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Tree Species Sprouting from Root Buds in a Semideciduous Forest Affected by Fires

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ABSTRACT

*Tree species which sprouted from root buds were identified in a 3.6ha area of a Semideciduous Seasonal Forest fragment in Campinas, São Paulo State (22° 55' S and 47° 05' W), affected by several fires. Connection between sprouts and main trunk root system was confirmed by digging and root exposure. Twenty seven tree species with root buds were identified, with a high proportion of Leguminosae species. The majority of identified species (45%) were characteristic of initial secondary succession stages. Distances between sprouts and main trunks varied from 0.6m (*Guettarda viburnioides *Cham. and Schltdl- Rubiaceae.) to 14.0m (*Colubrina glandulosa *Perkins- Rhamnaceae). These results lead discussions about natural and/or human-made disturbances influence on the sprouting from root buds, and its possible consequences in forest dynamics, besides the spatial occupation, and structure of populations of tree species which present their potential capacity of regeneration.*

Key words: Disturbances; forests; fire; root buds; sprouting; vegetative propagation

INTRODUCTION

Human disturbances are the main factor involved in alteration of floristic composition and structural organization in the majority of Semideciduous Seasonal Forest communities in São Paulo State (Southeast Brazil) during last decades. These changes are due to deforestation, introduction of monocultures and pastures (Cavassan et al., 1984), selectively logging (Pagano et al., 1987; César and Leitão-Filho, 1990; Gandolfi et al., 1995), and specially fires (Castellani and Stubblebline, 1993; Pagano et al.,1995; Schittler et al.,1995). It is has been argued that natural regeneration and secondary succession after such disturbances in these forest fragments are related to: i) period of disturbance occurrence (Denslow, 1980); ii) initial composition and seed bank germination (Denslow, 1980; Uhl, 1982; Brokaw, 1985), and iii) sprouting of vegetative structures which remained after disturbances (Jeník, 1994; Casttellani and Stubblebline, 1993).

Vegetative regeneration of tree species includes three aspects (Jeník, 1994): the capacity of aerial branch reiteration (epicormic shoots), sprouting of basal portions of trunk (coppice shoots), and sprouting from root buds (sucker shoots). Tree sprouting from root buds follows damage to aerial portion of the main trunk (Peterson, 1975; Schier, 1975; Schier et al., 1978; Uhl, 1982; Lacey and Johnston, 1990; Jeník, 1994, Bosela et al., 1997). This is related to tropical forest habitats associated

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with several kinds of natural and man-made disturbances, such fires (Lacey, 1974; Unwin et al., 1985; Uhl and Kauffman, 1989; Bowman, 1991; Kauffman, 1991), hurricanes (Vandermeer et al., 1990; Yih et al., 1991), floods (Gavin and Peart, 1999), and harvesting and "slash and burn" activities (Stocker, 1981; Uhl et al., 1981; Miller and Kauffman, 1997; Rijks et al., 1998; Thompson et al., 1998; Dickinson et al., 2000).

Evaluation of root sprouting in Seasonal Semideciduous Forests of Southeast Brazil, however, are still very scarce (Penha, 1998; Hayashi et al., 2001), and also others kinds of vegetative propagation, such as basal coppicing and epicormic sprouting. But tree root sprouting should be a common phenomenon in these areas, due to fragmentation and man-made disturbances. The trade-off between germination, seedling stablishment, and vegetative propagation depends on the variability of several disturbance features, in terms of type, intensity, scale, frequency, and predictability (Orbony, 1994; Stuefer, 1996). In this sense, trees that originating from root buds in tropical forest habitats could guarantee the survival of the species (Janzen, 1980; Uhl, 1982; Cook, 1985; Lacey and Johnston, 1990; Greig, 1993). The same consequences could be expected in relation to Semideciduous Seasonal forest habitats (Penha, 1998; Hayashi et al., 2001). This strategy plays an important role in the resilience of any disturbed site, that is, the degree to which community function, process composition and structure would return to their original state (Denslow, 1985). Root sprouts can show rapid growth rates because they can use the pre-existing root system and photosynthates produced by the original main trunk (Kauffman, 1991; Stocker, 1991). In relation to trees that sprout from root buds, the relationship between root suckering and several traits of disturbances, included the role of root sprouting in Semideciduous Seasonal Forests, has not been discussed yet. To explore whether these events occur in Seasonal Semideciduous Forest fragments, an urban forest remnant seriously affected by frequent fires was selected. The main questions were: i) Which tree species sprouted from root buds?; and ii) What percentage of tree species sprouted from root buds in the forest community?

STUDY AREA

The selected Semideciduous Seasonal Forest remnant belongs to Instituto Agronômico of Campinas (IAC), and is located at “Centro Experimental de Campinas”, Santa Elisa Farm, in Campinas, São Paulo State, Brazil (22° 55' S and 47° 05' W). Total area is 15.87ha and the mean elevation of the region is 660m. Climate is Cwa type (Koeppen, 1948): a dry winter, with a hot and rainy summer. Mean precipitation is 1371mm/year, and mean monthly temperatures varies from 23.1°C (January) to 17.1°C (July). The study area is located in the urban zone of Campinas, and it is near to a highway, which has been the source of several fires. Large fires occurred in 1983, 1985, 1988 and 1994. More than 6.0ha of the forest remnant were affected during the 1988 fire.

METHODS

Identification of tree species with root sprouts was performed five and fourteen months after September 1988 fire. Eight transects were established in 3.6ha of the area affected by fire. These transects had 100.0m extension into the forest, and were located at a perpendicular position to the smallest fragment width. The distance between each of the eight transects was 10.0m. Individuals that sprouted from root buds and their sucker shoots were sampled along these transects. Other kinds of vegetative propagation, such as coppicing sprouts from main trunks and epicormic sprouts from tissues beneath bark on mainstems and trunks, were not included on sampling.

The connection between sprouts and main trunk root system was confirmed by digging and root exposure (Fig. 1). Alignment of young stems near a more developed trunk of the same species, and connection to roots were the evidences used to make distinction between root suckers and young stems originating from seeds. Sucker shoots also differed from saplings by absence of a primary root. The distances between root sprouts and main trunks were also measured. Tree species with root buds identified in this study were classified into successional groups (Santos et al., 1996; Bernacci and Leitão-Filho, 1997) such as: a) pioneers species; b) initial secondary species; c) late secondary species, and d) understory species.

RESULTS AND DISCUSSION

Twenty-seven tree species with root buds (belonging to 17 families) were identified (Table 1; Fig. 1). A species survey in the same fragment, in a 0.5 ha area (Penha, 1998), identified 85 tree species (DBH ≥ 5.0cm), belonging to 71 genera and 36 families. Therefore, the number of tree species originating from root buds represented aproximatelly 31.8% of the local tree species. Some tree species with root buds identified in this study were also recorded in secondary successional studies in another nearby Semideciduous Seasonal Forest remnant in Campinas affected by fire (Santa Genebra Reserve - 22° 48' S and 47° 07' W - Castellani and Stubblebline, 1993). These species were *Aspidosperma polyneuron* Müll. Arg., *Centrolobium tomentosum* Guill. ex Benth., *Croton floribundus* (L.) Spreng., *Galipea multiflora* (A. St-Hil.) Engl., *Holocalix balansae* Micheli, *Machaerium hirtum* (Vell.) Steffeld and *Machaerium stipitatum* Vogel.

The Leguminosae family contained the greatest number of tree species with root buds (nine species). The families Rubiaceae, Rutaceae, Sapindaceae e Solanaceae each had two species with root buds (Table 1). The Leguminosae has the greatest species richness in São Paulo State forest remnants. Sampled species with root buds at Santa Elisa forest remnant are very common in several forest fragments, showing high density values, such as *Bauhinia forficata* Link, *Centrolobium tomentosum* Guill. *ex* Benth., and *Lonchocarpus cultratus* (Vell.) A.M.G. Azevedo and H.C. Lima (Cavassan et al., 1985; Pagano et al., 1987; Rodrigues et al., 1989; Kotchekoff-Henriques and Joly, 1994; Schittler et al. 1995; Pagano et al., 1995). Therefore, the high species richness and density values within the Leguminosae in forest fragments affected by disturbances could be due, at least partially, to the high incidence of root sprouting potential in this family.

The distances observed between root sprouts and main trunks varied from 0.6m (*Guettarda viburnioides* Cham. and Schltdt.- Rubiaceae) to 14.0m (*Colubrina glandulosa* Perkins- Rhamnaceae). This feature is the difference of root sprouting compared to other modes of vegetative propagation: root sprouts could generate aggregation of independent trunks (clones), and also allow the exploitation of places relatively distant from the main trunk. Therefore, root sprouts could be considered distinctive individuals in a phytosociological survey, if the connections between sprouts and main trunk have not been verified through exposure of root system or other methodology, such as molecular markers (Rocha et al., 1997).

Twelve of the 27 tree species with root buds (45%) were characteristics of initials stages of secondary succession ("initial secondary species" - Table 1). The importance of initial secondary species in these Semideciduous Seasonal forest fragments has been shown (Gandolfi et al., 1995), including undisturbed forest fragments (Bernacci and Leitão-Filho, 1997; Santos et al., 1996). However, there is little information about the relationship between tree species successional traits and their potential of sprouting from root buds (Greig, 1993).

Pioneer species preferentially established through germination of their seeds, deposited on the forest soil before gap opening (Uhl et al., 1981; Young et al., 1987). However, if the intensity of fires were strong enough, the soil seed banks could not become available. In these cases, root sprouting, coppicing, and epicormic shoots could be an important strategy for regeneration in such disturbed sites. The same argument could be used to explain the presence of initial secondary species and late secondary species soon after the beginning of successional forest dynamics, if the disturbance did not eliminate totally the individuals. Therefore, sprouting from root buds could represent an effective process of spatial reoccupation, because sucker shoots have the potential to emerge at variable distances from the main trunk, and eventually develop their own adventitious root system. In this way, they would become independent, like *Rollinia sylvatica* (A. St.-Hil.) Mart. in this study (Fig. 1). Shoots would not be required to pass through sensitive phases of development, such as germination and seedling establishment, which depends on the intensity of disturbance (Uhl et al., 1981; Kauffman, 1991).

The manner in which root sprouts occupy space should influence the competition among individuals and species. In addition, the reproductive biology and the pollination in these tree species must also be considered, due to aggregation of clones. Finally, systematic studies of Semideciduous Seasonal forest tree species sprouting from root buds, such as sucker shoot emission, their growth and survivorship rates after

disturbance emphasize the importance of this kind of vegetative propagation in tropical forest dynamics.

Several studies could be proposed, especially within communities that have suffered intensive intervention in their original traits, to revegetate sites with these species that recover with greater facility after a major disturbance. In this sense, it would be important to compare populations of tree species with root buds in forest fragments which suffered variable intensities of disturbance, such as occurrence of fire, to evaluate some populational quantitative traits: clone frequencies, spatial pattern, and phenological traits.

Table 1 - Tree species that sprouted from root buds in a 3.6ha area of a Semideciduous Seasonal Forest remnant, Santa Elisa Farm, Campinas, São Paulo State, Brazil. Successional classification: **P**: pioneers species (5/27 species); **IS**: initial secondary species (12/27 species); **LS**: late secondary species (6/27 species); **US**: understory species (5/27 species).

Family	Species	Classification
Annonaceae	*Rollinia sylvatica* (A. St.-Hil.) Mart.	IS
Bignoniaceae	*Tabebuia chrysotricha* (Mart. ex DC.) Standl.	IS
Boraginaceae	*Cordia trichotoma* (Vell.) Arrab. ex Steud.	IS
Euphorbiaceae	*Actinostemon concolor* (Spreng.) Müll. Arg.	US
Lauraceae	*Cryptocarya moschata* Nees	LS
Lecythidaceae	*Cariniana estrellensis* (Raddi) Kunth	LS
Leguminosae - Caesalpiniodeae	*Bauhinia forficata* Link	P
	Hymenaea courbaril L.	LS
Leguminosae - Mimosoideae	*Acacia polyphylla* DC.	P
	Inga laurina (Sw.) Willd.	IS
Leguminosae - Papilionoideae	*Centrolobium tomentosum* Guill. ex Benth.	IS
	Lonchocarpus cultratus (Vell.) A.M.G. Azevedo and H.C. Lima	IS
	Lonchocarpus subglaucescens Mart. ex Benth.	IS
	Machaerium hirtum (Vell.) Stefelld	IS
	Machaerium stipitatum Vogel	IS
Monimiaceae	*Mollinedia widgrenii* A. DC.	US
Rhamnaceae	*Colubrina glandulosa* Perkins	IS
Rubiaceae	*Coutarea hexandra* (Jacq.) K. Schum.	US
	Guettarda viburnioides Cham. and Schltdl.	US
Rutaceae	*Esenbeckia febrifuga* (A. St.-Hil.) A. Juss. *ex* Mart.	US
	Metrodorea stipularis Mart.	LS
Sapindaceae	*Allophylus edulis* (A. St.-Hil.) Radlk.	P
	Cupania vernalis Camb.	IS
Simaroubaceae	*Picramnia ramiflora* Planch.	LS
Solanaceae	*Solanum granuloso-leprosum* Dunal	P
	Solanum pycnanthemum Mart.	P
Verbenaceae	*Vitex montevidensis* Cham.	LS

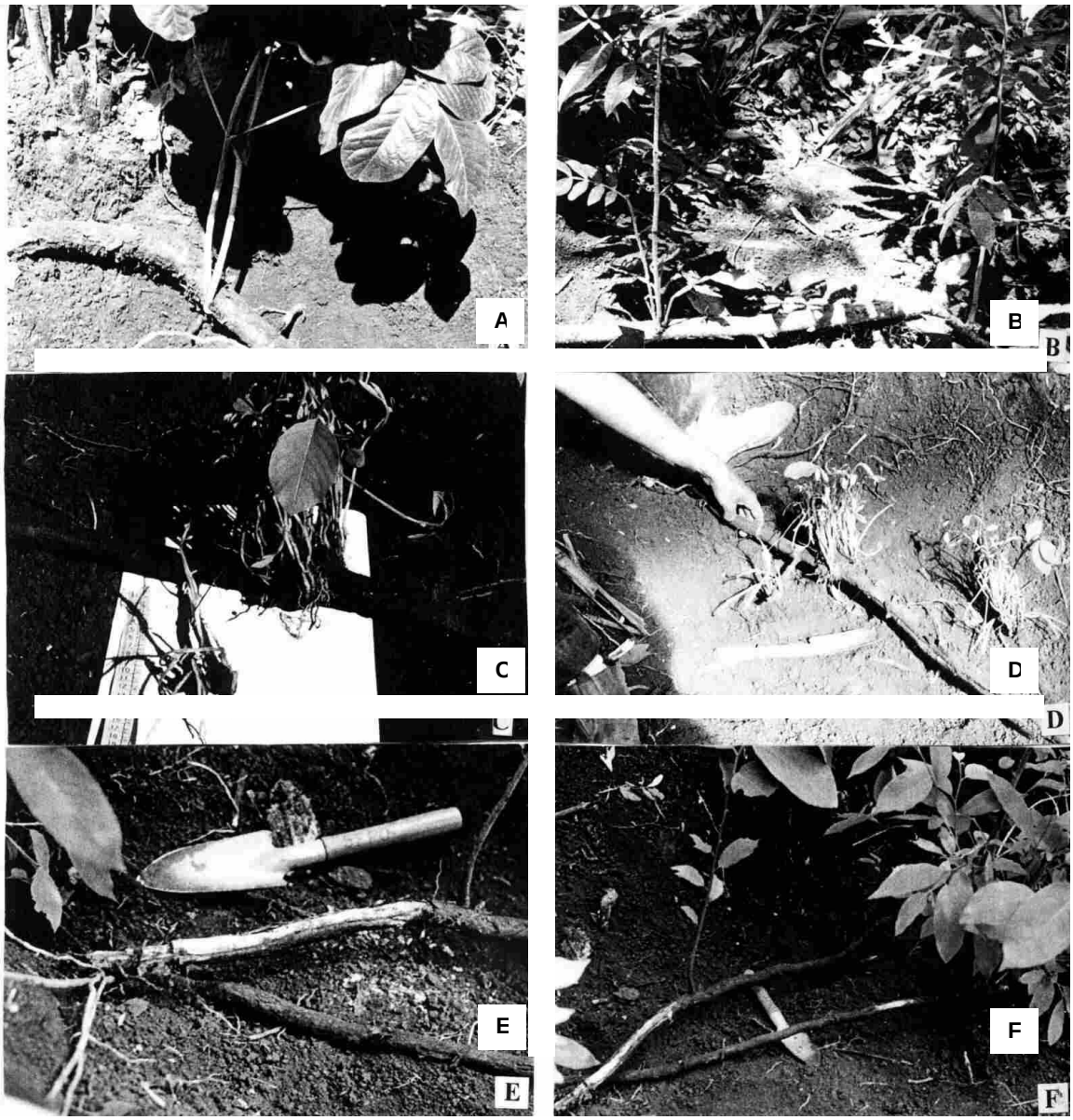

Figure 1 - A) *Centrolobium tomentosum* Guill. *ex.* Benth. root shoot - necrosis of underground tissues and the development of secondary roots; B) *Inga laurina* (Sw.) Willd. - root shoots emitted from root buds; C and D) *Rollinia sylvatica* (A. St.-Hil.) Mart. root shoots and their development 5 months after the September 1988 fire, and E and F) *Rollinia sylvatica* (A. St.-Hil.) Mart. root shoots after the September 1988 fire. Santa Elisa Farm, Campinas, São Paulo State, Brazil.

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RESUMO

Foram identificadas as espécies arbóreas que rebrotaram a partir de raízes gemíferas em 3,6ha de um fragmento de Floresta Estacional Semidecidual em Campinas, São Paulo, alvo de freqüentes incêndios. A identificação foi feita através de transectos de 100 metros de extensão no trecho de floresta selecionado e da exposição do

sistema subterrâneo para verificar a ligação entre os brotos e seus troncos principais. Foram registradas 27 espécies que rebrotaram a partir de raízes, a maioria Leguminosae. Grande parte das espécies é característica de estádios iniciais da sucessão secundária. As distâncias máximas entre brotos e os troncos principais variaram de 0,6m (*Guettarda viburnioides* Cham. and Schltdt.-Rubiaceae) a 14m (*Colubrina glandulosa* Perkins-Rhaminaceae). Com os resultados obtidos, discute-se a relação da rebrota a partir de raízes e a ação dos distúrbios, além da influência da rebrota na ocupação espacial e na estrutura de espécies arbóreas com este potencial de regeneração.

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