# SOIL HETEROGENEITY EFFECT ON THE SPATIAL DISTRIBUTION OF *SAVIA DICTYOCARPA*(PHYLLANTHACEAE).

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## INTRODUCTION

### Introduction

The spatial distribution of individuals depends on different factors: environmental heterogeneity; species dispersal process; and successive mortality events throughout ontogeny (Peres & Baider 1997, Clark *et al.*, 1998, Barot *et al.*, 1999, Fonseca *et al.*, 2004, Guzmán *et al.*, 2008). Forest environmental heterogeneity influences plant distribution in space and time, in a way that recruitment of young stages can be highly influenced by favorable spots, especially by light and soil characteristics (Comita *et al.*, 2007). Then, to understand the regeneration processes of a tree species population, it is necessary to describe how the spatial distribution of the ontogenetic stages changes along ontogeny and investigate which factors are associated with shifts of the spatial pattern.

There is often a lack of significant relation among the spatial patterns of successive life stages (Herrera *et al.*, 1994). Different species of tropical trees frequently show an aggregated pattern in the early stages of life and a gradual decrease of aggregation in later stages (Henriques & Souza 1989, Oliveira - Filho *et al.*, 1996, Lopes 2007). That is because on the population level, environmental filters, i.e., the combination of factors locally affecting the specific number of individuals of a given cohort as time progresses, are most often spatially heterogeneous.

Soils can exhibit significant heterogeneity on intermediate and fine spatial scales, and relatively minor differences in soil properties can be important determinants of plant growth (Hall *et al.*, 2004). A variety of soil variables have been related to the spatial distribution of tropical trees, such as phosphorus, calcium, magnesium, potassium, and aluminum contents, soil porosity, and water availability (Sollins 1998, Hall *et al.*, 2004, Palmiotto *et al.*, 2004, Paoli *et al.*, 2005). Clark & Clark (1999) found that almost 30% of the species of their studied area showed to be edaphically biased on a mesoscale landscape. Comita *et al.*, (2007) also found an association of species distribution with soil variables and pointed that habitat associations of large trees typically do not form when they are young; rather, many species appear to exhibit different ecological habitat preferences across life stages.

## OBJECTIVES

### Objective

Our goal is to investigate the role of soil physical and chemical characteristics on the spatial pattern of *Savia dictyocarpa* (Phyllanthaceae) population and if there are shifts in this relation along ontogeny. *S. dictyocarpa* is an endemic species in the Atlantic forest, a shade tolerant canopy tree that is especially abundant in the Seasonal Semideciduous Forest of southeastern Brazil (Lorenzi 1992). Its wood is used for constructing simple objects and mostly for producing charcoal (Lorenzi 1992), however, the major impact on populations comes from habitat fragmentation and replacement of forest areas with agriculture in the last century.

## MATERIAL AND METHODS

### Material and Methods
### Field Collections

Our field data were surveyed in a 233.7 - ha fragment of the Seasonal Semideciduous Forest called Mata Ribeirão Cachoeira ($22^0$50'S, $46^0$55'W) in the Sousas - Joaquim Egídio Environmental Protection Area of Campinas municipality, São Paulo State, southeastern Brazil. The forest canopy varies between 15 and 25 m and there are no signs of recent human disturbances, such as logging, charcoal or garbage. We used 50 plots of 10 x 10 m that were set according to Greig - Smith's (1963) unrestricted randomization procedure by Cielo Filho *et al.*, (2007), in which we sampled all the individuals of *Savia dictyocarpa* (Phyllanthaceae). We collected a surface (0 - 20 cm) soil sample from the center of each plot, which was analyzed in IAC soil laboratories (for methods see Camargo *et al.*, 1986). The soil characteristics

that were analyzed were: organic matter, pH, P, K, Ca, Mg, Al, H+Al, base saturation, cation exchange capacity, clay (%), silt (%), total sand (%), fine sand (%) and thick sand (%).

**Data analysis**

In our analysis we considered the ontogenetic stages of juvenile (51), immature (69), adult (67), and senile (6), as characterized by Sims & Martins (2008). There were not seedlings on sampled area and infant were excluded from the analysis because there were only four individuals.

Firstly, we tested for spatial autocorrelation in each ontogenetic stage and each soil characteristic considering Moran's I coefficient, which varies between - 1 and + 1, indicating positive or negative autocorrelation in the data (Legendre & Legendre 1998). We used Moran's I coefficients for a series of 15 distance classes of 22 m interval and plotted I against distance classes in a series of correlograms with significance level corrected by Bonferroni procedure.

We tested for correlation among the ontogenetic stages to assess whether different ontogenetic stages would tend to occur in the same patch and tested for significance of the correlation between the number of individuals of each ontogenetic stage per plot soil variables in space using Total and Partial Mantel tests.

## RESULTS AND DISCUSSION

### Results and Discussion

All the correlograms were not globally significant, except for fine sand, indicating that all ontogenetic stages and almost all measured environmental variables were not spatially structured, that is, they were randomly distributed in space. When looking for a relation between soil variables and distribution of each ontogenetic stage we found just few significant positive relations between:1) clay and senile; 2) fine sand and senile. When investigating whether ontogenetic stages were associated with each other, we found that juvenile and immature had significant positive correlation along with juvenile and senile stages, meaning that these stages overlapped in space.

This lack of shift in the spatial pattern throughout the ontogeny is not usual in tropical tree species and could not be explained by the variables we measured. We can only speculate about the lack of both spatial shift along ontogeny and overall significant correlations between the established ontogenetic stages and environmental variables. It is possible that the random pattern of all established ontogenetic stages is related to other factors that we did not consider here, such as soil water content, light environment deciduousness gaps, litter fall and allelopathy.

The aggregation decrease along ontogeny was observed in some species of the Brazilian Atlantic forest. However, different habitat associations among life stages suggest that sites that are initially beneficial for establishment and survival can turn to be suitable for continued survival at later stages, and vice versa (Comita *et al.*, 2007). Thus, S. dictyocarpa seedling survival, that were not observed in this study, could have been affected by random spatial distribution of some biotic or abiotic factor, leading to random distribution, and this pattern would be kept in later stages,

suggesting that the definitive spatial pattern of the individuals is printed early in the ontogeny.

Also, significant correlations between the distribution of tropical tree species and soil components are not an overall rule (Clark *et al.*, 1999; Comita *et al.*, 2007). Paoli *et al.*, (2005) found that the most common Dipterocarp species were indifferent to substrate variation. The only soil variables significantly associated with the senile were clay and fine sand. Since clay and sand have contrasting properties and roles in the soil, we think this could be a spurious correlation.

The positive spatial association between juvenile and immature could indicate that individuals of these stages are recruited in the same environment, meaning that they need similar environmental conditions for growth. The spatial association of immature and senile individuals indicates that senility is precocious in the population we studied. Probably the frequent damage of immature individuals by fallen debris prevents some of them to be recruited to adult and so they become senile with continued damage along time. Therefore, it is likely that immature mortality is related to fallen branches from canopy, a process that decreases aggregation and can lead to spatial segregation between immature and adult.

## CONCLUSION

### Conclusion

We found a random spatial pattern in the juvenile, immature, adult, and senile stages of Savia dictyocarpa, and since we could not sample any seedling and infant, we were not able to know whether a shift occurs in the spatial pattern of the population we studied. The absence of viable seeds, seedlings, infants and reproductive adults could indicate both a strong irregular flowering pattern and a serious breakage in the pollination system of the population as a consequence of fragmentation and disturbance. The absence of consistent correlations between the ontogenetic stages and abiotic variables indicate that mortality, survival, and recruitment of individuals in the population of *S. dictyocarpa* could rely on processes that were not accounted here or that are stochastic in space and time.

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