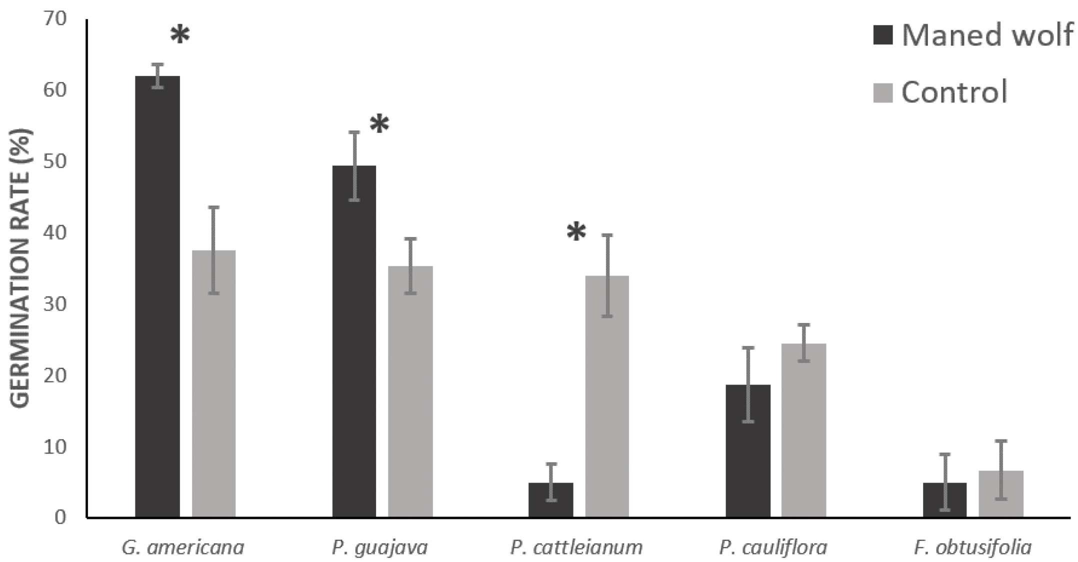

Figure 1. Germination rate (mean values and standard deviations) of seeds of *Genipa Americana, Psidium guajava, Psidium cattleianum, Plinia cauliflora* and *Ficus obtusifolia* for the maned wolf and control treatments. The (*) between columns mean statistically different values between them ($p < 0.05$).

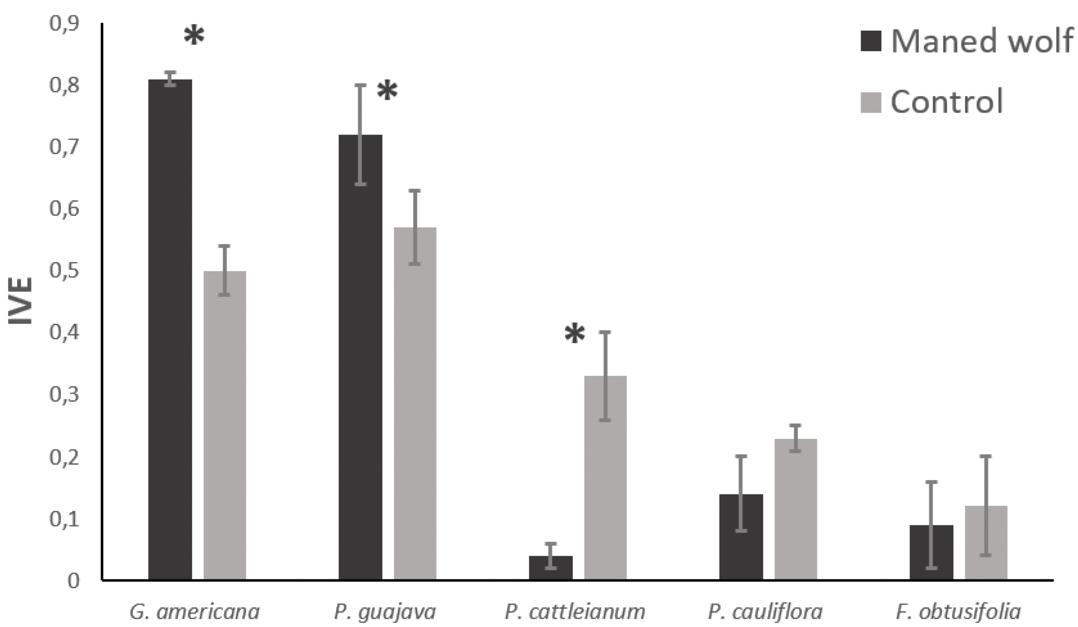

Figure 2. Emergence velocity index (IVE) (mean values and standard deviation) for seeds of *Genipa americana, Psidium guajava, Psidium cattleianum* and *Ficus obtusifolia* for the maned wolf and control treatments and for seeds of *Plinia cauliflora* (median and interquartile deviation) for the maned wolf and control treatments. The (*) between columns mean statistically different values between them ($p < 0.05$).

Results

For *G. americana* and *P. guajava* species*,* seeds from the maned wolf treatment showed significantly higher germination rates (%) and emergence velocity indices (IVE) than those from the control treatment (germination rates $p < 0.0001$ and $p = 0.0063$ for *G. americana* and *P. guajava,* respectively; IVE $p < 0.0001$ and $p = 0.0236$ for *G. americana* and *P. guajava,* respectively). For *P. cattleianum,* a higher germination rate (%) and emergence velocity index (IVE) were observed with the control treatment (germination rate, $p < 0.0001$; IVE, $p = 0.0001$). No significant differences were observed in seed germination rate and IVE for *P. cauliflora* and *F. obtusifolia* (germination rate $p = 0.1806$ and $p = 0.6675$ for *P. cauliflora* and *F. obtusifolia,* respectively; IVE $p = 0.1489$ and $p = 0.6026$ for *P. cauliflora* and *F. obtusifolia,* respectively) (Figures 1 and 2).

Discussion

The results obtained showed that *C. brachyurus* can act as a seed disperser in its home range, since all tested seed species germinated after consumption and defecation. Specifically, *G. americana* and *P. guajava* defecated seeds showed higher germination rates and higher velocities of seedling emergence than the controls, demonstrating a possible positive effect of the consumption of these species by maned wolves and an improvement in the germination process. These results reveal that *C. brachyurus* can both disperse the seeds and improve the propagative performance of these species.

In addition to moving within their large home range (Dietz 1984, Jácomo et al. 2009), maned wolves travel long distances daily, with an average of 14 km/night (Emmons 2012). This allows the seeds to be distanced from the mother plant, resulting in reduced plant mortality due to competition, predation, and pathogen infestation, which are common in areas with high seed densities (Janzen 1969, Cain et al. 2000). In addition, sites further away could provide improved germination and colonization of new habitats, as well as influence gene flow and the temporal and spatial genetic structure within and between populations (Willson & Travest 2000, Jordano & Godoy 2002). Furthermore, olfactory information between co-species of large canids is communicated through urine and feces that are deposited on the ground or on exposed elevated objects (Aza 2012). Maned wolves often defecate on termite mounds, anthills, and roadsides, among other structures (Dietz 1984, Aza 2012), which may play a role in increasing seed germination beyond passage through the digestive tract. For example, termite mound soils may improve water and nutrient availability to plants (Sileshi et al. 2010, Okullo & Moe 2012, Acanakwo et al. 2017) favoring germination, which is promoted by the marking habit of the species.

Although *Genipa americana* has been reported to be consumed by other canids (*Cerdocyon thous* Linnaeus 1766 and *Lycalopex vetulus* Lund 1842) in Central Brazil (Kotvisky et al. 2019), there is only one record of maned wolves feeding on this species (Bolivia; Castro & Emmons 2012), whereas species such as. *P. guajava*, *P. cauliflora*, and *Ficus* sp. have been previously identified as part of the diet of *C. brachyurus* (Motta-Junior & Martins 2002, Gressler et al. 2006, Kotviski et al. 2019). However, during the development of this study, the consumption of *G. americana* fruits was verified through necropsy of free-living specimens brought to CCFS-ISA facilities for veterinary care. This finding, along with the germination rates (62.0% for the maned wolf treatment vs. 37.5% for the control treatment) and speed of emergence indexes (0.81 vs. 0.50 for the maned wolf and control treatments, respectively) observed in this study, may indicate a mutualistic interaction between these species.

Previous reports have identified *P. guajava* as a food source for *C. brachyurus* (Motta-Junior & Martins 2002), which is one of the main species of carnivorous mammals that disperse seeds from this plant species (Gressler et al. 2006). Therefore, considering the germination rates (49.33% maned wolf treatment vs. 35.33% control treatment) and emergence velocity indexes (0.72 maned wolf treatment vs. 0.57 control treatment) observed in this study, an important mutualistic interaction may also exist between these two species, as was observed with *C. brachyurus* and *G. americana.* In a previous study, Motta-Junior & Martins (2002) observed higher germination rates for seeds of *P. guajava* (97% maned wolf treatment vs. 95% control treatment) than those observed in our study (49.33% maned wolf treatment vs. 35.33% control treatment). However, those authors found no significant differences between the treatments. In this study, we observed differences in germination parameters between *P. guajava* seeds defecated by the maned wolf and those that were unconsumed, with greater values recorded with the former treatment. These differences may be associated with methodological differences of the studies, ranging from the use of a greenhouse without control of environmental variables using sand as a substrate (this study), to experiments conducted in the laboratory with controlled light and temperature on moist filter paper (Motta-Junior & Martins 2002), or possible differences in seed quality depending on their production location.

Although *P. guajava* is a naturalized plant (Sobral et al. 2015), and its evolutionary history and domestication process are unknown (Arévalo-Marín et al. 2021), this species is highly utilized by wild animals (Gressler et al. 2006, Torres & Guitiérrez 2018), and zoochory is the main dispersal method for its seeds (Gressler et al. 2006). Non-native species have been shown to cause loss of biological diversity (Pimm et al. 1995, Sala et al. 2000); however, they can also provide conservation benefits (Schlaepfer et al. 2011), such as habitat or food resources for native species, replacements for extinct taxa, additional ecosystem services, and restoration inducements (Schlaepfer et al. 2011). Studies have shown the positive effects of *P. guajava* on forest regeneration and restoration of native tree species in tropical and subtropical forests (Aide et al. 2000, Lugo 2004, Berens et al. 2008).

Seeds of *Psidium cattleianum* are dispersed by birds, ants, bats, monkeys, and ungulates (Gressler et al. 2006). Our results indicated a delay in the germination process after passage through the digestive tract of *C. brachyurus,* which partially refuted our initial hypothesis. Unlike the results observed for the other species of fruits analyzed in this study, the physical passage of *P. cattleianum* seeds through the digestive tract of the maned wolf may have affected the viability of part of the defecated seeds, while other portions of the ingested and dispersed seeds remained viable. Increased germination speed can favor plant establishment under adverse conditions (Fenner 1985), which can be beneficial when vegetation is sparse. Delayed germination also improves diversity by allowing less competitive species to develop (Grubb 1977, Fenner 1985). The behavior of *P. cattleianum* in areas where it occurs naturally is unclear because there is a gap in the scientific literature on the ecology and behavior of this species; however, germination in the maned wolf treatment indicates that this canid may play an important role in maintaining the biodiversity of plant species through the dispersal of seeds.

Zoochory is the main dispersal method of *P. cauliflora* (Gressler et al. 2006). Gressler et al. (2006) listed the maned wolf as one of the main species of carnivorous mammals that disperse the seeds of this plant. *Ficus* sp. has also been reported as food for *C. brachyurus* (Kotviski et al. 2019) and other canids, such as *Cerdocyon thous*, *Lycalopex vetulus,* and *Canis latrans* Say 1823 (Facure et al. 2003, Silverstein 2005, Kotviski et al. 2019). Although the consumption of *P. cauliflora* and *F. obtusifolia* fruits by maned wolves has been reported, germination of the seeds was not assessed. Our study found no differences in the germination rate and speed of seedling emergence between treatments. These facts suggest that seeds of these species are not modified as they pass through the digestive system of the animal, thereby maintaining their viability for germination after consumption and dispersal by *C. brachyurus.*

Overall, our results showed that *C. brachyurus* is a canid that can act as a seed dispersal agent, since germination occurred with the maned wolf treatment for all plant taxa evaluated. This demonstrates an important mutualistic interaction between the maned wolf and these plants. Considering that greater than 90% of tropical plant species depend on animals for the dispersal of their seeds (Jordano 2000), the decrease in population and/or extinction of these conveyors (such as *C. brachyurus*, which is an endangered species) may affect partner plants and microbiome associations (Del-Claro & Dirzo 2021).

This population reduction or elimination of frugivorous animals and seed dispersers, such as *C. brachyurus*, can delay forest regeneration (Farwig & Berens 2012) and induce other negative environmental effects. For example, the disappearance of large animals has caused a reduction in the seed size of some fruit plants that are normally included in the diets of these species (Emer et al. 2020, Del-Claro & Dirzo 2021). Therefore, it is clear that seed dispersing animals are important for the conservation of the environment, and the loss of these species can have negative effects on the ecological and evolutionary dynamics of communities and compromise the processes of ecological succession and restoration of degraded areas (Fleming & Kress 2011, Rocha et al. 2012, Galetti & Dirzo 2013).

Additionally, the germination percentages and speeds reported in our results, along with the extensive home range of *C. brachyurus,* demonstrate the potential contribution of this species to the expansion of geographic dispersal, gene flow, and recruitment of the respective plants. However, there is a gap in the scientific literature in terms of ecological data and the spatial behavior of maned wolves (Aximoff et al. 2020). The species has been detected in buffer zones that contain crops such as sugarcane, soybeans, corn, and cotton, as well as silviculture and pasture areas (Santos et al. 2003, Coelho et al. 2008, Vynne et al. 2011, Vynne et al. 2014, Paolino et al. 2016, Pônzio et al. 2022). The maned wolf may travel these matrices and spread seeds across the various landscapes, contributing to the recovery of degraded areas of the Cerrado, and such forest species are commonly recommended and used in the recovery of these areas (Valeri et al. 2003, Martins et al. 2014, Nascimento et al. 2019). Furthermore, *C. brachyurus* can disperse seeds of plants that have a wide distribution, including those that occur in areas of contact between the Cerrado and the Atlantic Forest. The maned wolf has expanded into areas of this biome (Bereta et al. 2017; Muscat et al. 2021) to consume the available fruits (Motta-Júnior & Martins 2002, Kotviski et al. 2019); therefore, this species may contribute to the natural regeneration of degraded areas once covered by the Atlantic Forest. Thus, actions that contemplate the conservation of *C. brachyurus,* and consequently its ecological and functional role as a seed disperser, can assist in the implementation of management practices aimed at the maintenance or recovery of important ecological processes, including those in landscapes with anthropogenic modifications.

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Igor Paiva Ramos: Substantial contribution in the concept and design of the study; contribution to data analysis and interpretation; contribution to critical revision, adding intellectual content.

Marco Eustáquio de Sá: Substantial contribution to design of the study; contribution to critical revision, adding intellectual content.

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Conflicts of Interest

The authors declare that they have no conflicts of interest related to the publication of this manuscript.

Data Availability

Supporting data are available at <https://data.scielo.org/dataset.xhtml?persistentId=doi%3A10.48331%2Fscielodata.AQYC2S&showIngestSuccess=true&version=DRAFT>

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