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Demografia da *Sorocea bonplandii* em remanescentes da Floresta Estacional Decidual, Sul do Brasil

Demography of *Sorocea bonplandii* in Seasonal Deciduous Forest, Southern Brazil

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Resumo

Sorocea bonplandii é uma pequena árvore de interesse farmacológico característica do subosque da Floresta Atlântica. Todos os indivíduos de *S. bonplandii* com DAP ≥5 cm foram avaliados pelo método dos quadrantes em 13 fragmentos florestais alocados na região do Alto Uruguai. Em cinco desses fragmentos, todos os indivíduos da espécie foram inventariados pelo uso do método de parcelas permanentes. Os parâmetros analisados foram: número de plantas ha^{-1}, diâmetro DAP, altura total, e a altura da primeira ramificação. O número de plantas encontradas com DAP ≥5 cm ha^{-1} variou de 15 a 148, correspondendo a aproximadamente 10% do total de plantas lenhosas neste ecossistema. Quando examinadas todas as plantas, independentemente de diâmetro, 1834 a 6074 plantas ha^{-1} foram encontradas. A densidade absoluta variou fortemente, mas a densidade relativa, quando classificadas em classes da altura total foi similar em todos os fragmentos. Foi observada maior concentração de plantas jovens, caracterizando assim o comportamento típico de banco de plântulas para a espécie. Com base no índice de dispersão espacial de Morisita, *S. bonplandii* exibiu distribuição caracteristicamente agrupada. Esse trabalho faz parte de um estudo maior sobre a Floresta Estacional Decidual, ecossistema ecológica e economicamente importante no sul do Brasil. A única maneira de proteger os últimos remanescentes florestais deste ecossistema, possivelmente seja por meio de uso sustentável. Portanto, sendo *S. bonplandii* uma espécie não madeireira e com potencial para uso fitofarmacológico, trata-se claramente de uma das candidatas promissores para manejo da Floresta Estacional Decidual.

Palavras-Chave: Distribuição espacial agrupada, Espécie abundante, Floresta Subtropical Atlântica, Planta medicinal, Regeneração natural

Abstract

Sorocea bonplandii is a pharmacologically interesting tree characteristic of the sub-canopy stratus of the Atlantic Forest. In 13 forest remnants in the Alto Uruguai River region, individuals of this species with DBH ≥5 cm have been evaluated using the point-centered quarter method. In five of the remnants, all individuals of the species have been analysed using the permanent sample plots method. The parameters analysed were plants ha^{-1}, DBH, total height, and height at first bifurcation. Absolut diameter varied from 15 to 148 *S. bonplandii* plants ha^{-1} (DBH ≥5 cm), corresponding to approximately 10% of all woody plants. When all plants independent of DBH were examined, 1834-6074 plants ha^{-1} were found. While the absolute number of plants ha^{-1} exhibited a great variation, the relative distribution of height classes was similar in all remnants, indicating typical seedling bank behaviour. *S. bonplandii* exhibited a characteristic clumped spatial distribution based on Morisita index. The current work is part of a larger study of the ecologically and economically important Subtropical Atlantic Forest in Southern Brazil. The only way to protect the last remainders of this ecosystem is to define knowledge-based ways of sustainable uses. *S. bonplandii* clearly is one of the most promising candidates for phytopharmocological, non-timber uses of Subtropical Atlantic Forest plants.

Keywords: Clumped spatial distribution, Medicinal plant, Natural regeneration, Subtropical Atlantic Forest, Abundant species

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INTRODUCTION

Sorocea bonplandii (Baill.) W.C. Burger, Lanj. & Wess. Boer., a small tree which dominates the sub-canopy stratus of the Subtropical Atlantic Forest, has been described as one of the most characteristic species of this ecosystem (RAMBO, 1956; KLEIN, 1972; DIAS *et al*., 1992; KEEL *et al*., 1993; NASCIMENTO *et al*., 2000; JARENKOW *et al*., 2001). The Seasonal Deciduous Forest (SDF) ecosystem occurs along the Uruguai River. It is one of the three forest ecosystems in Southern Brazil, the other ones being the Ombrophilous Dense Forest, also called Tropical Atlantic Forest (TAF), and the Ombrophilous Mixed Forest, also called Araucaria Forest (RAMBO, 1951; RAMBO, 1956; KLEIN, 1972; KLEIN, 1984). SDF, reaches from the source of the river in the South East of Brazil down into Argentina, in altitudes between 800 and 200 m above sea level. This ecosystem is connected to a similar one along the borders of the Parana River, in the West of the South Brazilian State Parana and into Paraguay and Argentina (KLEIN, 1972). When the floristic composition of the last remainders of this important ecosystem in Brazil, was analysed, *S. bonplandii* was found to be one of the prevalent woody species (RUSCHEL *et al*., 2006). In this work, was described the phytosociology of this species, as it occurs in the 'Parque Estadual Turvo' and in 13 forest remnants of this ecosystem in the Alto Uruguai River region.

Sorocea bonplandii (Moraceae) is a lactescent, subtropical to tropical native evergreen forest species, a small tree with an average height of 6 to 12 m and an averages trunk diameter of 15 to 25 cm (KLEIN, 1972; LORENZI, 1998, CARVALHO *et al*., 2000). Popular names for the species include cincho, soroca, cancrosa, espinheira-santa-falsa, mata-olho, räspelbaum, carapicica-de-folhas-miúdas, carapicica, folha-de-serra, canxim, araçari e Nandypá (REITZ e KLEIN, 1964; KLEIN, 1972; RAMBO, 1956; GONZALENZ TORES, 1986; LORENZI, 1998 and KELLER, 2001). The tree is shade tolerant but adapted to diffuse light, typically appearing towards the climax state of forest development (RAMBO, 1956; KLEIN, 1972; BRACK *et al*., 1995; IVANAUSKAS *et al*., 1999; CARVALHO *et al*., 2000, DISLICH *et al*., 2001; AMADOR and VIANA, 2000; ARMELIN and MANTOVANI, 2001). Fruits are oval shape of an with intensive red color to almost black color when mature, containing a single seed (FIGURE 1). Flowering time is given as June to December, mature fruits appear from October to December (LORENZI, 1998; ARAÚJO, 2002; THE NEW YORK BOTANICAL GARDEN, 2003), and seeds are dispersed by zoochory (NASCIMENTO *et al*., 2000; GENTRY, 1982).

Within the communities of aboriginal Guaranis, in the Misiones region of Argentina (KELLER, 2001; KELLER, 2003) and Paraguay (GONZALENZ TORES, 1986), *S. bonplandii* is considered as one of the eight species of major value, used for food, medicine, and arts-and-craft. Accordingly, phythopharmacological research has been performed on *S. bonplandii*. Hano *et al*. (1995a and 1995b) isolated new pharmacologically active isoforms of phenols, sorocenols A to F. Vilegas *et al*. (1998) and Di Stasi *et al*. (2000) found that *Z. ilicifolia* (Papilionacea), *Maytenus ilicifolia* and *M. aquifolium* (Celastraceae), and *S. bonplandii* (Moraceae), share qualitatively similar phytochemical compounds. Gonzalez *et al*. (2001) verified that these species all exibited high antiulcerogenic and analgesic activities, while only *Zollernia ilicifolia* had toxic effects. These medicinal properties had been recognized by the aboriginal people and their traditional communities (GONZALENZ TORES, 1986; KELLER, 2001; KELLER, 2003).

Although *Maytenus ilicifolia* and *M. aquifolium* were recognized as medicinal plant before *S. bonplandii*, nevertheless these species are sold and consumed equally. Fresh or dry leaves of *S. bonplandii* are morphologically indistinguishable from *Maytenus* leaves by collectors and consumers. In addition, they are used for the same purposes. Traditionally, they are also utilized as blood depurator, antiulcerogenic, analgesic, tonificant, cicatrizant, laxative, diuretic, abortive, antiasthmatic and antiseptic (SCHEFFER, 2004).

Due to the low density and the mechanical flexibility of its wood, *S. bonplandii* is used for arts-and-crafts among traditional communitis of the Alto Uruguai river region (RUSCHEL, 2000) and the Guaranís indian tribes of the Mbya and Chiripa in Southern Brazil, Argentina, and Paraguay (KELLER, 2001). The Indian name of the species, Ñandyta or Ñamboyta, derives from the use of the plant, ″ñambo″ meaning confection and "yta" basket arc (Keller, personal communication). It is interesting to note that for this use, two ethno-species are recognized, the difference is in the internal log coloration: the white one is considered adequate for arts-and-crafts uses while the yellow one is not.

In the present work, the demographic structure of the species *S. bonplandii* in both old growth and secondary forest remnants of the Subtropical Atlantic Forest of Alto Uruguai river ecosystem in Southern Brazil has been characterized.

METHODS

Study area

The study was carried out in SAF remnants of the Atlantic Forest domain in the subtropical region of the hydrographic basin of the Uruguai River in Southern Brazil. The 13 remnants analysed were: Beato-Roque (BRO), Capela-Colégio (CCO), Capela-Seara (CSE), Capoeirinhas (CAP), Isabel-Bildhauer (IBI), Isabel-Neumann (INE), Iporã do Oeste (IPO), Itaquaruçu (ITA), Pirapó (PIR), Tigre (TIG), Parque Estadual Turvo (TUR), Soledade (SOL), and São Valentin (SVA) (FIGURE 1 and TABLE 1). In addition to these SAF remnants, one remnant of the Tropical Ombrophilous Dense Forest (Floresta Ombrófila Densa, TAF) was included for comparison: São Pedro de Alcântara (SPA).

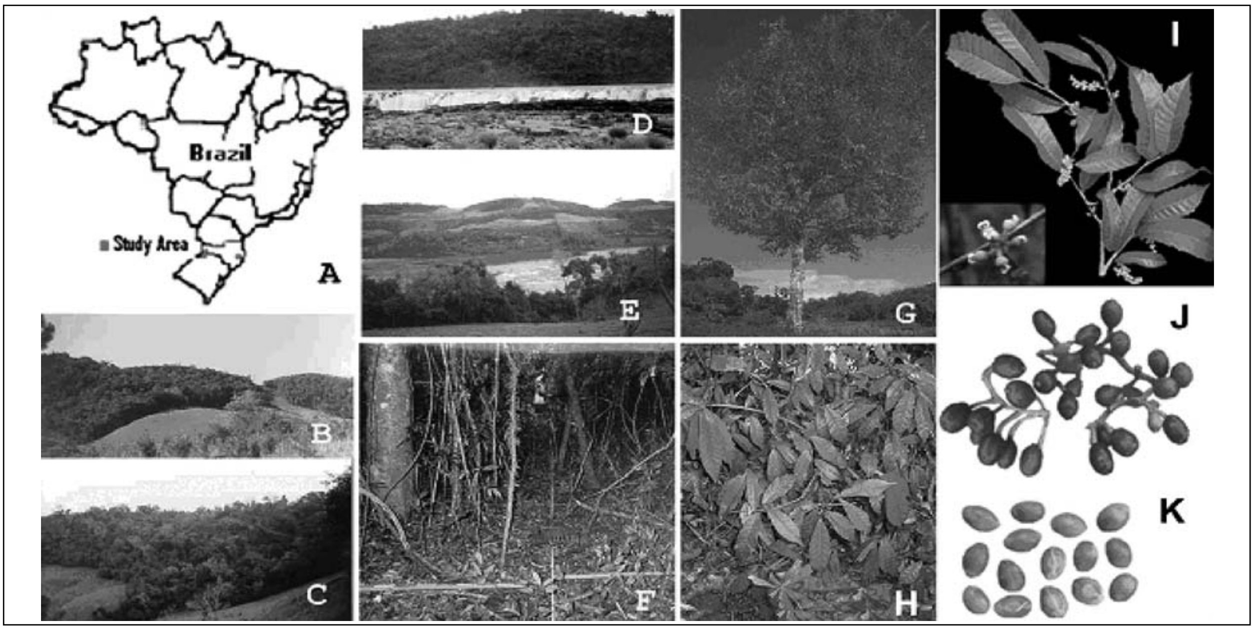

Figure 1. Details, A - location of the study area, B-E - forest remnants (B = SPA, C = CCO, D = River Uruguay and Forest Park of Misiones, Argentina, E = River Uruguai and landscape of the forest remnants of the Alto Uruguai river region), F - methodologies of sampling plots, G - K *Sorocea bonplandii* specimen, G - adult plant, H - bank of saplings, I - branch with male and female flowers, J - mature fruits, K - seeds. (G to K from LORENZI (1998) with permission). (Detalhes, A – localização da área de estudo, B-E - remanescentes florestais (B = SPA, C = CCO, D = Rio Uruguai e Parque Florestal Misiones, Argentina, E = Rio Uruguai e remanescentes florestais da região do Alto-Uruguai-SC/RS), F –metodologia de amostragem, G - K espécie Sorocea bonplandii, G - planta adulta, H – banco de plântulas, I – ramos com inflorescência masculina e feminina, J – frutos maduros, K - sementes. (G a K de LORENZI (1998) com permissão)).

Table 1. Details of geographical location, inventory method, description of the nature of past exploitation of the evaluated Atlantic Forest remnants in Southern Brazil. (Detalhes sobre a localização geográfica, métodos de inventário, descrição e histórico de uso dos remanescentes florestais avaliados em Floresta Atlântica, Sul do Brasil).

Remnants	Forest Ecosystem[1]	Nature of Exploitation[2]	Area (ha)	Sample Points and (Error, %)[3]	Altitude (m)	Latitude (South)	Longitude (West)
CAP	SAF	WE	114	42 (17.8)	430	27° 05' 38"	53° 28' 20"
PIR	SAF	WE	17	40 (18.6)	470	26° 57' 47"	53° 33' 10"
SOL	SAF	WE	11	42 (18.2)	510	27° 05' 04"	53° 40' 07"
TUR	SAF	WE	17,491	141 (5.3)	290-350	27° 11'-12' 34"	53° 51' 03"-33"
CCO	SAF	ES	50	53 (15.4)	320	27° 11' 25"	53° 38' 02"
IBI	SAF	ES	22	24 (34.0)	365	27° 02' 45"	53° 40' 12"
INE	SAF	ES	11	32 (20.9)	455	27° 03' 08"	53° 40' 27"
IPO	SAF	ES	12	32 (14.4)	560	26° 57' 53"	53° 32' 20"
SVA	SAF	ES	50	48 (13.6)	590	26° 56' 12"	53° 31' 30"
TIG	SAF	ES	12	39 (16.9)	350	27° 04' 21"	53° 27' 38"
BRO	SAF	EI	11	45 (16.9)	470	27° 04' 06"	53° 36' 54"
CSE	SAF	EI	18	39 (13.5)	250	27° 12' 23"	53° 39' 00"
ITA	SAF	EI	80	32 (17.7)	515	27° 07' 41"	53° 32' 04"
SPA	TAF	EI	40	- (-)	300	27-28°	48-49°

[1]SAF – Subtropical Atlantic Forest; TAF – Tropical Atlantic Forest.
[2]Nature of exploitation: ES - selective exploitation; EI - intensive exploitation; WE - without exploitation.
[3]Point-centered quarter method and Standard error according to Krebs (1989).

Experimental design and field sampling

A first set of data was collected in the period of June to September 1999, in all 13 SDF remnants from all woody plants with diameter at breast height (DBH) ≥5 cm, namely DBH, total height (TH), and height at first bifurcation (HB). To sample the plants, the point-centered quarter method (PCQ) was used (KREBS, 1989). A second set of data was collected from January to March 2002, in five SAF and one TAF remnants, namely CCO, SOL, SVA, TIG, TUR, and SPA from plants of *S. bonplandii* of all growth stages, to characterise the natural regeneration of the species. The method of permanent rectangular sample plots was used to sample the plants; the sample plots (3 m x 30 m) were established systematically in equal distances of 30 m along the major diagonal of the remnant.

Data analysis

The sampling error 'e' of the parameter 'total number of plants per sample plot' was estimated according to the equation $n = (N t^2 S^2) / N (e\, m)^2 + t^2 S^2$, as proposed by Husch *et al.* (1982), where n = number of sample plots; N = possible number of plots in the area of investigation; S^2 and m are the variance and arithmetic mean of the evaluated parameter (e.g. number of plants), respectively; e = sampling error; and t = critical Student value of distribution (P ≥0.05, DF = n-1). In case of the PCQ-method, the sample error associated with the number of inventory points and plant density (plants ha^{-1}) was estimated based on the distances of the sampled trees from the inventory points, according to Pollard (1971) as referenced by Krebs (1989).

To deal with the spatial distribution of plants, the Morisita dispersion index had been used (MORISITA, 1959), defined as $I_{Mor} = n (\Sigma x^2 \quad N) / \{N (N \quad 1)\}$, where n = number of sample plots; Σx^2 = sum of the squares of the number of plants per plot; N = sum of the plants of all plots. According to Sakai and Oden (1983), the Morisita index is little influenced by the size of the plots and detects with excellent quality the degree of spatial dispersion of the species. Values of the index smaller than one represent random dispersion, values close to one indicate uniform dispersion, and values higher than one indicate grouped dispersion. Significant deviation from random distribution was tested by the comparison of F values, according to Morisita (1959): $F = (I_{Mor} (N - 1) + n – N) / (n - 1)$.

In addition, the chi-square test (χ^2 - contingency table), analysis of variance (ANOVA), and pairwise comparisons of means using Student-Newman-Keuls (SNK) test were performed to analyse the statistical significance of differences of height and diameter distributions among the remnants (BEIGUELMAN, 1991; SOKAL and ROHLF, 1995).

RESULTS

In order to evaluate the natural regeneration of the *S. bonplandii*, all individuals of this species were analysed in five SAF remnants and in one TAF remnant, using the method of sample plots. The generally large variation in numbers of plants per plot found in most remnants and the correspondingly large sampling error point to a uniformly clumped distribution of *S. bonplandii* (TABLE 2). This assumption is confirmed by calculating the Morisita spatial distribution index which significantly differs from one (1) in all remnants (TABLE 3).

A clumped distribution was found for all size classes of *S. bonplandii*, a species exhibiting typical seedling bank behaviour where more than two thirds of the plants were below one meter in height, and around 95% of all individual trees measured less than 5 m, while adult trees can grow to a total height of at least 14 m (TABLE 4). The absolute number of plants per hectare varied greatly, from 6,074 (TIG) to 1,834 (SVA) in the SAF-remnants, and some of the differences were statistically significant (TABLE 4). However, the relative distribution of all size classes of plants was statistically similar in all forest remnants, significant differences were mainly seen among the remnants when the taller trees (>5 m) were analysed separately (χ^2-test, P > 0.05). The overall relative distribution was even similar in the TAF-remnant (SPA) where *S. bonplandii* had a much lower density with less than 100 individuals per hectare.

Similarly, the relative distribution of trunk diameters (DBH) was similar in all remnants, including the TAF remnant (SPA) (FIGURE 2).

FIGURE 3A shows the typical 'inverted J' distribution of plants with DBH ≥5 cm over all 14 forest remnants, where the thickest trees measured 20 cm in DBH. The 'inverted J' distribution was also seen when plants of all size classes were included (FIGURE 2, TABLE 4). FIGURE 3B shows that among the trees with DBH ≥5 cm, 90.8% of the individuals measured between 3.1

and 9.0 m in height, with the tallest tree reaching 15 m. The first bifurcation usually occurred below 5 m (90.7%), but never below 1 m and never above 9 m.

Table 2. Data of the natural regeneration inventory of *Sorocea bonplandii* plants analysed in Atlantic Forest remnants in Southern Brazil. (Dados sobre o levantamento da regeneração natural de plantas de *Sorocea bonplandii* avaliadas em remanescentes da Floresta Atlântica, Sul do Brasil).

Remnant	Nr. of plots (90 m²)	Plants evaluated	Plants / plot			Error (%)*
			Mean[1]	Min	Max	
CCO	9	325	36.1 c	21	65	30
SOL	8	365	45.6 b	2	271	69
SVA	13	215	16.5 e	1	116	61
TIG	6	328	54.7 a	40	67	24.5
TUR	24	714	29.7 d	0	221	65
SPA	13	11	0.8 f	0	7	95

* According to Husch et al. (1982)
[1]Equal letters indicate no statistically significant difference (ANOVA, $F = 118.1$, $P < 0.001$, d.f. = 5, 67; SNK-test, $P > 0.05$).

Table 3. Morisita Index of dispersion, for the different total height classes of *Sorocea bonplandii* plants in Atlantic Forest remnants, Southern Brazil. (Índice de dispersão de Morisita, calculado para diferentes classes de altura total de *Sorocea bonplandii* em remanescentes da Floresta Atlântica, Sul do Brasil).

	Class of total height (h) in meters				
Remnant	h <0.5	0.5< h <2	2< h <5	h >5	Total
CCO	1.3 **	1.08^{ns}	1.17^{ns}	1.18^{ns}	1.11 **
SOL	1.81 **	1.67 **	1.06^{ns}	1.58^{ns}	1.57 **
SVA	2.03 **	1.76 **	3.2 **	3.14 *	1.87 **
TIG	1.19 **	1.27 *	1.15^{ns}	1.06^{ns}	1.03^{ns}
TUR	4.63 *	2.65 **	2.16 **	3.69 *	3.22 **
means	2.19 **	1.69 **	1.75 **	2.13 **	1.76 **
SPA	13.00 **	4.33^{ns}	-	-	5.44 **

significance of the difference from random distribution (Morisita index = 1): ns, not significant ($P > 0.05$); * significant at $P < 0.05$; ** significant at $P < 0.01$ (F-Test, Fisher-Snedecor)

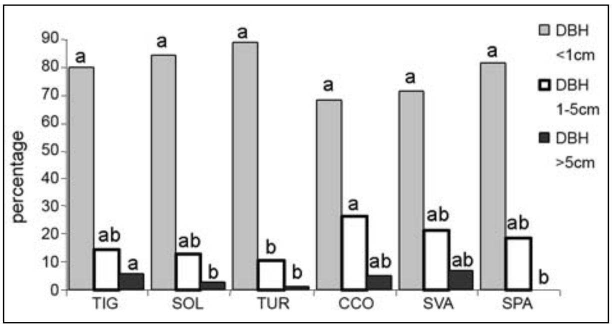

Figure 2. Relative distribution of *Sorocea bonplandii* plants for DBH classes in remnants of the Atlantic Forest in Southern Brazil. Bars with different superscript letters for the same DBH class differ significantly at $P > 0.05$, SNK-test. (Distribuição relativa das plantas de *Sorocea bonplandii* nas classes diamétricas em remanescentes da Floresta Atlântica, Sul do Brasil. Baras com letras diferentes dentro da mesma classe diamétrica diferem significativamente, $P > 0.05$, teste – SNK).

Table 4. Absolute density of *Sorocea bonplandii* plants (ha^{-1}) for the different total height classes, in five Atlantic Forest remnants, Southern Brazil. (Densidade absoluta (plantas ha^{-1}) de *Sorocea bonplandii*, observada nas diferentes classes de altura-total, em remanescentes da Floresta Atlântica, Sul do Brasil).

Height (m)	CCO	SOL	SVA	TIG	TUR	Means (%)	SPA
0 – 0.99	2741	3764	988	4111	2552	2831.2 (69.7)	59
1 – 1.99	346	528	479	704	366	484.6 (11.9)	17
2 – 2.99	346	278	94	352	194	252.8 (6.2)	9
3 – 3.99	222	222	85	167	97	158.6 (3.9)	0
4 – 4.99	148	111	68	333	46	141.2 (3.5)	0
subtotal[1] (%)[2]	3803^{a} $(94.8)^{abd}$	4903^{b} $(96.7)^{abd}$	1714^{c} $(93.5)^{cb}$	5667^{d} $(93.3)^{acbd}$	3255^{e} $(98.5)^{abde}$	868.4 (95.3)	85^{f} $(90.4)^{de}$
5 – 5.99	62	69	34	146	32	68.6 (1.7)	9
6 – 6.99	25	42	17	93	5	36.4 (0.9)	0
7 – 7.99	37	28	9	37	14	25.0 (0.6)	0
8 – 8.99	49	28	9	93	0	35.8 (0.9)	0
9 – 9.99	25	0	17	19	0	12.2 (0.3)	0
10 – 10.99	12	0	9	0	0	4.2 (0.1)	0
11 – 11.99	0	0	9	0	0	1.8 (0.0)	0
12 – 12.99	0	0	9	19	0	5.6 (0.1)	0
13 – 13.99	0	0	9	0	0	1.8 (0.0)	0
subtotal[1] (%)[3]	210^{a} $(5.2)^{a}$	167^{bf} $(3.3)^{bd}$	120^{c} $(6.6)^{c}$	407^{df} $(6.7)^{bd}$	51^{ef} $(1.5)^{e}$	191.4 (4.7)	9^{bdef} $(9.6)^{f}$
total[1]	4013^{a} $(100)^{a}$	5070^{b} $(100)^{a}$	1834^{c} $(100)^{a}$	6074^{d} $(100)^{a}$	3306^{e} $(100)^{a}$	4059.8 $(100)^{a}$	94^{f}

[1] Equal superscript letters indicate no statistically significant difference to the corresponding remnants ($P > 0.05$, χ^2–test for relative densities).
[2,3] percentage of the total plants per forest remnant, for the plants with h <5 m ([2]) and h >5 m ([3]).

An interesting but common observation was the death of the apical shoot top which was apparent in up to 10% of the trees (SVA = 9.8, CCO = 6.2, SOL = 2.2, TUR = 1.0, TIG = 0.6, SPA = 0.0). This mortality of the apex was not related to the plant height.

The density of *S. bonplandii* plants with DBH ≥5 cm in the thirteen SAF remnants varied greatly, from 14.7 to 147.6 plants ha^{-1}, with an average of 77.0 (±41.4) plants ha^{-1}. Thus, around 10% of all individual shrub-arboreal forest plants belonged to the species *S. bonplandii* (TABLE 5). In contrast, only 0.43% of the woody plants belonged to that species in the TAF remnant, SPA.

Table 5. Absolute density (AD, plants ha^{-1}) and relative density (RD) of *Sorocea bonplandii* plants in the arboreal community of Atlantic Forest remnants, Brazil. (Densidade absoluta (AD, plantas ha^{-1}) e densidade relativa (RD) de *Sorocea bonplandii* na comunidade arbórea em remanescentes da floresta Atlântica, Brasil).

Location[1]	Method[2]	DBH (cm)	AD(ha^{-1})	RD	Author
SAF - CAP-SC	PCQ	≥ 5	26.5	3	Present Study
SAF - PIR-SC	PCQ	≥ 5	94.6	10.8	Present Study
SAF - SOL-SC	PCQ	≥ 5	127.4	13.8	Present Study
SAF - TUR-RS	PCQ	≥ 5	72.1	8.2	Present Study
SAF - CCO-SC	PCQ	≥ 5	147.6	14.6	Present Study
SAF - IBI-SC	PCQ	≥ 5	120.1	11.5	Present Study
SAF - INE-SC	PCQ	≥ 5	83.3	12.5	Present Study
SAF - IPO-SC	PCQ	≥ 5	14.7	4.7	Present Study
SAF - SVA-SC	PCQ	≥ 5	42.7	6.3	Present Study
SAF - TIG-SC	PCQ	≥ 5	112.6	16.4	Present Study
SAF - BRO-SC	PCQ	≥ 5	59.2	6.5	Present Study
SAF - CSE-SC	PCQ	≥ 5	75.7	17.4	Present Study
SAF - ITA-SC	PCQ	≥ 5	19.6	3.9	Present Study
mean ± SD			77 (±41.4)	9.97 (±4.2)	Present Study
SAF - TUR/RS [3]	PCQ	≤ 10	-	28.97	Dias *et al*. (1992)
		≥ 10	-	16.12	
	PM	≥ 10	41	10.02	
SAF – RS	PM	≤ 3.2	2,222	6.41	Nascimento *et al*. (2000)
		≥ 3.2	225	6.59	
SAF – RS	PM	≥ 5	255	13.74	Jarenkow and Waechter (2001)
FMS – RS	PM	≥ 5	122	5,46	Jurinitz and Jarenkow (2003)
SAF - Argentina	PM	≥ 10	0.083	0.026	Cristóbal *et al*. (1996)
SAF - Argentina	PM	≥ 5	231	12.45	Placci *et al*. (1992)
FMS - SP	PM	≥ 4.8	3	0.12	Ivanauskas *et al*. (1999)
FMS - SP	PCQ	≥ 10	8	0.94	Silva and Leitão-Filho (1982)
FMS - SP	PM	≥ 3 ≤ 15	128	0.6	Salis *et al*. (1996)
FMS - MG	PM	≥ 5	1	0.065	Vilela *et al*. (2000)
FMS - MG	PM	≥ 5	2.7	0.2	Santos *et al*. (2003)
FOM - PR	PM	≥ 5	25	1.57	Dias *et al*. (1998)
TAF –ROU/SC	PM	≤ 3	72.7	0.64	Veloso and Klein (1959)
		≥ 3	55.9	0.49	
TAF - AZA/SC	PM	≤ 3	22	0.33	
		≥ 3	10.8	0.17	
TAF – SAP/SC	PM	≤ 3	4.9	0.05	
		≥ 3	2.4	0.03	
TAF – MUE/SC	PM	≤ 3	117.4	2.3	
		≥ 3	102.3	2	
TAF – MAL/SC	PM	≤ 3	407	2.3	
		≥ 3	40.5	0.2	
TAF – SPA/SC	PM	≥ 5	6.7	0.43	Mantovani *et al*. (2005)
TAF/SPstatt	PM	≥ 15.9	6	1.9	Dislich *et al*. (2001)
TAF/SPstatt	PM	≥ 2.5	-	1.24-0.8	Melo, (2000)

[1] forest ecosystem - name of remnant-federal state or country: SAF, Seasonal-Deciduous-Forest; FMS, Semi-Deciduous Mesofila Forest; FOM, Araucarie Atlântic Forest; TAF, Ombrophylous-Dense-Forest. ROU, Ribeirão do Ouro; AZA, Azambuja; SAP, São Pedro; MUE, Mueller; MAL, Maluche. SC, Santa Catarina; RS, Rio Grande do Sul; SP, São Paulo; MG, Minas Gerais; PR, Paraná; [2] PM, method of sample plots; PCQ, point-centered quarter method; [3] total height > 1 m

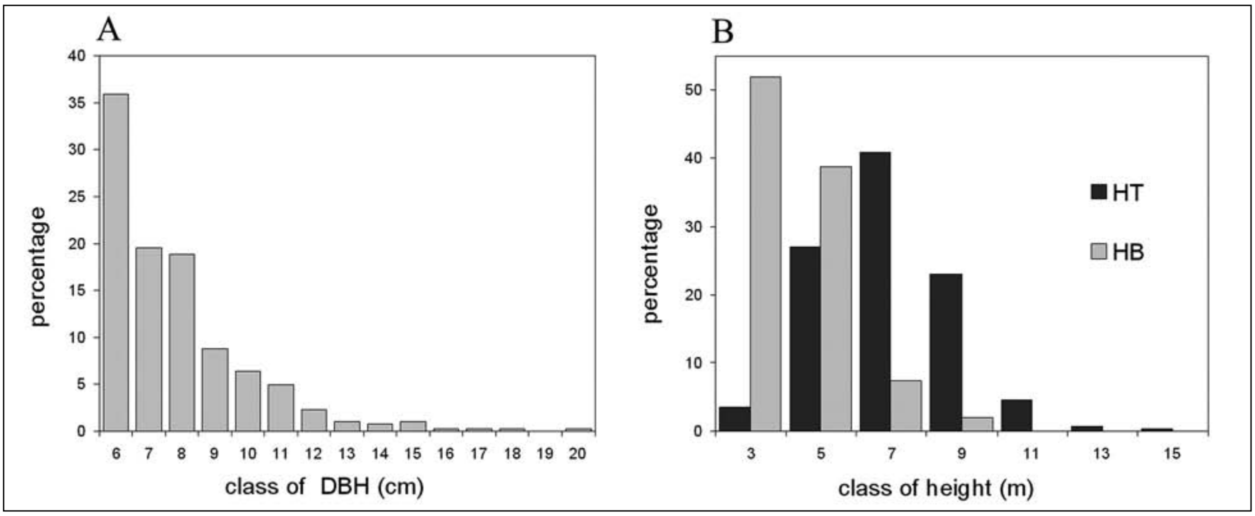

Figure 3. Relative distribution of the *Sorocea bonplandii* plants (DBH ≥5 cm) in remnants of the Atlantic Forest in Southern Brazil: A) concerning classes of diameter (DBH, cm); B) concerning classes of total height (HT, m) and concerning classes of height of the first branch (bifurcation, HB, m). (Distribuição relativa das plantas de *Sorocea bonplandii* com DBH ≥5 cm, em remanescentes da Floresta Atlântica, Sul do Brasil: A) com base em classes diamétricas (DBH - cm); B) com base em classes de Altura total (HT - m) e com base em classes de altura do primeiro ramo (bifurcação,HB - m)).

DISCUSSION

The sustainable management of natural forest species depends on the knowledge of their structure and dynamics (FANTINI *et al.*, 1992; GARTLAND *et al.*, 1994; MARTINEZ-RAMOS and ALVAREZ-BUYLLA, 1995; REIS *et al.*, 2000). To develop a management plan for a forest species ensuring maintenance of population stability, basic criteria need to be known. However, while much knowledge is available on the floristic composition of forest communities, little is known of the population patterns of individual species. The ecological or commercial value of a species is the most critical information to priorize a species to be studied. Were therefore opted for a detailed demographic analysis - to be followed by a genetic study - on *S. bonplandii* in the Subtropical Atlantic Forest (SAF).

As found in previous studies (see introduction), it was found that *S. bonplandii* is a species of wide distribution in the Atlantic Forest in Southern Brazil, Argentina, and Paraguay. Outside its typical appearance in the SAF-ecosystem where this tree reaches high plant densities up to almost 18%, *S. bonplandii* occurs from Minas Gerais State to Rio Grande do Sul State in altitudes ranging from sea level to 1500 m (LORENZI, 1998; CARVALHO *et al.*, 2000; THE NEW YORK BOTANICAL GARDEN, 2003; SANTOS *et al.*, 2003). However, it is much less frequent (< 2.5%) in the TAF and other Atlantic Forest ecosystems (TABLE 5), rendering it more prone to genetic erosion there. Clearly, the dominance of *S. bonplandii* represents a differential feature of the SAF ecosystem. *S. bonplandii* and *Ginnanthes concolor* Müell. Arg. unambiguously characterize the subcanopy stratus of this ecosystem (RAMBO, 1956; KLEIN, 1972; GONZALENZ TORES, 1986; DIAS *et al.*, 1992; PLACCI *et al.*, 1992; SOUZA, 2001; Ruschel A.R. *et al.* 2006).

S. bonplandii exhibits a grouped or cluster spatial distribution, with uniformly distributed, continuous groupings. Within a given forest remnant, the Morisita index was similar for all height classes, but it differed somewhat between remnants. The Morisita index was highest in "Parque Estadual Turvo", the only intact forest remnant of the SDF ecosystem, indicating that a grouped distribution is natural for this species. Such a conspicuous grouping of plants by species can be caused by a number of reasons, such as the type of seed dispersion, natural gap dynamics of the forest, and edafic gradients (JANZEN, 1970; ALVAREZ-BUYLLA and MARTINEZ-RAMOS, 1992; GENTRY, 1998; GIVNISH, 1999; ARAÚJO *et al.*, 2004).

In addition, the distribution of the *S. bonplandii* plants across the different height classes followed the pattern of an inverted "J" curve, suggesting seedling bank behaviour. Such a behaviour in natural regeneration had been described previously for *Euterpe edulis* (Mart.) (REIS *et al.*, 2000), and for a number of other species, including *S. bonplandii* (ARAÚJO *et al.*, 2004) where seedling banks but not seed banks were detected.

It is unclear whether the high frequency of plants with a necrotic apical shoot top - a phenomenon seen in all plant height classes and in most forest remnants - represents a natural behaviour of the species, whether it has a genetic basis, or effect of climate conditions, whether it is caused by anthropogenic action.

S. bonplandii - among other non-timber species such as *Maytenus ilicifolia* Mart. Reiss, *Piper cernuum* Vell., *Rauwolfia sellowii* Müell. Arg., *Casearia sylvestris* Sw., *Bauhinia forficata* Link., and *Picrasma crenata* Engler - possesses commercial value in the traditional medicine as well as for the phytotherapy industry (MÜLLER and AIRES, 1935; HILL *et al.*, 1984; VILEGAS *et al.*, 1998; CHAZDON and Coe, 1999; REIS *et al.*, 2000; KELLER, 2001; MARIOT *et al.*, 2002). In addition, in the same ecosystem of *S. bonplandii*, several timber species of high commercial value occur (RAMBO, 1956; KLEIN, 1972; GARTLAND *et al.*, 1994; CALDATO *et al.*, 2002; RUSCHEL *et al.*, 2003, 2005). Clearly, the SAF ecosystem merits further studies to establish a management and conservation plan allowing sustainable uses and, thus, protection. Further studies might also include ecological aspects such as the spatial distribution and ratio of male and female plants, annual growth, and reproductive aspects (flowering, fruit set, seed production and seedlings, agents of pollination and seed dispersion).

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