27/02

UNIVERSIDADE ESTADUAL DE CAMPINAS

INSTITUTO DE BIOLOGIA

SECRETARIA
DE
PÓS-GRADUAÇÃO
I. B.

LEANDRO TAVARES VIEIRA

PADRÕES GEOGRÁFICOS E ESTRUTURA DE COMUNIDADE DO ESTRATO HERBÁCEO DA MATA ATLÂNTICA MERIDIONAL

Este exemplar corresponde à redação final
da tese defendida pelo(a) candidato (a)
Leandro Tavares Vieira

e aprovada pela Comissão Julgadora.

Fernando R. Martins
27/02/2008

Dissertação apresentada ao Instituto de Biologia de Universidade Estadual de Campinas, para a obtenção do título de Mestre em Ecologia.

Orientador: Prof. Dr. Fernando Roberto Martins

Campinas
2008

FICHA CATALOGRÁFICA ELABORADA PELA
BIBLIOTECA DO INSTITUTO DE BIOLOGIA – UNICAMP

Vieira, Leandro Tavares
V673p Padrões geográficos e estrutura de comunidade do estrato herbáceo da Mata Atlântica meridional / Leandro Tavares Vieira. – Campinas, SP: [s.n.], 2008.

Orientador: Fernando Roberto Martins.
Dissertação (mestrado) – Universidade Estadual de Campinas, Instituto de Biologia.

1. Comunidades vegetais. 2. Estacionalidade. 3. Mata Atlântica. 4. Biodiversidade. 5. Biogeografia. I. Martins, Fernando Roberto. II. Universidade Estadual de Campinas. Instituto de Biologia. III. Título.

(rcdt/ib)

Título em inglês: Geographic patterns and community structure of herbaceous layer of meridional Atlantic Forest.
Palavras-chave em inglês: Plant communities; Seasonality; Mata Atlântica (Brazil); Biodiversity; Biogeography.
Área de concentração: Ecologia.
Titulação: Mestre em Ecologia.
Banca examinadora: Fernando Roberto Martins, Rafael Silva Oliveira, Rosemary de Jesus de Oliveira.
Data da defesa: 27/02/2008.
Programa de Pós-Graduação: Ecologia.

Campinas, 27 de fevereiro de 2008.

Profº Dr. Fernando Roberto Martins Fernando R. Martins

Profº Dr. Rafael Silva Oliveira Rafael S. Oliveira

Profª Drª. Rosemary de Jesus de Oliveira Rosemary de J. Oliveira

Profº Dr. Flavio Antonio Maës dos Santos ____________________

Profº Dr. Marco Antonio de Assis ____________________

“*Aprender é a única coisa de que a mente nunca se cansa, nunca tem medo e nunca se arrepende*”.

Leonardo da Vinci (1452-1519)

Agradecimentos

À CAPES pela bolsa de estudos e à FAPESP pelo suporte financeiro para a realização do projeto.

Um agradecimento especial ao professor Fernando Roberto Martins pela dedicada orientação, confiança e amizade.

Aos membros da pré-banca e banca pelas preciosas sugestões: Rafael Oliveira, Rosemary de Oliveira, Marco Assis e Vanilde C. Zanette.

Aos grandes professores do Programa de Pós-Graduação em Ecologia e da Biologia Vegetal: Flávio Santos, João Semir, Jorge Tamashiro, Carlos Joly, Rafael Oliveira, André Freitas, Ricardo Rodrigues, Sergius Gandolfi, Marlies Sazima, Thomas Lewinsohn, Woodruff Benson, Vera Solferini, George Shepherd e tantos outros que tanto contribuíram para a evolução do meu pensamento científico, mesmo que tenha sido por breves momentos. “Eram os deuses astronautas?”.

À Ligia Sims pelo louvável auxílio em campo e ao Luciano Pereira pelo auxílio em campo e nas identificações das plântulas.

Ao Tamashiro Sama pela enorme ajuda na identificação das espécies, principalmente com os indivíduos de 2 cm de altura com apenas uma folha carcomida e ao João Semir pelo auxílio com as herbáceas em geral.

Aos especialistas de algumas famílias, que alguns eu nem cheguei a conhecer, mas que colaboraram muito para que o máximo de espécies fosse identificado. São eles: Ana Paula Santos Gonçalves (Poaceae); Washington Marcondes-Ferreira (Apocynaceae); Edson Dias da Silva (Fabaceae); Marcos José da Silva (Fabaceae); Itayguara Ribeiro da Costa

(Myrtaceae); Tiago Domingos Mouzinho Barbosa (Lauraceae); Marco Assis (Bignoniaceae); Júlio Lombardi (Hippocrateaceae); Juan Domingo Urdampilleta (Sapindaceae).

À Célia, pelo seu profissionalismo exemplar acompanhado de um carinho todo especial com que trata todos os alunos da Ecologia.

Aos funcionários e administradores do Condomínio Colinas do Atibaia.

Ao pessoal do transporte: João Batista Santos, Carlinhos e Joaquim que foram de uma simpatia e comprometimento insuperáveis.

À todos os amigos que também ajudaram muito na identificação das espécies: Bruno Aranha, Guilherme Aguirre, Leonardo Meirelles, Arildo Dias, Juliano van Melis, André Rochelle.

Aos meus amigos contemporâneos de curso: Alexandre, Carlão, Sebastian, Gui Becker, Mônica, Gui Aguirre, Carol, Kamila, Marcela, Leonardo, Fernanda, Shirley, Joana, Vanessa.

Aos amigos do laboratório. Vou me esforçar para não esquecer de ninguém: Júlia (esta mereceria um parágrafo só pra ela), Priscila, Alessandra, Rafael, Bruno Aranha, Bruno Rosado, Pedro, Ligia, André, Arildo, Juliano, Christiane, Carina, Carol Scultori, Carol Virillo, Roque, Sandro, Silvana, Rose, Rosemary, Larissinha, Larissão, Maíra, Mari Cruz, Mariana, Fabíola, Viviane, Antônio, Archimedes, Marisa, Cristina, Luciano.

Aos amigos da ecologia e da taxonomia: Henrique, Lucas, Adriana, Marina, Gaby, Paulo Henrique, Rafael, Leonardo, Roberta, André, Rubão, João Aranha, Cátia, Marcelinho, Gustavo, Tiago, Leo.

Aos meus amigos da vida, que são muitos, mas pensei em cada um nesse momento. Alguns longe, outros perto, mas todos são importantes para mim.

Aos meus eternos amigos de infância, os quais eu amo muito e sem eles como uma referência tudo ficaria dez mil vezes mais difícil: Eduardo, Diogo, Danilo, Fernando, Lana Angelina, Luciana, Paulo César, Helen, Henrique e Juliana, Priscila, Luciana Diehl, Paulo Henrique, Rafael, Natália, e um agradecimento especial ao Luciano, pois sem sua ajuda este sonho não teria nem começado. À eles dedico esta dissertação juntamente com minha família.

À minha família, meu irmão Ricardo, meus avós, tios, primos que tanto me ajudaram de todas as formas possíveis em todos estes anos.

Agradeço com todo meu amor aos meus pais, João e Beth, que são meus exemplos, meus guias, meus heróis.

ÍNDICE

RESUMO

A Mata Atlântica vem experimentando alguns séculos de contínua devastação. O resultado deste processo é que, atualmente, restam cerca de 92.000 km^2 ou apenas 7,5% da cobertura original, na maioria em pequenos fragmentos disjuntos. Muitas espécies e informações já estão extintas antes mesmo de serem conhecidas. Por exemplo, muito pouco se conhece a respeito do estrato herbáceo, e estudos do estrato arbóreo ainda são insuficientes para responder muitas questões sobre a origem e os limites da Mata Atlântica, a estrutura comunitária e seus condicionantes, e os efeitos de fatores ambientais em sua composição. O termo "estrato herbáceo" foi empregado neste trabalho de acordo com duas principais definições: como um conjunto de plantas abaixo de uma certa altura, no primeiro capítulo; e para incluir certos tipos de formas de vida ou crescimento, no segundo capítulo. O primeiro capítulo foi realizado na Mata Ribeirão Cachoeira, SE Brasil (22º50' S - 46º55' O, 680 m de altitude), um fragmento da Floresta Estacional Semidecídua, caracterizada por um verão úmido e um inverno seco durante o qual cerca de 30% das árvores perdem suas folhas. Buscamos testar a hipótese de que a vegetação rasteira (plantas vasculares até um metro de altura) está constantemente sob condições restritivas devido a uma dupla estacionalidade: restrição de luz na estação chuvosa e restrição de água na estação seca. A maioria dos descritores da comunidade apresentou valores significativamente maiores na estação chuvosa, indicando que a água no solo parece ser mais restritiva para a vegetação rasteira do que a disponibilidade de luz. Os valores de cobertura significativamente maiores na estação chuvosa poderiam indicar que muitas espécies do estrato rasteiro perdem pelo menos parcialmente suas folhas durante a seca. Entretanto, a ordenação das parcelas pela

DCA indicou que essas diferenças não são muito grandes e que a comunidade permanece similar nas duas estações, corroborando parcialmente nossa hipótese. No segundo capítulo, buscamos testar a hipótese de que a flora do estrato herbáceo (espécies herbáceas terrestres) apresenta o mesmo padrão de distribuição que a flora arbórea, que sabidamente varia em gradientes associados à latitude, longitude e altitude. Para isso utilizamos metadados florísticos e computamos 947 espécies do estrato herbáceo em 41 locais de Mata Atlântica do sul e sudeste do Brasil. Classificamos as amostras como Floresta Ombrófila de Terras Baixas, Floresta Ombrófila ou Estacional Submontana e Montana. Consideramos uma matriz binária de 304 espécies distribuídas em 39 locais, na qual foram realizadas análises de ordenação e de agrupamento. Todas as análises distinguiram três centros florísticos: Floresta Estacional, Floresta Ombrófila de Terras Baixas e Floresta Ombrófila de Terras Altas (florestas Submontana e Montana juntas). Assim, o padrão de distribuição do estrato herbáceo é diferente daquele encontrado para a flora arbórea. Isto pode indicar que as espécies do estrato herbáceo são muito especializadas e que elas foram submetidas a processos biogeográficos diferentes daqueles que agiram sobre a flora arbórea. Este trabalho mostra a grande importância do estrato herbáceo para a compreensão dos efeitos da sazonalidade em Florestas Estacionais e dos processos biogeográficos na Mata Atlântica.

Palavras-chave: Comunidades vegetais, estacionalidade, Mata Ribeirão Cachoeira, biodiversidade, biogeografia.

ABSTRACT

The Brazilian Atlantic Forest has been experiencing some centuries of a continuous devastation. The result of this process is that today the Atlantic Forest is restricted to *ca.* 92,000 km² or 7.5% of its original area, mostly in disjunct fragments. Many species and information have already gone extinct before they were known. For example, very little is known about the herb layer, and studies done on the tree component are still insufficient to answer many questions about the origin and boundaries of the Atlantic Forest, community structure and its conditioners, and the effects of abiotic factors on their composition. In our study we used the term “herbaceous layer” according to its two main definitions: as a set of plants below a certain height, in the first chapter; and as a set of plants with a similar life-form or growth habit, in the second chapter. The first chapter was carried out in the Ribeirão Cachoeira Forest, SE Brazil (22º50' S - 46º55' W, 680 m a.s.l.), a Tropical Semideciduous Seasonal Forest characterized by a rainy summer and dry winter in which around 30% of the trees shed their leaves. Our aim is to test the hypothesis that the ground layer is faced with year-long restraining conditions due to a double seasonality: light restriction in the rainy season and water restriction in the dry season. Most community descriptors had significantly higher values in the rainy season, thus indicating that water shortage seems to be more restrictive to the ground layer than light availability. Significantly higher values of cover observed in the rainy season could indicate that some species in the ground layer lose at least partilly their leaves in the dry season. On the other hand, plot ordination through DCA indicated that these differences were not very large, and that the community remained similar in both rainy and dry season. In the second chapter, our aim was to test the hypothesis that the herb layer flora has the same geographic pattern of the tree flora, which continuously varies in gradients associated with latitude, longitude, and altitude. We used floristic metadata and computed 947 species of 41 samples of the herb layer taken from the Atlantic Forest in southern and southeastern Brazil. We classified the samples as Lowland Rainforest, Submontane and Montane Rainforest or Seasonal Forest. We considered a binary matrix of 304 species distributed in 39 sites, and performed ordination and cluster analyses. All analyses distinguished three floristic centers: Seasonal Forest, Lowland Rainforest, and Upland Rainforest (Submontane and Montane forests pooled together). Thus, the geographic pattern of the herb layer flora is quite different from that of the tree flora. This could indicate that herb layer species are very specialized and were subjected to biogeographic processes that were different from those acting upon the tree flora. This work shows the great importance that the herbaceous layer has in the understanding of seasonality effects on tropical forests and in the higlighting of biogeographic processes in the Brazilian Atlantic Forest.

Key-words: Plant communities, seasonality, Ribeirão Cachoeira forest, biodiversity, biogeography.

INTRODUÇÃO GERAL

Mata Atlântica

Antes do estabelecimento europeu na região litorânea do Brasil, a Mata Atlântica (*sensu lato*; Joly *et al.* 1992, Rizzini 1997) cobria de 1 a 1,5 milhão de km^2, estendendo-se do estado do Rio Grande do Sul ao estado do Rio Grande do Norte (Fonseca 1985, Viana & Tabanez 1996). Como logo o processo de colonização e ocupação do território brasileiro se desenvolveu nas regiões próximas ao litoral, a Mata Atlântica vem experimentando alguns séculos de contínua devastação. O resultado desse processo é que, no momento, existem apenas fragmentos disjuntos da floresta, particularmente em locais de topografia muito acidentada que impede qualquer atividade agrícola (Leitão-Filho 1987). Atualmente restam cerca de 92.000 km^2 ou apenas 7,5% da cobertura original (Myers *et al.* 2000). Estima-se que existam na Mata Atlântica 20.000 espécies de plantas, sendo 8.000 delas endêmicas, o que corresponde a 2,7% das plantas endêmicas existentes no planeta, daí ser a Mata Atlântica considerada um dos 25 "hot spots" de diversidade do mundo e o quarto em importância de endemismo de plantas (Myers *et al.* 2000).

A Mata Atlântica *s.l.* apresenta uma grande de diversidade de formações florestais influenciadas por variações climáticas, topográficas e edáficas que ocorrem ao longo de sua área de distribuição (Leitão-Filho 1987). O sistema de classificação da vegetação brasileira (Veloso *et al.* 1991) distingue cada formação florestal da Mata Atlântica de acordo com características climáticas, topográficas e vegetacionais. No primeiro capítulo, estudamos uma área num fragmento da Floresta Estacional Semidecídua no município de Campinas, estado de São Paulo. No segundo capítulo, reunimos levantamentos florísticos do estrato herbáceo feitos no sul e sudeste brasileiro e classificamos as formações da Mata Atlântica de acordo com Veloso *et al.* (1991).

Mata Ribeirão Cachoeira – Floresta Estacional Semidecídua

A Mata Ribeirão Cachoeira tem uma área total de 245 ha, está inserida na Área de Proteção Ambiental (APA) dos subdistritos de Souzas e Joaquim Egídio e pertence ao condomínio rural Colinas do Atibaia (Figura 1). Situa-se na porção nordeste do município de Campinas (22°50’13’’S - 46°55’58’’W), com um de seus vértices tangenciando as margens do rio Atibaia (Miranda, 1996; Santin 1999). As altitudes variam de 630 a 760m. O relevo é constituído por morros, morrotes e morrotes paralelos com declividades de 12 a 30%. O solo predominante é do tipo Argissolo (EMBRAPA 1999). O clima é Cwa de Koeppen, com uma estação quente e chuvosa de outubro a março, com temperaturas médias mensais entre 23,2 ºC e 24,6 ºC e precipitação média total de 1143,3 mm; e uma estação seca de abril a setembro, com temperaturas médias mensais entre 18,9 ºC e 22,8 ºC e precipitação média total de 272,9 mm (período de observação: 1993-2006, CIIAGRO 2007). Ao longo de sua porção meridional corre o Ribeirão Cachoeira, um riacho de substrato rochoso que forma numerosas corredeiras e pequenos saltos. A vegetação é densa, com altura de dossel variando entre 15 a 25m e árvores emergentes de mais de 30m. A floresta também é conhecida por Mata da Fazenda Embaúba, Mata das Três Pontes, Mata da Fazendinha e Japizinho (Santos & Kinoshita, 2003).

Trata-se do segundo maior fragmento florestal do município de Campinas e, seguramente, o mais bem conservado. Seu melhor estado de conservação pode ser devido a fatores relativos à sua localização e histórico. A APA em que está inserido apresenta apenas 4,93%, de sua área total (223km²), ocupada por manchas urbanas, todo o restante corresponde a áreas agrícolas (8,35%), reflorestamentos e fragmentos florestais com diferentes graus de perturbação (39,25%) e pastos (47,42%). A industrialização na APA conta com apenas dois estabelecimentos dentro da área urbana de Souzas. As atividades econômicas limitam-se a serviços de atendimento local, à cultura (patrimônio histórico) e lazer. O tráfego de veículos automotores é mais restrito, pois existem poucas estradas e vias de acesso, que são em sua maioria de pequeno porte e não pavimentadas, o que diminui a emissão de poluentes no ar e na água (Miranda, 1996).

Seu entorno também é menos sujeito às situações impactantes. Os lotes do condomínio Colinas do Atibaia têm área mínima de 20.000 m², e a maior parte dos já ocupados corresponde a chácaras de fim de semana. O acesso ao condomínio é restrito a moradores e proprietários, o que reduz os riscos de alteração da composição original como colonização por espécies exóticas trazidas por moradores e riscos de incêndio acidental ou proposital. A ausência de agricultura no entorno da mata também favorece sua conservação, salvando-a de pesticidas e queimadas (Miranda, 1996). Seu tamanho e forma apresentam uma relação comprimento/largura de aproximadamente 2:1, o que significa uma baixa razão borda/interior e, portanto, menor fração de área sob efeito de borda (Forman & Godron, 1986; Harris, 1984).

Estrato Herbáceo

Viajando pela África em 1870, G. A. Schweinfurth observou no dossel da floresta o que hoje seria próximo aos termos "estratificado" e "caótico" (Parker & Brown 2000). Mais tarde, o naturalista e geógrafo alemão Alexander von Humboldt, em suas explorações científicas pelos Andes e Amazônia, descrevia essas florestas tropicais como uma "floresta sobre uma floresta", onde cada camada constitui um habitat específico para animais e plantas que nela vivem. Dessa forma, uma floresta tropical sustenta várias comunidades bastante diferenciadas entre si (Richards 1996).

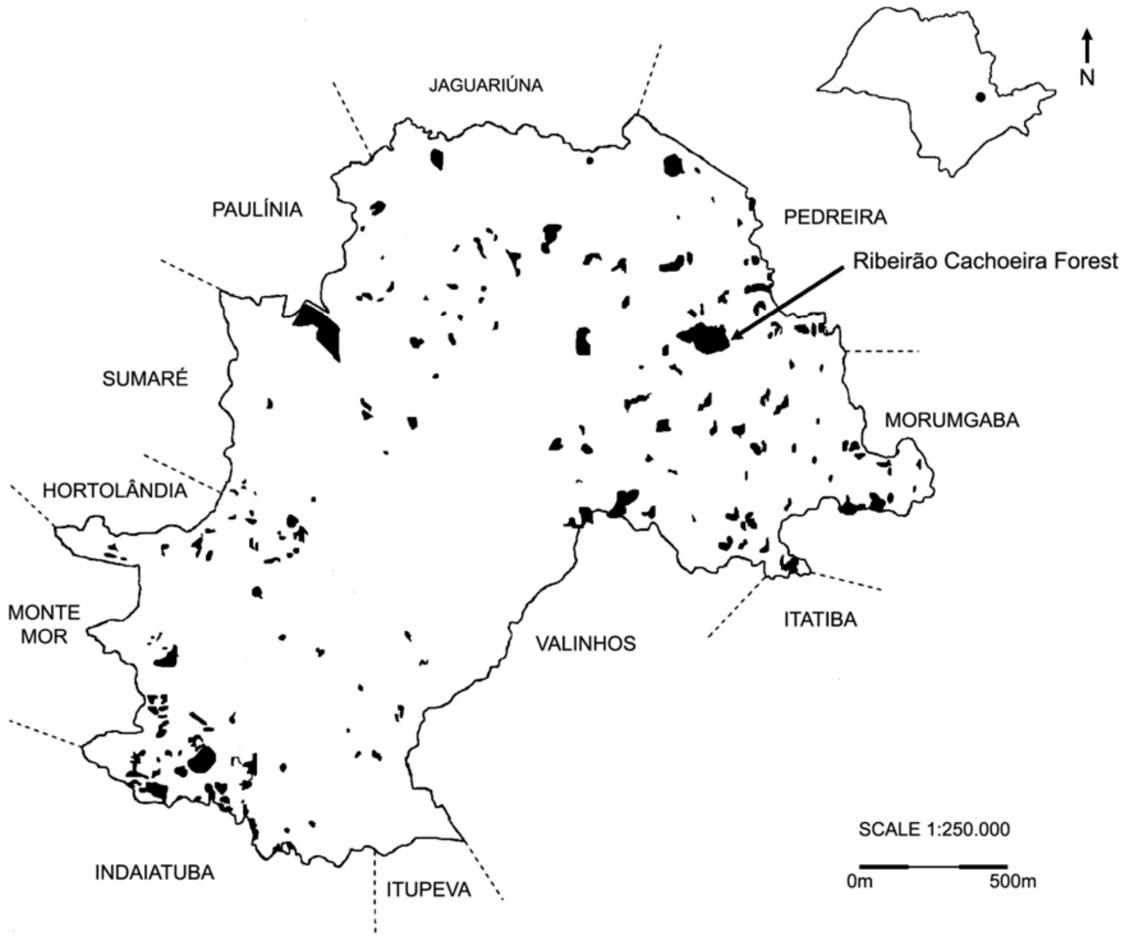

Figura 1. Mapa da cobertura vegetal do município de Campinas, destacando a Mata Ribeirão Cachoeira. Extraído e modificado de Santin (1999).

Estudos com o estrato herbáceo ainda são muito escassos no Brasil, e os poucos que existem estão concentrados nas regiões sul e sudeste. A definição de estrato herbáceo é também muitas vezes confundida, variando de autor para autor ou com o objetivo pretendido. Parker & Brown (2000) fizeram uma revisão do uso do termo estratificação e encontraram dez diferentes definições. As duas definições mais comuns em estratos inferiores de floresta, e empregadas neste trabalho, são: (1) como um grupo de plantas com uma certa altura, em que a floresta é dividida em estratos de acordo com uma altura determinada pelos autores; ou (2) como um grupo de plantas com formas de vida ou hábitos semelhantes. Na língua portuguesa, essas duas definições ficam pouco claras à primeira vista, pois em ambos os casos há o emprego do termo "estrato herbáceo", porém em inglês, essa distinção é facilmente reconhecida como "ground layer" e "herb layer", respectivamente. No primeiro capítulo utilizamos a primeira definição, também chamada de "vegetação rasteira"; no segundo capítulo, fazendo menção à forma de crescimento da planta, utilizamos a segunda definição, "estrato herbáceo".

a) Vegetação Rasteira

A valorização ecológica dos estratos inferiores e de outras formas de vida ou hábitos de crescimento que não as arbóreas teve um impulso com o trabalho de Gentry & Dodson (1987), no qual afirmam que espécies arbóreas (DAP ≥ 10cm) constituem somente 15 a 22% do total das espécies em florestas neotropicais, sendo o restante das espécies representado por lianas, epífitas, ervas, arbustos e pequenas árvores que nunca atingem um DAP ≥ 10cm. Estudos sobre composição e estrutura da comunidade dos indivíduos jovens de espécies arbóreas e sua interação com outros elementos que compartilham nichos semelhantes indicaram que eles podem oferecer informações mais diretas e precisas sobre a dinâmica das formações florestais do que as obtidas somente com estudos do componente arbóreo (Bernacci, 1992). Espécies de estratos inferiores são sensíveis às mudanças climáticas e edáficas, às características do estrato arbóreo e aos distúrbios antrópicos, mostrando alterações na riqueza específica e na densidade populacional (Veblen *et al.* 1979, Poulsen 1996, Turner *et al.* 1996).

b) Estrato Herbáceo

Segundo Mantovani (1987), há um número limitado de espécies herbáceas terrestres no interior de florestas, pois as condições ambientais peculiares exigem um alto grau de especialização. As plantas herbáceas de florestas apresentam adaptações estruturais e fisiológicas de sobrevivência interessantes, refletindo as condições ambientais em que vivem (Richards 1996). Espécies herbáceas poderiam ser utilizadas como indicadoras de condições ambientais, pois devido ao seu pequeno porte e sistema radicular superficial, estão submetidas a maior competição, tornando-se particularmente sensíveis às diferenças do ambiente (microclima e solo), às quais os vegetais de maior porte não manifestariam reação (Citadini-Zanette 1984; Citadini-Zanette & Baptista 1989), porém o entendimento do papel ecológico dessas espécies ainda é incipiente. À medida que estudos com plantas herbáceas vêm sendo executados, cria-se uma expectativa de valorização desse estrato, já que ele constitui um banco genético com grande número de espécies, e particularmente, com grande variedade de formas de vida.

Objetivos

O primeiro capítulo objetivou analisar o efeito de uma dupla sazonalidade sobre a vegetação rasteira num fragmento da Floresta Estacional Semidecídua. Nossa hipótese é que a vegetação rasteira estaria constantemente sob condições restritivas ao longo do ano devido a restrições de água edáfica na estação seca e a restrições de luz em decorrência do fechamento do dossel na estação chuvosa.

No segundo capítulo buscamos investigar a distribuição geográfica de espécies herbáceas na Mata Atlântica do sul e sudeste do Brasil. Nosso objetivo foi testar a hipótese de que a flora do estrato herbáceo apresenta o mesmo padrão geográfico que a flora arbórea, que varia continuamente em gradientes associados à latitude, longitude e altitude.

Referências

Bernacci, L. C. (1992) *Estudo florístico e fitossociológico de uma floresta no município de Campinas, com ênfase nos componentes herbáceo e arbustivo.* Dissertação de mestrado, Instituto de Biologia, Universidade Estadual de Campinas, Campinas.

CIIAGRO (2007) *Boletim Climático: Campinas. Centro Integrado de Informações Agrometeorológicas* - Instituto Agronômico de Campinas, Campinas.

Citadini-Zanette, V. & Baptista, L.R.M. (1989) Vegetação herbácea terrícola de uma comunidade florestal em Limoeiro, município de Torres, Rio Grande do Sul, Brasil. *Boletim do Instituto de Biociências da UFRGS*, **45**, 1-87.

Citadini-Zanette, V. (1984) Composição florística e fitossociologia da vegetação herbácea terrícola de uma mata de Torres, Rio Grande do Sul, Brasil. *Iheringia*, **32**, 23-62.

EMBRAPA (1999) *Sistema brasileiro de classificação de solos*. Empresa Brasileira de Pesquisa Agropecuária - Centro Nacional de Pesquisa de Solos, Brasília.

Fonseca, G.A.B. (1985) The vanishing Brazilian Atlantic forest. *Biological Conservation*, **34**, 17-34.

Forman, R.T.T. & Godron, M. (1986) *Landscape Ecology.* John Wiley and Sons, Inc. New York, USA.

Gentry, A. H. & Dodson, C. (1987) Contribuition of nontrees to species richness of a tropical rain forest. *Biotropica*, **19**, 149-156.

Harris, L. D. (1984). The Fragmented Forest: Island Biogeographic Theory and the Preservation of Biotic Diversity. Univ. Chicago Press, Chicago.

Joly, C. A., Leitão-Filho, H. F. & Silva, S. M. (1992) The floristic heritage. In: Câmara, I. G. (coord). *Mata Atlântica*. Index & Fundação S.O.S. Mata Atlântica, São Paulo.

Leitão-Filho, H. F. (1987) Considerações sobre a florística de florestas tropicais e sub-tropicais do Brasil. *Instituto de Pesquisas e Estudos Florestais*, **35**, 41-46

Mantovani, W. (1987) *Análise florística e fitossociológica do estrato herbáceo-subarbustivo do cerrado na Reserva Biológica de Mogi Guaçu e Itirapina*. Tese de Doutorado, Instituto de Biologia, Universidade Estadual de Campinas, Campinas.

Miranda, Z. A. I. (1996) *Plano de gestão da Área de Proteção Ambiental da região de Souzas e Joaquim Egídio - APA Municipal*. Relatório da Secretaria de Planejamento e Meio Ambiente de Campinas.

Myers, N. Mittermeier, R. A., Mittermeier C. G., Fonseca, G. A. B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, **403**, 853-858.

Parker, G. G. & Brown, M. J. (2000) Forest Canopy Stratification - Is It Useful? *American Naturalist*, **155**, 473-484.

Poulsen, A. D. (1996) Species richness an density of ground herbs within a plot of lowland rain forest in north-west Borneo. *Journal Of Tropical Ecology*, **12**, 177-190.

Richards, P.W. (1996). *The tropical rain forest: an ecological study*. Cambridge University Press, Cambridge.

Rizzini, C. T. (1997) *Tratado de fitogeografia do Brasil: aspectos ecológicos, sociológicos e florísticos*. Rio de Janeiro, Âmbito Cultural Edições.

Santos, K., & L. S. Kinoshita. (2003) Flora arbustivo-arbórea do fragmento de floresta estacional semidecidual do Ribeirão Cachoeira, município de Campinas, SP. *Acta Botanica Brasílica*, **17**, 325-341.

Turner, I.M., Tan, H.T.W. & Chua, K.S. (1996) Relatonships between herb layer and canopy composition in a tropical rain forest successional mosaic in Singapore. *Journal of Tropical Ecology*, **12**, 843-851.

Veblen, T.T., Veblen, A.T. & Schlegel, F.M. (1979) Understorey patterns in mixed evergreen-deciduous Nothofagus forests in Chile. *Journal of Ecology*, **67**, 809-823.

Veloso, H. P.; Rangel-Filho, A. L. R.; Lima, J. C. A. (1991) *Classificação da Vegetação Brasileira, Adaptada a um Sistema Universal.* Fundação Instituto Brasileiro de Geografia e Estatísitica, Rio de Janeiro.

Viana, V.M., Tabañez, A.J., (1996) Biology and conservation of forest fragments in the Brazilian Atlantic moist forest. In: Schelhas, J., Greenberg, R. (Eds.), *Forest Patches in Tropical Landscapes*. Island Press, London, pp. 151-167.

Santin, D.A. (1999) *A vegetação remanescente do município de Campinas (SP): mapeamento, caracterização fisionômica e florística, visando a conservação*. Tese de doutorado, Instituto de Biologia, Universidade Estadual de Campinas, Campinas.

CAPÍTULO 1

Title: Seasonality effects on the ground layer of a Tropical Semideciduous Seasonal Forest fragment in Southeastern Brazil[1].

LEANDRO TAVARES VIEIRA* and FERNANDO ROBERTO MARTINS

Departamento de Botânica, Instituto de Biologia, Universidade Estadual de Campinas, Caixa postal 6109, Campinas 13083-970, SP, Brazil, and * Programa de Pós-Graduação em Ecologia, Universidade Estadual de Campinas, Caixa postal 6109, Campinas 13083-971, SP, Brazil.

Correspondence: F. R. Martins (fmartins@unicamp.br)

Running title: Seasonality effects on the ground layer.

---

[1] Capítulo segue formato da revista Journal of Ecology

Summary

1 Brazilian semideciduous seasonal forests are characterized by drought periods, in which ca. 30% of the canopy trees shed at least partially their leaves, thus increasing light availability in the ground layer during the dry season. We hypothesized that the ground layer is faced with year-long restraining conditions: light restriction in the rainy season, and water restriction in the dry season.

2 We sampled all vascular plants from base floor to one meter in height in fifty 2 x 2 m random plots in the rainy and dry seasons of 2006 in Ribeirão Cachoeira Forest, SE Brazil (22º50' S - 46º55' W, 680 m a.s.l.), and measured canopy openness by means of hemispherical photographs taken in each plot in each season. We calculated and compared community and population descriptors in both seasons, and ordinated plots in the rainy and dry season with Detrended Correspondence Analysis.

3 In a total of 191 species, we recorded 5,475 individuals of 172 species in the rainy season with Shannon's H' = 3.987 nats.individual^{-1}; whereas in the dry season we recorded 4,966 individuals of 189 species with H' = 3.918 nats.individual^{-1}. Most descriptors were significantly greater in the rainy season. There was no correlation between canopy openness and community descriptors. DCA ordination indicated proximity of samples between seasons.

4 More favorable conditions seem to occur in the rainy season. The expectation that species composition of the ground layer is associated with canopy openness during the dry season may be a spurious correlation. Species in the ground layer may at least partially lose leaves in dry season. Soil water shortage seems to affect ground layer more than light restriction, although community composition and structure remained similar in both rainy and dry seasons.

Keywords: Community descriptors, deciduoness, Detrended Correspondence Analysis (DCA), growth-form, light environment, Ribeirão Cachoeira Forest, water shortage.

Introduction

Most of what we know about tropical plant communities is based upon canopy trees, and many tropical forest plots have been inventoried for trees down to 10 cm dbh, but smaller woody plants, climbers, epiphytes and herbs are rarely included in plot enumerations (Turner *et al.* 1996). The lack of knowledge is greater concerning the effects of abiotic factors on the composition of these marginal plants communities. In plant communities, most evidences suggest that patterns of distribution and abundance are determined early in life history (Uhl *et al.* 1988, Hubbell *et al.* 1999, Webb & Peart 1999, Harms *et al.* 2000, Silvera *et al*. 2003). Environmental variables, such as light and water availability, seem to be the most important factors ruling the composition of tropical forests, as pointed out by studies on phenology (Borchert 1994, Barone 1998), distribution (Borchert 1994), gap dynamics (Denslow *et al.*1990, Kabakoff & Chazdon 1996, Becker *et al.* 1998, Denslow *et al.*1998,), and germination (Everham III *et al.* 1996).

A positive relationship between light environment and growth rates has been documented (e.g. Chazdon 1986, Condit *et al.* 1993, Oberbauer *et al.* 1993, King 1994, Clark & Clark 1999, Kobe 1999, Sterck *et al.* 1999, Poorter 2001, Montgomery & Chazdon 2002, Sterck *et al.* 2003, King *et al.* 2005). Low light availability often limits plant growth and rules mortality in understorey environments, and even small variations in light conditions can have a great impact on photosynthesis, growth and regeneration of understorey species (e.g. Chazdon 1986, Pearcy 1983; Pearcy & Calkin 1983, Raich 1989, Mulkey *et al.* 1991, 1993). Water is also reported as a limiting factor for growth and mortality, especially in tropical dry forests (e.g. Reich & Borchert 1984, Wright 1991, Gerhardt 1996, Poorter & Hayashida-Oliver 2000).

Tropical dry forests are deciduous, wet forests are evergreen, and forests in between are called semideciduous (Condit *et al.* 2000). Tropical seasonal forests are characterized by drought periods in which plants experience soil water shortage (Kursar *et al.* 2005). Therefore, in addition to total rainfall, in tropical seasonal forests the length and strength of the dry season strongly influence plant growth, mortality, and association with habitats (Veenendaal *et al.* 1995, Condit 1998, Nakagawa *et al.* 2000, Engelbrecht & Kursar 2003). In Brazilian semideciduous seasonal forests about 30% of the canopy trees shed at least partially their leaves in the dry season (IBGE 1992). This value can reach about 50 to 70% considering all tree species (e.g. Matthes 1980, Morellato-Fonzar 1987, Morellato 1991, Fonseca 1998). Deciduousness is directly related to light availability in the understorey and ground layer communities (e.g. Chazdon & Fetcher 1984, Chazdon & Pearcy 1991, Popma & Bongers 1991, Poorter & Hayashida-Oliver 2000). However, there are very few studies assessing light environment and its variation along the year in the understorey of semideciduous seasonal forests. Studying a semideciduous seasonal forest in SE Brazil, Gandolfi (2000) observed that during rainy season understorey beneath deciduous canopy trees had a light regime that was very similar to understorey beneath perennial canopy trees, but during the dry season its light regime was similar to that observed in gaps.

We suppose that, as a consequence of the seasonality of semideciduous forests, the ground layer is submitted to an opposite seasonal regime of water and light availability: during the rainy season, when soil water is available, light is restricted by the fully leafed canopy; and during the dry season, when light is supplied through deciduous canopy trees, soil water is restricted due to diminished rainfall. Our aim is to test the hypothesis that, as a consequence of this opposite seasonality, the ground layer is faced with year-long restrictive conditions. If this hypothesis holds, we expect no significant alteration of the structure of the ground layer community along the year seasons.

Material and Methods

Study Site

This work was carried out in the Ribeirão Cachoeira Forest, the second largest forest fragment (245 ha) in a region where forest cover was highly fragmented (Santin 1999). It is located in the Environmental Protection Area of the municipality of Campinas, São Paulo state, SE Brazil, at the coordinates 22º50' S and 46º55' W. The fragment is crossed in the east-west direction by the Cachoeira stream, a tributary of Atibaia River. According to IBGE (1992), the vegetation is classified as Semideciduous Seasonal Forest due to the climatic seasonality and deciduousness observed in about 30% of the highest trees during the dry season. According to CIIAGRO (2007), the climate is Koeppen's Cwa, with a hot rainy season from October to March, with monthly average temperatures between 23.2 ºC and 24.6 ºC and average total precipitation of 1143.3 mm; and a dry season from April to September, with monthly average temperatures between 18.9 ºC and 22.8 ºC and average total precipitation of 272.9 mm (Figure 1). Altitude varies from 630 to 760 m, and soil is Red-Yellow Argisol with sandy texture and many rock fragments (Embrapa 1999).

The stand we studied is located in the south portion of the forest, on the left margin of the Cachoeira stream. It was selected by Cielo-Filho (2001) with the aid of a 1:25,000 aerial photograph and examination in the field. To choose this area, he avoided great declivity variations and the presence of too large gaps. There are no signs of recent anthropogenic disturbances in the area, such as coal on the ground surface, soot on trunks, and presence of stumps or coppiced trees (Cielo-Filho 2001).

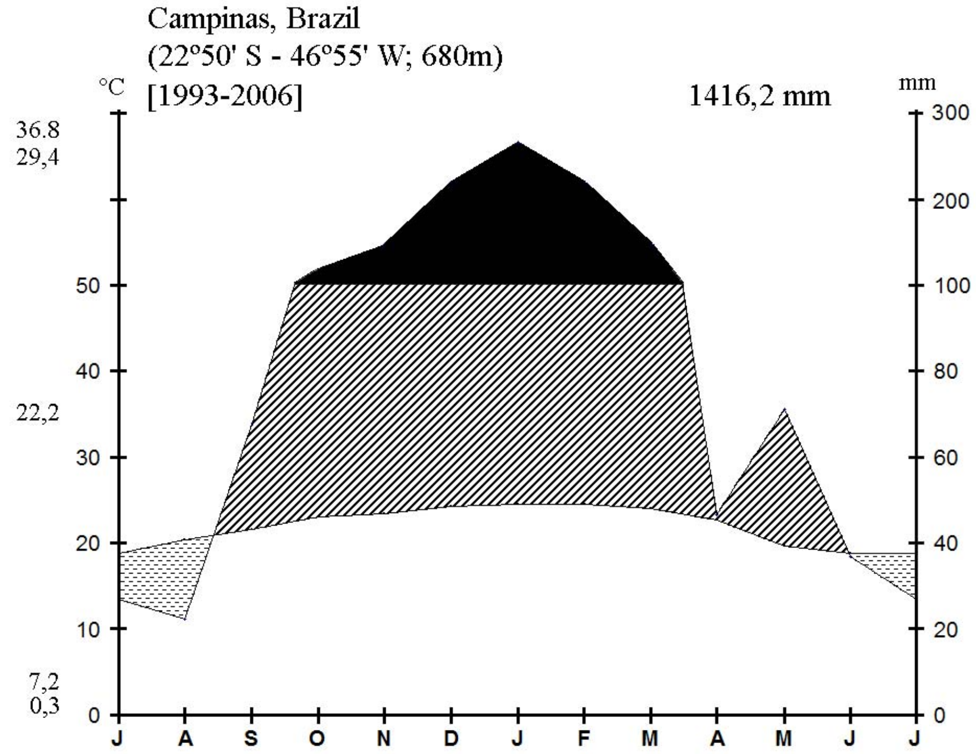

Figure 1. Climatic diagram for Campinas municipality, São Paulo state, Brazil. Source: CIIAGRO (2007).

Sampling

The sampling was made in plots arranged in accordance to the irrestricted randomization procedure proposed by Greig-Smith (1983). Fifty 2 x 2 m plots were randomly installed at the corners of 10 x 10 m quadrats (figure 2), with the vertices demarcated by permanent PVC pipe stakes, totalizing 0.02 ha. For details consult Cielo-Filho *et al.* (2007). We sampled all vascular plants ranging in height from the base floor to one meter both in the rainy (January and February) and dry (July and August) seasons of 2006. We tagged each individual with a numbered plastic label, and recorded its height, diameter at soil level (DSL) and cover in each season, first in the rainy then in the dry season. Plant cover is a visual assessment of the percentage cover of every species in each plot (Mueller-Dombois & Ellenberg 1974). We measured the cover of each individual according to classes of percentage, which ranged from 0.1% (approximately a plant covering 5 cm² or less) to 10%, and added all values of each species for each plot. In one plot, the total percentage of plant cover can exceed 100% because the individuals occupied different heights. Each stem that was independently rooted and not obviously connected to another stem at the soil level was included and treated as an independent individual.

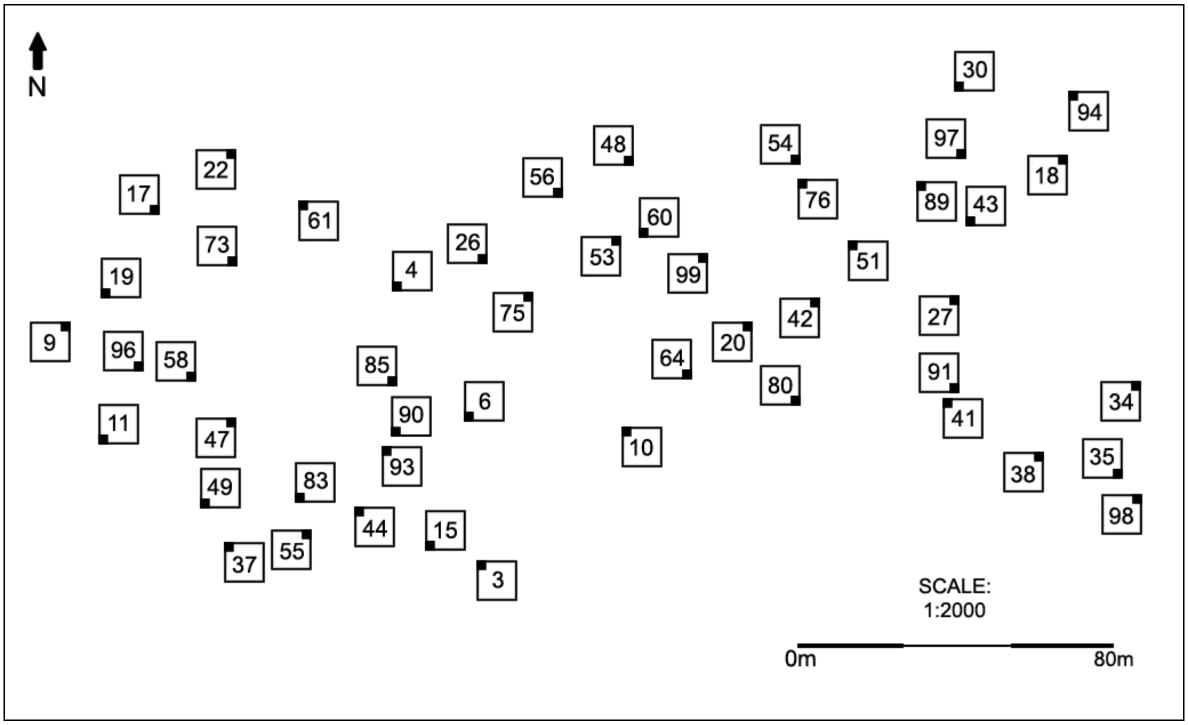

Figure 2. Fifty 2 x 2m plots in the corners of 10 x 10 m quadrats arranged in accordance with the irrestricted randomization procedure in the sample area in Ribeirão Cachoeira Forest. The numbers do not follow a sequence.

The identification of vegetative material is very difficult, especially in the initial stages of plant life, even with the help of taxon specialists. Because of this we classified some species only to genus or family, whereas we left others as unknown morphospecies. The vouchers were lodged in the Herbarium of the State University of Campinas (UEC).

The families were arranged according to the Angiosperm Phylogeny Group (2003) for angiosperms and Smith *et al.* (2006) for ferns.

We divided the taxa into seven growth-forms when at the adult stage, based on literature, herbarium collections, and field observation: tree (adult with one main woody trunk that reaches the canopy); treelet (adult with one main woody trunk, branching above 1m from the ground and never reaching the canopy); shrub (adult with woody stems either multiple or branching beneath 1m from the ground), herb (adult with non-lignified stem, including palmettos); liana (adult woody climbing plants); and vines (adult herbaceous climbers), as suggested by Gerwing *et al.* (2006). We also created a category called miscellanea to refer to young individuals whose identification to species or classification into the above growth-forms was not possible.

We measured canopy openness by means of hemispherical photographs using a digital Nikon Coolpix 950 camera with a 8 mm Nikon Fisheye Converter. Photographs were taken at the center of each plot at 1.0 m above ground level, and the camera body was aligned to magnetic north. The base of the camera was levelled using a bull´s eye level at each position. The forest canopy was photographed in the rainy and dry seasons, always at the first or last one and half hour of sunlight, following suggestion by Whitmore *et al.* (1993). The images were analyzed with the software Gap Light Analyzer 2.0 (Frazer *et al.* 1999).

In the sampling year the average temperature was 22.36 ºC and the total precipitation 1265 mm. The monthly average temperature was 24.5 ºC and 20.2 ºC in the rainy and dry seasons, respectively. The monthly average precipitation was 182.9 mm in the rainy season and 27.9 mm in the dry season (CIIAGRO 2007).

Data Analysis

To test for community changes between the rainy and the dry seasons, we calculated for each species in each season some absolute and relative phytossociological descriptors (density, frequency, basal area and plant cover) and a synthetic descriptor (Importance Value Index IVI), which is the sum of relative density, frequency and basal area, and has a maximum value of 300 (Muller-Dombois & Ellemberg 1974):

$$\text{absolute density AD} = \frac{ni}{A};$$

$$\text{relative density RD} = \frac{ni}{N} \times 100;$$

$$\text{absolute frequency AF} = \frac{Ui}{UT} \times 100;$$

$$\text{relative frequency RF} = \frac{AFi}{\sum AF} \times 100;$$

$$\text{absolute basal area ABA} = \frac{BAi}{A};$$

$$\text{relative basal area RBA} = \frac{BAi}{\sum BA_i} \times 100;$$

$$\text{absolute plant cover APC} = \frac{PCi}{A};$$

$$\text{relative plant cover RPC} = \frac{PCi}{\sum PCi} \times 100;$$

where n*i* = number of individuals of specie *i*;

A = sample area (in hectare);

N = total number of individuals;

Ui = number of plots with specie i;

UT = total number of plots:

The number of individuals, species, genera and families were compared between seasons with a chi-square (x^2) test using Yates' correction (Zar 1999). We assumed H_0: $\mu 1 = \mu 2$ and H_a: $\mu 1 \neq \mu 2$, where μ1 represents the rainy season data and μ2 the dry season data, with $\alpha = 0.05$. These computations were performed with BIOESTAT 3.0 (Ayres *et al.* 2003). To test for differences of community descriptors between rainy and dry season, we considered the number of individuals, absolute density, absolute basal area, absolute frequency and absolute plant cover for each species, each family or each plot in each season. We performed a two-tailed paired-sample *t* test with $\alpha = 0.01$, and we assumed H_0: $\mu 1 - \mu 2 = 0$ and H_a: $\mu 1 - \mu 2 \neq 0$, where μ1 represents the rainy season data and μ2 the dry season data. This test is appropriate when each observation in sample 1 is in some way correlated with an observation in sample 2. This test does not have the normality and equality of variances assumptions of the two-sample *t* test, but it assumes instead that the differences come from a normally distributed population of differences (Zar 1999). We tested for normality in the data distribution with the Kolmogorov-Smirnov goodness-of-fit test, assuming the null hypothesis that the sample came from a normal population. The Kolmogorov-Smirnov test is properly applied to continuous frequency distributions without grouped data and is very powerful for large samples (Sokal & Rohlf 1995). These computations were performed with SYSTAT 9.0 (Wilkinson 1998).

We also calculated Shannon-Weaver diversity index H′, which is the expression of the information entropy content per individual within an infinite population (Shannon &

Weaver 1948) given by:

$$H' = -\sum_{i=1}^{S} p_i \log p_i ,$$

where p_i is the proportion of individuals found in the *i*th species, expressed by:

$$p_i = \frac{n_i}{N} ,$$

where n_i is the number of individual of specie *i* and *N* is the total number of individuals in the sample.

We tested for difference of the Shannon-Weaver H’ between the rainy and dry season throuhg the *t* test (Hutcheson 1970) at α = 0.05:

$$t = \frac{H'_1 - H'_2}{s_{H'_1 - H'_2}} ,$$

and

$$s_{H'_1 - H'_2} = \sqrt{s^2_{H'_1} + s^2_{H'_2}} .$$

The variance of each H’ may be approximated by

$$s^2_{H'} = \frac{\sum f_i \log^2 f_i - (\sum f_i \log f_i)^2 / n}{n^2} ,$$

where *n* is the sample size, and f_i the number of observations in category *i*.

The degrees of freedom associated to *t* are approximated by

$$v = \frac{(s^2_{H'_1} + s^2_{H'_2})^2}{\frac{(s^2_{H'_1})^2}{n_1} + \frac{(s^2_{H'_2})^2}{n_2}} .$$

These computations were performed with Bio-Dap software (Thomas & Clay 2000).

We also calculated Simpson's index C, which is sensitive to the abundance only of the more plentiful species in a sample and can therefore be regarded as a measure of "abundance concentration" (Whittaker 1967). The formula can be expressed below as described by Simpson (1949), and C can be understood as the probability that two randomly chosen individuals from a given community belong to the same species.

$$C = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N - 1)}$$

We tested for difference of the Simpson's index between the dry and rainy season in the same way we did for Shannon-Weaver index by substituting H' for C value and considering the variance of Simpson (Simpson 1949), which is calculated by:

$$S_C^2 = \frac{4}{N}\left|\sum_{i=1}^{S}\left(\frac{ni}{N}\right)^3 - \left(\sum_{i=1}^{S}\left(\frac{ni}{N}\right)^2\right)^2\right|;$$

To test for differences of canopy openness (in percent) between the rainy and dry seasons, we applied arcsine squareroot transformation, which is especially appropriate to percentages and proportion data (Sokal & Rohlf 1981):

$$b = (2/\pi)\arcsin(\sqrt{x_{ij}}),$$

where x_{ij} is the value on the matrix for line *i* and column *j*.

Prior to transformation, the data were set to range between zero and one by relativization by maximum:

$$b = x_{ij} / x\max_j,$$

where *max* is the largest value in column *j*.

The transformations were performed with software PC-ORD 4.0 (McCune & Mefford 1999). After transformation, we tested for canopy openness differences between the seasons with the one-tailed paired-sample *t* test with $\alpha = 0.01$, and we assumed H_0: $\mu 1 - \mu 2 = 0$ and H_a: $\mu 1 \leq \mu 2$, where $\mu 1$ represents the rainy season data and $\mu 2$ the dry season data. These calculations were performed with software SYSTAT 9.0 (Wilkinson 1998).

In order to test whether the plant cover increases with the increasing of canopy openness, we calculated Pearson product-moment correlation coefficients (r) based on arcsine squareroot-transformed data, assuming $\alpha = 0.05$, H_0: $r = 0$ and H_a: $r \neq 0$, where 0 is absence of association. Plant cover data also were arcsine squareroot-transformed. These computations were performed with BIOESTAT 3.0 (Ayres *et al.* 2003). Before choosing Pearson's correlation, we tested for normality in the data distribution of canopy openness and plant cover by applying Kolmogorov-Smirnov goodness-of-fit test, as described above. These computations were performed with SYSTAT 9.0 (Wilkinson 1998).

To assess which of the variables accounted for most of the variation among plots and which was the most important in discriminating among plots, we applied Detrended Correspondence Analysis (DCA; Hill & Gauch 1980), a modification of traditional Correspondence Analysis (CA). DCA is an indirect gradient analysis technique, in which environmental gradients are not studied directly but are inferred from species composition data (Palmer 1993). The process of detrending, which removes the "arc effect", is implemented through the division of the CA first axis into a number of segments. Within each of these segments, the site scores for the second axis are adjusted by subtracting the within-segment mean on the second axis from the score for each site. As a result, each segment has a mean value of zero for scores on the second axis. This process is repeated several times, and the results are averaged to determine the axis scores (Jackson & Somers 1991). Therefore, detrending is simply a forced adjustment of the site scores on the second axis and all subsequent axes so that no linear or low-order polynomial relationships remain within prior axes (Hill & Gauch Jr. 1980, Gauch Jr. 1982). In addition to detrending, DCA rescales the axes with the assumption that all species show a unimodal response curve with homogeneous variances along each gradient. This rescaling procedure tends to expand interpoint spacing between sites or species located at the ends of the axes.

DCA has received many critiques (see, e.g. Kenkel & Orloci 1986, Minchin 1987, Wartenberg *et al.* 1987, Peet *et al.* 1988), which state the rescaling procedure to be arbitrary, so that Jackson & Sommers (1991) did not recommend its use. However, an important criterion for selecting an ordination technique is that it effectively summarizes community variation relative to underlying gradients (Gauch Jr. 1982). Since our aim was not to investigate the occurrence of gradients, but to know how the plots are ordinated in each season without the "arc effect", we chose the DCA ordination. For this approach, we built a primary matrix in which the plots (50 for each season) were the objects (*n*) whereas the species cover was the descriptor (*m*). We excluded species with less than 10% of plant cover in one of the two seasons, and obtained a matrix with 100 plots and 45 species. The DCA was applied followign the standard procedure, with 27 segments and four rescalings. According to our hypothesis, we expected that each plot of one season would be ordinated very close to the same plot of another season. These computations were performed with FITOPAC (Shepherd 1996).

To assess the proximity of each plot between the dry and rainy seasons, we divided the sample plot scores on the four DCA axes in rainy and dry season and applied a Pearson product-moment correlation coefficients (r) for scores corresponding to the plots crossing both seasons. We assume $\alpha = 0.05$, H_0: $r = 0$ and H_a: $r \neq 0$, where 0 is absence of association. Prior, we tested for normality in the data distribution of sample scores by applying the Kolmogorov-Smirnov goodness-of-fit test, as described above. These computations were performed with BIOESTAT 3.0 (Ayres *et al.* 2003).

Results

Species richness and composition

We sampled a total of 191 species distributed in 110 genera and 56 families (appendix 1). Out of the total 191 species 171 were present in both seasons with 105 genera and 53 families.

In the rainy season we recorded 5,475 individuals distributed in 54 families, 105 genera and 172 species, of which 7 were identified to genus, 15 to family, and 21 only to class (morphospecies belonging to Magnoliopsida). The species with the highest IVI were *Clytostoma campanulatum* (30.7), *Oeceoclades maculata* (19.97) and *Actinostemon communis* (16.65). *Clytostoma campanulatum* and *A. communis* also had the greatest numbers of individuals (630 and 424, respectively, table 1 and appendix 2).

In the dry season we recorded 4,966 individuals distributed in 55 families, 109 genera and 189 species, of which 7 identified to genus, 17 to family, and 30 only to class. The species with the highest IVI were *Clytostoma campanulatum* (IVI = 32.6, n_i = 617), *Actinostemon communis* (IVI = 17.35, n_i = 355) and *Adenocalymma bracteatum* (IVI = 15.82, n_i = 413) (table 1 and appendix 3).

The species with the greatest cover was *Clytostoma campanulatum* (22.8 and 18.2% of relative plant cover in rainy and dry season, respectively), *Actinostemon communis* (9 and 7.4% in rainy and dry season, respectively), *Adenocalymma bracteatum* (7.9 and 6.84%), *Coffea arabica* (4.71 and 3.4%), *Parodiolyra micrantha* (4.5 and 3.75%) and *Serjania lethalis* (4.43 and 3.6%) (see appendix 2 & 3).

Table 1. Number of individuals and Importance Value Index (IVI) recorded in the rainy and dry seasons for the 12 species with the greatest IVI in both seasons.

Species	Life-form	IVI		Number of individuals	
		Rainy Season	Dry Season	Rainy Season	Dry Season
Clytostoma campanulatum	Liana	30.7	32.6	630	617
Oeceoclades maculata	Herb	19.97	10.65	62	62
Actinostemon communis	Treelet	16.65	17.35	424	355
Adenocalymma bracteatum	Liana	13.82	15.82	400	413
Coffea Arabica	Treelet	11.19	12.46	152	155
Mansoa difficilis	Liana	10.16	10.53	322	293
Pereskia aculeata	Vine	8.98	9.03	138	126
Serjania lethalis	Liana	7.84	8.39	193	192
Metrodorea nigra	Treelet	7.41	7.78	94	91
Ardisia warminguii	Shrub	6.83	7.62	155	154
Aspidosperma polyneuron	Tree	6.55	6.11	85	74
Oxalis rombeo-ovata	Herb	6.19	6.66	102	113

The most speciose families were Bignoniaceae, Euphorbiaceae, Myrtaceae, Rubiaceae, and Fabaceae. The number of species in these families varied little between the rainy and dry seasons, practically the same species being present in both seasons (table 2 and appendix 4 & 5). Bignoniaceae was also the family that held the greatest proportion of total IVI in both seasons, followed by Euphorbiaceae, Orchidaceae, Rubiaceae, Sapindaceae and Rutaceae (table 2 and appendix 4 & 5). Bignoniaceae was present in 100% of the plots in both seasons, followed by Sapindaceae (94% and 84% in the rainy and dry season, respectively), Euphorbiaceae (92% and 88%) and Rutaceae (86% and 82%). Bignoniaceae had also the greatest relative density and relative basal area (table 3 and appendix 4 & 5).

The total 191 species comprised 23 herbs, 31 lianas, 12 vines, 18 shrubs, 42 trees, 25 treelets and 40 miscellanea (appendix 1). Liana was the most abundant group with around 2,300 individuals (about 37% of total IVI), followed by the treelets with around 900 individuals (about 18% of total IVI), and herbs with around 700 individuals (also about 15% of total IVI, table 4).

Table 2. Number of species and individuals and proportion of total Importance Value Index (%IVI) for the 12 most speciose families.

Family	Number of Species		Number of Individuals		%IVI	
	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
Bignoniaceae	13	13	1872	1800	22.07	23.73
Euphorbiaceae	11	11	563	473	7.7	7.93
Myrtaceae	10	11	135	141	2.19	2.26
Rubiaceae	10	10	242	194	5.2	5.26
Fabaceae	8	9	100	82	1.87	2.14
Sapindaceae	6	6	365	273	4.8	4.33
Rutaceae	6	6	236	198	4.78	4.55
Lauraceae	6	7	33	29	0.91	0.83
Acanthaceae	5	6	180	160	2.61	2.53
Celastraceae	5	5	131	120	2.91	2.91
Meliaceae	5	5	56	54	1.77	1.88
Malpighiaceae	5	5	94	100	1.97	2.59

Table 3. Other community descriptors for the 12 most frequent families. AF = absolute frequency; RD = relative density; RBA = relative basal area.

Family	AF		RD		RBA	
	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
Bignoniaceae	100	100	34.19	36.25	26.07	28.74
Sapindaceae	94	84	6.67	5.5	2.12	2.27
Euphorbiaceae	92	88	10.28	9.52	7.33	8.79
Rutaceae	86	82	4.31	3.99	4.9	4.58
Rubiaceae	76	70	4.42	3.91	6.66	7.55
Cactaceae	74	74	2.52	2.54	3.75	3.55
Apocynaceae	68	66	2.36	2.42	5.29	4.45
Celastraceae	68	58	2.39	2.42	2.26	2.71
Acanthaceae	60	54	3.29	3.22	0.97	1.02
Myrtaceae	56	50	2.47	2.84	0.77	0.85
Orchidaceae	56	58	1.52	1.65	17.25	7.78
Malpighiaceae	54	60	1.72	2.01	0.97	2.04

Clytostoma campanulatum, *Adenocalymma bracteatum* and *Mansoa difficilis* were present with high IVI in both seasons, as well as their family, the Bignoniaceae, which had around 23% of the total Importance Value Index (table 2). Bignoniaceae was sampled with 13 species, of which 10 were lianas and the others were miscellanea, thus highlighting the importance of lianas in the ground layer of tropical semideciduous seasonal forests. Pooling lianas and vines together, the climbers attained 41% of total IVI (table 4).

Table 4. Number of species, number of individuals and proportion of the total Importance Value Index (%IVI) for growth-forms.

Growth-forms	Number of Species		Number of Individuals		%IVI	
	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
Herb	22	22	737	632	17.2	13.9
Liana	31	31	2422	2256	36.3	38.1
Vines	11	12	206	197	4..3	4.5
Miscellanea	31	40	204	136	4.3	3.3
Shrub	15	18	359	348	6.8	7.9
Tree	39	42	591	542	13.1	13.7
Treelets	24	24	956	855	17.8	18.5

Rainy vs. Dry season

There was no significant difference between seasons in number of species (x^2= 0.709, p = 0.399), number of genera (x^2= 0.019, p = 0.891) and number of families (x^2= 0.0, p = 1). However, the number of individuals was greater in the rainy season (x^2= 24.716, p = 0.000**).

The number of individuals per species was significantly greater in the rainy season (t = 3.957, p = 0.000**), with averages of 28.66 and 26 individuals per specie in the rainy and dry season, respectively. The same result was found for absolute frequency per species (t = 3.744, p = 0.000**), absolute density per specie (t = 3.957, p = 0.000**) and absolute plant cover per specie (t = 4.407, p = 0.000**). However, for absolute basal area per specie there was no difference between seasons (t=-0.496, p = 0.620).

In the rainy season, the total density was 273,750 individuals per hectare, whereas in the dry season it was 248,300. The number of individuals per plot was greater in the rainy season than in the dry season (t = 5.237, p = 0.000**) with means of 109.5 and 99.3 individuals per plot, respectively. The number of species per plot significantly differed between the rainy and dry seasons (t = 4.398, p = 0.000**), with a mean of 27.3 and 25.16 species per plot, respectively. Also, the absolute density per plot was higher in the rainy season (t = 5.237, p = 0.000**). However, there was no significant difference between seasons in absolute basal area per plot (t =-0.871 p = 0.388), with means of 2.41 and 2.52 m^2 per hectare in the rainy and dry seasons, respectively (Appendices 6 & 7). Plant cover per plot ranged 7% - 184% with a mean of 72% in the rainy season, totalizing 3,603% in all plots pooled together. In the dry season it ranged between 8% and 107% with mean of 51.5%, summing up 2,576% in all plots. The absolute plant cover per plot was significantly greater in the rainy season (t = 8.598, p = 0.000**).

We found similar results for plant families. There was significant difference between seasons in number of individuals (t = 3.191, p = 0.002**), absolute density (t = 3.191, p = 0.002**) and absolute plant cover (t = 2.900, p = 0.005**). However, the number of species (t =-1.797, p = 0.077), absolute frequency (t = 2.247, p = 0.028) and absolute basal area (t =-0.459, p = 0.647) per family did not differ between seasons.

Shannon-Weaver and Simpson Indices

In the rainy season, Shannon-Weaver index for species was 3.987 nats/individual^{-1} and Simpson index was 0.037. In the dry season, Shannon-Weaver index for species was 3.918 nats/individual^{-1} and Simpson index was 0.040. We recorded significantly greater values for Shannon-Weaver index ($t = 2.866$, $p < 0.05$*) in the rainy season and Simpson index ($t = -2.672$, $p < 0.05$*) in the dry season.

Canopy openness and plant cover

The canopy openness per plot ranged between 1.3 and 11.9%, with mean of 4.7% in the rainy season, and between 3.6 and 11.7%, with mean of 7.1% in the dry season, a significant difference ($t=-8.321$, $p = 0.000$**). Canopy openness and plant cover data were normally distributed according to Kolmogorov-Smirnov goodness-of-fit test ($P > 0.05$). According to Pearson's correlation, the canopy openness and the plant cover per plot were not correlated in any season. Pearson product-moment correlation coefficients (r) were 0.0893 ($p = 0.537$) and 0.0171 ($p = 0.906$) in the rainy and dry seasons, respectively.

Multivariate Analysis

The Detrended Correspondence Analysis, as we expected, indicated that the location of most plots in the DCA ordination space was close to the same plot in the different season (figure 3). The eigenvalues (representing the total variance accounted for by each axis) for the first two DCA axes were higher than those of axes 3 and 4 (respectively 0.393 and 0.288 for axes 1 and 2, and 0.192 and 0.170 for axes 3 and 4), justifying the use of DCA

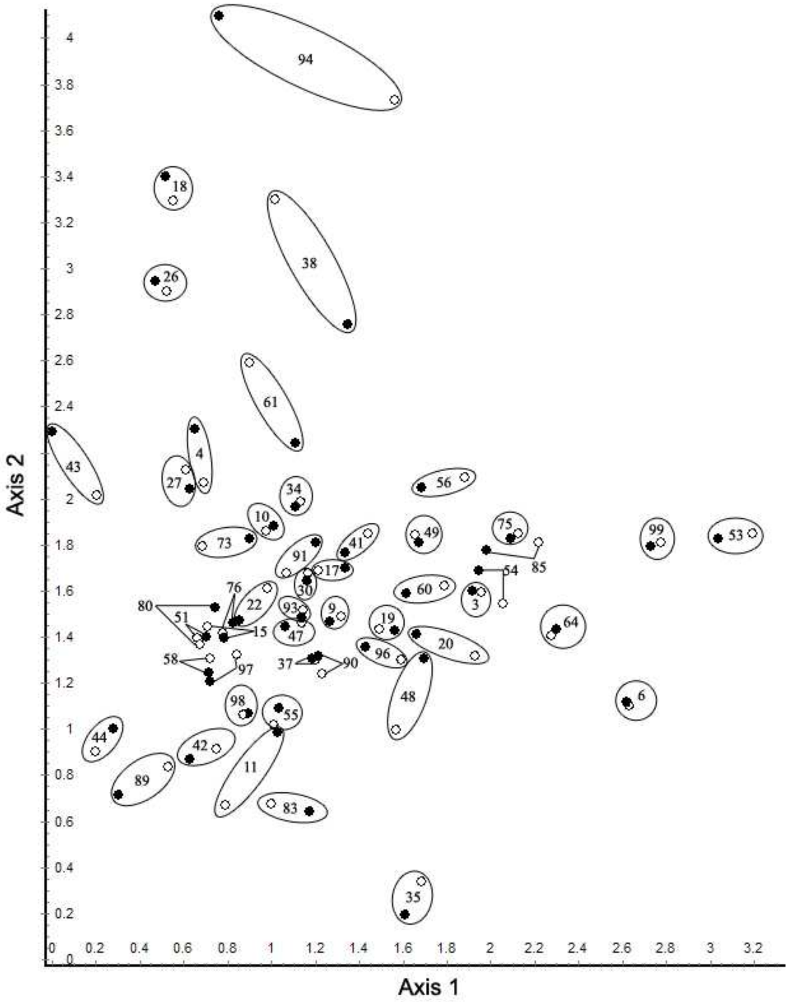

Figure 3. Detrended Correspondence Analysis (DCA) ordination of sample plots for the first two axes. The numbers repressent plots (see figure 2), black circles represent rainy season plots and empty circles represent dry season plots.

axes 1 and 2 as the main ordination framework. The proximity of each plot in the rainy season to itself in the dry season was also remarkable in axes 1 x 3 and 2 x 3 (results not shown). The sample scores in all axes were normally distributed according to Kolmogorov-Smirnov goodness-of-fit test ($P > 0.05$). The correlations of sample scores on all four DCA axes between seasons was significant ($p = 0.000^*$) with r-values respectively: $r = 0.967$, $r = 0.975$, $r = 0.962$ and $r = 0.931$.

Discussion

The great number of species recorded in Ribeirão Cachoeira Forest shows the great importance of the ground layer to the species richness of tropical forests as pointed out by Gentry & Dodson (1987). However, there is an enormous difficulty to identify these species due to small size, great variation in morphology between the adult species and its seedlings or saplings, and almost none flowering specimen. The great number of individuals recorded in both seasons also shows the great importance of this stratum. The different values of abundance descriptors among the species we found are common in most plant communities (Whittaker 1967).

Climber species were the most representative group in the ground layer, probably as an outcome of their capacity to produce clones in a variety of ways, such as by rhizomatous and stoloniferous expansion, layering and sprouting of fallen stems, splitting of climbing stems, and sprouting from roots (Peñalosa 1984, Caballé 1994). Without genetic analysis, it is often difficult to determine whether independently rooted stems are independent genetic individuals or parts of a clone in which ramets have lost their connections (Gerwing *et al.* 2006). Because of this, Peñalosa (1984) believed that basal branching in lianas may allow them to attain ages of several centuries.

The great abundance of climbers we found in the ground layer might also be an outcome of their capacity of “foraging” for support or canopy gaps and other areas of higher light intensities. Peñalosa (1984) stated that climbers are complex and highly organized systems with specialization of shoots into photosynthetic, climbing and exploratory structures. A phenomenon of directed foraging for supports was described for root-climbing vines (Strong & Ray 1975): the vines grew along the forest floor in the direction of the darkest part of the horizon, which is often the trunk of a large tree, thus enhancing their likelihood of encountering a large tree trunk to ascend. One possible mechanism behind these directed “foraging” behavior involves growth responses to minor differences in concentrations of ethylene near and away from stems of other plants, but this hypothesis awaits testing (Strong & Ray 1975).

Almost all community descriptors had significantly greater values in the rainy season (total number of individuals, number of individuals per specie, per family and per plot, absolute frequency per specie, absolute density per specie, per family and per plot, absolute plant cover per specie, per family and per plot, and number of species per plot). Only absolute basal area per specie, per family and per plot and absolute frequency per family did not differ between seasons. The total numbers of species, genera and families also did not differ between seasons. These results seem to indicate more favorable ecological condition in the rainy season. The value of Shannon-Weaver index in the rainy season together with the greater value of Simpson index in the dry season indicated a greater abundance concentration in the dry season. We suppose this to result from differential mortality among species in the dry season, thus leading to a relative enhancement of the abundance of the surviving species.

The fact that plant cover in the plots significantly diminished in the dry season when compared with the rainy season could indicate that water shortage in the dry season is a very important factor limiting plant growth in the ground layer. This fact could indicate that species in the ground layer may also lose leaves due to drought. However, some authors (e.g. Frankie *et al.* 1974, Wright 1991, Condit 2000) have reported that deciduous species have a lower percentage of deciduousness in the smaller size classes and that understory species are seldom deciduous, but none of these studies has focused the ground layer. Apparently, there is hitherto almost no evidence of deciduoness in the ground layer of tropical forests, and only two herbaceous species in Barro Colorado Island were reported as deciduous (Croat 1978). Deciduousness is usually considered an adaptation that reduces water stress during dry periods in the tropics (Borchert 1980, Reich & Borchert 1984; Borchert 1992; van Schaik *et al.* 1993); so why might this not occur in the ground layer of tropical semideciduous seasonal forests? More studies are necessary to test this hypothesis.

Canopy openness was larger in the dry season, and considering that the stand studied is a semideciduous forest, this result was expected. We also expected that in plots with larger canopy openness there would be larger plant cover in the ground layer, independently of the season, but this did not occur. The absence of correlation between canopy openness and the community descriptors may indicate that light dynamics of tropical forests is more complex than we suppose. In tropical rainforests, only a small fraction of the solar radiation incident above the canopy trees reaches the ground layer, but a seasonal variation is expected in seasonal semideciduous forests (Chazdon & Pearcy 1991). Our results show that in the sesasonal semideciduous forest that we studied, more radiation attains the ground layer in the dry season, thus corroborating Gandolfi (2000). Ground layer plants of tropical forest experience a highly dynamic light environment, with brief, often unpredictable periods of direct solar irradiance (sunflecks) punctuating the dim and diffuse background irradiance (Chazdon & Pearcy 1991). Sunflecks are directly related with carbon gain by plants (Chazdon 1986, Oberbauer *et al.*1993), but it depends of size, shape, duration and peak photon flux density of the sunflecks, besides the height and precise arrangement of vegetation within the forest canopy as well as the position of the sun in the sky, a function of solar declination and solar time (Chazdon & Pearcy 1991, see Gandolfi 2000). Many authors described how light environment in closed canopy forests affects the growth, survival and life histories of ground layer species (e.g. Augspurger 1984, Chazdon 1988, King 1994, Montgomery & Chazdon 2002, King *et al.* 2005). All these studies were carried out in tropical wet rainforest, in which there is no a biologically important dry season. Therefore, the expectation that species composition of the ground layer of tropical seasonal semideciduous forests is associated with canopy openness during the dry season may be a spurious correlation.

Although there were statistically significant differences of community descriptors between the rainy and dry seasons, the DCA ordinated the samples close to one another in both rainy and dry seasons, a pattern confirmed by Pearson correlation between DCA axes. The comparison of these results may indicate that different species respond differently to the prevailing conditions in the rainy and in the dry seasons (hence the differences of H', C, density, frequency, number of individuals and species and plant cover), but the community as a whole keeps fairly similar in both seasons (hence the proximity of each plot in one season with itself in the other season).

Our initial hypothesis was that species in the ground layer of a tropical semideciduous seasonal forest are in permanently restraining conditions: in the dry season due to water shortage, and in the rainy season due to light limitation. Our results corroborate this hypothesis only partially by highlighting the overall limitation of species and community during the dry season. The absence of correlation between canopy cover and plant cover per plot, even during the rainy season, indicates that light availability in the ground layer of tropical seasonal forests is not yet fully understood and more studies are needed.

Acknowledgements

We thank Colinas do Atibaia Condominium for allowing access to Ribeirão Cachoeira Forest, FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) for field trip support (Process 06/00088-1), and Ligia Paulilo Sims for commendable support in field work. First author received a grant from CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior).

Literature Cited

Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society*, **141**, 399-436.

Augspurger, C.K. (1984). Light Requirements of Neotropical tree seedlings: A comparative study of growth and survival. *Journal of Ecology*, **72**, 777-795.

Ayres, M., Ayres J.R,M. & Santos, A.S. (2003). *BioEstat 3.0: aplicações estatísticas nas áreas das ciências biológicas e médicas*. Belém, Sociedade Civil Mamirauá.

Barone, J.A. (1998) Effects of Light Availability and Rainfall on Leaf Production in a Moist Tropical Forest in Central Panama. *Journal of Tropical Ecology*, **14**,309-321.

Becker, P., Rabenold, P.E., Idol, J.R., Smith, A.P. (1988) Water Potential Gradients for Gaps and Slopes in a Panamanian Tropical Moist Forest's Dry Season. *Journal of Tropical Ecology*, **4**,173-184.

Borchert, R. (1980) Phenology and Ecophysiology of Tropical Trees: Erythrina Poeppigiana O. F. Cook. *Ecology*, **61**, 1065-1074.

Borchert, R. (1992) Computer simulation of tree growth periodicity and climatic hydroperiodicity in tropical forests. *Biotropica*, **24**, 385-395.

Borchert, R. (1994) Soil and stem water storage determine phenology and distribution of Tropical Dry Forest trees. *Ecology*, **75**, 1437-1449.

Caballé, G. (1994) Ramet proliferation by longitudinal splitting in the Gabonese Rain Forest liana *Dalhousiea africana* S. Moore (Papilionaceae). *Biotropica*, **26**, 266-275.

Chazdon, R. L. & Fetcher, N. (1984) Photosynthetic light environments in a Lowland Tropical Rain Forest in Costa Rica. *Journal of Ecology*, **72**, 553-564.

Chazdon, R.L. & Pearcy, R.W. (1991) The Importance of sunflecks for forest understory plants. *BioScience* , **41**, 760-766.

Chazdon, R.L. (1986) Light variation and carbon gain in Rain Forest understorey palms. *Journal of Ecology*, **74**, 995-1012.

Chazdon, R.L. (1988) Sunflecks and their importance to forest understorey plants. *Advances in Ecological Research*, **18**, 1-63.

Cielo-Filho, R. (2001) *Estrutura de abundância de um trecho de Floresta Estacional Semindecídua no Município de Campinas, Estado de São Paulo: Mata Ribeirão Cachoeira*. MSc Dissertation, Institute of Biology, State University of Campinas, Campinas.

Cielo-Filho, R., Gneri, M.A. & Martins, F.R. (2007). Position on slope, disturbance, and tree species coexistence in a Seasonal Semideciduous Forest in SE Brazil. *Plant Ecology*, **190**, 189-203.

CIIAGRO. (2007) *Boletim Climático: Campinas. Centro Integrado de Informações Agrometeorológicas*. Instituto Agronômico de Campinas, Campinas.

Clark, D.A. & Clark, D.B. (1999) Assessing the growth of tropical rain forest trees: issues for forest modeling and development. *Ecological Applications*, **9**, 981–997.

Condit, R. (1998) Ecological implications of changes in drought patterns: shifts in forest composition in Panama. *Climatic Change*, **39**, 413–427.

Condit, R., Hubbell, S.P. & Foster, R.B. (1993) Mortality and growth of a commercial hardwood 'el cativo', *Prioria copaifera*, in Panama. *Forest Ecology and Management*, **62**, 107–122.

Condit, R., Watts, K., Bohlman, S.A., Pérez, R., Foster, R.B., & Hubbell, S.P. (2000) Quantifying the deciduousness of tropical forest canopies under varying climates. *Journal of Vegetation Science*, **11**, 649–658

Croat, T.B. (1978) *Flora of Barro Colorado Island*. Stanford University Press, Stanford.

Denslow, J.S, Schultz, J.C., Vitousek, P.M., Strain, B.R. (1990) Growth responses of tropical shrubs to treefall gap environments. *Ecology*, **71**, 165–179.

Denslow, J.S., Ellison, A.M., Sanford, R.E. (1998) Treefall gap size effects on above- and below-ground processes in a Tropical Wet Forest. *Journal of Ecology*, **86**, 597–609.

EMBRAPA. (1999) *Sistema brasileiro de classificação de solos.* Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Solos, Brasília.

Engelbrecht, B.M.J. & Kursar, T.A. (2003) Comparative drought-resistance of seedlings of 28 species of co-occurring tropical woody plants. *Oecologia*, **136**, 383–393.

Everham III, E.M., Myster, R.W., van de Genachte, E. (1996) Effects of light, moisture, temperature, and litter on the regeneration of five tree species in the Tropical Montane Wet Forest of Puerto Rico. *American Journal of Botany*, **83**, 1063–1068.

Fonseca, R.C.B. (1998) *Fenologia de trecho de Floresta Estacional Semidecidual, em Botucatu, SP: Relação com as formas de vida, estrutura e fases de desenvolvimento do masaico sucessional*. MSc Dissertation, Superior School of Agriculture "Luiz de Queiroz", University of São Paulo, Piracicaba.

Frankie, G.W., Baker, H.G., Opler, P.A. (1974) Comparative phenological studies of trees in Tropical Wet and Dry Forests in the lowlands of Costa Rica. *Journal of Ecology*, **62**, 881–919.

Frazer, G.W., Canham, C.D., & Lertzman, K.P. (1999) *Gap Light Analyzer (GLA), Version 2.0. Imaging software extract canopy structure and gap light transmission indices from true-colour fisheye photographs, users manual and program documentation*. Simon Fraser University, Bunaby, British Columbia, and the Institute of Ecosystem Studies, Millbrook, New York.

Gandolfi, S. (2000) *História natural de uma Floresta Estacional Semidecidual no Município de Campinas (São Paulo, Brasil).* PhD Thesis, Institute of Biology, State University of Campinas, Campinas.

Gauch Jr, H.G. (1982) *Multivariate analysis in community ecology*. Cambridge University Press. Cambridge.

Gentry, A.H. & Dodson, C. (1987) Contribuition of nontrees to species richness of a tropical rain forest. *Biotropica*, **19**, 149–156.

Gerhardt, K. (1996) Effects of root competition and canopy openness on survival and growth of tree seedlings in a tropical seasonal dry forest. *Forest Ecology and Management*, **82**, 33–48.

Gerwing, J.J., Schnitzer, S.A., Burnham, R.J., Bongers F., Chave, J., Dewalt, S.J., Ewango, C.E.N., Foster, R., Kenfack, D., Martínez-Ramos, M., Parren, M., Parthasarathy, N., Pérez-Salicrup, D.R., Putz, F.E., & Thomas, D.W. (2006) A standard protocol for liana censuses. *Biotropica*, **38**, 256–261.

Greig-Smith, (1983) *Quantitative plant ecology*. 3 ed. Oxford. Black. Well.

Harms, K.E., Wright, S.J., Calderon, O., Hernandez, A. & Herre, E.A. (2000) Pervasive density-dependent recruitment enhances seedling diversity in a neotropical forest. *Nature*, **404**, 493–495.

Hill, M.O. & Gauch Jr, H.G. (1980) Detrended correspondence analysis: an improved ordination technique. *Vegetatio*, **42**, 47–58.

Hubbell, S.P., O'Brien, S.T., Harms, K.E., Foster, R.B., Condit, R., Wechsler, B., Wright, S.J. & Loo De Lao, S. (1999) Light gaps, recruitment limitation, and tree diversity in a neotropical forest. *Science*, **283**, 554–557.

Hutcheson, K. (1970) A test for comparing diversities based on the Shannon formula. *Journal of Theoretical Biology*, **21**, 151–154.

IBGE. (1992) *Manual técnico da vegetação brasileira*. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.

Jackson, D.A. & Somers, K.M. (1991) Putting things in order: the ups and downs of detrended correspondence analysis. *American Naturalist*, **137**, 704–712.

Kabakoff, R.P., Chazdon, R.L. (1996) Effects of canopy species dominance on understorey light availability in low-elevation secondary forest stands in Costa Rica. *Journal of Tropical Ecology*, **12**, 779–788.

Kenkel, N., & Orloci, L. (1986) Applying metric and nonmetric multidimensional scaling to ecological studies: some new results. *Ecology*, **67**, 919–928.

King, D.A. (1994) Influence of light level on the growth and morphology of saplings in a Panamanian Forest. *American Journal of Botany*, **81**, 948–957.

King, D.A., Davies, S.J., Nur Supardi, M.N. & Tan, S. (2005) Tree growth is related to light interception and wood density in two mixed dipterocarp forests of Malaysia. *Functional Ecology*, **19**, 445–453.

Kobe, R.A. (1999) Light gradient partitioning among tropical tree species through differential seedling mortality and growth. *Ecology*, **80**, 187–201.

Kursar, T.A., Engelbrecht, B.M.J. & Tyree, M.T. (2005) A comparison of methods for determining soil water availability in two sites in Panama with similar rainfall but distinct tree communities. *Journal of Tropical Ecology*, **21**, 297–305.

Mattes, L.A.F. (1980) *Composição florística, estrutura e fenologia de uma floresta residual do planalto paulista: Bosque dos Jequitibás (Campinas, SP).* PhD Thesis, Institute of Biology, State University of Campinas, Campinas.

McCune, B. & Mefford, M. J. (1999). PC-ORD. M*ultivariate Analysis of Ecological Data. Version 4.0* MjM Softwar Design. Gleneden Beach, Oregon. U.S.A.

Minchin. P.R. (1987) An evaluation of the relative robustness of techniques for ecological ordination. *Vegetatio*, **69**, 89–107.

Montgomery, R.A. & Chazdon, R.L. (2002) Light gradient partitioning by tropical tree seedlings in the absence of canopy gaps. *Oecologia*, **131**, 165–174.

Morellato, L.P.C. (1991) *Estudo da fenologia de árvores, arbustos e lianas de uma Floresta Semidecídua no Sudeste do Brasil*. PhD Thesis, Institute of Biology, State University of Campinas, Campinas.

Morellato-Fonzar, L.P.C. (1987) *Estudo comparativo de fenologia e dinâmica de duas formações florestais na Serra do Japi, Jundiaí*. MSc Dissertations, Institute of Biology, State University of Campinas, Campinas.

Mueller-Dombois, R. & Ellenberg, H. (1974) A*ims and methods of vegetation ecology*. Willey and Sons, New York.

Mulkey, S.S, Smith, A.P., Wright, S.J. (1991) Comparative life history and physiology of two understory neotropical herbs. *Oecologia*, **88**, 263–273.

Mulkey, S.S., Wright, S.J., Smith, A.P. (1993) Comparative physiology and demography of three Neotropical forest shrubs: alternative shade adaptive character syndromes. *Oecologia*, **96**, 526–536.

Nakagawa, M., Tanaka, K., Nakashizuka, T., Ohkubo, T., Kato, T., Maeda, T., Sato, K., Miguchi, H., Nagamasu, H., Ogino, K., Teo, S., Hamid, A.A. & Lee, H.S. (2000) Impact of severe drought associated with the 1997-1998 El Niño in a tropical forest in Sarawak. *Journal of Tropical Ecology*, **16**, 355–367.

Oberbauer, S.F., Clark, D.B., Clark, D.A., Rich, P.M., & Vega, G. (1993) Light environment, gas exchange, and annual growth of saplings of three species of Rain Forest trees in Costa Rica. *Journal of Tropical Ecology*, **9**, 511–523.

Palmer, M.W. (1993) Putting things in even better order: the advantages of canonical correspondence analysis. *Ecology*, **74**, 2215–2230.

Pearcy, R.W. & Calkin, H. (1983) Carbon dioxide exchange of C3 and C4 tree species in the understory of a Hawaiian forest. *Oecologia*, **58**, 26–32.

Pearcy, R.W. (1983) The light environment and growth of C3 and C4 species in the understory of a Hawaiian forest. *Oecologia*, 58: 19–25.

Peet, R.K., Knox, R.G., Case, J.S. & Allen, R.B. (1988) Putting things in order: the advantages of detrended correspondence analysis. *American Naturalist*, **131**, 924–934.

Peñalosa, J. (1984) Basal branching and vegetative spread in two Tropical Rain Forest lianas. *Biotropica*, **16**, 1–9.

Poorter, L. & Hayashida-Oliver, Y. (2000) Effects of seasonal drought on gap and understorey seedlings in a Bolivian Moist Forest. *Journal of Tropical Ecology*, **16**, 481–498.

Poorter, L. (2001) Light-dependent changes in allocation and their effects on the growth of rain forest tree species. *Functional Ecology*, **15**, 113–123.

Popma, J. & Bongers, F. (1991) Acclimation of seedlings of three Mexican Tropical Rain Forest tree species to a change in light availability. *Journal of Tropical Ecology*, **7**, 85–97.

Raich, J.W. (1989) Seasonal and spatial variation in the light environment in a Tropical Dipterocarp Forest and gaps. *Biotropica*, **21**, 299–302.

Reich, P.B. & Borchert, R. (1984) Water stress and tree phenology in a Tropical Dry Forest in the lowlands of Costa Rica. *Journal of Ecology*, **72**, 61–74.

Santin D.A. (1999) *A vegetação remanescente do município de Campinas (SP): mapeamento, caracterização fisionômica e florística, visando a conservação*. MSc Dissertation, Institute of Biology, State University of Campinas, Campinas.

Shannon, C.E & Weaver, W. (1948) *The Mathematical Theory of Communication*. Urbana: University of Illinois Press.

Shepherd, G.J. (1996) *Fitopac 1: manual do usuário.* Department of Botany, State University of Campinas, Campinas.

Silvera, K., Skillman, J.B. & Dalling, J.W. (2003) Seed germination, seedling growth and habitat partitioning in two morphotypes of the tropical pioneer tree Trema micrantha in a seasonal forest in Panama. J*ournal of Tropical Ecology*, **19**, 27–34.

Simpson, E.H. (1949) Measurement of diversity. *Nature*, **163**, 688.

Smith, A.R., Pryer, K.M., Schuettpelz, E., Korall, P., Schneider, H., & WOLF, P.G. (2006) A classification for extant ferns. *Táxon*, **55**, 705–731.

Sokal, R.R. & Rohlf, F.J. (1995) *Biometry: the principles and practice of statistics in biological research*. W. H. Freeman, New York.

Sterck, F.J., Clark, D.B., Clark, D.A. & Bongers, F. (1999) Light fluctuations, crown traits and response delays for tree saplings in a Costa Rican lowland rain forest. *Journal of Tropical Ecology*, **15**, 83–95.

Sterck, F.J., Martinez-Ramos, M., Dyer-Leal, G., Rodríguez-Velazquez, J. & Poorter, L. (2003) The consequences of crown traits for the growth and survival of tree saplings in a Mexican lowland rainforest. *Functional Ecology*, **17**, 194–200.

Strong, D.R. & RAY, T.S. (1975) Host tree location behavior of a tropical vine (*Monstera gigantea*) by scototropism. *Science*, **190**, 804–806.

Thomas, G. & Clay, D. (2000) *Biodap - Ecological diversity and its measurement*. Ed. Resource Conservation Fundy National Park. New Brunswick, Canada. Available in: http://nhsbig.inhs.uiuc.edu/populations/bio–dap.zip

Turner, I.M., Tan, H.T.W. & Chua, K.S. (1996) Relatonships between herb layer and canopy composition in a tropical rain forest successional mosaic in Singapore. *Journal of Tropical Ecology*, **12**, 843–851.

Uhl, C., Clark, K., Dezzeo, N. & Maquirino, P. (1988.) Vegetation dynamics in Amazonian treefall gaps. *Ecology*, **69**, 751–763.

van Schaik, C.P., Terborgh, J.W., Wright, S.J. (1993) The phenology of Tropical Forests: adaptive significance and consequences for primary consumers. *Annual Review of Ecology and Systematics*, **24**, 353–377.

Veenendaal, E., Swaine, M.D., Agyeman, V., Blay, D., Abebrese, I. & Mullins, C.E. (1995) Differences in plant and soil water relations in and around a forest gap in West Africa during the dry season may influence seedling establishment and survival. *Journal of Ecology*, **83**, 83–90.

Wartenberg, D.S. Ferson. & Rohlf, F. J. (1987) Putting things in order: a critique of detrended correspondence analysis. *American Naturalist*, **129**, 434–448.

Webb, C.O. & Peart, D.R. (1999) Seedling density dependence promotes coexistence of Bornean rain forest trees. *Ecology*, **80**, 2006–2017.

Whitmore,T.C., Brown, N.D., Swaine, M.D., Kennedy, D., Goodwinbaley, C.I. & Gong, W.K. (1993) Use of hemisferical photographs in forest Ecology: measurement of gap size and radiation totals in a Borneo tropical rain forest. *Journal of Tropical Ecology*, **9**, 131–151.

Whittaker, R.H. (1967) Dominance and diversity in land plant communities. *Science*, **147**, 250–260.

Wilkinson, L., (1998) *SYSTAT 9.0 for Windows: Statistics*. SPSS Inc., Chicago.

Wright, S.J. (1991) Seasonal drought and the phenology of understory shrubs in a Tropical Moist Forest. *Ecology*, **72**, 1643–1657.

Zar, J.H. (1999) *Biostatistical analysis*. 2 ed. Prentice Hall, New Jearsey.

Appendix 1

Ground layer species in a 0.02 ha of a Tropical Semideciduous Seasonal Forest fragment in Southeastern Brazil – Ribeirão Cachoeira Forest.

	Rainy Season	Dry Season	Growth-form
Acanthaceae			
Acanthaceae 1	X	X	Herb
Geissomeria longiflora Lindl.	X	X	Herb
Justicia carnea Lindl.		X	Herb
Justicia lythrioides (Nees) V.A.Graham	X	X	Herb
Lepidagathis diffusa Lindau	X	X	Herb
Ruellia brevifolia (Pohl) C.Ezcurra	X	X	Herb
Agavaceae			
Herreria salsaparrilha Mart.	X	X	Herb
Amaranthaceae			
Alternanthera micrantha R. E. Fr.	X	X	Herb
Chamissoa acuminata Mart.	X	X	Vine
Chamissoa altissima (Jacq.) Kunth	X	X	Vine
Anacardiaceae			
Astronium graveolens Jacq.	X	X	Tree
Anonnaceae			
Guatteria nigrescens Mart.	X	X	Tree
Apocynaceae			
Aspidosperma polyneuron Müll.Arg.	X	X	Tree
Aspidosperma ramiflorum Müll.Arg.	X	X	Tree
Araceae			
Asterostigma lombardii E.G.Gonç.	X		Herb
Arecaceae			
Syagrus romanzoffiana (Cham.) Glassman	X	X	Herb
Aristolochiaceae			
Aristolochia arcuata Mart.	X	X	Vine
Bignoniaceae			
Adenocalymma bracteatum (Cham.) DC.	X	X	Liana
Adenocalymma marginatum (Cham.) DC.	X	X	Liana
Arrabidaea conjugata (Vell.) Mart.	X	X	Liana
Bignoniaceae 1	X	X	Miscellanea
Bignoniaceae 2	X	X	Miscellanea
Bignoniaceae 3	X	X	Miscellanea
Clytostoma binatum (Thunb.) Sandwith	X	X	Liana
Clytostoma campanulatum (Cham.) Bur.	X	X	Liana
Macfadyena unguis-cati (L.) A.H.Gentry	X	X	Liana
Mansoa difficilis (Cham.) Bureau & K.Schum.	X	X	Liana
Melloa quadrivalvis (Jaqc.) A.H.Gentry	X	X	Liana
Pleonotoma tetraquetra (Cham.) Bureau.	X	X	Liana
Stizophyllum perforatum (Cham.) Miers	X	X	Liana

Appendix 1 (*cont..*)

Boraginaceae			
Cordia cf. ecalyculata Vell.	X	X	Tree
Cactaceae			
Pereskia aculeata Mill.	X	X	Vine
Cannabaceae			
Celtis ehrenbergiana (Klotzsch) Liebm.	X	X	Treelet
Celtis iguanaea (Jacq.) Sarg.	X	X	Shrub
Celastraceae			
Anthodon decussatum Ruiz & Pav.	X	X	Liana
Elachyptera micrantha (Cambess.) A.C.Sm.	X	X	Liana
Hippocratea volubilis L.	X	X	Liana
Maytenus aquifolium Mart.	X	X	Treelet
Tontelea sp.	X	X	Liana
Commelinaceae			
Dichorisandra incurva Mart.	X	X	Herb
Connaraceae			
Connarus regnellii Schellenb.	X	X	Tree
Convolvulaceae			
Ipomoea purpurea (L.) Roth	X	X	Vine
Cucurbitaceae			
Cucurbitaceae 1		X	Vine
Dilleniaceae			
Davilla rugosa Poir.	X	X	Liana
Doliocarpus cf. dentatus (Aubl.) Standl.	X	X	Liana
Dioscoriaceae			
Dioscorea alata L.	X	X	Vine
Dioscorea discolor	X	X	Vine
Dryopteridaceae			
Dryopteris sp.	X	X	Herb
Euphorbiaceae			
Actinostemon communis (Müll.Arg.) Pax	X	X	Treelet
Actinostemon concepcionis (Chodat & Hassl.) Hochr.	X	X	Treelet
Actinostemon concolor (Spreng.) Müll.Arg.	X	X	Treelet
Croton floribundus Spreng.	X	X	Treelet
Dalechampia triphylla Lam.	X	X	Liana
Euphorbiaceae 1	X	X	Miscellanea
Euphorbiaceae 2	X	X	Miscellanea
Euphorbiaceae 3		X	Miscellanea
Sebastiania edwalliana Pax & Hoffm	X	X	Shrub
Sebastiania sp.			Shrub
Tragia sellowiana Muell-Arg.	X	X	Vine
Fabaceae			
Acacia polyphylla DC.	X	X	Tree
Bauhinia microstachya (Raddi) J.F.Macbr.	X	X	Liana
Centrolobium tomentosum Guillemin ex Benth.	X	X	Tree
Dalbergia frutescens (Vell.) Britton	X	X	Liana

Appendix 1 (*cont.*.)

Holocalyx balansae Mich.	X	X	Tree
Hymenaea courbaril L.		X	Tree
Inga luschnatiana Benth.	X	X	Tree
Machaerium acutifolium Vogel	X	X	Tree
Piptadenia gonoacantha (Mart.) J.F.Macbr.	X	X	Tree
Lamiaceae			
Aegiphila sellowiana Cham.	X	X	Treelet
Lauraceae			
Endlicheria paniculata (Spreng.) J.F.Macbr.	X	X	Tree
Licaria armeniaca (Nees) Kosterm.	X	X	Tree
Nectandra megapotamica (Spreng.) Mez	X	X	Tree
Ocotea odorifera (Vell.) Rohwer	X	X	Tree
Ocotea beulahiae Baitello.	X	X	Tree
Ocotea indecora (Schott) Mez.		X	Tree
Ocotea diospyrifolia (Meisn.) Mez	X	X	Tree
Lecythidaceae			
Cariniana estrellensis (Raddi) Kuntze	X	X	Tree
Cariniana legalis (Mart.) Kuntze	X	X	Tree
Malpighiaceae			
Banisteriopsis anisandra (A. Juss.) B. Gates.	X	X	Liana
Banisteriopsis sp.	X	X	Liana
Heteropterys intermedia (A.Juss.) Griseb.	X	X	Liana
Malpighiaceae 1	X	X	Miscellanea
Malpighiaceae 2	X	X	Miscellanea
Malvaceae			
Abutilon peltatum K.Schum.	X	X	Shrub
Byttneria catalpifolia Jacq.	X	X	Vine
Malvaceae 1		X	Shrub
Malvaceae 2	X	X	Shrub
Marantaceae			
Marantaceae 1	X	X	Herb
Melastomataceae			
Miconia pusilliflora (DC.) Naudin	X	X	Treelet
Meliaceae			
Trichilia casaretti C.DC.	X	X	Treelet
Trichilia catigua A.Juss.	X	X	Treelet
Trichilia clausenii C.DC.	X	X	Treelet
Trichilia elegans A.Juss.	X	X	Treelet
Trichilia pallida Sw.	X	X	Treelet
Monimiaceae			
Mollinedia clavigera Tul.	X	X	Shrub
Mollinedia widgrenii A.DC.	X		Treelet
Moraceae			
Brosimum glaziovii Taub.	X	X	Treelet
Morphospecie			
Morphospecie 01	X	X	Miscellanea

Appendix 1 (*cont..*)

Morphospecie 02	X	X	Miscellanea
Morphospecie 03		X	Miscellanea
Morphospecie 04	X	X	Miscellanea
Morphospecie 05	X	X	Miscellanea
Morphospecie 06	X	X	Miscellanea
Morphospecie 07	X	X	Miscellanea
Morphospecie 08		X	Miscellanea
Morphospecie 09		X	Miscellanea
Morphospecie 10		X	Miscellanea
Morphospecie 11		X	Miscellanea
Morphospecie 12	X	X	Miscellanea
Morphospecie 13	X	X	Miscellanea
Morphospecie 14	X	X	Miscellanea
Morphospecie 15		X	Miscellanea
Morphospecie 16	X	X	Miscellanea
Morphospecie 17	X	X	Miscellanea
Morphospecie 18	X	X	Miscellanea
Morphospecie 19	X	X	Miscellanea
Morphospecie 20	X	X	Miscellanea
Morphospecie 21		X	Miscellanea
Morphospecie 22	X	X	Miscellanea
Morphospecie 23		X	Miscellanea
Morphospecie 24	X	X	Miscellanea
Morphospecie 25	X	X	Miscellanea
Morphospecie 26	X	X	Miscellanea
Morphospecie 27	X	X	Miscellanea
Morphospecie 28	X	X	Miscellanea
Morphospecie 29		X	Miscellanea
Morphospecie 30	X	X	Miscellanea
Myrsinaceae			
Ardisia warminguii (Mez) Bernacci & Jung-Mend.	X	X	Shrub
Myrsine umbellata Mart.	X	X	Tree
Myrtaceae			
Calycorectes acutatus (Miq.) Toledo		X	Tree
Calyptranthes clusiifolia (Miq.) O.Berg	X	X	Tree
Eugenia burkartiana (D. Legrand.) D. Legrand.	X	X	Tree
Eugenia cerasiflora Miq.	X	X	Tree
Eugenia egensis DC.	X	X	Tree
Eugenia excelsa O.Berg	X	X	Tree
Eugenia ligustrina (Sw.) Willd.	X	X	Tree
Eugenia sp.1	X	X	Tree
Eugenia sp.2	X	X	Tree
Myrceugenia campestris (DC.) D.Legrand & Kausel	X	X	Tree
Myrcia fallax (Rich.) DC.	X	X	Tree
Olacaceae			
Schoepfia brasiliensis A.DC.	X	X	Tree

Appendix 1 (*cont..*)

Orchidaceae			
Cyclopogon cf congestus (Vell.) Hoehne	X	X	Herb
Oeceoclades maculata (Lindl.) Lindl.	X	X	Herb
Prescottia stachyodes (Sw.) Lindl.	X	X	Herb
Oxalidaceae			
Oxalis rombeo-ovata A.St.-Hil.	X	X	Herb
Phytolaccaceae			
Gallesia integrifolia (Spreng.) Harms	X	X	Tree
Seguieria langsdorffii Moq.	X	X	Tree
Piperaceae			
Ottonia leptostachya Kunth	X	X	Shrub
Piper amalago L.	X	X	Shrub
Pothomorphe umbellata (L.) Miq.		X	Shrub
Poaceae			
Olyra ciliatifolia Raddi	X	X	Herb
Parodiolyra micrantha (Kunth) Davidse & Zuloaga	X	X	Herb
Pharus parvifolius Nash.	X	X	Herb
Pseudoechinolaena polystachya (Kunth) Stapf.	X	X	Herb
Polygalaceae			
Polygala klotzschii Chodat.	X	X	Shrub
Rhamnaceae			
Gouania virgata Reissek	X	X	Liana
Rosaceae			
Prunus myrtifolia (L.) Urb.	X	X	Tree
Rubiaceae			
Coccocypselum cordifolium Nees & Mart.	X	X	Herb
Coffea arabica L.	X	X	Treelet
Manettia gracilis Cham. & Schltdl.	X	X	Vine
Psychotria brevicollis Müll.Arg.	X	X	Shrub
Psychotria carthagenensis Jacq.	X	X	Shrub
Psychotria cephalantha (Müll.Arg.) Standl.	X	X	Shrub
Psychotria chaenotricha DC.	X	X	Shrub
Psychotria myriantha Müll.Arg.	X	X	Shrub
Rubiaceae 1	X	X	Shrub
Rudgea jasminoides (Cham.) Müll.Arg.	X	X	Treelet
Rutaceae			
Almeidea lilacina A.St.-Hil.	X	X	Treelet
Conchocarpus pentandrus (A.St.-Hil.) Kallunki & Pirani	X	X	Treelet
Esenbeckia grandiflora Mart.	X	X	Treelet
Esenbeckia leiocarpa Engl.	X	X	Tree
Galipea jasminiflora (A.St.-Hil.) Engl.	X	X	Treelet
Metrodorea nigra A.St.-Hil.	X	X	Treelet
Salicaceae			
Casearia decandra Jacq.		X	Tree
Sapindaceae			
Cupania vernalis Cambess.	X	X	Tree

Appendix 1 (*cont.*.)

Paullinia meliaefolia Juss.	X	X	Liana
Serjania glabrata Kunth	X	X	Liana
Serjania lethalis A.St.-Hil.	X	X	Liana
Serjania meridionalis Cambess.	X	X	Liana
Urvillea laevis Radlk.	X	X	Liana
Sapotaceae			
Chrysophyllum gonocarpum (Mart. & Eichl.) Engl	X	X	Tree
Smilacaceae			
Smilax fluminensis Steud.	X	X	Vine
Solanaceae			
Brunfelsia pauciflora (Cham. & Schltdl.) Benth.		X	Shrub
Solanum gnaphalocarpon Vell.	X	X	Treelet
Sonalum sp.	X	X	Miscellanea
Thelypteridaceae			
Thelypteridaceae 1	X	X	Herb
Trigoniaceae			
Trigonia nivea Cambess.	X	X	Liana
Urticaceae			
Urera baccifera (L.) Gaudich.	X	X	Treelet
Verbenaceae			
Verbenaceae 1	X	X	Miscellanea
Violaceae			
Hybanthus atropurpureus (A.St.-Hil.) Taub.	X	X	Shrub
Violaceae 1	X	X	Miscellanea

Appendix 2

Community descriptors for ground layer species in 0.02ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in rainy season (January – February). NI = Number of Individuals; IVI = Importance Value Index; AD = Absolute Density (number individuals/hectare); RD = Relative Density (%); AF = Absolute Frequency; RF = Relative (%); ABA = Absolute Basal Area (m²/herctare); RBA = Relative Basal (%); APC = Absolute Plant Cover; RPC = Relative Plant Cover (%). Species are arranged in decrease of IVI

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Clytostoma campanulatum	630	30.7	31500	11.51	92	3.37	0.3813	15.82	33167.5	24.7787
Oeceoclades maculata	62	19.97	3100	1.13	50	1.83	0.4098	17	1677.5	1.2532
Actinostemon communis	424	16.65	21200	7.74	64	2.35	0.158	6.56	13140	9.8166
Adenocalymma bracteatum	400	13.82	20000	7.31	78	2.86	0.0882	3.66	11477.5	8.5746
Coffea arabica	152	11.19	7600	2.78	66	2.42	0.1444	5.99	6852.5	5.1193
Mansoa difficilis	322	10.16	16100	5.88	90	3.3	0.0235	0.97	4597.5	3.4347
Pereskia aculeata	138	8.98	6900	2.52	74	2.71	0.0903	3.75	3560	2.6596
Serjania lethalis	193	7.84	9650	3.53	78	2.86	0.035	1.45	5940	4.4376
Metrodorea nigra	94	7.41	4700	1.72	70	2.57	0.0754	3.13	5200	3.8848
Ardisia warminguii	155	6.83	7750	2.83	42	1.54	0.0592	2.46	4025	3.0070
Aspidosperma polyneuron	85	6.55	4250	1.55	52	1.91	0.0746	3.09	2557.5	1.9106
Oxalis rombeo-ovata	102	6.19	5100	1.86	44	1.61	0.0655	2.72	5147.5	3.8456
Adenocalymma marginatum	131	5.45	6550	2.39	54	1.98	0.0259	1.08	3220	2.4056
Parodiolyra micrantha	124	5.4	6200	2.26	34	1.25	0.0455	1.89	6560	4.9008
Hippocratea volubilis	84	4.76	4200	1.53	48	1.76	0.0354	1.47	4357.5	3.2554
Hybanthus artropurpureus	54	4.71	2700	0.99	42	1.54	0.0526	2.18	2992.5	2.2356
Melloa quadruvalis	72	4.51	3600	1.32	54	1.98	0.0294	1.22	2417.5	1.8061
Clytostoma binatum	63	4.39	3150	1.15	36	1.32	0.0462	1.92	3750	2.8015
Aspidosperma ramiflorum	44	4.24	2200	0.8	34	1.25	0.0528	2.19	2870	2.1441
Cariniana legalis	40	4.17	2000	0.73	36	1.32	0.0511	2.12	2417.5	1.8061
Arrabidea conjugata	89	3.56	4450	1.63	48	1.76	0.0042	0.17	822.5	0.6145
Urvillea laevis	91	3.29	4550	1.66	38	1.39	0.0057	0.23	935	0.6985
Polygala klotzchii	64	3.07	3200	1.17	14	0.51	0.0335	1.39	3410	2.5475
Macfadyena ungis-cati	57	3.06	2850	1.04	34	1.25	0.0186	0.77	1340	1.0011

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Syagrus romanzoffiana	66	3.04	3300	1.21	38	1.39	0.0107	0.45	1252.5	0.9357
Lepidagathis diffusa	80	2.78	4000	1.46	28	1.03	0.0071	0.3	1090	0.8143
Bignoniaceae 1	55	2.71	2750	1	40	1.47	0.0056	0.23	397.5	0.2970
Actinostemon concepcionis	51	2.71	2550	0.93	46	1.69	0.0023	0.1	520	0.3885
Serjania meridionalis	53	2.67	2650	0.97	38	1.39	0.0073	0.3	915	0.6836
Olyra ciliatifolia	47	2.63	2350	0.86	24	0.88	0.0215	0.89	2987.5	2.2319
Galipea jasminiflora	59	2.62	2950	1.08	28	1.03	0.0123	0.51	1770	1.3223
Piptadenia gonoacantha	43	2.17	2150	0.79	32	1.17	0.0052	0.22	1210	0.9040
Ruellia brevifolia	49	2.08	2450	0.89	24	0.88	0.0075	0.31	1390	1.0384
Almeidea lilacina	30	1.93	1500	0.55	30	1.1	0.0068	0.28	607.5	0.4538
Malpighiaceae 1	40	1.92	2000	0.73	26	0.95	0.0058	0.24	1017.5	0.7602
Astronium graviollens	24	1.85	1200	0.44	26	0.95	0.0111	0.46	960	0.7172
Celtis ehreubergiana	23	1.73	1150	0.42	16	0.59	0.0175	0.72	1687.5	1.2607
Seguieria langsdorfii	13	1.71	650	0.24	16	0.59	0.0213	0.89	1167.5	0.8722
Esenbeckia leiocarpa	36	1.7	1800	0.66	24	0.88	0.0039	0.16	585	0.4370
Sebastiania edwalliana	27	1.66	1350	0.49	22	0.81	0.0088	0.36	850	0.6350
Banisteriopsis anisandra	18	1.66	900	0.33	22	0.81	0.0127	0.53	1350	1.0086
Trigonia nivea	39	1.64	1950	0.71	24	0.88	0.001	0.04	282.5	0.2110
Eugenia egensis	56	1.6	2800	1.02	12	0.44	0.0033	0.13	622.5	0.4651
Trichilia clausenii	17	1.58	850	0.31	22	0.81	0.0112	0.46	892.5	0.6668
Anthondon decussatum	24	1.53	1200	0.44	24	0.88	0.0051	0.21	690	0.5155
Ocotea beulahiae	27	1.47	1350	0.49	22	0.81	0.0042	0.17	472.5	0.3530
Gallesia integrifolia	29	1.38	1450	0.53	20	0.73	0.0029	0.12	330	0.2465
Bignoniaceae 3	18	1.37	900	0.33	28	1.03	0.0004	0.02	105	0.0784
Conchocarpus pentandrus	16	1.37	800	0.29	8	0.29	0.019	0.79	1225	0.9152
Alternanthera micrantha	40	1.36	2000	0.73	16	0.59	0.0009	0.04	280	0.2092
Coccocypselum cordifolium	52	1.25	2600	0.95	6	0.22	0.002	0.08	320	0.2391
Heteropterys intermedia	25	1.19	1250	0.46	16	0.59	0.0036	0.15	805	0.6014
Justicia lithroides	28	1.18	1400	0.51	14	0.51	0.0037	0.16	770	0.5752
Bignoniaceae 2	22	1.18	1100	0.4	20	0.73	0.0011	0.05	167.5	0.1251
Morphospecie 26	22	1.15	1100	0.4	20	0.73	0.0004	0.02	125	0.0934
Croton floribundus	24	1.11	1200	0.44	16	0.59	0.0021	0.09	592.5	0.4426
Geissomeria longiflora	20	1.07	1000	0.37	14	0.51	0.0046	0.19	500	0.3735

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Prescottia stachyodes	18	1.06	900	0.33	14	0.51	0.0053	0.22	185	0.1382
Piper amalago	14	1.06	700	0.26	16	0.59	0.0052	0.22	750	0.5603
Dichorisandra incurva	16	1.05	800	0.29	16	0.59	0.0042	0.17	445	0.3324
Trichilia catigua	11	1	550	0.2	14	0.51	0.0069	0.29	805	0.6014
Trichilia elegans	14	0.93	700	0.26	14	0.51	0.0038	0.16	455	0.3399
Eugenia ligustrina	22	0.92	1100	0.4	8	0.29	0.0055	0.23	730	0.5454
Centrolobium tomentosum	21	0.91	1050	0.38	8	0.29	0.0055	0.23	492.5	0.3679
Ottonia leptostachya	15	0.88	750	0.27	8	0.29	0.0076	0.32	1362.5	1.0179
Serjania glabrata	12	0.88	600	0.22	16	0.59	0.0017	0.07	417.5	0.3119
Tragia sellowiana	14	0.87	700	0.26	16	0.59	0.0008	0.03	272.5	0.2036
Doliocarpus cf. dentatus	8	0.85	400	0.15	16	0.59	0.0029	0.12	442.5	0.3306
Machaerium acutifolium	15	0.84	750	0.27	14	0.51	0.0012	0.05	267.5	0.1998
Morphospecie 02	12	0.83	600	0.22	16	0.59	0.0005	0.02	82.5	0.0616
Stizophyllun perforatum	9	0.82	450	0.16	14	0.51	0.0036	0.15	400	0.2988
Eugenia sp.1	10	0.8	500	0.18	16	0.59	0.0007	0.03	85	0.0635
Dalechampia triphylla	13	0.79	650	0.24	14	0.51	0.0009	0.04	127.5	0.0953
Holocalyx balansae	11	0.78	550	0.2	14	0.51	0.0017	0.07	225	0.1681
Morphospecie 21	10	0.78	500	0.18	16	0.59	0.0003	0.01	72.5	0.0542
Myrceugenia campestris	12	0.75	600	0.22	14	0.51	0.0004	0.01	105	0.0784
Maytenus aquifolium	6	0.75	300	0.11	8	0.29	0.0083	0.35	262.5	0.1961
Elachyptera micrantha	16	0.74	800	0.29	6	0.22	0.0055	0.23	1000	0.7471
Myrsine umbellata	15	0.74	750	0.27	12	0.44	0.0007	0.03	102.5	0.0766
Basnisteropsis sp.	9	0.72	450	0.16	14	0.51	0.001	0.04	300	0.2241
Cupania vernalis	12	0.69	600	0.22	12	0.44	0.0008	0.03	112.5	0.0840
Smilax fluminensis	11	0.68	550	0.2	10	0.37	0.0027	0.11	205	0.1532
Urera baccifera	9	0.67	450	0.16	12	0.44	0.0016	0.07	190	0.1419
Eugenia cerasiflora	15	0.66	750	0.27	10	0.37	0.0005	0.02	75	0.0560
Psychotria chaenotrichia	14	0.64	700	0.26	8	0.29	0.0023	0.09	312.5	0.2335
Morphospecie 01	13	0.64	650	0.24	10	0.37	0.001	0.04	177.5	0.1326
Ipomoea purpurea	10	0.63	500	0.18	8	0.29	0.0037	0.15	450	0.3362
Morphospecie 22	8	0.6	400	0.15	12	0.44	0.0004	0.02	55	0.0411
Trichilia casaretti	12	0.54	600	0.22	6	0.22	0.0024	0.1	310	0.2316
Rubiaceae 1	6	0.54	300	0.11	10	0.37	0.0016	0.07	117.5	0.0878

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Eugenia sp.2	8	0.51	400	0.15	8	0.29	0.0016	0.07	137.5	0.1027
Rudgea jasminoides	7	0.49	350	0.13	8	0.29	0.0018	0.07	230	0.1718
Marantaceae 1	6	0.48	300	0.11	6	0.22	0.0037	0.15	467.5	0.3493
Morphospecie 05	5	0.47	250	0.09	10	0.37	0.0002	0.01	70	0.0523
Aegiphila sellowiana	5	0.46	250	0.09	6	0.22	0.0035	0.15	337.5	0.2521
Asterostigma lombardii	5	0.45	250	0.09	8	0.29	0.0016	0.07	150	0.1121
Dryopteris sp.	4	0.44	200	0.07	8	0.29	0.0018	0.07	450	0.3362
Cordia cf. ecalyculata	5	0.41	250	0.09	6	0.22	0.0024	0.1	175	0.1307
Connarus regnellii	3	0.41	150	0.05	6	0.22	0.0033	0.14	225	0.1681
Psychotria myriantha	4	0.38	200	0.07	4	0.15	0.0038	0.16	110	0.0822
Chamissoa acuminata	8	0.37	400	0.15	4	0.15	0.0018	0.07	210	0.1569
Dioscorea alata	7	0.37	350	0.13	6	0.22	0.0006	0.03	137.5	0.1027
Violaceae 1	6	0.34	300	0.11	6	0.22	0.0002	0.01	30	0.0224
Miconia pussiliflora	6	0.33	300	0.11	6	0.22	0.0001	0	37.5	0.0280
Paullinea meliaefolia	4	0.33	200	0.07	6	0.22	0.0008	0.03	212.5	0.1588
Actinostemon concolor	3	0.33	150	0.05	4	0.15	0.0032	0.13	200	0.1494
Mollinedia clavigera	3	0.33	150	0.05	4	0.15	0.0031	0.13	375	0.2802
Davilla rugosa	5	0.32	250	0.09	4	0.15	0.0019	0.08	162.5	0.1214
Pleonotoma tetraquetra	4	0.31	200	0.07	6	0.22	0.0004	0.02	72.5	0.0542
Manettia gracilis	3	0.31	150	0.05	6	0.22	0.0008	0.03	162.5	0.1214
Eugenia burkartiana	6	0.3	300	0.11	4	0.15	0.001	0.04	130	0.0971
Inga luschnatiana	4	0.3	200	0.07	4	0.15	0.002	0.08	225	0.1681
Solanum gnaphalocarpon	3	0.3	150	0.05	6	0.22	0.0006	0.02	75	0.0560
Gouania virgata	3	0.28	150	0.05	6	0.22	0.0001	0.01	67.5	0.0504
Morphospecie 17	3	0.28	150	0.05	6	0.22	0.0001	0	22.5	0.0168
Herreria salsaparilha	5	0.26	250	0.09	2	0.07	0.0023	0.1	187.5	0.1401
Chamissoa altissima	3	0.26	150	0.05	2	0.07	0.0032	0.13	35	0.0261
Nectandra megapotamica	1	0.26	50	0.02	2	0.07	0.0041	0.17	300	0.2241
Psychotria brevicolis	2	0.25	100	0.04	4	0.15	0.0015	0.06	187.5	0.1401
Trichilia pallida	2	0.25	100	0.04	4	0.15	0.0016	0.07	200	0.1494
Abutilon peltatum	2	0.24	100	0.04	2	0.07	0.0032	0.13	212.5	0.1588
Dalbergia frutescens	3	0.23	150	0.05	4	0.15	0.0008	0.03	100	0.0747
Thelypteridaceae 1	3	0.23	150	0.05	4	0.15	0.0006	0.02	212.5	0.1588

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Eugenia excelsa	2	0.23	100	0.04	2	0.07	0.0028	0.12	262.5	0.1961
Myrcia fallax	2	0.23	100	0.04	4	0.15	0.0011	0.04	112.5	0.0840
Ocotea odorifera	2	0.23	100	0.04	4	0.15	0.001	0.04	100	0.0747
Acanthaceae 1	3	0.22	150	0.05	4	0.15	0.0005	0.02	42.5	0.0318
Euphorbiaceae 03	3	0.21	150	0.05	4	0.15	0.0001	0	15	0.0112
Pseudoechinolaena polystachya	3	0.21	150	0.05	4	0.15	0.0003	0.01	50	0.0374
Prunus myrtidifolia	2	0.21	100	0.04	4	0.15	0.0007	0.03	87.5	0.0654
Morphospecie 16	3	0.2	150	0.05	4	0.15	0.0001	0	15	0.0112
Dioscorea discolor	5	0.19	250	0.09	2	0.07	0.0007	0.03	117.5	0.0878
Bauhinia micrantha	2	0.19	100	0.04	4	0.15	0.0001	0	55	0.0411
Calyptranthes clusiifolia	2	0.19	100	0.04	2	0.07	0.0018	0.08	225	0.1681
Malpighiaceae 2	2	0.19	100	0.04	4	0.15	0.0001	0	50	0.0374
Schoepfia brasiliensis	2	0.19	100	0.04	4	0.15	0.0001	0	17.5	0.0131
Morphospecie 25	2	0.18	100	0.04	4	0.15	0	0	17.5	0.0131
Verbenaceae 1	1	0.18	50	0.02	2	0.07	0.002	0.08	25	0.0187
Psychotria cephalanta	1	0.17	50	0.02	2	0.07	0.0019	0.08	112.5	0.0840
Aristolochia arcuata	4	0.15	200	0.07	2	0.07	0.0001	0	92.5	0.0691
Cyclopogon cf. congestus	3	0.15	150	0.05	2	0.07	0.0006	0.03	75	0.0560
Byttneria catalpifolia	3	0.14	150	0.05	2	0.07	0.0003	0.01	125	0.0934
Cariniana estrellensis	1	0.14	50	0.02	2	0.07	0.0013	0.05	100	0.0747
Chrysophyllum gonocarpum	1	0.14	50	0.02	2	0.07	0.0012	0.05	50	0.0374
Licaria armeniaca	1	0.14	50	0.02	2	0.07	0.0011	0.04	75	0.0560
Esenbeckia grandiflora	1	0.12	50	0.02	2	0.07	0.0006	0.02	37.5	0.0280
Sebastiania sp.	2	0.11	100	0.04	2	0.07	0.0001	0	10	0.0075
Morphospecie 06	1	0.11	50	0.02	2	0.07	0.0004	0.01	37.5	0.0280
Morphospecie 07	1	0.11	50	0.02	2	0.07	0.0004	0.01	12.5	0.0093
Pharus parvifolius	1	0.11	50	0.02	2	0.07	0.0004	0.01	25	0.0187
Psychotria cathargenensis	1	0.11	50	0.02	2	0.07	0.0004	0.02	75	0.0560
Acacia polyphylla	1	0.1	50	0.02	2	0.07	0.0002	0.01	50	0.0374
Brosimum glaziovii	1	0.1	50	0.02	2	0.07	0.0002	0.01	25	0.0187
Endlicheria paniculata	1	0.1	50	0.02	2	0.07	0.0001	0.01	37.5	0.0280
Euphorbiaceae 01	1	0.1	50	0.02	2	0.07	0.0002	0.01	25	0.0187
Euphorbiaceae 02	1	0.1	50	0.02	2	0.07	0.0002	0.01	12.5	0.0093

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Guatteria nigrescens	1	0.1	50	0.02	2	0.07	0.0002	0.01	37.5	0.0280
Morphospecie 04	1	0.1	50	0.02	2	0.07	0.0002	0.01	25	0.0187
Morphospecie 12	1	0.1	50	0.02	2	0.07	0.0003	0.01	25	0.0187
Morphospecie 13	1	0.1	50	0.02	2	0.07	0.0001	0.01	12.5	0.0093
Ocotea diospyrifolia	1	0.1	50	0.02	2	0.07	0.0002	0.01	25	0.0187
Tontelea sp.	1	0.1	50	0.02	2	0.07	0.0002	0.01	25	0.0187
Malvaceae 2	1	0.09	50	0.02	2	0.07	0	0	12.5	0.0093
Mollinedia widgrenii	1	0.09	50	0.02	2	0.07	0.0001	0	12.5	0.0093
Morphospecie 14	1	0.09	50	0.02	2	0.07	0	0	5	0.0037
Morphospecie 18	1	0.09	50	0.02	2	0.07	0	0	50	0.0374
Morphospecie 19	1	0.09	50	0.02	2	0.07	0	0	5	0.0037
Morphospecie 20	1	0.09	50	0.02	2	0.07	0	0	5	0.0037
Morphospecie 27	1	0.09	50	0.02	2	0.07	0	0	12.5	0.0093
Morphospecie 28	1	0.09	50	0.02	2	0.07	0	0	5	0.0037
Morphospecie 30	1	0.09	50	0.02	2	0.07	0	0	37.5	0.0280
Solanum sp.	1	0.09	50	0.02	2	0.07	0.0001	0	25	0.0187

Appendix 3

Community descriptors for ground layer species in 0.02ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in dry season (July – August). NI = Number of Individuals; IVI = Importance Value Index; AD = Absolute Density (number individuals/hectare); RD = Relative Density (%); AF = Absolute Frequency; RF = Relative Frequency (%); ABA = Absolute Basal Area (m²/herctare); RBA = Relative Basal Area (%); APC = Absolute Plant Cover; RPC = Relative Plant Cover (%). Species are arranged in decreasing IVI.

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Clytostoma campanulatum	617	32.6	30850	12.42	90	3.58	0.4195	16.6	23452.5	18.2066
Actinostemon communis	355	17.35	17750	7.15	58	2.31	0.1995	7.9	9520	7.3905
Adenocalymma bracteatum	413	15.82	20650	8.32	76	3.02	0.1133	4.48	8815	6.8432
Coffea arabica	155	12.46	7750	3.12	64	2.54	0.1718	6.8	4950	3.8428
Oeceoclades maculata	62	10.65	3100	1.25	44	1.75	0.1934	7.65	1200	0.9316
Mansoa difficilis	293	10.53	14650	5.9	84	3.34	0.0327	1.29	3112.5	2.4163
Pereskia aculeata	126	9.03	6300	2.54	74	2.94	0.0897	3.55	1495	1.1606
Serjania lethalis	192	8.39	9600	3.87	68	2.7	0.0459	1.82	4640	3.6021
Metrodorea nigra	91	7.78	4550	1.83	68	2.7	0.0821	3.25	4285	3.3265
Ardisia warminguii	154	7.62	7700	3.1	40	1.59	0.0739	2.92	3775	2.9306
Oxalis rombeo-ovata	113	6.66	5650	2.28	48	1.91	0.0626	2.48	3902.5	3.0296
Aspidosperma polyneuron	74	6.11	3700	1.49	48	1.91	0.0684	2.71	1880	1.4595
Parodiolyra micrantha	120	5.93	6000	2.42	32	1.27	0.0567	2.25	4840	3.7574
Adenocalymma marginatum	130	5.52	6500	2.62	40	1.59	0.033	1.31	2543	1.9742
Cariniana legalis	43	5.17	2150	0.87	38	1.51	0.0706	2.79	2255	1.7506
Hybanthus artropurpureus	51	5	2550	1.03	42	1.67	0.0581	2.3	1055	0.8190
Clytostoma binatum	65	4.9	3250	1.31	40	1.59	0.0507	2	2915	2.2630
Melloa quadruvalis	61	4.83	3050	1.23	44	1.75	0.0469	1.86	1600	1.2421
Hippocratea volubilis	66	4.45	3300	1.33	36	1.43	0.0427	1.69	2572.5	1.9971
Aspidosperma ramiflorum	46	3.94	2300	0.93	32	1.27	0.0441	1.74	2025	1.5720
Polygala klotzchii	62	3.65	3100	1.25	14	0.56	0.0467	1.85	2740	2.1271
Syagrus romanzoffiana	63	3.41	3150	1.27	36	1.43	0.018	0.71	685	0.5318
Macfadyena ungis-cati	67	3.31	3350	1.35	36	1.43	0.0135	0.53	1128	0.8757
Actinostemon concepcionis	51	3.03	2550	1.03	48	1.91	0.0023	0.09	307.5	0.2387

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Arrabidea conjugata	65	2.77	3250	1.31	34	1.35	0.0029	0.11	490	0.3804
Banisteriopsis anisandra	17	2.62	850	0.34	24	0.95	0.0335	1.33	1252.5	0.9723
Lepidagathis diffusa	68	2.6	3400	1.37	24	0.95	0.0071	0.28	695	0.5395
Seguieria langsdorfii	13	2.6	650	0.26	18	0.72	0.0411	1.63	1075	0.8345
Bignoniaceae 1	48	2.49	2400	0.97	34	1.35	0.0043	0.17	320	0.2484
Galipea jasminiflora	54	2.48	2700	1.09	20	0.79	0.0152	0.6	1185	0.9199
Ruellia brevifolia	47	2.38	2350	0.95	28	1.11	0.008	0.32	840	0.6521
Olyra ciliatifolia	38	2.35	1900	0.77	24	0.95	0.016	0.63	2237.5	1.7370
Malpighiaceae 1	40	2.33	2000	0.81	26	1.03	0.0124	0.49	707.5	0.5492
Piptadenia gonoacantha	32	2.27	1600	0.64	32	1.27	0.0088	0.35	645	0.5007
Anthondon decussatum	35	2.21	1750	0.7	24	0.95	0.0139	0.55	840	0.6521
Urvillea laevis	33	2.2	1650	0.66	34	1.35	0.0046	0.18	292.5	0.2271
Eugenia egensis	71	2.14	3550	1.43	14	0.56	0.004	0.16	600	0.4658
Astronium graviollens	23	2.13	1150	0.46	26	1.03	0.016	0.63	902.5	0.7006
Serjania meridionalis	30	1.96	1500	0.6	32	1.27	0.0022	0.09	272.5	0.2115
Sebastiania edwalliana	20	1.72	1000	0.4	20	0.79	0.0132	0.52	640	0.4968
Celtis ehreubergiana	22	1.68	1100	0.44	16	0.64	0.0151	0.6	872.5	0.6773
Heteropterys intermedia	35	1.57	1750	0.7	18	0.72	0.0039	0.15	740	0.5745
Trichilia clausenii	16	1.57	800	0.32	20	0.79	0.0115	0.45	585	0.4541
Esenbeckia leiocarpa	25	1.47	1250	0.5	20	0.79	0.0043	0.17	407.5	0.3163
Trichilia catigua	12	1.41	600	0.24	14	0.56	0.0154	0.61	600	0.4658
Stizophyllun perforatum	13	1.27	650	0.26	18	0.72	0.0074	0.29	522.5	0.4056
Ocotea beulahiae	21	1.25	1050	0.42	18	0.72	0.0028	0.11	247.5	0.1921
Eugenia ligustrina	25	1.22	1250	0.5	10	0.4	0.008	0.32	620	0.4813
Ottonia leptostachya	14	1.22	700	0.28	8	0.32	0.0157	0.62	950	0.7375
Piper amalago	13	1.22	650	0.26	16	0.64	0.0081	0.32	517.5	0.4017
Alternanthera micrantha	24	1.21	1200	0.48	14	0.56	0.0043	0.17	185	0.1436
Prescottia stachyodes	17	1.2	850	0.34	20	0.79	0.0015	0.06	105	0.0815
Justicia lithroides	24	1.19	1200	0.48	14	0.56	0.0039	0.15	307.5	0.2387
Myrsine umbellata	18	1.19	900	0.36	20	0.79	0.0008	0.03	120	0.0932
Bignoniaceae 2	17	1.11	850	0.34	18	0.72	0.0012	0.05	92.5	0.0718
Machaerium acutifolium	14	1.03	700	0.28	18	0.72	0.001	0.04	147.5	0.1145
Trigonia nivea	14	1.01	700	0.28	18	0.72	0.0004	0.01	315	0.0602

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Almeidea lilacina	13	1.01	650	0.26	14	0.56	0.0049	0.2	77.5	0.2445
Croton floribundus	21	1	1050	0.42	10	0.4	0.0045	0.18	610	0.4736
Geissomeria longiflora	17	0.99	850	0.34	12	0.48	0.0043	0.17	372.5	0.2892
Doliocarpus cf. dentatus	10	0.98	500	0.2	16	0.64	0.0035	0.14	665	0.5163
Conchocarpus pentandrus	14	0.95	700	0.28	8	0.32	0.0087	0.35	617.5	0.4794
Trichilia elegans	13	0.92	650	0.26	14	0.56	0.0026	0.1	345	0.2678
Gallesia integrifolia	16	0.89	800	0.32	14	0.56	0.0004	0.01	80	0.0621
Holocalyx balansae	8	0.87	400	0.16	12	0.48	0.006	0.24	255	0.1980
Psychotria chaenotrichia	15	0.86	750	0.3	10	0.4	0.004	0.16	337.5	0.2620
Serjania glabrata	8	0.81	400	0.16	14	0.56	0.0024	0.09	342.5	0.2659
Dichorisandra incurva	11	0.78	550	0.22	12	0.48	0.002	0.08	212.5	0.1650
Urera baccifera	9	0.77	450	0.18	12	0.48	0.0027	0.11	122.5	0.0951
Tragia sellowiana	9	0.75	450	0.18	14	0.56	0.0003	0.01	107.5	0.0621
Pleonotoma tetraquetra	8	0.75	400	0.16	14	0.56	0.0008	0.03	80	0.0835
Smilax fluminensis	12	0.74	600	0.24	12	0.48	0.0006	0.03	107.5	0.0835
Morphospecie 01	13	0.71	650	0.26	10	0.4	0.0012	0.05	107.5	0.0835
Maytenus aquifolium	5	0.66	250	0.1	8	0.32	0.0062	0.25	217.5	0.1688
Centrolobium tomentosum	16	0.64	800	0.32	2	0.08	0.0061	0.24	282.5	0.2193
Trichilia casaretti	11	0.63	550	0.22	8	0.32	0.0023	0.09	200	0.1553
Dioscorea alata	8	0.59	400	0.16	10	0.4	0.0007	0.03	165	0.1281
Basnisteropsis sp.	6	0.58	300	0.12	10	0.4	0.0017	0.07	187.5	0.1456
Rubiaceae 1	6	0.58	300	0.12	10	0.4	0.0015	0.06	65	0.0505
Ipomoea purpurea	7	0.57	350	0.14	8	0.32	0.0029	0.12	210	0.1630
Elachyptera micrantha	13	0.56	650	0.26	2	0.08	0.0055	0.22	410	0.3183
Morphospecie 02	8	0.56	400	0.16	10	0.4	0.0001	0.01	40	0.0311
Dalechampia triphylla	7	0.55	350	0.14	10	0.4	0.0002	0.01	55	0.0427
Eugenia sp.1	7	0.55	350	0.14	10	0.4	0.0004	0.02	50	0.0388
Rudgea jasminoides	7	0.55	350	0.14	8	0.32	0.0024	0.1	185	0.1436
Cupania vernalis	6	0.54	300	0.12	10	0.4	0.0006	0.02	75	0.0582
Myrceugenia campestris	10	0.53	500	0.2	8	0.32	0.0003	0.01	50	0.0388
Aegiphila sellowiana	4	0.52	200	0.08	6	0.24	0.005	0.2	212.5	0.1650
Eugenia cerasiflora	12	0.49	600	0.24	6	0.24	0.0002	0.01	60	0.0466
Byttneria catalpifolia	12	0.48	600	0.24	2	0.08	0.0041	0.16	357.5	0.2775

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Inga luschnatiana	6	0.47	300	0.12	6	0.24	0.0028	0.11	312.5	0.1436
Dryopteris sp.	4	0.47	200	0.08	8	0.32	0.0018	0.07	185	0.2426
Cordia cf. ecalyculata	5	0.46	250	0.1	6	0.24	0.0029	0.12	175	0.1359
Connarus regnellii	3	0.46	150	0.06	6	0.24	0.004	0.16	175	0.1359
Psychotria myriantha	5	0.45	250	0.1	4	0.16	0.0048	0.19	105	0.0815
Marantaceae 1	5	0.43	250	0.1	6	0.24	0.0023	0.09	105	0.0815
Dalbergia frutescens	2	0.41	100	0.04	4	0.16	0.0054	0.21	50	0.0388
Chamissoa acuminata	8	0.39	400	0.16	4	0.16	0.0017	0.07	187.5	0.1456
Davilla rugosa	5	0.39	250	0.1	4	0.16	0.0033	0.13	205	0.1591
Paullinea meliaefolia	4	0.38	200	0.08	6	0.24	0.0015	0.06	125	0.1164
Celtis spinosa	1	0.38	50	0.02	2	0.08	0.0071	0.28	150	0.0970
Ocotea odorifera	3	0.37	150	0.06	6	0.24	0.0019	0.08	92.5	0.0718
Eugenia sp.2	3	0.36	150	0.06	6	0.24	0.0016	0.06	80	0.0621
Eugenia burkartiana	6	0.34	300	0.12	4	0.16	0.0015	0.06	175	0.0408
Solanum gnaphalocarpon	3	0.34	150	0.06	6	0.24	0.001	0.04	52.5	0.0679
Abutilon peltatum	1	0.34	50	0.02	2	0.08	0.0061	0.24	87.5	0.1359
Violaceae 1	4	0.32	200	0.08	6	0.24	0.0001	0	20	0.0155
Euphorbiaceae 03	3	0.31	150	0.06	6	0.24	0.0004	0.02	22.5	0.0175
Mollinedia clavigera	2	0.31	100	0.04	4	0.16	0.0029	0.11	150	0.1164
Bignoniaceae 3	3	0.3	150	0.06	6	0.24	0	0	15	0.0116
Chamissoa altissima	6	0.29	300	0.12	4	0.16	0.0003	0.01	50	0.0291
Acanthaceae 1	3	0.29	150	0.06	4	0.16	0.0017	0.07	37.5	0.0388
Trichilia pallida	2	0.28	100	0.04	4	0.16	0.0021	0.08	137.5	0.1067
Actinostemon concolor	3	0.27	150	0.06	4	0.16	0.0013	0.05	80	0.0621
Prunus myrtidifolia	3	0.27	150	0.06	4	0.16	0.0013	0.05	112.5	0.0873
Myrcia fallax	2	0.26	100	0.04	4	0.16	0.0015	0.06	100	0.0776
Psychotria brevicolis	2	0.26	100	0.04	4	0.16	0.0015	0.06	112.5	0.0873
Herreria salsaparilha	5	0.24	250	0.1	2	0.08	0.0015	0.06	40	0.0311
Miconia pussiliflora	4	0.24	200	0.08	4	0.16	0.0001	0	27.5	0.0213
Thelypteridaceae 1	3	0.24	150	0.06	4	0.16	0.0005	0.02	130	0.1553
Morphospecie 29	2	0.24	100	0.04	4	0.16	0.0009	0.04	200	0.1009
Aristolochia arcuata	3	0.23	150	0.06	4	0.16	0.0002	0.01	67.5	0.0524
Eugenia excelsa	2	0.22	100	0.04	2	0.08	0.0024	0.1	200	0.1553

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Cyclopogon cf. congestus	3	0.21	150	0.06	2	0.08	0.0017	0.07	17.5	0.0388
Bauhinia micrantha	2	0.21	100	0.04	4	0.16	0.0002	0.01	50	0.0136
Gouania virgata	2	0.21	100	0.04	4	0.16	0.0003	0.01	50	0.0388
Malpighiaceae 2	2	0.21	100	0.04	4	0.16	0.0002	0.01	37.5	0.0291
Pothomorphe umbellata	2	0.21	100	0.04	4	0.16	0.0003	0.01	17.5	0.0136
Morphospecie 05	2	0.2	100	0.04	4	0.16	0	0	17.5	0.0136
Schoepfia brasiliensis	2	0.2	100	0.04	4	0.16	0.0001	0.01	75	0.0078
Sebastiania sp.	2	0.2	100	0.04	4	0.16	0.0001	0.01	10	0.0078
Psychotria cephalanta	1	0.2	50	0.02	2	0.08	0.0026	0.1	10	0.0582
Calyptranthes clusiifolia	2	0.18	100	0.04	2	0.08	0.0015	0.06	200	0.1553
Acacia polyphylla	1	0.16	50	0.02	2	0.08	0.0016	0.06	50	0.0388
Dioscorea discolor	3	0.15	150	0.06	2	0.08	0.0002	0.01	87.5	0.0912
Cariniana estrellensis	1	0.15	50	0.02	2	0.08	0.0014	0.05	117.5	0.0679
Guatteria nigrescens	1	0.15	50	0.02	2	0.08	0.0014	0.05	5	0.0039
Licaria armeniaca	1	0.15	50	0.02	2	0.08	0.0012	0.05	50	0.0388
Manettia gracilis	1	0.15	50	0.02	2	0.08	0.0012	0.05	37.5	0.0291
Verbenaceae 1	1	0.15	50	0.02	2	0.08	0.0012	0.05	12.5	0.0097
Chrysophyllum gonocarpum	1	0.14	50	0.02	2	0.08	0.001	0.04	100	0.0776
Hymenaea courbaril	1	0.14	50	0.02	2	0.08	0.0011	0.05	37.5	0.0291
Justicia carnea	1	0.14	50	0.02	2	0.08	0.0009	0.04	25	0.0194
Psychotria cathargenensis	1	0.14	50	0.02	2	0.08	0.0009	0.04	50	0.0388
Casearia decandra	1	0.13	50	0.02	2	0.08	0.0007	0.03	12.5	0.0097
Nectandra megapotamica	1	0.13	50	0.02	2	0.08	0.0008	0.03	150	0.1164
Cucurbitaceae 1	2	0.12	100	0.04	2	0.08	0.0001	0	10	0.0078
Pseudoechinolaena polystachya	2	0.12	100	0.04	2	0.08	0.0001	0	50	0.0136
Esenbeckia grandiflora	1	0.12	50	0.02	2	0.08	0.0005	0.02	25	0.0388
Morphospecie 06	1	0.12	50	0.02	2	0.08	0.0004	0.02	17.5	0.0194
Brosimum glaziovii	1	0.11	50	0.02	2	0.08	0.0001	0.01	12.5	0.0097
Brunfelsia pauciflora	1	0.11	50	0.02	2	0.08	0.0002	0.01	50	0.0388
Endlicheria paniculata	1	0.11	50	0.02	2	0.08	0.0002	0.01	25	0.0194
Euphorbiaceae 01	1	0.11	50	0.02	2	0.08	0.0002	0.01	12.5	0.0097
Euphorbiaceae 02	1	0.11	50	0.02	2	0.08	0.0002	0.01	12.5	0.0097
Morphospecie 12	1	0.11	50	0.02	2	0.08	0.0003	0.01	25	0.0194

	NI	IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Morphospecie 30	1	0.11	50	0.02	2	0.08	0.0003	0.01	25	0.0194
Ocotea diospyrifolia	1	0.11	50	0.02	2	0.08	0.0002	0.01	25	0.0194
Ocotea indecora	1	0.11	50	0.02	2	0.08	0.0002	0.01	5	0.0039
Pharus parvifolius	1	0.11	50	0.02	2	0.08	0.0004	0.01	25	0.0194
Solanum sp.	1	0.11	50	0.02	2	0.08	0.0002	0.01	37.5	0.0291
Calycorectes acutatus	1	0.1	50	0.02	2	0.08	0	0	12.5	0.0097
Coccocypselum cordifolium	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Malvaceae 1	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Malvaceae 2	1	0.1	50	0.02	2	0.08	0.0001	0	5	0.0039
Morphospecie 03	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 04	1	0.1	50	0.02	2	0.08	0.0001	0	12.5	0.0097
Morphospecie 07	1	0.1	50	0.02	2	0.08	0	0	12.5	0.0097
Morphospecie 08	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 09	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 10	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 11	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 13	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 14	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 15	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 16	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 17	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 18	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 19	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 20	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 21	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 22	1	0.1	50	0.02	2	0.08	0.0001	0.01	12.5	0.0097
Morphospecie 23	1	0.1	50	0.02	2	0.08	0.0001	0	5	0.0039
Morphospecie 24	1	0.1	50	0.02	2	0.08	0	0	12.5	0.0097
Morphospecie 25	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 26	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 27	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Morphospecie 28	1	0.1	50	0.02	2	0.08	0	0	5	0.0039
Tontelea sp.	1	0.1	50	0.02	2	0.08	0.0001	0.01	12.5	0.0097

Appendix 4

Community descriptors for ground layer families in 0.02ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in rainy season (January – February). N Spp = Number of Species; % Spp = Percentage of Number of Species; NI = Number of Individuals; IVI = Importance Value Index; %IVI = Percentage of IVI; AD = Absolute Density (number individuals/hectare); RD = Relative Density (%); AF = Absolute Frequency; RF = Relative Frequency (%); ABA = Absolute Basal Area (m²/herctare); RBA = Relative Basal (%); APC = Absolute Plant Cover; RPC = Relative Plant (%). Families are arranged in decreasing IVI.

	N Spp	%Spp	NI	IVI	%IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Bignoniaceae	13	7.56	1872	66.23	22.08	93600	34.19	100	5.97	0.6284	26.07	61935	34.3773
Euphorbiaceae	11	6.4	563	23.11	7.7	28150	10.28	92	5.5	0.1767	7.33	15765	8.7504
Orchidaceae	3	1.74	83	22.11	7.37	4150	1.52	56	3.35	0.4157	17.25	1937.5	1.0754
Rubiaceae	10	5.81	242	15.62	5.21	12100	4.42	76	4.54	0.1606	6.66	8480	4.7069
Sapindaceae	6	3.49	365	14.41	4.8	18250	6.67	94	5.62	0.0512	2.12	8532.5	4.7360
Rutaceae	6	3.49	236	14.35	4.78	11800	4.31	86	5.14	0.1181	4.9	9425	5.2314
Apocynaceae	2	1.16	129	11.7	3.9	6450	2.36	68	4.06	0.1274	5.29	5427.5	3.0126
Cactaceae	1	0.58	138	10.69	3.56	6900	2.52	74	4.42	0.0903	3.75	3560	1.9760
Celastraceae	5	2.91	131	8.72	2.91	6550	2.39	68	4.06	0.0546	2.26	6335	3.5163
Poaceae	4	2.33	175	8.63	2.88	8750	3.2	44	2.63	0.0676	2.8	9622.5	5.3410
Myrsinaceae	2	1.16	170	8.58	2.86	8500	3.11	50	2.99	0.0599	2.48	4127.5	2.2910
Acanthaceae	5	2.91	180	7.84	2.61	9000	3.29	60	3.58	0.0234	0.97	3792.5	2.1050
Oxalidaceae	1	0.58	102	7.21	2.4	5100	1.86	44	2.63	0.0655	2.72	5147.5	2.8571
Myrtaceae	10	5.81	135	6.58	2.19	6750	2.47	56	3.35	0.0186	0.77	2485	1.3793
Morphospecie	21	12.21	90	6.25	2.08	4500	1.64	74	4.42	0.0044	0.18	870	0.4829
Malpighiaceae	5	2.91	94	5.91	1.97	4700	1.72	54	3.23	0.0233	0.97	3522.5	1.9552
Violaceae	2	1.16	60	5.91	1.97	3000	1.1	44	2.63	0.0528	2.19	3022.5	1.6777
Fabaceae	8	4.65	100	5.63	1.88	5000	1.83	52	3.11	0.0167	0.69	2625	1.4570
Meliaceae	5	2.91	56	5.32	1.77	2800	1.02	54	3.23	0.0259	1.07	2662.5	1.4778
Lecythidaceae	2	1.16	41	5.19	1.73	2050	0.75	38	2.27	0.0523	2.17	2517.5	1.3973
Arecaceae	1	0.58	66	3.92	1.31	3300	1.21	38	2.27	0.0107	0.45	1252.5	0.6952
Phytolaccaceae	2	1.16	42	3.68	1.23	2100	0.77	32	1.91	0.0243	1.01	1497.5	0.8312
Polygalaceae	1	0.58	64	3.39	1.13	3200	1.17	14	0.84	0.0335	1.39	3410	1.8927

	N Spp	%Spp	NI	IVI	%IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Lauraceae	6	3.49	33	2.72	0.91	1650	0.6	28	1.67	0.0108	0.45	1010	0.5606
Piperaceae	2	1.16	29	2.5	0.83	1450	0.53	24	1.43	0.0128	0.53	2112.5	1.1726
Anacardiaceae	1	0.58	24	2.45	0.82	1200	0.44	26	1.55	0.0111	0.46	960	0.5329
Amaranthaceae	3	1.74	51	2.37	0.79	2550	0.93	20	1.19	0.0059	0.25	525	0.2914
Trigoniaceae	1	0.58	39	2.19	0.73	1950	0.71	24	1.43	0.001	0.04	282.5	0.1568
Cannabaceae	1	0.58	23	2.1	0.7	1150	0.42	16	0.96	0.0175	0.72	1687.5	0.9367
Dilleniaceae	2	1.16	13	1.51	0.5	650	0.24	18	1.08	0.0048	0.2	605	0.3358
Commelinaceae	1	0.58	16	1.42	0.47	800	0.29	16	0.96	0.0042	0.17	445	0.2470
Urticaceae	1	0.58	9	0.95	0.32	450	0.16	12	0.72	0.0016	0.07	190	0.1055
Smilacaceae	1	0.58	11	0.91	0.3	550	0.2	10	0.6	0.0027	0.11	205	0.1138
Convolvulaceae	1	0.58	10	0.81	0.27	500	0.18	8	0.48	0.0037	0.15	450	0.2498
Dioscoreaceae	2	1.16	12	0.75	0.25	600	0.22	8	0.48	0.0013	0.06	255	0.1415
Araceae	1	0.58	5	0.64	0.21	250	0.09	8	0.48	0.0016	0.07	150	0.0833
Marantaceae	1	0.58	6	0.62	0.21	300	0.11	6	0.36	0.0037	0.15	467.5	0.2595
Dryopteridaceae	1	0.58	4	0.62	0.21	200	0.07	8	0.48	0.0018	0.07	450	0.2498
Malvaceae	3	1.74	6	0.61	0.2	300	0.11	6	0.36	0.0035	0.15	350	0.1943
Lamiaceae	1	0.58	5	0.6	0.2	250	0.09	6	0.36	0.0035	0.15	337.5	0.1873
Solanaceae	2	1.16	4	0.58	0.19	200	0.07	8	0.48	0.0007	0.03	100	0.0555
Monimiaceae	2	1.16	4	0.56	0.19	200	0.07	6	0.36	0.0031	0.13	387.5	0.2151
Boraginaceae	1	0.58	5	0.55	0.18	250	0.09	6	0.36	0.0024	0.1	175	0.0971
Connaraceae	1	0.58	3	0.55	0.18	150	0.05	6	0.36	0.0033	0.14	225	0.1249
Melastomataceae	1	0.58	6	0.47	0.16	300	0.11	6	0.36	0.0001	0	37.5	0.0208
Rhamnaceae	1	0.58	3	0.42	0.14	150	0.05	6	0.36	0.0001	0.01	67.5	0.0375
Thelypteridaceae	1	0.58	3	0.32	0.11	150	0.05	4	0.24	0.0006	0.02	212.5	0.1179
Agavaceae	1	0.58	5	0.31	0.1	250	0.09	2	0.12	0.0023	0.1	187.5	0.1041
Rosaceae	1	0.58	2	0.31	0.1	100	0.04	4	0.24	0.0007	0.03	87.5	0.0486
Olacaceae	1	0.58	2	0.28	0.09	100	0.04	4	0.24	0.0001	0	17.5	0.0097
Verbenaceae	1	0.58	1	0.22	0.07	50	0.02	2	0.12	0.002	0.08	25	0.0139
Aristolochiaceae	1	0.58	4	0.2	0.07	200	0.07	2	0.12	0.0001	0	92.5	0.0513
Sapotaceae	1	0.58	1	0.19	0.06	50	0.02	2	0.12	0.0012	0.05	50	0.0278
Anonnaceae	1	0.58	1	0.14	0.05	50	0.02	2	0.12	0.0002	0.01	37.5	0.0208
Moraceae	1	0.58	1	0.14	0.05	50	0.02	2	0.12	0.0002	0.01	25	0.0139

Appendix 5

Community descriptors for ground layer families in 0.02ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in dry season (July – August). N Spp = Number of Species; % Spp = Percentage of Number of Species; NI = Number of Individuals; IVI = Importance Value Index; %IVI = Percentage of IVI; AD = Absolute Density (number individuals/hectare); RD = Relative Density (%); AF = Absolute Frequency; RF = Relative Frequency (%); ABA = Absolute Basal Area (m²/herctare); RBA = Relative Basal Area (%); APC = Absolute Plant Cover; RPC = Relative Plant Cover (%). Families are arranged in decreasing IVI.

	N Spp	%Spp	NI	IVI	%IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Bignoniaceae	13	6.88	1800	71.19	23.73	90000	36.25	100	6.2	0.7262	28.74	45113.5	35.0223
Euphorbiaceae	11	5.82	473	23.78	7.93	23650	9.52	88	5.46	0.2222	8.79	11350	8.8112
Rubiaceae	10	5.29	194	15.79	5.26	9700	3.91	70	4.34	0.1907	7.55	5922.5	4.5977
Rutaceae	6	3.17	198	13.65	4.55	9900	3.99	82	5.09	0.1157	4.58	6860	5.3255
Orchidaceae	3	1.59	82	13.03	4.34	4100	1.65	58	3.6	0.1965	7.78	1355	1.0519
Sapindaceae	6	3.17	273	12.98	4.33	13650	5.5	84	5.21	0.0573	2.27	5772.5	4.4813
Apocynaceae	2	1.06	120	10.96	3.65	6000	2.42	66	4.09	0.1125	4.45	3905	3.0315
Cactaceae	1	0.53	126	10.68	3.56	6300	2.54	74	4.59	0.0897	3.55	1495	1.1606
Myrsinaceae	2	1.06	172	9.4	3.13	8600	3.46	48	2.98	0.0747	2.96	3895	3.0238
Celastraceae	5	2.65	120	8.72	2.91	6000	2.42	58	3.6	0.0684	2.71	4052.5	3.1460
Poaceae	4	2.12	161	8.62	2.87	8050	3.24	40	2.48	0.0732	2.9	7120	5.5274
Malpighiaceae	5	2.65	100	7.78	2.59	5000	2.01	60	3.72	0.0516	2.04	2925	2.2707
Oxalidaceae	1	0.53	113	7.73	2.58	5650	2.28	48	2.98	0.0626	2.48	3902.5	3.0296
Acanthaceae	6	3.17	160	7.6	2.53	8000	3.22	54	3.35	0.0259	1.02	2290	1.7778
Myrtaceae	11	5.82	141	6.79	2.26	7050	2.84	50	3.1	0.0214	0.85	2025	1.5720
Fabaceae	9	4.76	82	6.43	2.14	4100	1.65	56	3.47	0.033	1.3	1670	1.2964
Violaceae	2	1.06	55	6.26	2.09	2750	1.11	46	2.85	0.0582	2.3	1075	0.8345
Lecythidaceae	2	1.06	44	6.22	2.07	2200	0.89	40	2.48	0.072	2.85	2342.5	1.8185
Meliaceae	5	2.65	54	5.65	1.88	2700	1.09	52	3.23	0.0339	1.34	1867.5	1.4498
Morphospecie	30	15.87	51	4.66	1.55	2550	1.03	56	3.47	0.004	0.16	515	0.3998
Arecaceae	1	0.53	63	4.21	1.4	3150	1.27	36	2.23	0.018	0.71	685	0.5318
Phytolaccaceae	2	1.06	29	4.21	1.4	1450	0.58	32	1.99	0.0414	1.64	1155	0.8966
Polygalaceae	1	0.53	62	3.97	1.32	3100	1.25	14	0.87	0.0467	1.85	2740	2.1271
Piperaceae	3	1.59	29	3.15	1.05	1450	0.58	26	1.61	0.0241	0.95	1485	1.1528

	N Spp	%Spp	NI	IVI	%IVI	AD	RD	AF	RF	ABA	RBA	APC	RPC
Anacardiaceae	1	0.53	23	2.71	0.9	1150	0.46	26	1.61	0.016	0.63	902.5	0.7006
Lauraceae	7	3.7	29	2.48	0.83	1450	0.58	26	1.61	0.0073	0.29	595	0.4619
Cannabaceae	2	1.06	23	2.46	0.82	1150	0.46	18	1.12	0.0222	0.88	997.5	0.7744
Amaranthaceae	3	1.59	38	2.26	0.75	1900	0.77	20	1.24	0.0063	0.25	410	0.3183
Dilleniaceae	2	1.06	15	1.69	0.56	750	0.3	18	1.12	0.0068	0.27	870	0.6754
Trigoniaceae	1	0.53	14	1.41	0.47	700	0.28	18	1.12	0.0004	0.01	77.5	0.0602
Malvaceae	4	2.12	15	1.21	0.4	750	0.3	8	0.5	0.0103	0.41	542.5	0.4212
Commelinaceae	1	0.53	11	1.05	0.35	550	0.22	12	0.74	0.002	0.08	212.5	0.1650
Urticaceae	1	0.53	9	1.03	0.34	450	0.18	12	0.74	0.0027	0.11	122.5	0.0951
Smilacaceae	1	0.53	12	1.01	0.34	600	0.24	12	0.74	0.0006	0.03	107.5	0.0835
Dioscoreaceae	2	1.06	11	1	0.33	550	0.22	12	0.74	0.0009	0.04	282.5	0.2193
Solanaceae	3	1.59	5	0.78	0.26	250	0.1	10	0.62	0.0014	0.05	175	0.1359
Convolvulaceae	1	0.53	7	0.75	0.25	350	0.14	8	0.5	0.0029	0.12	210	0.1630
Dryopteridaceae	1	0.53	4	0.65	0.22	200	0.08	8	0.5	0.0018	0.07	312.5	0.2426
Lamiaceae	1	0.53	4	0.65	0.22	200	0.08	6	0.37	0.005	0.2	212.5	0.1650
Boraginaceae	1	0.53	5	0.59	0.2	250	0.1	6	0.37	0.0029	0.12	175	0.1359
Connaraceae	1	0.53	3	0.59	0.2	150	0.06	6	0.37	0.004	0.16	175	0.1359
Marantaceae	1	0.53	5	0.56	0.19	250	0.1	6	0.37	0.0023	0.09	105	0.0815
Monimiaceae	1	0.53	2	0.4	0.13	100	0.04	4	0.25	0.0029	0.11	150	0.1164
Rosaceae	1	0.53	3	0.36	0.12	150	0.06	4	0.25	0.0013	0.05	112.5	0.0873
Melastomataceae	1	0.53	4	0.33	0.11	200	0.08	4	0.25	0.0001	0	27.5	0.0213
Thelypteridaceae	1	0.53	3	0.33	0.11	150	0.06	4	0.25	0.0005	0.02	200	0.1553
Aristolochiaceae	1	0.53	3	0.32	0.11	150	0.06	4	0.25	0.0002	0.01	67.5	0.0524
Rhamnaceae	1	0.53	2	0.3	0.1	100	0.04	4	0.25	0.0003	0.01	50	0.0388
Olacaceae	1	0.53	2	0.29	0.1	100	0.04	4	0.25	0.0001	0.01	10	0.0078
Agavaceae	1	0.53	5	0.28	0.09	250	0.1	2	0.12	0.0015	0.06	40	0.0311
Anonnaceae	1	0.53	1	0.2	0.07	50	0.02	2	0.12	0.0014	0.05	5	0.0039
Verbenaceae	1	0.53	1	0.19	0.06	50	0.02	2	0.12	0.0012	0.05	12.5	0.0097
Sapotaceae	1	0.53	1	0.18	0.06	50	0.02	2	0.12	0.001	0.04	100	0.0776
Cucurbitaceae	1	0.53	2	0.17	0.06	100	0.04	2	0.12	0.0001	0	10	0.0078
Salicaceae	1	0.53	1	0.17	0.06	50	0.02	2	0.12	0.0007	0.03	12.5	0.0097
Moraceae	1	0.53	1	0.15	0.05	50	0.02	2	0.12	0.0001	0.01	12.5	0.0097

Appendix 6

Community descriptors for each plot of ground layer in 0.02 ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in rainy season (January – February). NI = Number of Individuals; N Spp = Number of Species; AD = Absolute Density (number individuals/hectare); ABA = Absolute Basal Area (m²/herctare); APC = Absolute Plant Cover; GO = Gap Openness (%). Plots are arranged in numeric order.

	NI	N Spp	AD	ABA	APC	GO
3	108	25	270000	3.4312	3505	4.09
4	35	13	87500	0.3893	1027.5	11.94
6	108	21	270000	2.1448	3375	3.52
9	136	33	340000	2.8993	5822.5	4.51
10	162	31	405000	2.9472	6322.5	3.21
11	43	20	107500	0.7911	1317.5	3.64
15	76	29	190000	3.0122	4035	3.66
17	67	22	167500	5.7595	2482.5	5.52
18	90	15	225000	1.6699	4282.5	3.8
19	67	22	167500	1.6597	2197.5	5
20	98	27	245000	1.6614	2125	3.89
22	137	40	342500	1.9369	3230	5.22
26	32	11	80000	0.5504	1485	3.08
27	128	34	320000	3.3715	4242.5	5.81
30	97	25	242500	1.6056	2680	3.76
34	160	34	400000	3.0698	7172.5	7.69
35	31	13	77500	0.7393	1180	3.27
37	166	33	415000	3.2703	5245	5.25
38	29	9	72500	0.1283	350	3.38
41	44	20	110000	0.4918	1212.5	2.16
42	114	30	285000	1.8403	3067.5	3.54
43	157	42	392500	0.7402	1992.5	4.55
44	184	32	460000	3.1259	7097.5	4.77
47	125	37	312500	2.6996	3912.5	2.74
48	30	17	75000	0.7269	917.5	1.3
49	112	37	280000	2.0357	3597.5	5.46
51	61	18	152500	1.9979	2327.5	3.48
53	139	22	347500	5.3372	4530	5.33
54	68	22	170000	1.7907	2362.5	4.22
55	267	63	667500	4.9302	7717.5	4.32
56	102	33	255000	2.9292	4577.5	3.97
58	102	31	255000	2.3686	3960	5.36
60	156	28	390000	5.2997	7777.5	4.36
61	47	24	117500	5.4599	1200	5.89
64	184	33	460000	3.1447	5090	4.87
73	34	17	85000	0.533	605	5.17
75	212	35	530000	4.1128	6635	4.86
76	119	30	297500	2.6693	5185	8.62

	NI	N Spp	AD	ABA	APC	GO
80	151	31	377500	3.5419	4242.5	7.54
83	129	27	322500	1.5952	3267.5	5.76
85	33	18	82500	0.7837	1685	3.96
89	232	46	580000	3.8418	6727.5	3.29
90	142	36	355000	2.5732	5280	3.88
91	28	13	70000	0.922	705	3.07
93	66	24	165000	1.8952	2755	6.04
94	44	11	110000	0.1178	477.5	4.27
96	132	29	330000	1.3368	3490	6
97	126	35	315000	2.0747	3057.5	6.08
98	219	46	547500	5.9125	9197.5	5.28
99	146	20	365000	2.668	3435	5.22

Appendix 7

Community descriptors for each plot of ground layer in 0.02 ha of a tropical semideciduous seasonal forest fragment (Ribeirão Cachoeira Forest) in southeastern Brazil in dry season (January – February). NI = Number of Individuals; N Spp = Number of Species; AD = Absolute Density (number individuals/hectare); ABA = Absolute Basal Area (m²/herctare); APC = Absolute Plant Cover; GO = Gap Openness (%). Plots are arranged in numeric order.

	NI	N Spp	AD	ABA	APC	GO
3	104	24	260000	3.4567	2515	5.37
4	15	5	37500	0.1797	390	11.72
6	71	19	177500	3.018	2875	6.49
9	138	30	345000	2.9364	3692.5	10.03
10	168	31	420000	3.8296	5052.5	7.87
11	32	14	80000	0.6939	765	11.16
15	72	27	180000	2.6356	2012.5	9.12
17	79	23	197500	3.8056	1855	11.75
18	83	16	207500	2.745	3857.5	4.92
19	33	18	82500	0.9815	1057.5	8.84
20	78	26	195000	1.5874	1385	7.93
22	136	42	340000	1.2529	2310	8.35
26	28	11	70000	0.459	867.5	7.4
27	133	34	332500	2.6637	4647.5	5.48
30	92	28	230000	2.0301	1950	5.61
34	161	35	402500	3.9715	4785	9.82
35	26	10	65000	0.4697	547.5	4.93
37	159	31	397500	2.9954	3702.5	7.27
38	17	9	42500	0.0863	435.5	3.6
41	40	22	100000	0.3325	907.5	4.73
42	87	31	217500	2.3339	2277.5	6.62
43	149	39	372500	1.1991	2417.5	5.66
44	182	30	455000	3.5911	4990	6.31
47	105	35	262500	2.6063	2767.5	3.92
48	23	10	57500	0.7806	732.5	4.54
49	103	31	257500	1.9736	2337.5	8.65
51	50	15	125000	3.2203	1305	5.17
53	142	22	355000	3.6739	3167.5	10.6
54	61	19	152500	2.1573	1452.5	9.59
55	230	59	575000	4.6076	4962.5	8.07
56	87	25	217500	3.2169	3202.5	5.64
58	80	26	200000	2.9887	2575	4.97
60	149	25	372500	7.5217	5337.5	10.45
61	41	19	102500	1.8092	970	8.93
64	171	31	427500	4.3724	4155	4.35
73	19	11	47500	0.5598	390	9.72
75	193	32	482500	3.7459	4917.5	6.5

	NI	N Spp	AD	ABA	APC	GO
76	108	24	270000	2.8784	4022.5	8.77
80	146	28	365000	5.3079	3120	7.43
83	98	24	245000	1.9305	2317.5	7.07
85	17	9	42500	0.7181	917.5	6.01
89	196	54	490000	5.4983	5130	5.28
90	122	33	305000	2.7833	3815	6.16
91	30	14	75000	0.4237	582.5	3.83
93	63	21	157500	1.4428	2028	8.47
94	19	7	47500	0.0886	487.5	5.12
96	115	29	287500	2.0347	2325	6.23
97	166	42	415000	3.2809	2907.5	5.9
98	199	41	497500	5.7942	4950	8.66
99	150	17	375000	3.6797	2642.5	6.71

CAPÍTULO 2

Title: Geographic distribution of herb layer species in Southern and Southeastern Brazilian Atlantic Forest fragments[1]

LEANDRO TAVARES VIEIRA* and FERNANDO ROBERTO MARTINS

Departamento de Botânica, Instituto de Biologia, Universidade Estadual de Campinas, Caixa postal 6109, Campinas 13083-970, SP, Brazil, and * Programa de Pós-Graduação em Ecologia, Universidade Estadual de Campinas, Caixa postal 6109, Campinas 13083-970, SP, Brazil.

Correspondence: F. R. Martins (fmartins@unicamp.br)

Running title: The Herb Layer of the Brazilian Atlantic Forest.

---

[1] Capítulo segue formato da revista Journal of Biogeography

Abstract

Aim The Brazilian Atlantic Forest *sensu lato* is constituted by three main portions: the Atlantic Rainforest along the coast, Mixed Rainforest at the south border of the Atlantic Rainforest, and the Seasonal Forest to the hinterland, all three grading into one another in gradients associated mainly to rainfall and temperature. Since herbs in the forest floor are very finely tuned to their special environment, we asked whether changes of the forest type above them would be enough to change their flora in the same way. Our aim was to test the hypothesis that the herb layer flora presents the same pattern of the tree flora and thus varies in similar gradients.

Location Southern and Southeastern Brazilian Atlantic Forest fragments.

Methods Using metadata, we computed 947 species of the herb layer in 41 sites, classified as Lowland, Submontane and Montane Rainforest, Mixed Rainforest and Seasonal Forest. We considered a binary matrix of 304 species distributed in 39 sites and performed ordination analyses by DCA, NMS and CCA, cluster analyses by UPGMA, and TWINSPAN, in an attempt to recognize floristic gradients or different floristic centers.

Results Both classification and ordination analyses distinguished three floristic centers: Seasonal Forest, Lowland Rainforest, and Upland Rainforest (Submontane and Montane forests pooled together). Altitude was important only to distinguish Lowland from Upland Rainforests.

Main conclusions The distribution pattern of the herb layer flora is different from that of the tree flora: whereas the tree flora varies in gradients along latitude, longitude and altitude, the herb layer flora presents distinct floristic centers. This might indicate that the herb layer species are very specialized and that they were subjected to biogeographic processes that were different from those acting upon the tree flora. Our study shows the great importance that the herbaceous layer has to understand biogeographic processes in the Brazilian Atlantic Forest.

Keywords

Historical biogeography, phytogeography, floristic center, gradient analysis, DCA, NMS, CCA, UPGMA, TWINSPAN.

Introduction

The original area covered by the Atlantic Forest in Brazil when European colonization began in 1500 A.D. was ca. 1,300,000 km^2, spreading from the state of Rio Grande do Norte at the easternmost tip of South America to the state of Rio Grande do Sul at the south Brazilian border (Collins, 1990). Today, the Atlantic Forest is restricted to ca. 92,000 km^2 or 7.5% of its original area, mostly in small fragments (Myers *et al.*, 2000). Many researchers have emphasized the intensive destruction of the Atlantic Forest (e.g. Morellato & Haddad 2000; Myers *et al.*, 2000; Oliveira-Filho & Fontes, 2000; Tabanez & Viana, 2000) and argued that many species and information have already gone extinct before they were known. For example, very little is known about the herb layer species, and studies of the tree component are still insufficient to answer many questions about the origin and boundaries of the Atlantic Forest. Therefore, more research on the Atlantic Forest is required in order to bring enough information for effective conservation, rational management, and public policy (Morellato & Haddad, 2000).

The Atlantic Forest *sensu lato* (*s.l.*) is a large geographic region south to Amazon and east to the Andes constituted by three phyto-ecological regions: the Atlantic Dense Ombrophilous Forest (Atlantic Rainforest), the Mixed Ombrophilous Forest (Mixed Rainforest or Araucaria Rainforest), and the Seasonal Semideciduous Forest (Veloso *et al.*, 1991; IBGE, 1992). The Atlantic Rainforest occupies a relatively narrow belt with variable width alongside the Brazilian coast where a warm, wet climate without a dry season occurs; the Mixed Rainforest occurs mainly at the south border of the Atlantic Rainforest, under a mild, wet climate; whereas the Seasonal Semideciduous Forest spreads into the hinterland up to thousands of kilometers from the sea, and experiences a tropical seasonal climate with a relatively severe dry season lasting generally from April to September (Leitão-Filho, 1982; Torres *et al.*, 1997; Morellato & Haddad, 2000; Morellato *et al.*, 2000; Oliveira-Filho & Fontes, 2000). Rainfall diminishes and dry season length along the year elongates in close correlation with the distance from the sea, thus strongly influencing floristic and structural changes in the tree communities towards the hinterland (Leitão-Filho, 1982; Salis *et al.*, 1995; Torres *et al.*, 1997; Ivanauskas *et al.*, 2000; Oliveira-Filho & Fontes, 2000; *Scudeller et al.*, 2001; Scudeller, 2002; Oliveira, 2006).

Along with the climatic influence, different forest formations occur as altitude varies within each phyto-ecological region (IBGE, 1992; Oliveira-Filho & Fontes, 2000): Lowland, Submontane, and Montane Rainforest or Seasonal Forest, and Montane Mixed Rainforest (with *Araucaria angustifolia* (Bertol.) Kuntze), whose altitude limits vary according to latitude. Here we call Upland Rainforest both the Submontane and the Montane forest formations considered together. The Atlantic Rainforest occurs to the east of the crest of the Serra do Mar, a mountain chain that runs south-north along the Brazilian coastline (Eiten, 1970) and includes two main geomorphologic regions: the Atlantic Plateau and the Coastal Province (IPT, 1981). The Atlantic Plateau is characterized by highlands with altitudes from 675 to 2770 m, mostly between 700 and 1100 m, constituted almost entirely by crystalline rocks of Pre-Cambrian and Cambrian-Ordovician age. The Coastal Province is a heterogeneous region constituted by lowlands, hills and mountains of different origins and ages, generally Cenozoic, and occurs from the coastline to the edge of the Atlantic Plateau with altitudes from zero to 1100 m (IPT, 1981). The Mixed Rainforest occurs mainly in the states of Paraná and Rio Grande do Sul at the south of the Atlantic

Rainforest, on the Araucaria Plateau, which extends from the Serra do Mar at east to the boundaries with Argentina and Paraguay at west. The Araucaria Plateau attains altitudes around 1,000 m a.s.l. at east, where Triassic-Cretacean volcanic rocks emerge, and gradually decreases in altitude toward west, where sedimentary covers predominate (IBGE, 1990). The Seasonal Semideciduous Forest occurs on the Paraná Sedimentary Basin, beginning at the west edge of the Atlantic Plateau, stretching southward into eastern Paraguay and northeastern Argentina, and constituted mostly by continental sediments and basaltic lava of Mesozoic age (Ross & Moroz, 1997). The relief is lightly wavy, with altitudes from 400 to 1100 m, and the soils have in general good drainage (IPT, 1981).

In the whole region of the Atlantic Forest *s l.* the tree species are distributed in gradients whatever latitude, longitude or altitude is considered (e.g. Salis *et al.*,1995; Ivanauskas, 1997; Torres *et al.*, 1997; Ivanauskas *et al.*, 2000; Oliveira-Filho & Fontes, 2000; Scudeller *et al.*, 2001; Scudeller, 2002; Ferraz *et al.*, 2004; Oliveira, 2006). Studying 125 sites in southeastern Brazil, Oliveira-Filho & Fontes (2000) stated that the tree flora of the Atlantic Forest suffers a gradual east-west differentiation between rain and seasonal forests influenced by rainfall regime, thus confirming Salis *et al.* (1995) and Torres *et al.* (1997) and being confirmed by Oliveira (2006). Oliveira-Filho & Fontes (2000) also claimed the existence of a north-south gradient associated with rainfall and temperature with greater frequency of frosts towards the south (Leitão-Filho, 1982). Ivanauskas *et al.* (2000), Scudeller *et al.* (2001) and Scudeller (2002) found a gradual differentiation between lowland and upland rainforests closely influenced by altitude. Studying the Seasonal Semideciduous Forest, Salis *et al.* (1995), Torres *et al.* (1997), Yamamoto *et al.* (2005) and Oliveira (2006) also found a gradient associated with altitude.

Species distribution in gradients refers to a continuous species replacement or change in community composition along environmental gradients (Whittaker, 1972), based on their tolerances to various environmental factors and resource requirements (Hutchinson, 1957). In other words, given a habitat gradient (e.g. elevation or soil moisture conditions) species evolve to occupy different positions along this gradient (Whittaker, 1972), the species rarely overlapping completely (Callaway, 1997). Biogeographic patterns may have historical links deep into the evolutionary time, but be circumscribed by ecological variables operating in the present (Crisci, 2001; Zink *et al.*, 2000), which are based on two main controversial theories of speciation models: vicariance and dispersal. The dispersal speciation theory assumes that species ancestors dispersed from a primitive range across pre-existing barriers, became isolated, and evolved into new species (Udvardy, 1969). The crossing of a barrier by an expanding species is called jump dispersal (Pielou, 1979), whereas the biotic progression in space step by step is called range expansion (Schaffer, 1977), thus leading to a range shift (Myers & Giller, 1988). The vicariance speciation theory (Nelson & Platnick, 1981) states that the speciation was generated through the fragmentation of widespread ancestors by vicariant (isolating) events, such as uplifting of mountain ranges. Today, most biogeographers are equally receptive to both hypotheses of vicariance and dispersal (Ronquist, 1997; Yonder & Nowak, 2006), but when there is absence of vicariant events, they consider the dispersal model to predominate. Abrupt discontinuities in vegetation patterns may be associated with abrupt discontinuities in the physical environment (Whittaker, 1975). However, there is no abrupt physical discontinuances, such as great mountains or rivers in southern and southeastern Brazil, that could imply a discreet dissociation of phyto-ecological regions (see e.g. Leitão-Filho, 1987;

Oliveira-Filho & Fontes, 2000; Scudeller, 2002; Méio *et al.*, 2003; Oliveira, 2006), thus pointing to the importance of dispersal speciation in the tree flora of the Atlantic Forest *s.l.*

The Atlantic Forest formations have many tree strata (IBGE, 1992). Alexander von Humboldt described each stratum in a tropical forest as “a forest above a forest”, where each layer constitutes a specific habitat, leading to the co-existence of many differentiated communities within the forest itself (Richards, 1996). However, tropical forest stratification has many interpretations, and its meaning is often misunderstood (Richards, 1996, Parker & Brown, 1999). One of the most common definitions of “layer” is to indicate a group of plants with similar form (Parker & Brown, 1999), such as the herb layer or herbaceous layer constituted by herbs rooted in the forest soil. An herbaceous plant can be defined in two ways: a) a plant that has a soft or malleable stem without the presence of much lignified cell wall; and b) a plant whose stem does not have a secondary growth, for example, palmettos. The first concept of herbaceous plant is sometimes misunderstood, especially because assessing the amount of lignified cell wall is subjective, and, hence, different authors accept different concepts of what an herb is.

Because they thrive in particular ecological conditions, herbaceous plants in the forest floor present exceptionally interesting adaptations (Richards, 1996) that reflect their environment in whichever forest type, thus acting as a forest quality indicator (Cestaro, 1986; e.g. Pregitzer & Barnes, 1982; Moore & Vankat, 1986; Cserep *et al.*, 1991; Strong *et al.*, 1991). Considering this fine tuning with their environment, would herb species be distributed according to the same pattern shown by the Atlantic Forest trees, thus indicating the action of similar biogeographic processes? Or would they be limited by the special microclimate each forest type imposes upon them, thus occurring as discrete floristic centers? Our aim is to test the expectation that the geographic distribution of the herb layer flora presents the same pattern of the arboreal flora. In order to test this expectation we posed the following questions as guidelines:

1) Would the geographic distribution of the herb layer species occur in gradient? This pattern would be observed when many herb species are common to different sites of the Atlantic Forest, the geographic ranges of different species overlap at least partially, and the species replace one another in a continuous way. The occurrence of a gradient would indicate that the herb layer flora constitutes a single floristic center, similarly to what occurs with the tree flora, thus pointing to the importance of dispersal events.

2) Would the geographic distribution of the herb layer species constitute distinct groups? Contrarily to the distribution in gradient, this pattern would indicate the repartition of the herb layer flora into distinct floristic centers. The occurrence among the herb layer species of a geographic pattern that is different from that of the Atlantic Forest tree species could be an evidence of different events in their evolutionary history, thus pointing to the importance of vicariance events.

Methods

Floristic data

We considered the herb layer as the forest compartment occupied by terrestrial herbs, characterized as vascular, mechanically independent and little lignified plants (Cestaro *et al.*, 1986). We considered as herbaceous plant every species that the authors of the original papers considered to be a terrestrial herb, including palmettos, and we reviewed the literature to confirm the habit of each species.

We selected floristic lists from published surveys dealing with the herb layer or with terrestrial herbaceous plant and that had been carried out in the southern and southeastern Brazilian Atlantic Forest *s.l.* We selected the contributions in form of scientific papers, theses or dissertation published until July 2007 plus an ongoing research by our group (Aranha 2008). We considered only the contributions that provided adequate information on the locality and respective geographic coordinates, so as to allow us to locate the site in a given formation of the Atlantic Forest. By applying these criteria we selected 41 surveys from 35 references (table 1). Although there were differences in sample size, methods and definitions among the original surveys, we considered that the data provided a reasonable basis for comparison (e.g. Castro *et al.*, 1999; Durigan *et al.*, 2003; Ratter *et al.*, 2003; Bridgewater *et al.*, 2004). Once the information gathered, we constructed a refined floristic list with 947 species, 382 genera and 93 families (appendix 1), after synnonimizing the original binomials with the aid of the websites Missouri Botanical Garden VAST (W^3TROPICOS, 2007) and Plant Systematics Org (2007) and making orthographic correction and taxonomic systematization according to the Angiosperm Philogeny Group II (APG II 2003) for angiosperms and Smith *et al.* (2006) for ferns.

Classification of the forest formations

In order to attribute a survey to a forest formation, we firstly classified the surveys according to the rainfall regime and altitude belts. We categorized the rainfall regime as typical of a rainforest when the less rainy month received more than 60 mm of rain, whereas the occurrence of a marked dry season in which the driest month received 60 mm or less of rain was typical of a seasonal forest. We set the altitude belts according to Veloso *et al*. (1991) and IBGE (1992). In latitudes at north of 24° S we considered lowland under 50 m altitude, submontane between 51 and 500 m altitude, and montane between 501 m and 1500 m altitude. In latitudes at south of 24° S we considered lowland under 30 m, submontane between 31 and 400 m, and montane between 401 m and 1100 m altitude. Then, with the aid of geographic coordinates we located each survey in the map provided by IBGE (1999), and attributed each survey to a formation of the Atlantic Forest *s.l.* (Table 1): Submontane Seasonal Forest (2 surveys); Montane Seasonal Forest (10); Lowland Rainforest (12); Submontane Rainforest (8); and Montane Rainforest (9). Six surveys were also considered Mixed Rainforest (Table 1).

Table 1. Areas of Atlantic Forest compared in this study. The sites are arranged from north to south. NS: number of species; SSF: submontane seasonal forest, MSF: montane seasonal forest, LRF: lowland rainforest, SRF: submontane rainforest, MRF: montane rainforest; * mixed rainforest (with *Araucaria angustifolia).*

Code	Locality	Vegetation Type	Coordinates	NS	Reference
01	Timóteo – MG	MSF	19º41'S, 48º38'W	104	Lombardi & Gonçalves, 2000
02	Caratinga – MG	MSF	19º50'S, 41º50'W	100	Lombardi & Gonçalves, 2000
03	Nova Lima – MG	MSF	19º58'S, 43º55'W	29	Andrade, 1992
04	Paulo de Faria – SP	SSF	19º58'S, 49º32'W	21	Stranghetti & Ranga, 1998
05	Viçosa – MG	MSF	20º45'S, 42º55'W	22	Meira–Neto & Martins, 2003
06	Potirendaba – SP	SSF	21º02S, 49º22W	5	Stranghetti *et al.*, 2003
07	Brotas – SP	MSF	22º17'S, 48º08'W	5	Zickel, 1995
08	Campinas – SP	MSF	22º48'S, 47º02'W	36	Kinoshita *et al.*, 2006
09	Campinas – SP	MSF	22º49'S, 47º06'W	13	Zickel, 1995
10	Campinas – SP	MSF	22º50'S, 46º55'W	18	Vieira & Martins unpublished
11	Campinas – SP	MSF	22º55'S, 47º03'W	17	Bernacci, 1992
12	Ubatuba – SP	LRF	23º20'S, 44º56'W	7	Assis, 1999
13	Ubatuba – SP	SRF	23º22'S, 45º05'W	7	Aranha 2008
14	Guarulhos – SP	MRF	23º25'S, 46º36'W	13	Silva, 2006
15	Fênix – PR	MSF	23º55'S, 51º51'W	18	Mikich & Silva, 2001
16	Cananéia – SP	LRF	25º03'S, 47º53'W	20	Sugiyama, 2003
17	Curitiba – PR	MRF*	25º25'S, 49º16'W	129	Kozera *et al.*, 2006
18	Curitiba – PR	MRF*	25º25'S, 49º17'W	35	Cervi *et al.*, 1988
19	Morretes – PR	MRF	25º26'S, 48º55'W	44	Kozera, 2001
20	Ilha do Mel – PR	LRF	25º32'S, 48º18'W	91	Silva, 1998
21	Ilha do Mel – PR	SRF	25º33'S, 48º18'W	34	Kozera, 2001
22	Foz do Iguaçu – PR	MRF*	25º40'S, 54º30'W	11	Cain *et al.*, 1956
23	Matinhos – PR	LRF	25º43'S, 48º30'W	41	Sonehara, 2005

24	Tijucas do Sul – PR	MRF*	25º45’S, 49º20’W	4	Liebsch & Acra, 2004
25	Itapoá – SC	LRF	26º04’S, 48º18’W	71	Negrelle, 2002
26	Itapoá – SC	LRF	26º04’S, 48º38’W	23	Dorneles & Negrelle, 1999
27	Vale do Itajaí – SC	MRF	26º39’S, 49º16’W	214	Klein, 1979
28	Esmeralda – RS	MRF*	28º12’S, 51º11’W	27	Cestaro *et al.*, 1986
29	Torres – RS	LRF	29º20’S, 49º18’W	27	Citadini-Zanette, 1984
30	Torres – RS	LRF	29º21’S, 49º17’W	65	Lindeman *et al.*, 1975
31	Canela – RS	MRF*	29º23’S, 50º41’W	33	Diesel & Siqueira, 1991
32	Rolante – RS	SRF	29º35’S, 50º26’W	27	Diesel & Siqueira, 1991
33	Parobé – RS	LRF	29º41’S, 50º51’W	16	Diesel & Siqueira, 1991
34	Porto Alegre – RS	SRF	29º45’S, 51º12’W	24	Oliveira *et al.*, 2005
35	Viamão – RS	SRF	30º05’S, 50º50’W	44	Müller & Waechter, 2001
36	Viamão – RS	SRF	30º16’S, 51º02’W	27	Knob, 1978
37	Viamão – RS	SRF	30º20’S, 50º50’W	10	Palma & Jarenkow, 2003
38	Viamão – RS	SRF	30º20’S, 50º50’W	9	Baptista & Irgang, 1972
39	Palmares do Sul – RS	LRF	30º21’S, 50º21’W	11	Mauhs & Barbosa, 2004
40	Viamão – RS	LRF	30º22’S, 51º01’W	91	Bueno & Martins-Mazzitelli, 1996
41	Pelotas – RS	LRF	32º00’S, 52º30’W	52	Cain *et al.*, 1956

Primary Matrices

We constructed a databank considering presence or absence of the species identified to binomials in the 41 sites. We had a total of 947 species (appendix 1), of which 643 (67.9% of the total species) were recorded at a single site. Because of this high number of isolated species, there would be a lot of zeros in our primary matrices, which would yield a lot of noise (ter Braak, 1995) in the analysis. To avoid this noise, which could mask patterns, we excluded these species from our analyses. After this exclusion, the localities of Potirendaba (SSF06) and Ubatuba (SRF13) were represented by one only specie and these sites were also excluded from our analyses.

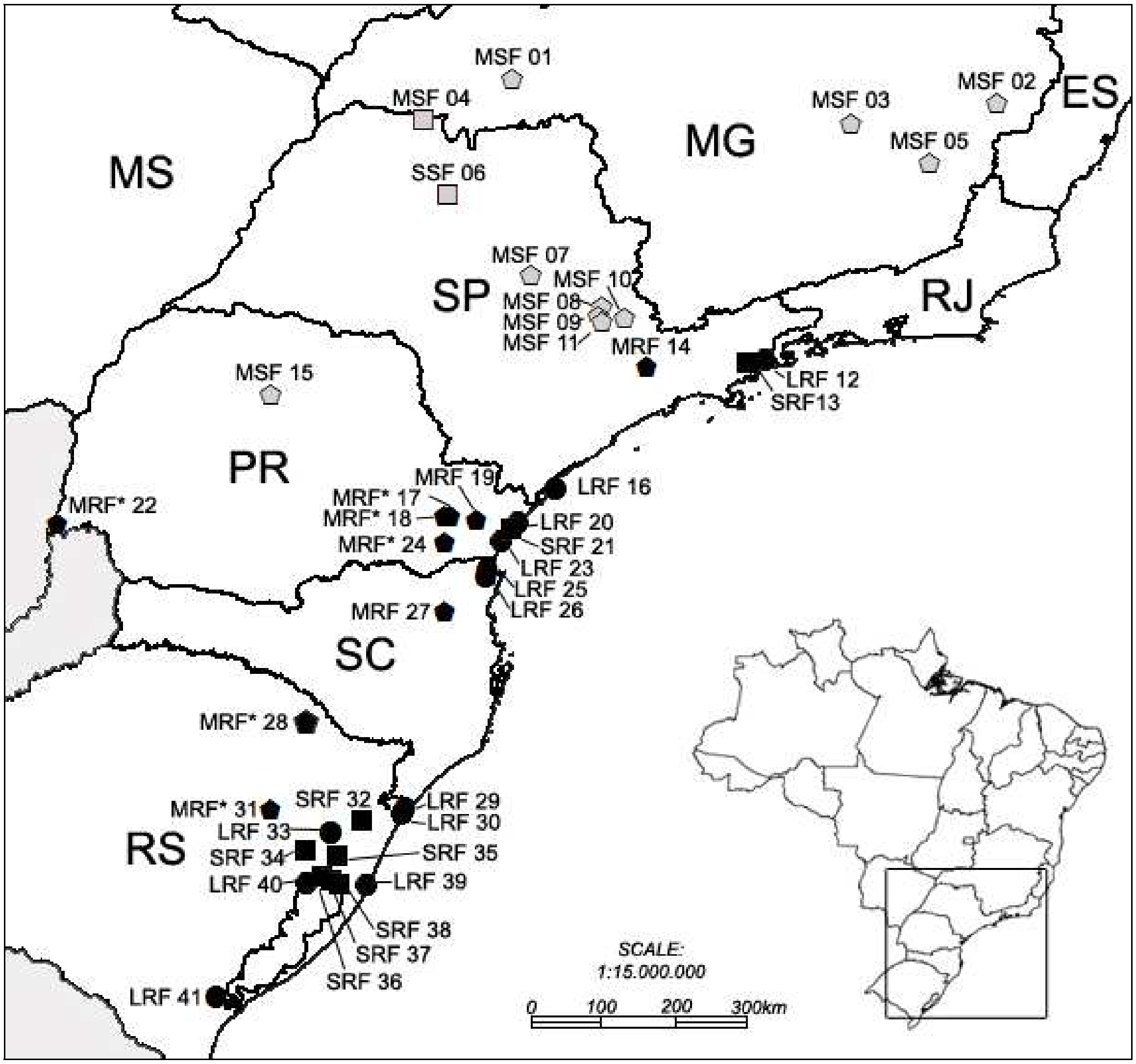

Figure 1. Location of the sites considered in this study with their codes and vegetation types: □ SSF: submontane seasonal forest, ⬠MSF: montane seasonal forest, ●LRF: lowland rainforest, ■SRF: submontane rainforest, ⬟MRF: montane rainforest; * mixed rainforests (with *Araucaria angustifolia)*.

We constructed a primary floristic matrix with binary (presence/absence) data considering 39 sites as objects and 304 species as descriptors (appendix 2). This primary floristic matrix was used in all multivariate analyses. We also constructed a primary environmental matrix, in which the sites were the objects and the environmental variables were the descriptors. For each site we considered longitude, latitude, altitude, and the averages of total yearly precipitation and temperature. We obtained these data from the original publications and by consulting AGRITEMPO (2007). The localities of Potirendaba (SSF06) and Ubatuba (SRF13) were excluded from our primary environmental matrix. Both the primary environmental and floristic matrices were used in Canonical Correspondence Analysis (CCA).

Multivariate Analyses

We used three multivariate techniques of ordination in order to assess the existence of a gradient pattern. Økland (1996) and McCune (1997) suggested the application of an indirect ordination method, where the pure community structure is expressed (McCune, 1997), together with a direct ordination method. Thus, we first applied the Detrended Correspondence Analysis (DCA; Hill & Gauch 1980), which is a modification of the traditional Correspondence Analysis (CA). DCA is an indirect gradient analysis technique, in which environmental gradients are not studied directly but are inferred from species composition data (Palmer, 1993). The process of detrending, which removes the "arc effect", is implemented through the division of the CA first axis into a number of segments. Within each of these segments, the site scores for the second axis are adjusted by subtracting the within-segment mean on the second axis from the score for each site. As a result, each segment has a mean value of zero for scores on the second axis. This process is repeated several times, and the results are averaged to determine the axis scores (Jackson & Somers, 1991). Therefore, detrending is simply a forced adjustment of the site scores on the second axis and all subsequent axes so that no linear or low-order polynomial relationships remain within prior axes (Hill & Gauch, 1980; Gauch, 1982). In addition to detrending, DCA rescales the axes with the assumption that all species show a unimodal response curve with homogeneous variances along each gradient. This rescaling procedure tends to expand interpoint spacing between sites or species located at the ends of the axes. We performed the DCA with the software PC-Ord 4.0 (McCune & Mefford, 1999) with default settings and without downweighting the rare species. The survey LRF12 was considered an outlier on the first run and was excluded from this analysis. If a gradient pattern existed we would expect a linear arrangement of the sites in the ordination with the first two axes.

We applied a Non-Metric Multidimensional Scaling (NMS), which is also an indirect ordination method, to confront with DCA results. The NMS is a particularly robust technique, but differs fundamentally in design and interpretation from other ordination techniques (Kruskal & Wish, 1978; Clarke 1993). The principle basically is simple: the biotic relationship between any two samples is expressed by a coefficient of similarity or dissimilarity of species composition, resulting in a triangular matrix of similarity or dissimilarity between every pair of samples. This matrix is then used to classify the samples into groups and to map the sample inter-relationships in an ordination (Clarke, 1993). Thus, if the herb layer were distributed in distinct floristic centers, we would expect the samples to distribute in clusters in this ordination.

We performed the NMS with the software PC-Ord 4.0 (McCune & Mefford, 1999). To assess the best dimensionality, we selected the slow and thorough "autopilot" mode with Sørensen's distance measure, as recommended by McCune & Mefford (1999), and obtained a three-dimensional solution. The number of runs with real data and the interactions to evaluate stability was set to 10 (default), the stability criterion was set to 0.001, the maximum number of interaction was set to 100 (default), and the step down dimensionality option was chosen with an initial step length set to 0.20 (default). One particular advantage of NMS is the distance-preserving property, which is the preservation of the rank order of among-sample dissimilarities in the rank order of distances (Clarke, 1993). In other words, the distance between two samples in the ordination diagram is relative to their dissimilarity, although in general it is not possible to arrange samples so that the mutual distances between them in the ordination diagram are equal to the calculated dissimilarity values (ter Braak, 1995). Therefore, a measure is needed that expresses in a single number how well or how badly the distances in the ordination diagram correspond to the dissimilarity values. Such measure is called "stress" (ter Braak, 1995). When stress tends to zero, the rank order reaches a perfect agreement (Clarke, 1993). We applied the Monte Carlo test with $\alpha = 0.05$ and 999 random permutations to allow us compare the stress obtained with our real data with the stress obtained with randomized data.

In order to assess the influence of environmental factors on the distribution of the herb layer, we applied a Canonical Correspondence Analysis (CCA), a direct gradient analysis, in which the species composition is directly and immediately related to environmental variables (Palmer, 1993). We performed CCA on both floristic and environmental primary matrices with the software PC-Ord 4.0 (McCune & Meffrod, 1999).

We used centered and normalized scores, and the species scores were set to linear combinations of environmental variables as recommended by Palmer (1993). In order to estimate the approximated significance of the relationship between the floristic data set and the environmental variables, we applied a Monte Carlo test based on 5000 random permutations (McCune & Meffrod, 1999), assuming H_0 as a non-linear relationship between the matrices.

In an attempt to confirm the results obtained with the ordinations analyses, we used two multivariate techniques of classification, following closely the procedures used by Oliveira-Filho & Ratter (1995), Ratter *et al.* (1996) and Ratter *et al.* (2003). The two techniques were (a) an agglomerative hierarchical classification by Unweighted Pair-Grouping Method by Arithmetic Averages (UPGMA) using Sørensen Coefficient of Community as a measure of similarity (Kent & Coker, 1992); and (b) a divisive hierarchical classification by Two-Way Indicator Species Analysis (TWINSPAN; Hill, 1979). These computations were performed with the software FITOPAC 1.6 (Sheperd, 2006). If there were a gradient, we would expect the UPGMA dendrogram to display a series of steps; otherwise, the dendrogram would display distinct groups on the first divisions. If a gradient occurred, we would expect a gradual ramification in TWINSPAN, but if there were distinct floristic groups, we would expect ramification inside great groups to occur.

In TWINSPAN, the maximum level of divisions was set to five, the minimum group size for division was five, and the maximum number of indicator species per division was set to seven. As the data had the binary (presence/absence) format, there was one pseudo-species at level zero. All divisions had an eigenvalue greater than 0.30, which is considered significant to explain the variation that occurs in nature (Kent & Coker, 1992). These computations were performed with the software FITOPAC 1.6 (Sheperd, 2006).

Results

Floristic Data

The number of herbaceous species sampled in each survey ranged from 4 to 214 species. A total of 947 species in 382 genera and 93 families were computed in all 41 sites pooled together (appendix 1). The most constant species were *Chaptalia nutans* (L.) Polak, *Pseudoechinolaena polystachya* (H.B.K.) Stapf and *Tradescantia fluminensis* Vell. occurring in 11 sites; *Oplismenus hirtellus* (L.) P.Beauv. in ten sites; *Carex sellowiana* Schlecht., *Dichorisandra hexandra* (Aubl.) Standl. and *Elephantopus mollis* Kunth in nine sites; *Anemia phyllitidis* (L.) Sw., *Bromelia antiacantha* Bertol., *Coccocypselum lanceolatum* (Ruiz & Pav.) Pers., *Ichnanthus pallens* (Sw.) Munro ex Bentham, *Pharus glaber* H.B.K. and *Spathicarpa hastifolia* Hook. in eight sites. A number of 643 (67.9%) out of the total number of 947 species occurred in only one site.

The most speciose genera were *Asplenium* and *Panicum* with 22 species; *Begonia* with 21; *Cyperus* and *Piper* with 18 species; and *Justicia* with 15. Out of the total 382 genera 217 (56.8%) had only one species. The most constant genera were *Panicum* occurring in 17 sites; *Coccocypselum* and *Piper* in 16; *Asplenium, Blechnum, Justicia* and *Tradescantia* in 15; *Dichorisandra, Olyra and Oplismenus* and in 14; and *Doryopteris* and *Pharus* in 13 sites. A proportion of 46.1% (176) of the total number of 382 genera occurred in only one site.

The richest families in species were Poaceae with 120 species, Asteraceae (58), Cyperaceae (57), Orquidaceae (53), Dryopteridaceae (48), Bromeliaceae (38), and Acanthaceae with 36 species. Out of the total 93 families 22 had only one species, and 38 families had only one genus. The most constant families were Poaceae occurring in 37 sites; Cyperaceae (29); Commelinaceae (28); Asteraceae and Rubiaceae (23); Acanthaceae and Piperaceae (22) and Orchidaceae in 21 sites. Out of the total number of 93 families 20 (21.7%) occurred in only one site.

Multivariate Analyses

Detrended Correspondence Analysis (DCA)

The total variance ("inertia") was 10.268, which is the sum of the eigenvalues for all ordination axes, or a statistical measure of the total variance in the data set (ter Braak, 1986; 1990). The eigenvalues (representing the total variance accounted for by each axis) for the first two DCA axes were 0.643 and 0.478, respectively. Values over 0.5 often denote a good separation of the species along the axis (ter Braak, 1995). The gradient lengths of the first two axes were estimated as 4.9 and 5.0 s.d., respectively. Sites differing 4.0 s.d. or more in scores can be expected to have no species in common (ter Braak, 1995); in our case, this means that sites close at the opposite ends of the axis have hardly any species in common. The DCA ordination diagram showed no clear gradient in both axes; instead, three great groups could be defined (Figure 2a). On the right to left-inferior quadrant, a group was constituted by Lowland Rainforest surveys from northern São Paulo coast to southern Rio Grande do Sul. On the left-superior quadrant, surveys from the Seasonal Forest in Campinas (São Paulo state) and one site in Minas Gerais formed another group. A third group was formed on the left-middle of the diagram (Figure 2a) with surveys from the Upland Rainforest in center-northern São Paulo to southern Rio Grande do Sul. Five sites of the Seasonal Forest were blended with the Upland Rainforest group and two sites of montane rainforest were blended with the Seasonal Forest group. There was no separation of the Mixed Rainforest.

Non-Metric Multidimensional Scaling (NMS)

The non-metric multidimensional scaling produced a three-dimensional solution with a stress average from real data of 52.1, 30.4 and 21.7, respectively. The Monte Carlo test indicated that each axis solution provided significantly greater reduction in stress than expected by chance ($p = 0.001^*$). The NMS ordination diagram showed a clustered pattern with three great groups (figure 2b). One group, formed on the right of the diagram, was constituted by surveys in the Lowland Rainforest from northern São Paulo to northern Rio Grande do Sul. Another group, formed on the left superior part of the diagram, was composed almost entirely by Seasonal Forests, except for three surveys from montane seasonal forest (MSF01, MSF02 and MSF15). A third group was formed on the middle of the diagram with surveys of the Upland Rainforest from northern São Paulo through center Paraná to southern Rio Grande do Sul. Again, no separation of the Mixed Rainforest was detected.

Canonical Correspondence Analysis (CCA)

The total variance (“inertia”) was 10.696, and the eigenvalues for the three first axes were 0.57, 0.52 and 0.41 respectively. These are considered relatively high values and

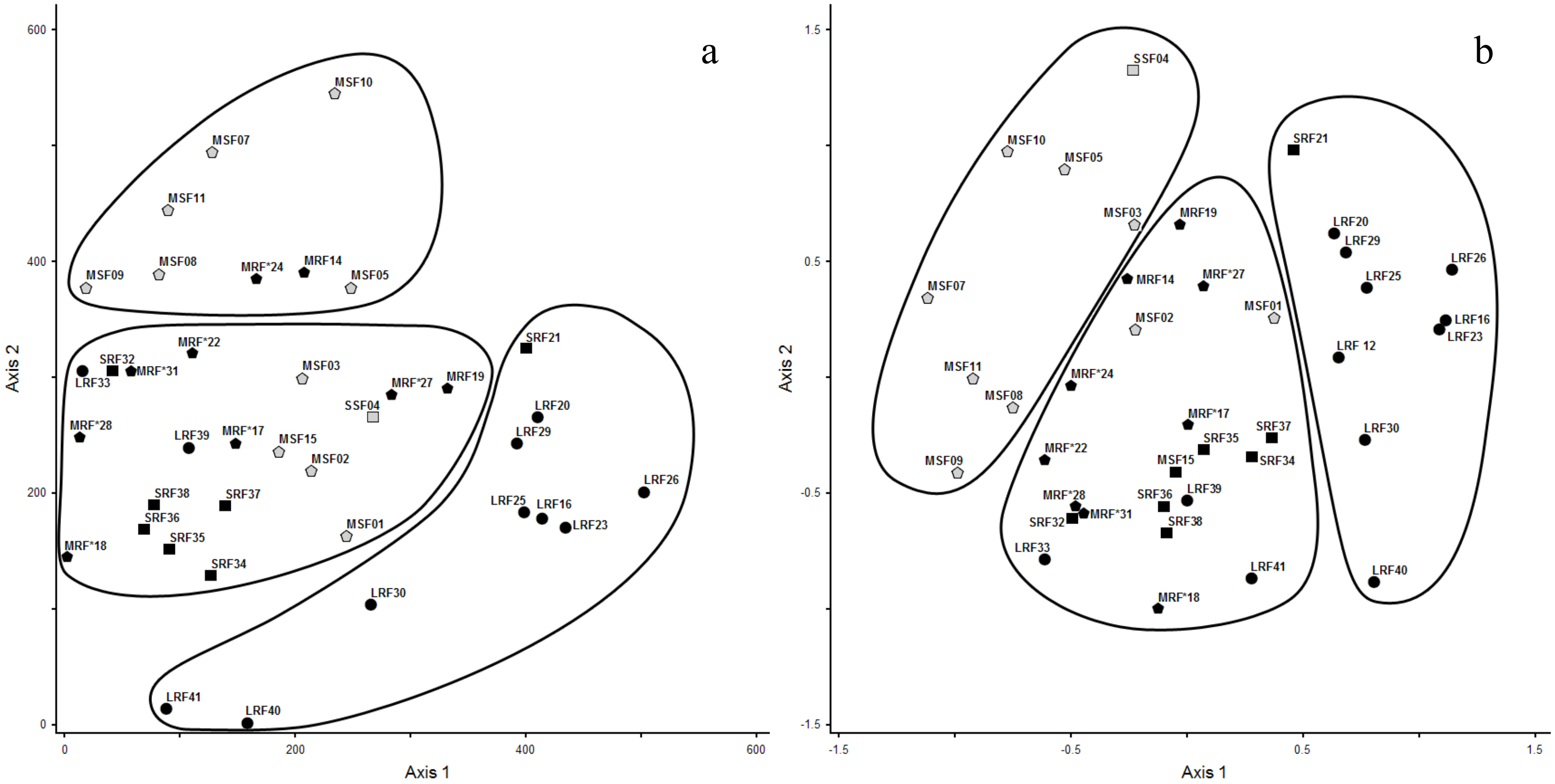

Figure 2. Ordination diagrams: a) Detrended Correspondence Analysis (DCA); b) Non-metric Multidimensional Scaling (NMS). The legends of sites are in table 1, and the groups are detailed in the text.

represent a measure of the relative amount of variation (in species composition) “explained” by each axis (ter Braak, 1986; Økland, 1990). For all three axes, there was a significant relationship between floristic composition and environmental variables ($p < 0.05^*$).

The first axis was associated with temperature on the negative side, and longitude and latitude on the positive side; and the second axis was associated with altitude against precipitation (figure 3). The main ordination framework (axis 1 x 2) indicated that the herb layer of the Seasonal Forest was influenced by altitude and temperature (right inferior

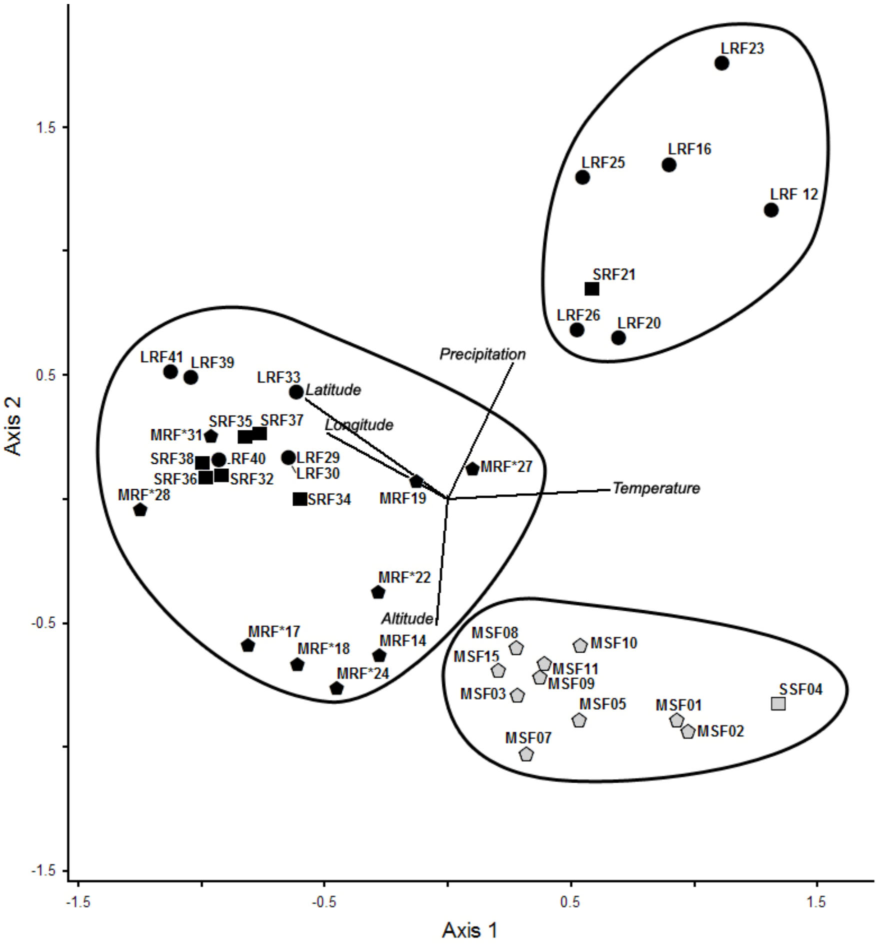

Figure3. Ordination diagram of Canonical Correspondence Analysis (CCA). The legends of sites are in table 1, and the groups are detailed in the text

quadrant), whereas the sites of the Lowland Rainforest were most influenced by temperature and precipitation (right superior quadrant). The herb layer of forests in Rio Grande do Sul, mostly submontane rainforests, corresponded to a homogenous group influenced by longitude and latitude (left superior quadrant). The sites of montane rainforests localized on the slopes of Serra do Mar occupied the middle to the left-inferior quadrant of the diagram, being influenced by altitude, longitude and latitude. The sites of Serra do Mar and Rio Grande do Sul can be grouped together and corresponded to the Upland Rainforest group formed in DCA and NMS analyses.

Unweighted Pair-Grouping Method by Arithmetic Averages (UPGMA)

The UPGMA analysis produced a dendrogram (figure 4) in which five groups could be distinguished at the level of 0.06 of Sørensen Coefficient of Community Similarity. Group A was constituted by only one site, the lowland rainforest of Ubatuba (LRF12). Group B was constituted by eastern rainforests from northern São Paulo to northern Rio Grande do Sul, mostly lowland rainforests. Group C had few surveys of seasonal forest from northern São Paulo to southern Minas Gerais, all sites close at 20º latitude. Group D was composed by all remaining surveys from seasonal forest, except for the presence of one montane rainforest of southern Paraná (MRF*24) and for the absence of one montane seasonal forest in Campinas (MSF09). Group E included the remaining rainforests, mostly upland rainforests (submontane and montane rainforests), from northeastern São Paulo to southern Rio Grande do Sul, except for the presence of one montane seasonal forest in Campinas (MSF09) and the absence of one montane mixed rainforest (MRF*24).

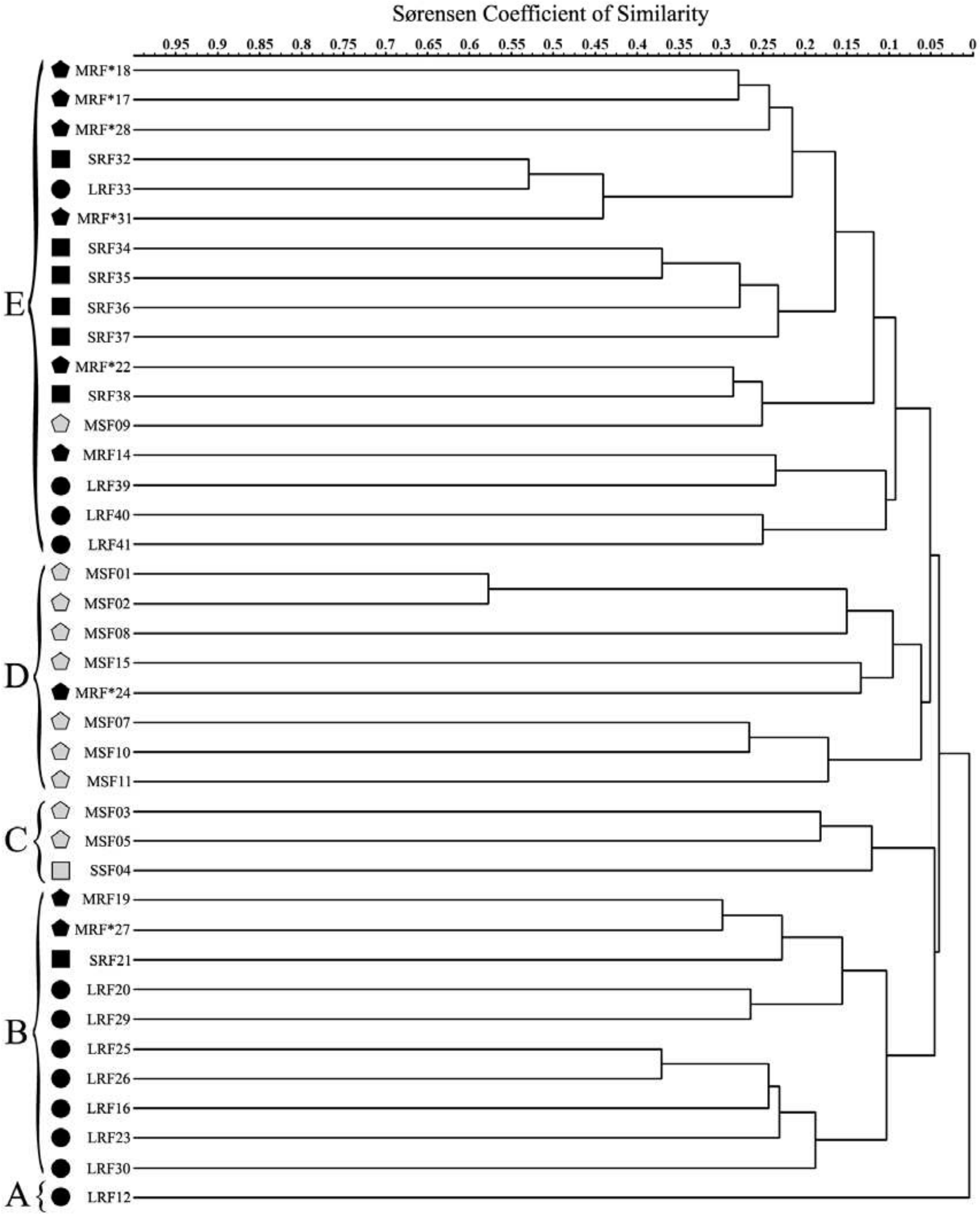

Figure 4. Dendrogram with UPGMA and Sørensen Coefficient of Community. The legends of sites are in table 1, and the groups are detailed in the text.

Divisive Hierarchical Classification by Two-Way Indicator Species Analysis (TWINSPAN)

The application of TWINSPAN produced eleven groups formed in the second to the fifth levels of division. These groups were classified in three main blocks, namely Lowland Rainforest, Seasonal Forest and Upland Rainforest (figures 5).

The first block was composed by groups I, J and K and constituted by lowland rainforests on the coast from northeastern São Paulo to northern Rio Grande do Sul. The second block grouped surveys from the Seasonal Forest, including groups A, B, C and D. This block also included three montane rainforests, the MRF19 (group A), the MRF14 in group B and MRF*24 in group C. The third block was constituted by upland rainforests, except for the presence of five lowland rainforests of Rio Grande do Sul, LRF30, LRF 40 and LRF41 in group H, LRF33 in group F and LRF39 in group G. Out of the six sites with *Araucaria angustifolia* five were in this third block. The TWINSPAN identified 52 preferential species in the Lowland Rainforest block, 54 in the Seasonal Forest block and 118 in the Upland Rainforest block (appendix 3). In these formations 22 species were exclusive to the Lowland Rainforest block, 33 to the Seasonal Forest and 76 to the Upland Rainforest, thus summing up 43.1% of all 304 species used in this analysis. Only 24 species (7.9%, appendix 4) occurred in all three blocks, 20 species (6.6%) were encountered both in Seasonal Forest and Lowland Rainforest blocks, 52 (17.1%) in both Upland Rainforest and Lowland Rainforest blocks, and 80 (25.3%) in both Upland Rainforest and Seasonal Forest blocks.

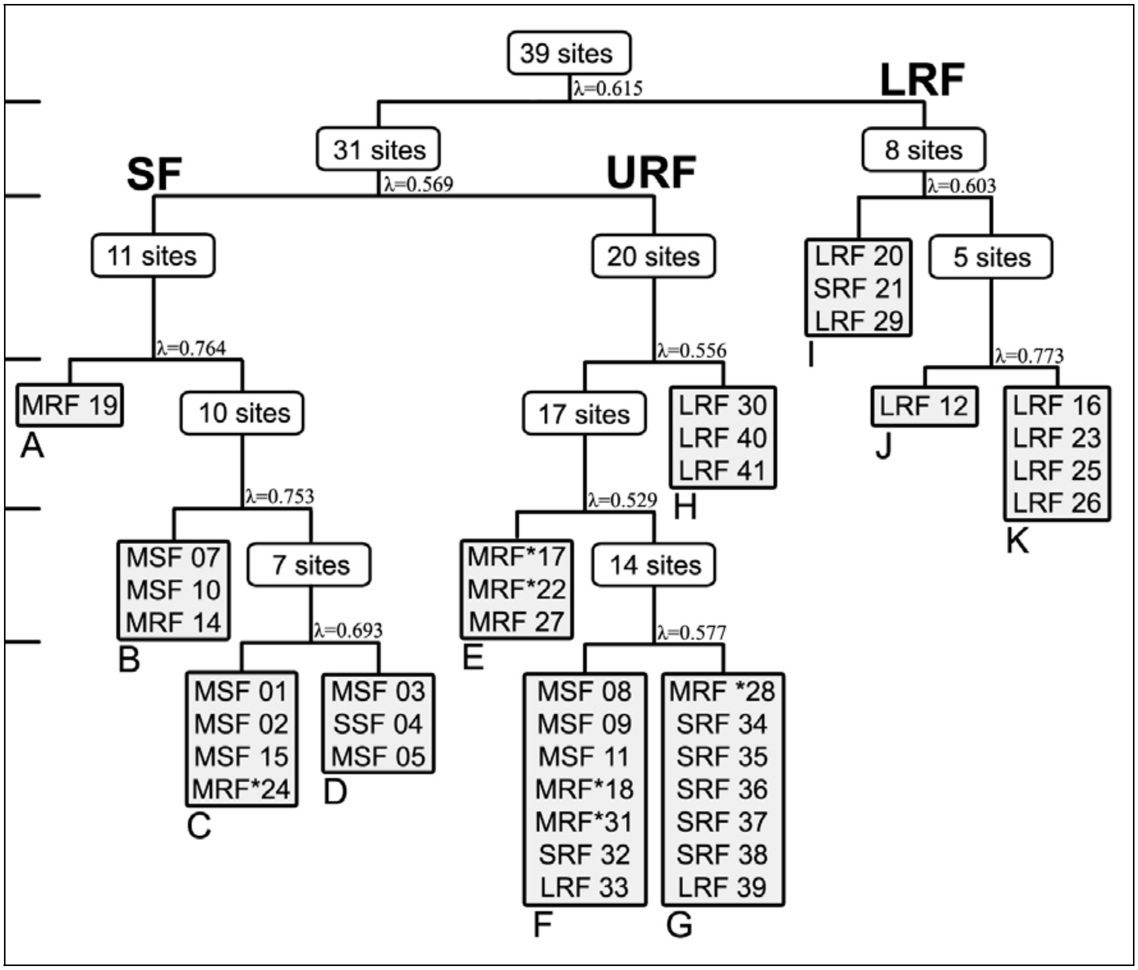

Figure 5. TWINSPAN results showing the groups of the Lowland Rainforest (LRF), Upland Rainforest (URF) and Seasonal Forest (SF). The legends of sites are in table 1 and the groups are detailed in the text.

Floristic Centers

The high degree of agreement between both classification and ordination analyses give us a comfortable position to assume that the distribution of the herb layer flora of southern and southeastern Brazilian Atlantic Forest occurs in distinct floristic centers, and does not follow the same pattern in gradient shown by tree species. Thus, three great floristic centers can be recognized for the species of the herbaceous layer: Seasonal Forest, Lowland Rainforest, and Upland Rainforest (Figure 6).

The Seasonal Forest floristic center occurs in the hinterland from southern Minas Gerais to center-north Paraná. This group is a union of groups C and D of UPGMA with the Seasonal Forest block of TWINSPAN. DCA and NMS revealed a great heterogeneity of this floristic center indicated by the greater dispersion of sites on the diagram, but on CCA the Seasonal Forest grouped into a concise cluster with very similar environmental variables among sites.

The Upland Rainforest floristic center extends from the slopes of Serra do Mar in center-northern São Paulo through center Paraná to southern Rio Grande do Sul. It is constituted by surveys from submontane and montane rainforests and is a union of groups E from UPGMA and Upland Rainforest block from TWINSPAN. The altitude variation within this floristic center was only noticed on the CCA ordination. The DCA and NMS showed the same pattern, *i. e.*, the position of the Upland Rainforest between Lowland Rainforest and Seasonal Forest.

The Lowland Rainforest floristic center extends from the coast of northern São Paulo to northern Rio Grande do Sul and resulted from the union of the groups A and B of UPGMA with the Lowland Rainforest block of TWINSPAN. The ordination analyses indicated this floristic center to be a very concise group. This floristic center is particularly influenced by high temperatures and rainfall, according to CCA results.

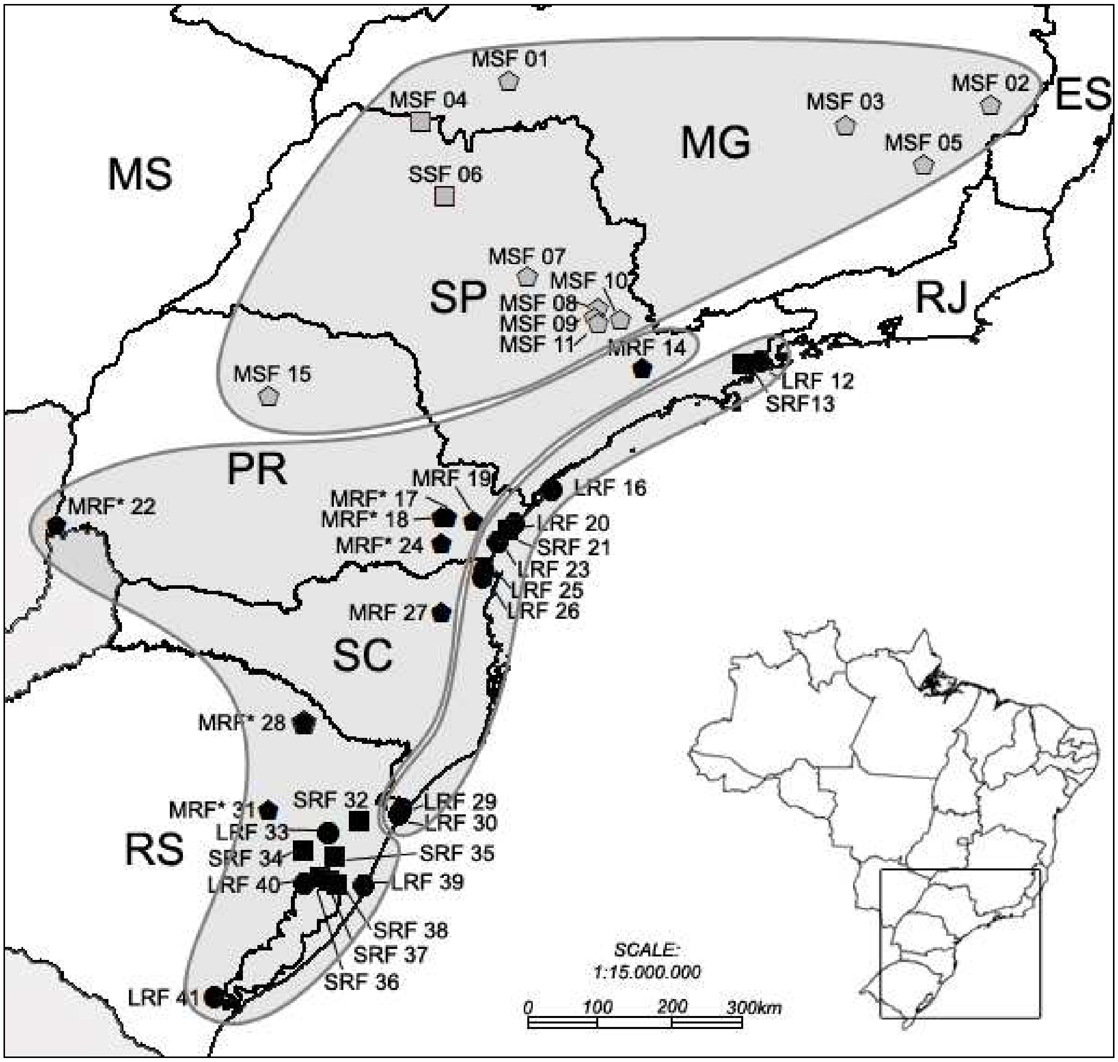

Figure 6. Floristic Centers according the agreement of multivariate analyses techniques. The legends of the sites are in table 1.

Discussion

The great number of species of the herb layer is remarkable, considering that they were sampled in only 41 sites. A similar study considering woody species in the Brazilian Cerrado yielded 951 species surveyed in 376 sites (Ratter *et al.*, 2003). The occurrence of 947 terrestrial herb species in only 41 surveys reinforces both the great diversity of the Atlantic Forest *s.l.* and the need of more studies dealing with the herb layer. Almost 70% of these species were sampled in a single site, thus confirming Richards' (1996) statement that the herbs in the forest floor thrive in very particular ecological conditions, which demand a high level of specialization (Mantovani, 1987).

We consider our results to be trustworthy, since the analyses we used were complementary and produced similar results, giving us a good background to state that three great floristic centers could be distinguished in the distribution of the herb layer flora: Seasonal Forest, Upland Rainforest and Lowland Rainforest. Altitude was important only to distinguish Lowland from Upland rainforests. Also, the presence of *Araucaria angustifolia* in the Upland Rainforest did not produce any distinction among the sites in this center. However, altitude and the presence of *Araucaria angustifolia* could be significant in a fine scale, for example, influencing the variation of abundance and spatial pattern of the herb layer species within each site or floristic center.

These three floristic centers could be the outcome of evolutionary processes, which could include complex exchange of species and genes (Joly *et al.*, 1999). Coastal line changed dramatically along the late Tertiary period and the Pleistocene. Some areas of the coastal plains were up to 180 km wider during the drier period and, at the peak of the humid period, areas that are today above sea level were submersed (Bigarella, 1973). Moreover, the alternation of humid tropical and subtropical with arid and semiarid climates in Quaternary period unchained a strong influence in species distribution and speciation processes of flora and fauna (Ab'Saber, 1977), especially in the Atlantic Forest (Joly *et al.*, 1999). Sites in the Lowland Rainforest center were strongly influenced by these fluctuations of sea level, as well as by the expansions and retractions of the Atlantic Forest on the slopes of the Serra do Mar (Bigarella, 1973; Joly *et al.*, 1992). Thus, it is likely that the distinction of Upland Rainforest and Lowland Rainforest was influenced by these events and especially by the presence of the eastern mountain ridge from Rio de Janeiro to southern Santa Catarina. The absence of a remarkable mountain chain between the coast and the hinterland in Rio Grande do Sul could be an explanation for the lack of a distinction between the coastal plains and hinterland we found in our results for this state.

Smith (1962) and Eiten (1970) stated that all the forest formation of the Atlantic Forest have a common origin, whereas Joly *et al.* (1999) claimed that these formations differ in flora, fauna, and origin. Whereas many authors found the tree flora of the Atlantic Forest to distribute according to gradients, which would indicate a common origin, we found three distinct floristic centers for the herb layer flora. Our results seem to corroborate the hypothesis that the forest formations of the Atlantic Forest could have different origins. However, if the Atlantic Forest had one center of origin, we suppose that environmental changes along the evolutionary process could have had different impacts on trees and ground herbs. Terrestrial herbs in tropical forests are submitted to a severe competition due to their superficial root system and little size (Citadini-Zanette, 1984; Citadini-Zanette & Baptista, 1989), and their shorter life cycle implies a high level of specialization. These characteristics would have been important in giving rise to different floristic centers of ground herbs in different forest formations of the Atlantic Forest along evolutionary time.

The distribution of the herb layer flora in three distinct floristic centers agrees with the broad divisions of the Atlantic Forest into rainforests (Lowland Rainforest on the one hand, and Submontante and Montane Rainforest on the other hand) and seasonal forests (Submontane and Montane Seasonal Forest). However, the distribution pattern of the ground herb flora we observed does not support the distinction of the Mixed Rainforest (with *Araucaria angustifolia*) as a separate phyto-ecological region, as claimed by Veloso *et al*. (1991) and IBGE (1992). Moreover, whereas the tree flora varies in gradients among all Atlantic Forest formations, the ground herb flora occurs in three distinct floristic centers. Also, altitude seems to not influence species distribution within each floristic center, although it is important to put the Seasonal Forest and the Upland Rainforest centers apart from the Lowland Rainforest center. These findings indicate that biogeographic processes ruling the ground herb flora and the tree flora are different and can produce different geographic patterns. Our results confirm that ground herbs are very specialized species and highlight the great importance of the herb layer for the knowledge of geographic patterns in the Brazilian Atlantic Forest.

Literature Cited

Ab'Saber, A.N. (1977) Espaços ocupados pela expansão dos climas secos na América do Sul, por ocasião dos períodos glaciais quaternários. Instituto de Geografia, Universidade de São Paulo, SP. *Paleoclimas*, **3**

Agritempo (2007) *Sistema de Monitoramento Agrometeorológico*. www.agritempo.gov.br

Andrade, P.M. (1992) *Estrutura do estrato herbáceo de trechos da Reserva Biológica Mata do Jambreiro*, Nova Lima, Minas Gerais. Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas.

Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society*, **141**, 399–436.

Aranha, B. A. (2008). *Determinismo ambiental e estocasticidade em uma comunidade do subosque da Floresta Atlântica.* Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas.

Assis, M.A. (1999) Florística e caracterização das comunidades vegetais da planície costeira de Picinguaba, Ubatuba–SP. Tese de Doutorado, Universidade Estadual de Campinas, Campinas, Brasil.

Baptista, L.M. & Irgang, B.E. (1972) Nota sobre a composição florística de uma comunidade florestal dos arredores de Porto alegre. *Iheringia Série Botânica*, **16**, 3–8.

Bernacci, L.C. (1992) *Estudo florístico e fitossociológico de uma floresta no município de Campinas, com ênfase nos componentes herbáceo e arbustivo*. Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas.

Bigarella, J.J. (1973) Paleocurrents and the problem of continental drift. *Geologische Rundschau*, **62**, 447–477.

Bridgewater, S., Ratter, J.A. & Ribeiro, J.F. (2004) Biogeographic patterns, β-diversity and dominance in the cerrado biome of Brazil. *Biodiversity and Conservation,* **13**, 2295–2318.

Bueno, O.L. & Martins-Mazzitelli, S.M.A. (1996) Fitossociologia e florística da vegetação herbáceo-subarbustiva da Praia de Fora, Parque Estadual de Itapuã, Rio Grande do Sul. *Iheringia Série Botânica*, **47**, 123–137.

Cain, S.A., Castro, G.M.O., Pires, J.M. & Silva, N.T. (1956) Application of some phytosociological techniques to Brazilian Rain Forest. *American Journal of Botany*, **43**, 911–41.

Callaway, R.M. (1997) Positive interactions in plant communities and the individualistic-continuum concept. *Oecologia*, **112**, 143–149.

Castro, A.A.J.F., Martins, F.R., Tamashiro, J.Y. & Shepherd, G.J. (1999) How rich is the flora of the Brazilian cerrados? *Annual Missouri Botanical Garden*, **86**, 192–224.

Cervi, A.C., Acra, L.A., Rodrigues, L., Gabriel, M.M. & Lopes, M. (1988) Contribuição ao conhecimento das plantas herbáceas de uma floresta de Araucária do primeiro planalto paranaense. *Insula*, **18**, 83–98.

Cestaro, L.A., Waechter, J.L. & Baptista, L.R.M. (1986) Fitossociologia do estrato herbáceo da mata de Araucária da Estação Ecológica de Aracuri, Esmeralda, Rio Grande do Sul. Revista *Hoehnea*, **13**, 59–72.

Citadini-Zanette, V. & Baptista, L.R.M. (1989) Vegetação herbácea terrícola de uma comunidade florestal em Limoeiro, município de Torres, Rio Grande do Sul, Brasil. *Boletim do Instituto Biociências*, **45**, 1–87.

Citadini-Zanette, V. (1984) Composição florística e fitossociologia da vegetação da vegetação herbácea terrícola de uma mata de Torres, Rio Grande do Sul, Brasil. *Iheringia Série Botânica*, **32**, 23–62.

Clarke, K.R. (1993) Non-parametric multivariate analyses of changes in community structure. *Australian Journal of Ecology*, **18**, 117–143.

Collins, M. (1990) *The last rain forests*. Mitchell Beazley Publ./IUCN, London, England. 200 pp.

Crisci, J.V. (2001) The Voice of Historical Biogeography. *Journal of Biogeography*, **28**, 157–168.

Cserep, Sz., Standovar, T. & Vanicsek, L. (1991) Tree seedling composition as a function of site quality indicated by herbaceous species in a sessile oak stand. *Vegetatio*, **95**, 71–85.

Diesel, S. & Siqueira, J.C. (1991) Estudo fitossociológico herbáceo/arbustivo da mata ripária da bacia hidrográfica do Rio dos Sinos, Rio Grande do Sul. *Revista Pesquisas*, **42**, 205–257.

Dorneles, L.P.P. & Negrelle, R.R.B. (1999) Composição florística e estrutura do compartimento herbáceo de um estágio sucessional avançado da Floresta Atlântica no sul do Brasil. *Biotemas*, **12**, 7–30.

Durigan, G., Siqueira, M.F., Franco, G.A.D.C., Bridgewater, S. & Ratter, J.A. (2003) The vegetation of priority areas for cerrado conservation in São Paulo State, Brazil. *Edinburgh Journal of Botany*, **60**, 217–241.

Eiten, G. (1970) A vegetação do estado de São Paulo. *Boletim do Instituto de Botânica*, **7**.

Ferraz, E.M.N., Araújo, E.L. & Silva, S.I. (2004) Floristic similarities between lowland and montane areas of Atlantic Coastal Forest in Northeastern Brazil. *Plant Ecology*, **174**, 59–70.

Gauch, H.G.Jr. (1982) *Multivariate analysis in community ecology*. Cambridge University Press. Cambridge.

Hill, M.O. & Gauch, H.G.Jr. (1980) Detrended correspondence analysis: an improved ordination technique. *Vegetatio*, **42**, 47–58.

Hutchinson, G.E. (1957) Concluding remarks. *Cold Spring Harbor Symposia on Quantitative Biology*, **22**, 415–427.

IBGE – Fundação Instituto Brasileiro de Geografia e Estatística. (1999) *Base cartográfica integrada do Brasil ao milionésimo digital*. IBGE, Rio de Janeiro. www.ibge.gov.br/servidor_arquivos_geo/.

IBGE – Fundação Instituto Brasileiro de Geografia e Estatística. (1990) *Geografia do Brasil – Região Sul*. IBGE, Rio de Janeiro. Volume 2.

IBGE – Fundação Instituto Brasileiro de Geografia e Estatística. (1992) *Manual técnico da vegetação brasileira*. IBGE, Rio de Janeiro.

IPT – Instituto de Pesquisas Tecnológicas. (1981) *Mapa geomorfológico do estado de São Paulo*. Instituto de Pesquisas Tecnológicas do Estado de São Paulo, escala 1: 1000 000. v. 1.

Ivanauskas, N.M., Monteiro, R. & Rodrigues, R.R. (2000) Similaridade florística entre áreas de floresta atlântica no estado de São Paulo. *Brazilian Journal of Ecology*, **1–2**, 71–81.

Ivanauskas, N.M. (1997) *Caracterização florística e fisionômica da Floresta Atlântica sobre a formação Pariquera-Açu, na zona da morraria costeira do estado de São Paulo*. Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas.

Jackson, D.A. & Somers, K.M. (1991) Putting Things in Order: The Ups and Downs of Detrended Correspondence Analysis. *The American Naturalist*, **137**, 704–712

Joly, C.A., Aidar, M.P.M., Klink, C.A., McGrath, D.G., Moreira, A.G., Moutinho, P., Nepstad, D.C., Oliveira, A.A., Pott, A., Rodal, M.J.N. & Sampaio, E.V.S.B. (1999) Evolution of the Brazilian phytogeography classification systems: implications for biodiversity conservation. *Ciência e Cultura*, **51**, 331–348.

Joly, C.A., Leitão-Filho, H.F. & Silva, S.M. (1992) The floristic heritage. In: Câmara I.G. (Coord.), *Atlantic Rain Forests*. Editora Index Ltda & Fundação Mata Atlântica, Rio de Janeiro, RJ. pp. 95–125.

Kent, M.C. & Coker, P. (1992) *Vegetation description and analysis: a practical approach*. Belhaven, London.

Kinoshita, L.S., Torres, R.B., Forni-Martins, E.R., Spinelli, T., Ahn, Y.J. & Constâncio, S.S. (2006) Composição florística e síndromes de polinização e de dispersão da mata do Sítio São Francisco, Campinas, SP, Brasil. *Acta Botânica Brasilica* **20**, 313–327.

Klein, R.M. (1979) Ecologia da flora e vegetação do vale do Itajaí. *Sellowia*, **31**, 8–164.

Knob, A. (1978) Levantamento fitossociológico da formação mata do Morro do Coco, Viamão, Rio Grande do Sul. *Iheringia Série Botânica*, **23**, 65–108.

Kozera, C. (2001) *Composição florística e estrutura fitossociológica do estrato herbáceo-subarbustivo em áreas de Floresta Ombrófila Densa localizadas na Ilha do Mel e no Parque Estadual Pico do Marumbi, Paraná, Brasil*. Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas.

Kozera, C., Dittrich, V.A.O., Silva, S.M. (2006) Composição florística da floresta ombrófila mista montana do parque municipal do Barigüi, Curitiba, PR. *Floresta*, **36**, 45–58.

Kruskal, J.B. & Wish, M. (1978) *Multidimensional Scaling*. Sage Publications, Beverly Hills, California.

Leitão-Filho, H.F. (1982) Aspectos taxonômicos das florestas do estado de São Paulo. *Silvicultura*, **16**, 197–206.

Leitão-Filho, H.F. (1987) Considerações sobre a florística de florestas tropicais e sub-tropicais do Brasil. *Instituto de Pesquisas e Estudos Florestais*, **35**, 41–46.

Liebsch, D. & Acra, L.A. (2004) Riqueza de espécies de sub-bosque de um fragmento de Floresta Ombrófila Mista em Tijucas do Sul, PR. *Ciência Florestal*, **14,** 67–76.

Lindeman, J.C., Baptista, L.R.M., Irgang, B.E., Porto, M.L., Girardi-Deiro, A.M. & Baptista, M.L.L. (1975) Estudos botânicos no Parque Estadual de Torres, Rio Grande do Sul, Brasil. II. Levantamento florístico da Planície do Curtume, da área de Itapeva e da área colonizada. *Iheringia Série Botânica*, **21**, 15–52.

Lombardi, J.A. & Gonçalves, M. (2000) Composição florística de dois remanescentes de Mata Atlântica do sudeste de Minas Gerais, Brasil. *Revista Brasileira de Botânica*, **23**, 255–282.

Mantovani, W. (1987) *Análise florística e fitossociológica do estrato herbáceo-subarbustivo do cerrado na Reserva Biológica de Mogi Guaçu e Itirapina.* Tese de Doutorado. Instituto de Biologia, UNICAMP, Campinas, SP.

Mauhs, J. & Barbosa, J.F. (2004) Levantamento do componente herbáceo em floresta de restinga psamófila, Palmares do Sul, RS. *Pesquisas Botânica*, **55**, 137–141.

McCune, B. & Mefford, M.J. (1999). PC-ORD. *Multivariate Analysis of Ecological Data*. Version 4.0 MjM Softwar Design. Gleneden Beach, Oregon. U.S.A.

McCune, B. (1997) Influence of noisy environmental data on canonical correspondence analysis. *Ecology*, **78**, 2617–2623.

Méio, B.B., Freitas, C.V., Jatobá, L., Silva, M.E.F., Ribeiro, J.F. & Henriques, R.P.B. (2003) Influência da flora das florestas Amazônica e Atlântica na vegetação do cerrado sensu stricto. *Revista Brasileira de Botânica*, **26**, 437–444.

Meira-Neto, J.A.A. & Martins, F.R. (2003) Estrutura do sub-bosque herbáceo-arbustivo da mata da silvicultura, uma floresta estacional semidecidual no Município de Viçosa-MG. *Revista Árvore*, **27**, 459–471.

Mikich, S.B. & Silva, S.M. (2001) Composição florística e fenologia das espécies zoocóricas de remanescentes de floresta estacional semidecidual no centro-oeste do Paraná, Brasil. *Acta Botânica Brasílica*, **15**, 89–113.

Moore, M.R., & Vankat, J. L. (1986) Responses of the herb layer to the gap dynamics of a mature beech-maple forest. *American Midland Naturalist*, **115**, 336–347.

Morellato, L.P.C., Talora, D.C., Takahasi, A., Bencke, C.C., Romera, E.C. & Zipparro, V.B. (2000) Phenology of Atlantic rain forest trees: a comparative study. *Biotropica*, **32**, 811–823.

Morrelato, L.P.C. & Haddad, C.F.B. (2000) Introduction: The Brazilian Atlantic Forest. *Biotropica*, **32**, 786–792.

Müller, S.C. & Waechter, J.L. (2001) Estrutura sinusial dos componentes herbáceo e arbustivo de uma floresta costeira subtropical. *Revista Brasileira de Botânica*, **24**, 395–4006.

Myers, A.A. & Giller, P.S. (1988) Process, pattern and scale in biogeography. In: Myers, A.A. & Giller, P.S. (eds.) *Analytical biogeography. An integrated approach to the study of animal and plant distributions*. Chapman and Hall, London. P.3–12.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, **403**, 853–858.

Negrelle, R.R.B. (2002) The Atlantic forest in the Volta Velha Reserve: a tropical rain forest outside the tropics. *Biodiversity and Conservation*, **11**, 887–919.

Nelson, G. & Platnick, N.I. (1981) *Systematics and biogeography: cladistics and vicariance*. New York: Columbia University Press.

Økland, R.H. (1996) Are ordination and constrained ordination alternative or complementary strategies in general ecological studies? *Journal of Vegetation Science*, **7**, 289–292.

Oliveira, M. L.A.A, Balbueno, R.A. & Senna, R.M. (2005) Levantamento florístico de fragmentos florestais na bacia hidrográfica do rio Gravataí, Rio Grande do Sul, Brasil. *Iheringia Série Botânica*, **60**, 269–284.

Oliveira, R.J. (2006) *Variação da composição florística e da diversidade alfa das florestas atlânticas no estado de São Paulo*. Tese de Doutorado, Universidade Estadual de Campinas, Campinas.

Oliveira-Filho, A. T., & Fontes, M.A.L. (2000) Patterns of floristic differentiation among Atlantic forests in southeastern Brazil, and the influence of climate. *Biotropica*, **32**, 793–810.

Oliveira-Filho, A.T. & Ratter, J.A. (1995) A study of the origin of central Brazilian forests by the analysis of plant species distribution patterns. *Edinburgh Journal of Botany*, **52**, 141–194.

Palma, C.B. & Jarenkow, J.A. (2003 Efeito da sazonalidade na estrutura da sinúsia herbácea terrícola de uma floresta estacional, Viamão, RS. In: V. Claudino-Sales; I.M. Tonini & E.W.C. Dantas (eds.) *Anais de Trabalhos Completos do VI Congresso de Ecologia do Brasil*. Fortaleza, Universidade Federal do Ceará. p. 413–415

Palmer, M.W. (1993) Putting Things in Even Better Order: The Advantages of Canonical Correspondence Analysis. *Ecology*, **74**, 2215–2230.

Parker, G.G. & Brown, M.J. (2000) Forest Canopy Stratification – Is It Useful? *The American Naturalist*, **155**, 473–484.

Pielou, E.C. (1979) *Biogeography*. John Wiley and Sons, New York.

Plant Systematics Org (2007) *Tompkins County Flora Project*. L. H. Bailey Hortorium Herbarium (BH). Department of Plant Biology. Cornell University. Ithaca, NY. http://www.plantsystematics.org/

Pregitzer, K.S., & Barnes, B.V. (1982) The use of ground flora to indicate edaphic factors in upland ecosystems of the McCormick Experimental Forest, Upper Michigan. *Canadian Journal of Forest Research*, **12**, 661–672.

Ratter, J.A., Bridgewater, S. & Ribeiro, J.F. (2003) Analysis of the floristic composition of the Brazilian cerrado vegetation III: Comparison of the woody vegetation of 376 areas. *Edinburgh Journal of Botany*, **60**, 57–109.

Ratter, J.A., Bridgewater, S., Atkinson, R. & Ribeiro, J.F. (1996) Analysis of the floristic composition of the Brazilian Cerrado vegetation II: Comparison of the woody vegetation of 98 areas. *Edinburgh Journal of Botany*, **53**, 153–180.

Richards, P.W. (1996). *The tropical rain forest: an ecological study*. Cambridge University Press, Cambridge.

Ronquist, F. (1997). Dispersal-Vicariance Analysis: A New Approach to the Quantification of Historical Biogeography. *Systematic Biology*, **46**, 195–203.

Ross, J.L.S. & Moroz, I.C. (1997) *Mapa Geomorfológico do estado de São Paulo, escala 1:500.000*. FFLCH/IPT/FAPESP.

Salis, S.M., Sheperd, G.J. & Joly, C.A. (1995) Floristic comparison of mesophytic semideciduous forests of the interior of the state of São Paulo, Southeast Brazil. *Vegatatio*, **119**, 155–164.

Schaefer, C.W. (1977) On dispersal. *Systematical Zoology*, **26**, 446.

Scudeller, V.V. (2002) *Análise fitogeográfica da Mata Atlântica, Brasil*. Tese de Doutorado, Universidade Estadual de Campinas, Campinas.

Scudeller, V.V., Martins, F.R. & Shepherd, G.J. (2001) Distribution and abundance of arboreal species in the Atlantic ombrophilous dense forest in southeastern Brazil. *Plant Ecology*, **152**, 185–199.

Shepherd, G.J. (1996) *Fitopac 1: manual do usuário*. Departamento de Botânica/UNICAMP, Campinas.

Silva, S.M. (1998) *As formações vegetais da planície litorânea da Ilha do Mel, Paraná: composição florística e principais características estruturais*. Tese de Doutorado, Universidade Estadual de Campinas, Campinas.

Silva, V.S. (2006) *Levantamento florístico e fitossociológico das espécies herbáceaes da região de borda do Núcleo Cabuçu, Parque Estadual da Cantareira*. Tese de Doutorado, Universidade de São Paulo – Escola Superior de Agricultura "Luiz de Queiroz", Piracicaba, Brasil.

Smith, L.B. (1962) Origins of the flora of southern Brazil. *Contributions from the U.S. National Herbarium*, **35**, 215–249.

Smith, A.R., Pryer, K.M., Schuettpelz, E., Korall, P., Schneider, H., & Wolf, P.G. (2006) A classification for extant ferns. *Táxon*, **55**, 705–731.

Sonehara, J.S. (2005) *Aspectos florísticos e fitossociológicos de um trecho de vegetação de restinga no Parque Estadual do Rio da Onça – Matinhos, PR*. Dissertação de Mestrado. Universidade Federal do Paraná, Curitiba, Brasil.

Stranghetti, V. & Ranga, N.T. (1998) Levantamento florístico das espécies vasculares da floresta estacional mesófila semidecídua da Estação Ecológica de Paulo de Faria, SP. *Revista Brasileira de Botânica*, **21**, 295–304.

Stranghetti, V., Ituralde, R.B., Gimenez, L.R. & Almella, D. (2003) Florística de um fragmento florestal do sítio São Pedro, município de Potirendaba, Estado de São Paulo. *Acta Scientiarum: Biological Sciences*, **25**, 167–172.

Strong, W.L., Bluth, D. J., Laroi, G. H., & Corns, I. G. W. (1991) Forest understory plants as predictors of lodge pole pine and white spruce site quality in west-central Alberta. *Canadian Journal of Forest Research*, **21**, 1675–1683.

Sugiyama, M. (2003) *Estudos florísticos e fitossociológicos em comunidades vegetais de Restinga da Ilha do Cardoso, Cananéia, SP*. Tese de Doutorado, Universidade Federal de São Carlos, São Carlos, Brasil.

Tabanez, A.A.J., Viana, V.A. (2000) Patch Structure within Brazilian Atlantic Forest Fragments and Implications for Conservation. *Biotropica*, **32**, 925–933.

ter Braak, C.J.F. (1995) Ordination. In: Jongmann, R. H. G., ter Braak, C. J. F. & van Tangeren, O. R. F. (eds.) *Data analysis in community and landscape ecology*. Cambridge University Press, Cambridge, pp. 91–173.

ter Braak, C.J.F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, **67**, 1167–1179.

ter Braak, C.J.F. (1990) *Update Notes: CANOCO Version 3.10*. Agricultural Mathematics Group. Wageningen, Netherlands. 35 pp.

Torres, R.B., Martins, F.R. & Kinoshita, L.S. (1997). Climate, soil and tree flora relationships in forests in the state of São Paulo, southeastern Brazil. *Revista Brasileira de Botânica*, **20**, 41–49.

Udvardy, M.D.F. (1969) *Dynamic zoogeography*. New York: Van Nostrand Reinhold.

Veloso, H.P., Rangel-Filho, A.L.R., Lima, I.C.A. (1991) *Classificação da vegetação brasileira, adaptada a um sistema universal*. Rio de Janeiro: IBGE

Vieira, L.T. & Martins, F.R. (2008). *Seasonality effects on the ground layer of a Tropical Semideciduous Seasonal Forest fragment in Southeastern Brazil*. In Press.

W^{3}Tropicos (2005) *Missouri Botanical Garden's VAST (VAScular Tropicos) nomenclatural database*. http://mobot.mobot.org/W3T/Search/vast.html

Whittaker, R.H. (1972) Evolution and Measurement of Species Diversity. *Taxon*, **21**, 213–251.

Whittaker, R.H. (1975) *Communities and Ecosystems*. New York: Macmillan. 165pp.

Yamamoto, L.F., Kinoshita, L.S. & Martins, F.R. (2005) Florística dos componentes arbóreo e arbustivo de um trecho da Floresta Estacional Semidecídua Montana, município de Pedreira, estado de São Paulo. *Revista Brasileira de Botânica*, **28**, 191–202.

Yonder, A.D. & Nowak, M.D. (2006) Has Vicariance or Dispersal Been the Predominant Biogeographic Force in Madagascar? Only Time Will Tell. *Annual Review of Ecology, Evolution, and Systematics*, **37**, 405–431.

Zickel, C.S. (1995) *Fitossociologia e dinâmica do estrato herbáceo de dois fragmentos florestais do estado de São Paulo*. Tese de Doutorado, Universidade Estadual de Campinas, Campinas, Brasil.

Zink, R.M., Blackwell-Rago, R.C. & Ronquist, F. (2000). The shifting roles of dispersal and vicariance in biogeography. *Proceedings of the Royal Society of London B.*, **267**, 497–503.

Appendix 1

List of all 947 herbaceous species in the 41 surveys. Angiosperms according to the Angiosperm Philogeny Group II (APG II 2003) and Ferns according to Smith et al. (2006). Families and species are sorted alphabetically in each main taxonomic group.

Ferns

Anemiaceae	*Anemia flexuosa* (Savigny) Sw.
	Anemia phyllitidis (L.) Sw.
	Anemia tomentosa (Sav.) Sw.
	Anemia tweediana Hooker
	Anemia ulbrichtii Rosenst.
	Anemia warmingii Prantl.
Aspleniaceae	*Asplenium abscissum* Willd.
	Asplenium alatum H. B. K.
	Asplenium araucarietii Sehenem
	Asplenium bradei Ros.
	Asplenium brasiliense Swartz
	Asplenium claussenii Hieron.
	Asplenium cyrtopteron Kze.
	Asplenium divergens Meit.
	Asplenium gastonis Fée
	Asplenium harpeodes Kunze
	Asplenium inequilaterale Willd.
	Asplenium kunzeanum Klotsch ex Rosenst.
	Asplenium lacinulatum Schrad.
	Asplenium martianum C. Chr.
	Asplenium meniscifolium Langsd & Fisch.
	Asplenium obtusifolium L.
	Asplenium pseudonitidum Raddi
	Asplenium radicans L.
	Asplenium sellowianum C. Presl.
	Asplenium serra Langsd & Fisch.
	Asplenium squamosum L.
	Asplenium triquetrum N.Murak. & R.C.Moran
	Gymnopteris tomentosa (Lam.) Und.
Blechnaceae	*Blechnum auriculatum* Cav.
	Blechnum australe (Cav.) de la Sota
	Blechnum austrobrasilianum de la Sota
	Blechnum binervatum (Desv.) R.M.Tryon & Stolze
	Blechnum brasiliense Desv.
	Blechnum confluens Cham. e Schltdl.
	Blechnum cordatum (Desv.) Hieron.
	Blechnum fraxineum Willd.
	Blechnum meridensis (Kl.) Mett.
	Blechnum occidentale L.

	Blechnum plumieri (Kunze) Mett.
	Blechnum schomburgkii (Klotzsch) C. Chr.
	Blechnum serrulatum Rich.
	Salpichlaena volubilis (Kaulf.) J.Sm.
Cyatheaceae	*Alsophila setosa* Kaulf.
	Alsophila sternbergii (Pohl ex Sternb.) D.S.Corant
	Alsophila verruculosa Rosenst.
	Cyathea atrovirens (Langsd. & Fisch.)
	Cyathea corcovadensis (Raddi) Domin
	Cyathea delgadii Sternb.
	Cyathea phalerata Mart.
	Nephelea sternbergii (Pohl) Tryon
	Trichipteris atrovirens (Langsd. & Fisch.) Tryon
	Trichipteris corcovadensis (Raddi) Copel.
Davalliaceae	*Nephrolepis occidentalis* Kunze
Dennstaedtiaceae	*Dennstaedtia dissecta* (Sw.) T.More
	Dennstaedtia obtusifolia (Willd.) Moore
	Hypolepis repens (L.) C. Presl
Dicksoniaceae	*Dicksonia sellowiana* Hook.
Dryopteridaceae	*Ctenitis anniesii* (Rosenst.) Copel.
	Ctenitis falciculata (Raddi) Ching
	Ctenitis submarginallis (Langsd. & Fisch.) Ching
	Didymochlaena truncatula J.Sm
	Diplazium ambiguum Raddi
	Diplazium celtifolium Kze.
	Diplazium cristatum (Desr.) Alston
	Diplazium lindbergii (Mett.) Alston
	Diplazium marginatum (L.) Diels
	Diplazium plantiginifolium (L.) Urb.
	Diplazium striatum Pr.
	Dryopteris amplissima (Pr.) O. Kze.
	Dryopteris connexa (Kaulf.) C. Chr.
	Dryopteris ctenitidis (Link.) O. Ktze.
	Dryopteris decussata var brasiliensis C. Chr.
	Dryopteris iguapensis C. Chr.
	Dryopteris patentiformis Rosenst.
	Dryopteris pedicellata (Chr.) C. Chr.
	Dryopteris raddii Rosenst.
	Dryopteris riograndensis (Lindm.) C. Chr.
	Dryopteris scabra (Pr.) C. Chr.
	Dryopteris serrata (Cav.) C. Chr.
	Dryopteris vivipara (Raddi) C. Chr.
	Dryopterys effusa (Sw.) Urb.
	Elaphoglossum edawlli Ros.
	Elaphoglossum inguapense Brade
	Elaphoglossum itatiayense Rosenst.
	Elaphoglossum macahense (Fée) Ros.
	Elaphoglossum macrophylium (Mett.) Christ.

	Elaphoglossum schombourgkii (Fée) Moore *Lastreopsis amplissima* (C. Presl) Tindale *Lomagramma guianensis* (Aubl.) Ching *Megalastrum connexum* (Kaulf.) A. R. Sm. e R. C. Moran *Olfersia cervina* (L.) Kunze *Polybotrya cervina* (L.) Kaulf. *Polybotrya cilindrica* Kaulf. *Polybotrya osmundaceae* Willd. *Polystichum montevidense* (Spreng.) Rosenst. *Polystichum platylepis* Fee *Polystichum platyphyllum* Presl. *Rumohra adiantiformis* (Forst.) Ching. *Stigmatopteris brevinervis* (Fée) R.C.Moran *Stigmatopteris caudata* (Rauddi) C.Chr. *Stigmatopteris heterocarpa* (Fée) Rosenst. *Stygmatopteris carrii* (back.) C. Chr. *Stygmatopteris caudata* (Raddi.) C. Chr. *Stygmatopteris heterocarpa* (Fée) Ros. *Tectaria martinicensis* (Spr.) Cop.
Gleicheniaceae	*Dicranopteris flexuosa* (Schrad.) Underw. *Dicranopteris pectinata* (Willd.) Under. *Sticherus penniger* (Mart.) Copel.
Hymenophyllaceae	*Hymenophyllum elegans* Spreng *Hymenophyllum vestitum* (C. Presl) Bosch *Trichomanes coliariatum* Bosch *Trichomanes cristatum* Kaulf. *Trichomanes hymenoides* Hedw. *Trichomanes krausii* Hook. & Grev. *Trichomanes pyxidiferum* L. *Trichomanes rigidum* Sw.
Lindsaeaceae	*Lindsaea bifida* (Kaulf.) Mett. *Lindsaea botrychioides* St. Hil. *Lindsaea lancea* (L.) Bedd. *Lindsaea ovoidea* Fée *Lindsaea portoricensis* Desv. *Lindsaea quadrangularis* Raddi
Marattiaceae	*Danaea elliptica* Sm. *Danaea moritziana* C. Presl. *Danaea mulleriana* Ros. *Danaea stenophylla* Kze. *Marattia kaulfussi* J. Sm. *Marattia laevis* Sm. *Marattia raddi* Desv. *Marattia verschaffeltiana* (De Vriese) St. Hill.
Ophioglossaceae	*Botrychium virginatum* (L.) Swartz
Osmundaceae	*Osmunda cinnamomea* L.
Polypodiaceae	*Campyloneurum major* (Hier. Ex Hick) Lell. *Campyloneurum mimus* Fée

	Campyloneurum phyllitidis (b.) Presl.
	Didymochlaena lunulata Desv
	Didymochlaena truncatula (Sw.) J. Sm.
	Microgramma lindbergii (Mett.) Seta
	Pecluma paradiseae (Langsd. Et Fisch.) Price
	Pecluma pectinatiformis (Lindm.) M. G. Price
	Polypodium catharinae Langsd. Et Fisch.
	Polypodium chnoophorum Kunze
	Polypodium crassifolium L.
	Polypodium laetum Raddi
	Polypodium latipes Langsd. & Fisch.
	Polypodium lepdopteris (Langsd. & Fisch.) Kuntze
	Polypodium recurvatum Kaulf.
	Polypodium repens Aubl.
	Polypodium robustus Fée
	Polypodium triseriale Sw.
Pteridaceae	*Acrostichum danaefolium* Langsd. & Fisch.
	Adiantopsis chlorophyla (Swartz) Fée
	Adiantopsis regularis (Mett.) Moore
	Adiantum brasiliense Raddi
	Adiantum cuneatum Langsd & Fisch.
	Adiantum obliquum Willd.
	Adiantum pentadactylon L. & F.
	Adiantum raddianum C. Presl.
	Adiantum terminatum Miq.
	Cheilanthes regularis Mett.
	Doryopteris concolor (Langsd. & Fisch.) Kuhn
	Doryopteris lorentzii (Hier.) Diels
	Doryopteris multipartita (Fée) Sehnem
	Doryopteris pedata (L.) Fee
	Doryopteris sagittifolia (Raddi) J. Sm.
	Doryopteris stierii Rosenst.
	Gymnograma myriophilla Sw.
	Lyndsaya quadramgularis Raddi.
	Pteris brasiliense
	Pteris decurrens Pr.
	Pteris deflexa Link.
	Pteris denticulata Sw.
	Pteris lechleri Mett.
	Pteris splendens Klf.
	Stenoloma bififum (Klf.) Fée
Schizaeaceae	*Actinostachys pennula* (Sw.) Hook.
	Actinostachys subtrijuga (Mart.) C. Presl.
	Schizaea elegans (Vahl) Sw.
	Schizaea fluminensis Miers ex Sturn
	Schizaea pennula Sw.
Thelypteridaceae	*Lastrea lindmanii* (C. Chr.) Copel
	Thelypteris araucariensis Ponce

	Thelypteris dentata (Forssk.) E.St. John
	Thelypteris hispidula (Decne.) C. F. Reed.
	Thelypteris interrupta (Willd.) Iwatsuki
	Thelypteris longifolia (Desv.) R. M. Tryon
	Thelypteris maxoniana A. R. Sm.
	Thelypteris opposita (Vahl) Ching
	Thelypteris raddi (Rosenst.) C. F. Reed
	Thelypteris reticulata (L.) Proctor
	Thelypteris riograndensis (Lindm.) C. F. Reed
	Thelypteris scabra (Presl.) Lellinger
	Thelypteris serrata (Calv.) Alston

Magnollids

Piperaceae	*Ottonia martiana* Miq.
	Peperomia arechavaletae C. DC.
	Peperomia blanda H.B.K.
	Peperomia caulibarbis Miq.
	Peperomia corcovandensis Gardner
	Peperomia glabella (Sw.) A. Dietr.
	Peperomia hilariana Miq.
	Peperomia ibiramana Yunck.
	Peperomia lyman-smithii Yunck
	Peperomia pereskiaefolia (Jacq.) H. B. K.
	Peperomia urocarpa Fisch et. Mey.
	Piper aduncum L.
	Piper amalago L.
	Piper amplum Kunth
	Piper anonifolium Kunth
	Piper boucheanum C.DC.
	Piper caldense C. DC.
	Piper dilatatum Rich.
	Piper gaudichaudiamum Kunth
	Piper genicalatum Sw.
	Piper lindbergii C. DC.
	Piper loefgrenii
	Piper lucaeanum Kunth.
	Piper mikanianum (Kunth) Steud.
	Piper mollicomum Kunth.
	Piper scutifolium Yunck.
	Piper setebarraense var. pilosum E.F. Guim. & L. Costa
	Piper solmsianum C.DC.
	Piper vicosanum Yuncker

Monocots

Alismataceae	*Echinodorus bolivianus* (Rusby) Holm-Niels.
	Echinodorus macrophyllus (Kunth) Micheli

Amaryllidaceae	*Amaryllis blumenavia* (C. Kch & Buché) Thaub. *Amaryllis gertiana* Ravenna *Amaryllis psittacina* Ker. *Amaryllis reticulata* L'Her. *Amaryllis striata* Lam. *Crinum salsum* Ravenna *Hippeastrum aulicum* (Ker Gawl.) Herb. *Hippeastrum paniceum* (Lam.) Kumrze *Hypoxis decumbens* L.
Araceae	*Anthurium acutum* N. E Brown *Anthurium harrisii* (Grah.) G. Don. *Anthurium itanhaemse* Engler *Anthurium loefgrenii* Engl *Anthurium scandens* (Augl.) Engl. *Asterostigma lividum* (Lodd.) Engl. *Asterostigma lombardii* E.G.Gonç. *Philodendron bipinnatifidum* Schott *Philodendron crassinervium* Lindley *Spathicarpa hastifolia* Hook. *Xanthosoma maximilianii* Schott
Arecaceae	*Attalea dubia* (Mart.) Burret *Bactris ferruginea* Burret *Bactris lindmaniana* Drude ex Lindman *Desmoncus polyacanthos* Mart. *Euterpe edulis* Mart. *Geonoma brevispatha* Barb. Rodr. *Geonoma elegans* Mart. *Geonoma gamiova* Barb. Rodr. *Geonoma schottiana* Mart. *Syagrus romanzoffiana* (Cham.) Glassman *Trithrinax brasiliensis* (Burm.) Drude & Griseb
Bromeliaceae	*Aechmea caudata* Lindman *Aechmea cylindrata* Lindm. *Aechmea distichanta* Lem. *Aechmea gamosepala* Wittm. *Aechmea lamarckei* Mez *Aechmea organensis* Wawra *Aechmea ornata* (Gaud.) Baker *Aechmea pectinata* Baker *Aechmea ramosa* Mart. ex Schult. *Aechmea recurvata* (Klotzsch) L.B. Smith *Ananas bracteatus* (Lindl.) Schult. *Ananas fritz-muelleri* Camargo. *Billbergia distachia* (Vell.) Mez. *Billbergia leptopoda* L.B. Sm. *Bromelia antiacantha* Bertol. *Bromelia balansae* Mez *Canistrum lindeni* (Regel) Mez

	Catopsis sessiliflora (Ruiz & Pavon) Mez
	Dyckia encholirioides (Gaudich.) Mez
	Nidularium billbergioides (Schult.) L. B. Smith
	Nidularium innocenti Lemaire
	Nidularium procerum Lindrs.
	Nidularium seidelli Lo. B. Sm. & Reitz
	Quesnelia arvensis Mez.
	Tillandsia geminiflora Brongn.
	Tillandsia stricta Sol.
	Tillandsia usneoides (L.) L.
	Vriesea altodasserae L. B. Smith
	Vriesea atra Mez
	Vriesea carinata Wawra
	Vriesea ensiformis (Vell.) Beer
	Vriesea erythrodactylon (E. Morr.) E. Morr. ex Mez
	Vriesea gigantea Gaud.
	Vriesea incurvata Gaud.
	Vriesea philippocoburgii Wawra
	Vriesea platynema Gaud.
	Vriesea rodigasiana E. Morren.
	Vriesea vagans (L.B. Smith) L.B. Smith
Burmanniaceae	*Apteria aphylla* (Nutt.) Barnhart ex Small
	Cymbocarpa refracta Miers
	Dictyostega orobanchoides (Hook.) Miers
	Gymnosiphon cornutus (Benth.) B. & H.
Commelinaceae	*Commelina difusa* Burm.
	Commelina elegans H.B.K.
	Commelina erecta L.
	Commelina obliqua Vahl
	Commelina robusta Kunth.
	Commelina virginica L.
	Dichorisandra hexandra (Aubl.) Standl.
	Dichorisandra incurva Mart
	Dichorisandra tejucensos Mart.
	Dichorisandra thyrsiflora J.C. Mikan
	Dichorisandra villosula Mart.
	Gibasis geniculata (Jacq.) Rohweder
	Tradescantia anagallidea Seub.
	Tradescantia crassula Link & Otto
	Tradescantia fluminensis Vell.
	Tradescantia sellowiana Kunth
	Tradescantia zanonia (L.) Sw.
Costaceae	*Costus arabicus* L.
	Costus cuspidatus (Nees & Mart.) Maas
	Costus scaber Ruiz & Pav.
	Costus spiralis (Jacq.) Roscoe
Cyclanthaceae	*Asplundia polymera* (Hand.- Mzt.) Harl.
Cyperaceae	*Androtrichum trigynum* (Spreng) Pfeiffer

Becquerelia muricata Nees
Bulbostylis capillaris (L.) C.B.Clarke
Carex brasiliensis A. St. Hil.
Carex pseudo-cyperus L.
Carex purpureovaginata Boeck.
Carex sellowiana Schlecht.
Carex seticulmis Boeck
Carex sororia Kunth
Cyperus aggregatus (Willd.) Endl.
Cyperus cayennensis (Lam.) Brit
Cyperus celluloso-reticulatus. Boeck.
Cyperus consanguineus Kunth
Cyperus distains L. F.
Cyperus esculentus L.
Cyperus ferax Rich.
Cyperus haspan L.
Cyperus incomtus Kunth
Cyperus luzulae (L.) Retz.
Cyperus meyenianus Kunth
Cyperus odoratus L.
Cyperus polystachyus Rottb.
Cyperus reflexus Vahl
Cyperus rigens Presl.
Cyperus sesquiflorus (Torr.) Mattf. & Kukenth.
Cyperus unicolar Boeck.
Cyperus consanguineus Kunth var. minarum (Boeck.)Kük.
Eleocharis capillaceae Kunth
Eleocharis geniculata (L.) Roem. & Schult.
Eleocharis interstincta (Vahl) Roem. & Schult.
Eleocharis nana Kunth.
Fimbristylis dichotoma Vahl
Hypolytrum schraderianum Nees
Pleurostachys beyrichii (Nees) Steud.
Pleurostachys densifoliata Pfeiff.
Pleurostachys foliosa Kunth
Pleurostachys gaudichaudii Brongn.
Pleurostachys regnelli Clarke
Pleurostachys sellowii Kunth
Pleurostachys stricta Kunth.
Pleurostachys urvillei Brongn.
Rhynchospora aurea Vahl.
Rhynchospora biflora Boeck.
Rhynchospora corymbosa (L.) Britt.
Rhynchospora exaltata Kunth
Rhynchospora floribunda Boeck.
Rhynchospora holoschoenoides (Rich.) Herter
Rhynchospora tenuis Link
Rhynchospora uniflora Boeck.

	Scleira virgata (Nees) Steud. *Scleria arundinaceae* Kunth *Scleria hirtella* Sw. *Scleria latifolia* Sw. *Scleria muricata* (Nees) Boeck *Scleria panicoides* Kunth *Scleria plusiophylla* Steud. *Scleria secans* (L.) Urb.
Eriocaulaceae	*Eriocaulon modestum* Kunth
Heliconiaceae	*Heliconia aemygdiana* Burle-Marx *Heliconia angusta* Vell. *Heliconia episcopalis* Vell. *Heliconia laneana* Barreiros *Heliconia psittacorum* L.F. *Heliconia spathocircinata* Aristeg. *Heliconia velloziana* L. Emygdio
Iridaceae	*Crocosmia crocosmiflora* (Nicholson) N. E. Br. *Neomarica candida* (Hassl.) Sprague *Neomarica coerulea* (Ker.) Sprange *Sisyrinchium iridifolia* H.B.K. *Sisyrinchium macrocephalum* Grahan
Juncaceae	*Juncus bufonius* L. *Juncus marginatus* Rostk *Juncus timotensis* Barros
Marantaceae	*Calathea brasiliensis* Koem. *Calathea lindbergii* Petersen *Calathea zebrina* (Sims) Lindl. *Ctenanthe casupoides* Petersen *Ctenanthe compressa* (A. Dietr.) Eichl. *Ctenanthe lanceolata* Petersen *Ctenanthe tonckat* (Aubl.) Eichler *Ischnosiphon ovatus* Koernicke *Maranta arundinacea* L. *Maranta bicolor* Ker-Gawl *Maranta depressa* Morren *Maranta divaricata* Roscoe *Maranta parvifolia* Peterson *Maranta ruiziana* Koern. *Saranthe eichleri* Petersen *Saranthe ustulata* Petersen *Stromanthe papilosa* Petersen
Mayacaceae	*Mayaca fluviatilis* Aubl.
Musaceae	*Musa rosea* Baker
Orchidaceae	*Aspidogyne bicolor* (Barb. Rodr.) Garay *Aspidogyne bruxelli* (Pabst) Garay *Aspidogyne fimbrillaris* (B.S.Wns.) Garay *Beadlea elata* (Sw.) Small *Brasilaelia purpurata* (Lindl. & Paxton) Campacci

Cleistes macrantha (Rodr.) Schltr.
Cleistes paranaensis Schltr.
Corymborchis flava (Sw.) Ldl.
Cranichis candida (Barbosa) Cogn
Cyclopogon argyrifolius Rodr,
Cyclopogon bicolor
Cyclopogon chloroleucus (Barb. Rodr.) Garay
Cyclopogon elatus (Sw.) Schlecht.
Cyclopogon elegans Hoehne
Cyclopogon multiflorus Schltr.
Cyclopogon variegatus Barb. Rodr.
Cyrtopodium polyphyllum (Vell.) Pabst ex. Barros
Epidendrum alongatum Jacq.
Epidendrum ellipticum R. Grah.
Epidendrum fulgens Brongn.
Erythrodes arietina (Rchb.f. & Warm) Arnes
Erythrodes austrobrasiliensis (Porsch) Pabst
Erythrodes lindeleyana (Cogn.) Ames
Erythrodes nobilis (Rchb. f.) Pabst
Erythrodes schelechteriana (Hoehne) Pabst
Galeandra beyrichii Reichb. F.
Govenia utriculata Lindl.
Habenaria repens Nutt.
Hapolorchis micranthus (Barb. Rodr.) Hoehne
Liparis elata Lindl.
Liparis nervosa (Thunb.) Lindl
Malaxis excavata (Lindl.) O. Ktze.
Malaxis pabstii Pabst
Mesadenella cuspidata (Lindl.) Garay
Mesadenella esmeraldae (Lindl. et. Rchb. F.) pabst et. Garay
Octomeria crassifolia Lindl.
Octomeria fibrifera Schltr
Oeceoclades maculata (Lindl.) Lindl.
Paradisianthus micranthus (Rodr.) Schltr.
Pelexia adnata (Sw.) Poit ex L.C. Rich
Pelexia hynophila (B. Rodr.) Schltr.
Pelexia macropoda (Rodr.) Schltr.
Prescottia colorans Lindl.
Prescottia densiflora Lindl.
Prescottia stachyoides Lindl.
Psilochilus modestus Barb. Rodr.
Sarcogloitis fasciculata (Vell.) Schltr
Sarcoglottis juergensii Schlecht.
Sauroglossum nitidum (VelL.) Schltr.
Stenorrhynchus coccineus (Vell.) Hoehme
Stenorrhynchus lanceolatus (Aubl.) L. C. Rich.
Stigmatosema polyaden (Vell.) Garay
Wullschlaegelia aphylla (Sw.) Rchb. f.

Poaceae	*Acroceras zizanioides* (Kunth.) Dandy
	Andropogon lateralis Nees
	Andropogon selloanus (Hack.) Hackel
	Aristida altissima Arech.
	Aristida circinalis Lind.
	Athroostachys capitata (Hook.) Benth.
	Aulomenia aristulata (Doell) McClure
	Aulonemia cingulata McClure et L. B. Sm
	Axonopus capillaris (Lam.) Chase
	Axonopus obtusifolius (Raddi) Chase
	Bambusa tuldoides Munro
	Briza subaristata Lam.
	Bromuns catharticus Vahl.
	Bromus brachyanthera Doell
	Bromus unioloides HBK.
	Bromus uruguayensis Arech.
	Cenchrus pauciflorus Benth.
	Chusquea capituliflora Pair.
	Chusquea discolor Hack.
	Chusquea tenella Nees
	Coix lacryma-jobi L.
	Digitaria sanguinale (Burn. F.) Scop
	Elyonurus muticus (Spreng.) Kuntze
	Eragrostis cataclasta Nicora
	Eragrostis ciliaris (L.) R.Br
	Eragrostis lugens Nees
	Eragrostis neesii Trinius
	Eragrostis purpurascens (Spreng.) Schultes
	Festuca ulochaeta Nees ex Steud.
	Guadua angustifolia Kunth
	Gynerium sagitatum Beauv.
	Homolepsis glutinosa (Sw.) Zuloaga & Soderstr.
	Hyparrhenia rufa (Nees) Stapf
	Ichnanthus bacularius Swallen
	Ichnanthus candicans (Nees) Doell
	Ichnanthus inconstans (Trin. ex. Ness) Doell
	Ichnanthus leiocarpus (Spreng.) Kunth
	Ichnanthus nemoralis (Schrad.) Hitchc. & Chase
	Ichnanthus pallens (Sw.) Munro ex Bentham
	Ichnanthus procurrens (Nees.) Swallen
	Ichnanthus ruprechtii Döll
	Ichnanthus tenuis (Presl) Hitch. e Chase
	Imperata brasiliensis Trin.
	Ischaenum minus J. et C.
	Lasiacis divaricata (L.) Hitchc.
	Lasiacis ligulata Hitchcok & Case
	Lasiacis sorghoidea (Desv.) Hitchc.
	Lithachne horizontalis Chase

Melica sarmentosa Nees
Olyra ciliatifolia Raddi.
Olyra glaberrima Raddi
Olyra humilis Nees
Olyra latifolia L.
Olyra micrantha H.B.K.
Oplismenus hirtellus (L.) P.Beauv.
Oplismenus setarius (Lam.) Roem. & Schult.
Panicum decipiens Nees.
Panicum elephanthipes Nees
Panicum glutinosum Sw.
Panicum helobium Mez.
Panicum laxum Sw.
Panicum longipedicellatum Swallen
Panicum maximum Jacq.
Panicum millegrama Pair
Panicum missionurn Ekman
Panicum ovuliferum Trinius
Panicum pantrichum Hack.
Panicum parvifolium Lam.
Panicum pilosum Sw.
Panicum polygnatum Lam.
Panicum racemosum (Pal. De Beauv.) Spreng
Panicum repens L.
Panicum rhizogonum Hack.
Panicum rude Nees
Panicum sabulorum Lam.
Panicum schwackeanum Mez
Panicum sellowii Nees
Panicum stoloniferum Poir.
Paradiolyra micrantha (Kunth) Davidse & Zuloaga
Paspalum arenarium Schrader
Paspalum conjugatum P.J. Bergius
Paspalum conspersum Schrad. ex. Schultes
Paspalum corcovadense Raddi
Paspalum decubens Sw.
Paspalum inaequivalve Raddi
Paspalum intermedium Munro
Paspalum mandiocanum Trin.
Paspalum nutans Lam.
Paspalum paniculatum L.
Paspalum plicatum (Michx.) Pers.
Paspalum pumilum Nees
Pennisetum latifolium Spreng.
Pharus glaber H.B.K.
Pharus lappulaceus Aubl.
Pharus latifolius L.
Piptochaetium bicolor (Vahl.) E. Desv.

	Piptochaetium lasianthum Griseh.
	Piptochaetium montevidense (Spreng.) Parodi
	Piptochaetium panicoides (Lam.) Desv.
	Pseudochinolaena polystachya (H.B.K.) Stapf
	Reitzia smithii Swallen
	Rhynchelitrum repens (Willd.) C. E. Hubb.
	Schizachyrium microstachyum (Desv. ex. Ham.) Roseng
	Setaria geniculata (Lam.) Beauv.
	Setaria parviflora (Poir.) Kerguélen
	Setaria poiretiana (Schult.) Kunth
	Setaria scandens Schrad. ex Schult.
	Setaria vulpiseta (Lam.) Roem. & Schult.
	Sorghastrum agrostoides (Speg.) Hitch.
	Sorghastrum scaberrimum (Nees) Herter
	Spartina alterniflora Loisel.
	Spartina densiflora Brongn.
	Sporobolus indicus (L.) R. Br.
	Sporobolus pseudairoides Parodi
	Stenotaphrum secundatum
	Stipa melanosperma J. Presl.
	Stipa rnegapotamica Spreng.
	Streptochaeta spicata Schrader ex Nees
	Vulpia australis (Nees. ex. Stendel) Blom.
	Zea mays L.
Typhaceae	*Typha domingensis* Pers.
Xyridaceae	*Xyris guaranitica* Malme
	Xyris jupicai L. C. Rich.
	Xyris macrocephala Vahl
	Xyris stenophylla Alb. Nilsson
Zingiberaceae	*Hedychium coronarium* J.König
	Renealmia petasites Gagnep.

Eudicots

Acanthaceae	*Aphelandra chamissoniana* Nees
	Aphelandra colorata (Vell. Conc.) Wassh
	Aphelandra hirta (Klotzsch) Wassh.
	Aphelandra ignea (Schrad.) Nees ex Steud.
	Aphelandra liboniana Lind. ex. Hook
	Aphelandra lutea Nees
	Aphelandra mirabillis Rizz.
	Aphelandra ornata (Nees) T. Anderson
	Beloperone monticola Nees
	Dicliptera tweediana Less.
	Geissomeria longiflora Lindl
	Geissomeria schottiana
	Justicia brasiliana Roth
	Justicia carnea Lindl.

	Justicia catharginensis Lindau
	Justicia cydoniifolia (Ness) Lindau
	Justicia dusenii (Lindau) Wasshausen et Smith
	Justicia glomerata Nees
	Justicia involucrata (Nees) Leonard
	Justicia kleinii Wass & Smith
	Justicia lythrioides (Nees) V.A.Graham
	Justicia meyeniana (Nees) Lindau
	Justicia nodicaulis Nees
	Justicia paranaensis (Rizz.) Wass & Smith
	Justicia rizzinii Wassh.
	Justicia scheidweileri V. A.W. Graham
	Justicia schenckiana Lindau.
	Lepidagathis diffusa (Nees) Lindau
	Pseuderantherum riedelianum Nees
	Ruellia angustiflora (Nees) Lindau
	Ruellia brevifolia (Pohl) C.Ezcurra
	Ruellia elegans Poir
	Ruellia gemminiflora H. B. K.
	Ruellia puri (Nees) Lindau
	Ruellia sanguinea Griseb.
	Staurogyne mandioccana Nees.
Amaranthaceae	*Achyranthes aspera* L.
	Alternanthera micrantha R.E. Fries
	Alternanthera pilosa Moq.
	Alternanthera tenella Colla
	Celosia grandifolia Moq.
	Chamissoa acuminata Mart.
	Chenopodium retusum Jussieu ex. Moquin
	Gomphrena vaga Mart.
	Iresine diffusa H. & B. ex Willd.
	Pfaffia gnaphaloides (L.f.)
Apiaceae	*Centella asiatica* (L.) Urb.
	Cyclospermum leptophyllum (Pers.) Sprague ex Britton & P. Wilson
	Hydrocotyle bonariensis Lam.
	Hydrocotyle callicephala Cham
	Hydrocotyle leucocephala Cham. & Schlecht
Apocynaceae	*Asclepias curassavica* L.
	Tassadia subulata (Vell.) Font. & Schw.
Asteraceae	*Acanthospermum australe* (Loefl.) O. Kuntze
	Achyrocline satureoides (Lam.) DC.
	Acmella brachyglossa Cas.
	Adenostemma brasilianum (Pers.) Cass.
	Adenostemma involucratum R.M. King & H. Rob.
	Adenostemma verbesina (L.) Sch. Bip.
	Ageratum conyzoides L.
	Austroeupatorium silphiifolium (Mart.) R.M. King & H. Rob.
	Baccharis anomala DC.

Baccharis cinerea DC.
Baccharis gaudichaudiana DC.
Baccharis ochracea Spreng.
Baccharis sagittalis (Less.) DC.
Baccharis trimera (Less.) DC.
Baccharis trinervis (Lam.) Pers
Baccharis usterii Heering
Bidens laevis (L.) Britton, Sterns & Poggenb.
Bidens pilosa L.
Blainvillea biaristata DC.
Blainvillea dichotoma (Murr.) Cass.
Chaptalia nutans (L.) Polak
Chromolaena maximilianii (DC.) R.M. King & H. Rob.
Conyza floribunda H.B.K.
Conyza notobellidiastrum Griseb.
Conyza rivularis (L.) Polak
Cosmos bipinnatus Cav.
Elephantopus mollis Kunth
Elephantopus tomentosus L.
Emilia fosbergii Nicolson
Emilia sonchifolia DC.
Erigeron notobellidiastrum (Gris.) Blake.
Eupatorium inulaefolium Humb., Bonpl. e Kunth
Eupatorium laevigatum Lam.
Eupatorium lobbi Klatt
Eupatorium odoratum L.
Eupatorium pauciflorum Kunth
Eupatorium squalidum DC. Prodr.
Facelis retusa (Lam.) Sch. Bip.
Gamochaeta falcata (Lam.) Cabr.
Gamochaeta spicata (Lam.) Cabrera
Grindelia tehuelches (Spreng) DC.
Mikania buddleiaefolia DC.
Orthopappus angustifolius (Sw.) Gleason
Porophyllum ruderale (Jacq.) Cass.
Praxelis clematidea (Griseb.) R.M. King & H. Rob.
Pterocaulon alopecuroides (Lam.) DC.
Pterocaulon angustifolium DC.
Pterocaulon lorentzii Malme
Senecio brasiliensis (Spreng.) Less.
Senecio crassiflorus (Lam.) DC.
Senecio heterotrichus DC.
Senecio leptolobus DC.
Solidago chilensis Meyen
Sonchus oleraceus L.
Sphagneticola trilobata (L.) Pruski
Spilanthes decumbens (Sm.) A.H. Moore
Tagetes minuta L.

	Wedelia paludosa DC.
Balanophoraceae	*Scybalium fungiforme* Schott & Endl.
Balsaminaceae	*Impatiens walleriana* Hook.f
Begoniaceae	*Begonia angulata* Vell.
	Begonia biguassuensis Brade
	Begonia catharinensis Brade.
	Begonia convolvulacea A. DC.
	Begonia cucculata Willd.
	Begonia echinosepala Regel
	Begonia fischeri Schrank
	Begonia hirtella Link.
	Begonia hispida Schott ex. A. DC.
	Begonia hookeriana Gardner
	Begonia hugelii (Klotzsch) A. DC.
	Begonia isotericarpa Irmscher
	Begonia itupanervis Brade
	Begonia lineolata Brade
	Begonia parilis Irmscher
	Begonia patula Haworth
	Begonia pilgeriana Irmscher
	Begonia polyandra Irmscher
	Begonia pulchella Raddi.
	Begonia semperflorens Link & Otto
	Begonia subvillosa Kl.
Boraginaceae	*Heliotropium procumbens* Vell.
	Heliotropium transalpinum Vell.
	Heliotroptum riaridoides Cham.
	Tournefortia paniculata Cham.
Brassicaceae	*Cardamine chenopodifolia* Pers.
Cactaceae	*Cereus peruvianus* (L.) Miller
	Opuntia vulgaris P. Mill.
	Rhipsalis cereuscula Haw.
Calyceraceae	*Acicarpha tribuloides* Juss.
Campanulaceae	*Centropogon cornutus* (L.) Druce
	Lobelia fistulosa Vell.
Cannaceae	*Canna confusa* Richardson e L. B. Sm.
	Canna indica L.
Caryophyllaceae	*Cardionema ramosissimum* (Weinm.) Nels. & Macbr.
	Drymaria cordata (L.) Willd.
	Silene gallica L.
Convolvulaceae	*Dichondra repens* Forster
Droseraceae	*Drosera brevifolia* Pursh.
Ericaceae	*Gaultheria organensis* Meissner
Euphorbiaceae	*Acalypha brasiliensis* var cordata M. Arg.
	Acalypha communis Müll. Arg.
	Acalypha gracilis Müll. Arg.
	Chiropetalum gymnadenium (A. Arg.) P. ex. K. H.
	Chiropetalum tricoccum (Vell.) Chodat e Hassl.

	Croton glandulosus L. *Croton labutus* L. *Croton lundianus* (Diedr.) Mull. Arg. *Euphorbia comosa* Vell. *Euphorbia heterophylla* L. *Euphorbia hyssopifolia* (L.) Small *Phyllanthus corcovadensis* Muell. *Phyllanthus niruri* L. *Phyllanthus nobilis* Müll. Arg. *Phyllanthus submarginatus* Müll.Arg. *Sebastiana corniculata* (Vahk) Müll. Arg.
Fabaceae	*Aeschynomene histrix* Poir. *Aeschynomene pratensis* Small. *Centrosema virginianum* (L.) Benth. *Chamaecrista flexuosa* L. *Chamaecrista nictitans* (L.) Moench *Chamaecrista rotundifolia* (Pers.) Greene *Crotalaria juncea* L. *Desmodium adscendens* (Sw.) DC. *Desmodium affine* Schlecht. *Desmodium axillare* (Sw.) DC. *Desmodium incanum* DC. *Desmodium uncinatum* (Jacq.) DC. *Galactia striata* (Jacq.) Urb. *Indigofera sabulicola* Benth. *Mimosa invisa* Mart. *Mimosa pudica* L. *Rhynchosia minima* (L.) DC. *Stylosanthes leiocarpa* Vogel *Stylosanthes viscosa* Sw. *Zornia diphylla* (L.) Pers. *Zornia latifolia* Sm.
Gentianaceae	*Macrocarpea rubra* Malme *Voyria aphylla* (Jack.) Pers.
Geraniaceae	*Geranium albicans* St. Hil.
Gesneriaceae	*Sinningia aggregata* (Ker Gawl.) Wiehler *Sinningia villosa* Lindl.
Lamiaceae	*Hyptis fasciculata* Benth. *Hyptis gaudichaudii* Benth. *Hyptis heterodon* Epling *Hyptis mutabilis* (Rich.) Briq. *Hyptis suaveolens* (L.) Poit. *Leonotis nepetifolia* (L.) R. Br. *Leonurus sibiricus* L. *Marsypianthes chamaedrys* (Vahl) Kuntze *Ocinum selloi* Benth. *Salvia guaranitica* A.St.-Hil. ex Benth. *Salvia melissiflora* Benth.

	Scutellaria uliginosa St. Hill.
	Stachys arvensis L.
Lentibulariceae	*Utricularia tricolor* Saint Hill.
	Utricullaria breviscapa Griseb.
	Utricullaria foliosa L.
Loganiaceae	*Buddleja stachyoides* Cham. & Schltdl.
	Buddleja thyrsoides Lam
	Dichondra microcalyx (H. Hallier) Fabris
	Spigelia dussenii L.B. Sm.
	Spigelia humboldtiana Cam. & Schlecht.
	Spigelia pusilla Mart.
	Spigelia tetraptera Taub. ex. L. B. Sm.
Lygodiaceae	*Lygodium volubile* Sw.
Lythraceae	*Cuphea calophylla* C. et S. (Koehne) Lourt.
	Cuphea carthagenensis (Jacq.) J.F. Macbr.
	Heimia myrtifolia Cham. e Schltdl.
	Heimia salicifolia (HBK.) Link & Otto
Malvaceae	*Byttneria australis* St. Hill.
	Pavonia communis St . Hill
	Pavonia sepium St. Hill.
	Sida acuta Burm. f.
	Sida carpitifolia L. f.
	Sida rhombifolia L.
	Sida urens L.
	Triumfetta bartramia L.
	Triumfetta semitriloba Jacq.
	Urena lobata L.
	Waltheria indica L.
	Wissadula parviflora (A. St.-Hil.) R. E. Fr.
Melastomataceae	*Bertolonia acuminata* Gardn.
	Bertolonia mosenii Cogn.
	Clidemia hirta (L.) D. Don
	Leandra australis (Cham.) Cogn.
	Leandra cardiophylla Cogn.
	Leandra xanthocoma (Naudin) Cogn.
	Ossoaea amygdaloides (DC.) Triana
	Ossoaea brachstachya (DC.) Triana
	Tibouchina clinopodifolia (DC.) Cogn.
Menyanthaceae	*Nymphoides humboldtiana* (Kunth) Kuntze
	Nymphoides indica (L.) Ktze.
Moraceae	*Dorstenia argentata* Hook. F.
	Dorstenia arifolia Lam.
	Dorstenia carautae C.C.Berg.
	Dorstenia hirta Desv.
	Dorstenia sucrei Carauta
	Dorstenia tenuis Bonpl. Ex. Bur.
Ochnaceae	*Lavradia velloziana* Vauld.
	Sauvagesia erecta L.

Onagraceae	*Ludwigia elegans* (Cambess.) Hara
	Ludwigia peruviana (L.) Hara
	Ludwigia quadrangularis (Micheli) Hara
	Oenothera longiflora L.
Oxalidaceae	*Oxalis articulata* Savign.
	Oxalis debilis Humb., Bonpl. & Kunth
	Oxalis linarantha A. Lourteig
	Oxalis rombeo-ovata A.St.-Hil.
Phytolaccaceae	*Petiveria alliaceae* Linn.
	Phytolacca thyrsiflora Fenzl ex J.A. Schmidt
Plantaginaceae	*Plantago australis* Lam.
	Plantago brasiliensis Sims
Plumbaginaceae	*Plumbago scadens* L.
Polygalaceae	*Monnina dictyocarpa* Griesb.
	Monnina itapoanensis Marques & Vianna
	Monnina oblongifolia Arech.
	Polygala lancifolia A. St.-Hil. & Moq.
	Polygala laureola A. St.-Hill.
	Polygala paniculata L.
	Polygala timoutoides Chodat.
Polygonaceae	*Homocladium platycladium* (F.Müll.) L.H. Bailey
	Polygonum acuminatum H.B.K.
	Polygonum hydropiperoides Michx.
	Polygonum meissnerianum C. & S.
	Polygonum punctatum Elliott
Portulacaceae	*Talinum paniculatum* (Jacq.) Gaertn.
	Talinum patens (Jacq.) Will.
Primulaceae	*Anagalis arvensis* L.
Ranunculaceae	*Anemone sellowii* Pritzel
	Clematis dioica L.
	Ranunculus bonariensis var januarii (Poiret) Urban
Rosaceae	*Rubus erythroclados* Mart.
	Rubus rosifolius Sm.
Rubiaceae	*Borreria centranthoides* Cham. & Schlecht.
	Borreria verticillata (L.) Meyer
	Chioccoca alba (L.) Hitchc.
	Coccocypselum condalia Pers
	Coccocypselum cordatum Krausse.
	Coccocypselum cordifolium Nees et Mart.
	Coccocypselum glabrifolium Standl.
	Coccocypselum guianense (Aubl.) K. Schum
	Coccocypselum hasslerianum Chodat
	Coccocypselum lanceolatum (Ruiz & Pav.) Pers.
	Coccocypselum sessiliflorum Standley
	Coccosypselum lyman-smithii Standl.
	Diodia alata Nees et Mart.
	Diodia apiculata (Roem. & Schult.) K. Schum.
	Diodia radula Cham. & Schlecht.

	Diodia saponariifolia (Cham. & Schltdl.) K. Schum. *Geophila macropoda* (Ruiz & Pav.) DC. *Geophila repens* (L.) I. M. Johnst. *Hedyotis salzmanii* (DC.) Steud. *Hoffmannia peckii* K. Schum. *Lipostoma capitatum* (Graham) D. Don. *Malanea forsteronioides* Müll. Arg. *Manettia luteo-rubra* (Vell.) Benth. *Mitracarpus megapotamicus* (Spreng.) O. Kuntze *Psychotria hygrophiloides* Benth. *Psychotria stachyoides* Benth. *Relbunium hypocarpium* (L.) Hemsl. *Richardia brasiliensis* Gomes *Schenkia blumenaviensis* K. S.
Santalaceae	*Phoradendron piperoides* (Kunth) Trel.
Scrophulariaceae	*Bacopa stricta* (Schrad.) Edwall *Linaria texana* Scheele *Scoparia dulcis* L. *Scoparia plebeya* Cham. et Schlecht. *Stemodia trifoliata*
Solanaceae	*Cyphomandra corymbiflora* Sendtn. *Nicandra physalodes* Gaertn. *Petunia integrifolia* (Hook.) Schinz et Thellung *Petunia littoralis* Smith et Downs *Petunia ovalifolia* Miers *Petunia reitzii* Smith. et Downs *Physalis pubescens* L. *Salpichroa origanifolia* (Lam.)Thell. *Solanum acerosum* Sendtn. *Solanum affine* Sendtn. *Solanum americanum* Mill. *Solanum atripurpureum* Schrank *Solanum capsicastrum* Link. *Solanum ciliaturn* Lam. *Solanum gracile* Dun. *Solanum hoehnei* Morton. *Solanum jatrophaefolium* Sendtn. *Solanum muelleri* Bitter *Solanum reflexum* Schrank *Solanum sisymbrifolium* Lam. *Solanum trachytrichium* Bitter *Solanum viarum* Dunal
Urticaceae	*Boehmeria caudata* Sw. *Pilea artrogramma* Miq. *Pilea nummulariifolia* (Sw.) Wedd. *Pilea pubescens* Liebm. *Urtica urens* L.
Valerianaceae	*Valeriana salicariifolia* Vahl

Verbenaceae	*Lantana brasiliensis* Link. *Lantana undulata* Schranke *Stachytarpheta cayennensis* (Rich.) Vahl
Violaceae	*Hybanthus parviflorus* (Mut.) Baillon *Viola cerasifolia* A.St.-Hil.

Appendix 2

Binary matrix (presence/absence) with the 39 localities and the 304 species used to run the multivariate analyses. SSF: submontane seasonal forest, MSF: montane seasonal forest, LRF: lowland rainforest, SRF: submontane rainforest, MRF: montane rainforest, * Mixed Forest (with *Araucaria angustifolia)*. The numbers correspond to references in table 1. The sites are arranged from north to south. More details for the localities are in table 1 and figure 1.

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Acalypha communis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acalypha gracilis	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0
Acanthospermum australe	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Achyrocline satureoides	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Adenostemma involucratum	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adenostemma verbesina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Adiantum raddianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Adiantum terminatum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aechmea lamarckei	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aechmea ornata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aechmea pectinata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aechmea ramosa	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aechmea recurvata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
Ageratum conyzoides	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alternanthera tenella	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaryllis reticulata	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ananas bracteatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ananas fritz-muelleri	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anemia phyllitidis	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Anemia tweediana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Anthurium harrisii	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Anthurium loefgrenii	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthurium scandens	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Apteria aphylla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asclepias curassavica	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspidogyne bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Asplenium abscissum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Asplenium bradei	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Asplenium claussenii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0
Asplenium kunzeanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asplenium sellowianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Asplenium serra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Asterostigma lividum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asterostigma lombardii	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Attalea dubia	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulomenia aristulata	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis cinerea	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis trimera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Bactris lindmaniana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Begonia cucculata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Begonia echinosepala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Begonia hirtella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Begonia itupanervis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Begonia semperflorens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Bertolonia mosenii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bidens pilosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
Billbergia leptopoda	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blainvillea biaristata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blechnum austrobrasilianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Blechnum binervatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Blechnum brasiliense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1
Blechnum fraxineum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blechnum meridensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Blechnum occidentale	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Blechnum plumieri	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blechnum serrulatum	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Briza subaristata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Bromelia antiacantha	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0	0	0	0	1
Bromelia balansae	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buddleja stachyoides	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calathea zebrina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campyloneurum phyllitidis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Canna indica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Carex brasiliensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex sellowiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	1	1	1	1	0	0
Celosia grandifolia	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centella asiatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Chamissoa acuminata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Chaptalia nutans	0	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	1	1	1	1
Chromolaena maximilianii	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chusquea tenella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Clematis dioica	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Clidemia hirta	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Coccocypselum condalia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Coccocypselum cordifolium	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coccocypselum guianense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Coccocypselum lanceolatum	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0
Coccocypselum sessiliflorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Commelina difusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Commelina elegans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Commelina erecta	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Commelina obliqua	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Conyza floribunda	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conyza notobellidiastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Conyza rivularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Corymborchis flava	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Costus cuspidatus	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Costus scaber	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Costus spiralis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Croton glandulosus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Croton labutus	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ctenitis submarginallis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Cuphea calophylla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cyathea corcovadensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyathea phalerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus incomtus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Cyperus luzulae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus reflexus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cyrtopodium polyphyllum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danaea elliptica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dennstaedtia dissecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desmodium adscendens	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Desmodium affine	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Desmodium incanum	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichondra microcalyx	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Dichorisandra hexandra	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichorisandra incurva	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichorisandra thyrsiflora	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Dichorisandra villosula	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicksonia sellowiana	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dictyostega orobanchoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Didymochlaena truncatula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Diodia alata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Diplazium cristatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Doryopteris concolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Doryopteris multipartita	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	0	0	0	0
Doryopteris pedata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1
Elaphoglossum macrophylium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Eleocharis nana	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Elephantopus mollis	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0
Epidendrum ellipticum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epidendrum fulgens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erythrodes arietina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erythrodes austrobrasiliensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphorbia comosa	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euterpe edulis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Festuca ulochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galeandra beyrichii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Geissomeria longiflora	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geonoma elegans	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geonoma schottiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Geophila repens	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Hapolorchis micranthus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Heimia myrtifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Heliconia aemygdiana	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heliconia angusta	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heliconia spathocircinata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Heliotropium transalpinum	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Homolepsis glutinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hydrocotyle leucocephala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Hypolytrum schraderianum	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hyptis mutabilis	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hyptis suaveolens	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ichnanthus pallens	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Iresine diffusa	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia brasiliana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
Justicia carnea	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Justicia catharginensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia dusenii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia glomerata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia kleinii	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia rizzinii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia scheidweileri	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Justicia schenckiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lantana brasiliensis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lantana undulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lasiacis divaricata	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lasiacis ligulata	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lastreopsis amplissima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leonurus sibiricus	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidagathis diffusa	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lindsaea botrychioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lindsaea lancea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lindsaea quadrangularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liparis nervosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lygodium volubile	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Maranta arundinacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	1	1	1	0	0	0	0
Maranta divaricata	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maranta ruiziana	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marsypianthes chamaedrys	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megalastrum connexum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Mesadenella cuspidata	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Mesadenella esmeraldae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mimosa pudica	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neomarica candida	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Nidularium innocenti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Nidularium procerum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ocinum selloi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Oeceoclades maculata	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olyra ciliatifolia	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Olyra glaberrima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olyra humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	0	0
Olyra latifolia	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olyra micrantha	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenus hirtellus	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	1	0	0	1	0	0	1
Oplismenus setarius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Ossoaea amygdaloides	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottonia martiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxalis articulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Oxalis linarantha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	0
Panicum glutinosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Panicum maximum	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panicum ovuliferum	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Panicum pantrichum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panicum parvifolium	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Panicum pilosum	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panicum rude	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panicum schwackeanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Panicum sellowii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Paradiolyra micrantha	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paspalum corcovadense	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Paspalum inaequivalve	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Paspalum mandiocanum	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Paspalum plicatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Pavonia sepium	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0	0	0	0	0
Pecluma paradiseae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pecluma pectinatiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peperomia caulibarbis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Peperomia glabella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Peperomia pereskiaefolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0
Peperomia urocarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Petiveria alliaceae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Pharus glaber	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1
Pharus lappulaceus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0
Pharus latifolius	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllanthus niruri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Pilea pubescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper amalago	1	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper amplum	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper caldense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper dilatatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Piper gaudichaudiamum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper lucaeanum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper mikanianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Piper solmsianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Piper vicosanum	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleurostachys foliosa	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleurostachys gaudichaudii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleurostachys stricta	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pleurostachys urvillei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybotrya cilindrica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygala lancifolia	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygala laureola	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonum acuminatum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polygonum meissnerianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polygonum punctatum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Polypodium catharinae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polypodium chnoophorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polypodium latipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polypodium lepdopteris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Polystichum platyphyllum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Prescottia colorans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prescottia stachyoides	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pseuderantherum riedelianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudochinolaena polystachya	1	1	1	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0
Psilochilus modestus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pteris decurrens	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteris deflexa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pteris denticulata	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0
Relbunium hypocarpium	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Renealmia petasites	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhynchospora corymbosa	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhynchospora exaltata	1	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Rhynchospora floribunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruellia angustiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Ruellia elegans	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruellia puri	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruellia sanguinea	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Rumohra adiantiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Salvia melissiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sarcogloitis fasciculata	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sauroglossum nitidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Sauvagesia erecta	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schenkia blumenaviensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Schizaea elegans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleira virgata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleria hirtella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Scleria latifolia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleria panicoides	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Scleria plusiophylla	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleria secans	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scybalium fungiforme	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio brasiliensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Setaria geniculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Setaria vulpiseta	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum americanum	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum reflexum	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum sisymbrifolium	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Spathicarpa hastifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0
Spigelia dussenii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stachytarpheta cayennensis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Staurogyne mandioccana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0

	MSF01	MSF02	MSF03	SSF04	MSF05	MSF07	MSF08	MSF09	MSF10	MSF11	LRF 12	MRF14	MSF15	LRF16	MRF*17	MRF*18	MRF19	LRF20	SRF21	MRF*22	LRF23	MRF*24	LRF25	LRF26	MRF*27	MRF*28	LRF29	LRF30	MRF*31	SRF32	LRF33	SRF34	SRF35	SRF36	SRF37	SRF38	LRF39	LRF40	LRF41
Stenorrhynchus lanceolatus	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syagrus romanzoffiana	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Talinum patens	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Thelypteris dentata	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Thelypteris interrupta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tibouchina clinopodifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tillandsia usneoides	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Tournefortia paniculata	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tradescantia crassula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Tradescantia fluminensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1	1	0	0	1	0	1
Tradescantia zanonia	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichomanes cristatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichomanes rigidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triumfetta semitriloba	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
Typha domingensis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vriesea carinata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Vriesea gigantea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
Vriesea incurvata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vriesea philippocoburgii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vriesea rodigasiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wedelia paludosa	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zornia diphylla	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3

List of preferential species indicated by TWINSPAN analysis for the three main blocks of the Atlantic Forest herb layer: Lowland Rainforest; Seasonal Forest; and Upland Rainforest. Species are sorted alphabetically and species in bold are exclusive to the correspondent block. Number in parenthesis is the frequency of the specie in the block. For non exclusive species, the number after bar represents the total frequency of the specie.

Lowland Rainforest (8 sites)

Aechmea ornata (2); ***Aechmea pectinata*** (2); *Anthurium harrisii* (2/3); ***Anthurium loefgrenii*** (3); *Anthurium scandens* (2/4); ***Aspidogyne bicolor*** (2); *Attalea dubia* (2/3); *Bertolonia mosenii* (2/4); *Blechnum serrulatum* (4/5); ***Calathea zebrina*** (2); *Coccocypselum condalia* (5/6); *Coccocypselum cordifolium* (3/4); ***Costus spiralis*** (2); ***Cyrtopodium polyphyllum*** (2); *Desmodium adscendens* (3/5); *Dictyostega orobanchoides* (3/4); ***Elaphoglossum macrophylium*** (2); ***Eleocharis nana*** (2); ***Epidendrum fulgens*** (2); *Erythrodes arietina* (2/3); *Geonoma schottiana* (2/3); *Hydrocotyle leucocephala* (2/3); *Justicia catharginensis* (2/3); *Justicia dusenii* (2/3); ***Lantana undulata*** (2); *Lindsaea lancea* (2/3); ***Lindsaea quadrangularis*** (3); ***Liparis nervosa*** (2); *Maranta divaricata* (2/3); *Mesadenella esmeraldae* (2/3); *Neomarica candida* (4/5); ***Nidularium innocenti*** (4); *Nidularium procerum* (2/4); *Ossoaea amygdaloides* (2/3); ***Ottonia martiana*** (2); ***Pecluma paradiseae*** (2); *Peperomia urocarpa* (3/4); ***Piper solmsianum*** (2); *Polybotrya cilindrica* (2/3); *Polygala laureola* (4/6); *Polypodium catharinae* (2/3); *Polypodium chnoophorum* (3/4); *Polypodium latipes* (3/4); *Psilochilus modestus* (2/3); *Sauvagesia erecta* (3/4); *Schizaea elegans* (3/4); *Scleria panicoides* (3/5); ***Spigelia dussenii*** (2); ***Trichomanes cristatum*** (4); ***Vriesea incurvata*** (3); ***Vriesea philippocoburgii*** (2); ***Vriesea rodigasiana*** (2).

Seasonal Forest (11 sites)

Adenostemma involucratum (2); ***Aechmea lamarckei*** (2); ***Aechmea ramosa*** (2); *Ageratum conyzoides* (2/3); *Asclepias curassavica* (2/3); ***Asterostigma lombardii*** (2); ***Baccharis cinerea*** (2); ***Begonia itupanervis*** (1); ***Billbergia leptopoda*** (2); *Blechnum plumieri* (2/3); ***Buddleja stachyoides*** (2); *Celosia grandifolia* (2/3); ***Chromolaena maximilianii*** (2); ***Costus cuspidatus*** (2); ***Costus scaber*** (2); ***Croton labutus*** (2); *Dichorisandra thyrsiflora* (4/7); ***Dichorisandra villosula*** (2); ***Euphorbia comosa*** (2); ***Geissomeria longiflora*** (4); *Geophila repens* (3/6); ***Heliconia aemygdiana*** (2); ***Heliconia angusta*** (2); ***Heliconia spathocircinata*** (2); ***Hypolytrum schraderianum*** (2); *Hyptis mutabilis* (2/3); *Justicia carnea* (3/6); ***Justicia glomerata*** (2); ***Justicia scheidweileri*** (2); ***Lantana brasiliensis*** (2); *Lasiacis ligulata* (3/4); *Mimosa pudica* (2/3); *Oeceoclades maculata* (2/3); ***Olyra latifolia*** (2); *Olyra micrantha* (3/5); ***Panicum maximum*** (2); *Panicum pilosum* (2/4); *Paradiolyra micrantha* (2/3); *Paspalum corcovadense* (2/3); ***Pharus latifolius*** (2); *Piper amalago* (3/5); *Piper lucaeanum* (2/3); ***Piper vicosanum*** (3); *Polygala lancifolia* (2/3); *Pteris decurrens* (2/3); ***Rhynchospora exaltata*** (5); ***Ruellia elegans*** (2); ***Ruellia puri*** (3); ***Scleira virgata*** (2); ***Stenorrhynchus lanceolatus*** (2); *Syagrus romanzoffiana* (2/4); ***Tradescantia zanonia*** (3); *Vriesea carinata* (2/4); ***Wedelia paludosa*** (2).

Upland RainForest (20 sites)

Acalypha gracilis (7); ***Adenostemma verbesina*** (3); ***Adiantum raddianum*** (3); ***Aechmea recurvata*** (3); *Anemia phyllitidis* (4/8); ***Anemia tweediana*** (2); ***Apteria aphylla*** (2); ***Asplenium abscissum*** (2); ***Asplenium bradei*** (2); ***Asplenium claussenii*** (6); ***Asplenium sellowianum*** (2); *Asplenium serra* (2/3); *Asterostigma lividum* (3/4); ***Baccharis trimera*** (2); *Begonia cucculata* (3/4); ***Begonia semperflorens*** (2); ***Bidens pilosa*** (3); *Blainvillea biaristata* (2/3); ***Blechnum austrobrasilianum*** (2); *Blechnum brasiliense* (4/5); ***Blechnum meridensis*** (2); *Blechnum occidentale* (2/3); ***Briza subaristata*** (2); *Bromelia antiacantha*

(6/8); ***Canna indica*** (3); ***Carex brasiliensis*** (2); ***Carex sellowiana*** (9); ***Centella asiatica*** (2); *Chamissoa acuminata* (3/5); *Chaptalia nutans* (9/11); ***Chusquea tenella*** (2); *Clematis dioica* (2/3); *Coccocypselum lanceolatum* (5/8); *Coccocypselum sessiliflorum* (2/3); ***Commelina difusa*** (2); ***Conyza notobellidiastrum*** (2); ***Conyza rivularis*** (5); ***Ctenitis submarginallis*** (3); ***Cuphea calophylla*** (2); ***Cyperus incomtus*** (3); *Desmodium affine* (2/3); ***Dichondra microcalyx*** (2); *Dichorisandra incurva* (2/3); ***Didymochlaena truncatula*** (3); *Diplazium cristatum* (3/4); ***Doryopteris concolor*** (2); ***Doryopteris multipartita*** (7); ***Doryopteris pedata*** (3); *Elephantopus mollis* (5/8); ***Erythrodes austrobrasiliensis*** (2); ***Festuca ulochaeta*** (2); ***Galeandra beyrichii*** (2); ***Hapolorchis micranthus*** (2); ***Heimia myrtifolia*** (2); ***Heliotropium transalpinum*** (2); ***Homolepsis glutinosa*** (2); ***Iresine diffusa*** (3); ***Justicia brasiliana*** (3); *Lasiacis divaricata* (2/3); *Lindsaea botrychioides* (2/3); *Maranta arundinacea* (5/7); *Megalastrum connexum* (2/3); *Mesadenella cuspidata* (4/5); ***Ocinum selloi*** (3); ***Olyra ciliatifolia*** (2); *Olyra humilis* (5/7); ***Oplismenus hirtellus*** (10); *Oplismenus setarius* (4/5); ***Oxalis articulata*** (2); ***Oxalis linarantha*** (6); ***Panicum glutinosum*** (3); *Panicum ovuliferum* (3/4); ***Panicum parvifolium*** (2); ***Panicum rude*** (2); ***Panicum schwackeanum*** (2); ***Panicum sellowii*** (2); ***Paspalum inaequivalve*** (2); *Paspalum mandiocanum* (2/3); ***Paspalum plicatum*** (2); ***Pavonia sepium*** (7); ***Peperomia caulibarbis*** (2); *Peperomia pereskiaefolia* (3/5); *Petiveria alliaceae* (4/5); *Pharus glaber* (7/8); ***Pharus lappulaceus*** (4); ***Phyllanthus niruri*** (2); ***Pilea pubescens*** (2); ***Piper mikanianum*** (4); ***Pleurostachys stricta*** (3); *Polygonum punctatum* (3/4); *Polypodium lepdopteris* (2/3); ***Polystichum platyphyllum*** (2); *Pseudochinolaena polystachya* (7/11); ***Pteris deflexa*** (3); *Pteris denticulata* (5/6); *Relbunium hypocarpium* (3/4); ***Rhynchospora floribunda*** (2); ***Ruellia angustiflora*** (2); *Ruellia sanguinea* (3/4); *Rumohra adiantiformis* (2/3); ***Salvia melissiflora*** (2); ***Schenkia blumenaviensis*** (2); ***Scleria hirtella*** (2); ***Scybalium fungiforme*** (2); ***Senecio brasiliensis*** (2); ***Setaria geniculata*** (2); ***Setaria vulpiseta*** (2); *Solanum americanum* (3/4); *Solanum sisymbrifolium* (2/3); ***Spathicarpa hastifolia*** (8); *Staurogyne mandioccana* (2/3); *Talinum patens* (3/5); ***Tibouchina clinopodifolia*** (2); ***Tournefortia paniculata*** (2); ***Tradescantia crassula*** (2); ***Tradescantia fluminensis*** (11); *Triumfetta semitriloba* (4/7); *Vriesea gigantea* (2/3).

Appendix 4

List of the 24 species occurring in all three blocks from TWINSPAN analysis for Atlantic Forest herb layer. Species are sorted alphabetically and the number in parenthesis is the frequency in block Seasonal Forest, Upland Rainforest and Lowland Rainforest respectively, separated by bars.

Anemia phyllitidis (2/4/2);
Anthurium scandens (1/1/2);
Bertolonia mosenii (1/1/2);
Blechnum binervatum (1/1/1);
Clidemia hirta (2/2/1);
Coccocypselum lanceolatum (2/5/1);
Dennstaedtia dissecta (1/1/1);
Desmodium adscendens (1/1/3);
Dichorisandra hexandra (4/4/1);
Dichorisandra thyrsiflora (4/1/2);
Euterpe edulis (1/1/1);
Geophila repens (3/1/2);
Ichnanthus pallens (2/3/3);
Justicia carnea (3/2/1);
Nidularium procerum (1/1/2);
Olyra micrantha (3/1/1);
Panicum pilosum (2/1/1);
Piper amplum (1/1/1);
Pleurostachys urvillei (1/1/1);
Polygonum acuminatum (1/1/1);
Prescottia stachyoides (2/1/2);
Scleria panicoides (1/1/3);
Syagrus romanzoffiana (2/1/1);
Vriesea carinata (2/1/1).

CONSIDERAÇÕES FINAIS

As duas abordagens de estrato herbáceo empregadas neste trabalho mostraram-se bastante eficazes em responder os respectivos objetivos pretendidos, demonstrando a grande importância da estratificação para o entendimento de como as florestas tropicais são organizadas e como sua estrutura pode estar relacionada ecologicamente com fatores ambientais e funcionais. Parker & Brown (1999) não concordam com a utilidade da estratificação em florestas, porém esta afirmação está baseada em estudos com florestas temperadas.

Mesmo com o aumento de trabalhos com estrato herbáceo, o número ainda é notavelmente pequeno quando comparado com estratos superiores. O segundo capítulo em especial, mostrou como é fundamental a determinação dos hábitos de vida das espécies em levantamentos florísticos. Mesmo sendo algo subjetivo e arbitrário, a classificação dos hábitos de vida, além de fornecer dados para novos trabalhos, pode revelar informações importantes dos grupos funcionais nas diferentes formações florestais, principalmente da Mata Atlântica, onde a alta taxa de destruição pode comprometer de forma irreversível o conhecimento de sua flora. Assim, reiteramos o apontamento de Gentry & Dodson (1987) que atenta para a importância da inclusão de espécies de estratos inferiores e outras formas de vida além das árvores em levantamentos florísticos para uma melhor avaliação da riqueza e diversidade das florestas tropicais.

Trabalhar com estrato herbáceo pode ser vantajoso, pois requer menos tempo e menor esforço para obter uma larga amostra de indivíduos (Poulsen 1996). Em contrapartida, a dificuldade na identificação de plântulas e indivíduos jovens de árvores, trepadeiras e herbáceas pode ser uma razão para a falta de encorajamento por parte dos pesquisadores em incluir o estrato herbáceo em levantamentos florísticos ou em estudos de ecologia de comunidades. Porém, à medida que novos estudos vão sendo realizados com este estrato, a dificuldade tende a diminuir proporcionalmente.

A partir dos resultados encontrados no primeiro capítulo, algumas questões puderam ser levantadas, como por exemplo: a) algumas trepadeiras possuem a capacidade de forragear em busca de forófitos e luz? b) A mortalidade de indivíduos da estação chuvosa para a seca ocorre de forma diferenciada entre as espécies? c) A vegetação rasteira perde suas folhas durante a seca? Quais espécies? d) A falta de correlação entre composição da vegetação rasteira e abertura de dossel se deve pela falta de precisão do método ou pela complexidade da dinâmica de luz no interior das florestas tropicais?

No segundo capítulo, os resultados mostraram-se relevantes para a discussão quanto à origem e os limites da Mata Atlântica, porém algumas questões ainda permanecem em aberto: a) O três centros florísticos encontrados seriam indícios de que a Mata Atlântica possui três centros de origens? b) A altitude pode ser um fator determinante na distinção da composição florística do estrato herbáceo se analisado separadamente cada centro florístico? c) A distinção em três centros florísticos suportaria a idéia de que somente a Floresta Ombrófila Densa, que corresponderia ao centro florístico Floresta Ombrófila de Terras Altas, deveria ser considerada como “Mata Atlântica”, como defendido por Ferri (1980) e Leitão-Filho (1971)? Ou os três centros florísticos, mesmo com diferentes composições, devam ser considerados como Mata Atlântica, como defendido por Rizzini *et al.* (1988), Oliveira-Filho & Fontes (2000)?

A distinção em três centros florísticos de Mata Atlântica para o estrato herbáceo tem conseqüências importantes para a conservação independentemente da questão acadêmica sobre a origem e os limites da Mata Atlântica. Para garantir que o máximo da biodiversidade da Mata Atlântica seja preservado, é importante a conservação de áreas ao longo dos três centros florísticos e em todas as fisionomias de Mata Atlântica.

Referências

Ferri, M.G. (1980) *A vegetação brasileira*. EDUSP, São Paulo, SP.

Gentry, A.H. & Dodson, C. (1987) Contribuition of nontrees to species richness of a tropical rain forest. *Biotropica*, **19**, 149–156.

Leitão-Filho, H.F. (1987) Considerações sobre a florística de florestas tropicais e sub-tropicais do Brasil. *Instituto de Pesquisas e Estudos Florestais*, **35**, 41–46.

Oliveira-Filho, A.T., & Fontes, M.A.L. (2000) Patterns of floristic differentiation among Atlantic forests in southeastern Brazil, and the influence of climate. *Biotropica*, **32**, 793–810.

Parker, G.G. & Brown, M.J. (2000) Forest canopy stratification – Is It Useful? *American Naturalist*, **155**, 473–484.

Poulsen, A.D. (1996) Species richness and density of ground herbs within a plot of Lowland Rainforest in North-West Borneo. *Journal of Tropical Ecology*, **12**, 177–190.

Rizzini, C.T., Coimbra-Filho, A.F. & Houaiss, A. (1988) *Ecossistemas brasileiros*. Editora Index, Rio de Janeiro, RJ.