

Impact of forest fragment size on the population structure of three palm species (Arecaceae) in the Brazilian Atlantic Rainforest

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Abstract: The main threats to natural populations in terrestrial ecosystems have been widely recognized to be the habitat fragmentation and the exploitation of forest products. In this study, we compared the density of the populations and the structure of three tropical palm species, *Astrocaryum aculeatissimum*, *Euterpe edulis* and *Geonoma schottiana*. For this, we selected five forest fragments of different sizes (3 500ha, 2 400ha, 57ha, 21ha and 19ha) where palms were censused in nine 30x30m plots. We tracked the palms survival from 2005 to 2007, and recorded all new individuals encountered. Each individual was assigned in one of the five ontogenetic stages: seedling, infant, juvenile, immature and reproductive. The demographic structure of each palm species was analyzed and compared by a generalized linear model (GLM). The analysis was performed per palm species. The forest fragment area and the year of observation were explanatory variables, and the proportion of individuals in each ontogenetic class and palm density were response variables. The total number of individuals (from seedlings to reproductives, of all species) monitored was 6 450 in 2005, 7 268 in 2006, and 8 664 in 2007. The densities of two palm species were not influenced by the size of the fragment, but the population density of *A. aculeatissimum* was dependent on the size of the fragment: there were more individuals in the bigger than in the smaller forest fragments. The population structure of *A. aculeatissimum*, *E. edulis*, and *G. schottiana* was not altered in the smaller fragments, except the infants of *G. schottiana*. The main point to be drawn from the results found in this study is that the responses of density and population structure seem not to be dependent on fragment size, except for one species that resulted more abundant in bigger fragments. Rev. Biol. Trop. 62 (2): 433-442. Epub 2014 June 01.

Key words: population structure, population density, *Astrocaryum aculeatissimum*, *Euterpe edulis*, *Geonoma schottiana*.

One of the main threats to natural populations in terrestrial ecosystems is habitat fragmentation (Tabarelli & Gascon, 2005; Ewers & Didham, 2006; Melo, Arroyo-Rodríguez, Fahrig, Martínez-Ramos & Tabarelli, 2013). In the tropics, high deforestation rates have converted formerly continuous rainforest to anthropogenic landscapes, where forest habitats have been reduced to scattered forest fragments of varying sizes and quality (Ranta, Blom, Niemelä, Elina & Sitonem, 1998; Fischer & Lindenmayer, 2007). Both experimental and observational studies about the effects of forest

fragmentation in plant populations, have demonstrated that the biotic and abiotic changes associated with fragmentation, can dramatically alter the fertility, growth, and survivorship of the remaining plant populations (Bruna, Fiske & Trager, 2009). Following forest fragmentation, the remaining forest usually suffers degradation by timber harvest, the extraction of non-timber products, like leaves, fruits, and palm heart, and weed invasion (Ewers & Didham, 2006; Melo et al., 2013). The ability of a population to tolerate a certain level of exploitation is strongly influenced by the parts



of the plant that are harvested, and the species life history particularities (Rodríguez-Buriticá, Orjuela & Galeano, 2005). These alterations, habitat fragmentation, and the harvesting of non-timber products, frequently result in the loss of habitat quality and species. Such is the case of the Atlantic Rainforest in Southeastern Brazil, where most of the forest has been converted to other land uses, thereby endangering endemic flora and fauna (Giulietti, Harley, Queiroz, Wanderley & Van den Berg, 2005). The Brazilian Atlantic Rainforest has experienced intense urbanization since the 1960s, and today 70% of the Brazilian population lives in the region (Melo et al., 2013).

It is frequently hypothesized that plant populations in forest fragments will be reduced in size, exhibit an altered population structure, and show an increased probability of extinction by demographic, environmental, and genetic stochasticity (Jules, 1998). One current view in conservation biology is that the conservation of any particular species in nature will only be successful through the maintenance of its former populations (Primack, 1995). The extinction of a species may occur through the successive extirpations of its population, turned locally unsustainable after direct and indirect changes in habitat quality (Fahrig, 2002; Souza & Martins, 2004, Ewers & Didham, 2006).

Despite the recognized conservation value of forest remnants (Fischer & Lindenmayer, 2007; Santos, Kinoshita & Santos, 2007; Melo et al., 2013), and the well-established threats that fragmentation poses to natural populations, surprisingly few studies have devoted attention to the population ecology of long-lived plant species in tropical forest fragments (Silva-Matos, Freckleton, & Watkinson, 1999; Souza & Martins, 2002; Bruna & Kress, 2002; Bruna, 2003; Bruna & Oli, 2005; Souza 2007). Among other reasons, such studies are needed because long-lived, iteroparous plants may build up remnant populations under conditions where the completion of the whole life cycle is not possible (Eriksson, 1996). Such populations may respond favorably to habitat improvement under management policies, but are condemned

if unfavorable conditions, represented by forest degradation, are prolonged for more than the lifetime of its individuals (Souza & Martins, 2004). Also, obtaining information on the consequences of fragmentation for populations persisting in fragmented tropical landscapes is necessary to derive effective conservation strategies for these species-rich regions (Laurance & Bierregaard, 1997).

Despite the use of population structure, some previous studies considered that it represents a poor predictor of population performance (Condit, Sukumar, Hubbell & Foster, 1998). In a conservation setting, where long-term demographic monitoring may not be feasible, a population's stage structure can be the basis for immediate management decisions (Bruna & Kress, 2002). In fact, Schemske, Husband, Ruckelshaus, Goodwillie, Parker & Bishop (1994) suggested that a good starting point for the recovery of threatened plant species is an assessment of the current demographic structure of the populations of interest.

In this paper, we compared the density of the populations and the stage structure of three tropical palm species: *Astrocaryum aculeatissimum* (Schott) Burret, *Euterpe edulis* Mart. (palmito Juçara), and *Geonoma schottiana* Mart. ("ouricana"). These species are endemic, except *G. schottiana*, and are palms that are abundant in the Brazilian Atlantic Rainforest. Specifically, we tested the following two predictions: a) densities of *A. aculeatissimum*, *E. edulis* and *G. schottiana* are reduced in the smaller forest fragments relative to larger ones, suggesting reductions in population sizes due to either episodic catastrophes or ongoing demographic decline; and b) the demographic structure of populations is altered in the smaller forest fragments, specially due to a negative impact on the seedlings.

MATERIAL AND METHODS

Study site: The study was carried out in five areas of lowland Atlantic Rainforest ("floresta pluvial baixo montana", according to Rizzini, 1979), two reserves (big fragments):

the National Biological Reserve of Poço das Antas (fragment 1—ca. 3 500ha) and the National Biological Reserve of União (fragment 2—ca. 2400ha), and three private fragments (small fragments): Santa Helena (fragment 3—ca. 57ha), Estreito (fragment 4—ca. 21ha), and Afetiva-Jorge (fragment 5—ca. 19ha). They are located in the municipalities of Silva Jardim, Casimiro de Abreu, and Rio das Ostras, state of Rio de Janeiro, Southeastern Brazil (22°30'22.33"S - 42°15'42.19"W). Details on the vegetation structure of the fragments can be found in Carvalho and Nascimento (2009). The two reserves and the three fragments are surrounded by pasture, agricultural fields, and secondary forest. The climate is classified as Walter and Lieth's Equatorial type (Walter, 1971), with an average annual temperature of 24.6°C and mean annual rainfall of ca. 2100mm (1987-1997 data, Souza & Martins, 2004). There is no distinct dry season; however, despite large variations between years, a drier period normally occurs from May to August.

Study species: The three studied species were chosen because they are present in all five fragments. *A. aculeatissimum* is a monoecious, shade-tolerant, slow-growing, solitary or multi-stemmed palm with abundant black spines in the stem (Henderson, Galeano, & Bernal, 1995; Lorenzi, Souza, Medeiros-Costa, Cerqueira & Ferreira, 2004). It is typically 4-8m in height and 11-15cm in diameter (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). This species is endemic to the Southeastern Atlantic Rainforest, occurring from Bahia to Santa Catarina (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). It grows in the understory of lowland forest, and is rarely found in flooded sites and occasionally in the matrix surrounding forest fragments. *E. edulis* is a monoecious, solitary, shade-tolerant, and slow-growing palm. It is a subcanopy palm, can reach 20m in height and 10-15cm in diameter (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). It occurs in forests primarily along the Atlantic coast of Brazil, reaching inland at least to Brasilia and just reaching Argentina

and Paraguay (Henderson, Galeano, & Bernal, 1995). It occupies the crests or slopes of hills and flooded sites up to 1 000m elevation (Henderson, Galeano, & Bernal, 1995). This species is harvested for its palm heart and it is one of the most abundant and valuable non-timber forest products in the Atlantic Rainforest (Fantini & Guris, 2007). Intensive harvesting has led to the decline of the palm over much of the region; many of the surviving populations are small and fragmented (Galetti & Aleixo, 1998; Silva-Matos, Freckleton, & Watkinson, 1999). *G. schottiana* is a monoecious, solitary or rarely multi-stemmed species, and is a shade-tolerant and slow-growing palm (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). It is typically 1-4m in height, 2.5-4cm in diameter, and occupies the forest understory of lowland forest (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). This species occurs in Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Minas Gerais and Goiás, in the Atlantic Rainforest and in Cerrado (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004). In the studied region, the leaves of *G. schottiana* are currently harvested for floral arrangements. There are two methods of harvesting the leaves: cutting the stem of the plant (causing mortality), or removing only the leaves (personal observation).

Based on morphological and morphometric analysis, we distinguished five stages for each palm species (Table 1). The meaning of the stage names for each studied species is described and discussed in Portela and Santos (2011).

Demographic plots and censuses: Palms were censused in nine 30x30m plots in each fragment, distributed systematically in three blocks, 100m apart to each other. Each block had three plots that were 50m separated from each other. A total of 0.81ha was censused in each fragment. One block was established in the middle of each fragment and the other two blocks were established on the sides of the first block. For the two National Biological Reserves, we used a previously established

TABLE 1
 Characteristics of the five ontogenetic stages for the three species studied
 (*Astrocaryum aculeatissimum*, *Euterpe edulis*, and *Geonoma schottiana*) in the five forest fragments
 of the Atlantic Rainforest based on morphological and morphometric analysis

Stage	<i>Astrocaryum aculeatissimum</i>	<i>Euterpe edulis</i>	<i>Geonoma schottiana</i>
Seedling	Bifid leaves	Palmate leaves	Bifid leaves.
Infant	Bifid leaves, incompletely segmented ones, or only incompletely segmented ones.	Completely segmented leaves, but palmate ones can still be present. Stemless.	Bifid leaves, incompletely segmented ones, or completely segmented ones, with a diameter but stemless.
Juvenile	First completely segmented leaf blades, but bifid leaves and incompletely segmented ones can be also present.	Only completely segmented leaf blades, an apparent stem with a diameter smaller than 52mm.	Bifid leaves, incompletely segmented ones, or completely segmented ones, with an apparent stem and a diameter of up to 30 mm.
Immature	Completely segmented leaf blades and an apparent stem but no signs of a reproductive event.	Completely segmented leaf blades, an apparent stem with a diameter bigger than 52 mm but no signs of a reproductive event.	Bifid leaves, incompletely segmented ones, or completely segmented ones, with an apparent stem and a diameter bigger than 30 mm but no signs of a reproductive event.
Reproductive	Recognized by the production of flowers and fruits.	Recognized by the production of flowers and fruits.	Recognized by the production of flowers and fruits.

trail close to the center of the fragment; all other methods were the same. All individuals of the three palm species were tagged with a numbered aluminum label between June and September of 2005. The survivorship of the plants was subsequently monitored between June and September of 2006 and 2007. All new plants were also tagged. Each individual was assigned to one of the five above-mentioned stages. The density of each species was estimated using the total number of individuals in the nine plots, a total of 0.81ha, for each year. During June-September of 2007, the number of *E. edulis* and *G. schottiana* individuals inside the plots was counted to estimate the intensity of harvesting in each fragment.

The comparison of the density and demographic structure of each palm was analyzed by Generalized linear models (GLM). The analysis was performed per palm species. The forest fragment area and year of observation were explanatory variables, and the proportion of individuals in each ontogenetic class and palm

density were response variables. The population density of *A. aculeatissimum*, *E. edulis*, and *G. schottiana* was adjusted to a quasi-poisson distribution. The proportion of seedlings and immatures of *A. aculeatissimum*, infants, juveniles, and reproductives of *E. edulis*, and infants, juveniles, immatures, and reproductives of *G. schottiana* was adjusted to a binomial distribution; the proportion of infants, juveniles, and reproductives of *A. aculeatissimum*, seedlings and immatures of *E. edulis*, and seedlings of *G. schottiana* was adjusted to a quasi-binomial distribution. Analyses were implemented in the software package R 2.15.1 (R Development Core Team, 2012).

RESULTS

Plant density: The population density of *A. aculeatissimum* was dependent on the size of the forest fragment ($t=-3.831$, $p=0.0028$), but was not dependent on the year ($t=1.234$, $p=0.24302$). There were more individuals in

TABLE 2

Density (number of individuals/hectare) of *A. aculeatissimum*, *E. edulis*, and *G. schottiana* in the five fragments (big fragments: 1-3 500ha, 2-2 400ha; small fragments: 3-57ha, 4-21ha, 5-19ha) and in the three years (2005, 2006, and 2007)

Fragment/year	<i>A. aculeatissimum</i>			<i>E. edulis</i>			<i>G. schottiana</i>		
	2005	2006	2007	2005	2006	2007	2005	2006	2007
Big 1	381.5	409.9	416.0	1060.5	955.6	906.2	2255.6	3 055.6	4114.8
Big 2	1546.9	1718.5	1786.4	17.3	24.7	24.7	7.4	7.4	9.9
Small 3	686.4	756.8	779.0	192.6	171.6	166.7	259.3	175.3	166.7
Small 4	51.9	50.6	55.6	33.3	119.8	335.8	459.3	549.4	753.1
Small 5	738.3	767.9	824.7	111.1	103.7	122.2	67.9	74.1	109.9

the bigger fragments than in the smaller fragments (Table 2). The population density of *E. edulis* and *G. schottiana* was not dependent on the size of the forest fragment ($t=-1.398$, $p=0.190$; $t=-0.704$, $p=0.496$, respectively) or on the year ($t=-0.321$, $p=0.754$; $t=0.753$, $p=0.467$, respectively).

The density *E. edulis* and *G. schottiana* did not show a relationship with fragment size, but the two palm species had a higher density in at least one of the bigger fragments compared with the smaller ones (Table 2). None of the three species had a higher density in the smaller fragments.

Population structure (Fig. 1): The proportion of *A. aculeatissimum* individuals in the seedling ($Z=-0.722$, $p=0.4702$), infant ($Z=-0.368$, $p=0.720$), juvenile ($Z=0.686$, $p=0.507$), immature ($Z=0.211$, $p=0.833$), and reproductive ($Z=0.456$, $p=0.657$) ontogenetic stages was not dependent on the size of the fragment. It was not dependent neither on the year: seedlings ($Z=0.091$, $p=0.9276$), infants ($Z=-0.582$, $p=0.572$), juveniles ($Z=-0.689$, $p=0.507$), immatures ($Z=-0.194$, $p=0.847$), and reproductives ($Z=-0.040$, $p=0.969$).

Similar results were found for *E. edulis* for which the proportion of its individuals during the seedling ($T=-0.803$, $p=0.439$), infant ($Z=-1.950$, $p=0.0511$), juvenile ($Z=1.570$, $p=0.1163$), immature ($Z=2.019$, $p=0.0686$), and reproductive ($Z=-0.163$, $p=0.871$) ontogenetic stages was not dependent on the size of the fragment, and neither dependent on the

year: seedlings ($T=-0.229$, $p=0.823$), infants ($Z=-1.788$, $p=0.0738$), juveniles ($Z=1.742$, $p=0.0816$), immatures ($Z=0.367$, $p=0.7204$), and reproductives ($Z=-0.133$, $p=0.894$).

For *G. schottiana*, the proportion of individuals in the seedling ($T=-0.748$, $p=0.4700$), juvenile ($Z=-0.086$, $p=0.932$), immature ($Z=-1.470$, $p=0.14152$), and reproductive ($Z=-0.920$, $p=0.3578$) ontogenetic stages was not dependent on the size of the fragment. However, the proportion of infants ($Z=4.619$, $p=0.000$) varied according to the size of the fragment, showing higher values in the smaller fragments. Additionally, the population structure was dependent on the year: infants ($Z=-1.298$, $p=0.1943$), juveniles ($Z=-0.068$, $p=0.946$), and reproductives ($Z=-1.849$, $p=0.0644$), except for seedlings ($T=5.876$, $p=0.000$) and immatures ($Z=-2.677$, $p=0.00744$), which varied, especially during the first year when compared with the other two years.

Harvesting: In the studied areas, only *A. aculeatissimum* individuals were not harvested; nevertheless, the palm heart of *E. edulis* (with the subsequent death of the individual) and the leaves of *G. schottiana* were under harvesting activities. We only found this harvesting in the three private fragments (Table 3). In fragment 4, we did not find any harvesting activity in the plots, but there were some harvested individuals outside the plots. For *G. schottiana*, harvesting of leaves rarely causes mortality, however, sometimes the whole crown is cut

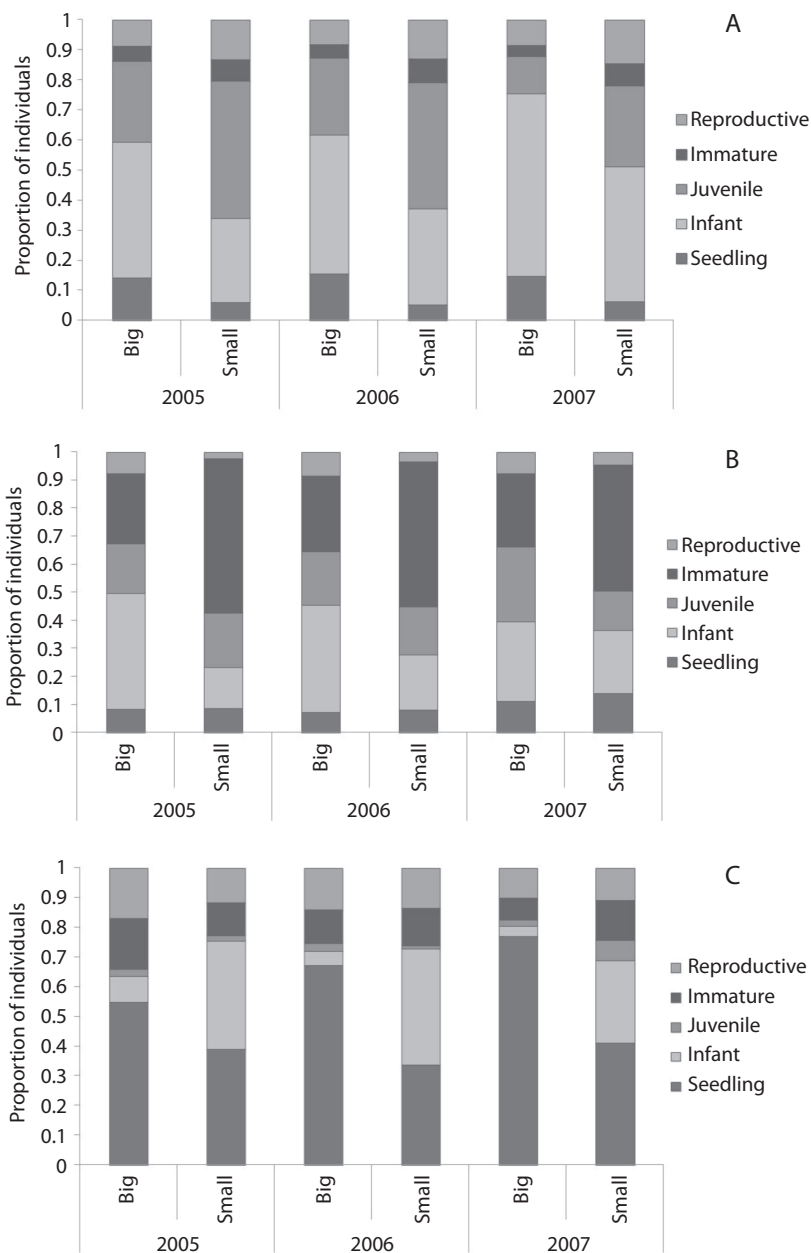


Fig. 1. Population structure of *Astrocaryum aculeatissimum* (A), *Euterpe edulis* (B), and *Geonoma schottiana* (C), presented in terms of the proportion of the median number of individuals in each fragment (big fragments: 3 500ha and 2 400ha; small fragments: 57ha, 21ha, and 19ha) and in each year.

TABLE 3

Number of *Euterpe edulis* individuals in the plots that had the palm heart extracted, resulting in the death of the individual and number of *Geonoma schottiana* individuals in the plots that had their leaves extracted or their stem cut during the 2007 season in the five forest fragments (big fragments: 1-3 500ha, 2-2 400ha; small fragments: 3-57ha, 4-21ha, 5-19ha) studied in the Atlantic Rainforest, state of Rio de Janeiro, Southeastern Brazil

Fragment	<i>Euterpe edulis</i> harvested	<i>Geonoma schottiana</i> leaves extracted	<i>Geonoma schottiana</i> stem cut
Big 1	0	0	0
Big 2	0	0	0
Small 3	8	19 (9 reproductives and 10 immatures)	2 (reproductives)
Small 4	0	21 (15 reproductives, 5 immatures, and 1 juvenile)	6 (5 reproductives, 1 immature)
Small 5	21	1 (immature)	0

(Table 3), but usually, the oldest leaves were cut and the newest leaves were left.

DISCUSSION

The density of *A. aculeatissimum* was the only one affected by the size of the forest fragment; the other two species were not directly influenced. The population structure of *A. aculeatissimum*, *E. edulis*, and *G. schottiana* was not altered in the smaller fragments, except the infants of *G. schottiana*. Therefore, one may conclude that a neutral effect of fragment size on the population structure was found for these three palm species.

The densities of palms reported in the literature are much higher than those we have found. Sampaio and Scariot (2010, *G. schottiana*) and Reis et al. (2000, *E. edulis*), who studied the same species, found a much higher density. Rodríguez-Buriticá et al. (2005), who studied another *Geonoma* species that was lightly harvested, found a higher density than the one we found in our study. Souza and Martins (2004), who studied other palm species in the same region, found a similar density for some populations and a higher density for others.

The three palms had a higher density in at least one of the bigger fragments when compared to the smaller ones, although a statistically significant difference was only found for *A. aculeatissimum*. None of the three species

had a higher density in one of the smaller fragments. A similar result was previously reported by Arroyo-Rodríguez, Aguirre, Benítez-Malvido & Mandujano (2007), who studied *Astrocaryum mexicanum*; they determined that smaller and more irregular fragments presented lower reproductive densities. Chazdon (1996) showed that, in addition to natural factors like soil, topography, and humidity, human activity and historical perturbation also influenced the distribution and the dynamics of palm populations. Additionally, the species responses to habitat fragmentation are governed by the traits of individual species, like dispersal abilities (Ewers & Didham, 2006).

Considering the size of the fragments, the two bigger fragments were Reserves, and no harvesting of *E. edulis* and *G. schottiana* was permitted. Fragment 1 had been a protected reserve since 1975, and fragment 2 since 1998. However, neither the fragment size nor the protected status, influenced the population size of these two palm species. On the other hand, *A. aculeatissimum* is not a harvested species and has clonal growth (more than 50% of the population are clonal, Portela & Santos, 2011), and its density is negatively affected by the reduction of habitat or modification of forest structure that comes with the fragmentation. Galetti, Donatti, Pires, Guimarães & Jordano (2006), also studying *A. aculeatissimum*, concluded that a large fraction of the Atlantic Rainforest palms that relied on scatter-hoarding rodents might become regionally extinct due

to forest fragmentation and defaunation. The reduction in *A. aculeatissimum* population size in the smaller fragments could be a response of the absence of its seed dispersers and, consequently, a reduction in recruitment. The effect of the loss of seed dispersers can be especially pervasive for plants that rely on few frugivore species for seed dispersal, such as large-seeded palms like *A. aculeatissimum*. Other studies have also reported the absence of large-bodied dispersers in small fragments and the relatively high abundance of small seed predators (Chinchilla, 2009). The other two palm species also depend on animals to disperse their seeds, and some seed dispersers have been reported as birds, ranging from small to large animals (Galetti et al., 2013).

The population structure of *A. aculeatissimum*, *E. edulis*, and *G. schottiana* was not altered in the smaller fragments and did not vary between the studied years. The Brazilian Atlantic Rainforest has been drastically devastated since the beginning of the European colonization (Dean, 1996). Also, according to reports from former residents of the studied region, obtained and described by Carvalho and Nascimento (2009), the fragments were part of a continuous forest until about a century ago. The studied palm species are forest-dependent species (Henderson, Galeano, & Bernal, 1995; Lorenzi et al., 2004); nevertheless, their population structure was not affected by forest fragmentation. These populations may be in equilibrium in the studied landscape, since the area has been fragmented since the last century. Despite Ewers and Didham (2006), in their revision about species' responses to habitat fragmentation, reporting that time-scales of 50-90 years after fragmentation, may not be sufficient to ensure that species have reached equilibrium. Nevertheless, results on the population structure of the three palm species in an old fragmented area seem to suggest that they are in equilibrium. The main point to be drawn from the results of this study is that the density responses (except for a species that is highly dependent on large-bodied dispersers) and population structure, are not affected

by the size of the forest fragment in an old fragmented landscape.

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RESUMEN

Impacto del tamaño del fragmento de bosque en la estructura de la población de tres especies de palmas del Bosque Atlántico Brasileño. Uno de los principales riesgos que corren las poblaciones naturales de los ecosistemas terrestres es la fragmentación de hábitat y la explotación de los recursos forestales. Aquí hemos comparado la densidad de las poblaciones y el estado estructural de tres especies de palmeras, *Astrocaryum aculeatissimum* (Schott) Burret, *Euterpe edulis* Mart. y *Geonoma schottiana* Mart., en fragmentos de diferente tamaño. Las palmas fueron censadas en nueve cuadrantes de 30x30m en cinco fragmentos de bosque de diferente tamaño (3 500ha, 2 400ha, 57ha, 21ha y 19ha). Realizamos el seguimiento de la sobrevivencia de las palmas entre 2005-2007, y registramos todos los nuevos individuos encontrados. Cada individuo fue designado dentro de alguno de los siguientes cinco estadios ontogenéticos: plántula, infantil, juvenil, inmaduro y reproductivo. La comparación de la estructura demográfica fue analizada usando Modelos Lineales Generalizados (GLM). Estos fueron utilizados para cada especie por separado, con el área del fragmento de bosque y el año como variables explicativas, así como proporción de individuos en cada estadio ontogenético y densidad de las palmeras como variables de respuesta. El número total de individuos monitoreado (desde semillas hasta adultos reproductivos, para todas las especies) fue 6 450 en 2005, 7 268 en 2006 y 8 664 en 2007. La densidad de población para dos especies de palmas no fue influenciada por el tamaño del fragmento, excepto para *Astrocaryum aculeatissimum*, cuya densidad dependió del tamaño del fragmento. Hubo más individuos en los fragmentos mayores que en los fragmentos menores. La estructura de la población de *A. aculeatissimum*, *E. edulis* y *G. schottiana* no se vio alterada en los fragmentos pequeños, excepto para *G. schottiana* en estado infante. El punto principal que se desprende de los resultados

encontrados en este estudio es que la respuesta de la densidad y estructura de la población parece no ser dependiente del tamaño de fragmento, excepto para una especie que es más abundante en los fragmentos mayores.

Palabras clave: estructura de la población, densidad de la población, *Astrocaryum aculeatissimum*, *Euterpe edulis*, *Geonoma schottiana*.

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