Structure and Dynamics of Tree Species of the Atlantic Forest

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ABSTRACT

The goals of this project are to describe the structure and dynamics of tree species of the Atlantic rain forest in the State Park of Serra do Mar (44°48'W and 23°22'S). We believe that an approach considering the spatial and temporal variations in a single geographical area, at the community and population level, is fundamental for an understanding of the structure and organization of the biodiversity in the Atlantic forest. The floristic composition and structure of the community varies along an altitudinal gradient (0-1000 m). Tree species showed an aggregated distribution pattern in the area and some of them are segregated in space. The analysis of four selected species indicates differences in microhabitat occupation between juveniles and adults of each species. The preliminary results presented reinforce the need to include a temporal and spatial approach, at different scales, to understand the patterns of biodiversity distribution in the Atlantic forest.

Key words: Atlantic forest, altitudinal gradient, spatial structure, regeneration.

INTRODUCTION

Studies of the dynamics and structure of tree populations are considered essential to understanding the processes that regulate the dynamics and structure of natural communities and for the management and conservation programs. In spite of this, there are few data in the literature on the demography of tropical tree species. A first step to acquiring knowledge of the structure and dynamics of a forest system is the physiognomic and floristic description of the vegetation. These descriptions produce basic information for understanding the patterns and causes of spatial variation in communities of tropical forests.

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The Brazilian Atlantic forest is considered one of the world's hot-spots for biodiversity conservation (Hanazaki *et al.*, 1996). Until the beginning of this century, the Atlantic forest embraced 16 Brazilian states, covering about 1.100.000 km^2, retaining now, just about 5% of its original covering (Siqueira, 1994), and is extinct in some states of the northeast of Brazil. In a revision of 192 papers that report studies of tree communities of the Atlantic rain forest, Siqueira (1994) indicates a list of 1338 tree species, divided in two floristic groups, one in NE and the other in SE/S. Such numbers refer to studies developed between 1905 and 1994, in an extension of approximately 1.500 km (from states of Alagoas to Rio Grande do Sul), including a latitudinal variation of about 21° and an altitudinal variation of the order of 2.000 m. Considering time differences among the studies in

different localities and the high heterogeneity of habitats along the Atlantic forest distribution, the diversity patterns and the distribution of this diversity is still not very well-known. These problems point to the necessity of strategies to obtain data and analyze the results considering different time and spatial scales.

The distribution of species in the communities generates patterns of richness in different spatial scales. Several studies have demonstrated floristic differences among samples in an area (Silva & Leitão-Filho, 1982; Almeida *et al.*, 1993; Oliveira, 1997) and among areas (Silva & Shepherd, 1986; Almeida *et al.*, 1993; Siqueira, 1994). Furthermore, differences in abundance of species among areas have also been reported (Almeida *et al.*, 1993; Oliveira, 1997). The sum of the differences in species composition and abundance can generates patterns of diversity at different spatial scales (α-, β-, γ-diversity) when combined with habitat distribution and heterogeneity. As comparisons among areas are generally based on a unique sample of each area (because the available data), this points to a question about the magnitude of the differences due to different areas or to different samples. There is a lack of studies approaching this problem directly.

In a time scale, the problems can be divided into two levels. First, if we consider the increase of deforestation in these areas during this century, comparisons among studies developed at different times can include differences in degradation of the areas, including possible invadering species and excluding locally extinct species. This is an axis not considered in the analysis that needs be attacked if we want to understand the patterns of species distribution and richness distribution along the Atlantic forest. Second, the composition and structure of the communities can vary in time, independently of the deforestation pressure. Some studies point to the dynamic aspects of the communities and to the dynamics of tree species in forest communities (Rankin-de-Merona *et al.*, 1990; Felfili, 1995; Martini, 1996; Santos *et al.*, 1996; Oliveira, 1997; Rolim, 1997). Variations in species abundance and composition in permanent plots have been related in these and other studies. However, there is a lack of data for different areas and for different time scales to allow us to understand patterns at large scales.

The goals of this project are to obtain information about the structure and dynamics of tree species of the Atlantic forest. We believe that an approach considering the spatial and temporal variations in a single geographical area, at the community and populational level, is fundamental for understanding the structure and organization of the biodiversity in the Atlantic forest. So, the strategy adopted is focused on three levels. The first level is the description of floristic composition and structural variations in the community along an altitudinal gradient. The second, the description of dynamics and spatial structure of tree species in plots of coastal plain forest and slope forest. The third, the description of the regeneration and dynamics of spatial patterns of selected tree species that occur in this area.

THE STUDY AREA

This study is being carried out in the State Park of Serra do Mar, Núcleo Picinguaba – located to the north of the municipality of Ubatuba-SP (44°48′W and 23°22′S). According to the IBGE's classification system (Veloso *et al.*, 1991), the forest area is of dense ombrophilous forest, generally named Atlantic forest. The area includes two vegetation types: the coastal plain forest and the slope forest which covers ca. 8000 ha (Fig. 1).

The climate of the area is classified as Af, according to Köppen (1948), a rainy tropical climate with rains the whole year. According to Silveira (1964) it is hot and humid, with high temperatures and high rainfall indexes. The average annual rainfall is 2624 mm. The largest rainfall indexes occur in the summer, during the months of December to February. The winter is less humid with low rainfall during the months of June to August. The average annual air temperature of 21.9°C with monthly temperatures ranging from 12.6°C (July) to 30.4°C (February).

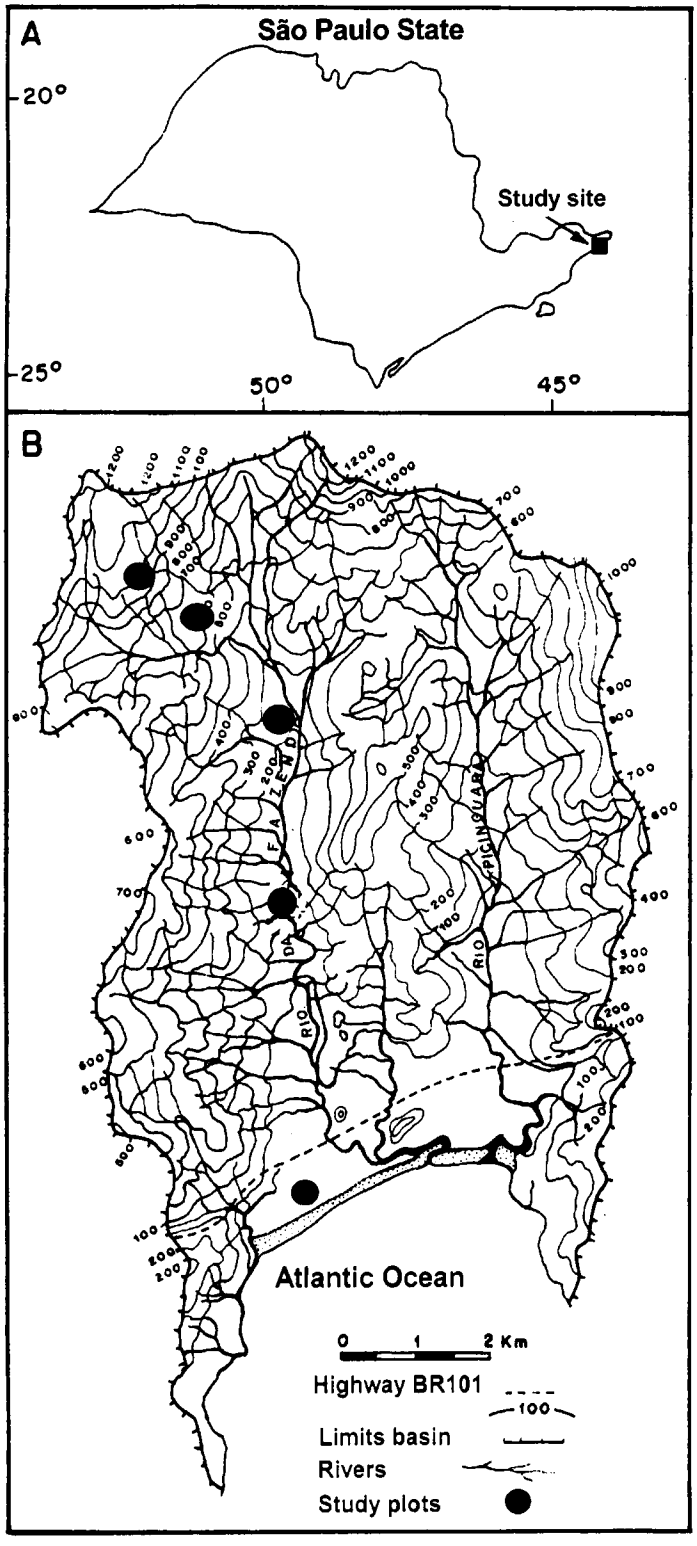


Fig. 1 — (a) Location of the municipality of Ubatuba in the state of São Paulo, southeast Brazil. (b) Location of the sampled plots that make up the 2.34 ha area of Atlantic forest in the Núcleo Picinguaba.

COMMUNITY STRUCTURE AND ITS VARIATION WITH ALTITUDE

There is an increase in the number of studies relating the floristic composition with soil and topographic heterogeneity at small scales in the tropical forests (Oliveira-Filho *et al.*, 1994; Clark *et al.*, 1995). This part of the project proposes the study of the variations in structure of a tree community and its relationships with an altitudinal gradient, relating variations in edaphic and topographic characteristics to the different sampled altitude levels.

All individuals with dbh ≥ 5 cm were sampled in plots established at 5 altitudes (0, 100, 300, 600 and 1000 m above the sea level). At the 100 m level, two sample areas were established, one in a riverine and the other in an upland slope forest.

At the moment, 301 tree species belonging to 160 genera and 60 families have been recorded in 2.34 ha. We observed differences in structure of the community among the altitude levels (Fig. 2). The great spatial heterogeneity is also observed if we analyze differences in species composition and abundance among the samples.

These results emphasize the necessity of including a component of spatial variation among samples of a same area when comparing different areas. The current limitations in the interpretation of similarities or differences among areas are due to the lack of replicated data in each area, which might indicate the magnitude of those similarities or differences. This probably becomes more critical in highly diversified environments as the Atlantic forest.

DYNAMICS, SPATIAL PATTERNS AND SEED DISPERSAL OF TREE SPECIES

Several phenological behaviors, such as the flowering and fruiting patterns in trees are related to the climatic seasonal rhythms (Morellato, 1991). These behaviors will affect the fecundity schedules of the plant species. On the other hand, the seed dispersal processes affects seedling establishment and the survival schedules of the individuals, and consequently acts on the observed spatial patterns of the population.

At this level, the aim of the project is to describe the fruiting phenology of the tree community in the coastal plain forest (level = 0 m) and in the slope forest (level = 100 m). Furthermore, the dispersal syndromes of the tree species are characterized and related with the spatial patterns and position in the forest strata. The areas were resampled for analysis of community dynamics and tree demography.

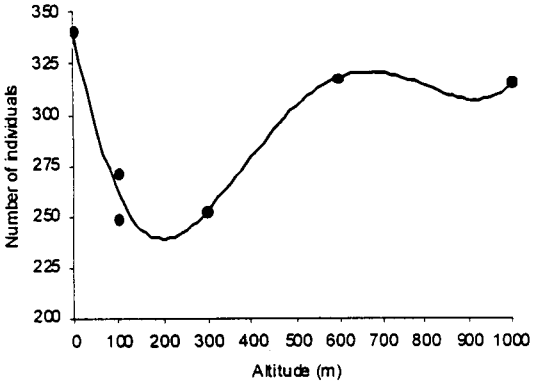
A preliminary analysis indicates differences in fruiting patterns in the two sample areas. On the other hand, the proportion of each dispersal syndrome is similar in the two areas, but differs among the forest strata. Most of the sampled species show an aggregated pattern, and some of them appear segregated in the space (Fig. 3b-d). These spatial patterns seem not to be related to the actual distribution of the canopy coverage (Fig. 3a). The analysis of the structure and dynamics of these species and the relation between the observed patterns and the soil characteristics is being performed. The results point to an increase in the number of individuals and in basal area in both areas. This reinforces the dynamic nature of the community studied and the need for data at different time scales.

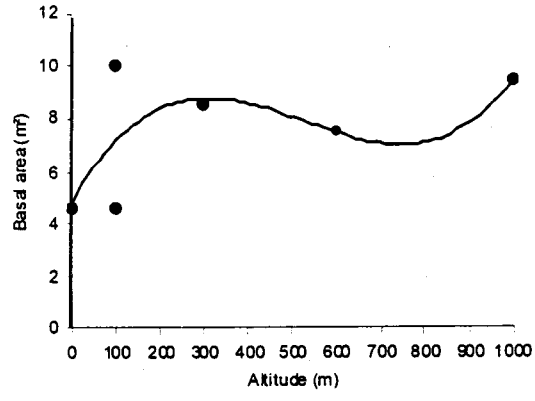
SEED DISPERSAL, RECRUITMENT AND SURVIVAL OF TREE SPECIES

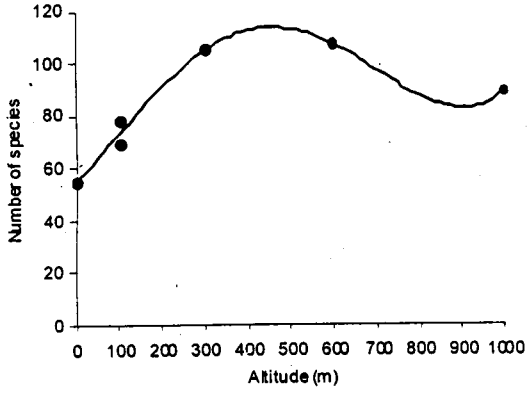
Data on the rates of growth, mortality and recruitment in tree populations are necessary to understand the relationships between the dynamics of tropical forests and the population processes that regulate the component species (Primack *et al.*, 1985).

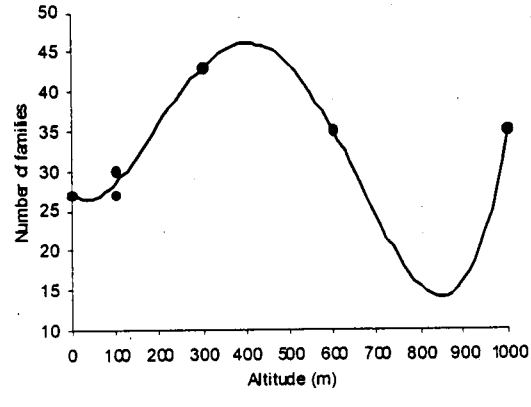
Here, at this level, the study has the aim of investigating the regeneration patterns of four tree species in the riverine forest of the Fazenda river (level = 100 m), obtaining data on seed dispersal, germination, seedling establishment and size structure of these species.

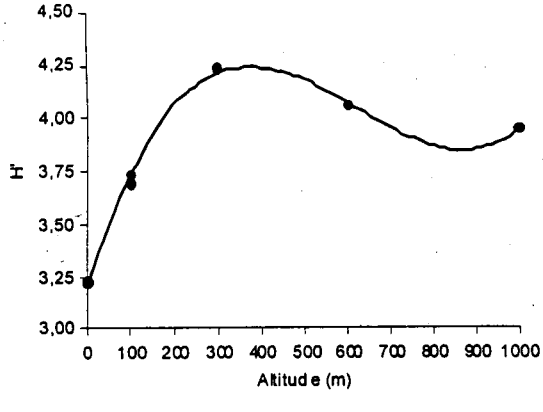
The species are *Sloanea guianensis* Benth. (Elaeocarpaceae), *Chrysophyllum flexuosum* Mart. (Sapotaceae), *Swartzia simplex* var. *grandiflora* (Raddi) Cowan (Fabaceae) and *Rheedia gardneriana* Planch. & Tr. (Clusiaceae). The first is an











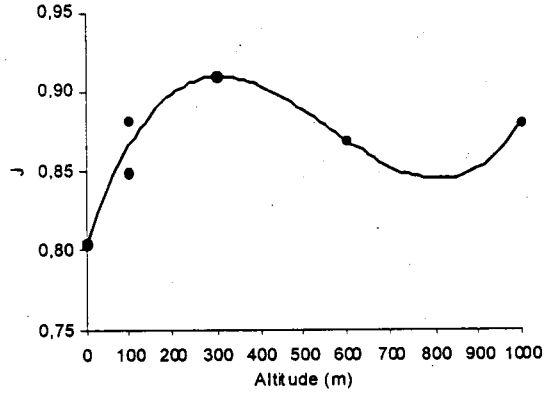


Fig. 2 — Variations in density, basal area, number of species, number of families, diversity index (H') and equitability (J) of tree species in different altitudinal levels. The lines are polynomial trend adjustments of different orders.

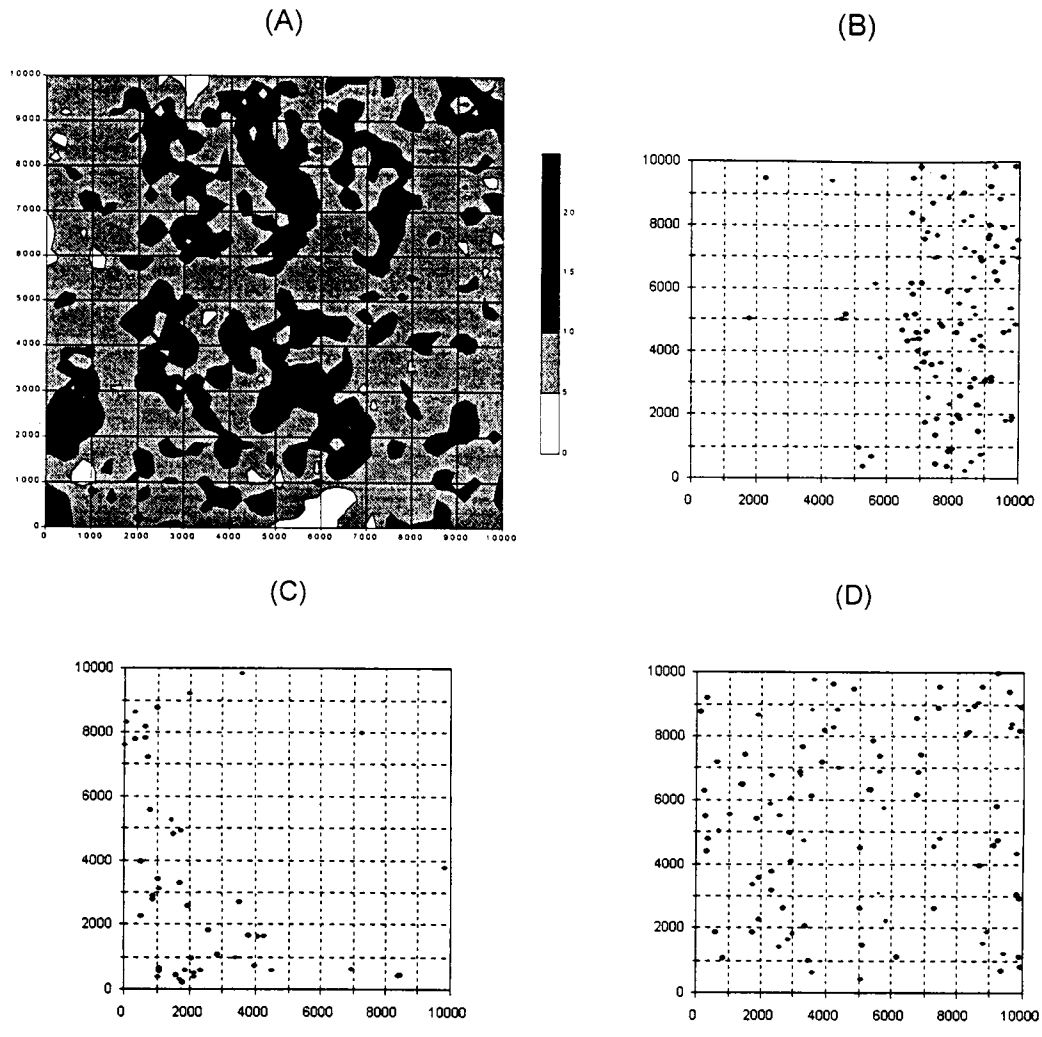


Fig. 3 — Spatial distribution of the canopy stratification (A), and of the individuals of *Guatteria gomeziana* (B), *Eugenia subavenia* (C) and *Jacaranda puberula* (D) in the sampled coastal plain forest area.

emergent species in the forest and the last a subcanopy species (Sanchez, 1994; Sanchez *et al.*, in press). The other two species are canopy species. According the revision study of Siqueira (1994), *Rheedia gardneriana* was present in 41% of the studies analyzed, occurring from the northeast to the southern region. *Sloanea guianensis* was present in 25%, occurring in the southeast and southern regions. *Chrysophyllum flexuosum* and *Swartzia simplex* occurred only in the studies made in the southeast region, the first one in 10% and last one in 3% of the studies revised by that author.

We sampled 67 individuals with dbh ≥ 1 cm of *Rheedia*, 56 of *Chrysophyllum*, 35 of *Swartzia* and 39 of *Sloanea* in a plot of 1.07 ha. A preliminary analysis seems to indicate differences in size structure among the species and differences in occupation of microhabitat (relative to differences in light availability) by juveniles and adults of the studied species (Fig. 4).

CONCLUSION

The preliminary results presented strongly support the need to include a temporal and spatial approach, at different scales, to understand the pat-

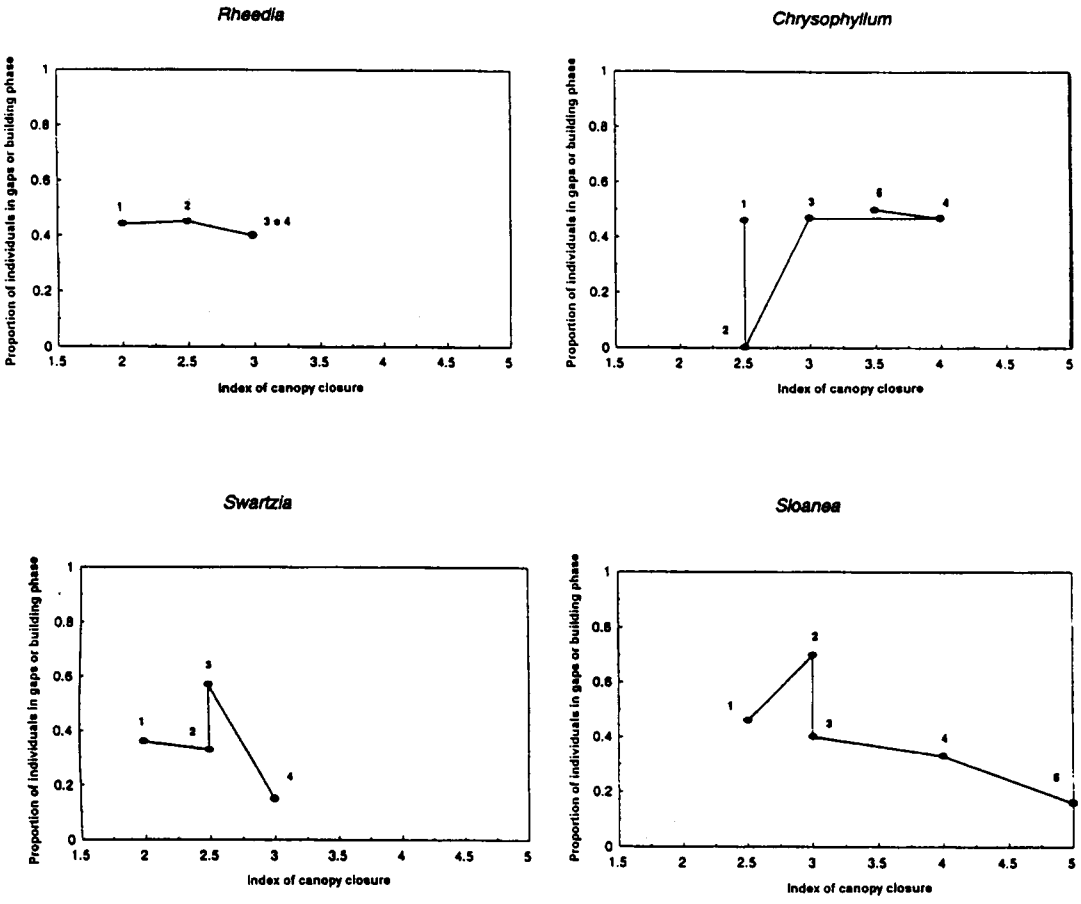


Fig. 4 — Distribution of the 4 species by microhabitat. The numbers in the figure refers to size classes of the individuals (1: height ≥ 0.5 m and dbh < 1 cm; 2: 1 cm ≤ dbh < 5 cm; 3: 5 cm ≤ dbh < 10 cm; 4: 10 cm ≤ dbh < 30 cm; 5: dbh ≥ 30 cm). The index of canopy closure is a relative measurement of lateral and vertical light that reaches the canopy and varies from 1 (shaded canopy) to 5 (exposed canopy) (see Clark & Clark, 1987). The y-axis represents the proportion of individuals that occupy plots not classified as mature forest (see Clark & Clark, 1987).

terns of biodiversity distribution in the Atlantic forest. A temporal approach is necessary at different time scales, because of the almost complete absence of data for Atlantic forest in the literature. A spatial approach should include local heterogeneity in the comparisons, since most of the comparisons in the literature implicitly assume that the areas are homogeneous.

At least, we expect that the continuity of the project, with this approach, will contribute to understanding the factors that determine the composition and structure of the communities and to the conservation and management of Atlantic forest areas.

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