ARCHITECTURAL AND LIFE HISTORY TRAITS OF TREE SPECIES ASSOCIATED WITH LIANA INFESTATION AT SEMIDECIDUOUS FORESTS FROM CAMPINAS, SP, BRAZIL

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INTRODUCTION

Lianas play a key role in forest dynamics and processes in the ecosystem. Lianas may reduce host tree growth rate, fecundity and suppress gap phase regeneration, and can also have a large impact in stand - level processes such as evapotranspiration and liter - fall production (Putz 1984, Stevens 1987, Schnitzer & Bongers 2002). The abundance and biomass of lianas may be increasing in the Neotropics (Phillips *et al.,* 2002, Wright *et al.,* 2004), a phenomenon that could have implications for dynamics of tropical forests, specially the forest carbon sequestration. Lianas compete strongly with host tree for resources above and below - ground, leading to increases in mortality rates of host trees (Putz 1984, Schnitzer *et al.,* 2005). Some studies have demonstrated that there are some tree species, which are less infested by lianas than others (Putz 1984, van der Heidjen *et al.,* 2008). These taxa, with lower rates of liana infestation, might have some architectural and morphological traits such as long branch - free bole, flexible stems, fast growth and smooth bark that would allow them to avoid liana infestation (Putz 1984, Balfour & Bound 1993, Campbell & Newberry 1993). Taking into account the negative effects of lianas on host tree, trees which remain free of liana infestation may have a competitive advantage in relation to their infested pairs. In this case, an increase of liana abundance in tropical forests could change the tree species composition and diversity of these forests. Thus it is very important to know which species are more susceptible to liana infestation.

In studies of the relationship between lianas and host trees it is important taking into account the part of the tree infested by lianas (i.e. crown infestation or trunk infestation), since there are different traits associated with each routes of liana infestation (van der Heidjen *et al.,* 2008). Here we examined liana - host tree interaction, focusing on tree crown infestation, in seasonal dry tropical forests, in which the liana - host tree relationship has been rarely investigated. The region where the study was carried out in São Paulo state is characterized by a high degree of fragmentation and reduced forest cover, which enforces the importance of the present study.

OBJECTIVES

We utilized a data set with estimates of liana infestation rates on tree species of ten semideciduous forest fragments of Campinas municipality, and we addressed two main questions: Do tree species differ in their susceptibility to lianas? Which are the characteristics of the host tree correlated with liana infestation?

MATERIAL AND METHODS

Field Collections
The data set utilized in this study was collected in ten semideciduous forest fragments within or just - outside the perimeter of Environmental Protection Area (EPA) of Campinas municipality, São Paulo state, southeastern Brazil (22º45' - 23º00' S, 47º00' - 47º12'W). The climate is classified as Köppen's Cwag'. Mean rainfall is ca. 1409 mm year - 1 irregularly distributed throughout the year, with a dry season from June trough August and a rainy season from December trough February (Mello *et al.,* 1994). The prevalent soil is Red - Yellow Argisol (Alfisol), and the topography ranges from slightly hilly to strongly hilly mountainous (Oliveira *et al.,* 1999, Santos *et al.,* 2007).
Data processing and Statistical Analyses
We selected trees with diameter at breast height greater or equal to (DBH $\geq$ 10 cm), presenting 10 or more individuals in each fragment. Liana infestation rate per species was calculated as the number of infested individuals divided by the total of individuals. To examine the relationship between trees' architectural and morphological traits and liana infestation, we considered all fragments pulled together and,

only species with 25 or more individuals were utilized. The architectural traits utilized were branch free - bole height (i.e. the height to the first branch), leaf phyllotaxy and leaf compoundness (simple or compound). The leaf phenology (deciduous or evergreen), wood density and maximal tree stature (Hmax.) were investigated as life history traits. The values of species - specific wood density were obtained from Chave *et al.,* (2006). Where unavailable, genus - or family - level average values of wood density were used, following Baker *et al.,* (2004). Maximal tree stature for each species was calculated as the 95th percentile of height values in the population (Poorter *et al.,* 2003).

To determine whether each tree species had significantly different liana infestation rate than expected based on the infested trees average for each separated fragment, we estimated the expected proportion of infested individuals per each tree species using a binomial distribution (Sokal & Rohlf 1995), then contrasted it with the observed proportion of infested individuals using a goodness of fit chi - squared tests. Simple correlations (Pearson's correlation) were used to examine the relationship between liana infestation rate and traits of the tree species. For Hmax, we used a log - transformed data to filling the requirements of a normal distribution (Sokal & Rohlf 1995). The probability of one tree to get infested by lianas increases with their size in diameter, for this reason we categorized the trees in three diameter classes: 10 cm-19.9 cm; 20-39.9 cm, and $\geq$ 40 cm. In the analyses of diameter classes we examined separately the only palm species included in the study, *Syagrus romanzoffiana*, because palms differ morphologically and phylogenetically from dicot trees by having extremely long leaves and lacking secondary growth after the initial establishment period. All statistical analysis were made in the SYSTAT 11 (Willinkinson 2001).

RESULTS AND DISCUSSION

Eighteen species were sampled in more than one fragment. In each fragment where these species were sample, they had a proportion of liana - infested individuals significantly different, higher or lower, from the average of infested trees of the fragment. Based on this result we classified the species according to liana susceptibility in three groups: high, low and variable. The only species with high liana susceptibility was *Piptadenia gonoacantha*, which presented significantly higher liana infestation rate than the average of infested trees in the fragment (n = 60, P = 0.002; n = 56, P= 0.01). To species *Nectandra megapotomica* (n = 14, P = 0.01; n = 25, P < 0.001) and *Syagrus romanzoffiana* (n = 11, P < 0.001; n = 10, P = 0.001), liana infestation rate was significantly lower than the mean number of infested trees in the fragment. Thus, these species were classified as species with low liana susceptibility. There were fours species for which, depending on the fragment where they occurred, they had lower liana infestation rate than the mean number of infested trees and, higher liana infestation rate than the mean number of infested trees. These species were: *Aspidosperma polyneuron* [n = 59, P = 0.006 for lower liana infestation rate than the mean number of infested trees in the fragment **(Low Susceptibility - LS)**; n = 13, P < 0.035 for higher liana infestation rate than the mean number of infested trees **(High Susceptibility - HS)**], *Calycorectes acutatus* [n = 26, P = 0.023 **(LS)**; n = 21, P = 0.047 **(HS)**], *Centrolobium tomentosum* [n = 16, P = 0.043 **(LS)**; n = 28, P = 0.003 **(HS)**] and *Croton floribundus* [n = 52, P = 0.04 **(LS)**; n = 30, P < 0.,04 **(HS)**].

Liana infestation rate increased with trees' diameter (Trees: $2 = 11.31, P¡0.01 with Yates' s correction), except for palm Syagrus ro$ = 1.08, P = 0.5 with Yates's correction).

The low susceptibility of liana infestation of the *Syagrus romanzoffiana* is consistent with results previously reported (Putz 1984, Pérez - Salicrup *et al.,* 2001). The long unbranched boles and large leaves falling frequently seem to be traits very effective in repelling lianas. An increase in tree diameter could lead to higher probability of liana infestation, due to higher exposition time of the tree to be infested by lianas (Putz 1984, Pérez - Salicrup *et al.,* 2001). However, in the case of *Syagrus romanzoffiana* the liana infestation rate did not increase with diameter, suggesting that architectural and morphological traits of palms might be effective to keep them free of liana.

The variable susceptibility to liana infestation exhibited by some species (*A. polyneuron*, *C. acutatus*, C. tomentosum and C. floribundus) could be associated to the size and degree of disturbance of the studied fragments. Thus, the likelihood of a tree to get infested by lianas could be influenced by both, traits of tree species and forest structure (Pérez - Salicrup *et al*., 2001, van der Heidjen *et al.,* 2008).

In general, tree species with higher liana infestation rate were characterized by a low first branch height (Pearson's r = - 0.27; P < 0.05) and deciduousness (Pearson's r = 0.29; P < 0.05). Trees with low first branch height showed higher liana infestation, similar result was found by Campanello *et al.,* (2007) in the Argentine's semideciduous forest, and the same pattern had been registered for other forest types (Putz 1984, Boulfor & Bond 1993, Pérez - Salicrup *et al.,* 2001). The first branch of a tree may represent a climbing support (trellis) for liana trying to ascend from the forest floor (Hegarty 1991). This architectural trait seems to be closely associated with the probability of liana infestation.

Our results are different from those found by Malizia & Grau (2006) for the relationship between leaf phenology and liana infestation. The shed of leaves by deciduous species increases the light amount under the tree's crown (Gandolfi 2000), thus we believe that over time more lianas may climb up deciduous trees than evergreen trees.

CONCLUSION

Tree species traits were important to avoid crown colonization by lianas. However, the fact that species such as *Aspidosperma polyneuron*, *Calycorectes acutatus*, *Centrolobium tomentosum* and *Croton floribundus* had showed higher liana infestation in one fragment and lower liana infestation in another (variable susceptibility) suggests that both traits and structure of forest may influence tree species vulnerability to liana infestation. Moreover, bole first branch height and leaf phenology are important traits associated with liana infestation.

In summary, our results pointed out that architectural (bole first branch height), life history traits (leaf phenology) and forest structure are important factors influencing the liana infestation on tree species.

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