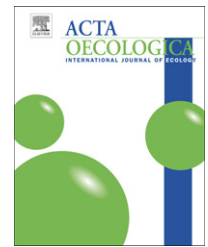


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Original article

Seed dispersal services by coatis (*Nasua nasua*, Procyonidae) and their redundancy with other frugivores in southeastern Brazil

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ABSTRACT

Coati effectiveness as seed dispersers and their potential in maintaining this service through an annual cycle were evaluated during 33 months in an Atlantic forest fragment in southeastern Brazil. We determined the range of fruit and seed traits consumed by coatis, the phenology of fruit consumption, the patterns of fruit consumption and seed defecation, and the effects of ingestion in the speed and success of seed germination. In addition, we assessed redundancy among the seed dispersal services provided by coatis and other resident frugivores. Coatis consumed fruits of 53 species and dispersed seeds of at least 49 out of these species. Most consumed plant species were pioneer (59%), had fruits >15 mm diameter (58%), and were yellow or green (54%). Seeds were found in 54.5% out of 288 faecal samples. The number of seeds in faeces correlated negatively to seed mass and ranged from 1 to 1209 seeds; 50% of the faeces had <50 seeds. Passage through coatis gut did not alter speed or success of seed germination of tested species, except for *Myrcia guajavaefolia*, whose germination success was increased approximately 50% after pulp removal by coatis. Considering fruit colour and seed size, redundancy of seed dispersal services between coatis and other frugivores ranged from 39 to 70%. In defaunated fragments, coatis may provide a 'key role' in maintaining seed dispersal services for a large variety of species and they may promote gene flow among forest patches and the regeneration of disturbed sites.

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1. Introduction

From 50 to over 90% of tropical trees and shrubs produce fleshy fruits and rely on frugivorous vertebrates to disperse

their seeds, by offering them energetic rewards, such as lipids, carbohydrates, and protein (Howe and Smallwood, 1982). Seed dispersal provides many advantages for plants, including occupancy of vacant sites (colonization), avoidance of sites

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occupied by relatives or other individuals of the same species (escape from distance or density-dependent mortality), and occupancy of specific microsites critical for establishment (directed dispersal) (for reviews see Howe and Smallwood, 1982; Willson and Traveset, 1992). In fragmented landscapes, seed dispersal by frugivores may guarantee the possibility of gene flow among natural vegetation patches (Jordano and Godoy, 2002) and the regeneration of degraded areas (Grime and Hillier, 1992; Duncan and Chapman, 2002).

However, due to habitat loss, fragmentation and hunting, some frugivorous species, mainly large-bodied such as tapirs, deer, and peccaries, are becoming scarce or even extinct in forest fragments (Willis, 1979; Chiarello, 1999; Cullen et al., 2000; Roldán and Simonetti, 2001). With the defaunation of these and other frugivores, some plant species may suffer a decrease in seed dispersal and, consequently, in seedling recruitment and/or survival (Terborgh and Wright, 1994; Dirzo and Miranda, 1990; Pizo, 1997; Cordeiro and Howe, 2001; Galetti et al., 2003; Alves-Costa, 2004). However, the impact of frugivore defaunation could be reduced, if frugivorous species that are more resistant or even benefit from anthropogenic impacts are able to disperse seeds of a great variety of morphological fruit types, compensating, at least partially, for the decline of other frugivores.

Coatis are medium-sized (3–6 kg) gregarious Procyonids, common throughout most Neotropical forests [*Nasua nasua* (Linnaeus) in South America and *N. narica* (Linnaeus) in Central and North America], where they are often the most abundant species of the order Carnivora (see Gompper and Decker, 1998). These mammals are omnivorous, feeding on fruits, small vertebrates and forest floor invertebrates (*N. narica*: Russell, 1982; Gompper, 1996; *N. nasua*: Gompper and Decker, 1998; Alves-Costa et al., 2004). Seeds are found in 30–77% of coati faeces, depending on the season and the availability of other food resources (Alves-Costa et al., 2004). Coatis thrive in disturbed fragments (Terborgh, 1990; Bisbal, 1993; Chiarello, 1999) and should be an important species for the maintenance of seed dispersal services in such habitats.

We evaluated some aspects of coati effectiveness (*sensu* Schupp, 1993) as seed dispersers and their potential in maintaining this service throughout the year in fragmented forest remnants with an impoverished community of large frugivores. For this purpose, we determined the range of fruit and seed characteristics consumed by *Nasua nasua*, patterns of fruit consumption and seed defecation, the phenology of seed species in faeces over 33 months, and the effects of ingestion in speed and success of seed germination for some of the most consumed fruit species. In addition, we assessed the redundancy among the seed dispersal services provided by coatis and other frugivorous species that frequently persist in defaunated fragments in southeastern Brazil.

2. Materials and methods

2.1. Study area

The study was conducted in the Mangabeiras Park; a reserve located near the Curral mountain range, in the city of Belo

Horizonte, state of Minas Gerais in southeastern Brazil (19°56'S, 43°54'W; 1040–1175 m a. s. l.). Annual rainfall averages 1767 mm, with a marked dry season (April–September), when rainfall averages 217 mm. Most of the precipitation falls from October to March (1551 mm), and mean annual temperature is approximately 26 °C (details in Alves-Costa et al., 2004).

The park encompasses 236 ha, including semideciduous Atlantic forest (covering 40% of the area), cerrado vegetation (a Brazilian savanna, 30%), and grasslands at higher elevations (30%), and represents a transition zone between the Atlantic forest and the cerrado biomes. The cerrado includes open areas (with scattered trees) as well as areas in transition to forest (called Cerradão). There is a total of about 320 plant species in the Park area and the most common families are Compositae (mainly genera *Eremanthus*), Leguminosae (*Bauhinia*, *Dalbergia*, *Inga*), Melastomataceae (*Miconia* and *Tibouchina*), Myrtaceae (*Myrcia*) and Solanaceae (*Solanum*) (Pedersoli, 1997). Access for tourists is limited to some paved trails and entertainment areas, which encompass approximately 4% (10 ha) of the total area. The park is surrounded by iron mining, residential areas and some natural vegetation along the highest ranges of the mountains. Hunting is forbidden, but occurs.

Coatis are frequently seen in the Park. On one occasion (August 1996, during the mating period), 70 individuals were seen together in the study area (CPAC, pers. observation). Females with six puppies were frequent, reflecting a high birth rate compared with literature data (commonly 3–4 puppies; Gompper and Decker, 1998). Other frugivorous species >500 g in the study area are limited to *Penelope superciliaris* Temminck (Rusty-margined guan, Cracidae), *Didelphis albiventris* Lund (White-eared opossum, Didelphidae) and *Cercocyon thous* Hamilton Smith (Crab-eating fox, Canidae). Smaller non-volant frugivorous mammals are *Callithrix penicillata* E. Geoffroy (Black tufted-ear marmoset, Callitrichidae), *Sciurus aestuans* Linnaeus (Guianan squirrel, Rodentia), *Philander frenata* Linné (Gray four-eyed opossum, Didelphidae), *Marmosops incanus* Lund (Mouse opossum, Didelphidae) and *Gracilianus agilis* Burmeister (Agile gracile mouse opossum, Didelphidae) (Câmara and Lessa, 1993; Lessa et al., 1998). In addition, there are 159 bird species (almost 25% of the Minas Gerais state avifauna), but large frugivorous birds, such as cotingas (Cotingidae), toucans (Ramphestidae) and trogons (Trogonidae) are absent (Jr. Melo et al., 1996). There are no studies on bats in that area.

2.2. Fruits consumed by coatis

From April 1995 to December 1997, weekly field visits were conducted in order to determine the fruit species consumed by coatis. During each visit, some areas frequently visited by coatis as well as trails crossing the Park (including urbanized areas, forest and cerrado habitats) were walked in search of coatis and/or their fresh faeces. Faeces were identified by their characteristic size, shape and smell and by coati footprints found nearby. Direct observations of fruit consumption were included when the animals could be located while foraging. The faeces were washed (within 24 h after

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