BAMBOO-DOMINATED GAPS IN THE ATLANTIC RAIN FOREST: IMPACTS ON VEGETATION STRUCTURE AND SPECIES DIVERSITY

R.A.F. Lima[1]; D.C. Rother[2]; L.S. Araujo[3]; S. Gandolfi[1] & R.R. Rodrigues[1]

[1]Escola Superior de Agricultura 'Luiz de Queiroz' – ESALQ/USP, Departamento de Ciências Biológicas. Av. Pádua Dias 11, Piracicaba, SP;[2]Universidade Estadual Paulista – UNESP, Instituto de Biociências, Departamento de Botânica. Av. 24A 1515, Rio Claro, SP;[3]Escola Superior de Agricultura 'Luiz de Queiroz' – ESALQ/USP, PPG em Ecologia Aplicada. Av. Pádua Dias 11, Piracicaba, SP.

INTRODUCTION

Know as species with life cycles markedly different from other evergreen plant species, bamboos are generally well adapted to invade disturbed areas.

With fast rates of growth and clone reproduction, bamboo species can invade rapidly forest gaps and therefore play an important part on forest structure and regeneration (Griscom & Ashton 2003), reducing species density and/or even bringing forest sucession to a standstill. In Brazil, studies on the dynamics and influences of bamboo species are concentrated in the Amazon region, more specifically in the state of Acre (Silveira 2005) where extent forest areas are covered by woody bamboos (mainly *Guadua*). In the Atlantic Rain Forest, some studies cited the occurrence and influences of bamboo species in forest structure and dynamics but none of them has directly tested or quantified such influences.

Recently, mapping efforts linked to management plans of some public conservation areas have shown that around 30% of forest areas in the Ribeira do Iguape River Basin may be dominated by woody bamboo species.

The main causes for the generation of such large forest areas invaded by bamboo species are still unclear. Some authors point out human activity as the principal factor for bamboo expansion, but some natural large disturbances may also be important for bamboo dispersal and growth. Considering actual Atlantic Rain Forest conservation status and the exceptional increase of bamboo-dominated areas in the last decades, studies on the ecology, influence and management of bamboo species become crucial to the Atlantic Rain Forest conservation strategies.

Therefore, this study aimed to quantify the influences of bamboo dominated forest areas on vegetation structure and species diversity based on data available from a permanent at São Paulo, south-eastern Brazil.

MATERIAL AND METHODS

Vegetation survey - Data collection was conducted in 10.24 ha permanent plot placed in 2002 at the Carlos Botelho State Park (coordinates: 24º10'S e 47º56'W; altitude: 350 m a.s.l.). Local climate is Cfa and vegetation is Lower Montane Atlantic Rain Forest (Rodrigues, 2005). The 10.24 ha plot was completely surveyed in 2006 for canopy openings and 20x20 m subplots were then gathered into two groups: closed-canopy and large gaps (>1,000 m^2; see Lima 2007 for further details). Hereafter referred as 'bambuzal', these forest stands had great bamboo stem density and some scattered canopy trees. The invading bamboo species is *Guadua tagoara* (Nees) Kunth (Poaceae), a semi-scandent species with heights and girths of 10-20 m and 5-10 cm, respectively, and distributed along the Brazilian coast from Bahia to Santa Catarina. Within each 20x20 m plot classified all individuals with diameter at breast height (DBH) e"4.8 cm (i.e., trees) were identified and measured for stem diameter. Additionally, within 20x20m plots, nested 10x10 m plots were randomly allocated to evaluate likewise the vegetation <4.8 cm DBH but taller than 1 m height (i.e., saplings, although life forms other than trees were included).

Data analysis – Total density, dominance and the mean individual basal area were calculated for all plots as measures of vegetation structure for saplings and trees. Because samples were not independent or randomly chosen, mean differences between closed-canopy and bambuzal were tested using a two-sample randomization test randomized t-test performed with 10,000 randomizations using the *RT* software version 2.1. In addition to the observed number of species, we estimated total sapling and tree species richness for each canopy condition, using the second order Jackknife estimator calculated by *EstimateS* version 7.5. Individual-based rarefaction curves were prepared to compare species richness between closed-canopy and bambuzal stands. Besides mean species richness, the Shannon diversity index (*H'*) and the Berger-Parker measure of dominance (*d*) were also calculated for 20x20 and 10x10 m plots in both canopy conditions using *EcoSim* version 7. Mean values and standard deviations for all analyses were estimated using with 5,000 randomizations, as well as their 95% confidence intervals that were used to determine differences in mean values.

RESULTS AND DISCUSSION

It was found 2,058 saplings and 2,959 tree individuals (total= 5,017) corresponding to a sampled area of 3,100 and 34,000 m^2, respectively. Therefore, mean sapling and tree total density was 6,639 and 870 $individuals.ha^{-1}$ for both canopy conditions together. Accordingly, mean sapling and tree total dominance was 5.22 and 26.05 $m^2.ha^{-1}$, correspondingly. There was strong statistical differences among the two canopy conditions evaluated (bamboo-dominated and closed-canopy) in respect to total tree density (two-sample randomization test: N= 85; $p< 0.000$), dominance ($p< 0.000$) but not for mean basal area ($p> 0.10$). For the first two parameters bambuzal plots had averages markedly smaller than closed-canopy plots. The same was not truth for sapling size class that had a quite different behavior in respect to such parameters. There was only a weak tendency that bambuzal plot were more dense than closed-canopy plots (two-sample randomization test: N= 31; $p= 0.098$) and dominance did not varied significantly between canopy conditions ($p> 0.10$). Moreover, mean basal area tended to be higher under closed-canopy ($p= 0.016$). Therefore, as found for other forests, bamboo dominance seem to alter vegetation structure specially for size classes larger than 5 cm DBH, probably due to direct and indirect physical damage related to bamboo clumps dynamics (Griscom & Ashton 2003, Silveira 2005).

Among the 5,017 individuals sampled, it was found a total of 235 observed species (195 and 179 species within saplings and trees, respectively). Bambuzal presented a total of 158 species while 206 species were found in closed-canopy plots. The rarefaction curves produced proved that bambuzal actually had lower mean species richness for both size classes. Such difference was more pronounced among saplings. The same pattern was observed for total estimated richness [bambuzal and closed canopy, respectively: 154 and 205 (saplings); 154 and 193 species (trees)] and for *H'* (respectively: 3.83 and 4.11 (saplings); 3.46 and 3.97 $nats.individual^{-1}$ (trees)]. Species dominance (*d*), in contrast, was significantly higher in the bambuzal for trees but not for saplings who the opposite occurred [respectively: 0.108 and 0.134 (saplings); 0.273 and 0.223 (trees)]. This former result was primarily related to high monocotyledon dominance in forest understorey (mainly *Euterpe*, *Geonoma*). The causes for the lower richness and diversity in bamboo-dominated areas are yet difficult to assert. Possible explanations may be related to the presence of *G. tagoara* itself (high physical damage rate and/or possible allelopathic effects) or to the stressful physiological environment of such large gaps that is certainly not supported by many plant species. Future research is therefore needed to quantify the role of these possible causes that probably act simultaneously on species diversity impoverishment (Acknowledgements: CNPq 132.938/2005-7, BIOTA/FAPESP 1999/09635-0 and FAPESP 03/12485-7).

REFERENCES

Griscom, B.W. & Ashton, P.M. 2003. Bamboo control of forest succession: *Guadua sarcocarpa* in Southeastern Peru. *For. Ecol. Manag.*, **175**: 445-454.

Lima, R.A.F. 2007. *Regime de distúrbio e dinâmica da regeneração natural na Floresta Pluvial Atlântica Submontana*. Msc. Dissertation. ESALQ/USP, Piracicaba. 233p.

Rodrigues, R.R. (Coord.) 2005. *Parcelas Permanentes em 40ha de florestas do Estado de São Paulo: uma experiência interdisciplinar*. 4º Relatório temático do projeto "Diversidade, dinâmica e conservação em florestas do estado de São Paulo: 40,96ha de parcelas permanentes". Piracicaba, ESALQ/USP. Available at < http://www.lerf.esalq.usp.br/parrel2005.php>.

Silveira, M. 2005. *A floresta aberta com bambu no sudoeste da Amazônia*: *padrões e processos em múltiplas escalas*. Rio Branco, EDUFAC. 157p.