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The Seed Bank of a Gallery Forest in Southeastern Brazil

Maria Tereza Grombone-Guaratini[1*], Hermógenes de Freitas Leitão Filho[1] and Paulo Yoshio Kageyama[2]

[1] Departmento de Botânica; Instituto de Biologia; Universidade Estadual de Campinas - UNICAMP; C. P. 6109; 13083-970; Campinas - SP - Brazil. [2] Departmento de Ciências Florestais; Escola Superior de Agricultura "Luiz de Queiroz"; C. P. 9; 13418-900; Piracicaba - SP - Brazil

ABSTRACT

The soil seed bank was studied in a gallery forest in Southeastern Brazil. Samples were collected from edge to edge along transects perpendicular to the river during the wet (December, 1990) and dry (August, 1991) seasons. The number of seeds found in the seed bank samples was greater in the dry season than in the wet season indicating that there was important variation in the seed stocks in these two periods. The similarity values between the seed bank and the community composition were low. The high density of weed species might be reflecting forest fragmentation and indicating a degree of perturbation.

Key words: Forest regeneration, forest succession, gallery forest, soil seed-bank

INTRODUCTION

The role of soil seed banks in the regeneration of natural or man-made clearings has been extensively investigated in tropical forests, particularly since the floristic composition and density of the seeds stored in the soil may indicate the regenerative potential of a forest (Butler and Chazdon, 1998). The composition and abundance of seed species in the soil, as well as the distribution of life forms, are influenced by factors such as floristic composition, the phenology of the local vegetation and disturbances occurring at the forest edge (Quintana-Ascencio et al., 1996; Butler and Chazdon, 1998).

Gallery forests are considered areas of permanent protection in Brazil. The expansion of agricultural activities has resulted in alarming levels of deforestation, and has put gallery forests at risk of enormous reductions in size or even complete extinction in the future. In this study, we hypothesized that the seed population could vary in different seasons as a function of the phenological patterns of the community. The floristic composition and life form abundance of a gallery forest soil seed bank sampled in different seasons were analysed to assess the floristic similarity between the forest seed bank and the tree species in the forest area (based on Gibbs and Leitão Filho, 1980 and Mantovani et al., 1989).

We sought for trees and shrubs that could be used in reforestation action programs.

The data were collected at the Estação Ecológica de Mogi Guaçú, which belonged to the Instituto Florestal located in the southeastern region of São Paulo State, Brazil (22°18' S, 47°13' W). The forest covers an area of 7.2 ha at an altitude of proximately 600 m. The irregular topography makes its lower areas susceptible to flooding during the wet season (Gibbs and Leitão Filho 1980). The

* Author for correspondence

regional climate is characterized by a cool, dry season (April to September), when rainfall is less than 70 mm and mean temperatures vary from 17.3o C to 20.3o C, and a hot, humid season (October to March) when rainfall is higher than 120 mm and mean temperatures vary from 21.3oC to 23.3oC. The gallery forest consists of semi-deciduous vegetation with variable width bordering one or both sides of a river. The canopy is about 15 m tall, of two predominant species: Sebastiania klotzchiana Muell. Arg. and Cyclobium vecchii Samp. ex Hoehne. The vegetation is a mixture of species adapted to temporary flooding, such as Inga vera Willd. and Genipa americana L., and other species characteristic of semi-deciduous forest, such Aspidosperma peroba Fr. All. and Cariniana estrelensis (Raddi) Kuntze. The undestory vegetation is variable, being dense in some places and resembling large gaps with sparse and few shrubs (Gibbs and Leitão Filho 1978). The forest is surrounded by Eucalyptus plantation and has others fragments near the river.

Sampling was done in one wet season (December, 1990) and one dry season (August, 1991). The samples were collected from edge to edge along five transects perpendicular to the river. Each transect contained 15 fixed sampling points at distances which varied according to the transect length (253-380 m). At each point, a sample (25 cm x 25 cm x 4 cm) was collected and subsequently placed on a 4 cm thick layer of sterilized sand in wooden boxes in a greenhouse. Five additional boxes of sterilized sand used to detect contaminating species were distributed randomly. Seedlings which germinated from the control boxes were considered to be contaminating species and were excluded from the analysis. The samples were maintained under natural lighting for 18 weeks at a mean temperature of 24oC from December to March and at 23oC between August and November and were kept humid in order to provide ideal germination conditions. Two months after the beginning of the experiment the samples were stirred to expose the seeds which had not germinated. The tree and shrub species were grouped into successional stages based on observations of the same species in other forests in southeastern Brazil (Bernacci and Leitão Filho, 1996; Gandolfi et al., 1995). The floristic similarity between the species identified in the two seed bank samples and the flora of the area forest studied (Gibbs and Leitão Filho, 1980) was determined using the Sørensen index (Pielou, 1977). The K2 - test was used to assess the normality of the population distribution after ln transformation. A paired t-test was used to compare the numbers of seeds found in both sampling periods, and a χ^2 contingency test was used to compare the species classes (pioneer trees, pioneer shrubs, non-pioneer trees, herbs and climbers) between seasons (Zar, 1999).

The number of seeds in the seed bank samples was higher in the dry season than in the wet season ($t = 6.73$, $df = 73$, $P < 0.01$). Seed density varied from 243 (± 287) seeds/m2 in the wet season to 499 (± 405) seeds/m2 in the dry season. These results differed from these reported by Grombone-Guaratini and Rodrigues (2002), who found that the seed density during the dry season was significantly lower than in the rainy season. The mean density of seeds in the soil seed bank studied (371 seeds/m²) was similar to that obtained for moist and wet tropical forests (384 seeds/m²) (Garwood, 1989). In general, the seed density in the seed bank of tropical forests was lower than 500 seeds/m² (Saulei and Swaine, 1988). The seed number within the species classes was significantly different between the dry and wet seasons.

In the rainy season, there were herbaceous plants (81%); woody plants 8.2%, climbers, 6.6% and shrubs, 4.2%. In the dry season, most germinated seeds were from herbaceous plants (76.4%), followed by woody plants 15.1%, climbers, 7.8% and shrubs, 0.7%. Fifty-seven species belonging to 45 genera and 25 families were identified in the rainy season samples, whereas 87 species from 66 genera and 34 families were found in the dry season samples. The woody species found in the soil seed bank were mainly those that regenerated only in large gaps, mainly through the seed bank (Cecropia pachystachya, Croton floribundus, C. urucurana, Helicteris brevispira and Trema micrantha) (Table 1).A low density of woody species compared to herbaceous species has been reported in previous studies (Young et al., 1987; Quintana-Ascencio et al., 1996; Dupuy and Chazdon, 1998; Grombone-Guaratini and Rodrigues, 2002), and might be reflecting the degree of perturbation and fragmentation since weeds became common components of the seed bank when the forest got fragmented or surrounded by non-natural vegetation (Graham and Hopkins, 1990; Hopkins et al., 1990; Poiani and Dixon, 1995; Dalling and Denslow, 1998).

The large number of weeds reflects various characteristics of these species, including their efficient dispersal mechanisms, the large number of dormant seeds in the soil, and the rapid germination and maturation of these plants to produce even more seeds (Hopkins et al., 1990). The proportion of seeds from herbaceous species found here was higher than in other studies of tropical forests, and might be indicating perturbation in this forest, but could also reflect forest´s size. Small forest fragments (1-10 ha) often become hyperdisturbed, with progressive changes in their floristic composition (Laurence et al., 2002).There was no strong correlation between the species composition of the seed bank and of the local forest.

Table 1 - The number of individuals (N), density and *P* values for tree, shrub, herb and climber species in the seed bank of soil seed samples collected at the Mogi Guaçú Ecological Station in December, 1990 (wet season) and August, 1991 (dry season).

Species	Wet season		Dry season	
	N	Density	N	Density
Pioneer trees				
Alchornea triplinervia Muell. Arg.	2	0.41	17	3.6
Cecropia pachystachya Tréc.	57	12.1	257	54.8
Croton floribundus Spreng.	1	0.21	2	0.4
Croton urucurana Baillon	32	6.8	13	2.8
Helicteris brevispira St. Hil.	6	1.3	13	2.8
Schinus terebinthifolius Raddi	10	2.1	-	-
Trema micrantha Blume	6	1.3	5	1.1
		$\chi^2 = 88.01$, $P < 0.01$		
Pioneer shrubs				
Calliandra sp.	-		1	0.2
Hybanthus atropurpureus (A. St. Hil.) Taub.	7	1.5	7	1.5
Solanum granuloso-leprosum Dunal	43	9.2	7	1.5
		$\chi^2 = 18.84$, $P < 0.01$		
Non-pionners trees				
Acacia glomerosa Benth.	-	-	16	3.4
Casearia sp.	-	-	19	4.0
Lafoensia pacarii A. St. Hil.	-	-	12	2.6
Luehea cf. *divaricata* Mart.	-	-	3	0.6
Sebastiania klotschiana (Muell. Arg.) Muell. Arg.	-	-	4	0.9
Syagrus romanzoffiamum (Cham.) Glass.	-	-	3	0.6
		$\chi^2 = 63$, $P < 0.01$		
Herbs	903	192.5	1781	379.7
		$\chi^2 = 287.2$, $P < 0.01$		
Climbers	74	15.8	182	38.8
		$\chi^2 = 45.6$, $P < 0.01$		
Total	1141	243.2	2343	499.4

The similarity values between the seed bank and the community composition's were 5% and 11% in the wet and dry season, respectively. Similar observations have been reported for other tropical forests (Guevara-Sada and Gómez-Pompa, 1976; Hall and Swaine, 1980; Rico-Gray and García-Franco, 1992).

The similarity between the species in the vegetation and the seed bank reflects the number of species present in the vegetation during the early stages of succession (Hopkins et al., 1990). Species present in mature forests generally have reproductive structures that remain in the soil for a very short period and germinate immediately after seed dispersion. In addition, the presence of species in the soil may reflect a coincidence between the fruiting season and the sampling season (Hopkins and Graham, 1983). Pioneer species such as *Alchornea triplinervia*, *Cecropia pachystachya*, *Croton floribundus*, *C. urucurana*, *Helicteris brevispira* and *Trema micrantha* were found in the soil in both sampling periods. Among

the non-pioneers, *Sebastiania klotschiana* (Muell. Arg.) Muell. Arg. had seeds in the soil when the seed bank sampling coincided with the fruiting period.

There is no information on the fruiting period of the other non-pioneer species found. The low similarity probably reflected the large time lapse between the soil seed bank sampling done and the local forest study reported earlier (Gibbs and Leitão Filho, 1980).

Marked variation was observed in the seed stocks in the two periods sampled. In tropical forests, seasonal variations in the composition and density of the soil seed community may partly reflect the annual and seasonal modes of production, deposition and stocking of seeds in the soil (Dalling et al. 1997, 1998; Butler and Chazdon, 1998; Dupuy and Chazdon, 1998). Additionally, factors such as the seasonal pattern of flooding and the constant removal and deposition of litter may affect the composition of the soil seed bank. Flooding, which is responsible for the dispersion of some species, could result in the elimination of the seeds of other species from the soil seed bank, especially those which are not adapted to anerobic conditions (Poiani and Dixon 1995). A rise in the water may also lead to rapid germination or attack by fungi or pathogens (Schiavini, 1993).

In conclusion, the results of this study showed that there was temporal variation in the soil seed bank. Future work on the influence of the patterns of fruiting and the frequency of flooding on the composition and density of seeds in the soil and on the establishment of seedlings should help to identify the sources of recruitment for new plants. An analysis of the effects of fragmentation on the process of succession may also help in preserving this ecosystem.

RESUMO

O banco de sementes do solo foi estudado em uma floresta de galeria. As amostras de banco de sementes foram coletadas ao longo de transectos abertos perpendicularmente à área do rio durante as estações chuvosa (dezembro/1990) e seca (agosto/1991). O número de sementes encontrado nas amostras de banco de sementes proveniente da estação seca foi significativamente maior do que o número de sementes encontrado nas amostras provenientes da estação chuvosa. Os resultados obtidos evidenciaram uma variação significativa entre o estoque de sementes encontrados nos dois períodos amostrados. A similaridade entre o estoque de sementes no solo e a flora local foi baixa. A alta densidade de espécies invasoras pode refletir a fragmentação e indicar o grau de perturbação da floresta.

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