



Short communication

Defaunation of large mammals leads to an increase in seed predation in the Atlantic forests

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ABSTRACT

Defaunation can trigger cascading events in natural communities and may have strong consequences for plant recruitment in tropical forests. Several species of large seed predators, such as deer and peccaries, are facing dramatic population collapse in tropical forests yet we do not have information about the consequences of these extinctions for seed predation. Using remote camera traps we tested if defaunated forests have a lower seed predation rate of a keystone palm (*Euterpe edulis*) than pristine areas. Contrary to our expectation, we found that seed predation rates were 2.5 higher in defaunated forests and small rodents were responsible for most of the seeds eaten. Our results found that defaunation leads to changes in the seed predator communities with potential consequences for plant–animal interactions.

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1. Introduction

Contemporary defaunation, the selective local extinction of large bodied species or populations driven by habitat fragmentation, poaching and illegal marketing (Dirzo et al., 2014), results in apparently impoverished ecosystems, the so-called “empty forest” (Redford, 1992). However, these forests are hardly “empty”; many species of small-bodied vertebrates still persist and carry on with their ecological activities to survive, grow and reproduce in scenarios in which usually the strongest competitors and most fierce predators have gone (Wright, 2003). The ecological and evolutionary consequences for forest dynamics brought about by contemporary defaunation have shown effects on biological systems, such as plant physiology (vegetative and reproductive performance), animal behavior (movement, foraging and dietary patterns) and ecosystem functioning (Dirzo et al., 2014; Galetti and Dirzo, 2013).

Large herbivores have been considered an important component to structure small mammal communities via direct impact (interference competition) or indirect (exploitative competition and habitat transformation) (Foster et al., 2014; Ripple et al., 2015). Experimental evidence suggests that areas with low abundance of large herbivores experience high abundance of small rodents (Galetti et al., in press; McCauley et al., 2006). In fact, most rodent species seem to be resilient to the main drivers of contemporary defaunation and tend to proliferate in areas where large mammals were extirpated (McCauley et al., 2006; Terborgh et al., 2001).

Rodents are predominantly seed consumers and are particularly diverse in Neotropical rainforests, not only in number of species and abundance but, also in sizes, diet, and behavior (Bonvicino et al., 2008). For instance, granivorous rodents can range from a small mouse (*Oligoryzomys* spp.) with less than 10 g to a paca (*Cuniculus paca*) weighing over 5000 g

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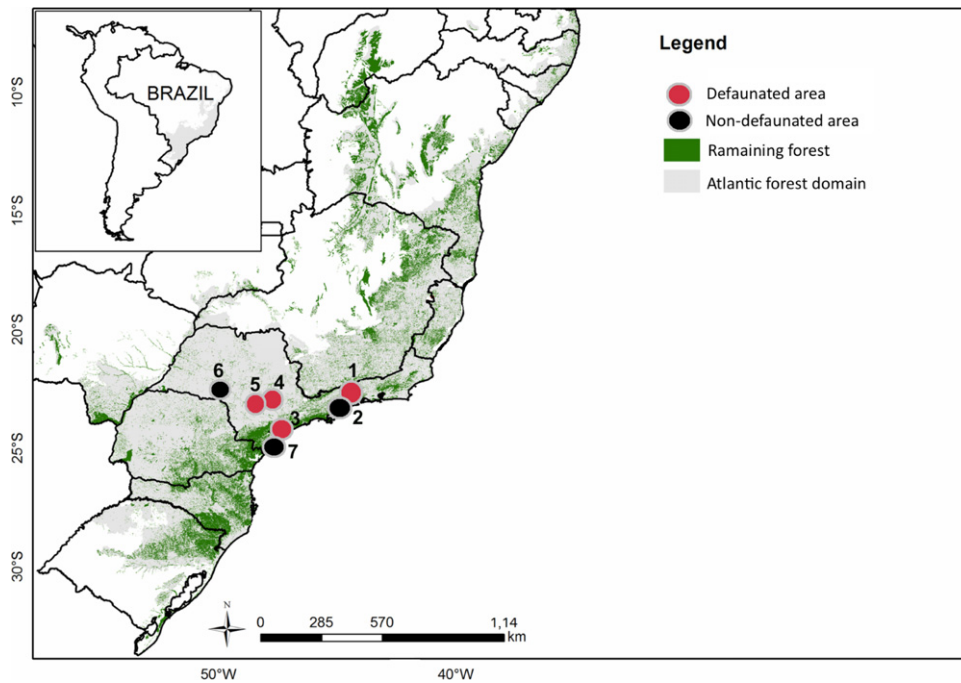


Fig. 1. Location of study areas in Atlantic Forest Brazil: (1) Serra do Mar State Park—Vargem Grande basis, (2) Serra do Mar State Park—Itamambuca basis, (3) Carlos Botelho State Park, (4) Mata Santa Genebra, (5) São José farm, (6) Caetetus Ecological Station, (7) Ilha do Cardoso State Park.

(Paglia et al., 2012). In addition, the populations of granivorous rodents are highly sensitive to food availability and may reach high densities when food sources are overabundant (Jaksic and Lima, 2003). Because post-dispersal seed predation by rodents is an important bottleneck for plant populations (Fleury et al., 2014), it is expected that defaunation of large mammalian herbivores will trigger the population of small rodents (Galetti et al., in press), that in turn will affect plant recruitment (Dirzo et al., 2007; Mendoza and Dirzo, 2007; Wright, 2003).

Here we compare the seed predation of a keystone palm in defaunated and non-defaunated Atlantic rainforests of Brazil. We were particularly interested in testing if the functional extinction of a dominant ungulate seed predator, the white-lipped peccary (*Tayassu pecari*) will translate into shifts in seed predation and seed predators of palms.

2. Material and methods

2.1. Studied species—the palmito *Euterpe edulis*

We tested our hypothesis comparing the seed predation rate and the seed predator assemblage of a keystone palm species (*Euterpe edulis*). *Euterpe edulis* produces medium-size fruits (ranging from 6.7 to 16.62 mm wide) and has recalcitrant seeds (i.e. they are sensitive to desiccation and storage) (Galetti et al., 2013; Panza et al., 2007). Germination experiments have shown that only defleshed seeds germinate and therefore require frugivore consumption (Leite et al., 2012). This palm is widely distributed along the Atlantic forest and several granivorous species, including birds (Galetti and Aleixo, 1998; Galetti et al., 2013), ungulates (Keuroghlian and Eaton, 2009; O’Farrill et al., 2013), and rodents (Galetti et al., 2010; Vieira et al., 2003) prey upon their seeds. There is no evidence that *E. edulis* can be dispersed by scatter hoarding rodents (Galetti et al., 2010).

2.2. Study areas

We sampled three non-defaunated (Ilha do Cardoso, Serra do Mar State Park—Itamambuca, Caetetus Ecologic Station) and four defaunated forests (Carlos Botelho State Park, Serra do Mar State Park—Vargem Grande, São José farm and Mata Santa Genebra) at São Paulo state, southeastern Brazil (Fig. 1). Non-defaunated forests were defined based on the presence of the white-lipped peccaries (*Tayassu pecari*) (Galetti et al., 2009).

2.2.1. Non-defaunated areas

Ilha do Cardoso State Park (hereafter IC) (25 ° 11’S, 47 ° 59’W), with 15,100 ha is a protected area in southernmost SP. About 75% of the whole island is covered with rainforest (11,100 ha), while the rest is divided into mangroves, restinga and

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