Universidade Estadual de Campinas

Instituto de Biologia

Marco Antônio Portugal Luttembarck Batalha

Florística, espectro biológico e padrões fenológicos do cerrado *sensu lato* no Parque Nacional das Emas (GO) e o componente herbáceo-subarbustivo da flora do cerrado *sensu lato*

Este exemplar corresponde à redação final da tese defendida pelo(a) candidato (a) Marco Antonio Portugal Luttembarck Batalha e aprovada pela Comissão Julgadora.
Fernando R. Martins
12/11/01

Orientador: Dr. Fernando Roberto Martins

Tese apresentada ao Instituto de Biologia da Universidade Estadual de Campinas para obtenção do título de Doutor em Ecologia

Campinas

2001

FICHA CATALOGRÁFICA ELABORADA PELA BIBLIOTECA DO INSTITUTO DE BIOLOGIA – UNICAMP

B311f

Batalha, Marco Antônio Portugal Luttembarck
Florística, espectro biológico e padrões fenológicos do cerrado sensu lato no Parque Nacional das Emas (GO) e o componente herbáceo-subarbustivo da flora do cerrado sensu lato/Marco Antônio Batalha. –Campinas, SP:[s.n.],2001.
213f.:ilus

Orientador: Fernando Roberto Martins
Tese (doutorado) – Universidade Estadual de Campinas. Instituto de Biologia.

1. Cerrado. 2. Savanas. 3. Fenologia. 4. Espectro. I.Martins, Fernando Roberto. II. Universidade Estadual de Campinas. Instituto de Biologia. III. Título.

Data da defesa: 12/11/2001

Banca examinadora

Prof. Dr. Fernando Roberto Martins (Orientador) ______________________

Prof. Dr. Leopoldo Magno Coutinho ______________________

Prof. Dr. Waldir Mantovani ______________________

Prof. Dr. José Felipe Ribeiro ______________________

Prof. Dr. George Shepherd ______________________

Profa. Dra. Kikyo Yamamoto ______________________

Prof. Dr. Flávio Antonio Maës dos Santos ______________________

"A mais nobre espécie de beleza é aquela que não arrebata de vez, que não se vale de assaltos tempestuosos e embriagantes, mas que lentamente se infiltra, que levamos conosco quase sem perceber e com que nos deparamos novamente em um sonho, e que, afinal, após ter longamente ocupado um lugar modesto em nosso coração, apodera-se completamente de nós, enchendo-nos os olhos de lágrimas e o coração de ânsias".

Friedrich Nietzsche, em *Humano, demasiado humano.*

... e foi assim para mim o cerrado, cuja beleza não é óbvia

e precisa ser atentamente descoberta...

Sumário

Agradecimentos

- Ao Prof. Dr. Fernando Roberto Martins, pela orientação, pelo que me ensinou e por ter me dado a honra de poder ter convivido ao menos um pouco com ele;
- À Fundação de Amparo à Pesquisa do Estado de São Paulo, pela bolsa concedida (processo 97/13.697-5);
- Ao Prof. Dr. Waldir Mantovani, pela cessão do seu laboratório, por tudo o que me ensinou desde minha Iniciação Científica e pela amizade;
- Ao Ibama, em especial ao ex-diretor do Parque Nacional das Emas Ary Soares dos Santos e ao atual gerente ambiental Gabriel Cardoso Borges, pela autorização para a realização do projeto (processo 02001,000376/98-90);
- Ao Dr. Mário Barroso Ramos-Neto, pela ajuda em todas as fases do projeto;
- Aos funcionários do Parque Nacional das Emas e suas famílias, pelo apoio durante todo o trabalho de campo: S. Edmar, S. Nicássio, S. Valdomiro, S. Élcio, S. José Carlos e S. Heleno;
- Ao técnico Paulo César Fernandes (PC), pela ajuda no laboratório e pela amizade;
- Ao Prof. Dr. Roberto Shimizu, pela ajuda na aula de qualificação, pela revisão do manuscrito e pela amizade;
- Ao Prof. Dr. Leopoldo Magno Coutinho, por ter me mostrado pela primeira vez o Parque Nacional das Emas, pelo que me ensinou nas suas aulas e por tudo o que fez no cerrado;
- Ao Rodrigo e à Simone, pelo apoio logístico em Campinas e pela amizade;
- Aos meus colegas pós-graduandos da Unicamp e da USP: Andrea, Boi, Cibele, Cláudia, Gerardo, Humberto, Marcelo, Paki, Patrícia, Soninha, Sydnei, Táti e Tozetti;
- Aos curadores e funcionários dos herbários do Instituto de Botânica de São Paulo, do

Departamento de Botânica do Instituto de Biociências da Universidade de São Paulo, do Instituto de Biologia da Universidade Estadual de Campinas, da Universidade de Brasília, do Instituto Brasileiro de Geografia e Estatística, do Jardim Botânico de Brasília e da Empresa Brasileira de Pesquisas Agropecuárias, pela permissão para visitá-los;

- Aos taxonomistas Kátia Althott, Marccus Alves, Maria Mercedes Arbo, Marta Camargo de Assis, Cristina Bestetti, Volker Bittrich, Armando Carlos Cervi, Inês Cordeiro, Carmen Cristóbal, Thais Scotti do Canto-Dorow, Samira Ismael Elias, Gerleni Esteves, Maria Ana Farinaccio, María Ferrucci, Pedro Fiaschi, Enrique Forero, Antônio Furlan, Eduardo Gonçalves, Maria Lúcia Kawasaki, Mizuê Kirizawa, Antonio Krapovickas, Júlio Antônio Lombardi, Mara Magenta, Waldir Mantovani, Amauri César Marcato, Renato Mello-Silva, Efigênia Melo, Marta Moraes, Regina Célia de Oliveira, Mateus Barradas Paciencia, José Rubens Pirani, Ana Paula Prata, Carolyn Proença, Neusa Taroda Ranga, Fátima Regina Salimena, João Ubiratan dos Santos, João Semir, Marcelo Simon, Eliane Rocio Vieira da Silva, Milene Maria da Silva, Rosângela Simão-Bianchini, Juliana Souza, Andrea Spina, Jorge Yoshio Tamashiro, Wayt Thomas, Roseli Torres, Maria da Graça Wanderley e Ana Zanin, pela inestimável ajuda na identificação do material botânico;
- Aos Profs. Drs. Leopoldo Magno Coutinho, Waldir Mantovani e José Rubens Pirani, pelas valiosas contribuições, críticas e sugestões à versão preliminar desta tese, feitas durante a fase de pré-banca;
- Ao assessor anônimo da Fapesp, pelas críticas construtivas e comentários pertinentes, que contribuíram para enriquecer o trabalho;
- e, em especial, à Carla Fortino, pela revisão do texto e, principalmente, pelo carinho.

Resumo

O cerrado é o segundo tipo vegetacional brasileiro em extensão territorial. Entre as reservas que o protegem, o Parque Nacional das Emas (PNE) é uma das maiores e mais bem preservadas. O PNE, com cerca de 132.000 ha, está localizado no Planalto Central Brasileiro, no sudoeste de Goiás, sob clima tropical subquente úmido com três meses de seca no inverno. A maior parte do PNE, mais de 90% de sua área, é coberta por fisionomias de cerrado (campo limpo, campo sujo, campo cerrado ou cerrado *sensu stricto*). Até o momento, os únicos estudos desenvolvidos no PNE envolviam sua fauna (especialmente, a de maior porte) ou o fogo.

De novembro de 1998 a outubro de 1999, realizamos um levantamento florístico nas fisionomias de cerrado no PNE, quando encontramos 601 espécies, pertencentes a 303 gêneros e 80 famílias. Entre as espécies coletadas, 12 foram invasoras e sete, novas para ciência. A proporção entre espécies herbáceo-subarbustivas e arbustivo-arbóreas foi de 3,03:1. As famílias mais ricas em espécies foram Asteraceae, Fabaceae, Poaceae, Myrtaceae e Lamiaceae, que compreenderam 48% do total de espécies. Os resultados encontrados nesse levantamento mostraram a importância do PNE para a conservação do cerrado, pois de 8 a 20% das espécies relacionadas para essa formação vegetal ocorrem na reserva.

Comparamos a distribuição de espécies por famílias obtidas para a flora do PNE com aquelas obtidas por outros autores para o Domínio do Cerrado e o cerrado *sensu lato*. Usamos esses padrões mais gerais como modelos nulos contra os quais a distribuição de espécies por famílias no PNE foi testada, caracterizando assim sua flora e discutindo alguns padrões fitogeográficos. As distribuições dos tamanhos de famílias e gêneros foram deslocadas para a menor classe, com um maior número de famílias e gêneros com uma única espécie. A distribuição de espécies por famílias no PNE foi significativamente diferente daquelas encontradas tanto no Domínio do Cerrado quanto nos

componentes herbáceo-subarbustivo e arbustivo-arbóreo do cerrado *sensu lato*. O componente herbáceo-subarbustivo da flora do cerrado no PNE se caracterizou pela super-representação de Myrtaceae e subrepresentação de Orchidaceae e Lythraceae, e o componente arbustivo-arbóreo, pela maior proporção do que a esperada de Myrtaceae e Nyctaginaceae. Quando comparado com áreas disjuntas de cerrado, o PNE se mostrou bem distinto, não só em nível de espécie, mas também em nível de família.

A partir da lista florística obtida nas fisionomias de cerrado no PNE, nós construímos o espectro biológico dessa flora, segundo o sistema de Raunkiaer. As principais formas de vida foram os hemicriptófitos e os fanerófitos, que representaram, respectivamente, 49,92% e 24,79% do número total de espécies. Quando comparados ao espectro normal de Raunkiaer, o espectro do PNE foi significativamente diferente, devido especialmente à maior proporção de hemicriptófitos. Outros sítios de cerrado também apresentaram maiores proporções de hemicriptófitos e fanerófitos, embora a importância relativa dessas classes tenha variado conforme as fisionomias predominantes. Quando comparados a espectros biológicos de outras formações vegetais, os sítios de cerrado formaram um grupo distinto, com autovalores mais próximos daqueles dos hemicriptófitos e fanerófitos. Os sítios de cerrado se distinguiram dos das demais savanas pela subrepresentação dos terófitos. Ainda que algumas vezes criticado quanto à sua aplicabilidade em comunidades tropicais, o sistema de Raunkiaer foi útil para caracterizar as floras de cerrado e separá-las dos demais tipos vegetacionais.

No cerrado, como em outras savanas, os padrões fenológicos estão fortemente associados à estacionalidade climática. Os padrões de floração e frutificação da comunidade foram analisados, relacionando-os às síndromes de dispersão e comparando os componentes herbáceo-subarbustivo e arbustivo-arbóreo. O componente herbáceo-subarbustivo se caracterizou pela maior proporção de espécies autocóricas, e o componente arbustivo-arbóreo, pela maior proporção de espécies zoocóricas. Houve uma estacionalidade marcante nos padrões de floração e frutificação da comunidade, embora eles tenham sido diferentes entre os componentes herbáceo-subarbustivo e arbustivo-arbóreo. As espécies arbustivo-arbóreas floresceram principalmente no início da estação chuvosa, enquanto que as herbáceo-subarbustivas floresceram geralmente no final dessa estação. Na estação seca, quando a dispersão de seus diásporos é mais eficiente, a proporção de espécies anemo e autocóricas frutificando foi maior. Durante a estação chuvosa, quando seus frutos podem se manter atrativos por mais tempo, as espécies zoocóricas frutificaram em maior número.

Ainda que freqüentemente negligenciado, o componente herbáceo-subarbustivo da flora do cerrado é mais rico do que o componente arbustivo-arbóreo, muito mais estudado. Tentamos compilar um listagem das espécies herbáceo-subarbustivas que ocorrem no cerrado, usando como critério de inclusão a classe de forma de vida. Todas as espécies não-fanerofíticas foram consideradas como pertencentes ao componente herbáceo-subarbustivo. Listamos 2.856 espécies, um número maior do que o limite inferior de uma estimativa anterior. As famílias mais ricas foram Asteraceae, Fabaceae, Poaceae, Euphorbiaceae, Lamiaceae, Rubiaceae e Orchidaceae, que englobaram 53,47% do número total de espécies. A distribuição dos tamanhos das famílias no cerrado como um todo pode ser usada para comparar e caracterizar o componente herbáceo-subarbustivo de áreas de cerrado. Os gêneros mais ricos foram *Hyptis*, *Vernonia*, *Chamaecrista*, *Paspalum* e *Mimosa*, todos pertencentes a uma das famílias mais bem representadas. Nossa listagem provavelmente é uma subestimativa do número verdadeiro de espécies no componente herbáceo-subarbustivo da flora do cerrado, devido aos poucos levantamentos disponíveis em que essas espécies tenham sido também coletadas. Futuros estudos que lidem com a vegetação do cerrado não podem mais ignorar o componente herbáceo-subarbustivo, que é mais rico e mais vulnerável do que o componente arbustivo-arbóreo.

Abstract

The cerrado, a savanna-like ecosystem, is the second largest vegetation type in Brazil. Among the reserves that protect it, Emas National Park (ENP) is one of the largest and best preserved. The ENP, with about 132,000 ha, is located in the Brazilian Central Plateau, southwestern Goiás State, under warm and wet tropical climate with three dry months in winter. Most of ENP's area, more than 90%, is covered by cerrado physiognomies. Until now, all studies carried out within the reserve were restricted to its fauna and fires.

From November 1998 to October 1999, we carried out a floristic survey in the cerrado physiognomies in ENP, when we found 601 species, belonging to 303 genera and 80 families. Among the collected species, 12 were weeds and seven, new to science. The herbaceous to woody species ratio was 3.03:1. The richest families were Asteraceae, Fabaceae, Poaceae, Myrtaceae, and Lamiaceae, which comprised 48% of the total number of species. The results obtained in this survey showed the importance of Emas National Park to the cerrado conservation, since from 8 to 20% of the species related for this vegetation type occur in the reserve.

We compared the frequency distribuition of species per family obtained for the ENP flora with those obtained by other authors for the cerrado vegetation and the Cerrado Domain. We used these more general pattern as null models against which the frequency distribution of species per family in ENP was tested, characterizing thus its flora and discussing some phytogeographical patterns. The frequency distribution of genus and family sizes was highy skewed to the smallest class, with a higher number of monospecific genera and families. The distribution of species per family in ENP was significantly different from those obtained in the Cerrado Domain and in the herbaceous and woody components of the cerrado flora. The herbaceous component of ENP flora was characterized by the overproportion of Myrtaceae and underproportion of Orchidaceae and Lythraceae, and the woody

component, by the overproportion of Myrtaceae and Nyctaginaceae. When compared with outlying cerrado sites, the ENP was quite distinct, not only on species level, but also on family level.

Based on the floristic list obtained in the cerrado physiognomies in ENP, we constructed the life-form spectrum of its flora, following Raunkiaer's system. The main life-form classes were hemicryptophytes and phanerophytes, which accounted, respectively, for 49.92% and 24.79% of the total number of species. When compared with Raunkiaer's normal spectrum, the ENP spectrum was significantly different, due especially by the overproportion of hemicryptophytes. Other cerrado sites presented also higher proportions of hemicryptophytes and phanerophytes, although their relative importance varied according to the prevailing physiognomies. When compared with life-form spectra from other vegetation types, the cerrado sites formed a distinct group, with eigenvalues closer to those of the hemicryptophytes and phanerophytes. The cerrado sites distinguished themselves from the savanna sites by their under-representation of therophytes. Even if sometimes criticized in its application on tropical communities, Raunkiaer's system was useful to characterize the cerrado floras and to separate it from other vegetation types.

In the cerrado, as in other savannas, the phenological patterns are closely linked to the climatic seasonality. The flowering and fruiting patterns of the community were analysed in relation to dispersal syndromes, comparing the herbaceous and the woody components. The herbaceous component was characterized by an overproportion of autochorous species, and the woody component, by an overproportion of zoochorous species. There was a striking seasonality in the community-wide pattern of flowering and fruiting, although they were different between the herbaceous and the woody components. Woody species flowered mainly during late dry and early wet seasons, whereas herbaceous species flowered generally during late wet season. At the dry season, when their diaspores could be dispersed more efficiently, the proportion of fruiting anemo and autochorous fruits was higher. During the rainy season, when their fruits could be kept attractive for longer time, the number of fruiting zoochorous species reached its peak.

Even if frequently neglected, the herbaceous component of the cerrado flora is richer than the much more studied woody component. We tried to compile a checklist of the herbaceous species that occur in the cerrado, using life-form class as criterion of inclusion. All non-phanerophytes species were assumed to belong to the herbaceous component. We listed 2,856 species, a figure higher than the lower limit of a previous estimation. The richest families were Asteraceae, Fabaceae, Poaceae, Lamiaceae, Euphorbiaceae, Rubiaceae, and Orchidaceae, which accounted for 53.47% of the total number of species. The distribution of family sizes in the cerrado as a whole can be used to compare and characterize the herbaceous component in cerrado sites. The richest genera were *Hyptis*, *Vernonia*, *Chamaecrista*, *Paspalum*, and *Mimosa*, all belonging to one of the best represented families. Our checklist is probably an underestimation of the actual number of species in the herbaceous component of the cerrrado flora, due to the few surveys currently available in which the herbaceous species had also been sampled. Future studies dealing with the cerrado vegetation can no longer ignore the herbaceous component, which is richer and more vulnerable than the woody component.

I – Introdução geral

Introdução geral

O Cerrado é a segunda maior província fitogeográfica brasileira e também a segunda mais ameaçada. Sua área nuclear ocupa a maior parte do Planalto Central Brasileiro, onde se situa o Parque Nacional das Emas (PNE), uma das maiores e mais importantes reservas dentre aquelas que representam o Cerrado. Não obstante, embora vários estudos envolvendo sua fauna de maior porte e a dinâmica das queimadas tenham sido lá desenvolvidos, sua vegetação permanecia praticamente desconhecida. Por esses motivos, decidimos dar nossa contribuição ao conhecimento da vegetação da reserva, estudando a flora do cerrado *sensu lato* lá existente e alguns de seus aspectos ecológicos.

No primeiro capítulo, procuramos caracterizar o PNE a partir de algumas informações existentes na literatura e outras obtidas durante nosso trabalho. Esperamos, assim, que o leitor tenha informações sobre sua localização, seu tamanho, sob qual clima se situa, seu relevo, seus tipos de solo, sua fauna, sua vegetação e sobre a questão do fogo em seu interior. Procuramos relacionar os trabalhos desenvolvidos até agora na reserva, nos quais aqueles com mais interesse podem procurar outras informações.

Se desejamos conhecer a vegetação do cerrado *sensu lato* no PNE, devemos, antes de mais nada, conhecer quais são as espécies que compõem a sua flora. No segundo capítulo, listamos as espécies encontradas, procurando descrever a flora do cerrado no PNE e comparar seus dois componentes, o componente herbáceo-subarbustivo e o arbustivo-arbóreo. A lista florística obtida foi a base para os três capítulos seguintes.

Como o capítulo anterior, o terceiro capítulo também trata da flora do cerrado *sensu lato* no PNE, ainda que com outra abordagem. Se, no capítulo 2, procuramos descrever a flora do cerrado *sensu lato* no PNE e comparar seus dois componentes, no capítulo 3, tentamos comparar essa flora com padrões mais gerais, tanto para o cerrado *sensu lato* quanto para todo o Domínio do Cerrado.

Também procuramos comparar a flora do PNE com aquelas de áreas disjuntas de cerrado no estado de São Paulo.

Um modo de se analisar comunidades vegetais sem necessitar de detalhamento taxonômico é com o estudo das formas de vida. No quarto capítulo, construímos o espectro de formas de vida para a flora do cerrado no PNE, comparando com o esperado de acordo com a literatura. Quando comparado a espectros de formas de vida de outros tipos vegetacionais, os espectros de cerrado formam um grupo distinto? Procuramos responder a essa pergunta, ainda nesse capítulo, compilando espectros construídos por vários autores para diversas regiões do mundo e em diversas formações vegetais.

De acordo com informações disponíveis na literatura, os componentes herbáceo-subarbustivo e arbustivo-arbóreo do cerrado se comportam de maneira distinta no que diz respeito à fenologia. Considerando a comunidade vegetal do cerrado *sensu lato*, os padrões de floração e frutificação se comportam de que maneira? Esses padrões são diferentes para os dois componentes da flora? Essas perguntas motivaram o quinto capítulo, em que estudamos os padrões fenológicos reprodutivos da comunidade vegetal no cerrado do PNE.

Embora o componente arbustivo-arbóreo do cerrado seja relativamente bem estudado, o componente herbáceo-subarbustivo permanece ainda pouco conhecido. Estimativas recentes dizem que enquanto o componente arbustivo-arbóreo possui cerca de 1.000 a 2.000 espécies, o componente herbáceo-subarbustivo possui de 2.000 a 5.000 espécies. Para termos idéia de quão rica é essa flora, compilamos, no sexto capítulo, uma listagem das espécies que ocorrem no componente herbáceo-subarbustivo da flora do cerrado *sensu lato*, consultando os poucos levantamentos florísticos ou fitossociológicos disponíveis, revisões taxonômicas e exsicatas depositadas em herbário.

Uma vez que a palavra "cerrado" é usada em sentidos diferentes ao longo do texto, é necessário que deixemos claro qual significado adotado por nós em cada caso: *i)* quando estivermos nos referindo ao Cerrado como província fitogeográfica, usaremos "Domínio do Cerrado" ou, simplesmente, "Cerrado", com iniciais maiúsculas. Neste sentido, estamos incluindo todos os tipos vegetacionais que aparecem nessa província, isto é, não só o cerrado, mas também a floresta estacional, floresta ripícola, vereda de buriti, campo úmido, campo de murundu, campo rupícola *etc.*; *ii*) quando estivermos nos referindo ao cerrado como tipo vegetacional, usaremos "cerrado *sensu lato*", "vegetação de cerrado" ou, simplesmente, "cerrado", com iniciais minúsculas. Neste sentido, adotamos a divisão fisionômica de Coutinho (1978); *iii*) quando estivermos nos referindo a uma das fisionomias do cerrado *sensu lato*, a fisionomia savânica mais fechada de acordo com o conceito de Coutinho (1978), usaremos "cerrado *sensu stricto*". As traduções do português para o inglês das fisionomias do cerrado *sensu lato* seguirão o proposto por Sarmiento (1984). Assim, teremos: campo limpo – *grassland*; campo sujo – *shrub savanna*; campo cerrado – *savanna woodland*; cerrado *sensu stricto* – *woodland*; cerradão – *tall woodland*.

Finalmente, em relação ao formato da tese, gostaríamos de fazer algumas considerações. A deliberação da CCPG da Unicamp n°. 001/98 estabelece a divisão da tese da seguinte forma: Resumo, *Abstract*, Introdução Geral, Capítulos, Conclusão Geral e Referências bibliográficas. No que diz respeito aos capítulos, essa mesma deliberação permite a formatação de cada um deles de acordo com as normas das revistas científicas a que serão submetidos. Como as revistas que escolhemos para publicá-los exigem ou, ao menos, permitem a sua redação em inglês, nossos capítulos, com exceção do primeiro, foram escritos nesse idioma. A divisão em capítulos se justifica, pois torna a publicação dos artigos científicos menos trabalhosa, embora, devido à independência de um capítulo em relação aos demais, repetições tornem-se inevitáveis.

Referências bibliográficas

COUTINHO, L. M. 1978. O conceito do cerrado. *Revista Brasileira de Botânica 1*: 17-23.

SARMIENTO, G. 1984. *The ecology of Neotropical savannas*. Cambridge, Harvard University.

II – Capítulos

1. Caracterizacão do Parque Nacional das Emas (GO)

Introdução

O Parque Nacional das Emas (PNE) foi criado em 1961, pelo decreto federal nº 49.874, a partir de terras doadas ao Estado pelo fazendeiro Filogônio Garcia. Em 1972, o decreto federal nº 70.376 excluiu dos limites do PNE parte das cabeceiras dos rios Jacuba e Araguaia, estabelecendo sua delimitação atual, com 132.941 ha. O PNE recebeu este nome devido ao grande número de emas (*Rhea americana*) que podem ser observadas em seu interior. O PNE, juntamente com o Parque Nacional de Brasília e o da Chapada dos Veadeiros, representa uma das principais reservas de Cerrado no Brasil e é considerado a maior e mais bem preservada (IBDF 1981), sendo, pois, uma das áreas criticamente prioritárias para a conservação do Cerrado (Conservation International 1999).

Este capítulo tem por objetivo descrever as características climáticas, geomórficas, edáficas, vegetacionais e faunísticas do Parque Nacional das Emas, sintetizando as informações disponíveis na literatura e incluindo algumas informações obtidas durante o levantamento florístico efetuado nessa área (Capítulo 2).

Localização

O PNE está localizado no Planalto Central Brasileiro, na região nuclear do Cerrado, nos municípios de Mineiros e Chapadão do Céu, sudoeste do Estado de Goiás, entre as coordenadas 17°49'-18°28'S e 52°39'-53°10'W (Figura 1). Dista cerca de 88 km de Mineiros, por estrada de asfalto, e 28 km de Chapadão do Céu, por estrada de terra.

Clima

O PNE está situado sob clima do tipo Aw de Köppen (1948), ou seja, tropical subquente úmido com três meses secos no inverno, ou Zonobioma II de Walter (1986), isto é, tropical úmido-árido com chuvas estivais (Figura 2). A pluviosidade anual varia de 1200 a 2000 mm, concentrada entre setembro e março, e a temperatura média anual é de cerca de 24,6°C (Ramos-Neto & Pivello 2000). Em junho e julho, ocorrem normalmente de uma a três geadas, que atingem com maior intensidade as áreas em topo de chapada (Ramos-Neto 2000). A ocorrência de veranicos, curtos períodos de seca durante o verão, é rara (Ramos-Neto 2000).

Relevo e solo

O PNE contém formações areníticas pertencentes ao Grupo São Bento, da formação Botucatu, datadas do período Juro-Cretáceo. Em alguns locais, como no Planalto do Rio Verde, há depósitos terciários que formam platôs (IBDF 1981). No parque, predomina um relevo plano, de topo de chapada, com altitudes variando de 820 a 890 m, além de partes mais baixas, com até 720 m (Ramos-Neto 2000). A fisiografia do parque é determinada pelo divisor de águas entre as bacias dos rios Formoso e Jacuba (Figura 3). As nascentes do rio Jacuba são caracterizadas por vales muito erodidos, cujas escarpas são muito íngremes, às vezes com até 80°, ao contrário das nascentes do rio Formoso, que não excedem 20° de inclinação (IBDF 1981). Os solos são do tipo Latossolo Vermelho-Escuro e Latossolo Vermelho-Amarelo, ambos distróficos (Ibama 1989).

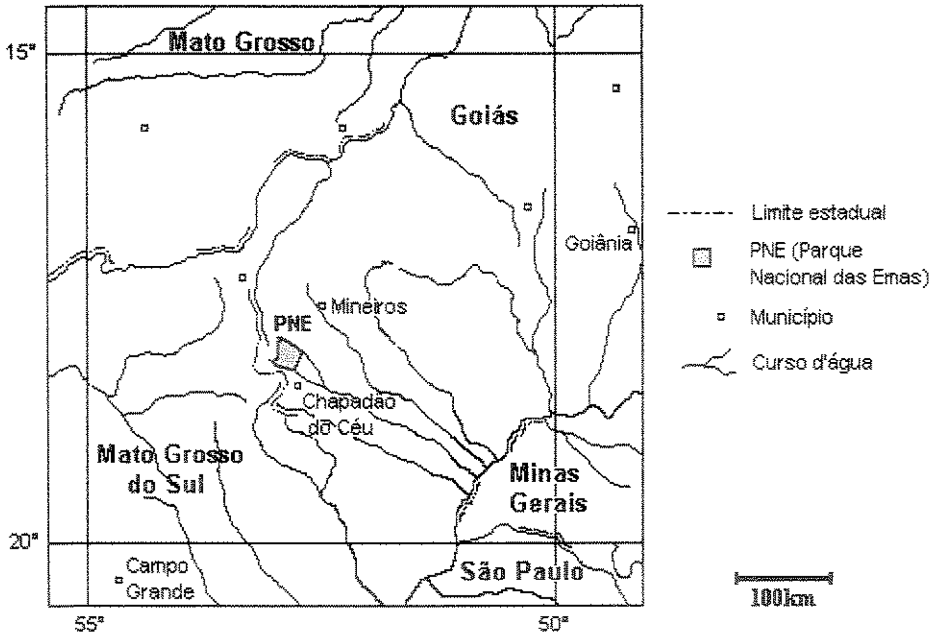

Figura 1. Localização do Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás (modificado de IBDF 1981).

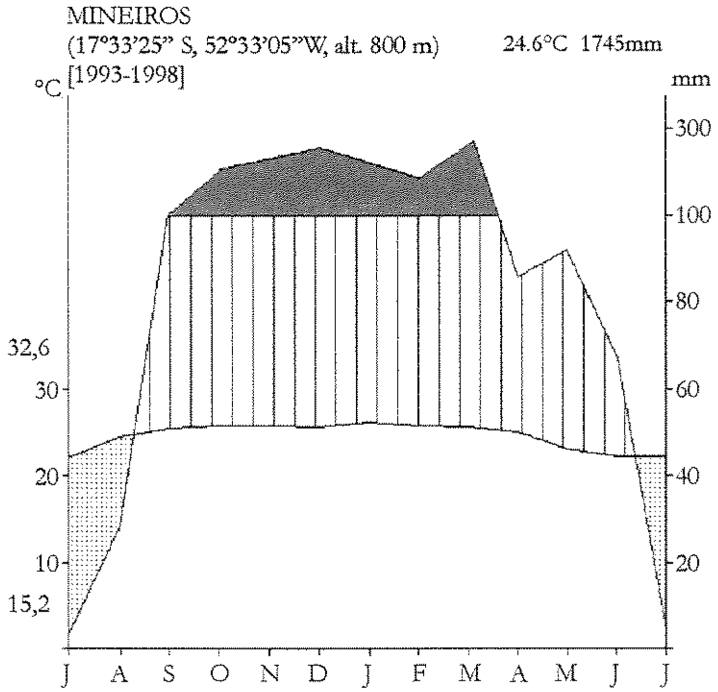

Figura 2. Diagrama climático (segundo Walter 1986) construído com dados obtidos no Mosteiro dos Monges Beneditinos, em Mineiros, Goiás. As temperaturas mínima e máxima absolutas estão ausentes, pois não estavam disponíveis nos dados originais.

Vegetação

Ramos-Neto (2000) realizou um mapeamento preliminar das formações vegetais no parque, distinguindo, a partir de imagens de satélite Landsat, áreas de cerrado, floresta e campo úmido (Figura 3).

O cerrado no PNE apresenta quase todas as suas variações fisionômicas, do campo limpo ao cerrado *sensu stricto*. Segundo o mapeamento de Ramos-Neto (2000), predominam na reserva as fisionomias abertas de cerrado – campos limpos, campos sujos e campos cerrados – que ocupam 78,5% da área (104.359 ha), especialmente nas áreas planas de topo de chapada (Figura 4). Nessas fisionomias mais abertas, há grandes extensões em que predomina uma espécie de gramínea, o capim-flecha (*Tristachya leiostachya*) (Ramos-Neto 2000). O cerrado *sensu stricto* ocupa 13,8% da área (18.408 ha), sendo encontrado principalmente nas encostas da bacia do rio Jacuba (Figura 5). Além do cerrado, outras formações vegetais estão presentes na reserva: as áreas de campos úmidos, campos de murundus e buritizais representam 4,8% da reserva (6.377 ha) e estão associadas às várzeas dos cursos d'água (Figura 6); as áreas de florestas estacionais semidecíduas e ripícolas ocupam 2,9% (3.853 ha) e estão associadas, respectivamente, a solos mais férteis e a cursos d'água.

Os limites entre o cerrado *sensu lato* e os demais tipos vegetacionais normalmente são abruptos, quer com as áreas de várzeas (Figura 5), quer com as manchas de floresta estacional. Cada uma das fisionomias de cerrado amostradas no PNE foi caracterizada por fotografias (Figura 7) e perfis diagramáticos de 15 x 1 m (Figura 8).

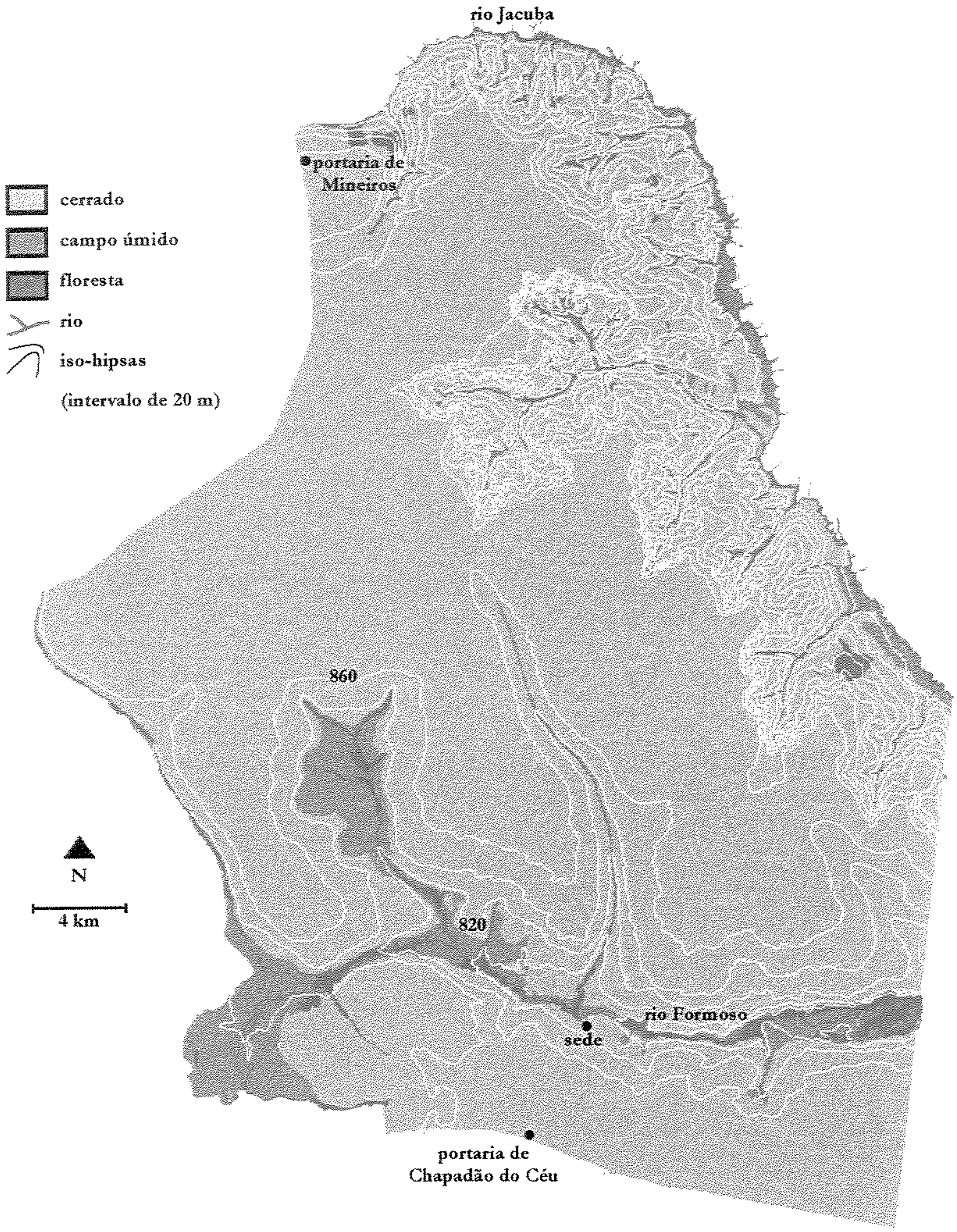

Figura 3. Relevo, hidrografia e formações vegetais no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás (modificado de Ramos-Neto 2000).

Figura 4. Topo de chapada no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás, mostrando o predomínio de fisionomias abertas de cerrado (novembro de 1998).

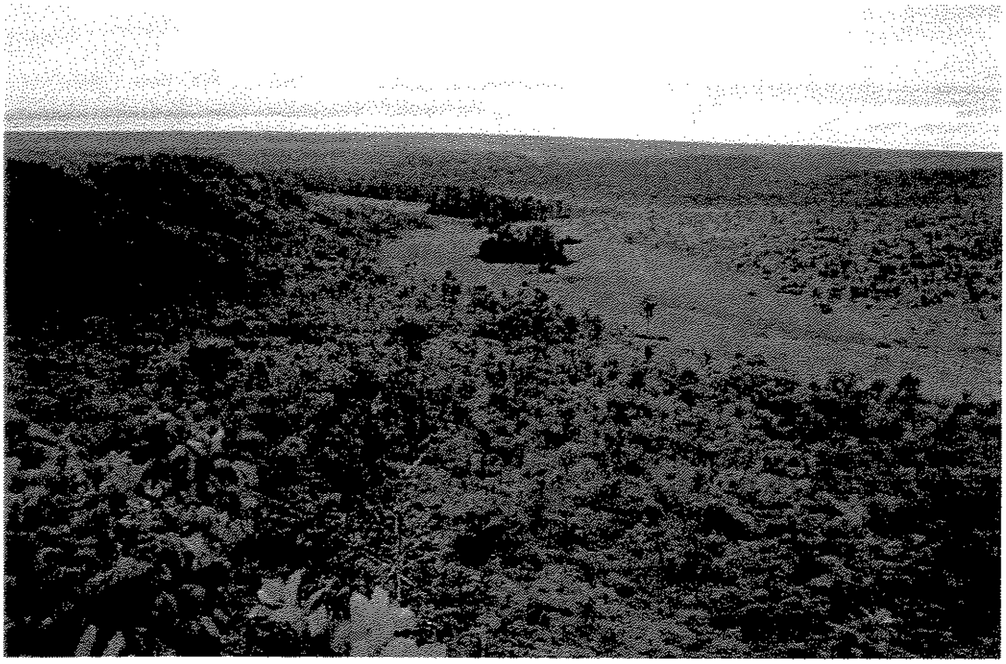

Figura 5. Encosta da bacia do rio Jacuba no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás, mostrando o predomínio de cerrado *sensu stricto* e o limite abrupto entre este e o campo úmido (novembro de 1998).

Figura 6. Campo úmido e vereda de buritis no córrego Buriti Torto, Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás (maio de 1999).

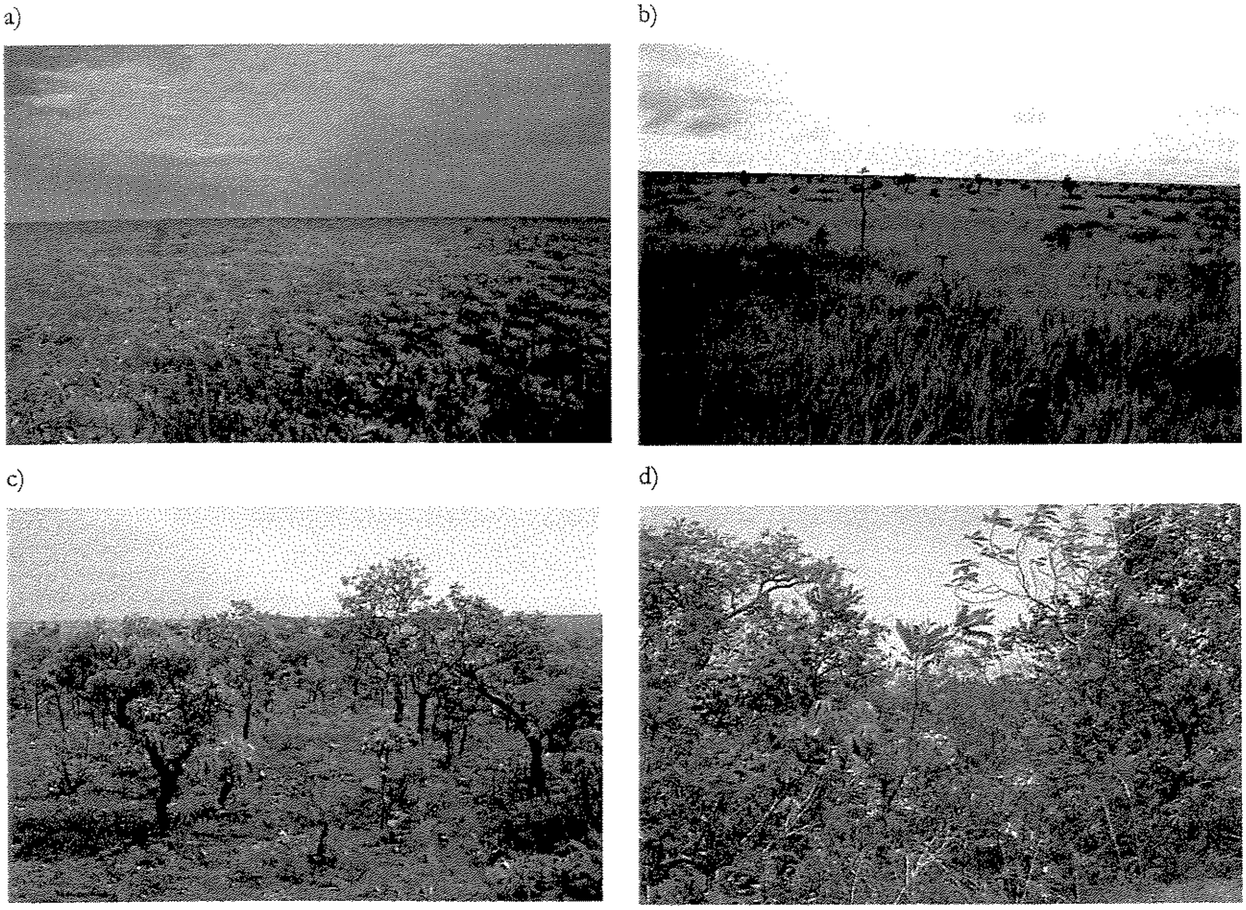

Figura 7. Fisionomias de cerrado no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás. a) campo limpo (outubro de 1999), b) campo sujo (novembro de 1998), c) campo cerrado (outubro de 1999), d) cerrado *sensu stricto* (outubro de 1999).

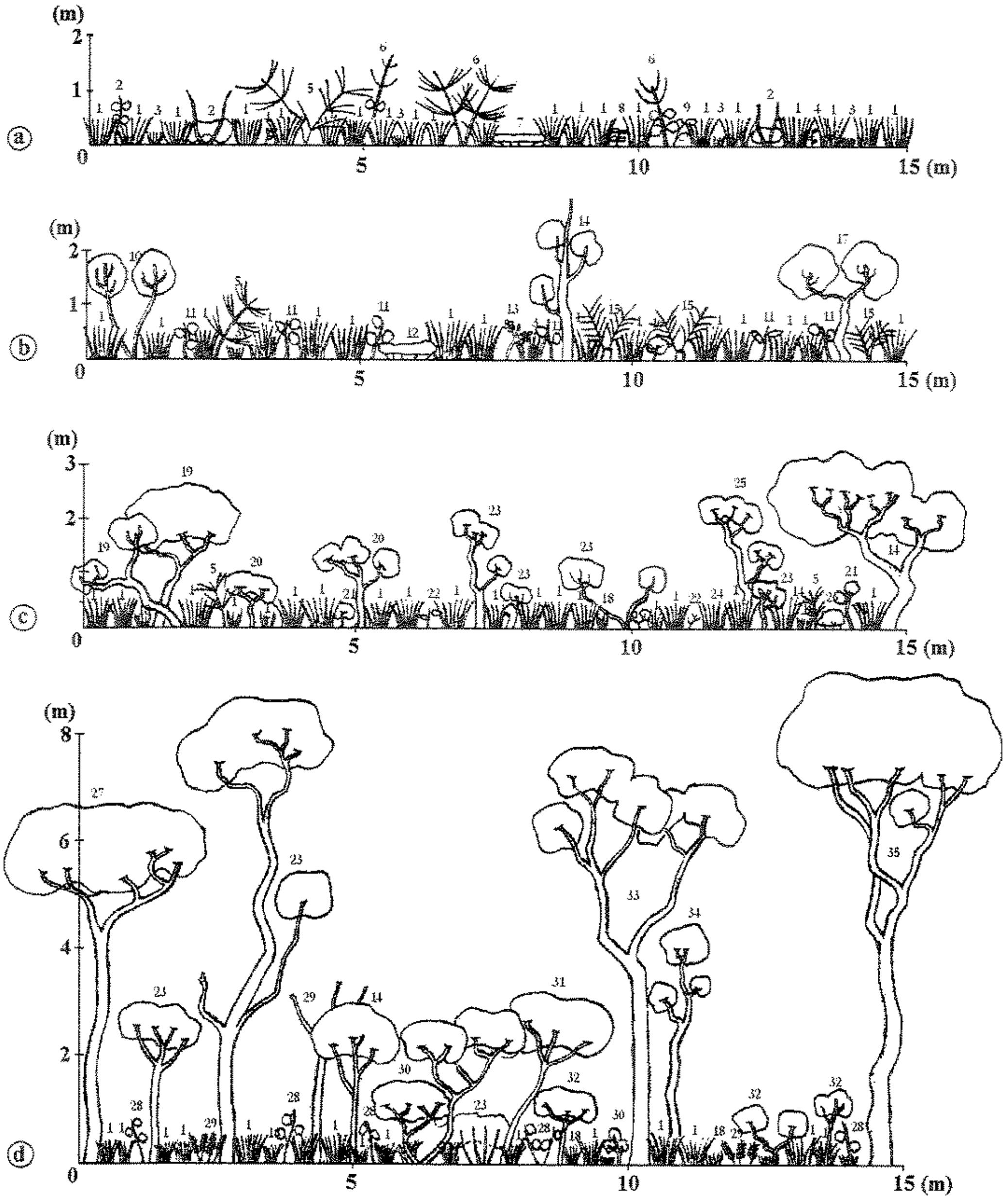

Figura 8. Perfis diagramáticos em quatro fisionomias de cerrado no Parque Nacional das Emas, Goiás. Legenda: a) campo limpo (18°06'34,1"S, 52°55'11,2"W), b) campo sujo (18°13'08,6"S, 52°45'15,9"W), c) campo cerrado (18°04'59,3"S, 52°52'06,9"W), d) cerrado *sensu stricto* (18°11'11,2"S, 52°44'35,9"W). 1 = *Tristachya leiostachya*, 2 = *Mimosa radula*, 3 = *Andropogon leucostachys*, 4 = *Erythroxylum suberosum*, 5 = *Allagoptera leucocalyx*, 6 = *Gomphrena virgata*, 7 = *Parinari excelsa*, 8 = *Hyptis villosa*, 9 = *Kielmeyra variabilis*, 10 = *Pouteria ramiflora*, 11 = *Coccoloba densifrions*, 12 = *Talisia angustifolia*, 13 = *Acosmium subelegans*, 14 = *Stryphnodendron adstringens*, 15 = *Attalea geraensis*, 16 = *Chamaecrista cathartica*, 17 = *Psidium laruotteanum*, 18 = *Axonopus barbigerus*, 19 = *Vochysia thyrsoidea*, 20 = *Ouratea spectabilis*, 21 = *Connarus suberosus*, 22 = *Protium heptaphyllum*, 23 = *Pouteria torta*, 24 = *Aristida riparia*, 25 = *Hymenaea stigonocarpa*, 26 = *Campomanesia pubescens*, 27 = *Qualea parviflora*, 28 = *Bauhinia rufa*, 29 = *Didymopanax vinosum*, 30 = *Diospyros hispida*, 31 = *Anadenanthera falcata*, 32 = *Byrsonima basiloba*, 33 = *Tabebuia aurea*, 34 = *Kielmeyera coriacea*, 35 = *Qualea grandiflora*.

Fauna

A fauna do PNE, notadamente as aves e os mamíferos de maior porte, constitui o aspecto mais relevante do parque do ponto de vista turístico (IBDF 1981). Fonseca *et al.* (2000) consideraram o PNE talvez o melhor local para se observar animais de grande porte na América do Sul. Alguns estudos foram realizados envolvendo essa fauna: Redford (1983) elaborou uma lista preliminar dos mamíferos ocorrentes no PNE; Rodrigues & Monteiro (1996) estudaram a relação comensal entre o veado-campeiro (*Ozotocerus bezoarticus*) e a ema (*Rhea americana*); Silveira *et al.* (1997) observaram a associação em caçadas entre o falcão-aplumado (*Falco femoralis*) e o lobo-guará (*Chrysocyon brachyurus*); Jácomo & Silveira (1998) relataram a captura de uma raposa (*Cerdocyon thous*) por uma sucuri (*Eunectes murinus*); Silveira *et al.* (1998) registraram a ocorrência do cachorro-vinagre (*Speothos venaticus*) na reserva; Rodrigues *et al.* (1999) relataram a ocorrência de albinismo parcial de um indivíduo de veado-campeiro (*O. bezoarticus*), comparando-o com indivíduos normais; e Rodrigues & Monteiro (2000) estudaram os padrões de atividade do veado-campeiro (*O. bezoarticus*) e encontraram atividade mais intensa nos meses úmidos.

Quanto aos animais invertebrados, há alguns estudos estão relacionados ao fenômeno de bioluminescência de certas larvas de coleópteros do gênero *Pyrearinus* (Phengodidae). Viviani & Bechara (1997), por exemplo, analisaram a bioluminescência e o ciclo de vida de 17 espécies de besouros dessa família no parque e em seu entorno.

Fogo

O fogo no PNE é um dos principais fatores de impacto: a cada três anos aproximadamente, queimadas incontroláveis (Figura 9) chegam a afetar mais de 70% de sua área (Ramos-Neto &

Pinheiro-Machado 1996), eventualmente atingindo até as copas das árvores (Figura 10). Dada a importância do fogo, boa parte dos estudos desenvolvidos no parque aborda a dinâmica das queimadas ou a sua influência sobre a fauna de maior porte. Shimabukuro *et al.* (1991) analisaram o uso de imagens de satélite como ferramenta para calcular e monitorar as áreas afetadas pelo fogo no PNE. Ramos-Neto & Pinheiro-Machado (1996) estudaram a relação do aumento da biomassa do capim-flecha (*Tristachya leiostachya*) com a ocorrência de incêndios de grandes dimensões. Ramos-Neto (1997) registrou, no Parque Nacional das Emas, pela primeira vez *in loco*, queimadas naturais no cerrado. Silveira *et al.* (1999) avaliaram o impacto de duas queimadas em 1994 e 1995 na fauna de mamíferos de grande porte e recomendaram um programa de manejo do fogo que envolveria queimadas controladas em diferentes porções do Parque. Ramos-Neto (2000) estudou vários aspectos do regime de queima no PNE, incluindo a recuperação da fitomassa epigéia e o balanço de nutrientes após o fogo, considerando suas implicações para a conservação da reserva. Ramos-Neto & Pivello (2000) registraram a ocorrência de queimadas no PNE, tanto as provocadas por raios quanto as provocadas por ação humana, e concluíram que estas são mais comuns na estação seca e queimam áreas maiores e aquelas, mais comuns no início e no final da estação chuvosa e queimam áreas menores. Por essa razão, eles recomendam a reavaliação das políticas de manejo atuais do parque.

Figura 9. Queimada em área de cerrado no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás (maio de 1999).

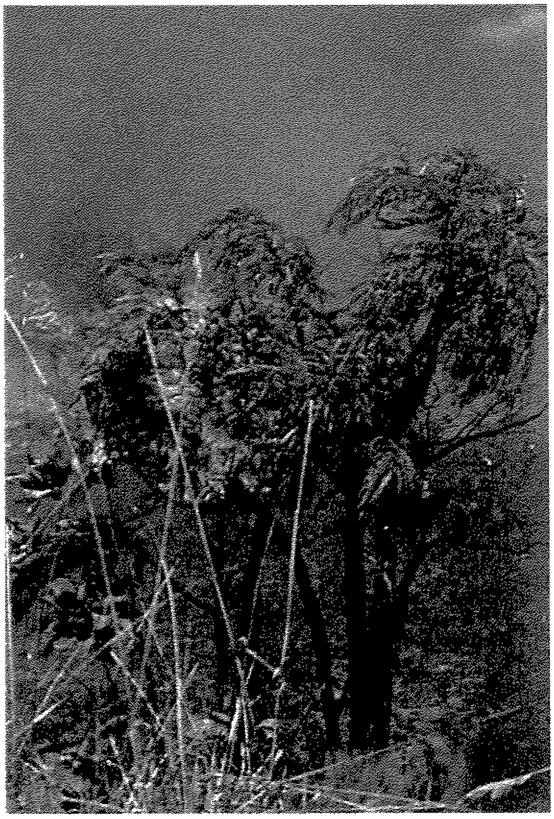

Figura 10. Queimada em área de cerrado no Parque Nacional das Emas (17°49'-18°28'S, 52°39'-53°10'W), Goiás, atingindo a copa de um indivíduo de *Anadenanthera falcata* (maio de 1999).

Referências bibliográficas

CONSERVATION INTERNATIONAL. 1999. *Ações prioritárias para a conservação do Cerrado e do Pantanal.* Brasília, Conservation International.

FONSECA, G. A. B. DA; MITTERMEIER, R. A.; CAVALCANTI, R. B. & MITTERMEIER, C. G. 2000. Brazilian Cerrado. *In* MITTERMEIER, R. A.; MYERS, N.; GIL, P. R. & MITTERMEIER, C. G. (eds). *Hotspots, Earth's biologically richest and most endangered terrestrial ecoregions.* Chicago, Conservation International. p. 148-159.

IBAMA. INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS. 1989. *Unidades de Conservação do Brasil.* Brasília, Ministério do Interior. v1.

IBDF. INSTITUTO BRASILEIRO DE DESENVOLVIMENTO FLORESTAL. 1981. *Plano de manejo - Parque Nacional das Emas.* Brasília, IBDF.

JÁCOMO, A. T. A. & SILVEIRA, L. 1998. Serpentes: *Eunectes murinus* (Green Anaconda). Diet. *Herpetological Review 29*: 241-241.

KÖPPEN, W. 1948. *Climatología.* México, Fondo de Cultura Económica.

RAMOS-NETO, M. B. 1997. Natural occurence of fire in Emas National Park, central Brazil. *Proceedings Australian Bushfire.* Darwin, CSIRO Tropical Ecosystem Research Centre.

RAMOS-NETO, M. B. 2000. *O Parque Nacional das Emas (GO) e o fogo: implicações para a conservação biológica.* Tese de Doutorado. Universidade de São Paulo.

RAMOS-NETO, M. B. & PINHEIRO-MACHADO, C. 1996. O capim-flecha (*Tristachya leiostachya* Nees) e sua importância na dinâmica do fogo no Parque Nacional das Emas. *In* MIRANDA, H. S.; SAITO, C. H. & DIAS, B. F. S. (orgs). *Impactos de queimadas em áreas de cerrado e restinga.* Brasília, Universidade de Brasília. p. 68-75.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park:

rethinking management strategies. *Environmental Management 26*: 675-684.

REDFORD, K. H. 1983. Lista preliminar de mamíferos do Parque Nacional das Emas. *Brasil Florestal 55*: 29-33.

RODRIGUES, F. H. G. & MONTEIRO, E. L. A. 1996. Comensalistic relation between pampas deer, *Ozotocerus bezoarticus* (Mammalia: Cervidae) and rheas, *Rhea americana* (Aves: Rheidae). *Brenesia 45*: 187-188.

RODRIGUES, F. H. G. & MONTEIRO, E. L. A. 2000. Home range and activity patterns of pampas deer in Emas National Park, Brazil. *Journal of Mammalogy 81*: 1136-1142.

RODRIGUES, F. H. G.; SILVEIRA, L.; JÁCOMO, A. T. A. & MONTEIRO-FILHO, E. L. A. 1999. Partial albinism in the pampas deer and a critical analysis about albino mammals. *Revista Brasileira de Zoologia 16*: 1229-1232.

SHIMABUKURO, Y. E.; SANTOS, J. R. DOS; LEE, D. C. L. & PEREIRA, M. D. 1991. Sensoriamento remoto para monitorar e estimar áreas queimadas – o caso do Parque Nacional das Emas. *Pesquisa Agropecuária Brasileira 26*: 1589-1598.

SILVEIRA, L.; JÁCOMO, A. T. A.; RODRIGUES, F. H. G. & DINIZ-FILHO, J. A. F. 1998. Bush dogs (*Speothos venaticus*) in Emas National Park, Central Brazil. *Mammalia 62*: 446-449.

SILVEIRA, L.; JÁCOMO, A. T. A.; RODRIGUES, F. H. G. & CRAWSHAW, P. G. 1997. Hunting association between the Aplomado Falco (*Falco femoralis*) and the Maned Wolf (*Chrysocyon brachyurus*) in Emas National Park, central Brazil. *Condor 99*: 201-202.

SILVEIRA, L.; RODRIGUES, F. H. G.; JÁCOMO, A. T. A. & DINIZ-FILHO, J. A. F. 1999. Impact of wildfires on the megafauna of Emas National Park, central Brazil. *Oryx 33*: 108-114.

VIVIANI, V. R. & BECHARA, E. J. H. 1997. Bioluminescence and biological aspects of Brazilian railroad-worms (Coleoptera: Phengodidae). *Annals of the Entomological Society of America 90*: 389-398.

WALTER, H. 1986. *Vegetação e zonas climáticas*. São Paulo, EPU.

2. The cerrado flora in Emas National Park (central Brazil)

Abstract – From November 1998 to October 1999, we carried out a floristic survey in the cerrado physiognomies in Emas National Park (central Brazil), one of the most important cerrado reserves, with about 132,000 ha. We found 601 species, belonging to 303 genera and 80 families. Among the collected species, 12 were weeds and seven, new to science. The herbaceous to woody species ratio was 3.03:1. The richest families were Asteraceae, Fabaceae, Poaceae, Myrtaceae, and Lamiaceae, which comprised 48% of the total number of species. The results obtained showed the importance of Emas National Park to the cerrado conservation, since from 8 to 20% of the species related for this vegetation type occur in the reserve. We emphasize the need of more floristic surveys in which the frequently neglected herbaceous component is also sampled.

Resumo – De novembro de 1998 a outubro de 1999, realizamos um levantamento florístico nas fisionomias de cerrado no Parque Nacional das Emas (Goiás, Brasil), uma das mais importantes reservas de cerrado, com cerca de 132.000 ha. Encontramos 601 espécies, pertencentes a 303 gêneros e 80 famílias. Entre as espécies coletadas, 12 foram invasoras e sete, novas para ciência. A proporção entre espécies herbáceo-subarbustivas e arbustivo-arbóreas foi de 3,03:1. As famílias mais ricas em espécies foram Asteraceae, Fabaceae, Poaceae, Myrtaceae e Lamiaceae, que compreenderam 48% do total de espécies. Os resultados encontrados mostraram a importância do Parque Nacional das Emas para a conservação do cerrado, pois de 8 a 20% das espécies relacionadas para essa formação vegetal ocorrem na reserva. Ressaltamos a necessidade de levantamentos florísticos que amostrem também o componente herbáceo-subarbustivo, freqüentemente negligenciado.

Key words – cerrado; savanna; floristics; flora; central Brazil; Emas National Park.

Introduction

Formerly, about 23% of the Brazilian territory was covered by the Cerrado Domain, especially in central Brazil (Ratter *et al.* 1997). As its name implies, in the Cerrado Domain, the cerrado vegetation prevails. Even if frequently neglected, the cerrado vegetation stands out by its high floristic richness (Ratter *et al.* 1997). Castro *et al.* (1999) compiled several floristic and phytosociological surveys carried out in cerrado sites from all over Brazil and estimated that 3,000 to 7,000 vascular plant species occur in this vegetation type. In addition to its floristic richness, the cerrado presents a high degree of endemism. Lenthall *et al.* (1999), for instance, listed 234 woody species occurring in 10 cerrado sites and verified that 80% of them were restricted to this vegetation type. Due to the high richness, high degree of endemism, and present conservation status, Fonseca *et al.* (2000) included the cerrado among the hotspots for conservation in the world.

According to Rizzini (1963), the cerrado flora has two components, the herbaceous and the woody ones, which are antagonistic because both are heliophilous. Following Coutinho's (1990) concept of cerrado, the importance of the herbaceous component decreases from open to closed physiognomies, while the importance of the woody component increases. Mantovani & Martins (1993) compared some cerrado sites and found a ratio between the herbaceous and the woody components ranging from 2:1 to 3:1.

Castro *et al.* (1999) emphasized the almost complete absence of studies that had sampled the herbaceous component, even though it is richer than the woody component. He also highlighted the uneven distribution of surveys, which are concentrated in few well studied areas (Castro *et al.* 1999). In Goiás State, there are surveys – published at least – only in Goiânia, Goiás, Mossâmedes, Padre Bernardo, Serra Dourada, and Silvânia (see Ratter *et al.* 1996 and Castro *et al.* 1999 for references).

Castro (1994) analysed the floristic composition of the woody component of 78 cerrado sites and found a strong geographic pattern in the distribution of its flora. They recognized two main groups, separated by a line that goes from northeastern to southwestern Brazil. The northwestern group is characterized by the presence of *Curatella americana* L. (Dilleniaceae) and the southeastern group, by the presence of *Piptocarpha rotundifolia* (Less.) Baker (Asteraceae).

The Emas National Park (ENP) is the largest cerrado reserve and the most important among those that represent this vegetation type (Conservation International 1999). The need of knowing the ENP flora had already been mentioned on its management plan (IBDF 1981). Although some papers about wildfires and its fauna exist (*e.g.*, Ramos-Neto & Pivello 2000, Rodrigues & Monteiro 2000), the vegetation of ENP remains poorly studied. An intense and systematic floristic survey, as carried out by us, will contribute to the knowledge of the ENP flora in particular and of the cerrado flora in general, especially of the poorly known herbaceous component. Furthermore, with this survey, we intend to provide subsidies for other studies carried out in the reserve and for phytogeographical studies about the cerrado flora.

To reach these aims, we will try to answer the following questions: What is the floristic composition of the cerrado physiognomies in ENP? Which families are the richest ones in its flora? Does the herbaceous to woody species ratio lie between those found by Mantovani & Martins (1993), that is, between 2:1 and 3:1? Are there woody species that should be included in the checklist elaborated by Castro *et al.* (1999)?

Material and Methods

The ENP is located in the Brazilian Central Plateau, southwestern Goiás State (17°49'-18°28'S, 52°39'-53°10'W), in the cerrado core region. The park was created on 1961, by Federal Decree 49.874, with 132,941 ha. Regional climate is tropical and humid, with wet summer and dry winter, which is classified as Aw following Köppen's (1948) system. Annual rainfall varies from 1,200 to 2,000 mm, concentrated from October to March, and mean annual temperature lies around 24,6°C (Ramos-Neto & Pivello 2000). Three quarters of ENP consist of flat tableland, 820-888 m high, and the remaining area consists of hilly terrain, 720-820 m high (Ramos-Neto & Pivello 2000).

The cerrado in ENP presents almost all physiognomies found in this vegetation type, from *campo limpo* (a grassland) to *cerrado sensu stricto* (a woodland). In the reserve, open cerrado physiognomies – *campo limpo*, *campo sujo* (a shrub savanna), and *campo cerrado* (a savanna woodland) – prevail, covering 68.1% of the total area, especially on the flat tableland (Ramos-Neto & Pivello 2000). The more closed *cerrado sensu stricto* covers 25.1% of the reserve, mainly on the hilly terrain. Other vegetation types also exists in the reserve: wet fields (4.9% of the total area) and riparian and seasonal semideciduous forests (1.2%).

In all cerrado physiognomies occurring in the reserve, we carried out a floristic survey from November 1998 to October 1999, in monthly field trips. On each one of them, the sampling effort varied from 50 to 60 hours. We established routes through the firebreaks that cross the reserve (Figure 1) and, on each day, we covered one of these routes. The routes comprised the following reference points (with approximate distances): i) U_2, U_1, Q, R, S, T, U_2 (51.5 km); ii) U_2, V, P_1, O, U_1 (52.5 km); iii) O, M, N, P_1 (45 km); iv) V, P_2, W, Y, V (47.5 km); v) X, Z_1, Z_2, Z_3, Z_2, Z_1, Y, W, X (47.5 km); vi) A, B, J, G, D, C, K_2, K_1, A (48 km).

We collected fertile botanical material along the pre-established routes. On the last two field trips, we collected also sterile material from the species previously not found at reproductive stage. We recorded information such as height; petals, sepals, and bracts colors; presence of latex; presence of characteristic odor; and growth habit. These informations were included in the voucher labels.

The collected material was identified on species level by comparing it to lodged vouchers and consulting taxonomic references. The specimens were then sent to taxonomists for confirmation. The voucher material was lodged mainly at the São Paulo State Botanical Institute herbarium (SP), but also at the following herbaria: CESJ, FLOR, HRCB, HUEFS, IAC, SP, SPF, UB, and UEC.

The species were classified in families according to the system proposed by Judd *et al.* (1999). It is important to highlight that in their system of classification some families, treated in a strict sense by other authors (*e.g.*, Cronquist 1988), were treated in a broad sense. For example, Apocynaceae, in Judd's *et al.* (1999) system, includes Asclepiadaceae (*sensu* Cronquist 1988); Fabaceae includes Mimosaceae and Caesalpiniaceae; and Malvaceae includes Bombaceae and Sterculiaceae.

We also classified the species in life-forms following Raunkiaer's (1934) system adapted by Mueller-Dombois & Ellenberg (1974). We considered the chamaephytes, epiphytes, hemicryptophytes, geophytes, lianas, vascular parasites, and therophytes as belonging to the herbaceous component and the phanerophytes as belonging to the woody component. We applied the chi-square test (Zar 1999) to verify if the herbaceous to woody species ratio was significantly different from the expected by Mantovani & Martins (1993). The results found were compared to the patterns obtained by Castro *et al.* (1999).

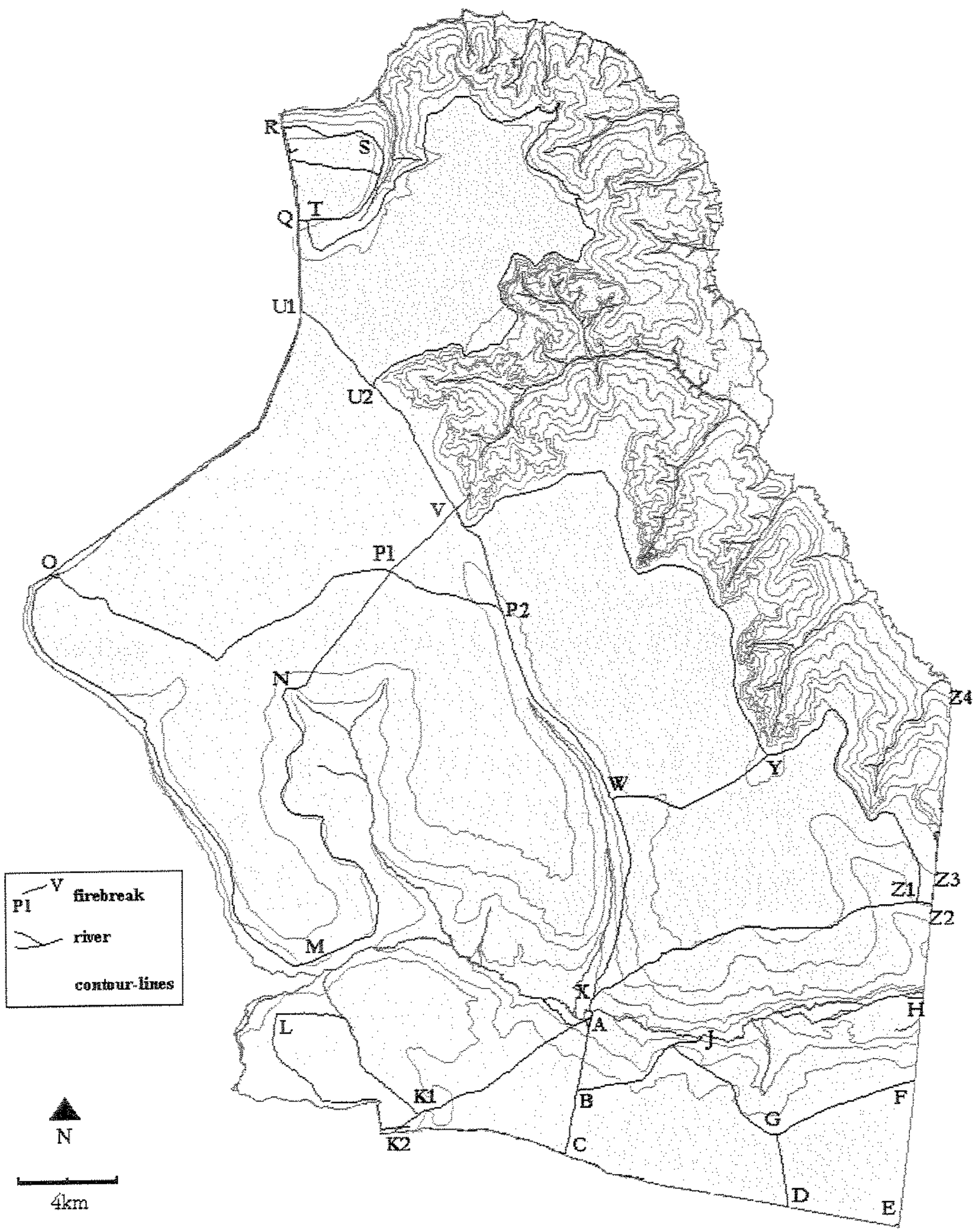

Figure 1. Firebreaks, with reference points, in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil (after Ramos-Neto 2000, modified).

Results

In the floristic survey, we collected 2,123 voucher specimens, representing 601 species, 303 genera, and 80 families (Table 1). Of the 601 species, 571 were identified on species level, including one new to science, *Piriqueta emasensis* Arbo (Turneraceae). Six out of the remaining 30 species were also new to science and are currently being described by taxonomists: *Annona* sp. nov. (Annonaceae), *Gyrostelma* sp. nov. (Apocynaceae), *Dimmerostema* sp. nov. (Asteraceae), *Ipomoea* sp. nov. (Convolvulaceae), *Hybanthus* sp. nov. (Violaceae), and another Convolvulaceae that belongs to a new genus. There were 22 species identified on genus level, one identified on family level, and one that we could not identify even on family level.

Twelve species (2.00% of the total number of species) were considered by Mendonça *et al.* (1998) as weeds that do not occur spontaneously in cerrado. In the *campo limpo*, we found 131 species; in the *campo sujo*, 439; in the *campo cerrado*; 419, and, in the *cerrado sensu stricto*, 217. Of the 601 species, 149 were phanerophytes and included in the woody component, while 452 presented other life-forms and were included in the herbaceous component. The herbaceous to woody species ratio was 3.03:1, a value not significantly different (χ^2 = 0.014, P = 0.906) from the highest ratio (3:1) found by Mantovani & Martins (1993).

The richest families were, on decreasing order, Asteraceae, Fabaceae, Poaceae, Myrtaceae, Lamiaceae, Malpighiaceae, Euphorbiaceae, Apocynaceae, Malvaceae, Rubiaceae, and Convolvulaceae, which represented 66.22% of the total number of species (Figure 2). In the herbaceous component, the richest families were Asteraceae, Fabaceae, Poaceae, Lamiaceae, Euphorbiaceae, Malpighiaceae, Myrtaceae, Convolvulaceae, and Apocynaceae, which comprised 65.27% of the herbaceous species (Figure 3). In the woody component, the richest families were Fabaceae, Myrtaceae, Malpighiaceae, Melastomataceae, Annonaceae, Apocynaceae, Vochysiaceae, Bignoniaceae, Nyctaginaceae, and Rubiaceae, which together accounted for 62.42% of the woody species (Figure 4).

Seventeen out of 149 woody species (11.41%) were not included by Castro *et al.* (1999) in their checklist for the cerrado woody flora: *Annona* sp. nov., *Aiouea trinervis* Meisn., *Apoclada arenicola* McClure, *Banisteriopsis acerosa* (Nied.) B. Gates, *Calliandra macrocalyx* Harms, *Dalbergia cuiabensis* Benth., *Mimosa amnis-atri* Barneby, *M. gemmulata* Barneby, *M. hebecarpa* Benth., *Myrcia bracteata* O. Berg, *M. camapuanensis* N.F.E. Silveira, *M. crassifolia* (O. Berg) Kiaersk., *M. fallax* (Rich.) A. DC., *M. linguaeformis* Kiaersk., *M. rhodeosepala* Kiaersk., *Olyra taquara* Sw., and *Psidium laruotteanum* Cambess.

Table 1 – Species collected in the floristic survey of the cerrado in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ch = chamaephyte, Ep = epiphyte, Geo = geophyte, H = hemicryptophyte, Li = Liana, Ph = phanerophyte, Th = therophyte, Vp = vascular parasite; physiognomy: 1 = *campo limpo* (grassland), 2 = *campo sujo* (shrub savanna), 3 = *campo cerrado* (savanna woodland), 4 = *cerrado sensu stricto* (woodland); # = M.A. Batalha's collector number. The asterisk indicates those species related by Mendonça *et al.* (1998) as weeds that do not occur spontaneously in the cerrado.

Family/species	**lf**	**physiognomy**				**#**
Acanthaceae						
Hygrophila brasiliensis (Spreng.) Lindau	H	1	2	3		2306
Ruellia geminiflora Kunth	H		2	3	4	2169
Ruellia incompta (Nees) Lindau	Ch			3	4	3592
Alstroemeriaceae						
Alstroemeria gardneri Bak.	H				4	2715
Amaranthaceae						
Froelichia procera (Seub.) Pedersen	H		2	3	4	2123
Gomphrena arborescens L. f.	H		2			2395
Gomphrena macrocephala A. St-Hil.	H	1	2	3		2214
Gomphrena pohlii Moq.	H	1	2	3		2091
Pfaffia helychrysoides (Moq.) Kuntze	H	1	2	3		2152
Pfaffia jubata Mart.	H	1	2	3	4	2283
Anacardiaceae						
Anacardium humile A. St-Hil.	Ch	1	2	3		2050
Tapirira guianensis Aubl.	Ph				4	3804
Annonaceae						

Family/species	lf	physiognomy				#
Annona coriacea Mart.	Ph			3	4	2695
Annona crassiflora Mart.	Ph		2	3		2403
Annona monticola Mart.	H		2			3620
Annona tomentosa R.E. Fries	Ch		2	3		2347
Annona warmingiana Mello-Silva & Pirani	H	1	2	3		3763
Annona sp. nov.	Ph		2	3		2621
Bocageopsis mattogrossensis (R.E. Fries) R.E. Fries	Ph				4	3506
Duguetia furfuracea (A. St-Hil.) Benth. & Hook. f.	Ph	1	2	3		2180
Duguetia glabriuscula (R.E. Fries) R.E. Fries	Ch	1	2	3		1955
Xylopia aromatica (Lam.) Mart.	Ph		2	3	4	2515
Apiaceae						
Didymopanax macrocarpum Seem.	Ph	1	2	3		2107
Didymopanax vinosum March.	Ph	1	2	3		2733
Eryngium ciliatum Cham. & Schltdl.	H	1	2	3		3890
Eryngium junceum Cham. & Schltdl.	H	1	2	3		2566
Apocynaceae						
Asclepias mellodora A. St-Hil.	H	1				2967
Aspidosperma macrocarpon Mart.	Ph			3	4	2232
Aspidosperma nobile Müll. Arg.	Ph			3	4	3661
Aspidosperma tomentosum Mart.	Ph			3	4	4028
Barjonia cymosa Fourn.	H			3	4	2897
Barjonia erecta (Vell.) K. Schum.	H		2			2182
Blepharodon bicuspidatum Fourn.	Li			3	4	2451
Gyrostelma sp. nov.	H		2			2081
Hancornia speciosa Gomez	Ph		2	3	4	2106
Hemipogon acerosus Decne.	H		2	3		2083
Himatanthus obovatus (Müll. Arg.) Woods.	Ph		2	3		2380
Macrosiphonia longiflora Müll. Arg.	H		2	3		2218
Macrosiphonia velame (A. St-Hil.) K. Schum.	H		2			2610
Mandevilla coccinea (Hook & Arn.) Woods.	H		2			2577
Mandevilla pohliana (Standelm.) A. Gentry	H		2	3		2099
Odontadenia lutea (Vell.) Markgr.	Li			3	4	2645
Oxypetalum aequaliflorum Fourn.	H		2			2241
Rauwolfia weddelliana Müll. Arg.	H	1	2	3		1962
Rhodocalyx rotundifolius Müll. Arg.	H			3		2281
Araceae						
Scaphispatha gracilis Brongn. ex Schott	H			3		2075
Arecaceae						
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	Ph		2			2498
Acrocomia hassleri (Barb. Rodr.) Hahn	Geo	1	2	3		3828
Allagoptera campestris (Mart.) Kuntze	Geo	1	2	3		2006
Allagoptera leucocalyx (Mart.) Kuntze	Geo	1	2	3		2215
Attalea geraensis Barb. Rodr.	Geo		2			2509
Syagrus flexuosa (Mart.) Becc.	Geo		2	3	4	2249

Family/species	lf	physiognomy				#
Aristolochiaceae						
Aristolochia gibertii Hook.	Li		2			2852
Aristolochia gracilis Duch.	Li				4	4029
Asteraceae						
Acanthospermum australe (Loefl.) Kuntze	Th	1	2			2527
Achyrocline satureoides (Lam.) A. DC.	Th		2			3400
Apopyros warmingii (Baker) Nesom	H		2			2176
Aspilia foliacea (Spreng.) Baker	H	1	2	3		3377
Aspilia laevissima Baker	H		2			2704
Aspilia leucoglossa Malme	H		2	3	4	2122
Aspilia platyphylla (Baker) Blake	H		2			2848
Ayapana amygdalina (Lam.) King & H. Rob.	H		2	3	4	3458
Baccharis camporum A. DC.	Ch		2	3		3313
Baccharis humilis Sch. Bip.	H	1	2	3		2172
Bidens gardneri Gardner	Th				4	3031
Calea clausseniana Baker	H			3		3771
Calea cuneifolia A. DC.	H		2	3		4011
Calea hymenolepis Baker	H		2			2886
Calea platylepis Sch. Bip. ex Baker	H		2			3204
Campuloclinium chlorolepis Baker	H			3		3120
Campuloclinium megacephalum (Mart.) King & H. Rob.	H	1	2	3		2605
Chaptalia integerrima (Vell.) Burk	Th		2	3		2089
Chromolaena chaeseae H. Rob.	Ch		2	3		3314
Chromolaena leucocephala Gardner	Ch		2	3		3409
Chromolaena squalida (A. DC.) King & H. Rob.	Ch		2	3		2328
Chromolaena stachyophylla (Spr.) King & H. Rob.	H		2			3416
Conyza bonariensis (L.) Cronq.	Th		2			2497
Dasyphyllum sprengelianum (Gardner) Cabrera	Ch			3	4	3042
Dimmerostema asperatum Blake	H	1	2	3	4	2592
Dimmerostema brasilianum Cass.	H	1	2	3		3161
Dimmerostema retifolium (Sch. Bip.)Blake	H		2	3		2246
Dimmerostema sp. nov.	H		2			2010
Elephantopus biflorus Less.	H			3		3159
Elephantopus mollis L.	H		2	3	4	3128
Elephantopus racemosus Gardner	H		2			3412
Emilia coccinea (Sims.) Sweet *	Th	1	2			2364
Erechtites hieracifolia (L.) Raf. *	Th	1	2			2368
Eremanthus erythropappus Sch. Bip.	Ph		2	3		2213
Eremanthus glomerulatus Less.	Ph			3	4	3333
Eremanthus sphaerocephalus Baker	H		2	3		2273
Eupatorium betonicaeforme Baker	H		2			3402
Eupatorium campestre A. DC.	H	1	2	3		1996
Eupatorium lanigerum Hook & Arn.	H			3	4	3946
Eupatorium myriocephalum Gardner	Ch		2			3406
Eupatorium purpurascens Sch. Bip.	H		2			3093
Eupatorium urticifolium L. f.	H	1	2			1973
Eupatorium sp.	H	1	2			3309
Gochnatia barrosoae Cabrera	Ch			3	4	3484

Family/species	lf	physiognomy				#
Gochnatia pulchra Cabrera	Ch			3		3014
Hoehnephyton trixoides (Gardner) Cabrera	H		2	3		3596
Ichthyothere sp. 1	H		2	3	4	2121
Ichthyothere sp. 2	H		2	3		3792
Ichthyothere sp. 3	H			3		3563
Isostigma megapotamicum Scherff	H	1	2	3	4	2149
Isostigma sp.	H			3		3819
Mikania cordifolia (L.) Willd.	Li		2			3156
Orthopappus angustifolius (Sw.) Gleason *	H		2			2402
Piptocarpha rotundifolia (Less.) Baker	Ph		2	3		1957
Porophyllum angustissimum Gardner	Th		2	3	4	2513
Pseudobrickellia pinifolia (Spr.) King & H. Rob.	H		2	3	4	3491
Pterocaulon virgatum (L.) A. DC.	H		2	3		3155
Riencourtia oblongifolia Gardner	H	1	2	3		2331
Riencourtia tenuifolia Gardner	H	1	2			2256
Spilanthes nervosa Chod.	H			3		1900
Stilpnopappus glomerulatus Gardner	H	1	2			2877
Stilpnopappus speciosus Baker	H		2			2504
Stomatanthes dictyophyllum (A. DC.) King & H. Rob.	H		2	3		2555
Vernonia argentea Less.	H		2	3		2388
Vernonia bardanoides Less.	H	1	2	3		2514
Vernonia brevipetiolata Sch. Bip.	H		2	3		3189
Vernonia buddleiifolia Sch. Bip. ex Baker	H	1	2			2338
Vernonia compactiflora Mart. ex Baker	H	1	2	3		2867
Vernonia desertorum Mart. ex A. DC.	H		2	3		3567
Vernonia erythrophylla Mart.	H		2			2094
Vernonia ferruginea Less.	H			3		3510
Vernonia grandiflora Less.	H		2	3		2487
Vernonia herbacea (Vell.) Rusby	H	1	2	3		1992
Vernonia ignobilis Less.	H		2	3		2168
Vernonia polyanthes (Spreng.) Less.	Ch		2			2336
Vernonia psilophylla A. DC.	H				4	2832
Vernonia rubricaulis Humb. & Bonpl.	H		2			2375
Vernonia rubriramea Mart.	Ch		2	3		3191
Vernonia simplex Less.	H		2			4014
Vernonia tomentella Mart. ex A. DC.	H		2	3		2063
Vernonia tragiaefolia A. DC.	H		2			2172
Vernonia varroniifolia A. DC.	H	1	2	3		3304
Vernonia venosissima Sch. Bip. ex Baker	H	1	2			2001
Vernonia virgulata Mart.	H		2	3		2033
Viguiera bakeriana Blake	H	1	2	3		2414
Viguiera sp. 1	H		2	3		2084
Viguiera sp. 2	H		2			1960
Wedelia macedoi H. Rob.	H		2	3	4	3920
Balanophoraceae						
Langsdorffia hypogea Mart.	VP				4	4030
Bignoniaceae						

Family/species	lf	physiognomy				#
Anemopaegma arvense (Vell.) Stellfeld ex de Souza	H	1	2	3		2883
Anemopaegma glaucum Mart. ex A. DC.	H		2	3		3035
Anemopaegma scabriusculum Mart. ex A. DC.	H	1	2	3		1938
Arrabidaea brachypoda (A. DC.) Bur.	Ch	1	2	3	4	2272
Arrabidaea pulchra (Cham.) Sandw.	Li		2	3	4	2460
Cybistax antisyphillitica Mart.	Ph			3		3246
Jacaranda caroba (Vell.) A. DC.	Ch			3	4	2279
Jacaranda decurrens Cham.	Ch		2	3	4	3799
Jacaranda rufa Silva Manso	Ch		2	3		2267
Memora pedunculata (Vell.) Miers.	Ch		2	3		2063
Tabebuia aurea (Silva Manso) S. Moore	Ph		2	3		3557
Tabebuia ochracea (Cham.) Standl.	Ph		2	3		3659
Zeyheria montana Mart.	Ph		2	3		2661
Boraginaceae						
Cordia villicaulis Fresen.	H	1	2	3		3811
Bromeliaceae						
Aechmea bromeliifolia (Rudge) Baker	Ep		2	3		2474
Ananas ananassoides L.B. Sm.	H			3		2878
Billbergia magnifica Mez	Ep			3		3755
Bromelia balansae Mez	H	1	2			2013
Dickia tuberosa (Vell.) Beer	H				4	2839
Burseraceae						
Protium ovatum Engl.	Ph		2	3		1930
Cactaceae						
Epyphyllum phyllanthus (L.) Haw.	Ep			3		3878
Caryocaraceae						
Caryocar brasiliense Cambess.	Ph		2	3	4	1989
Caryophyllaceae						
Polycarpea corymbosa (L.) Lam.	Th		2	3	4	3359
Celastraceae						
Plenckia populnea Reissek	Ph			3	4	2277
Tontelea micrantha (Mart.) A.C. Sm.	Ph		2	3		1934
Chrysobalanaceae						
Couepia grandiflora (Mart. & Zucc.) Benth. ex Hook. f.	Ph				4	3717
Licania humilis Cham. & Schltdl.	Ph			3	4	3034
Parinari excelsa Sabine	Ch	1	2	3		1978
Clusiaceae						
Kielmeyera abdita Saddi	Ch		2	3		2095
Kielmeyera coriacea Mart.	Ph		2	3	4	2119
Kielmeyera grandiflora (Wawra) Saddi	Ph		2	3	4	2061

Family/species	lf	physiognomy				#
Kielmeyera rubriflora Cambess.	Ph			3	4	3022
Kielmeyera trichophora Mart.	Ch		2	3		2035
Kielmeyera variabilis Mart.	Ch	1	2	3		1915
Cochlospermaceae						
Cochlospermum regium (Mart.) Pilg.	H		2	3	4	2428
Combretaceae						
Buchenavia tomentosa Eichl.	Ph			3	4	4031
Combretum hilarianum D. Dietr.	Ch		2	3	4	2133
Commelinaceae						
Commelina obliqua Vahl	Th		2	3	4	2060
Connaraceae						
Connarus suberosus Planch.	Ph		2	3	4	2374
Rourea induta Planch.	Ph		2	3	4	1931
Convolvulaceae						
Evolvulus cressoides Mart.	H	1				2917
Evolvulus fuscus Meisn.	H	1	2	3		3974
Evolvulus macroblepharis Mart.	H		2			3252
Ipomoea argentea Meisn.	H	1	2	3		2651
Ipomoea campestris Meisn.	H		2			3524
Ipomoea procumbens Mart. ex Choisy	H		2			2613
Ipomoea procurrens Meisn.	Li	1	2	3		2295
Ipomoea sp. nov.	H	1	2	3		2357
Ipomoea virgata Meisn.	H		2	3		3415
Jacquemontia guaranitica Hassl.	H	1	2			2636
Jacquemontia sphaerocephala Meisn.	H		2	3		2363
Merremia contorquens (Choisy) Hall. f.	Li		2	3	4	2600
Merremia digitata Meisn.	Li			3	4	2140
Turbina abutiloides (Kunth) O'Donnel	H	1	2	3		2512
Convolvulaceae sp. 1, gen. sp. nov.	H		2	3		1967
Cucurbitaceae						
Cayaponia espelina Cogn.	Li		2	3	4	2118
Ceratosanthes hilariana Cogn.	Li			3	4	3645
Melancium campestre Naud.	H		2	3		2608
Cyperaceae						
Bulbostylis junciformis (Kunth) C.B. Clarke	H	1	2			2300
Bulbostylis paradoxa (Spreng.) Lindm.	H			3	4	3565
Bulbostylis sphaerocephala (Nees) C.B. Clarke	H		2			2046
Bulbostylis truncata (Nees) M.T. Strong	H		2			3971
Cyperus aggregatus (Willd.) Endl.	H		2			2023
Cyperus meyenianus Kunth	H			3		2707
Killinga odorata Vahl.	H		2			2931
Rhynchosphora diamantina (C.B.Clarke) Kukenth	H	1	2	3		2316

Family/species	lf	physiognomy				#
Rhynchosphora emaciata Boeckm.	H		2			3087
Rhynchosphora exaltata Kunth	H			3	4	2466
Rhynchosphora rugosa (Vahl.) Gale	H		2			3534
Scleria scabra Willd.	H			3		2310
Dilleniaceae						
Davilla elliptica A. St-Hil.	Ph	1	2	3	4	2080
Davilla nitida (Vahl.) Kubitzki	Li			3		3988
Dioscoreaceae						
Dioscorea amaranthoides Presl.	Li		2	3		3124
Dioscorea claussenii Uline	Li		2	3	4	3044
Ebenaceae						
Diospyros hispida A. DC.	Ph		2	3		2031
Erythroxylaceae						
Erythroxylum campestre A. St-Hil.	Ph		2	3		2228
Erythroxylum deciduum A. St-Hil.	Ph				4	3716
Erythroxylum suberosum A. St-Hil.	Ph		2	3		1965
Euphorbiaceae						
Chamaesyce caecorum (Mart. ex Boiss.) Croizat	H	1	2	3		2137
Cnidosculus quercifolius Pohl	H		2	3		1946
Croton aberrans Müll. Arg.	H		2			2036
Croton antisyphiliticus Mart.	H		2	3		2017
Croton cinctus Müll. Arg.	H			3		3109
Croton glandulosus Müll. Arg.	H		2			2389
Croton goyazensis Müll. Arg.	H		2	3		2222
Croton lundianus Müll. Arg.	H		2			2205
Croton pohlianus Müll. Arg.	H		2	3		2196
Croton sclerocalyx Müll. Arg.	H		2			2885
Croton sp.	H	1	2	3		1964
Dalechampia humilis Müll. Arg.	H		2	3		1981
Dalechampia linearis Baill.	H		2			2076
Julocroton humilis Didr.	H	1	2	3		2207
Manihot caerulescens Pohl	H				4	2459
Manihot tripartita (Spreng.) Müll. Arg.	H	1	2	3	4	1908
Maprounea guianensis Aubl.	Ph				4	3930
Phyllanthus orbiculatus Müll. Arg.	Th			3	4	2445
Sapium glandulatum (Vell.) Pax	Ch		2	3		2301
Sebastiania bidentata (Mart.) Pax	H			3		2430
Fabaceae						
Acosmium subelegans (Mohl.) Yakovlev	Ph		2	3	4	3815
Aeschynomene marginata Benth.	Th				4	2716
Aeschynomene oroboides Benth.	H		2	3		2055
Anadenanthera falcata (Benth.) Speg.	Ph		2	3	4	2650
Andira cuiabensis Benth.	Ph				4	2045

Family/species	lf	physiognomy				#
Andira laurifolia Benth.	Ch	1	2	3		2342
Andira vermifuga (Mart.) Benth.	Ph				4	3718
Arachis tuberosa Bong. ex Benth.	H		2	3		2275
Bauhinia rufa Steud.	Ph		2	3	4	1907
Bowdichia virgilioides Kunth	Ph			3	4	3350
Calliandra dysantha Benth.	Ch	1	2	3		1979
Calliandra macrocalyx Harms	Ph		2	3	4	2230
Calopogonium sericeum (Benth.) Chodat ex Hassl.	Li		2	3		2569
Camptosema ellipticum (Desv.) Burkart	Li		2	3	4	3232
Centrosema venosum Mart. ex Benth.	Li		2	3	4	1924
Chamaecrista basifolia (Vogel) Irwin & Barneby	Ch				4	2710
Chamaecrista campestris Irwin & Barneby	Ch				4	2723
Chamaecrista cotonifolia (G. Don.) Killip.	Ch		2	3	4	4001
Chamaecrista desvauxii (Collad.) Killip.	Ch		2	3	4	2457
Chamaecrista filicifolia (Benth.) Irwin & Barneby	Ch			3	4	2325
Chamaecrista flexuosa (L.) Greene	Ch		2	3		2290
Chamaecrista lundii (Benth.) Irwin & Barneby	H		2	3		3435
Chamaecrista nictitans (L.) Moench.	Ch			3	4	2726
Chamaecrista planaltoana (Harms) Irwin & Barneby	H	1	2	3		2208
Chamaecrista rotundifolia (Pers.) Greene	H		2			1974
Chamaecrista setosa (Vogel) Irwin & Barneby	Ch			3	4	2725
Clitoria densifolia (Presl.) Benth.	H		2	3		2433
Copaifera langsdorffii Desf.	Ph		2	3	4	2127
Crotalaria maypurensis Kunth	Th		2			2597
Crotalaria nitens Benth.	H				4	2724
Crotalaria velutina Benth.	H		2	3		2881
Dalbergia cuiabensis Benth.	Ph			3	4	3214
Dalbergia miscolobium Benth.	Ph				4	3504
Desmodium barbatum (L.) Benth.	H				4	3024
Desmodium incanun (Sw.) A. DC.	Th		2	3		2523
Desmodium platycarpum Benth.	H				4	3944
Dimorphandra mollis Benth.	Ph		2	3		2047
Dioclea bicolor Benth.	Li		2	3		2042
Dyptichandra aurantiaca Tul.	Ph				4	3056
Eriosema crinitum (Kunth) Gardner	H	1	2	3		2483
Eriosema cupreum Harms.	H				4	2120
Eriosema glabrum Mart. ex Benth.	H		2	3		2251
Eriosema heterophyllum Benth.	H		2			3992
Eriosema longifolium Benth.	H	1	2			2194
Eriosema rufum Kunth	H	1	2	3	4	2444
Galactia decumbens (Benth.) Chodat & Hassl.	H	1	2	3		2371
Galactia dimorpha Burk.	H		2	3	4	2130
Galactia martii A. DC.	H	1	2	3		3512
Harpalyce brasiliana Benth.	Ph		2	3		2548
Hymenaea stigonocarpa Mart.	Ph			3	4	2326
Indigofera gracilis Bong.	H	1	2	3		2057
Lupinus subsessilis Benth.	H	1	2			2320
Machaerium acutifolium Vogel	Ph				4	2115
Mimosa amnis-atri Barneby	Ph			3	4	3589

Family/species	**lf**	**physiognomy**				**#**
Mimosa distans Benth.	Ch		2			2070
Mimosa foliolosa Benth.	Ph	1	2	3		2367
Mimosa gemmulata Barneby	Ph		2	3	4	2012
Mimosa gracilis Benth.	Ch	1	2	3		2395
Mimosa hebecarpa Benth.	Ph		2	3		1911
Mimosa nuda Humb. & Bonpl.	H	1	2	3	4	2074
Mimosa polycephala Benth.	Ch		2	3		2391
Mimosa radula Benth.	Ch	1	2	3		2452
Mimosa xanthocentra Mart.	Ch		2	3	4	2114
Periandra mediterranea (Vell.) Taub.	Ch		2	3	4	2671
Phaseolus firmulus Mart.	H			3	4	3488
Plathymenia reticulata Benth.	Ph			3	4	3977
Poiretia angustifolia Vogel	H	1	2			2386
Poiretia latifolia Vogel	H		2			3007
Poiretia longipes Harms.	H		2	3		2599
Pterodon pubescens Benth.	Ph		2	3	4	3833
Rhynchosia platyphylla Benth.	H		2			2653
Senna rugosa (G. Don.) Irwin & Barneby	Ph		2	3	4	2329
Senna silvestris (Vell.) Irwin & Barneby	Ph		2	3	4	2314
Senna velutina (Vogel) Irwin & Barneby	Ph			3	4	3032
Stryphnodendron adstringens (Mart.) Coville	Ph		2	3		1985
Stryphnodendron obovatum Benth.	Ph			3	4	2087
Stylosanthes bracteata Vogel	H		2			2155
Stylosanthes gracilis Kunth	Th	1				2562
Stylosanthes guianensis Sw.	Th		2	3		2423
Stylosanthes scabra Vogel	H			3		3323
Tephrosia adunca Benth.	H		2			2258
Vatairea macrocarpa (Benth.) Ducke	Ph				4	4032
Vigna linearis Kunth	Li				4	2838
Zornia latifolia Sm.	H		2			2676
Zornia reticulata Sm.	H		2			2481
Zornia virgata Moric.	H		2			3142
Fabaceae sp. 1	Ph		2			2796
Flacourtiaceae						
Casearia grandiflora Cambess.	Ph		2	3	4	2078
Casearia sylvestris Sw.	Ph		2	3	4	2473
Casearia sp.	H		2			2034
Gentianaceae						
Deianira nervosa Cham. & Schltdl.	H		2	3		3457
Irlbachia alata (Aubl.) Maas	H			3		2879
Irlbachia speciosa (Cham. & Schltdl.) Maas	H		2	3		3438
Gesneriaceae						
Sinningia elatior (Kunth) Chautems	H			3		3989
Hypoxidaceae						
Hypoxis sp.	Geo		2			4019

Family/species	lf	physiognomy				#
Icacinaceae						
Emmotum nitens (Benth.) Miers.	Ph				4	3244
Iridaceae						
Sisyrinchium vaginatum Spreng.	Geo	1	2	3	4	2253
Trimezia juncifolia (Kl.) Kunth	Geo	1	2	3		2062
Lamiaceae						
Eriope crassipes Benth.	H	1	2	3	4	2054
Hypenia macrantha (A. St-Hil. ex Benth.) Harley	H		2	3		3704
Hyptidodendron canum (Pohl ex Benth.) Harley	Ph				4	3493
Hyptis adpressa A. St-Hil. ex Benth.	H		2	3		4013
Hyptis caprariifolia Pohl ex Benth.	H		2	3		3006
Hyptis caudata Epling & Sativa	H			3	4	3643
Hyptis crinita Benth.	H			3		3334
Hyptis desertorum Pohl ex Benth.	H		2			4015
Hyptis eriophylla Pohl	H		2	3	4	2849
Hyptis ferruginosa Pohl ex Benth.	H	1	2	3		3979
Hyptis interrupta Pohl ex Benth.	H			3	4	3076
Hyptis lythroides Pohl ex Benth.	H			3		3708
Hyptis multiflora Pohl ex Benth.	H	1	2			2670
Hyptis recurvata Poit.	H		2			3535
Hyptis saxatilis A. St-Hil. ex Benth.	Ch			3	4	3111
Hyptis villosa Pohl ex Benth.	H	1	2	3		2255
Hyptis virgata Benth.	H	1	2	3		1925
Hyptis sp.	H			3	4	3544
Marsipianthes chamaedrys (Vahl) Kuntze	H		2			2531
Marsipianthes montana Benth.	H		2	3		3108
Ocimum sp.	H	1	2	3		2151
Peltodon pusillus Pohl	H		2	3		3271
Peltodon tomentosus Pohl	H			3	4	3065
Salvia sp.	H		2	3		2100
Lauraceae						
Aiouea trinervis Meisn.	Ph			3	4	3931
Cassytha filiformis L.	VP				4	2422
Lecythidaceae						
Eschweilera nana (Berg.) Miers	Ph				4	2825
Loganiaceae						
Strychnos pseudoquina A. St-Hil.	Ph				4	3943
Lythraceae						
Cuphea carthagenensis (Jacq.) Macbr.	H	1	2			2179
Cuphea linarioides Koehne	H	1	2	3		2136
Lafoensia pacari A. St-Hil.	Ph		2	3	4	3782

Family/species	lf	physiognomy				#
Malpighiaceae						
Banisteriopsis acerosa (Nied.) B. Gates	Ph		2	3		2809
Banisteriopsis amplectens B. Gates	Li			3		2429
Banisteriopsis campestris (A. Juss.) Little	Li		2	3		2346
Banisteriopsis gardneriana (A. Juss.) W. Anderson & Sattl.	Li			3		3756
Banisteriopsis laevifolia (A. Juss.) B. Gates	Li		2	3		2558
Banisteriopsis schizoptera (A. Juss.) B. Gates	Li				4	3049
Banisteriopsis stellaris (Griseb.) B. Gates	Li		2	3	4	2479
Banisteriopsis variabilis B. Gates	Li		2	3		2304
Byrsonima basiloba A. Juss.	Ph		2	3	4	2133
Byrsonima coccolobifolia A. Juss.	Ph		2	3	4	2233
Byrsonima crassa Nied.	Ph			3	4	1898
Byrsonima gaultherioides Griseb.	Ch		2	3		2898
Byrsonima guilleminiana A. Juss.	Ch	1	2	3		2044
Byrsonima intermedia A. Juss.	Ph		2	3	4	2467
Byrsonima rigida A. Juss.	Ch	1	2	3		2135
Byrsonima verbascifolia (Griseb.) B. Gates	Ph			3	4	2643
Camarea affinis A. St-Hil.	H		2	3		2417
Heteropterys anoptera A. Juss.	Li		2			3149
Heteropterys byrsonimifolia A. Juss.	Ph		2	3	4	2476
Heteropterys campestris A. Juss.	Li		2	3	4	2172
Heteropterys coriacea A. Juss.	Li			3	4	3089
Peixotoa reticulata Griseb.	Li		2	3		2079
Tetrapteris ambigua (A. Juss.) Nied.	Li		2	3		3279
Malvaceae						
Byttneria oblongata Pohl	H		2	3	4	2129
Eriotheca gracilipes (K. Schum.) A. Robyns	Ph		2	3	4	1936
Eriotheca pubescens (Mart. & Zucc.) A. Robyns	Ph		2	3	4	3336
Helicteres sacarolha A. St-Hil.	H		2	3		2468
Krapovichasia macrodon (A. DC.) Fryxell	H		2			2175
Melochia villosa (Mill.) Fawc. & Rendle	H	1	2			2499
Pavonia rosa-campestris A. St-Hil.	H		2	3	4	1962
Peltaea edouardii (Hochr.) Krapov. & Cristóbal	H	1	2	3		1940
Peltaea polymorpha (A. St-Hil.) Krapov. & Cristóbal	H	1	2	3		2528
Pseudobombax longiflorum (Mart. & Zucc.) A. Robyns	Ph			3	4	3507
Sida cerradoensis Krapov.	H		2			2960
Sida cordifolia L.	H		2			2961
Sida linearifolia A. St-Hil.	H				4	3051
Sida rhombifolia L. *	H	1	2	3	4	2840
Waltheria douradinha A. St-Hil.	H		2	3		2028
Waltheria indica L. *	H		2			2274
Melastomataceae						
Miconia albicans Triana	Ph			3	4	1987
Miconia fallax A. DC.	Ph		2	3	4	1986
Miconia ferruginata A. DC.	Ph		2	3		1988
Miconia ligustroides (A. DC.) Naud.	Ph			3		3465
Miconia rubiginosa (Bonpl.) A. DC.	Ph			3	4	1956

Family/species	**lf**	**physiognomy**				**#**
Mouriri elliptica Mart.	Ph			3	4	2131
Rhynchanthera ursina Naud.	Ch		2			3536
Tibouchina gracilis (Bonpl.) Cogn.	Ch	1	2	3		2635
Tibouchina stenocarpa (A. DC.) Cogn.	Ph		2			2800
Menispermaceae						
Cissampelos ovalifolia Ruiz & Pav.	H	1	2	3		1954
Moraceae						
Brosimum gaudichaudii Trècul	Ph			3	4	2109
Myristicaceae						
Virola sebifera Aubl.	Ph				4	3219
Myrsinaceae						
Myrsine leuconeura Mart.	Ph				4	2820
Myrtaceae						
Campomanesia adamantium (Cambess.) O. Berg	Ph		2	3		1929
Campomanesia pubescens (A. DC.) O. Berg	Ph	1	2	3		2226
Eugenia angustissima O. Berg	H		2	3		2413
Eugenia aurata O. Berg	Ph		2	3	4	2699
Eugenia bimarginata A. DC.	Ph				4	3502
Eugenia calycina Cambess.	Ch		2	3		2618
Eugenia complicata O. Berg	Ch		2			3583
Eugenia cristaensis O. Berg	H		2	3		2231
Eugenia piauhiensis O. Berg	Ph		2	3	4	2025
Eugenia piloesis Cambess.	Ph		2	3	4	2511
Eugenia punicifolia (Kunth) A. DC.	Ph		2	3	4	2265
Eugenia sp. 1	Ch			3		4017
Eugenia sp. 2	Ph			3	4	3601
Eugenia sp. 3	H		2			2237
Eugenia sp. 4	Ch		2	3		2923
Myrcia bella Cambess.	Ph		2	3	4	2127
Myrcia bracteata O. Berg	Ph		2			2673
Myrcia camapuanensis N.F.E. Silveira	Ph			3		1966
Myrcia crassifolia (O. Berg) Kiaersk.	Ph			3	4	2228
Myrcia decrescens O. Berg	Ph		2			1994
Myrcia fallax (Rich.) A. DC.	Ph				4	3689
Myrcia guianensis A. DC.	Ph		2	3	4	3691
Myrcia laruotteana Cambess.	Ph				4	3927
Myrcia lasiopus O. Berg	H	1	2			2689
Myrcia linguaeformis Kiaersk.	Ph			3	4	3555
Myrcia rhodeosepala Kiaersk.	Ph		2	3		3817
Myrcia torta A. DC.	Ch	1	2	3	4	3723
Myrcia uberavensis O. Berg	Ph		2	3		3561
Myrcia variabilis Mart. ex A. DC.	Ph			3	4	2041
Myrcia sp. 1	Ch		2	3		2238
Myrcia sp. 2	Ph			3		3260

Family/species	lf	physiognomy				#
Myrcia sp. 3	H		2	3		3442
Myrciaria delicatula (A. DC.) O. Berg	H	1	2			2995
Psidium australe Cambess.	Ch		2	3		2777
Psidium cinereum Mart.	Ch	1	2	3		2212
Psidium firmum O. Berg	Ch		2			3848
Psidium laruotteanum Cambess.	Ph		2	3	4	2250
Psidium multiflorum Cambess.	Ch	1	2			2547
Psidium rufum Mart. ex A. DC.	Ph		2			2199
Nyctaginaceae						
Guapira campestris (Netto) Lund.	Ch			3		3969
Guapira graciliflora (Mart. ex J.A. Schmidt) Lund.	Ph			3		3929
Guapira noxia (Netto) Lund.	Ph		2	3	4	3552
Neea macrophylla Poep. & Endl.	Ph				4	3080
Neea theifera Oerst.	Ph			3	4	2110
Ochnaceae						
Ouratea acuminata (A. DC.) Engl.	Ph		2	3		2463
Ouratea castanaefolia (A. DC.) Engl.	Ph		2	3	4	3577
Ouratea floribunda (A. St-Hil.) Engl.	Ch	1	2	3		2219
Ouratea nana (A. St-Hil.) Engl.	Ch		2	3	4	2462
Ouratea spectabilis (Mart.) Engl.	Ph		2	3	4	2045
Orchidaceae						
Epistephium sclerophyllum Lindl.	Geo		2	3	4	2830
Galeandra montana Barb. Rodr.	Geo				4	2727
Habenaria brevidens Lindl.	Geo			3		2811
Habenaria nasuta Rchb. f. & Warm.	Geo			3		2751
Habenaria obtusa Lindl.	Geo	1	2			2633
Oxalidaceae						
Oxalis sellowii Spreng.	H	1	2	3		1910
Passifloraceae						
Mitostemma brevifilis Gontsch.	Ch		2	3		3562
Passiflora mansoi (Mart.) Mast.	Li				4	3066
Poaceae						
Actinocladum verticillatum (Nees) McClure ex Saderston	Ph				4	3837
Andropogon bicornis L.	H		2			2866
Andropogon fastigiatus Sw.	H	1	2	3		3157
Andropogon leucostachys Kunth	H	1	2	3		1922
Andropogon selloanus (Hack.) Hack.	H		2	3		2614
Anthaenantiopsis perforata (Nees) Parodi	H		2			2344
Apoclada arenicola McClure	Ph				4	3855
Aristida longifolia Trin.	H				4	3233
Aristida riparia Trin.	H	1	2	3	4	2560
Axonopus aureus P. Beauv.	H		2	3		3017
Axonopus barbigerus (Kunth) Hithc.	H		2			2763

Family/species	lf	physiognomy				#
Axonopus brasiliensis (Spr.) Kuhlm.	H	1	2	3		2890
Axonopus derbyanus Black	H		2	3	4	2291
Brachiaria decumbens Stapf. *	H		2	3		2311
Ctenium chapadense (Trin.) Doell.	H		2	3		3420
Echinolaena inflexa (Poir.) Chase	H			3		2382
Elionurus latiflorus Nees	H	1	2	3	4	3770
Eragrostis airoides Nees	H		2			2178
Eragrostis articulata (Schrank) Nees	Th		2	3	4	2556
Eragrostis maypurensis (Kunth) Steud.	Th		2			2170
Gymnopogon foliosus (Willd) Nees	H		2			3083
Hyparrhenia bracteata (Humb. & Bonpl.) Stapf.	H			3		3833
Hyparrhenia rufa (Nees) Stapf. *	H	1	2	3		3181
Ichnanthus procurrens (Nees) Sw.	H	1				2561
Leptocoryphium lanatum (Kunth) Nees	H	1	2	3		3700
Loudetiopsis chrysothryx (Nees) Conert	H		2			2845
Melinis minutiflora P. Beauv. *	H		2	3		2278
Olyra taquara Sw.	Ph				4	3949
Panicum olyroides Kunth	H	1	2			1928
Panicum rudgei Roem & Shult.	H	1	2	3		2491
Panicum sp.	H	1				2969
Paspalum carinatum Humb. & Bonpl. ex Fleug.	H		2			2002
Paspalum convexum Humb. & Bonpl. ex Fleug.	H	1				2972
Paspalum erianthum Nees	H		2	3		2405
Paspalum gardnerianum Nees	H	1	2	3	4	2354
Paspalum geminiflorum Steud.	H		2	3		3250
Paspalum malacophyllum Trin.	H				4	3050
Paspalum multicaule Poir.	H	1	2			3168
Paspalum pectinatum Nees	H	1	2	3		2343
Paspalum sp. 1	H				4	3060
Paspalum sp. 2	H		2			2938
Pennisetum setosum (Sw.) L. C. Rich. *	H			3		3363
Rhynchelitrum repens (Nees) C.E. Hubb. *	Th		2	3		2572
Schyzacchirium condensatum (Kunth) Nees	H			3		3430
Setaria geniculata (L.) P. Beauv. *	Th		2			2495
Sporolobus acuminatus Boechat & Longhi-Wagner	H		2	3		2181
Sporolobus ciliatus (Trin.) Hack.	H	1	2			2986
Sporolobus indicus (L.) R. Brown	H		2			2519
Trachypogon spicatus (L. f.) Kuntze	H		2			2769
Thrasya petrosa Nees	H	1	2	3	4	2630
Tristachya leiostachya Nees	H	1	2	3		2269
Polygalaceae						
Polygala angulata A. DC.	H			3	4	2425
Polygala aphylla A.W.Benn.	H	1	2	3		3910
Polygala opina Wurdack	H	1	2	3		2223
Polygala violacea Aubl.	H		2	3		2492
Securidaca tomentosa A. St-Hil.	Li			3		3547
Polygonaceae						

Family / species	lf	physiognomy				#
Coccoloba densifrions Mart.	Ph		2	3	4	2111
Polypodiaceae						
Adiantum serratodentatum Humb. & Bonpl. ex Willd.	H		2			3403
Proteaceae						
Roupala montana Aubl.	Ph			3	4	2144
Rhamnaceae						
Crumenaria polygaloides Reissek	H	1	2			2920
Rubiaceae						
Alibertia sessilis (Vell.) K. Schum.	Ch		2	3	4	2108
Borreria suaveolens Meyers	H	1	2	3		1914
Chomelia ribesioides Benth. ex A. Gray	Ph		2	3	4	3928
Declieuxia fruticosa (Willd.) Kuntze	H		2	3	4	2138
Declieuxia oenanthoides Schult. & Schult.	H		2	3		2040
Declieuxia verticilata Müll. Arg.	H	1	2			2245
Diodia schumanii Standl.	Th	1	2	3		1972
Diodia teres Walt.	Th		2	3		2524
Galianthe grandifolia Cabral	H		2	3	4	2944
Genipa americana L.	Ph			3	4	2449
Palicourea coriacea (Cham.) K. Schum.	Ch	1	2	3	4	1903
Palicourea rigida Kunth	Ph	1	2	3	4	1941
Richardia humistrata (Cham. & Schltdl.) Steud.	H		2	3		1909
Richardia stellaris (Cham. & Schltdl.) Steud.	H			3		3036
Sipanea hispida Benth.	H		2			2485
Tocoyena formosa (Cham. & Schltdl.) K. Schum.	Ph		2	3	4	2124
Rutaceae						
Hortia brasiliana Vand. ex A. DC.	Ph	1	2	3		2765
Spiranthera odoratissima A. St-Hil.	Ch		2	3		2073
Sapindaceae						
Matayba guianensis Aubl.	Ph		2	3		3925
Serjania cissoides Radlk.	Li	1	2	3		1993
Serjania erecta Radlk.	Ch		2	3	4	2128
Serjania reticulata Cambess.	Li			3	4	3040
Talisia angustifolia Radlk.	Ch		2	3		1935
Toulicia tomentosa Radlk.	Ch			3		3088
Sapotaceae						
Pouteria ramiflora (Mart.) Radlk.	Ph		2	3	4	1984
Pouteria subcaerulea Pierre ex Dubard	Ch			3		1899
Pouteria torta (Mart.) Radlk.	Ph		2	3		1918
Pradosia brevipes (Pierre) Penn.	H	1	2	3		3772
Scrophulariaceae						
Buchnera lavandulacea Cham. & Schltdl.	H		2	3	4	2437

Family/species	lf	physiognomy				#
Esterhazia petiolata Barr.	H				4	3358
Scoparia dulcis L. *	Ch		2			2486
Simaroubaceae						
Simaba suffruticosa Engl.	Ch		2	3		3730
Simarouba amara Aubl.	Ph			3		3802
Smilacaceae						
Smilax cissoides Mart. ex Griseb.	Li		2	3	4	2330
Solanaceae						
Solanum lycocarpum A. St-Hil.	Ph		2	3		2020
Solanum subumbellatum Vell.	Ch		2			4005
Styracaceae						
Styrax ferrugineus Nees & Mart.	Ph			3	4	3227
Turneraceae						
Piriqueta emasensis Arbo, sp. nov.	H		2	3		1968
Piriqueta sidifolia (Cambess.) Urban	Ch			3	4	3059
Turnera purpurascens Arbo	H		2			2359
Verbenaceae						
Aegiphila lanata Mold.	Ch		2	3		2303
Aegiphila lhotzkiana Cham.	Ph			3	4	2315
Amasonia hirta Benth.	H			3	4	2385
Casselia chamaedryfolia Cham.	H		2	3		2066
Lippia hirta Schauer	Ch			3		2415
Lippia hoehnei Mold.	Ch		2	3	4	3690
Lippia lupulina Cham.	Ch		2	3	4	3642
Lippia martiana Schauer	Ch	1	2			2254
Lippia primulina S. Moore	H		2			3966
Lippia stachyoides Cham.	H		2			2257
Lippia turnerifolia Cham.	H		2	3		2505
Stachytarpheta maximilliani Schauer	H		2			2401
Stachytarpheta simplex Hayek.	H		2			2369
Violaceae						
Hybanthus poaya (A. St-Hil) Baill.	H		2	3	4	3947
Hybanthus sp. nov.	H		2			3513
Vitaceae						
Cissus erosa L.C. Rich	Li		2	3	4	2458
Vochysiaceae						
Qualea grandiflora Mart.	Ph		2	3	4	2065
Qualea multiflora Mart.	Ph				4	2434
Qualea parviflora Mart.	Ph				4	3952
Vochysia thyrsoidea Pohl	Ph		2	3		2892

Family/species	lf	physiognomy	#
Vochysia tucanorum Mart.	Ph	2	2496
Unknown			
Unknown sp. 1	Ch	2	2305

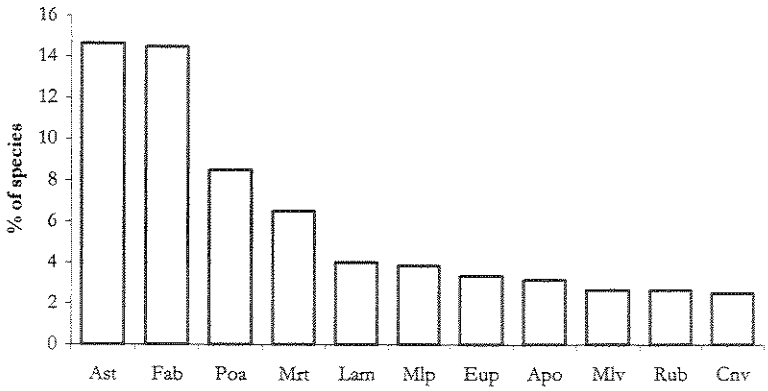

Figure 2. Percentage of species in the richest families of the cerrado flora in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ast = Asteraceae, Fab = Fabaceae, Poa = Poaceae, Mrt = Myrtaceae, Lam = Lamiaceae, Mlp = Malpighiaceae, Eup = Euphorbiaceae, Apo = Apocynaceae, Mlv = Malvaceae, Rub = Rubiaceae, and Cnv = Convolvulaceae. The other 69 families comprised 33.78% of the total number of species.

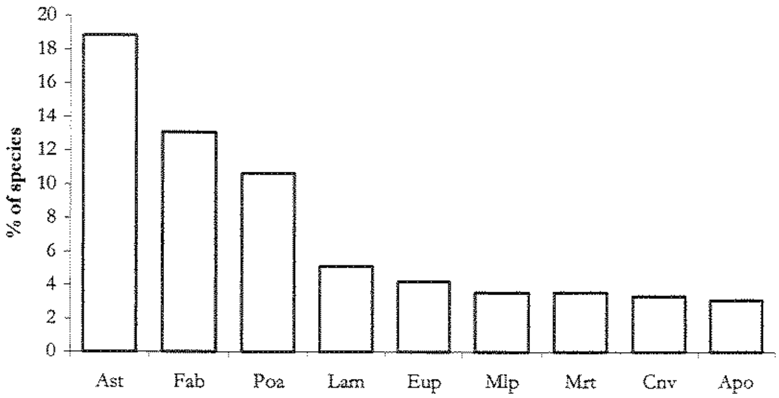

Figure 3. Percentage of species in the richest families of the cerrado herbaceous flora in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ast = Asteraceae, Fab = Fabaceae, Poa = Poaceae, Lam =

Lamiaceae, Eup = Euphorbiaceae, Mlp = Malpighiaceae, Mrt = Myrtaceae, Cnv = Convolvulaceae, and Apo = Apocynaceae. The other 55 families comprised 34.73% of the herbaceous species.

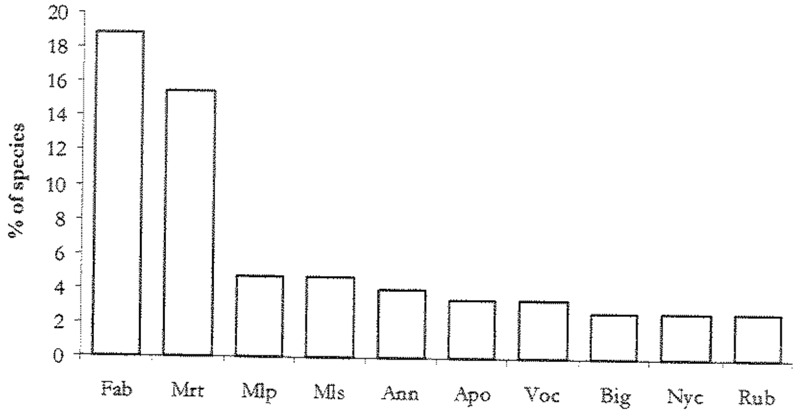

Figure 4. Percentage of species in the richest families of the cerrado woody flora in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Fab = Fabaceae, Mrt = Myrtaceae, Mlp = Malpighiaceae, Mls = Melastomataceae, Ann = Annonaceae, Apo = Apocynaceae, Voc = Vochysiaceae, Big = Bignoniaceae, Nyc = Nyctaginaceae, and Rub = Rubiaceae. The other 37 families comprised 37.58% of the woody species.

Discussion

If we assume that the number of species in the cerrado ranges from 3,000 to 7,000 (Castro *et al.* 1999), then the ENP comprises from 8.5 to 20.0% of the cerrado flora approximately, what reflects the importance of the reserve for the conservation of this vegetation type. The number of species in ENP shall be increased by those species not found in our survey. Floristic surveys certainly miss a number of species in a given area, especially those that are not at reproductive stage in the time of the visit, flower sporadicly, are ephemeral, or are inconspicuous, problems more frequent in the herbaceous component (Mantovani & Martins 1993, Castro *et al.* 1999).

Among the 601 species found in ENP, seven are new to science. Although the cerrado is one of the most studied vegetation in Brazil (Castro *et al.* 1999), the fact that undescribed species keep on appearing in floristic surveys – for example, also in Brasília, Federal District (Pereira *et al.* 1993) – shows that the cerrado is still not satisfactoraly sampled. The affirmation that the tropical flora remains undercollected (Prance *et al.* 2000) seems to be valid also for the cerrado vegetation. Some of the species not identified on species level in our inventory can be new to science as well.

Although the proportion of weedy species in the ENP flora was lower than those found by Mendonça *et al.* (1998) for the whole domain (around 5%), the invasion of ruderal plants – notably the African grasses *Brachiaria decumbens* Stapf and *Melinis minutiflora* P. Beauv. – in ENP is alarming. Plant invasion became a great problem in virtually all cerrado fragments (Pivello *et al.* 1999) and can turn into a serious problem also in ENP if precautions were not taken.

The intermediate cerrado physiognomies in ENP, *campo sujo* and *campo cerrado*, were richest than the extremes, what is in accordance with Batalha *et al.* (2001), who stated that ecotonal physiognomies of the cerrado are richer than its extremes, because in them both components are well represented.

The richest families in ENP, in the whole flora and in its two components separately, were those best represented in other cerrado sites (Mantovani & Martins 1993, Batalha *et al.* 1997, Batalha & Mantovani 2000), although their relative frequencies were not the same (Chapter 3). The exceptions were Convolvulaceae and Lamiaceae, well represented only in ENP, in the whole flora and in its herbaceous component.

The herbaceous to woody species ratio, although not significantly different than the maximum expected by Mantovani & Martins (1993), was higher than those found in other floras (Mantovani & Martins 1993, Batalha *et al.* 1997, Batalha & Mantovani 2000). This was probably a consequence of the prevailance of open physiognomies (*campo limpo* and *campo sujo*) in ENP.

The presence of *Piptocarpha rotundifolia* and the absence of *Curatella americana* in the ENP flora placed it in Castro's (1994) southeastern group. Within this group, Castro (1994) recognized four subgroups: two in the southern disjunct cerrados and two in the Central Plateau. Taking into account Castro's (1994) indicator species, the ENP could be placed only on one of the central groups, which is indicated by the presence of *Piptocarpha rotundifolia*, *Qualea parviflora* Mart. (Vochysiaceae), and *Casearia sylvestris* Sw. (Flacourtiaceae).

According to Castro *et al.* (1999), surveys in poorly sampled regions should contribute to add species to the cerrado woody species checklist. Indeed, the 17 species found in our survey that should be included in their list represent a high percentage of the species collected in ENP, what suggests that even the woody component remains undercollected. In the herbaceous component, this undercollection must be even greater. In the visits we paid to herbaria and in our search for references, the absence of surveys in this component became evident.

Only about 1% of the tropical regions has the most basic species inventories (Hammond 1992). In the ENP case, a small step was given with our floristic survey. Nevertheless, to know the ENP flora, surveys should be carried out also in the other vegetation types existing within the reserve, such as the seasonal semideciduous forest, the riparian forest, and the wet fields.

Aknowledgements – We are grateful to Fapesp, for financial support (process 97/13.697-5); to Ibama, for research license (process 02001,000376/98-90); to the Emas National Park staff, for their help in field; to M.B. Ramos-Neto, for logistical assistance; to W. Mantovani, for useful discussions and assistance in species identification; and to the taxonomists K. Althott, M. Alves, M.M. Arbo, M.C. Assis, C. Bestetti, R.S. Bianchini, V. Bittrich, A.C. Cervi, I. Cordeiro, C.L. Cristóbal, T.S.C. Dorow, S.I. Elias, G. Esteves, M.A. Farinaccio, M.S. Ferrucci, P. Fiaschi, E. Forero, A. Furlan, E. Gonçalves, M.L. Kawasaki, M. Kirizawa, A. Krapovickas, J.A. Lombardi, M. Magenta, A.C. Marcato, R. Mello-Silva, E. Melo, M. Moraes, R.C. Oliveira, M.B. Paciencia, J.R. Pirani, A.P. Prata, C. Proença, N.A.T. Ranga, F.R. Salimena, J.U.M. dos Santos, J. Semir, M.F. Simon, E.R.V. Silva, M.M. da Silva, J.P. Souza, A. Spina, J.Y. Tamashiro, W. Thomas, R.B. Torres, M.G. Wanderley, and A. Zanin, for their assistance in the identification of species.

References

BATALHA, M. A.; ARAGAKI, S. & MANTOVANI, W. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo 16*: 49-64.

BATALHA, M. A. & MANTOVANI, W. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparison between the herbaceous and the woody floras. *Revista Brasileira de Biologia 60*: 129-145.

BATALHA, M. A.; MANTOVANI, W. & MESQUITA JR., H. N. DE. 2001. Vegetation structure in cerrado physiognomies in southeastern Brazil. *Revista Brasileira de Biologia 61*: in press.

CASTRO, A. A. J. F. 1994. *Comparação florística-geográfica (Brasil) e fitossociológica (Piauí – São Paulo) de amostras de cerrado.* PhD. Thesis, State University of Campinas.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y. & SHEPHERD, G. J. 1999. How rich is the flora of the Brazilian cerrados? *Annals of the Missouri Botanical Garden 86*: 192-224.

CONSERVATION INTERNATIONAL. 1999. *Ações prioritárias para a conservação do Cerrado e do Pantanal.* Brasília, Conservation International.

COUTINHO, L. M. 1990. Fire in the ecology of the Brazilian cerrado. *In* GOLDAMMER, J. G. (ed). *Fire in the tropical biota.* Berlin, Springer. p. 82-105.

CRONQUIST, A. 1988. *The evolution and classification of flowering plants.* New York, New York Botanical Garden.

FONSECA, G. A. B. DA; MITTERMEIER, R. A.; CAVALCANTI, R. B. & MITTERMEIER, C. G. 2000. Brazilian Cerrado. *In* MITTERMEIER, R. A.; MYERS, N.; GIL, P. R. & MITTERMEIER, C. G. (eds). *Hotspots, Earth's biologically richest and most endangered terrestrial ecoregions.* Chicago, Conservation International. p. 148-159.

HAMMOND, P. M. 1992. Species inventory. *In* GROOMBRIDGE, B. (ed). *Global biodiversity.* London, Chapman & Hall. p. 17-39.

IBDF. INSTITUTO BRASILEIRO DE DESENVOLVIMENTO FLORESTAL. 1981. Plano de manejo - Parque Nacional das Emas. Brasília, IBDF.

JUDD, W. S.; CAMPBELL, C. S.; KELLOG, E. A. & STEVENS, P. F. 1999. *Plant systematics: a phylogenetic approach*. Sunderland, Sinauer.

KÖPPEN, W. 1948. *Climatología*. México, Fondo de Cultura Económica.

LENTHALL, J. C.; BRIDGEWATER, S. & FURLEY, P. A. 1999. A phytogeographic analysis of the woody elements of the New World savannas. *Edinburgh Journal of Botany 56*: 293-305.

MANTOVANI, W. & MARTINS, F. R. 1993. Florística do cerrado na reserva biológica de Moji Guaçu, SP. *Acta Botanica Brasilica 7*: 33-60.

MENDONÇA, R. C. DE; FELFILI, J. M.; WALTER, B. M. T.; SILVA JÚNIOR, M. C. DA; REZENDE, A. V.; FILGUEIRAS, T. S. & NOGUEIRA, P. E. 1998. A flora vascular do cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora*. Planaltina, Embrapa. p. 289-556.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology*. New York, John Willey & Sons.

PEREIRA, B. A. S.; SILVA, M. A. & MENDONÇA, R. C. 1993. *Reserva Ecológica do IBGE, Brasília – DF: lista de plantas vasculares*. Rio de Janeiro, IBGE.

PIVELLO, V. R.; CARVALHO, V. M. C.; LOPES, P. F.; PECCININI, A. A. & ROSSO, S. 1999. Abundance and distribution of native and alien grasses in a "cerrado" (Brazilian savanna) Biological Reserve. *Biotropica 31*: 71-82.

PRANCE, G. T.; BEENTJE, H.; DRANSFIELD, J. & JOHNS, R. 2000. The tropical flora remains undercollected. *Annals of the Missouri Botanical Garden 87*: 67-71.

RAMOS-NETO, M. B. 2000. *O Parque Nacional das Emas (GO) e o fogo: implicações para a conservação biológica*. PhD. Thesis. University of São Paulo.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environmental Management 26*: 675-684.

RATTER, J. A.; BRIDGEWATER, S.; ATKINSON, R. & RIBEIRO, J. F. 1996. An 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.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography*. Oxford, Claredon.

RIZZINI, C. T. 1963. A flora do cerrado. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado*. São Paulo, Edgard Blücher & Edusp. p. 125-178.

RODRIGUES, F. H. G. & MONTEIRO, E. L. A. 2000. Home range and activity patterns of pampas deer in Emas National Park, Brazil. *Journal of Mammalogy 81*: 1136-1142.

ZAR, J. H. 1999. *Biostatiscal analysis*. Upper Saddle River, Prentice Hall.

3. The flora of the cerrado in Emas National Park (central Brazil): a statistical approach

Abstract – The Emas National Park (ENP), located in central Brazil, is the largest and one of the most important reserves among those that represent the cerrado vegetation. We carried out a floristic survey in the cerrado physiognomies of ENP and found 601 species. Based on this floristic list, we compared the frequency distribuition of species per family obtained for the ENP flora with those obtained by other authors for the cerrado vegetation as a whole and the Cerrado Domain. We used these more general pattern as null models against which the frequency distribution of species per family in ENP was tested, characterizing thus its flora and discussing some phytogeographical patterns. The frequency distribution of genus and family sizes was highy skewed to the smallest class, with a higher number of monospecific genera and families. The distribution of species per family in ENP was significantly different from those obtained in the Cerrado Domain and in both components of the cerrado flora. The herbaceous component of ENP flora was characterized by the overproportion of Myrtaceae and underproportion of Orchidaceae and Lythraceae, and the woody component, by the overproportion of Myrtaceae and Nyctaginaceae. When compared with outlying cerrado sites, the ENP was quite distinct, not only on species level, but also on family level. Should more floristic surveys in which the herbaceous component had been sampled became available, the consistency of the patterns found in ENP in relation to the cerrado as a whole could be tested.

Resumo – O Parque Nacional das Emas (PNE), localizado no Brasil Central, é a maior e uma das mais importantes reservas entre aquelas que representam a vegetação de cerrado. Nós realizamos um levantamento florístico nas fisionomias de cerrados existente na reserva e encontramos 601 espécies. A partir dessa listagem florística, nós comparamos a distribuição de espécies por famílias obtidas para a flora do PNE com aquelas obtidas por outros autores para o cerrado *sensu lato* como um todo e o Domínio do Cerrado. Usamos esses padrões mais gerais como modelos nulos contra os quais a distribuição de espécies por famílias no PNE foi testada, caracterizando assim sua flora e discutindo alguns padrões fitogeográficos. As distribuições dos tamanhos de famílias e gêneros foram deslocadas para a menor classe, com um maior número de famílias e gêneros com uma única espécie. A distribuição de espécies por famílias no PNE foi significativamente diferente daquelas encontradas tanto no Domínio do Cerrado quanto nos componentes herbáceo-subarbustivo e arbustivo-arbóreo do cerrado *sensu lato*. O componente herbáceo-subarbustivo da flora do cerrado no PNE se caracterizou pela super-representação de Myrtaceae e subrepresentação de Orchidaceae e Lythraceae, e o componente arbustivo-arbóreo, pela maior proporção do que a esperada de Myrtaceae e Nyctaginaceae. Quando comparado com áreas disjuntas de cerrado, o PNE se mostrou bem distinto, não só em nível de espécie, mas também em nível de família. Quando outros levantamentos florísticos em que o componente herbáceo-subarbustivo tenha sido amostrado estiverem disponíveis, a consistência dos padrões encontrados no PNE em relação ao cerrado como um todo poderá ser testada.

Key words – cerrado; savanna; floristics; flora; central Brazil; Emas National Park.

Introduction

The Cerrado Domain is the second largest Brazilian phytogeographic province, occupying originally 23% of Brazil's land area (Ratter *et al.* 1997). As its name implies, in the Cerrado Domain, the cerrado vegetation prevails. The cerrado refers to several structural types, from grasslands to tall woodlands, but most of which fit the definition of tropical savannas (Sarmiento 1983). The cerrado core area covers the Brazilian Central Plateau (Figure 1), and outlying areas occur, for example, in the southern São Paulo State (Ratter *et al.* 1997). In addition to the cerrado vegetation itself, the Cerrado Domain comprises other vegetation types, such as dry forest, seasonal forest, riparian forest, wet field, and rocky field (Eiten 1977), which cover smaller areas, interspersed with the cerrado. The cerrado was included among the hotspots for conservation in the world due to its high richness, high degree of endemism, and current conservation status (Fonseca *et al.* 2000).

The cerrado vascular flora has two distinct components, the herbaceous and the woody ones, which are antagonistic because both are heliophilous (Rizzini 1963). Attempts to compile a checklist of the cerrado flora have been made since Rizzini (1963), who listed 537 woody species. More recently, Castro *et al.* (1999) compiled many floristic and phytosociological surveys and related 973 species identified with confidence for the cerrado woody component. Based on taxonomic revisions, floristic surveys, and visits to herbaria, we related 2,856 species in the cerrado herbaceous component (Chapter 6). For the whole Cerrado Domain, that is, including also the other vegetation types that occur interspersed with the cerrado, Mendonça *et al.* (1998) listed 6,429 species.

Castro (1994) recognized, for the woody flora at least, eight phytogeographical groups in the cerrado: two southern groups (mainly São Paulo and Paraná States), three central groups (Central Plateau), one northeastern group (Piauí and Ceará States), one western group (Pantanal, the Brazilian wetlands), and one coastal group (along the northeastern coast). The two southern groups and two of the three central groups are indicated by the presence of *Piptocarpha rotundifolia* (Less.) Baker (Asteraceae), while the remaining four groups, by the presence of *Curatella americana* L. (Dilleniaceae).

The Emas National Park (ENP) is located in the cerrado core region (Figure 1) and is the largest and one of the most important reserves among those that represent this vegetation type (Conservation International 1999). We carried out a floristic survey in the cerrado of ENP (Chapter 2), which allowed an assessment of the size, taxonomic composition, and similarity with other sites for the ENP vascular flora.

Our aim is to compare the ENP flora with other outlying cerrado sites and with general patterns found for the cerrado vegetation and the Cerrado Domain, trying thus to answer the following questions: Are the frequency distribution of species per family in ENP flora significantly different from those found by Mendonça *et al.* (1998) for the Cerrado Domain? If so, which families characterize the ENP flora? Are outlying cerrado sites (Mantovani & Martins 1993, Batalha *et al.* 1997, Batalha & Mantovani 2000) more similar among themselves than to a core cerrado site, such as ENP? When compared with these outlying cerrado sites, which families characterize the ENP and which families characterize the outlying sites? Are the distribution of species per family in ENP woody and herbaceous components significantly different from those found, respectively, by Castro *et al.* (1999) and on Chapter 6? If so, which families characterize the ENP woody and herbaceous components? Amongst the most frequent woody species in cerrado sites (Castro 1994), are there some not found in ENP? According to the indicator species of the eight cerrado phytogeographical groups (Castro 1994), can the ENP be placed in one of them?

Figure 1. Cerrado region and the location of Emas National Park (after Ramos-Neto & Pivello 2000, modified).

Material and Methods

The ENP is located in the Brazilian Central Plateau, in the cerrado core region, southwestern Goiás State (17°49'-18°28'S, 52°39'-53°10'W). The park was created in 1961, with 132,941 ha. Regional climate is tropical and humid, with wet summer and dry winter, which is classified as Aw following Köppen's (1948) system. Annual rainfall varies from 1,200 to 2,000 mm, concentrated from October to March, and mean annual temperature lies around 24,6°C (Ramos-Neto & Pivello

2000). Three quarters of ENP consist of flat tableland, 820-888 m high, and the remaining area consists of hilly terrain, 720-820 m high. In the reserve, 93.2% of its total area is covered by cerrado (Ramos-Neto & Pivello 2000).

In our floristic survey (Chapter 2), we found 601 species, 303 genera, and 80 families. Of these 601 species, 149 were considered as belonging to the woody component and 452, to the herbaceous component. For the whole flora and its two components, we calculated the frequency distribution of species per family.

To compare the distribution of species per family between the ENP and the Cerrado Domain, we first reclassified the checklist available for the latter (Mendonça *et al.* 1998) in families according to Judd *et al.* (1999). Then, we selected the ten richest families of each flora to carry out the comparison. Even if one of the richest families in one flora was not among the richest families in the other, it was included in the analysis. For example, Orchidaceae, which was one of the richest families in the Cerrado Domain but not in ENP, was included in the analysis. We constructed a contigency table and compared both frequency distributions with the chi-square test (Zar 1999).

The ENP flora was compared with outlying cerrado sites in Mojiguaçu (Mantovani & Martins 1993), Pirassununga (Batalha *et al.* 1997), and Santa Rita do Passa Quatro (Batalha & Mantovani 2000), all located in the southern São Paulo State. These three floristic lists were refined, and the species reclassified in families following Judd *et al.* (1999). The similarity values among these four sites were calculated with Sørensen index (Magurran 1988). To determine which families characterized each site, we used the principal component analysis (PCA) (Jongman *et al.* 1995). In this case, only those families with at least ten species in one of the sites were included. Data were standardized and centralized prior to the analysis.

To compare the distribution of woody species per family in ENP and in the whole cerrado, we also reclassified the checklist compiled by Castro *et al.* (1999) according to Judd's *et al.* (1999) system.

From their list, only those species identified with confidence were considered, that is, those species identified on genus or family level, or dubiously (*aff.* or *cf.*), were not included in the analysis. We compared the frequency distribution of species per family, using the ten richest families of each flora, with a contigency table (Zar 1999). To assess on which phytogeographical group the ENP woody flora should be placed, we used Castro's (1994) indicator species.

The distribution of herbaceous species per family in ENP flora was compared with those found in the cerrado herbaceous flora as a whole (Chapter 6). To verify whether these two distributions were significantly different, we arranged the data in a contigency table and applied the chi-square test (Zar 1999).

Results

The ENP flora presented a highly skewed frequency distribution to the smallest size class of both species per family (Figure 2) and species per genus (Figure 3), with one being the modal class for both distributions. Monospecific families made up 36.25% of the total families, and monospecific genera, 64.03% of the total genera.

The distribution of species per family was significantly different between the ENP and the Cerrado Domain (χ^2 = 158.35, $P < 0.001$), due mainly to the underproportion of Orchidaceae (20.84% of the chi-square value) and overproportion of Malvaceae (12.79%), Asteraceae (12.36%), and Lamiaceae (10.05%) in ENP flora (Table 1).

The similarity values (Table 2) between ENP and the outlying cerrados ranged from 0.413 (ENP *vs.* Pirassununga) to 0.441 (ENP *vs.* Santa Rita do Passa Quatro). These figures were higher among the outlying sites, with Pirassununga and Santa Rita do Passa Quatro being the most similar ones (0.660).

In the PCA, the first axis explained 54.06% of the variation, and the second axis, an additional 34.91%. The first axis separated clearly the ENP from the outlying cerrado sites, the former with positive eigenvalues and the latter with negative eigenvalues (Figure 4). The families with higher positive eigenvalues in the first axis were Convolvulaceae and Lamiaceae, and the families with higher negative eigenvalues were Melastomataceae and Rubiaceae (Figure 4).

The distribution of woody species per family was significantly different between the ENP and the whole cerrado ($\chi^2 = 22.86$, $P = 0.011$), due especially to the overproportion of Myrtaceae (34.76% of the chi-square value) and Nyctaginaceae (15.89%) and the underproportion of Asteraceae (13.05%) in ENP woody flora (Table 3).

Among the 50 most frequent species in cerrado samples, i.e., those which appeared on at least 30% of the sites related by Castro (1994), only *Astronium fraxinifolium* Schott (Anacardiaceae), *Curatella americana* L. (Dilleniaceae), *Sclerolobium aureum* (Tul.) Benth. (Fabaceae), and *Salvertia convallariodora* A. St-Hil. (Vochysiaceae) were not found in ENP. Taking into account Castro's (1994) indicator species, the ENP could be placed only on one of the central groups, which is indicated by the presence of *Piptocarpha rotundifolia* (Less.) Baker (Asteraceae), *Casearia sylvestris* Sw. (Flacourtiaceae), and *Qualea parviflora* Mart. (Vochysiaceae).

The frequency distribution of herbaceous species per family was also significantly different between the ENP and the whole cerrado ($\chi^2 = 42.77$, $P < 0.001$), due mainly to the overproportion of Myrtaceae, which was responsible for 30.24% of the chi-square value (Table 4). In relation to the whole cerrado, Lythraceae (13.99% of the chi-square value) and Orchidaceae (13.12%) presented a lower frequency than expected in the ENP herbaceous flora.

Table 1. Number of species per family in Emas National Park (ENP) and the whole Cerrado Domain. Family names were abbreviated according to Weber (1982).

	number of species			
	ENP		Cerrado Domain	
family	observed	expected	observed	expected
Ast	88	55.14	557	589.86
Fab	87	73.86	777	790.14
Poa	51	36.08	371	385.92
Mrt	39	21.37	211	228.63
Lam	24	10.86	103	116.14
Mlp	23	12.74	126	136.26
Eup	20	17.35	183	185.65
Apo	19	27.36	301	292.64
Mlv	16	5.47	48	58.53
Rub	16	22.74	250	243.26
Cnv	15	7.18	69	76.82
Mls	9	20.52	231	219.48
Orc	5	42.40	491	453.60
Lyt	3	9.92	113	106.08
Others	186	238.01	2598	2545.99

Table 2. Similarity values among four cerrado sites according to Sørensen index. ENP (Emas National Park) = 17°49'-18°28'S, 52°39'-53°10'W, Mojiguaçu = 22°15-16'S, 47°08-12'W, Pirassununga = 22°02'S, 47°30'W, Santa Rita (Santa Rita do Passa Quatro) = 21°36-44'S, 47°34-41'W.

	ENP	Mojiguaçu	Pirassununga	Santa Rita
ENP	1.000			
Mojiguaçu	0.426	1.000		
Pirassununga	0.413	0.629	1.000	
Santa Rita	0.441	0.559	0.660	1.000

Table 3. Number of woody species per family in Emas National Park (ENP) and the whole cerrado. Family names were abbreviated according to Weber (1982).

	number of woody species			
	ENP		cerrado	
family	observed	expected	observed	expected
Fab	28	26.83	174	175.17
Mrt	23	12.88	74	84.12
Mlp	7	7.30	48	47.70
Mls	7	7.97	53	52.03
Ann	6	4.25	26	27.75
Apo	5	3.45	21	22.55
Voc	5	3.85	24	25.15
Big	4	5.18	35	33.82
Nyc	4	1.59	8	10.41
Rub	4	6.11	42	39.89
Ast	3	7.84	56	51.16
Eup	1	3.32	24	21.68
Others	52	58.43	388	381.57

Table 4. Number of herbaceous species per family in Emas National Park (ENP) and the whole cerrado. Family names were abbreviated according to Weber (1982).

family	number of herbaceous species			
	ENP		cerrado	
	observed	expected	observed	expected
Ast	85	72.28	444	456.72
Fab	59	58.62	370	370.38
Poa	48	42.49	263	268.51
Lam	23	20.63	128	130.37
Eup	19	19.95	127	126.05
Mlp	16	11.48	68	72.52
Mrt	16	6.70	33	42.30
Cnv	15	13.94	87	88.06
Apo	14	12.98	81	82.02
Mlv	13	13.80	88	87.20
Cyp	12	8.33	49	52.67
Rub	12	15.17	99	95.83
Vrb	12	9.15	55	57.85
Orc	5	13.80	96	87.20
Lyt	2	9.56	68	60.44
Others	101	123.11	800	777.89

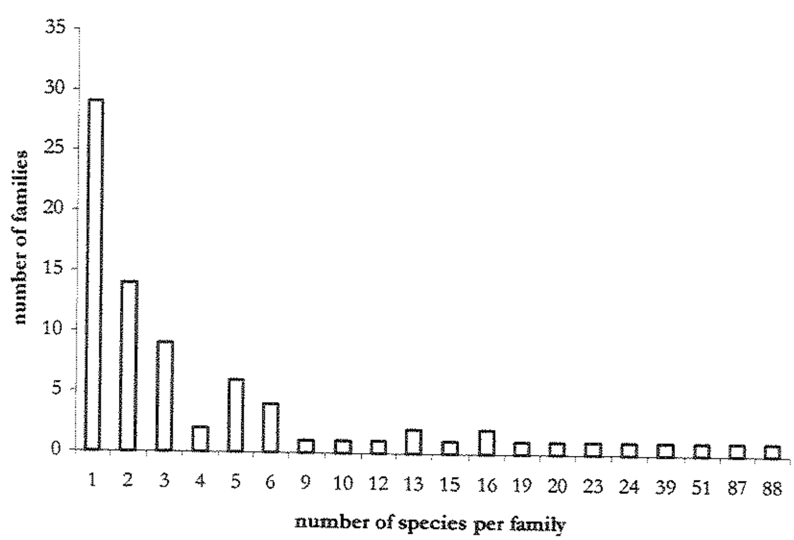

Figure 2. Frequency distribution of family sizes in the vascular flora of Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil.

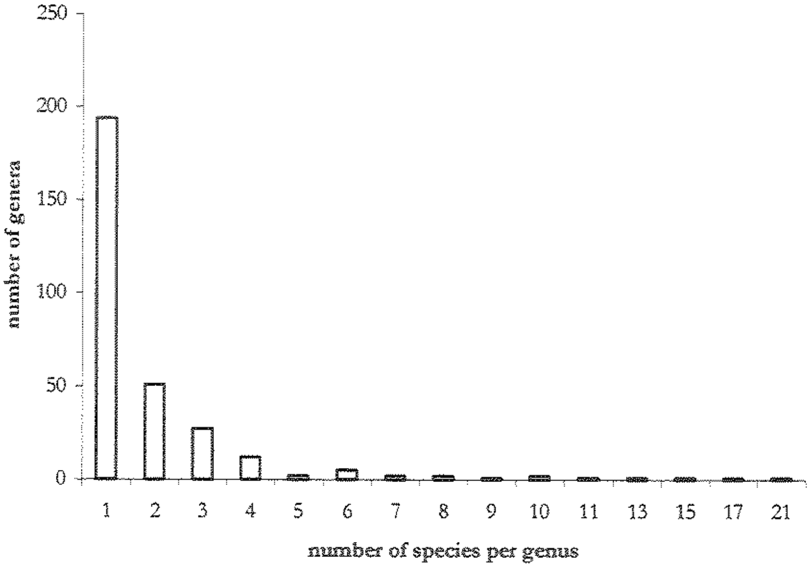

Figure 3. Frequency distribution of genera sizes in the vascular flora of Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil.

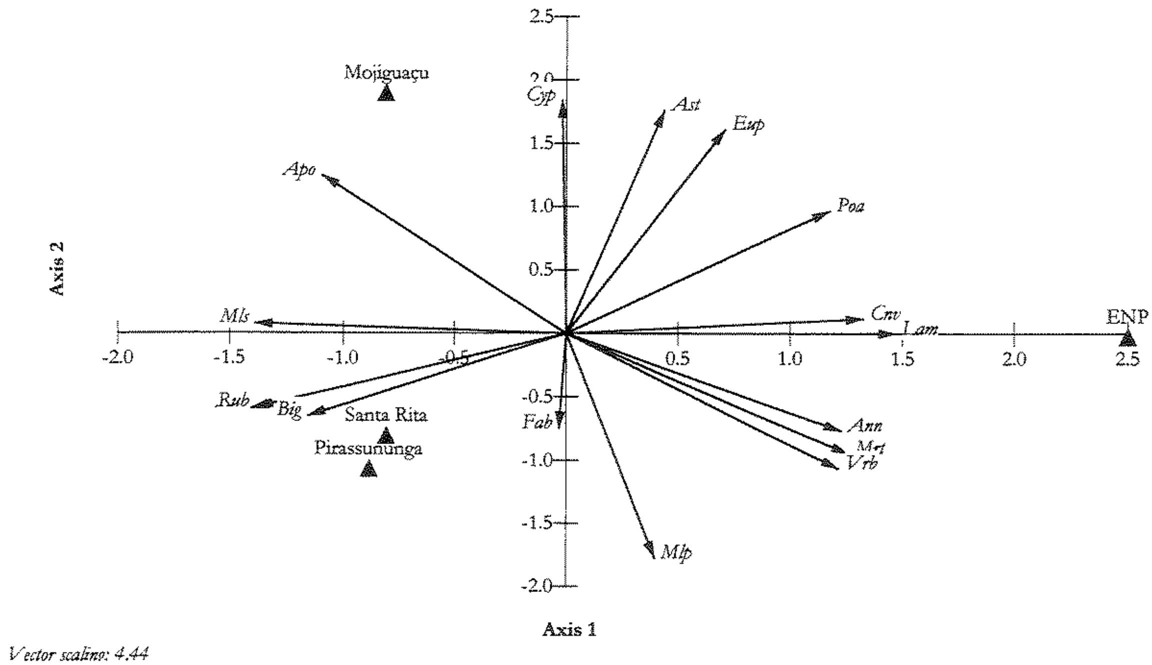

Figure 4. Principal component analysis biplot of the richest families in four cerrado floras. Emas (Emas National Park) = 17°49'-18°28'S, 52°39'-53°10'W, Mojiguaçu = 22°15-16'S, 47°08-12'W, Pirassununga = 22°02'S, 47°30'W, Santa Rita (Santa Rita do Passa Quatro) = 21°36-44'S, 47°34-41'W. Family names were abbreviated according to Weber (1982).

Discussion

The distribution of species per family and genus was highly skewed in ENP flora, with many monospecific families and genera, the same pattern found in the cerrado as a whole (Castro *et al.* 1999, Chapter 6). In Neotropical savannas, in general, and in the cerrado, in particular, there are many genera with one or few species (Sarmiento 1983). Some of them, as *Plenckia*, *Bowdichia*, *Cochlospermum*, *Diptychandra*, *Echinolaena*, *Hancornia*, *Harpalyce*, *Hoehnephyton*, *Pterodon*, *Spiranthera*, *Thrasya*, and *Tristachya*, all occurring in ENP, are quite abundant and frequent in cerrado sites (Sarmiento 1983). Based on this, Sarmiento (1983) postulated that this taxonomic isolation reflects an evolution within this ecosystem which has allowed a differentiation on generic level, representing thus a floristic paleoelement well adapted to the savanna environment.

Highly skewed distributions of family and genus sizes to the smallest class, however, were also found in other tropical floras (*e.g.*, Turner 1994, 1997). Turner (1994), for instance, found 24% and 55% of monospecific families and genera, respectively, in the flora of Singapore. If high proportions of monospecific families and genera are also found in other vegetation types, then there is no evidence in support of Sarmiento's (1983) hypothesis of the Neotropical savannas as a floristic paleoelement due to its high number of genera with one or few species. To test his hypothesis, one should compare the frequency distribution of species per genus and family between the savanna and the neighboring forest floras, as those of the Amazon and Atlantic rain forests. If the number of monospecific genera were higher in the cerrado than in the neighboring forests, then Sarmiento's (1983) hypothesis would be corroborated.

The frequency distribution of family sizes was significant different between ENP and the Cerrado Domain, with the overproportion of Asteraceae, Malvaceae, and Lamiaceae characterizing the former in relation to the latter. Since, in the Cerrado Domain, other vegetation types besides the cerrado itself exist, there is a bias in this comparison due to the inclusion of species which occur only in these other vegetation types. Most of these vegetation types present closed physiognomies (dry, seasonal, or riparian forests), with many woody species, and thus, when a given cerrado site is compared with the whole Cerrado Domain, a higher proportion of families with herbaceous species mainly is expected. Indeed, the three families which characterized the cerrado in ENP are composed especially by herbaceous species (Gentry 1993).

Besides, some families can be well represented in the other vegetation types but not in the cerrado and are thus expected to appear with lower proportion in cerrado sites when these are compared with the Cerrado Domain. Orchidaceae, which is underrepresented in ENP, could be one of these families, because many species are epiphytic and found only in closed and moist environments, such as forests (Gentry & Dodson 1987). On the other hand, this family was also well represented in the cerrado herbaceous component (Chapter 6), due to the large number of geophytic orchids (Mendonça *et al.* 1998). Orchidaceae could be a family with many species with restricted geographic range and therefore appearing with many species only when one is working on larger scales.

Probably, as a consequence of the larger geographic distance, the similarity values between ENP, a core cerrado site, and the outlying cerrados were lower than the similarity values among these outlying sites. Sørensen index is influenced by the number of species in the sites under comparison, but, regardless the richness of each site, the similarity values between ENP and the outlying sites were always lower than among the outlying sites. Comparison of different cerrado sites has shown that their floristic composition may vary widely even among sites geographically close, and that many species has sporadic or patchy distributions (Castro 1994). Nevertheless, although our comparison was restricted to few sites due to the almost complete absence of studies in which both herbaceous and woody components had been sampled, a geographic pattern in the floristic composition of cerrado sites seems to exist when both components are considered.

The first axis of the PCA was enough to separate clearly the ENP from the outlying sites, suggesting that there could be also differences on family level between core and outlying sites. Our analysis indicated that ENP is characterized by Convolvulaceae and Lamiaceae and the oulying sites, by Malvaceae, Melastomataceae, and Rubiaceae. When more floristic surveys are available, this pattern should be tested to check its consistency.

In the woody component, the frequency distribution of species per family in ENP was significantly different from those found in the whole cerrado (Castro *et al.* 1999), being characterized by a higher proportion of Myrtaceae and Nyctaginaceae and a lower proportion of Asteraceae in ENP. In the checklist compiled for the whole cerrado (Castro *et al.* 1999), the high proportion of undetermined taxa in some families may alter the frequency distribution of family sizes. For example, in addition to the 96 species belonging to Myrtaceae, there are more 100 taxa not identified with confidence (Castro *et al.* 1999).

Another bias in this comparison is the different criteria to consider a given species as belonging to the woody component. While we considered only the phanerophytes, according to Raunkiaer's (1934) system, as woody species, Castro *et al.* (1999) used as many criteria as appeared in the surveys they compiled, i.e., for them, if only one author considered a determined species as woody, it was included in their list. Many Asteraceae species included in their list are not phanerophytes and thus, if they occurred in ENP, were not considered by us as belonging to the herbaceous component. This could explain the underproportion of this family in ENP when compared with the cerrado as a whole.

The placement of ENP in one of Castro's (1994) central group is expected due its geographic location, in the Brazilian Central Plateau. Among the most frequent species in cerrado sites (Castro 1994), those not found in ENP, *Astronium fraxinifolium*, *Curatella americana*, *Salvertia convallariodora*, and *Sclerolobium aureum*, probably occur preferentially in other phytogeographical groups. To corroborate the placement of ENP in one of Castro's (1994) central group, his analysis should be redone, including the ENP data.

In the herbaceous component, the frequency distribution of species per family in ENP was also significantly different from those found in the whole cerrado (Chapter 6). The herbaceous component in ENP flora was also characterized by a higher proportion of Myrtaceae. The underproportion of Orchidaceae and Lythraceae, as stated previously, could be a consequence of many species with small geographic range. Although both herbaceous and woody components of ENP cerrado flora presented significantly different distribution of family sizes when compared with the whole cerrado, the chi-square value in the latter was much lower than in the former. This corroborates the hypothesis that the heterogeneity – in this case, the frequency distribution of family sizes – is much higher in the herbaceous than in the woody component of the cerrado flora (Mantovani & Martins 1993).

Conclusions

The flora of the cerrado in ENP presented the same pattern found in the whole cerrado concerning the frequency distribution of family sizes, that is, highly skewed to the smallest class. There is no evidence in support of Sarmiento's (1983) hypothesis of the cerrado as a floristic paleoelement, since this pattern is also found in other floras. The distribution of species per family for the whole cerrado can be used as null models, against which the flora of a particular site can be tested. In ENP, we found some families which characterized its flora in relation to those distributions found for the whole cerrado. These comparisons should be carried out for other sites, trying to find if there is a geographic or even a physiognomic pattern in the frequency distribution of species per family in the cerrado. The geographic component which exist in the floristic composition of cerrado sites, at least for the woody flora, seems to exist also on family level. In this case, some families would characterize some phytogeographical groups. Unfortunately, up to now, there are few surveys in which the herbaceous component, and not only the woody component, had been sampled. When other complete lists are available, the consistency of the patterns found in ENP in relation to the whole cerrado can be tested.

Aknowledgements – We are grateful to Fapesp, for financial support (process 97/13.697-5); to Ibama, for research license (process 02001,000376/98-90); to the Emas National Park staff, for their help in field; and to M.B. Ramos-Neto, for logistical assistance.

References

BATALHA, M. A.; ARAGAKI, S. & MANTOVANI, W. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo 16*: 49-64.

BATALHA, M. A. & MANTOVANI, W. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparison between the herbaceous and the woody floras. *Revista Brasileira de Biologia 60*: 129-145.

CASTRO, A. A. J. F. 1994. Comparação florística-geográfica (Brasil) e fitossociológica (Piauí – São Paulo) de amostras de cerrado. Ph. D. Thesis, State University of Campinas.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y. & SHEPHERD, G. J. 1999. How rich is the flora of the Brazilian cerrados? *Annals of the Missouri Botanical Garden 86*: 192-224.

CONSERVATION INTERNATIONAL. 1999. *Ações prioritárias para a conservação do Cerrado e do Pantanal.* Brasília, Conservation International.

EITEN, G. 1977. Delimitação do conceito Cerrado. *Arquivos do Jardim Botânico 21*: 125-134.

FONSECA, G. A. B. DA; MITTERMEIER, R. A.; CAVALCANTI, R. B. & MITTERMEIER, C. G. 2000. Brazilian Cerrado. *In* MITTERMEIER, R. A.; MYERS, N.; GIL, P. R. & MITTERMEIER, C. G. (eds).

Hotspots, Earth's biologically richest and most endangered terrestrial ecoregions. Chicago, Conservation International. p. 148-159.

GENTRY, A. H. 1993. *A field guide to woody plants of northwest South America.* Chicago, University of Chicago.

GENTRY, A. H. & DODSON, C. H. 1987. Diversity and biogeography of Neotropical vascular epiphytes. *Annals of the Missouri Botanical Garden 74*: 205-233.

JONGMAN, R. H. G.; TER BRAAK, C. J. F. & VAN TONGEREN, O. F. R. 1995. *Data analysis in community and landscape ecology.* Cambridge, Cambridge University.

JUDD, W. S.; CAMPBELL, C. S.; KELLOG, E. A. & STEVENS, P. F. 1999. *Plant systematics: a phylogenetic approach.* Sunderland, Sinauer.

KÖPPEN, W. 1948. *Climatología.* México, Fondo de Cultura Económica.

MAGURRAN, A. E. 1988. *Ecological diversity and its measurement.* Princeton, Princeton University.

MANTOVANI, W. & MARTINS, F. R. 1993. Florística do cerrado na reserva biológica de Moji Guaçu, SP. *Acta Botanica Brasilica 7*: 33-60.

MENDONÇA, R. C. DE; FELFILI, J. M.; WALTER, B. M. T.; SILVA JÚNIOR, M. C. DA; REZENDE, A. V.; FILGUEIRAS, T. S. & NOGUEIRA, P. E. 1998. A flora vascular do cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora.* Planaltina, Embrapa. p. 289-556.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environmental Management 26*: 675-684.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography.* Oxford, Claredon.

RIZZINI, C. T. 1963. A flora do cerrado. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado.* São Paulo, Edgard Blücher & Edusp. p. 125-178.

SARMIENTO, G. 1983. The savannas of tropical america. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Amsterdam, Elsevier. p. 245-288.

TURNER, I. M. 1994. The taxonomy and ecology of the vascular plant flora of Singapore: a statistical analysis. *Botanical Journal of the Linnean Society 114*: 215-227.

TURNER, I. M. 1997. A tropical flora summarized – a statistical analysis of the vascular plant diversity of Malaya. *Flora 192*: 157-163.

WEBER, W. A. 1982. Mnemonic three-letter acronyms for the families of vascular plants: a device for more effective herbarium curation. *Taxon 31*: 74-88.

ZAR, J. H. 1999. *Biostatiscal analysis.* Upper Saddle River, Prentice Hall.

4. Life-form spectrum of the cerrado in Emas National Park (central Brazil)

Abstract – The Emas National Park (ENP), located in central Brazil, is the largest reserve of the cerrado vegetation. We carried out a floristic survey in the cerrado physiognomies of ENP and constructed the life-form spectrum of its flora, following Raunkiaer's system. The main life-form classes were hemicryptophytes and phanerophytes, which accounted, respectively, for 49.92% and 24.79% of the total number of species. When compared with Raunkiaer's normal spectrum, the ENP spectrum was significantly different, due especially by the overproportion of hemicryptophytes. Other cerrado sites presented also higher proportions of hemicryptophytes and phanerophytes, although their relative importance varied according to the prevailing physiognomies. When compared with life-form spectra from other vegetation types, the cerrado sites formed a distinct group, with eigenvalues closer to those of the hemicryptophytes and phanerophytes. The cerrado sites distinguished themselves from the savanna sites by their under-representation of therophytes. Even if sometimes criticized in its application on tropical communities, Raunkiaer's system was useful to characterize the cerrado floras and to separate it from other vegetation types.

Resumo – O Parque Nacional das Emas (PNE), localizado no Planalto Central, é a maior reserva de cerrado. Nós realizamos um levantamento florístico nas fisionomias de cerrado do PNE e construímos o espectro biológico da sua flora, segundo o sistema de Raunkiaer. As principais formas de vida foram os hemicriptófitos e os fanerófitos, que representaram, respectivamente, 49,92% e 24,79% do número total de espécies. Quando comparados ao espectro normal de Raunkiaer, o espectro do PNE foi significativamente diferente, devido especialmente à maior proporção de hemicriptófitos. Outros sítios de cerrado também apresentaram maiores proporções de hemicriptófitos e fanerófitos, embora a importância relativa dessas classes tenha variado conforme as fisionomias predominantes. Quando comparados a espectros biológicos de outras formações vegetais, os sítios de cerrado formaram um grupo distinto, com autovalores mais próximos daqueles dos hemicriptófitos e fanerófitos. Os sítios de cerrado se distinguiram daqueles das demais savanas pela subrepresentação dos terófitos. Ainda que algumas vezes criticado quanto à sua aplicabilidade em comunidades tropicais, o sistema de Raunkiaer foi útil para caracterizar as floras de cerrado e separá-las dos demais tipos vegetacionais.

Key words – cerrado; savanna; life-form; biological spectrum; Raunkiaer; Emas National Park.

Introduction

Plant life-forms are usually understood as a growth form which displays an obvious relationship to key environmental factors (Mueller-Dombois & Ellenberg 1974), being characterized by the adaptations of plants to certain ecological conditions, as, for example, mean annual temperature or precipitation (Mera *et al.* 1999). According to Box (1981), the study of plant life-forms is important for the following reasons: plant life-forms provide the basic structural components of vegetation stands, being the most obvious level of subdivision for describing and explaining vegetation structure; primary physiological processes of plants are controlled by aspects of plant form; and plant form provides an useful means of getting at general principles of plant-environment relations without becoming mired in taxonomic detail.

Attempts to group plant species in life-forms began with Humboldt (1806), who proposed 17 main forms (*Hauptformen*), representing families or groups more or less analogous among themselves. Since then, several proposals to group plants according to their growth habits were published (see Cain 1950 and Mueller-Dombois & Ellenberg 1974 for references). In 1904, Raunkiaer proposed a classification system based on the position and degree of protection of the perennating buds, which are responsible for renewal after the unfavourable season. In this system, which was later translated into English (Raunkiaer 1934), the more pronounced the unfavourable season, the more protected the perennating buds. There are, in his classification, five major classes, arranged according to increased protection of the buds: phanerophytes, chamaephytes, hemicryptophytes, cryptophytes, and therophytes.

If life-forms indicate adaptations to climatic conditions, then climate can be characterized by the prevailance of certain life-forms. Assuming this premise, Raunkiaer (1934) formulated the concept of phytoclimate and proposed the "biological spectrum" to represent it. The biological, or life-form, spectrum is the percentual representation of the number of species belonging to each life-form class in a given flora. Raunkiaer (1934) determined the life-form of 1000 species, which he assumed to be representative of the world flora, and constructed a "normal biological spectrum". The normal spectrum could work as a null model to which a certain flora could be compared. Differences in the frequency of life-form classes between the flora under study and the normal spectrum would point out which life-form characterizes the climate in question.

Raunkiaer's system was modified, among others, by Braun-Blanquet (1928) and Mueller-Dombois & Ellenberg (1974), to include plant traits in the favourable season, which were originally neglected by Raunkiaer (1934). Although sometimes heavily criticized (*e.g.*, Sarmiento & Monasterio 1983), Raunkiaer's system is still the simplest and, in many ways, the most satisfying classification of plant life-forms (Begon *et al.* 1996).

This system has been widely applied in many vegetation types to classify plant species in life-forms, as, for example, in deserts (Qadir & Shevty 1986, El-Demerdash *et al.* 1994, El-Ghani 1998), meadows (Beaman & Andresen 1966), mediterranean vegetation (Dimopoulus & Georgiadis, 1992, Christodoulakis 1996), prairies (Stalter *et al.* 1991), savannas (Cole & Brown 1976, Sarmiento & Monasterio 1983), temperate forests (Buell & Wilbur 1948, Gao & Chen 1998), tundra (Raunkiaer 1934), tropical grasslands (Shankar *et al.* 1991), and tropical rain forests (Cain *et al.* 1956).

The Cerrado Domain is the second largest Brazilian phytogeographic province, occupying originally 23% of Brazil's land area (Ratter *et al.* 1997). As its name implies, in the Cerrado Domain, the cerrado vegetation prevails. The cerrado vegetation presents a wide physiognomic range, from grasslands to tall woodlands, but most of its physiognomies fit the definition of tropical savannas (Sarmiento 1983). The cerrado core area covers the Brazilian Central Plateau, and outlying areas occur, for example, in the southern São Paulo State (Ratter *et al.* 1997). The Emas National Park

(ENP) is located in the core region and is one of the most important reserves among those that represent this vegetation type (Conservation International 1999).

In the cerrado, some studies used Raunkiaer's system to classify the sampled species in life-forms. For instance, Mantovani (1983) classified the vascular plant species of an outlying cerrado site in life-forms, constructed its biological spectrum, and compared it with life-form spectra from core cerrado sites (Warming 1892, Ratter 1980). Batalha (1997) and Batalha *et al.* (1997) carried out floristic surveys in two outlying cerrado sites and also classified the species in life-form classes. In all of these sites, high proportions of hemicryptophytes and phanerophytes were found.

Our aim is to classify in life-forms the vascular plant species found in the cerrado of ENP, following Raunkiaer's (1934) system, constructing then the biological spectrum of this flora and comparing it with the normal spectrum and with those from other sites. Thus, our major questions were: Are hemicryptophytes and phanerophytes the prevailing life-forms in the cerrado flora of ENP, as in other cerrado sites (Mantovani 1983, Batalha 1997, Batalha *et al.* 1997)? Is the ENP life-form spectrum significantly different from Raunkiaer's (1934) normal spectrum? If so, which life-form characterizes the ENP spectrum? When compared with other cerrado sites, is there a physiognomic pattern among them? When compared with life-form spectra from other vegetation types, do the life-form spectra from cerrado sites form a distinct group?

Material and Methods

The ENP, with 132,941 ha, is located in the Brazilian Central Plateau, in the cerrado core region, southwestern Goiás State (17°49'-18°28'S, 52°39'-53°10'W). Regional climate is tropical and humid, with wet summer and dry winter, classified as Aw following Köppen's (1948) system. Three quarters of ENP consist of flat tableland, 820-888 m high, and the remaining area consists of hilly terrain, 720-820 m high (Ramos-Neto & Pivello 2000). The cerrado in ENP presents almost all physiognomies found in this vegetation type, from *campo limpo* (a grassland) to *cerrado sensu stricto* (a woodland). In the reserve, open cerrado physiognomies – *campo limpo*, *campo sujo* (a shrub savanna), and *campo cerrado* (a savanna woodland) – prevail, covering 68.1% of the total area, especially on the flat tableland (Ramos-Neto & Pivello 2000). The more closed *cerrado sensu stricto* covers 25.1% of the reserve, mainly on the hilly terrain. The remaining 6.9% is covered by other vegetation types (riparian forest, seasonal forest, and wet field), roads, and firebreaks. Every 3-4 years approximately, uncontrollable wildfires occur in ENP due to dry biomass accumulation (Ramos-Neto 2000).

In the cerrado physiognomies existing within the reserve, we carried out floristic surveys from November 1998 to October 1999, in monthly field trips, when we found 601 species (Chapter 2). In this survey, we recorded necessary informations to classify the plant species in life-forms: whether they were autotrophic or heterotrophic, whether they were self-supporting plants or not, whether they germinated in the soil or on other plants, the position of their perennating buds in the unfavourable season, and whether they were annual or perennial.

With these informations, we classified the species in life-forms following Raunkiaer's (1934) system adapted by Mueller-Dombois & Ellenberg (1974) and constructed the biological spectrum of the cerrado flora in ENP. This spectrum was compared with Raunkiaer's normal spectrum, when epiphytes, lianas, and vascular parasites were included in the "phanerophyte" class, as in Raunkiaer's (1934) original system.

To verify if the ENP biological spectrum was significantly different from the expected according to Raunkiaer's (1934) normal spectrum, we applied the chi-square test (Zar 1999). If so, we calculated the contribution percentage of each class in the chi-square value. In this case, the higher the difference between the expected and the observed in the class, the higher the percentage of its contribution.

We compiled life-form spectra from other cerrado sites (Warming 1892, Ratter 1980, Mantovani 1983, Batalha 1997, Batalha *et al.* 1997) and other vegetation types sites (Raunkiaer 1934, Buell & Wilbur 1948, Cain 1950, Cain *et al.* 1956, Cole & Brown 1976, Sarmiento & Monasterio 1983, Qadir & Shevty 1986, Danin & Orshan 1990, Stalter *et al.* 1991, Dimopoulos & Georgiadis 1992, Tareen & Qadir 1993, El-Demerdash 1994, Christodoulakis 1996, El-Ghani 1998, Gao & Chen 1998, Charest *et al.* 2000), with which we did detrended correspondence analyses (Jongman *et al.* 1995); first, for the cerrado sites only and, second, including the other sites, ploting both sites and life-forms eigenvalues. In the first case, we used Mueller-Dombois & Ellenberg's (1974) subdivisions and, in the second case, we used only Raunkiaer's (1934) five main classes.

Results

Of the 601 species found in the cerrado of ENP, 24.79% were phanerophytes; 12.81%, chamaephytes; 49.92%, hemicryptophytes; 2.00%, geophytes; 3.66%, therophytes; 5.99%, lianas; 0.50%, epiphytes; and 0.33%, vascular parasites (Figure 1). When this spectrum was rearranged to be compared with Raunkiaer's normal spectrum, the proportion of phanerophytes in the spectrum increased to 31.61%.

The difference between Raunkiaer's normal spectrum and the life-form spectrum of the cerrado in ENP was highly significant (χ^2 = 37.50, P <0.001). The proportions of phanerophytes, cryptophytes, and therophytes were lower than the expected by the normal spectrum, while the proportions of hemicryptophytes and chamaephytes were higher (Table 1). The highest contribution to the chi-square value was given by the hemicryptophytes, which were responsible for 58.69% of the total chi-square value. Therophytes contributed with additional 17.89%; phanerophytes, with 12.00%; cryptophytes, with 7.11%; and chamaephytes, with 4.30% (Figure 2).

In all biological spectra from cerrado sites, hemicryptophytes and phanerophytes were the life-form classes with highest proportions (Table 2). The highest percentage of geophytes was found in Lagoa Santa, where they accounted for 5.42% of the total number of species. The highest percentage of therophytes was 7.10%, in Mojiguaçu. In the correspondence analysis, the first axis explained 80.95% of the variation, and the second axis, 4.20%. In the first axis, Pirassununga and Santa Rita do Passa Quatro presented negative eigenvalues, while ENP, Lagoa Santa, and Mojiguaçu presented positive eigenvalues (Figure 3). In the second axis, ENP presented negative eigenvalues, while the remaining sites presented positive values. Regarding the life-form classes, we found higher positive eigenvalues for geophytes and hemicryptophytes in the first axis, and for geophytes and vascular semi-parasites in the second axis.

In the detrended correspondence analysis in which biological spectra from other vegetation types (Table 3) were also included, the first two axes explained 50.42% and 4.86% of the variation, respectively. The ordination biplot of this analysis showed that the cerrado sites formed a group quite distinct from the other vegetation types (Figure 4), with eigenvalues closer to those of the phanerophytes and hemicryptophytes. Other savanna sites appeared with higher eigenvalues in both axes, although widely dispersed. Sites under dry climate appeared generally with higher eigenvalues in the first axis than sites under wet climate. Sites under cold climate presented positive eigenvalues in the first axis and negative eigenvalues in the second axis.

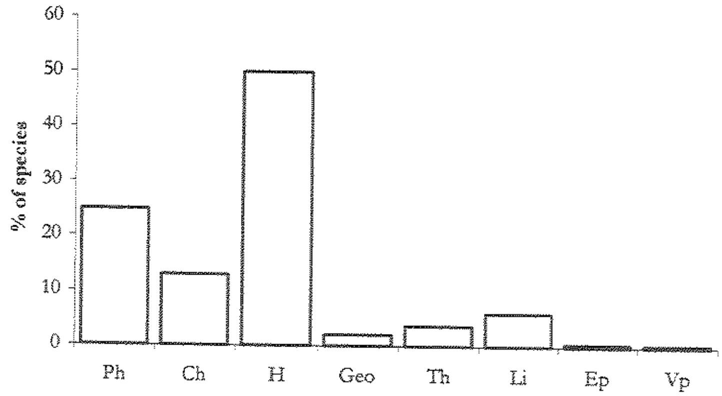

Figure 1. Life-form spectrum of the cerrado in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ph = phanerophyte, Ch = chamaephyte, H = hemicryptophyte, Geo = geophyte, Th = therophyte, Li = liana, Ep = epiphyte, Vp = vascular parasite.

Table 1. Comparison between Raunkiaer's normal spectrum (expected) and the life-form spectrum of the cerrado in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil (observed).

life-form class	expected %	observed %	expected number of species	observed number of species	χ^2
Phanerophyte	46.00	31.61	276.46	190	4.50
Chamaephyte	9.00	12.81	54.09	77	1.61
Hemicryptophyte	26.00	49.92	156.26	300	22.01
Cryptophyte	6.00	2.00	36.06	12	2.67
Therophyte	13.00	3.66	78.13	22	6.71
Total	**100.00**	**100.00**	**601**	**601**	**37.50*****

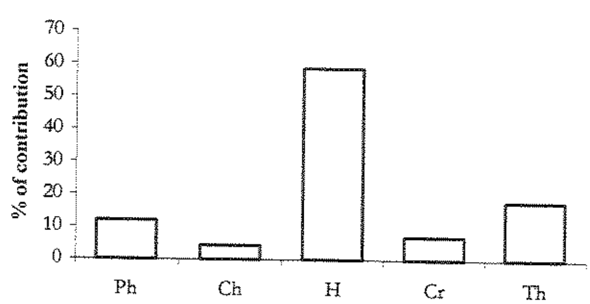

Figure 2. Contribution percentage of each class in the chi-square value in the comparison between Raunkiaer's normal spectrum (expected) and the life-form spectrum of the cerrado in Emas National Park (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil (observed). The proportions were lower than the expected for phanerophytes (Ph), cryptophytes (Cr), and therophytes (Th) and higher for hemicryptophytes (H) and chamaephytes (Ch).

Table 2. Life-form spectra of cerrado floras. Ph = phanerophyte, Ch = chamaephyte, H = hemicryptophyte, Geo = geophyte, Th = therophyte, Li = liana, Ep = epiphyte, Vsp = vascular semi-parasite, Vp = vascular parasite, ENP = Emas National Park.

local	artigo	no. of species	% of species								
			Ph	Ch	H	Geo	Th	Lia	Epi	Vsp	Vp
ENP	this study	601	24.79	12.81	49.92	2.00	3.66	5.99	0.50	0.00	0.33
Lagoa Santa	Warming (1892)	868	22.50	5.05	55.11	5.42	4.57	6.74	0.12	0.36	0.12
Mojiguaçu	Mantovani (1983)	521	23.61	14.01	44.53	2.11	7.10	7.49	0.77	0.38	0.00
Pirassununga	Batalha *et al.* (1997)	358	29.88	15.36	34.92	1.12	6.42	9.78	1.96	0.56	0.00
Santa Rita	Batalha (1997)	360	33.33	15.00	30.83	0.84	6.67	11.67	1.11	0.28	0.28

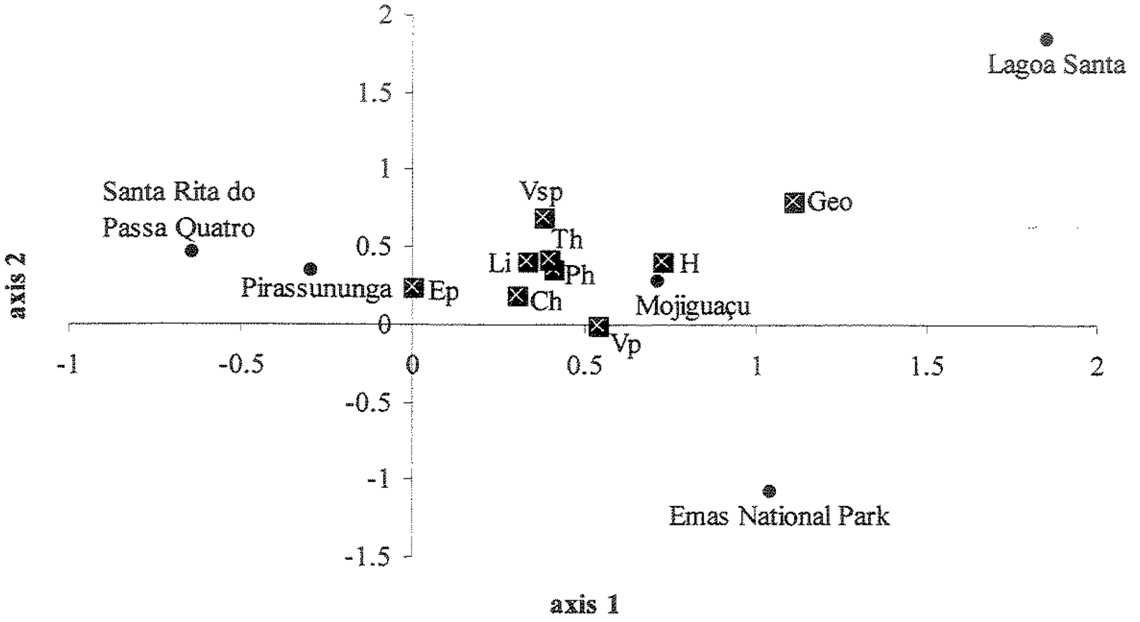

Figure 3. Detrended correspondence analysis biplot of cerrado sites and life-form classes. Emas National Park = 17°49'-18°28'S, 52°39'-53°10'W, Mojiguaçu = 22°15-16'S, 47°08-12'W, Pirassununga = 22°02'S, 47°30'W, Santa Rita do Passa Quatro = 21°36-44'S, 47°34-41'W, Lagoa Santa = 19°40'S, 43°51'W, Ph = phanerophyte, Ch = chamaephyte, H = hemicryptophyte, Geo = geophyte, Th = therophyte, Li = liana, Ep = epiphyte, Vsp = vascular semi-parasite, Vp = vascular parasite.

Table 3. Life-form spectra of different vegetation types used in the detrended correspondence analysis. Ph = phanerophyte, Ch = chamaephyte, H = hemicryptophyte, Cr = cryptophyte, Th = therophyte.

prevailing vegetation type	**life-form class (%)**					
site	**Ph**	**Ch**	**H**	**Cr**	**Th**	**reference**
boreal forest						
Terra Nova National Park, Canada	37.0	12.0	32.0	19.0	0.0	Charest *et al.* (2000)
cerrado						
Brasília, Brazil	39.1	13.5	44.9	1.8	0.7	Ratter *et al.* (1980)
Emas National Park, Brazil	31.6	12.8	49.9	2.0	3.7	this study
Lagoa Santa, Brazil	28.8	6.1	55.1	5.4	4.6	Warming (1892)
Mojiguaçu, Brazil	30.9	12.2	47.0	2.1	7.8	Mantovani (1983)
Pirassununga, Brazil	40.1	17.1	36.1	1.1	5.6	Batalha *et al.* (1997)
Santa Rita do Passa Quatro, Brazil	45.3	17.2	30.0	0.8	6.7	Batalha (1997)
cold steppe						
Akron, Colorado, USA	0.0	19.0	58.0	8.0	15.0	Paulsen (1915) *in* Cain (1950)
Danube, Southeastern Europe	7.0	5.0	55.0	10.0	23.0	Bojko (1934) *in* Cain (1950)
Pamir Mountain	1.0	12.0	63.0	10.0	14.0	Paulsen (1912) *in* Cain (1950)
Yekasternoslaw, Near East	5.0	3.0	55.0	13.0	24.0	Paulsen (1912) *in* Cain (1950)
dry temperate forest						
Sinjawi and Duki regions, Pakistan	31.1	10.7	27.7	2.5	27.9	Tareen & Qadir (1993)
hot desert						
Bir Ghanam, Lybia	0.0	27.3	9.1	4.5	59.1	Qadir & Shetvy (1986)
Canary Islands	19.0	19.0	10.0	4.0	47.0	Børgesen (1924) *in* Cain (1950)
Death Valley, California, USA	26.0	7.0	18.0	7.0	42.0	Raunkiaer (1934)
Eastern Egypt	6.5	29.0	22.0	4.2	38.3	El-Ghani (1998)
El Golea, central Sahara	9.0	13.0	15.0	7.0	56.0	Raunkiaer (1934)
Gardhaia, north Africa	3.0	16.0	20.0	3.0	58.0	Raunkiaer (1934)
Israel	8.0	16.0	16.0	7.0	52.0	Danin & Orshan (1990)
Jazan, Saudi Arabia	10.1	31.5	5.6	4.5	48.3	El-Demerdash *et al.* (1994)
Lybia	12.0	21.0	20.0	5.0	42.0	Raunkiaer (1934)
Ooldea, Australia	46.0	14.0	4.0	1.0	35.0	Adamson & Osborn (1922) *in* Cain (1950)
Oudja, Morocco	0.0	4.0	17.0	6.0	73.0	Braun-Blanquet & Maire (1924) *in* Cain (1950)
Transcaspian lowlands	11.0	7.0	27.0	14.0	41.0	Paulsen (1912) *in* Cain (1950)
Zeltin, Lybia	0.0	14.3	9.5	0.0	76.2	Qadir & Shetvy (1986)
hot steppe						
Tucson, Arizona, USA	18.0	11.0	24.0	0.0	47.0	Paulsen (1915) *in* Cain (1950)
Cyrenaica, north Africa	8.0	14.0	19.0	8.0	50.0	Raunkiaer (1934)
Madeira Islands	15.0	7.0	24.0	3.0	51.0	Raunkiaer (1934)
Timbuctu, Africa	24.0	36.0	9.0	6.0	25.0	Hagerup (1930) *in* Cain (1950)
Turhoona, Lybia	5.3	25.7	13.2	15.8	42.1	Qadir & Shetvy (1986)
Zwara, Lybia	6.3	46.9	9.4	3.1	34.4	Qadir & Shetvy (1986)
mediterranean vegetation						
Crete	9.0	13.0	27.0	12.0	38.0	Turrill (1929) *in* Cain (1950)
Ikaria, Greece	7.0	7.0	23.0	14.0	49.0	Christodoulakis (1996)
Israel	8.0	9.0	23.0	10.0	49.0	Danin & Orshan (1990)
Mount Killini, Greece	10.2	11.0	41.9	13.1	23.9	Dimopoulus & Georgiadis (1992)
Samos, Greece	9.0	13.0	32.0	13.0	33.0	Raunkiaer (1934)
Southern France	7.0	13.0	29.0	8.0	43.0	Braun-Blanquet (1925) *in* Cain (1950)

prevailing vegetation type	life-form class (%)					
site	**Ph**	**Ch**	**H**	**Cr**	**Th**	**reference**
prairie						
Konza, USA	11.1	0.9	33.1	24.9	29.9	Stalter *et al.* (1991)
rain forest						
Mucambo, Brazil	95.0	1.0	3.0	1.0	0.0	Cain *et al.* (1956)
Queensland, USA	96.0	2.0	0.0	2.0	0.0	Cromer & Pryor (1942) *in* Cain (1950)
savanna						
Barinas, Venezuela	11.0	3.0	18.0	40.0	28.0	Sarmiento & Monasterio (1983)
Calabozo, Venezuela	28.0	7.0	31.0	5.0	29.0	Aristeguieta (1966) *in* Sarmiento & Monasterio (1983)
Ghanzi, Botswana	19.9	16.4	28.2	7.6	27.9	Cole & Brown (1976)
Lake Edward, Zaire	5.0	38.0	22.0	5.0	29.0	Lebrun (1947) *in* Sarmiento & Monasterio (1983)
Lamto, Ivory Coast	9.0	1.0	62.0	9.0	19.0	César (1971) *in* Sarmiento & Monasterio (1983)
Northern Surinam	8.0	3.0	38.0	28.0	23.0	Van Donselaar-Tenbokkel Huinink (1966) *in* Sarmiento & Monasterio (1983)
Ookemeji, Nigeria	30.0	0.0	23.0	21.0	25.0	Hopkins (1962) *in* Sarmiento & Monasterio (1983)
Southern Kalahari, Africa	13.3	12.2	34.5	7.4	32.7	Cole & Brown (1976)
Southwestern Madagascar	21.0	18.0	26.0	3.0	32.0	Morat (1973) *in* Sarmiento & Monasterio (1983)
subtropical forest						
Matheran, India	66.0	17.0	2.0	5.0	10.0	Bharucha & Ferreira (1941) *in* Cain (1950)
temperate forest						
Alabama, USA	17.6	3.1	47.8	17.1	14.4	Ennis (1928) *in* Cain (1950)
Alberta, USA	25.8	1.8	48.2	17.1	7.1	Moss (1932) *in* Cain (1950)
Alto do Palmital, Brazil	80.0	6.0	11.0	3.0	0.0	Cain *et al.* (1956)
Cape Breton, USA	14.6	1.8	51.3	25.6	6.7	Ennis (1928) *in* Cain (1950)
Caiobá, Brazil	87.0	7.0	3.0	3.0	0.0	Cain *et al.* (1956)
North Carolina, USA	59.6	0.0	36.0	4.5	0.0	Buell & Wilbur (1948)
North Carolina, USA	35.9	2.8	44.1	17.2	0.0	Buell & Wilbur (1948)
China	31.5	2.3	33.9	19.7	12.7	Gao & Chen (1998)
Cincinnati, USA	33.6	3.9	34.4	23.4	3.9	Withrow (1932) *in* Cain (1950)
Cincinnati, USA	49.9	4.2	23.5	15.9	6.5	Withrow (1932) *in* Cain (1950)
Connecticut, USA	14.8	2.0	49.4	20.3	13.5	Ennis (1928) *in* Cain (1950)
Scotland	13.5	18.0	53.0	13.0	2.0	Watt (1931) *in* Cain (1950)
Georgia, USA	23.0	4.0	55.0	10.0	8.0	Raunkiaer (1934)
Hondo, Japan	28.9	2.0	47.4	11.7	10.0	Horikawa & Sato (1938) *in* Cain (1950)
Horto Botânico, Brazil	70.0	4.0	16.0	5.0	5.0	Cain *et al.* (1956)
Illinois, USA	16.3	1.3	49.7	18.6	14.1	Ewer (1932) *in* Cain (1950)
Indiana, USA	14.4	1.9	49.0	18.0	16.7	McDonald (1937) *in* Cain (1950)
Iowa, USA	15.3	1.0	48.6	20.9	14.2	Ennis (1928) *in* Cain (1950)
Long Island, USA	34.8	10.9	32.6	20.6	1.1	Cain (1936) *in* Cain (1950)
Michigan, USA	22.8	3.9	47.0	16.1	10.2	Gates (1930) *in* Cain (1950)
Minnesota, USA	38.5	4.4	41.8	15.4	0.0	Buell & Wilbur (1948)
Minnesota, USA	35.2	3.2	45.6	16.0	0.0	Buell & Wilbur (1948)
Mississipi, USA	19.5	3.1	49.4	15.2	12.8	Ennis (1928) *in* Cain (1950)
New York, USA	16.5	5.3	33.3	31.9	13.0	Taylor (1918) *in* Cain (1950)
Paris, France	8.0	6.5	51.5	25.0	9.0	Allorge (1922) *in* Cain (1950)
North Carolina, USA	30.0	2.1	45.0	11.1	11.9	Stalter *et al.* (1991)
Serbia	28.7	11.3	46.2	9.1	4.7	Turrill (1929) *in* Cain (1950)

prevailing vegetation type	life-form class (%)					
site	**Ph**	**Ch**	**H**	**Cr**	**Th**	**reference**
Stuttgart, Germany	9.0	3.0	54.0	17.0	17.0	Raunkiaer (1934)
Tenesse, USA	19.6	1.7	52.1	15.1	11.5	Cain (1945) *in* Cain (1950)
Virginia, USA	18.6	1.4	51.7	11.3	17.0	Allard (1944) *in* Cain (1950)
tundra						
Spitzbergen	1.0	22.0	60.0	15.0	2.0	Raunkiaer (1934)

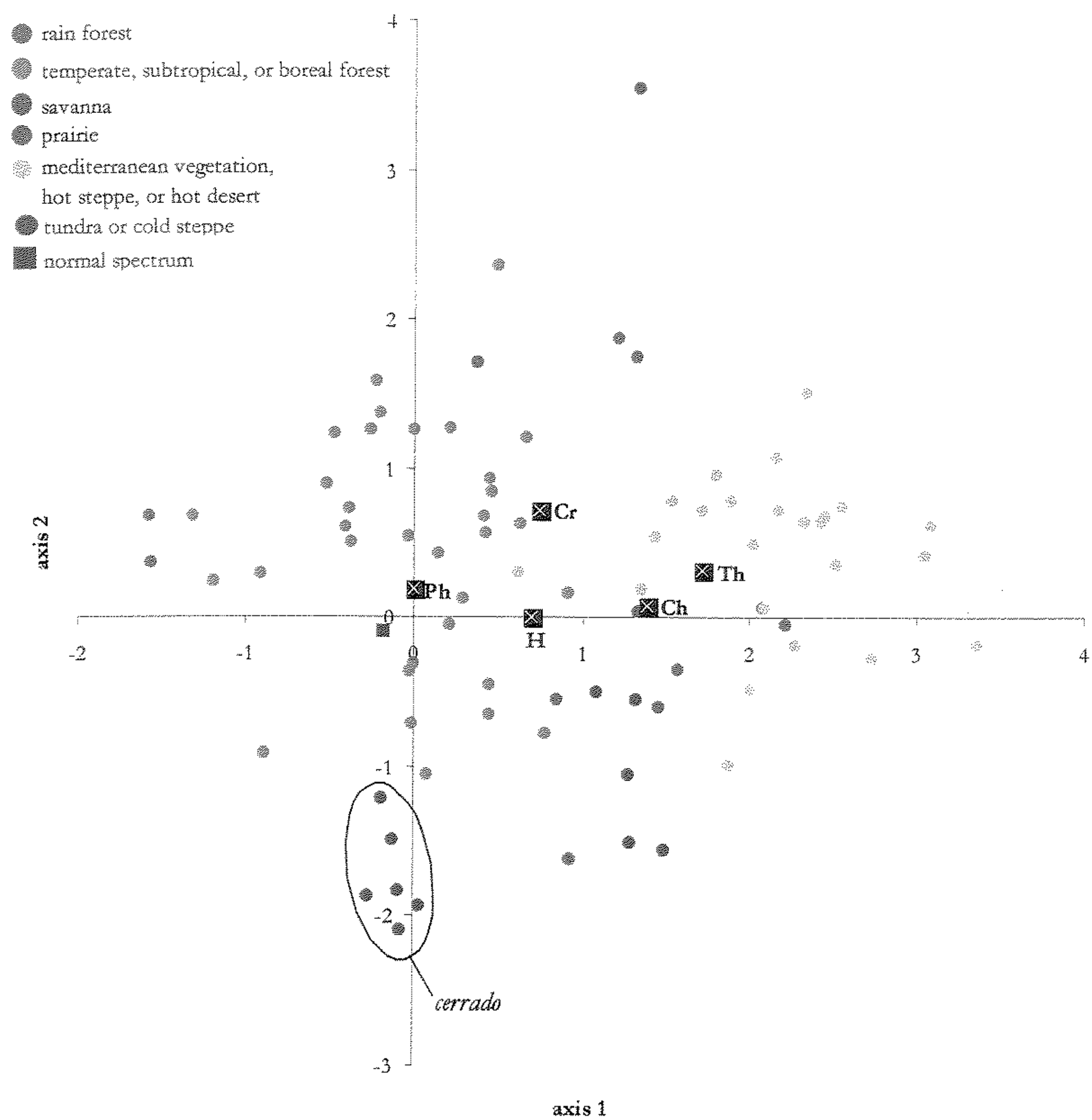

Figure 4. Detrended correspondence analysis biplot of biological spectra and life-form classes. Ph = phanerophyte, Ch = chamaephyte, H = hemicryptophyte, Cr = cryptophyte, Th = therophyte.

Discussion

The most represented classes in the life-form spectrum of the cerrado in ENP were the hemicryptophytes and the phanerophytes, as in other cerrado sites (Warming 1892, Ratter *et al.* 1980, Mantovani 1983, Batalha 1997, Batalha *et al.* 1997). Raunkiaer (1934), in his life-form classification, used a trait that would indicate adaptation of plants to a particular climate, namely the degree of protection of the perennating buds; therefore, the vegetation would be an expression of the climate. According to Sarmiento & Monasterio (1983), although the seasonal stress imposed by extended drought allows the plants a wide range of responses, generally, in savanna floras, the hemicryptophytes and geophytes are the prevailing life-forms. Considering the ENP, this hypothesis was partially corroborated since the hemicryptophytes were the prevailing life-form, with half the species belonging to this class, but the geophytes were under-represented.

The biological spectrum of the cerrado in ENP was significantly different from Raunkiaer's (1934) normal spectrum due especially to the higher proportion of hemicryptophytes, responsible for almost 60% of the chi-square value. According to Raunkiaer (1934), a hemicryptophytic phytoclimate corresponds to a cold-humid climate, typical of high latitudes or high altitudes. Sarmiento & Monasterio (1983) criticized the applicability of Raunkiaer's system to tropical communities, because it classifies life-forms on the supposition that the limiting factor for plant growth is low winter temperatures, which obviously is not an important ecological factor in such communities.

Even if in Raunkiaer's (1934) model a direct correspondence between climate and life-forms exists, other factors play a significant role in the determination of the occurrence of the cerrado and its physiognomic gradient. Lopes & Cox (1977), for example, pointed out five theories proposed by several authors to explain the occurrence and the physiognomic gradient of the cerrado: water stress, fire, waterlogging, oligotrophic scleromorphism, and aluminium toxicity. These factors could somehow be analogous to the stress imposed by cold in high latitude or altitude regions and, in this case, they would favour species with perennating buds protected under the ground, as the hemicryptophytes.

If there are other variables besides the climatic ones involved in the determination of the occurrence of the cerrado, then biological spectra of cerrado sites should reflect it. For example, if two sites are under the same climate, but, for other reasons, present different physiognomies, then their biological spectra should be different (Mantovani 1983). Raunkiaer (1934) himself stated that "although not part of the original design, this system of life-forms, while based on purely biological considerations, the adaptations of plants passing the unfavourable season, is in fact clearly a physiognomic system". Indeed, when we compared the cerrado sites through the correspondence analysis, those in which open physiognomies prevail (ENP, Lagoa Santa, and Mojiguaçu) presented positive eigenvalues in the first axis, while those in which closed physiognomies prevail (Pirassununga and Santa Rita do Passa Quatro) presented negative eigenvalues, appearing opposed in the ordination plots.

In the physiognomic gradient of the cerrado, the importance of trees and shrubs increases from open to closed physiognomies (Coutinho 1978). We expect, from open to closed physiognomies, a decrease in the proportion of hemicryptophytes, geophytes, and therophytes and an increase in the proportion of phanerophytes, lianas, epiphytes, vascular semi-parasites, and vascular parasites. This pattern was found in the comparison of the cerrado sites, when those sites in which closed physiognomies prevail (Pirassununga and Santa Rita do Passa Quatro) presented a higher proportion of phanerophytes, lianas, epiphytes, vascular semi-parasites, and vascular parasites; and those sites in which open physiognomies prevail (ENP, Lagoa Santa, and Mojiguaçu) presented a higher proportion of hemicryptophytes and geophytes.

In the ordination analysis in which spectra from other vegetation types were included, the cerrado sites formed a distinct group, with eigenvalues closer to those of phanerophytes and hemicryptophytes, as expected by the prevailance of these life-form classes in their biological spectra. Although most cerrado physiognomies fit the definition of savanna (Sarmiento 1983), the cerrado group appeared quite appart from the savanna sites, due mainly by the higher proportion of therophytes in the latter. Raunkiaer (1934) expected the therophytes, the best protected plants against drought, to appear under hot and dry climates, in which the favourable season is very short. Indeed, in our analysis, the annual plants eigenvalues were closer to those from deserts, steppes, and mediterranean vegetation sites, all under hot and dry climates.

The under-representation of annual plants in the cerrado vegetation has been noted by almost every author dealing with it (Sarmiento & Monasterio 1983). Water stress is not considered the main environmental factor determining the occurrence of the cerrado, since the shrubs and trees have deep root systems and water access the whole year (Ferri 1944). However, the herbaceous species, as the therophytes, suffer a period of water shortage in the dry season (Sarmiento & Monasterio 1983). In this sense, we could expect a higher representation of annual plants in the cerrado, what was not found by any author. This under-representation of therophytes in the cerrado vegetation poses an interesting question and deserves further investigation.

The ordination biplot also showed forest sites with eigenvalues closer to the phanerophytes, and tundra or cold steppes sites closer to the chamaephytes, in accordance with Raunkiaer's (1934) hypotheses. Among the forests, the temperate and boreal forests presented a higher proportion of hemicryptophytes than the rain forests, getting closer to the hemicryptohphyte climate, as proposed by Raunkiaer (1934). There seemed to be a gradient from wet to dry climates, from left to right in the ordination plot, and from hot to cold, from top-left to bottom-right. A further step in this approach would be including climatic data from each site, applying then a canonical correspondence analysis and testing to which climatic variable are each life-form class related.

Conclusions

The biological spectrum of the cerrado in ENP showed hemicryptophytes and phanerophytes as the most represented life-form classes, with the former characterizing the ENP spectrum in relation to the expected by the normal spectrum. This overproportion of hemicryptophytes and phanerophytes was also found in other cerrado spectra, although the relative importance of these two classes varied according the prevailance of open or closed physiognomies.

As long as non-climatic factors are very important in the determination of the occurrence of the cerrado vegetation and its physiognomic gradient, they should be considered when one wants to predict the life-form spectrum of a given area. Quantitative models could be constructed, trying to predict how the importance of each life-form class varies with the physiognomic gradient. Other factors could be analogous to low winter temperatures, predicted by Raunkiaer as the factor determining the prevailance of hemicryptophytes, as, for example, winter droughts and periodic burnings. The application of Raunkiaer's system, in this case, would be not only possible, but recommended if one intends to investigate which factors, besides climate, define the vegetation physiognomy in question.

In the ordination analysis, life-form spectra reflected well the different climate types and pointed out some environmental gradients, from wet to dry and from hot to cold climates. One could include the climatic variables of each site, trying to related them to the life-form classes. Canonical correspondence analysis offers, in this sense, a promising approach.

Aknowledgements – We are grateful to Fapesp, for financial support (process 97/13.697-5); to Ibama, for research license (process 02001,000376/98-90); to the Emas National Park staff, for their help in field; and to M.B. Ramos-Neto, for logistical assistance.

References

BATALHA, M. A. 1997. *Análise da vegetação da ARIE Cerrado Pé-de-Gigante.* MSc. Dissertation. University of São Paulo.

BATALHA, M. A.; ARAGAKI, S. & MANTOVANI, W. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo 16*: 49-64.

BEAMAN, J. H. & ANDERSEN, J. W. 1966. The vegetation, floristics and phytogeography of the summit of Cerro Potosi, Mexico. *The American Midland Naturalist 75*:1-33.

BEGON, M.; HARPER, J. L. & TOWNSEND, C. R. 1996. *Ecology: individuals, populations and communities.* Oxford, Blackwell.

BOX, E. U. 1981. *Macroclimate and plant forms: an introduction to predictive modeling in phytogeography.* The Hague, Dr. W. Junk.

BRAUN-BLANQUET, J. 1928. *Pflanzensoziologie.* Berlin, Springer.

BUELL, M. F. & WILBUR, R. L. 1948. Life-form spectra of the hardwood forests of the Itasca Park region, Minnesota. *Ecology 29*: 352-359.

CAIN, S. A. 1950. Life-forms and phytoclimate. *The Botanical Review 16*: 1-32.

CAIN, S. A.; CASTRO, G. M. DE O.; PIRES, J. M. & SILVA, N. T. DA. 1956. Application of some phytosociological techniques to Brazilian rain forests. *American Journal of Botany 43*: 911-941.

CHAREST, R.; BROUILLET, L.; BOUCHARD, A. & HAY, S. 2000. The vascular flora of Terra Nova National Park, Newfoundland, Canada: a biodiversity analysis from a biogeographical and life form perspective. *Canadian Journal of Botany 78*: 629-645.

CHRISTODOULAKIS, D. 1996. The flora of Ikaria (Greece, E. Aegean Islands). *Phyton 36*: 63-91.

COLE, M. M. & BROWN, R. C. 1976. The vegetation of the Ghanzi area of Western Botswana. *Journal of Biogeography 3*: 169-196.

CONSERVATION INTERNATIONAL. 1999. *Ações prioritárias para a conservação do Cerrado e do Pantanal.* Brasília, Conservation International.

COUTINHO, L. M. 1978. O conceito do cerrado. *Revista Brasileira de Botânica 1*: 17-23.

DANIN, A. & ORSHAN, G. 1990. The distribution of Raunkiaer life forms in Israel in relation to the environment. *Journal of Vegetation Science 1*: 41-48.

DIMOPOULUS, P. & GEORGIADIS, T. 1992. Floristic and phytogeographical analysis of Mount Killini (NE Peloponnisos, Greece). *Phyton 32*: 283-305.

EL-DEMERDASH, M. A.; HEGAZY, A. K. & ZILAY, A. M. 1994. Distribution of the plant communities in Tihamah coastal plains of Jazan region, Saudi Arabia. *Vegetatio 112*: 141-151.

EL-GHANI, M. M. A. 1998. Environmental correlates of species distribution in arid desert ecosystems of eastern Egypt. *Journal of Arid Environments 38*: 297-313.

FERRI, M. G. 1944. Transpiração de plantas permanentes dos "cerrados". *Boletim da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo, Botânica 4*: 155-224.

GAO, X. & CHEN, L. 1998. The revision of plant life-form system and an analysis of the life-form spectrum of forest plants in the warm temperate zone of China. *Acta Botanica Sinica 40*: 553-559.

HUMBOLDT, A. VON. 1806. *Ideen zu einer Physiognomik der Gewächse.* Stuttgart, Cotta.

JONGMAN, R. H. G.; TER BRAAK, C. J. F. & VAN TONGEREN, O. F. R. 1995. *Data analysis in community and landscape ecology.* Cambridge, Cambridge University.

KÖPPEN, W. 1948. *Climatología.* México, Fondo de Cultura Económica.

LOPES, A .S. & COX, F. R. 1977. Cerrado vegetation in Brazil: an edaphic gradient. *Agronomy Journal 69*: 828-831.

MANTOVANI, W. 1983. *Composição e similaridade florística, fenologia e espectro biológico do cerrado da Reserva*

Biológica de Moji Guaçu, Estado de São Paulo. MSc. Dissertation. State University of Campinas.

MERA, G. DE; HAGEN, M. A. & ORELLANA, J. A. V. 1999. Aerophyte, a new life form in Raunkiaer's classification? *Journal of Vegetation Science 10*: 65-68.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology.* New York, John Willey & Sons.

QADIR, S. A. & SHEVTY, O. A. 1986. Life form and leaf size spectra and phytosociology of some Lybian plant communities. *Pakistan Journal of Botany 18*: 271-286.

RAMOS-NETO, M. B. 2000. *O Parque Nacional das Emas (GO) e o fogo: implicações para a conservação biológica.* PhD. Thesis. University of São Paulo.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environmental Management 26*: 675-684.

RATTER, J. A. 1980. *Notes on the vegetation of Fazenda Água Limpa (Brasília – DF, Brasil).* Edinburgh, Royal Botancial Garden.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography.* Oxford, Claredon.

SARMIENTO, G. 1983. The savannas of tropical america. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas.* Amsterdam, Elsevier. p. 245-288.

SARMIENTO, G. & MONASTERIO, M. 1983. Life forms and phenology. *In* GOODAL, D. W. (ed). *Ecosystems of the world: tropical savannas.* Berlin, Elsevier. p.79-108.

SHANKAR, U.; TRIPATHI, R. S. & PANDEY, H. N. 1991. Structure and seasonal dynamics of humid tropical grasslands in Meghalaya, India. *Journal of Vegetation Science 2*: 711-714.

STALTER, R.; KINCAID, D. T. & LAMONT, E. E. 1991. Life forms of the flora at Hampstead Plains, New York, and a comparison with four other sites. *Bulletin of the Torrey Botanical Club 118*: 191-194.

TAREEN, R. B. & QADIR, S. A. 1993. Life form and leaf size spectra of the plant communities of diverse areas ranging from Harani, Sinjawi to Duki regions of Pakistan. *Pakistan Journal of Botany 25*: 83-92.

WARMING, E. 1892. Lagoa Santa, contribuição para a geografia fitobiológica. *In* WARMING, E. & FERRI, M. G. 1973. *Lagoa Santa e a vegetação dos cerrados brasileiros.* Belo Horizonte, Itatiaia; São Paulo, Edusp. p.1-282.

ZAR, J. H. 1999. *Biostatiscal analysis.* Upper Saddle River, Prentice Hall.

5. Reproductive phenology of the cerrado plant community in Emas National Park (central Brazil)

Abstract – The cerrado, a savanna-like ecosystem, is the second largest Brazil's vegetation type. Its core region occupies the Brazilian Central Plateau, under seasonal climate, with wet summer and dry winter. In the cerrado, as in other savannas, the phenological patterns are closely linked to the climatic seasonality. We studied the reproductive phenological patterns of the cerrado plant community in Emas National Park, one of the most important reserves among those that represent this vegetation type. From November 1998 to October 1999, in monthly field trips, we carried out a floristic survey in the reserve and found 601 species. The flowering and fruiting patterns of the community were analysed in relation to dispersal syndromes, comparing the herbaceous and the woody components. The herbaceous component was characterized by an overproportion of autochorous species, and the woody component, by an overproportion of zoochorous species. There was a striking seasonality in the community-wide pattern of flowering and fruiting, although they were different between the herbaceous and the woody components. Woody species flowered mainly during late dry and early wet seasons, whereas herbaceous species flowered generally during late wet season. At the dry season, when their diaspores could be dispersed more efficiently, the proportion of fruiting anemo and autochorous fruits was higher. During the rainy season, when their fruits could be kept attractive for longer time, the number of fruiting zoochorous species reached its peak. The phenological patterns found in Emas National Park were generally similar to those found in other cerrado sites.

Resumo – O cerrado é o segundo maior tipo vegetacional brasileiro, com sua região nuclear no Planalto Central, sob clima estacional, com verão chuvoso e inverno seco. No cerrado, como em outras savanas, os padrões fenológicos estão fortemente associados à estacionalidade climática. Estudamos os padrões fenológicos reprodutivos da comunidade vegetal do cerrado no Parque Nacional das Emas, uma das mais importantes reservas entre aquelas que representam esse tipo vegetacional. De novembro de 1998 a outubro de 1999, em coletas mensais, realizamos um levantamento florístico na reserva e encontramos 601 espécies. Os padrões de floração e frutificação da comunidade foram analisados em relação às síndromes de dispersão, comparando os componentes herbáceo-subarbustivo e arbustivo-arbóreo. O componente herbáceo-subarbustivo se caracterizou pela maior proporção de espécies autocóricas, e o componente arbustivo-arbóreo, pela maior proporção de espécies zoocóricas. Houve uma estacionalidade marcante nos padrões de floração e frutificação da comunidade, embora eles tenham sido diferentes entre os componentes herbáceo-subarbustivo e arbustivo-arbóreo. As espécies arbustivo-arbóreas floresceram principalmente no início da estação chuvosa, enquanto que as herbáceo-subarbustivas floresceram geralmente no final dessa estação. Na estação seca, quando a dispersão de seus diásporos é mais eficiente, a proporção de espécies anemo e autocóricas frutificando foi maior. Durante a estação chuvosa, quando seus frutos podem se manter atrativos por mais tempo, as espécies zoocóricas frutificaram em maior número. Os padrões fenológicos encontrados no Parque Nacional das Emas foram, de modo geral, similares àqueles encontrados em áreas disjuntas de cerrado.

Key words – cerrado; savanna; phenology; Emas National Park; central Brazil.

Introduction

Savannas are tropical and subtropical formations where the grass layer is almost continuous, interrupted only by shrubs and trees in varying proportions, and where the main growth patterns are closely associated with alternating wet and dry seasons (Bourlière & Hadley 1983). In tropical savannas, the temporal patterns in growth and reproduction are strongly linked to the climatic seasonality (Williams *et al.* 1997).

The Cerrado Domain occupied formerly approximately 2 millions km^2 of the Brazilian territory (Ratter *et al.* 1997), especially in the Central Plateau. As its name implies, in the Cerrado Domain, the cerrado vegetation prevails. Even if classifying the Brazilian cerrado as a savanna is not completely satisfying (Coutinho 1978), most of its physiognomies fit the forementioned definition of savanna, at least the intermediate ones – *campo sujo* (a shrub savanna), *campo cerrado* (a wooded savanna), and *cerrado sensu stricto* (a woodland).

The cerrado species, like those of other savannas, present periodic variations concerning flower and fruit production that may represent adaptations to biotic and abiotic factors (Schaik *et al.* 1993).

Rizzini (1963) stated that there are two components in the cerrado flora, the herbaceous component and the woody component, which are floristically distinct and antagonistic. Scholes & Archer (1997) hypothesized that the climatic seasonal pattern of tropical savannas, with alternating warm dry seasons and hot wet seasons, provides a potential axis of niche separation by phenology for the herbaceous and woody components.

Knowledge of plant phenology is fundamental to understanding the community dynamics of ecosystems, since the timing, duration, and degree of synchrony of the various phenological phases have major implications for plant community structure, function, regeneration, and the quantity and quality of resources available for consumer organisms (Williams *et al.* 1999).

According to Oliveira (1998), phenological data for the cerrado vegetation are fragmentary, with studies normally involving isolated species or small group of species, with different methods and approaches. The relationship between the phenological patterns of cerrado plant species and the climatic seasonality had already been discussed by Warming (1892), in the very first study about the cerrado vegetation. Since this pioneering work, many papers discussed some aspects of the phenology of cerrado species (*e.g.*, Coutinho 1977, Ribeiro *et al.* 1982, Gottsberger & Silberbauer-Gottsberger 1983, Oliveira & Sazima 1990, Proença & Gibbs 1994, Miranda 1995 – see Oliveira 1998 for other references), but few of them on the community level (Mantovani & Martins 1988, Batalha *et al.* 1997, Batalha & Mantovani 2000).

Until now, all community-wide studies in the cerrado were carried out in outlying sites, in the southern São Paulo State (Mantovani & Martins 1988, Batalha *et al.* 1997, Batalha & Mantovani 2000). Our aim with this study was to analyse the reproductive phenological patterns of the plant species in a core cerrado site on community level, trying to understand its different patterns as adaptive strategies. We discussed the phenological variations of both herbaceous and woody components, relating them to dispersal syndromes.

Based on the patterns described on the available papers (Mantovani & Martins 1988, Batalha *et al.* 1997, Batalha & Mantovani 2000), we had some *a priori* hypotheses: *i*) the proportion of flowering species is lower in the dry season than in the wet season; *ii*) the herbaceous species flower mainly at the end of rainy season, while the woody species flower mainly at the beginning of this season; *iii*) the proportion of anemo and autochorous species is higher in the herbaceous component, while the proportion of zoochorous species is higher in the woody component; *iv*) the anemo and autochorous species set fruit especially at the dry season, while the zoochorous species set fruit especially throughout the rainy season.

Material and Methods

We carried out this work in Emas National Park (ENP), a reserve with *ca.* 132,000 ha, located in the Brazilian Central Plateau, in the cerrado core region, southwestern Goiás State (17°49'-18°28'S and 52°39'-53°10'W). Regional climate is tropical and humid, with wet summer and dry winter, which is classified as Aw following Köppen's (1948) system or as ZBII following Walter's (1986) system. Annual rainfall varies from 1,200 to 2,000 mm, concentrated from October to March, and mean annual temperature lies around 24.6°C (Ramos-Neto & Pivello 2000).

The cerrado in ENP presents almost all physiognomies found in this vegetation type, from *campo limpo* (a grassland) to *cerrado sensu stricto* (a woodland). In the reserve, open cerrado physiognomies – *campo limpo*, *campo sujo*, and *campo cerrado* – prevail, covering 68.1% of the total area (Ramos-Neto & Pivello 2000). The more closed *cerrado sensu stricto* covers 25.1% of the reserve. Every 3-4 years approximately, uncontrollable wildfires occur in ENP due to dry biomass accumulation (Ramos-Neto 2000).

The flowering and fruiting patterns of the cerrado species were analysed from data obtained in the floristic survey carried out from November 1998 to October 1999 (Chapter 2). The botanical material at reproductive stage was collected along pre-established routes (Chapter 2), with a 50-60 hr monthly sampling effort. The voucher material was lodged mainly at the São Paulo State Botanical Institute herbarium (SP), but also at the following herbaria: CESJ, FLOR, HRCB, HUEFS, IAC, SP, SPF, UB, and UEC.

The species at reproductive stage were observed whether they were flowering or fruiting. The observations were simply qualitative, that is, on a given month, for example, if at least one individual of a determined species was found producing flowers, the species was considered to be on its flowering period. The number of species in any month producing flowers or fruits was expressed as a percentage of the total number of species. These data were compared to climatic records collected from 1993 to 1998 at the Benedictine Monks Monastery, in the nearby city of Mineiros (17°33'25"S and 52°33'05"W), with which a climatic diagram following Walter (1986) was constructed.

The species were classified in families according to the system proposed by Judd *et al.* (1999) and in life forms in accordance with Raunkiaer's (1934) system adapted by Mueller-Dombois & Ellenberg (1974). The chamaephytes, epiphytes, geophytes, hemicryptophytes, lianas, therophytes, and vascular parasites were considered as belonging to the herbaceous component; and the phanerophytes, as belonging to the woody component. The dispersal syndromes were classified according to Pijl (1972). To verify if the proportions of anemo, auto, and zoochorous species were significantly different than an even distribution, we applied the chi-square test (Zar 1999). The flowering and fruiting periods were related to the climatic seasonality and to diaspore dispersal syndromes, comparing the herbaceous and the woody components.

Results

The climatic diagram (Figure 1) showed that the dry period of the year goes from June to August, and the wet period from September to May. Annual rainfall and mean annual temperature were 1,745 mm and 24.6°C, respectively. Of the 601 species collected (Table 1), 149 were phanerophytes and thus considered as belonging to the woody component. The remaining 452 species presented other life-forms and were considered as belonging to the herbaceous component.

Eight out of the 601 species (1.33%) were not found at reproductive stage, neither flowering nor fruiting. We found a bi-modal peak in flowering, with one peak at the beginning of the rainy season, in October, and another peak at end of this season, in March (Figure 2). Similarly, the proportion of fruiting species presented two peaks, in April and September (Figure 2). The proportion of flowering herbaceous species was lowest in July, increasing along the rainy season, reaching its peak in March, and decreasing again till August (Figure 3). Fruit production presented a similar pattern, with a higher number of fruiting species in March and April and a lower number in July (Figure 3). The proportions of flowering and fruiting woody species were higher from August to October, peaking in September (Figure 4). The lowest proportions of flowering and fruiting species in this component were found in February (Figure 4). In the herbaceous component, the late rainy season was the peak period in flowering, whereas, in the woody component, the late dry to early rainy seasons were the peak period.

Regarding their diaspore syndrome, 183 species (30.45%) were anemochorous; 228 (37.94%), autochorous; and 182 (31.61%), zoochorous (Figure 5 and Table 2), figures considered non-significantly different than an even distribution according to the chi-square test (χ^2 = 5.85, P = 0.054). On the other hand, in the herbaceous component, the distribution of diaspore dispersal syndromes was significantly different than an even distribution (χ^2 = 46.01, P < 0.0001), with an overproportion of autochorous species. In the woody component, the distribution of diaspore syndromes was also uneven ($\chi^2 = 65.65$, $P < 0.0001$), but with an overproportion of zoochorous species.

Considering the whole plant community, the anemochorous species fruited especially from April to September; the authocorous species, from January to May; and the zoochorous species, from September to December (Figure 6). In the herbaceous component, the anemochorous species were found producing fruits mainly from April to June; the autochorous species, from January to May; and the zoochorous species, from January to April (Figure 7). In the woody component, the anemochorous species fruited especially from July to September; the autochorous species, from March to June; and the zoochorous species, from September to December (Figure 8). At the dry season, in the whole flora and in its two components, the proportions of anemo and autochorous species producing fruits were higher than those of zoochorous ones. At the rainy season, on the other hand, the proportion of fruiting zoochorous species was higher than those of anemo and autochorous species.

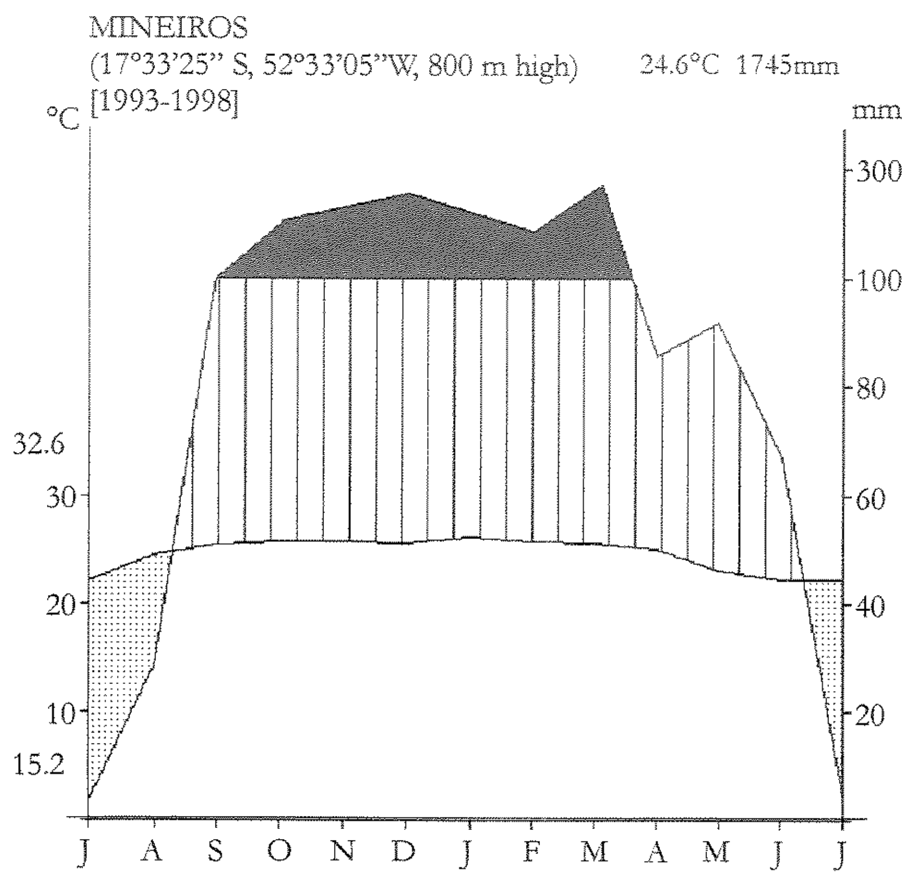

Figure 1. Climatic diagram following Walter (1986), constructed from data obtained at the Benedictine Monks Monastery, Mineiros, Goiás State, central Brazil. Absolute minimum and maximum temperatures were not available in the original data.

Table 1. Flowering and fruiting periods of the collected species in the cerrado of Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. lf = life-form, Ch = chamaephyte, Ep = epiphyte, Geo = geophyte, H = hemicryptophyte, Li = liana, Ph = phanerophyte, Th = therophyte, Vp = vascular parasite; ds = dispersal syndrome, Ane = anemochorous, Aut = autochorous, Zoo = zoochorous; fl. per. = flowering period, 1 = january, 2 = february, ..., 11 = november, and 12 = december; fr. period = fruiting period, 1 = january, 2 = february, ..., 11 = november, and 12 = december. The hyphen (-) represents continuity among months, while the comma (,) means interruption.

Family/species	lf	ds	fl. per.	fr. per.
Acanthaceae				
Hygrophila brasiliensis (Spreng.) Lindau	H	Aut	12-5	2-5
Ruellia geminiflora Kunth	H	Aut	3-11	4-11
Ruellia incompta (Nees) Lindau	Ch	Aut	4-8	6-9
Alstroemeriaceae				
Alstroemeria gardneri Bak.	H	Aut	1-2	3
Amaranthaceae				
Froelichia procera (Seub.) Pedersen	H	Aut	11-2	12-7
Gomphrena arborescens L. f.	H	Aut	12	1
Gomphrena macrocephala A. St-Hil.	H	Aut	1-3,7-9	1-4,8-9
Gomphrena pohlii Moq.	H	Aut	1-5,8-9	2-12
Pfaffia helychrysoides (Moq.) Kuntze	H	Aut	2-11	6-11
Pfaffia jubata Mart.	H	Aut	4-1	5-1
Anacardiaceae				
Anacardium humile A. St-Hil.	Ch	Zoo	6-10	8-11
Tapirira guianensis Aubl.	Ph	Zoo	7-8	11
Annonaceae				
Annona coriacea Mart.	Ph	Zoo	—	5-10
Annona crassiflora Mart.	Ph	Zoo	9-11	11-3
Annona monticola Mart.	H	Zoo	7	—
Annona tomentosa R.E. Fries	Ch	Zoo	9-12	12-4
Annona warmingiana Mello-Silva & Pirani	H	Zoo	8-10	8-10
Annona sp. nov.	Ph	Zoo	9,1,4	—
Bocageopsis mattogrossensis (R.E. Fries) R.E. Fries	Ph	Zoo	6-8	7-8
Duguetia furfuracea (A. St-Hil.) Benth. & Hook. f.	Ph	Zoo	1-12	3-12
Duguetia glabriuscula (R.E. Fries) R.E. Fries	Ch	Zoo	11	11-5
Xylopia aromatica (Lam.) Mart.	Ph	Zoo	9-12	1-12
Apiaceae				
Didymopanax macrocarpum Seem.	Ph	Zoo	9-3	12-6
Didymopanax vinosum March.	Ph	Zoo	1-9	3-10
Eryngium ciliatum Cham. & Schltdl.	H	Aut	9	—
Eryngium junceum Cham. & Schltdl.	H	Aut	9-1	10-1
Apocynaceae				
Asclepias mellodora A. St-Hil.	H	Ane	3	3

Family/species	lf	ds	fl. per.	fr. per.
Aspidosperma macrocarpon Mart.	Ph	Ane	8-9	8-11
Aspidosperma nobile Müll. Arg.	Ph	Ane	6-8	8-10
Aspidosperma tomentosum Mart.	Ph	Ane	—	—
Barjonia cymosa Fourn.	H	Ane	2-5	6-9
Barjonia erecta (Vell.) K. Schum.	H	Ane	—	11
Blepharodon bicuspidatum Fourn.	Li	Ane	12-7	12-7
Gyrostelma sp. nov.	H	Ane	11	—
Hancornia speciosa Gomez	Ph	Zoo	8-10	4,8-11
Hemipogon acerosus Decne.	H	Ane	4-11	5-11
Himatanthus obovatus (Müll. Arg.) Woods.	Ph	Ane	11-5	5-10
Macrosiphonia longiflora Müll. Arg.	H	Ane	9-11	2
Macrosiphonia velame (A. St-Hil.) K. Schum.	H	Ane	1	1
Mandevilla coccinea (Hook & Arn.) Woods.	H	Ane	1	—
Mandevilla pohliana (Standelm.) A. Gentry	H	Ane	11-4	2-4
Odontadenia lutea (Vell.) Markgr.	Li	Ane	1-5	2-5
Oxypetalum aequaliflorum Fourn.	H	Ane	11	—
Rauwolfia weddelliana Müll. Arg.	H	Zoo	8-4	10-4
Rhodocalyx rotundifolius Müll. Arg.	H	Ane	10-11	—
Araceae				
Scaphispatha gracilis Brongn. ex Schott	H	Aut	11	11
Arecaceae				
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	Ph	Zoo	9-10	1-12
Acrocomia hassleri (Barb. Rodr.) Hahn	Geo	Zoo	9	9-10
Allagoptera campestris (Mart.) Kuntze	Geo	Zoo	11-3	11-3
Allagoptera leucocalyx (Mart.) Kuntze	Geo	Zoo	9-4	9-4
Attalea geraensis Barb. Rodr.	Geo	Zoo	10-5	2-6
Syagrus flexuosa (Mart.) Becc.	Geo	Zoo	10-7	1-12
Aristolochiaceae				
Aristolochia gibertii Hook.	Li	Ane	2-3	3-4
Aristolochia gracilis Duch.	Li	Ane	5	6
Asteraceae				
Acanthospermum australe (Loefl.) Kuntze	Th	Zoo	1-4	1-5
Achyrocline satureoides (Lam.) A. DC.	Th	Aut	5	5-8
Apopyros warmingii (Baker) Nesom	H	Ane	11	11
Aspilia foliacea (Spreng.) Baker	H	Aut	1-10	1-11
Aspilia laevissima Baker	H	Aut	1	1
Aspilia leucoglossa Malme	H	Aut	10-4	10-4
Aspilia platyphylla (Baker) Blake	H	Aut	2	—
Ayapana amygdalina (Lam.) King & H. Rob.	H	Ane	6-8	7-8
Baccharis camporum A. DC.	Ch	Ane	4-5	4-5
Baccharis humilis Sch. Bip.	H	Ane	1,4,7-10	8-11
Bidens gardneri Gardner	Th	Zoo	3-6	3-6
Calea clausseniana Baker	H	Ane	—	8-9
Calea cuneifolia A. DC.	H	Aut	6-10	8-10
Calea hymenolepis Baker	H	Aut	2-3	2-3

Family/species	lf	ds	fl. per.	fr. per.
Calea platylepis Sch. Bip. ex Baker	H	Aut	4	—
Campuloclinium chlorolepis Baker	H	Ane	3	—
Campuloclinium megacephalum (Mart.) King & H. Rob.	H	Ane	1-3	1-4
Chaptalia integerrima (Vell.) Burk	Th	Ane	3,9-11	3-4, 9-11
Chromolaena chaeseae H. Rob.	Ch	Ane	3-6	4-6
Chromolaena leucocephala Gardner	Ch	Ane	4-6	4-6
Chromolaena squalida (A. DC.) King & H. Rob.	Ch	Ane	4	4-12
Chromolaena stachyophylla (Spr.) King & H. Rob.	H	Ane	5-10	10
Conyza bonariensis (L.) Cronq.	Th	Ane	9,12-5	9,12-6
Dasyphyllum sprengelianum (Gardner) Cabrera	Ch	Ane	9	9,3
Dimmerostema asperatum Blake	H	Ane	11-4	11-5
Dimmerostema brasilianum Cass.	H	Ane	4	5
Dimmerostema retifolium (Sch. Bip.)Blake	H	Ane	11-7	11-7
Dimmerostema sp. nov.	H	Ane	11	—
Elephantopus biflorus Less.	H	Ane	4	4
Elephantopus mollis L.	H	Ane	4	4-8
Elephantopus racemosus Gardner	H	Ane	4-5	5
Emilia coccinea (Sims.) Sweet	Th	Ane	12-9	1-9
Erechtites hieracifolia (L.) Raf.	Th	Ane	12-6	12-9
Eremanthus erythropappus Sch. Bip.	Ph	Ane	3-6	4-11
Eremanthus glomerulatus Less.	Ph	Ane	2-3	2-10
Eremanthus sphaerocephalus Baker	H	Ane	5-10	7-11
Eupatorium betonicaeforme Baker	H	Ane	5-6	5-6
Eupatorium campestre A. DC.	H	Ane	9-4	3-12
Eupatorium lanigerum Hook & Arn.	H	Ane	10-12	11-12
Eupatorium myriocephalum Gardner	Ch	Ane	4-5	—
Eupatorium purpurascens Sch. Bip.	H	Ane	3	—
Eupatorium urticifolium L. f.	H	Ane	11-7	12-7
Eupatorium sp.	H	Ane	3-5	5
Gochnatia barrosoae Cabrera	Ch	Ane	6-7	8
Gochnatia pulchra Cabrera	Ch	Ane	3-5	5-6
Hoehnephyton trixoides (Gardner) Cabrera	H	Ane	7-10	10
Ichthyothere sp. 1	H	Aut	5-6,10-12	5-6,10-12
Ichthyothere sp. 2	H	Aut	7-9	7-9
Ichthyothere sp. 3	H	Aut	7	—
Isostigma megapotamicum Scherff	H	Aut	7-3	1-12
Isostigma sp.	H	Aut	9-10	10
Mikania cordifolia (L.) Willd.	Li	Ane	4-9	5-9
Orthopappus angustifolius (Sw.) Gleason	H	Ane	12-6	1-10
Piptocarpha rotundifolia (Less.) Baker	Ph	Ane	9-12	1-12
Porophyllum angustissimum Gardner	Th	Ane	12-5	12-6
Pseudobrickellia pinifolia (Spr.) King & H. Rob.	H	Ane	6-9	8-9
Pterocaulon virgatum (L.) A. DC.	H	Ane	3	4
Riencourtia oblongifolia Gardner	H	Aut	12-5	12-5
Riencourtia tenuifolia Gardner	H	Aut	11-5	11-5
Spilanthes nervosa Chod.	H	Aut	11	11
Stilpnopappus glomerulatus Gardner	H	Ane	1-2	2
Stilpnopappus speciosus Baker	H	Ane	12-4	12-6
Stomatanthes dictyophyllum (A. DC.) King & H. Rob.	H	Ane	10-1	10-1

Family/species	lf	ds	fl. per.	fr. per.
Vernonia argentea Less.	H	Ane	12-4	12-6
Vernonia bardanoides Less.	H	Ane	12-4	3-10
Vernonia brevipetiolata Sch. Bip.	H	Ane	1-4	3-8
Vernonia buddleiifolia Sch. Bip. ex Baker	H	Ane	12-6	2-6
Vernonia compactiflora Mart. ex Baker	H	Ane	2-4	3-6
Vernonia desertorum Mart. ex A. DC.	H	Ane	6-10	6-10
Vernonia erythrophylla Mart.	H	Ane	11	11
Vernonia ferruginea Less.	H	Ane	6-7	8-9
Vernonia grandiflora Less.	H	Ane	4-5,10-12	4-5,11-12
Vernonia herbacea (Vell.) Rusby	H	Ane	5-2	1-12
Vernonia ignobilis Less.	H	Ane	9-11	5-1
Vernonia polyanthes (Spreng.) Less.	Ch	Ane	—	12
Vernonia psilophylla A. DC.	H	Ane	2	3
Vernonia rubricaulis Humb. & Bonpl.	H	Ane	—	12
Vernonia rubriramea Mart.	Ch	Ane	4-7	6-10
Vernonia simplex Less.	H	Ane	10	10
Vernonia tomentella Mart. ex A. DC.	H	Ane	4-5	5-2
Vernonia tragiaefolia A. DC.	H	Ane	11	11
Vernonia varroniifolia A. DC.	H	Ane	2-5	4-8
Vernonia venosissima Sch. Bip. ex Baker	H	Ane	3-6	4-11
Vernonia virgulata Mart.	H	Ane	6-11	7-12
Viguiera bakeriana Blake	H	Aut	4-1	4-1
Viguiera sp. 1	H	Aut	9-3	9-3
Viguiera sp. 2	H	Aut	11	11
Wedelia macedoi H. Rob.	H	Aut	1-12	3-12
Balanophoraceae				
Langsdorffia hypogea Mart.	VP	Zoo	5	—
Bignoniaceae				
Anemopaegma arvense (Vell.) Stellfeld ex de Souza	H	Ane	1-12	1-12
Anemopaegma glaucum Mart. ex A. DC.	H	Ane	3-10	6-11
Anemopaegma scabriusculum Mart. ex A. DC.	H	Ane	1-12	6-2
Arrabidaea brachypoda (A. DC.) Bur.	Ch	Ane	8-5	3-8
Arrabidaea pulchra (Cham.) Sandw.	Li	Ane	4-6	6
Cybistax antisyphillitica Mart.	Ph	Ane	—	3
Jacaranda caroba (Vell.) A. DC.	Ch	Ane	4-9	6-11
Jacaranda decurrens Cham.	Ch	Ane	8-10	9-10
Jacaranda rufa Silva Manso	Ch	Ane	9-5	12-9
Memora peduncalata (Vell.) Miers.	Ch	Ane	6-3	6-4
Tabebuia aurea (Silva Manso) S. Moore	Ph	Ane	7-9	9
Tabebuia ochracea (Cham.) Standl.	Ph	Ane	8-9	9
Zeyheria montana Mart.	Ph	Ane	1-5	5
Boraginaceae				
Cordia villicaulis Fresen.	H	Zoo	4-6,9-12	4-6,9-12
Bromeliaceae				
Aechmea bromeliifolia (Rudge) Baker	Ep	Aut	7-8	9-12

Family/species	lf	ds	fl. per.	fr. per.
Ananas ananassoides L.B. Sm.	H	Zoo	12-1	2-3
Billbergia magnifica Mez	Ep	Zoo	—	8
Bromelia balansae Mez	H	Zoo	9-12	12-1
Dickia tuberosa (Vell.) Beer	H	Ane	10-2	2-3
Burseraceae				
Protium ovatum Engl.	Ph	Zoo	4-9	6-12
Cactaceae				
Epyphyllum phyllanthus (L.) Haw.	Ep	Zoo	—	—
Caryocaraceae				
Caryocar brasiliense Cambess.	Ph	Zoo	4-11	9-1
Caryophyllaceae				
Polycarpea corymbosa (L.) Lam.	Th	Aut	4-5	5-6
Celastraceae				
Plenckia populnea Reissek	Ph	Ane	7-10	—
Tontelea micrantha (Mart.) A.C. Sm.	Ph	Zoo	7-1	11-1
Chrysobalanaceae				
Couepia grandiflora (Mart. & Zucc.) Benth. ex Hook. f.	Ph	Zoo	8	—
Licania humilis Cham. & Schltdl.	Ph	Zoo	3-9	7-10
Parinari excelsa Sabine	Ch	Zoo	6-4	8-4
Clusiaceae				
Kielmeyera abdita Saddi	Ch	Ane	1-12	9-5
Kielmeyera coriacea Mart.	Ph	Ane	6-12	1-12
Kielmeyera grandiflora (Wawra) Saddi	Ph	Ane	6-12	1-12
Kielmeyera rubriflora Cambess.	Ph	Ane	3-7	6-7
Kielmeyera trichophora Mart.	Ch	Ane	3-12	8-1
Kielmeyera variabilis Mart.	Ch	Ane	3-12	8-1
Cochlospermaceae				
Cochlospermum regium (Mart.) Pilg.	H	Ane	8-10	10-12
Combretaceae				
Buchenavia tomentosa Eichl.	Ph	Zoo	—	5
Combretum hilarianum D. Dietr.	Ch	Ane	10-1	1-6
Commelinaceae				
Commelina obliqua Vahl	Th	Aut	10-4	10-4
Connaraceae				
Connarus suberosus Planch.	Ph	Zoo	8	8-12
Rourea induta Planch.	Ph	Zoo	1-12	9-4
Convolvulaceae				

Family/species	lf	ds	fl. per.	fr. per.
Evolvulus cressoides Mart.	H	Aut	2	—
Evolvulus fuscus Meisn.	H	Aut	10-4	3-4
Evolvulus macroblepharis Mart.	H	Aut	4	—
Ipomoea argentea Meisn.	H	Aut	1-4	2-8
Ipomoea campestris Meisn.	H	Aut	6,11	—
Ipomoea procumbens Mart. ex Choisy	H	Aut	1-2	—
Ipomoea procurrens Meisn.	Li	Aut	11-5	3-5
Ipomoea sp. nov.	H	Aut	3-5	3-5
Ipomoea virgata Meisn.	H	Aut	11-1	—
Jacquemontia guaranitica Hassl.	H	Aut	11-1	—
Jacquemontia sphaerocephala Meisn.	H	Aut	12-4	4-7
Merremia contorquens (Choisy) Hall. f.	Li	Aut	11-5	3-7
Merremia digitata Meisn.	Li	Aut	11-5	4-5
Turbina abutiloides (Kunth) O'Donnel	H	Ane	12-5	3-6
Convolvulaceae sp. 1, gen. sp. nov.	H	Aut	11-2	1-2
Cucurbitaceae				
Cayaponia espelina Cogn.	Li	Zoo	9-11	9-3
Ceratosanthes hilariana Cogn.	Li	Zoo	7-10	9-10
Melancium campestre Naud.	H	Zoo	1-3	1-3
Cyperaceae				
Bulbostylis junciformis (Kunth) C.B. Clarke	H	Aut	7-3	3-5
Bulbostylis paradoxa (Spreng.) Lindm.	H	Aut	7-10	7-10
Bulbostylis sphaerocephala (Nees) C.B. Clarke	H	Aut	11-2	11-5
Bulbostylis truncata (Nees) M.T. Strong	H	Aut	10	—
Cyperus aggregatus (Willd.) Endl.	H	Aut	10-4	12-4
Cyperus meyenianus Kunth	H	Aut	1-2	2-3
Killinga odorata Vahl.	H	Aut	3	4
Rhynchosphora diamantina (C.B.Clarke) Kukenth	H	Aut	11-8	11-8
Rhynchosphora emaciata Boeckm.	H	Aut	3	3
Rhynchosphora exaltata Kunth	H	Aut	6-12	9-2
Rhynchosphora rugosa (Vahl.) Gale	H	Aut	6	6
Scleria scabra Willd.	H	Aut	—	12
Dilleniaceae				
Davilla elliptica A. St-Hil.	Ph	Zoo	3-12	3-12
Davilla nitida (Vahl.) Kubitzki	Li	Zoo	7	8-10
Dioscoreaceae				
Dioscorea amaranthoides Presl.	Li	Ane	3-4	4-8
Dioscorea claussenii Uline	Li	Ane	3	3
Ebenaceae				
Diospyros hispida A. DC.	Ph	Zoo	8-9	9-3
Erythroxylaceae				
Erythroxylum campestre A. St-Hil.	Ph	Zoo	6-3	1-12
Erythroxylum deciduum A. St-Hil.	Ph	Zoo	—	8

Family/species	lf	ds	fl. per.	fr. per.
Erythroxylum suberosum A. St-Hil.	Ph	Zoo	5-10	9-3
Euphorbiaceae				
Chamaesyce caecorum (Mart. ex Boiss.) Croizat	H	Aut	1-12	6-10
Cnidosculus quercifolius Pohl	H	Aut	8-11	9-12
Croton aberrans Müll. Arg.	H	Aut	—	7,11
Croton antisyphiliticus Mart.	H	Aut	5-10	5-11
Croton cinctus Müll. Arg.	H	Aut	3	3
Croton glandulosus Müll. Arg.	H	Aut	12-4	12-4
Croton goyazensis Müll. Arg.	H	Aut	7-8,11-2	7-8,11-2
Croton lundianus Müll. Arg.	H	Aut	11-12	12
Croton pohlianus Müll. Arg.	H	Aut	8-12	8-12
Croton sclerocalyx Müll. Arg.	H	Aut	—	2
Croton sp.	H	Aut	11-6	1-6
Dalechampia humilis Müll. Arg.	H	Aut	1-12	1-12
Dalechampia linearis Baill.	H	Aut	11	11
Julocroton humilis Didr.	H	Aut	3-11	3-11
Manihot caerulescens Pohl	H	Aut	12	12-4
Manihot tripartita (Spreng.) Müll. Arg.	H	Aut	9-6	11-6
Maprounea guianensis Aubl.	Ph	Aut	10	10
Phyllanthus orbiculatus Müll. Arg.	Th	Aut	12-3	12-3
Sapium glandulatum (Vell.) Pax	Ch	Zoo	4-12	12-5
Sebastiania bidentata (Mart.) Pax	H	Zoo	12-4	4
Fabaceae				
Acosmium subelegans (Mohl.) Yakovlev	Ph	Ane	9	—
Aeschynomene marginata Benth.	Th	Zoo	12-4	12-4
Aeschynomene oroboides Benth.	H	Zoo	4-11	4-11
Anadenanthera falcata (Benth.) Speg.	Ph	Ane	8-1	1-9
Andira cuiabensis Benth.	Ph	Zoo	3	4-11
Andira laurifolia Benth.	Ch	Zoo	8-9	8-12
Andira vermifuga (Mart.) Benth.	Ph	Zoo	8	—
Arachis tuberosa Bong. ex Benth.	H	Aut	8-10	—
Bauhinia rufa Steud.	Ph	Aut	1-12	1-12
Bowdichia virgilioides Kunth	Ph	Ane	5	5-8
Calliandra dysantha Benth.	Ch	Aut	1-12	3-10
Calliandra macrocalyx Harms	Ph	Aut	3-10	3-11
Calopogonium sericeum (Benth.) Chodat ex Hassl.	Li	Aut	12-3	2-4
Camptosema ellipticum (Desv.) Burkart	Li	Aut	12-5	12-5
Centrosema venosum Mart. ex Benth.	Li	Aut	11-3	2-4
Chamaecrista basifolia (Vogel) Irwin & Barneby	Ch	Aut	12-1	1-4
Chamaecrista campestris Irwin & Barneby	Ch	Aut	1-4	1-5
Chamaecrista cotonifolia (G. Don.) Killip.	Ch	Aut	6-10	8-10
Chamaecrista desvauxii (Collad.) Killip.	Ch	Aut	12-6	12-7
Chamaecrista filicifolia (Benth.) Irwin & Barneby	Ch	Aut	10-7	4-7
Chamaecrista flexuosa (L.) Greene	Ch	Aut	10-6	10-6
Chamaecrista lundii (Benth.) Irwin & Barneby	H	Aut	6-9	7-9
Chamaecrista nictitans (L.) Moench.	Ch	Aut	1-4	1-4
Chamaecrista planaltoana (Harms) Irwin & Barneby	H	Aut	1-12	1-12

Family / species	lf	ds	fl. per.	fr. per.
Chamaecrista rotundifolia (Pers.) Greene	H	Aut	11-4	11-4
Chamaecrista setosa (Vogel) Irwin & Barneby	Ch	Aut	1-7	5-7
Clitoria densifolia (Presl.) Benth.	H	Aut	9-2	3-4
Copaifera langsdorffii Desf.	Ph	Zoo	11-2	1-5
Crotalaria maypurensis Kunth	Th	Aut	1-4	1-4
Crotalaria nitens Benth.	H	Aut	1-3	3-6
Crotalaria velutina Benth.	H	Aut	—	2-4
Dalbergia cuiabensis Benth.	Ph	Ane	4-6	5-9
Dalbergia miscolobium Benth.	Ph	Ane	—	6
Desmodium barbatum (L.) Benth.	H	Zoo	3	3
Desmodium incanun (Sw.) A. DC.	Th	Zoo	1-4	1-5
Desmodium platycarpum Benth.	H	Zoo	10	10
Dimorphandra mollis Benth.	Ph	Zoo	10-2	1-8
Dioclea bicolor Benth.	Li	Aut	1-12	6-12
Dyptichandra aurantiaca Tul.	Ph	Ane	—	3-8
Eriosema crinitum (Kunth) Gardner	H	Aut	7-4	1-10
Eriosema cupreum Harms.	H	Aut	10	10
Eriosema glabrum Mart. ex Benth.	H	Aut	12-1	—
Eriosema heterophyllum Benth.	H	Aut	10	10
Eriosema longifolium Benth.	H	Aut	10-5	12-5
Eriosema rufum Kunth	H	Aut	9-2	9-6
Galactia decumbens (Benth.) Chodat & Hassl.	H	Aut	11-5	11-5
Galactia dimorpha Burk.	H	Aut	11-5	1-6
Galactia martii A. DC.	H	Aut	5-12	5-1
Harpalyce brasiliana Benth.	Ph	Aut	12-4	2-7
Hymenaea stigonocarpa Mart.	Ph	Zoo	10-3	10-3
Indigofera gracilis Bong.	H	Aut	7-1	7-10
Lupinus subsessilis Benth.	H	Aut	12-4	1-4
Machaerium acutifolium Vogel	Ph	Ane	7-10	11
Mimosa amnis-atri Barneby	Ph	Ane	3,7	7
Mimosa distans Benth.	Ch	Ane	11	—
Mimosa foliolosa Benth.	Ph	Zoo	7-3	7-4
Mimosa gemmulata Barneby	Ph	Ane	6-1	6-3
Mimosa gracilis Benth.	Ch	Ane	1-12	1-10
Mimosa hebecarpa Benth.	Ph	Ane	5-10	5-11
Mimosa nuda Humb. & Bonpl.	H	Zoo	11-4	12-5
Mimosa polycephala Benth.	Ch	Ane	12-7	3-7
Mimosa radula Benth.	Ch	Ane	1-12	12-9
Mimosa xanthocentra Mart.	Ch	Ane	9-4	1-8
Periandra mediterranea (Vell.) Taub.	Ch	Aut	12-5	1-7
Phaseolus firmulus Mart.	H	Aut	6-8	6-8
Plathymenia reticulata Benth.	Ph	Aut	8-10	11-12
Poiretia angustifolia Vogel	H	Aut	12-4	1-5
Poiretia latifolia Vogel	H	Aut	2-4	2-4
Poiretia longipes Harms.	H	Aut	1-5	1-5
Pterodon pubescens Benth.	Ph	Ane	9	—
Rhynchosia platyphylla Benth.	H	Aut	12-1	1
Senna rugosa (G. Don.) Irwin & Barneby	Ph	Aut	12-5	3-6
Senna silvestris (Vell.) Irwin & Barneby	Ph	Aut	7-5	12-5

Family/species	lf	ds	fl. per.	fr. per.
Senna velutina (Vogel) Irwin & Barneby	Ph	Aut	2-5	3-7
Stryphnodendron adstringens (Mart.) Coville	Ph	Zoo	5-10	1-12
Stryphnodendron obovatum Benth.	Ph	Aut	6-11	9-11
Stylosanthes bracteata Vogel	H	Aut	9-11	10-11
Stylosanthes gracilis Kunth	Th	Aut	1-4	4-5
Stylosanthes guianensis Sw.	Th	Aut	1-4	3-5
Stylosanthes scabra Vogel	H	Aut	5	5
Tephrosia adunca Benth.	H	Aut	11-1	1
Vatairea macrocarpa (Benth.) Ducke	Ph	Ane	—	—
Vigna linearis Kunth	Li	Aut	2-4	4
Zornia latifolia Sm.	H	Zoo	1-3	2-4
Zornia reticulata Sm.	H	Zoo	12-3	2-3
Zornia virgata Moric.	H	Zoo	4-5	5
Fabaceae sp. 1	Ph	Aut	—	2
Flacourtiaceae				
Casearia grandiflora Cambess.	Ph	Zoo	4-6	6
Casearia sylvestris Sw.	Ph	Zoo	6-10	8-10
Casearia sp.	H	Aut	4,11	—
Gentianaceae				
Deianira nervosa Cham. & Schltdl.	H	Aut	3-6	4-6
Irlbachia alata (Aubl.) Maas	H	Aut	2	—
Irlbachia speciosa (Cham. & Schltdl.) Maas	H	Aut	1-7	2-7
Gesneriaceae				
Sinningia elatior (Kunth) Chautems	H	Ane	10	10
Hypoxidaceae				
Hypoxis sp.	Geo	Aut	2,10	—
Icacinaceae				
Emmotum nitens (Benth.) Miers.	Ph	Zoo	4	5-9
Iridaceae				
Sisyrinchium vaginatum Spreng.	Geo	Aut	10-3	10-4
Trimezia juncifolia (Kl.) Kunth	Geo	Aut	10-2	11-3
Lamiaceae				
Eriope crassipes Benth.	H	Aut	3-11	1-12
Hypenia macrantha (A. St-Hil. ex Benth.) Harley	H	Aut	1-12	3-10
Hyptidodendron canum (Pohl ex Benth.) Harley	Ph	Aut	6-7	6-7
Hyptis adpressa A. St-Hil. ex Benth.	H	Aut	7-10	8-10
Hyptis capriariifolia Pohl ex Benth.	H	Aut	3-5	4-5
Hyptis caudata Epling & Sativa	H	Aut	4-7	6-7
Hyptis crinita Benth.	H	Aut	5-7	6-7
Hyptis desertorum Pohl ex Benth.	H	Aut	9-10	9-10
Hyptis eriophylla Pohl	H	Aut	2	2-4
Hyptis ferruginosa Pohl ex Benth.	H	Aut	8-4	10-5

Family/species	lf	ds	fl. per.	fr. per.
Hyptis interrupta Pohl ex Benth.	H	Aut	3-5	3-5
Hyptis lythroides Pohl ex Benth.	H	Aut	8	8
Hyptis multiflora Pohl ex Benth.	H	Aut	1-4	4-5
Hyptis recurvata Poit.	H	Aut	6	6
Hyptis saxatilis A. St-Hil. ex Benth.	Ch	Aut	3-9	6-9
Hyptis villosa Pohl ex Benth.	H	Aut	8-5	1-12
Hyptis virgata Benth.	H	Aut	1-12	1-12
Hyptis sp.	H	Aut	6	6
Marsipianthes chamaedrys (Vahl) Kuntze	H	Aut	1	1
Marsipianthes montana Benth.	H	Aut	3,8-10	3,9-10
Ocimum sp.	H	Aut	6-2	6-4
Peltodon pusillus Pohl	H	Aut	4-7	4-7
Peltodon tomentosus Pohl	H	Aut	3-4	4-5
Salvia sp.	H	Aut	4-10	4-12
Lauraceae				
Aiouea trinervis Meisn.	Ph	Zoo	3-5	5-10
Cassytha filiformis L.	VP	Zoo	12-1	—
Lecythidaceae				
Eschweilera nana (Berg.) Miers	Ph	Ane	2-5	4-5
Loganiaceae				
Strychnos pseudoquina A. St-Hil.	Ph	Zoo	—	—
Lythraceae				
Cuphea carthagenensis (Jacq.) Macbr.	H	Aut	11-3	11-3
Cuphea linarioides Koehne	H	Aut	10-6	10-6
Lafoensia pacari A. St-Hil.	Ph	Aut	9-10	—
Malpighiaceae				
Banisteriopsis acerosa (Nied.) B. Gates	Ph	Ane	2-7	5-9
Banisteriopsis amplectens B. Gates	Li	Ane	7-9	7-12
Banisteriopsis campestris (A. Juss.) Little	Li	Ane	12-3	1-6
Banisteriopsis gardneriana (A. Juss.) W. Anderson & Sattl.	Li	Ane	8	—
Banisteriopsis laevifolia (A. Juss.) B. Gates	Li	Ane	12-4	1-4
Banisteriopsis schizoptera (A. Juss.) B. Gates	Li	Ane	3	—
Banisteriopsis stellaris (Griseb.) B. Gates	Li	Ane	1-6	3-6
Banisteriopsis variabilis B. Gates	Li	Ane	3-6	4-8
Byrsonima basiloba A. Juss.	Ph	Zoo	1-12	1-12
Byrsonima coccolobifolia A. Juss.	Ph	Zoo	2-11	5-1
Byrsonima crassa Nied.	Ph	Zoo	1-12	1-12
Byrsonima gaultherioides Griseb.	Ch	Zoo	8-10	9-11
Byrsonima guilleminiana A. Juss.	Ch	Zoo	8-11	9-11
Byrsonima intermedia A. Juss.	Ph	Zoo	1-12	12-7
Byrsonima rigida A. Juss.	Ch	Zoo	11-5	11-5
Byrsonima verbascifolia (Griseb.) B. Gates	Ph	Zoo	8-10	9-10
Camarea affinis A. St-Hil.	H	Zoo	12-2	2
Heteropterys anoptera A. Juss.	Li	Ane	4	—

Family/species	lf	ds	fl. per.	fr. per.
Heteropterys byrsonimifolia A. Juss.	Ph	Ane	6-1	8-10
Heteropterys campestris A. Juss.	Li	Ane	12-5	4-5
Heteropterys coriacea A. Juss.	Li	Ane	3-9	4-10
Peixotoa reticulata Griseb.	Li	Ane	1-12	5-10
Tetrapteris ambigua (A. Juss.) Nied.	Li	Ane	4,8-9	8-9
Malvaceae				
Byttneria oblongata Pohl	H	Aut	8-5	1-9
Eriotheca gracilipes (K. Schum.) A. Robyns	Ph	Ane	4-9	7-12
Eriotheca pubescens (Mart. & Zucc.) A. Robyns	Ph	Ane	5-7	7-10
Helicteres sacarolha A. St-Hil.	H	Aut	11-4	2-4
Krapovichasia macrodon (A. DC.) Fryxell	H	Aut	11	—
Melochia villosa (Mill.) Fawc. & Rendle	H	Aut	12-2	1-2
Pavonia rosa-campestris A. St-Hil.	H	Aut	3-12	7-12
Peltaea edouardii (Hochr.) Krapov. & Cristóbal	H	Aut	1-12	1-12
Peltaea polymorpha (A. St-Hil.) Krapov. & Cristóbal	H	Aut	1-12	1-12
Pseudobombax longiflorum (Mart. & Zucc.) A. Robyns	Ph	Ane	6-8	9
Sida cerradoensis Krapov.	H	Aut	3	3
Sida cordifolia L.	H	Aut	3,8	3,8
Sida linearifolia A. St-Hil.	H	Aut	3	3
Sida rhombifolia L.	H	Aut	2-4	3-4
Waltheria douradinha A. St-Hil.	H	Aut	10-5	10-5
Waltheria indica L.	H	Aut	3-12	5-1
Melastomataceae				
Miconia albicans Triana	Ph	Zoo	1-10	10-5
Miconia fallax A. DC.	Ph	Zoo	1-10	10-2
Miconia ferruginata A. DC.	Ph	Zoo	3-10	8-12
Miconia ligustroides (A. DC.) Naud.	Ph	Zoo	6-10	6-10
Miconia rubiginosa (Bonpl.) A. DC.	Ph	Zoo	9-11	2
Mouriri elliptica Mart.	Ph	Zoo	3-11	5-11
Rhynchanthera ursina Naud.	Ch	Ane	6-7	6-7
Tibouchina gracilis (Bonpl.) Cogn.	Ch	Ane	1-6	3-6
Tibouchina stenocarpa (A. DC.) Cogn.	Ph	Ane	2-4	3-4
Menispermaceae				
Cissampelos ovalifolia Ruiz & Pav.	H	Zoo	1-12	12-5
Moraceae				
Brosimum gaudichaudii Trècul	Ph	Zoo	3-10	9-12
Myristicaceae				
Virola sebifera Aubl.	Ph	Zoo	—	4,7
Myrsinaceae				
Myrsine leuconeura Mart.	Ph	Zoo	—	2
Myrtaceae				
Campomanesia adamantium (Cambess.) O. Berg	Ph	Zoo	8-10	8-11

Family/species	lf	ds	fl. per.	fr. per.
Campomanesia pubescens (A. DC.) O. Berg	Ph	Zoo	6-3	9-12
Eugenia angustissima O. Berg	H	Zoo	12-9	5-6,10-12
Eugenia aurata O. Berg	Ph	Zoo	1-3	3-4
Eugenia bimarginata A. DC.	Ph	Zoo	6	—
Eugenia calycina Cambess.	Ch	Zoo	6,9	1,4,10
Eugenia complicata O. Berg	Ch	Zoo	—	7
Eugenia cristaensis O. Berg	H	Zoo	—	11
Eugenia piauhiensis O. Berg	Ph	Zoo	6-1	4-9
Eugenia piloesis Cambess.	Ph	Zoo	6-1	4-9
Eugenia punicifolia (Kunth) A. DC.	Ph	Zoo	—	11-3
Eugenia sp. 1	Ch	Zoo	—	10
Eugenia sp. 2	Ph	Zoo	7	10
Eugenia sp. 3	H	Zoo	—	11
Eugenia sp. 4	Ch	Zoo	2-5	5
Myrcia bella Cambess.	Ph	Zoo	7-11	10-1
Myrcia bracteata O. Berg	Ph	Zoo	1	—
Myrcia camapuanensis N.F.E. Silveira	Ph	Zoo	11	—
Myrcia crassifolia (O. Berg) Kiaersk.	Ph	Zoo	8-9	9-12
Myrcia decrescens O. Berg	Ph	Zoo	—	11
Myrcia fallax (Rich.) A. DC.	Ph	Zoo	8-10	—
Myrcia guianensis A. DC.	Ph	Zoo	6-10	7-1
Myrcia laruotteana Cambess.	Ph	Zoo	10	—
Myrcia lasiopus O. Berg	H	Zoo	10-1	2-3
Myrcia linguaeformis Kiaersk.	Ph	Zoo	7-9	9-10
Myrcia rhodeosepala Kiaersk.	Ph	Zoo	5,9-10	9-10
Myrcia torta A. DC.	Ch	Zoo	6-1	6-1
Myrcia uberavensis O. Berg	Ph	Zoo	7-10	10-1
Myrcia variabilis Mart. ex A. DC.	Ph	Zoo	4-10	10-12
Myrcia sp. 1	Ch	Zoo	9-11	10-12
Myrcia sp. 2	Ph	Zoo	4-9	8-9
Myrcia sp. 3	H	Zoo	5	6
Myrciaria delicatula (A. DC.) O. Berg	H	Zoo	11-3	—
Psidium australe Cambess.	Ch	Zoo	9-5	2-5
Psidium cinereum Mart.	Ch	Zoo	10-3	11-3
Psidium firmum O. Berg	Ch	Zoo	—	9
Psidium laruotteanum Cambess.	Ph	Zoo	6-11	9-11
Psidium multiflorum Cambess.	Ch	Zoo	8	1
Psidium rufum Mart. ex A. DC.	Ph	Zoo	4-5	10
Nyctaginaceae				
Guapira campestris (Netto) Lund.	Ch	Zoo	7-12	8-1
Guapira graciliflora (Mart. ex J.A. Schmidt) Lund.	Ph	Zoo	7-12	8-1
Guapira noxia (Netto) Lund.	Ph	Zoo	7-12	8-1
Neea macrophylla Poep. & Endl.	Ph	Zoo	12-3	12-3
Neea theifera Oerst.	Ph	Zoo	6-11	10-1
Ochnaceae				
Ouratea acuminata (A. DC.) Engl.	Ph	Zoo	4-12	7-12
Ouratea castanaefolia (A. DC.) Engl.	Ph	Zoo	7-9	7-9

Family/species	lf	ds	fl. per.	fr. per.
Ouratea floribunda (A. St-Hil.) Engl.	Ch	Zoo	1-12	4-10
Ouratea nana (A. St-Hil.) Engl.	Ch	Zoo	4-10	9-1
Ouratea spectabilis (Mart.) Engl.	Ph	Zoo	6-10	9-12
Orchidaceae				
Epistephium sclerophyllum Lindl.	Geo	Ane	2-3	2-4
Galeandra montana Barb. Rodr.	Geo	Ane	1-2	3
Habenaria brevidens Lindl.	Geo	Ane	2	—
Habenaria nasuta Rchb. f. & Warm.	Geo	Ane	2	—
Habenaria obtusa Lindl.	Geo	Ane	1	1
Oxalidaceae				
Oxalis sellowii Spreng.	H	Aut	1-12	1-10
Passifloraceae				
Mitostemma brevifilis Gontsch.	Ch	Zoo	7-11	9-12
Passiflora mansoi (Mart.) Mast.	Li	Zoo	3	3
Poaceae				
Actinocladum verticillatum (Nees) McClure ex Saderston	Ph	Aut	—	—
Andropogon bicornis L.	H	Ane	2-3	3-8
Andropogon fastigiatus Sw.	H	Zoo	3	4
Andropogon leucostachys Kunth	H	Ane	11-2	1-12
Andropogon selloanus (Hack.) Hack.	H	Ane	1	1
Anthaenantiopsis perforata (Nees) Parodi	H	Aut	12-4	12-4
Apoclada arenicola McClure	Ph	Aut	—	—
Aristida longifolia Trin.	H	Ane	4-5	5
Aristida riparia Trin.	H	Zoo	1-5	2-6
Axonopus aureus P. Beauv.	H	Zoo	1-2	1-4
Axonopus barbigerus (Kunth) Hithc.	H	Zoo	2-3	4-5
Axonopus brasiliensis (Spr.) Kuhlm.	H	Aut	9-3	9-3
Axonopus derbyanus Black	H	Zoo	10-6	10-6
Brachiaria decumbens Stapf.	H	Zoo	12-5	2-7
Ctenium chapadense (Trin.) Doell.	H	Ane	4-6	5-6
Echinolaena inflexa (Poir.) Chase	H	Zoo	12-4	1-6
Elionurus latiflorus Nees	H	Aut	1-12	1-12
Eragrostis airoides Nees	H	Aut	10-11	12-1
Eragrostis articulata (Schrank) Nees	Th	Aut	10-2	3-4
Eragrostis maypurensis (Kunth) Steud.	Th	Aut	4-5	4-6
Gymnopogon foliosus (Willd) Nees	H	Ane	3-5	4-6
Hyparrhenia bracteata (Humb. & Bonpl.) Stapf.	H	Ane	5	5
Hyparrhenia rufa (Nees) Stapf.	H	Zoo	3-8	4-9
Ichnanthus procurrens (Nees) Sw.	H	Aut	1	1
Leptocoryphium lanatum (Kunth) Nees	H	Aut	2-10	2-10
Loudetiopsis chrysothryx (Nees) Conert	H	Zoo	2	3-5
Melinis minutiflora P. Beauv.	H	Ane	6-12	6-12
Olyra taquara Sw.	Ph	Aut	—	—
Panicum olyroides Kunth	H	Aut	11-4	2-5
Panicum rudgei Roem & Shult.	H	Aut	12-6	12-6

Family/species	lf	ds	fl. per.	fr. per.
Panicum sp.	H	Aut	3	3
Paspalum carinatum Humb. & Bonpl. ex Fleug.	H	Ane	11	11
Paspalum convexum Humb. & Bonpl. ex Fleug.	H	Zoo	—	3
Paspalum erianthum Nees	H	Aut	8-5	5-12
Paspalum gardnerianum Nees	H	Zoo	12-6	12-6
Paspalum geminiflorum Steud.	H	Zoo	4	4
Paspalum malacophyllum Trin.	H	Zoo	3	3
Paspalum multicaule Poir.	H	Zoo	4-5	5
Paspalum pectinatum Nees	H	Ane	1-12	1-12
Paspalum sp. 1	H	Zoo	1-3	1-3
Paspalum sp. 2	H	Zoo	3	3
Pennisetum setosum (Sw.) L. C. Rich.	H	Ane	5-6	5-6
Rhynchelitrum repens (Nees) C.E. Hubb.	Th	Ane	1-2	2-6
Schyzacchirium condensatum (Kunth) Nees	H	Ane	6	6
Setaria geniculata (L.) P. Beauv.	Th	Zoo	12-3	2-6
Sporolobus acuminatus Boechat & Longhi-Wagner	H	Zoo	11-1	12-1
Sporolobus ciliatus (Trin.) Hack.	H	Aut	3-4	4-5
Sporolobus indicus (L.) R. Brown	H	Aut	1	1
Trachypogon spicatus (L. f.) Kuntze	H	Zoo	2	2
Thrasya petrosa Nees	H	Aut	1-5	1-5
Tristachya leiostachya Nees	H	Zoo	11-2	2-5
Polygalaceae				
Polygala angulata A. DC.	H	Aut	6-3	8-3
Polygala aphylla A.W.Benn.	H	Aut	1-12	3-10
Polygala opina Wurdack	H	Aut	11-3	—
Polygala violacea Aubl.	H	Aut	12-2	1-2
Securidaca tomentosa A. St-Hil.	Li	Ane	6-10	8-10
Polygonaceae				
Coccoloba densifrions Mart.	Ph	Zoo	6-3	6-4
Polypodiaceae				
Adiantum serratodentatum Humb. & Bonpl. ex Willd.	H	Ane	5	—
Proteaceae				
Roupala montana Aubl.	Ph	Ane	6	7-10
Rhamnaceae				
Crumenaria polygaloides Reissek	H	Ane	1-5	2-5
Rubiaceae				
Alibertia sessilis (Vell.) K. Schum.	Ch	Zoo	7-9	8-11
Borreria suaveolens Meyers	H	Aut	1-12	1-12
Chomelia ribesioides Benth. ex A. Gray	Ph	Zoo	10	11-3
Declieuxia fruticosa (Willd.) Kuntze	H	Zoo	11-7	11-7
Declieuxia oenanthoides Schult. & Schult.	H	Aut	11-3	2-3
Declieuxia verticilata Müll. Arg.	H	Zoo	10-7	11-7
Diodia schumanii Standl.	Th	Aut	1-12	1-12

Family/species	lf	ds	fl. per.	fr. per.
Diodia teres Walt.	Th	Aut	1-10	3-10
Galianthe grandifolia Cabral	H	Aut	1-6	3-6
Genipa americana L.	Ph	Zoo	9-12	1-12
Palicourea coriacea (Cham.) K. Schum.	Ch	Zoo	1-12	1-12
Palicourea rigida Kunth	Ph	Zoo	4-1	11-8
Richardia humistrata (Cham. & Schltdl.) Steud.	H	Aut	11-3	12-3
Richardia stellaris (Cham. & Schltdl.) Steud.	H	Aut	3-5	4-5
Sipanea hispida Benth.	H	Aut	12-2	12-2
Tocoyena formosa (Cham. & Schltdl.) K. Schum.	Ph	Zoo	6-1	12-6
Rutaceae				
Hortia brasiliana Vand. ex A. DC.	Ph	Zoo	2-9	7-9
Spiranthera odoratissima A. St-Hil.	Ch	Aut	1-11	5-11
Sapindaceae				
Matayba guianensis Aubl.	Ph	Zoo	8-10	11
Serjania cissoides Radlk.	Li	Ane	10-5	12-5
Serjania erecta Radlk.	Ch	Ane	7-4	2-7
Serjania reticulata Cambess.	Li	Ane	3-8	5-10
Talisia angustifolia Radlk.	Ch	Zoo	9-1	—
Toulicia tomentosa Radlk.	Ch	Ane	3-5	3-8
Sapotaceae				
Pouteria ramiflora (Mart.) Radlk.	Ph	Zoo	5-9	8-1
Pouteria subcaerulea Pierre ex Dubard	Ch	Zoo	—	11-12
Pouteria torta (Mart.) Radlk.	Ph	Zoo	6-8	8-12
Pradosia brevipes (Pierre) Penn.	H	Zoo	9-10	10
Scrophulariaceae				
Buchnera lavandulacea Cham. & Schltdl.	H	Ane	12-6	12-6
Esterhazia petiolata Barr.	H	Ane	5	5
Scoparia dulcis L.	Ch	Aut	10-12	10-12
Simaroubaceae				
Simaba suffruticosa Engl.	Ch	Zoo	8-9	9-10
Simarouba amara Aubl.	Ph	Zoo	—	—
Smilacaceae				
Smilax cissoides Mart. ex Griseb.	Li	Zoo	6-3	6-3
Solanaceae				
Solanum lycocarpum A. St-Hil.	Ph	Zoo	9-5	1-12
Solanum subumbellatum Vell.	Ch	Zoo	10	—
Styracaceae				
Styrax ferrugineus Nees & Mart.	Ph	Zoo	4-8	6-10
Turneraceae				
Piriqueta emasensis Arbo, sp. nov.	H	Aut	4,7-11	8-11

Family/species	lf	ds	fl. per.	fr. per.
Piriqueta sidifolia (Cambess.) Urban	Ch	Aut	3,12	—
Turnera purpurascens Arbo	H	Aut	11-1	12-1
Verbenaceae				
Aegiphila lanata Mold.	Ch	Zoo	10-2	12-2
Aegiphila lhotzkiana Cham.	Ph	Zoo	—	12-1
Amasonia hirta Benth.	H	Zoo	12-3	1-4
Casselia chamaedryfolia Cham.	H	Aut	10-11	—
Lippia hirta Schauer	Ch	Aut	11-12	1
Lippia hoehnei Mold.	Ch	Aut	8-11	8-11
Lippia lupulina Cham.	Ch	Aut	5-11	6-11
Lippia martiana Schauer	Ch	Aut	11-2	1-6
Lippia primulina S. Moore	H	Aut	10	—
Lippia stachyoides Cham.	H	Aut	11-12	—
Lippia turnerifolia Cham.	H	Zoo	7-12	9-12
Stachytarpheta maximilliani Schauer	H	Aut	12-4	12-4
Stachytarpheta simplex Hayek.	H	Aut	12-3	1-3
Violaceae				
Hybanthus poaya (A. St-Hil) Baill.	H	Aut	9-10	9-10
Hybanthus sp. nov.	H	Aut	6-12	9-12
Vitaceae				
Cissus erosa L.C. Rich	Li	Zoo	12-3	1-4
Vochysiaceae				
Qualea grandiflora Mart.	Ph	Ane	9-12	1-9
Qualea multiflora Mart.	Ph	Ane	8-2	3-9
Qualea parviflora Mart.	Ph	Ane	10	—
Vochysia thyrsoidea Pohl	Ph	Ane	2-7	4-8
Vochysia tucanorum Mart.	Ph	Ane	12-11	9
Unknown				
Unknown sp. 1	Ch	Zoo	11-12	—

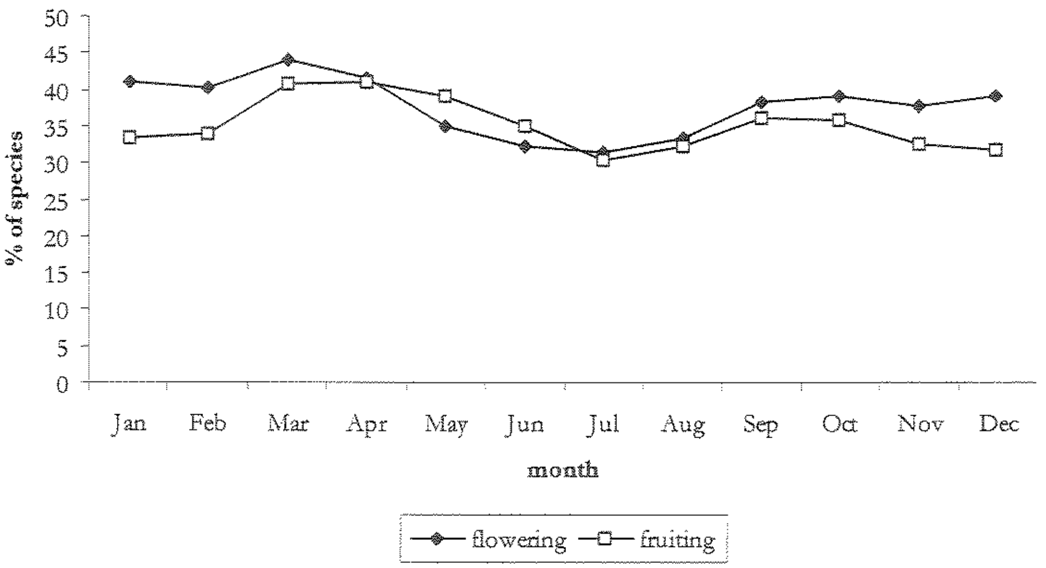

Figure 2. Percentage of flowering and fruiting species throughout the year in Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil.

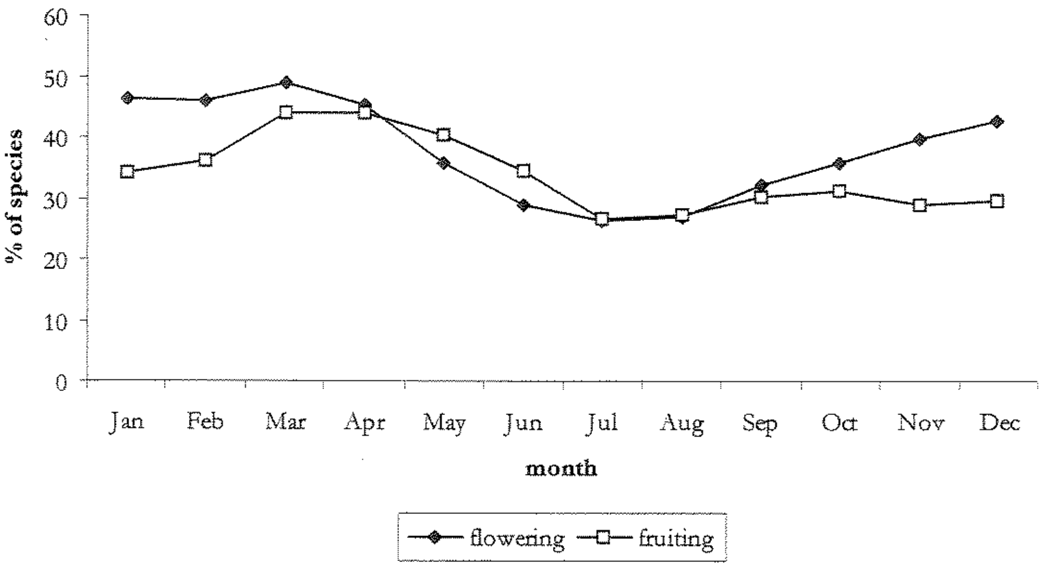

Figure 3. Percentage of flowering and fruiting herbaceous species throughout the year in Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil.

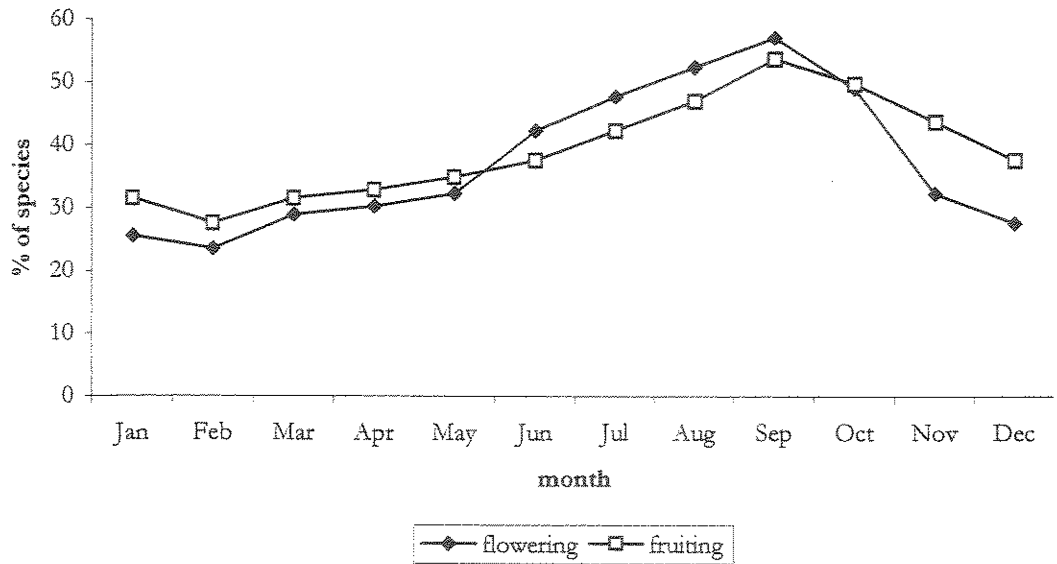

Figure 4. Percentage of flowering and fruiting woody species throughout the year in Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil.

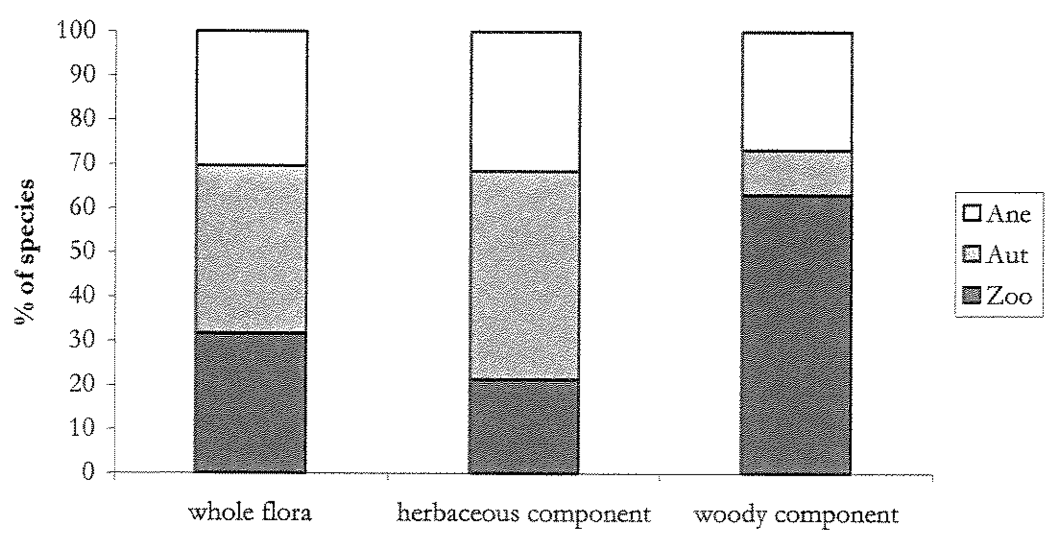

Figure 5. Percentual distribution of dispersion syndrome classes in the cerrado flora of Emas National Park, (17°49'-18°28'S and 52°39'-53°10'W), Goiás State, central Brazil. Ane = anemochorous, Aut = autochorous, Zoo = zoochorous.

Table 2. Differences between observed (O) and expected (E) proportions of dispersion syndrome classes in the cerrado flora of Emas National Park, (17°49'-18°28'S and 52°39'-53°10'W), Goiás State, central Brazil. Ane = anemochorous, Aut = autochorous, Zoo = zoochorous, ns = non-significant, *** = $P < 0.001$.

syndrome	whole flora			herbaceous component			woody component		
	O	E	χ^2	O	E	χ^2	O	E	χ^2
Ane	183	200.33	1.50	143	150.67	0.39	40	49.67	2.88
Aut	228	200.33	3.82	213	150.67	25.78	15	49.67	24.20
Zoo	190	200.33	0.53	96	150.67	19.84	94	49.67	39.56
total	601	601	**5.85 ns**	452	452	**46.01*** **	149	149	**65.65*** **

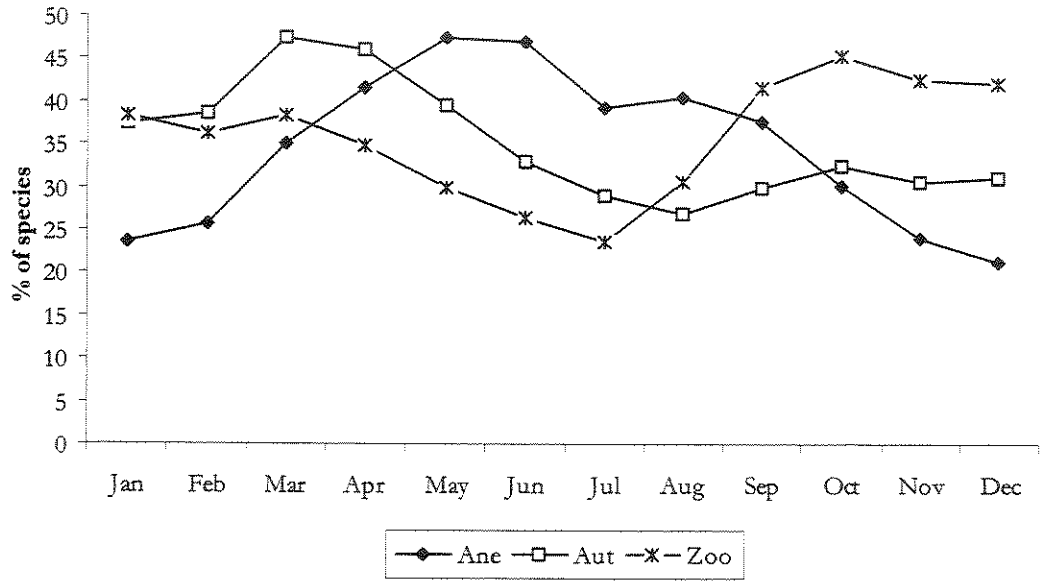

Figure 6 - Percentual distribution of fruiting species, according to their dispersion syndrome, throughout the year in the cerrado of Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ane = anemochorous, Aut = autochorous, Zoo = zoochorous.

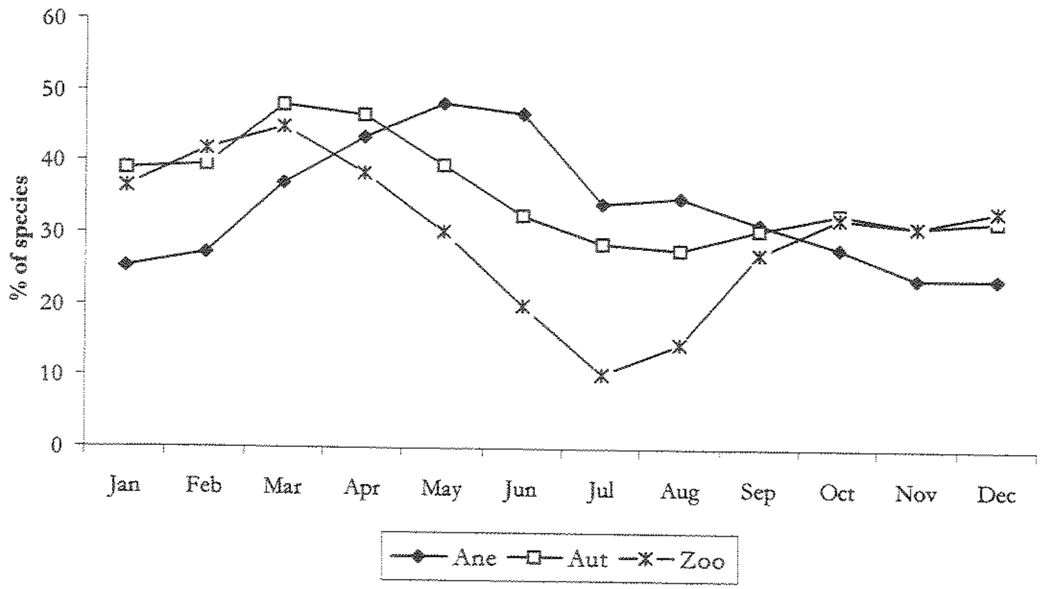

Figure 7. Percentual distribution of fruiting herbaceous species, according to their dispersion syndrome, throughout the year in the cerrado of Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ane = anemochorous, Aut = autochorous, Zoo = zoochorous.

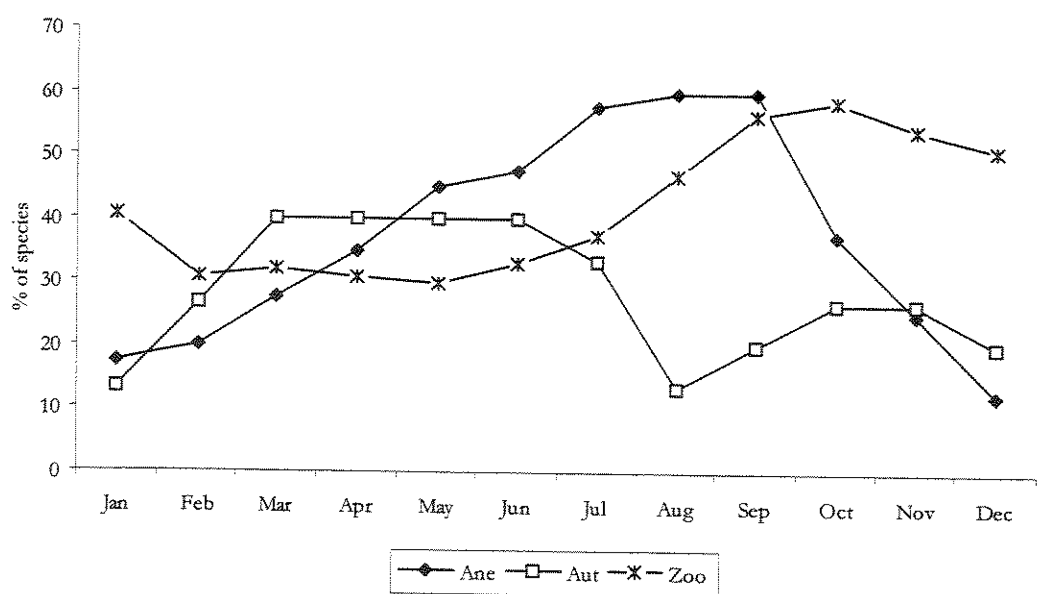

Figure 8. Percentual distribution of fruiting woody species, according to their dispersion syndrome, throughout the year in the cerrado of Emas National Park, (17°49'-18°28'S, 52°39'-53°10'W), Goiás State, central Brazil. Ane = anemochorous, Aut = autochorous, Zoo = zoochorous.

Discussion

In the cerrado plant community of ENP, flowering peaked twice in the year, on March and on October, corresponding, respectively, to the herbaceous and woody components. As expected by other studies carried out in outlying cerrado sites (Mantovani & Martins 1988, Batalha *et al.* 1997, Batalha & Mantovani 2000), the flowering pattern of each component of the cerrado flora was very different.

The flowering pattern of the herbaceous species, with a higher number of flowering species late in the rainy season, are also found in other tropical savannas (Sarmiento & Monasterio 1983). Tenório (1969) observed that the vegetative development of grasses allows carbohydrates accumulation, which is later used in flowering and fruiting. Carbohydrates accumulation of herbaceous species before flowering was later also observed by Figueiredo & Dietrich (1981), Isejima & Figueiredo-Ribeiro (1993), and Vieira & Figueiredo-Ribeiro (1993).

According to Isejima & Figueiredo-Ribeiro (1993) and Vieira & Figueiredo-Ribeiro (1993), changes in carbohydrate concentration, especially fructans, throughout the year, in cerrado herbaceous plants, are part of the mechanism for resistance to drought-induced stress. Sarmiento & Monasterio (1983) hypothesized that this strategy would guarantee the reproduction in the safest period in respect of water availability: during the period of water shortage, the aerial biomass rapidly decays, and then as the rainy season progresses they gradually develop their shoots and reproductive structures, to reach the maximum growth rates during the reproductive phenophases that occur in the period with higher water availability.

For many species, flowering occurred at distinct periods of the year, but always after fires, showing an adaptive response to fire, which allows synchrony in time of flowering (Coutinho 1980) and increased efficiency in diaspore dispersion (Coutinho 1977). For example, individuals of *Baccharis* *humilis* Sch. Bip. (Asteraceae) were found producing flowers in January, in April, and from July to October, in different recently burned areas.

The woody species presented reproductive phenological patterns different than those of the herbaceous species. The flowering period of the woody species was concentrated at late dry and early wet seasons. In outlying cerrado sites, in the southern São Paulo State, Mantovani & Martins (1988), Batalha *et al.* (1997), and Batalha & Mantovani (2000) found a higher proportion of flowering woody species at the beginning of the rainy season. However, at lower latitudes, in Federal District (Aoki & Santos 1980) and Pará State (Miranda 1995), most woody species flowered at the dry period of the year. In ENP, therefore, we found an intermediate pattern between the southern outlying sites and the northern core sites. Differences in flowering pattern of the woody species could be related to lower variations in temperature and day length throughout the year at northern sites.

Pioneering experiments carried out by Rawitscher (1942) and Ferri (1944) in an outlying cerrado site showed that trees and shrubs have a deep root system and, thus, water access during the whole year. Jackson *et al.* (1999), studying soil water partitioning among woody species, suggested that there may be a strong selective pressure for plants to develop a deep root system. Sarmiento & Monasterio (1983) suggested that if trees and shrubs, through this development of deep root systems, have water access during the whole year, there would be an advantage in reproducing during the period of water shortage, and leaving to the rainy season the function of storing reserves to support the dry season's activities. Pollinating insects activity would be favoured at this time of the year, due to lack of heavy rains that would damage the flowers and to leaf fall that would make the flowers more conspicuous (Janzen 1980).

Proença & Gibbs (1994) found flowering concentrated in the transition between dry and rainy seasons for six out of the eight species they investigated. Flowering at this transitional time is a favoured strategy, because the most marked fluctuations in humidity occur at this time of the year, and thus there is greater scope for humidity-linked synchronization (Proença & Gibbs 1994). This pattern was also found in Australian savannas by Williams *et al.* (1999), where the majority of woody species were flowering or fruiting at the transition between dry and wet seasons, named by them as the "build-up" period.

There was a clear distinction between herbaceous and woody species, regarding flowering time. Scholes & Archer (1997) stated that the coexistence of herbaceous and woody species in the savannas is a result of the interaction of several stresses and disturbances, acting differentially on each component and patchily in time and space. According to these authors, niches of herbaceous and woody species differ in both rooting depth and phenology, but there is more opportunity for phenological separation. Batalha & Mantovani (2000), in an outlying cerrado site, found striking differences between the patterns of the two components of the cerrado flora. These differences were also found by us in ENP, corroborating the hypothesis of niche separation by phenology between herbaceous and woody species.

We found in the herbaceous component of the cerrado flora in ENP an overproportion of autochorous species, which were the main responsible for the significancy of the chi-square value. In the woody component, on the other hand, the zoochorous species were over-represented. In other studied sites (Gottsberger & Silberbauer-Gottsberger 1983, Mantovani & Martins 1988, Batalha *et al.* 1997, Batalha & Mantovani 2000), a similar distribution was also found, but with an overproportion of anemochorous species in the herbaceous component as well.

During the driest months, in both components, the proportions of fruiting anemo and autochorous species were higher than those of zoochorous ones, what was also found by Gottsberger & Silberbauer-Gottsberger (1983), Mantovani & Martins (1988), Miranda (1995), Batalha *et al.* (1997), and Batalha & Mantovani (2000). The anemochorous and autochorous fruits are generally dry and thus their pericarps dehydrate during the drought, releasing their seeds. Augspurger

& Franson (1987) observed that, in areas under seasonal climate, anemochorous diaspore dispersal is more efficient at the dry season. Leaf fall observed mainly in the anemochorous species facilitates diaspore dispersal as well (Matthes *et al.* 1988).

Zoochorous species, on the contrary, fruited especially at the wettest period of the year, when their fleshy fruits can be kept attractive for a long time, as observed by Gottsberger & Silberbauer-Gottsberger (1983), Bianco & Pitelli (1986), Mantovani & Martins (1988), Miranda (1995), Batalha *et al.* (1997), and Batalha & Mantovani (2000). While, in the woody component, the proportion of fruiting species was higher throughout the whole rainy season, in the herbaceous component, this proportion was higher only at the end of this season. In savannas, herbaceous species are commonly more affected by seasonal climatic variation, because they have at the dry season more restrictions in water and nutrient availability (Seghieri *et al.* 1995). Therefore, as stated previously, herbaceous species can flower only after the period of carbohydrate accumulation (Figueiredo & Dietrich 1981, Isejima & Figueiredo-Ribeiro 1993, Vieira & Figueiredo-Ribeiro 1993) and fruiting is restricted to a short period at late wet season.

Previous works in other seasonal vegetation types in which the phenology of woody species was followed (Frankie *et al.* 1974, Morellato *et al.* 1989) showed similar patterns, that is, flowering after first rainfalls, fruiting anemo and autochorous species peaking at dry season, and fruiting zoochorous species throughout the whole rainy season. In Costa Rica, however, Frankie *et al.* (1974) found a higher number of flowering species at dry season, as in other cerrado sites located at lower latitudes (Aoki & Santos 1980, Miranda 1995).

When compared with other cerrado sites where reproductive phenological patterns of the plant community were studied, the patterns in ENP were, generally, very similar, with the exception of the flowering of the woody species. Nevertheless, even if these patterns seem to be consistent, quantitative and manipulative experiments are still lacking. Only with this approach, we could obtain more secure answers about the phenology of the cerrado plant community. Since, in ENP, fire plays an important role in the community dynamics (Ramos-Neto 2000), burned and unburned areas could be compared to test the influence of fire in flowering and fruiting on community level. Furthermore, experiments longer than one year should be carried out to detect supra-annual patterns that may occasionally happen in the reproductive events of the cerrado plant species.

Aknowledgements – We are grateful to Fapesp, for financial support (process 97/13.697-5); to Ibama, for research license (process 02001,000376/98-90); to the Emas National Park staff, for their help in field; to M.B. Ramos-Neto, for logistical assistance; and to the taxonomists K. Althott, M. Alves, M.M. Arbo, M.C. Assis, C. Bestetti, R.S. Bianchini, V. Bittrich, A.C. Cervi, I. Cordeiro, C.L. Cristóbal, T.S.C. Dorow, S.I. Elias, G. Esteves, M.A. Farinaccio, M.S. Ferrucci, P. Fiaschi, E. Forero, A. Furlan, E. Gonçalves, M. Kirizawa, A. Krapovickas, J.A. Lombardi, M.L. Kawasaki, M. Magenta, W. Mantovani, A.C. Marcato, R. Mello-Silva, E. Melo, M. Moraes, R.C. Oliveira, M.B. Paciencia, J.R. Pirani, A.P. Prata, C. Proença, N.A.T. Ranga, F.R. Salimena, J.U.M. dos Santos, J. Semir, M.F. Simon, E.R.V. Silva, M.M. da Silva, J.P. Souza, A. Spina, J.Y. Tamashiro, W. Thomas, R.B. Torres, M.G. Wanderley, and A. Zanin, for their assistance in the identification of species.

References

AOKI, H. & SANTOS, J. R. 1980. *Estudo da vegetação de cerrado na área do Distrito Federal, a partir de dados orbitais*. MSc. Dissertation. Instituto Nacional de Pesquisas Espaciais.

AUGSPURGER, C. K. & FRANSON, S. E. 1987. Wind dispersal of artificial fruits varying in mass, area and morphology. *Ecology 68*: 27-42.

BATALHA, M. A., ARAGAKI, S. & MANTOVANI, W. 1997. Variações fenológicas das espécies do cerrado em Emas (Pirassununga, SP). *Acta Botanica Brasilica 11*: 61-78.

BATALHA, M. A. & MANTOVANI, W. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparison between the herbaceous and the woody floras. *Revista Brasileira de Biologia 60*: 129-145.

BIANCO, S. & PITELLI, R. B. 1986. Fenologia de quatro espécies de frutíferas nativas dos cerrados de Selvíria, MS. *Pesquisas Agropecuárias Brasileiras 21*: 1229-1232.

BOURLIÈRE, F. & HADLEY, M. 1983. Present-day savannas: an overview. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Amsterdam, Elsevier. p. 1-17.

COUTINHO, L. M. 1976. *Contribuição ao conhecimento do papel ecológico das queimadas na floração de espécies do cerrado*. "Livre-Docência" Thesis. University of São Paulo.

COUTINHO, L. M. 1977. Aspectos ecológicos do fogo no cerrado. II. As queimadas e a dispersão em algumas espécies anemocóricas do estrato herbáceo-subarbustivo. *Boletim de Botânica da. Universidade de São Paulo 5*: 57-64.

COUTINHO, L. M. 1978. O conceito do cerrado. *Revista Brasileira de Botânica 1*: 17-23.

COUTINHO, L. M. 1980. As queimadas e seu papel ecológico. *Brasil Florestal 10:* 15-23.

FERRI, M. G. 1944. Transpiração de plantas permanentes dos "cerrados". *Boletim da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo, Botânica 4*: 155-224.

FIGUEIREDO, R. C. L. & DIETRICH, S. M. C. 1981. Variações estacionais nos compostos de reserva e no metabolismo do xilopódio de *Ocimum nudicaule* Benth. var. *anisifolia* Giul. (Labiatae). *Revista Brasileira de Botânica 4*: 73-82.

FRANKIE, G. W., BAKER, H. G. & OPLER, P. A. 1974. Comparative phenological studies of trees in tropical wet and dry forest in the lowlands Costa Rica. *Journal of Ecology 62*: 881-919.

GOTTSBERGER, G. & SILBERBAUER- GOTTSBERGER, I. 1983. Dispersal and distribution in the cerrado vegetation of Brazil. *Sonderbildung Naturwissenschaft Ver. Hamburg 7*: 315-352.

ISEJIMA, E. M. & FIGUEIREDO-RIBEIRO, R. C. L. 1993. Frutcan variations in tuberous roots of *Viguiera discolor* Baker (Asteraceae): the influence of phenology. *Plant Cell Physiology 34*: 723-727.

JACKSON, P. C.; MEIZNER, F. C.; BUSTAMANTE, M.; GOLDSTEIN, G.; FRANCO, A. RUNDEL, P. W.;

CALDAS, L.; IGLER, E. & CAUSIN, F. 1999. Partitioning of soil water among trees species in a Brazilian Cerrado ecosystem. *Tree Physiology 19*: 717-724.

JANZEN, D. H. 1980. *Ecologia vegetal nos trópicos*. EPU & Edusp, São Paulo.

JUDD, W. S.; CAMPBELL, C. S.; KELLOG, E. A. & STEVENS, P. F. 1999. *Plant systematics: a phylogenetic approach*. Sunderland, Sinauer.

KÖPPEN, W. 1948. *Climatología*. México, Fondo de Cultura Económica.

MANTOVANI, W. & MARTINS, F. R. 1988. Variações fenológicas das espécies do cerrado da Reserva Biológica de Moji Guaçu, Estado de São Paulo. *Revista Brasileira de Botânica 11*: 101-112.

MATTHES, L. A. F., LEITÃO-FILHO, H. F. DE, MARTINS, F.R. 1988. Bosque dos Jequitibás (Campinas, SP): Composição florística e estrutura do estrato arbóreo. *In* CONGRESSO DA SOCIEDADE DE BOTÂNICA DE SÃO PAULO *5*, Botucatu, 1988. *Anais*. Sociedade de Botânica de São Paulo, Campinas, p. 55-76.

MIRANDA, I. S. 1995. Fenologia do estrato arbóreo de uma comunidade de Alter-do-Chão, PA. *Revista Brasileira de Botânica 18*: 235-240.

MORELLATO, L. P., RODRIGUES, R. R., LEITÃO-FILHO, H. F. DE & JOLY, C. A. 1989. Estudo comparativo da fenologia de espécies arbóreas de floresta de altitude e floresta mesófila semidecídua na Serra do Japi, Jundiaí, São Paulo. *Revista Brasileira de Botânica 12*: 85-98.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology*. John Willey & Sons, New York.

OLIVEIRA, P. E. 1998. Fenologia e biologia reprodutiva das espécies de cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora*. Planaltina, Embrapa. p. 289-556.

OLIVEIRA, P. E. & SAZIMA, M. 1990. Pollination biology of two species of *Kielmeyera* (Guttiferae) form Brazilian cerrado vegetation. *Plant Systematics and Evolution 172*: 35-49.

PIJL, L. van der. 1972. *Principles of dispersion in higher plants*. Springer-Verlag, Berlin.

PROENÇA, C. E. B. & GIBBS, P. E. 1994. Reproductive biology of eight sympatric Myrtaceae from Central Brazil. *New Phytologist 126*: 343-354.

RAMOS-NETO, M. B. 2000. *O Parque Nacional das Emas (GO) e o fogo: implicações para a conservação biológica.* PhD. Thesis. University of São Paulo.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environmental Management 26*: 675-684.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography.* Oxford, Claredon.

RAWITSCHER, F. 1942. Algumas noções sobre a transpiração e o balanço de água de plantas brasileiras. *Anais da Academia Brasileira de Ciências 14*: 7-36.

RIBEIRO, J. F.; GONZALES, M. I. & OLIVEIRA, P. E. 1982. Aspectos fenológicos de espécies nativas de cerrado. *In* CONGRESSO NACIONAL DE BOTÂNICA *32*, Teresina, 1981. *Anais.* Sociedade de Botânica do Brasil, Teresina, p. 181-198.

RIZZINI, C. T. 1963. A flora do cerrado. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado.* São Paulo, Edusp & Edgard Blücher. p. 105-153.

SARMIENTO, G. & MONASTERIO, M. 1983. Life forms and phenology. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas.* Elsevier, Amsterdam. p. 79-108.

SCHAIK, C. P. VAN, 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.

SCHOLES, R. J. & ARCHER, S. R. 1997. Tree-grass interactions in savannas. *Annual Review of Ecology and Systematics 28*: 517-544.

SEGHIERI, J.; FLORET, C.; PONTAINER, R. 1995. Plant phenology in relation to water availability:

herbaceous and woody species in the savannas of northern Cameroon. *Journal of Tropical Ecology* *11*: 237-254.

TENÓRIO, E. C. 1969. Fenologia de gramíneas. *In* CONGRESSO NACIONAL DE BOTÂNICA *20*, Goiânia, 1969. *Anais*. Sociedade de Botânica do Brasil, Goiânia, p. 231-241.

VIEIRA, C. C. J. & FIGUEIREDO-RIBEIRO, R. C. L. 1993. Fructose-containing carbohydrates in the tuberous root of *Gomphrena macrocephala* St.-Hil. (Amaranthaceae) at different phenological phases. *Plant, Cell and Environment 16*: 919-928.

WALTER, H. 1986. *Vegetação e zonas climáticas*. São Paulo, EPU.

WARMING, E. 1892. Lagoa Santa, contribuição para a geografia fitobiológica. *In* WARMING, E. & FERRI, M. G. 1973. *Lagoa Santa e a vegetação dos cerrados brasileiros*. Itatiaia, Belo Horizonte. p. 1-282.

WILLIAMS, R. J.; MYERS, B. A.; MULLER, W. J.; DUFF, G. A. & EAMUS, D. 1997. Leaf phenology of woody species in a north Australian tropical savanna. *Ecology 78*: 2542-2558.

WILLIAMS, R. J.; MYERS, B. A.; EAMUS, D. & DUFF, G. A. 1999. Reproductive phenology of woody species in a north Australian tropical savanna. *Biotropica 31*: 626-636.

ZAR, J. H. 1999. *Biostatiscal analysis*. Upper Saddle River, Prentice Hall.

6. The herbaceous component of the cerrado flora: towards a checklist

Abstract – The cerrado, a savanna-like ecosystem, is the second largest vegetation type in Brazil. Even if frequently neglected, the herbaceous component of the cerrado flora is richer than the much more studied woody component. We tried to compile a checklist of the herbaceous species that occur in the cerrado, using life-form class as criterion of inclusion. All non-phanerophytes species were assumed to belong to the herbaceous component. We listed 2,856 species, a figure higher than the lower limit of a previous estimation. The richest families were Asteraceae, Fabaceae, Poaceae, Lamiaceae, Euphorbiaceae, Rubiaceae, and Orchidaceae, which accounted for 53.47% of the total number of species. The richest genera were *Hyptis*, *Vernonia*, *Chamaecrista*, *Paspalum*, and *Mimosa*, all belonging to one of the best represented families. The distribution of family sizes in the cerrado as a whole can be used to compare and characterize the herbaceous component in cerrado sites. Our checklist is probably an underestimation of the actual number of species in the herbaceous component of the cerrrado flora, due to the few surveys currently available in which the herbaceous species had also been sampled. Future studies dealing with the cerrado vegetation can no longer ignore the herbaceous component, which is richer and more vulnerable than the woody component.

Resumo – O cerrado é a segunda formação vegetal brasileira em extensão territorial. Ainda que freqüentemente negligenciado, o componente herbáceo-subarbustivo da flora do cerrado é mais rico do que o componente arbustivo-arbóreo, muito mais estudado. Nós tentamos compilar um listagem das espécies herbáceo-subarbustivas que ocorrem no cerrado, usando como critério de inclusão a classe de forma de vida. Todas as espécies não-fanerofíticas foram consideradas como pertencentes ao componente herbáceo-subarbustivo. Listamos 2.856 espécies, um número maior do que o limite inferior de uma estimativa anterior. As famílias mais ricas foram Asteraceae, Fabaceae, Poaceae, Euphorbiaceae, Lamiaceae, Rubiaceae e Orchidaceae, que englobaram 53,47% do número total de espécies. Os gêneros mais ricos foram *Hyptis*, *Vernonia*, *Chamaecrista*, *Paspalum* e *Mimosa*, todos pertencentes a uma das famílias mais bem representadas. A distribuição dos tamanhos das famílias no cerrado como um todo pode ser usada para comparar e caracterizar o componente herbáceo-subarbustivo de áreas de cerrado. Nossa listagem provavelmente é uma subestimativa do número verdadeiro de espécies no componente herbáceo-subarbustivo da flora do cerrado, devido aos poucos levantamentos disponíveis em que essas espécies tenham sido também amostradas. Futuros estudos que lidem com a vegetação do cerrado não podem mais ignorar o componente herbáceo-subarbustivo, que é mais rico e mais vulnerável do que o componente arbustivo-arbóreo.

Key words – cerrado; savanna; floristics; herbaceous flora; Emas National Park; central Brazil.

Introduction

The cerrado is the second largest vegetation type in Brazil, covering especially the Brazilian Central Plateau (Ratter *et al.* 1997). The cerrado vegetation is characterized by its wide physiognomic variation (Coutinho 1978), from grassland to woodland, but with most physiognomies fitting the definition of tropical savannas (Bourlière & Hadley 1983). Accompanying the physiognomic variation, the cerrado vegetation stands out by its high floristic richness (Ratter *et al.* 1997). Due to its high richness, high degree of endemism, and present conservation status, Fonseca *et al.* (2000) included the cerrado among the hotspots for conservation in the world.

Rizzini (1963) stated that there are two components in the cerrado flora, the herbaceous and the woody ones, which are antagonistic and floristically distinct. Coutinho (1978), in his "woodland-ecotone-grassland" concept of the cerrado, affirmed that the herbaceous component increases in importance from closed to open physiognomies, while the woody component decreases.

Based on samples from several sites in central Brazil, Rizzini (1963) gave the first comprehensive floristic list for the cerrado vegetation, relating 537 woody species. Some years later, including samples from outlying sites, he (Rizzini 1971) enlarged his list of woody plants to 653 species. Heringer *et al.* (1977) listed 774 species of trees and shrubs in the cerrado flora. Castro *et al.* (1999) compiled many floristic and phytosociological surveys carried out in cerrado sites from all over Brazil and estimated from 3,000 to 7,000 the number of vascular plant species in this vegetation type. Mendonça *et al.* (1998) did an extensive compilation of the flora of the whole Cerrado Domain –

including species that occur not only in the cerrado but also in the other vegetation types that appear interspersed with it, such as seasonal forest, riparian forest, wet fields, and rocky fields – and listed 6,429 species.

Castro (1994), analysing 78 floristic lists, found a strong geographic pattern in the distribution of the woody component of the cerrado flora and recognized eight phytogeographical groups: two southern groups (mainly São Paulo and Paraná), three central groups (Central Plateau), one northeastern group (Piauí and Ceará), one western group (Pantanal, the Brazilian wetlands), and one coastal group (along the northeastern coast). Similarly, Ratter et al. (1996) analysed the floristic composition of the woody component of 98 cerrado sites and recognized six groups: Southern (São Paulo and southern Minas Gerais), Southeastern (Minas Gerais), Central (Federal District, Goiás, and parts of Minas Gerais), Central-Western (Mato Grosso, Mato Grosso do Sul, and Goiás), Northern (especially Maranhão, Tocantins, and Piauí), and Amazonian (Amazonas, Acre, Rondônia, and Roraima).

Although the woody component of the cerrado flora is relatively well studied, the herbaceous component is poorly known (Mantovani & Martins 1993). Floristic or phytosociological surveys in which the herbaceous species were sampled are scarce and unevenly distributed (Castro *et al.* 1999). Sarmiento (1983) emphasized the high richness of the cerrado flora, but stated that it is a consequence of the number of woody species, since the herbaceous component is not much diversified. Ratter *et al.* (1997), however, affirmed that the diversity of the herbaceous component is much higher than those of the woody component and the number of herbaceous species is so high that detailed floristic lists are available for few sites.

In his checklist, Rizzini (1963) recorded 84 herbaceous species, whereas Heringer *et al.* (1977) listed 322 non-woody species. Among the 6,429 species related by Mendonça *et al.* (1998) for the whole Domain, 3,413 were considered as belonging to the herbaceous component. Castro *et al.*

(1999), assuming the herbaceous to woody species ratio varies from 2:1 to 3:1 (Mantovani & Martins 1993), estimated the number of herbaceous species in the cerrado flora ranging from 2,000 to 5,000.

Our aim with this paper is to relate, even if in a preliminary way, the herbaceous species of the cerrado flora, contributing to the knowledge of this vegetation type, especially the frequently neglected herbaceous component, and, therefore, giving subsidies to its conservation. We also propose that the distribution of family sizes in our checklist should be used as a null distribution, to which the flora of a given site could be compared and thus characterized.

Material and Methods

To elaborate the checklist of the vascular herbaceous species in the cerrado vegetation, we compiled floristic or phytosociological surveys, in which the herbaceous component had been sampled: Eiten (1963), Heringer *et al.* (1977), Goodland & Ferri (1979), Vincent *et al.* (1992), Mantovani & Martins (1993), Silva *et al.* (1996), Batalha *et al.* (1997), Sanaiotti *et al.* (1997), SEMA (1997), Mendonça *et al.* (1998) and references therein, Durigan *et al.* (1999), Batalha & Mantovani (2000), and the floristic list recorded by ourselves in Emas National Park (Chapter 2). Moreover, we used taxonomic papers of specific groups, such as: Hoehne (1942), Leitão-Filho (1972), Salles & Lima (1990), Esteves & Melhem (1992), Siqueira (1992), Kameyama (1995), Pereira *et al.* (1995), Fryxell (1999), and Cristóbal (2001). We also paid visits to the following herbaria: Embrapa's National Center of Genetic Resources (CEN), Brasília Botanical Garden (HEPH), Brazilian Institute of Geography and Statistics (IBGE), São Paulo Botanical Garden (SP), University of São Paulo (SPF), Brasília University (UB), and State University of Campinas (UEC).

We classified the species in life-forms following Raunkiaer's (1934) system adapted by Mueller-Dombois & Ellenberg (1974), considering as belonging to the herbaceous component all non-phanerophytes life-forms, that is, chaemaphytes, epiphytes, hemicryptophytes, geophytes, lianas, saprophytes, therophytes, vascular parasites, and vascular semi-parasites. We assigned the life-form class of the related species, at least if they were phanerophytes or not, after existing surveys or taxonomic descriptions in which life-forms were determined, or after examining lodged vouchers.

To decide whether a certain species should be included in our list, we assumed some premises: *i*) the species in question was explicitly cited as occurring at least in one cerrado physiognomy. If a given paper included species from other vegetation types (for example, Mendonça *et al.* 1998), we considered only those related for the cerrado; *ii*) a species identified dubiously (*cf.* or *aff.*) was considered as if it was identified with confidence; *iii*) the species was not an exotic or invasive one, according to Mendonça *et al.* (1998); *iv*) the species was considered as a non-phanerophyte, as mentioned above; and *v*) the species was identified correctly, either in lodged vouchers or in floristic and phytosociological surveys.

Following these criteria, we prepared a preliminary version of the list, which later was refined. We checked occasional misspellings, using the *Index Kewensis* 2.0 software, and synonims, using, when available, up-to-date taxonomic references. We arranged the herbaceous species in families according to the system proposed by Judd *et al.* (1999). It is important to highlight that in their system of classification some families, treated in a strict sense by other authors (*e.g.*, Cronquist 1988), were treated in a broad sense. For example, Apocynaceae, in Judd's *et al.* (1999) system, includes Asclepiadaceae (*sensu* Cronquist 1988); Fabaceae includes Mimosaceae and Caesalpiniaceae; and Malvaceae includes Bombaceae and Sterculiaceae.

We calculated the frequency distribution of family and genus sizes, i.e., the number of species per family and per genus. The number of species in the richest families was expressed as a percentage of the total number of species to check which were the richest families in the cerrado herbaceous flora. We also compared the frequency distribution of species per family in the herbaceous and in the woody components of the cerrado flora (Castro *et al.* 1999), using the ten richest families in the herbaceous component. To verify if these two distributions were significantly different, we arranged the data in a contigency table and applied the chi-square test (Zar 1999).

Results

In our checklist, we recorded 2,856 species in the herbaceous component of the cerrado flora (Table 1), belonging to 549 genera and 93 families. The herbaceous flora presented a skewed frequency distribution to the smallest size class of both species per family (Figure 1) and species per genus (Figure 2), with one being the modal class for both distributions. Monospecific families accounted for 18.28% of the total families, and monospecific genera, for 41.53% of the total genera.

The richest families were, on order, Asteraceae (444 species), Fabaceae (370), Poaceae (263), Lamiaceae (128), Euphorbiaceae (127), Rubiaceae (99), Orchidaceae (96), Malvaceae (88), Convolvulaceae (87), Apocynaceae (81), Polypodiaceae (77), Lythraceae (68), Malpighiaceae (68), Verbenaceae (55), and Bignoniaceae (52), which together made up 73.63% of the total number of species (Figure 3). The richest genera were *Hyptis* (89 species), *Vernonia* (84), *Chamaecrista* (68), *Paspalum* (51), *Mimosa* (50), *Croton* (46), *Diplusodon* (44), *Manihot* (36), *Ipomoea* (35), *Arachis* (32), *Habenaria* (32), and *Panicum* (31), which comprised 20.87% of the total number of species.

Of the 2,856 herbaceous species related by us as belonging to the cerrado flora, 183 were also included in the checklist elaborated by Castro *et al.* (1999) as belonging to the woody component. These species were marked with an asterisk in Table 1. The distribution of species per family (Table 2) was significantly different between the herbaceous and the woody components ($\chi^2 = 409.67$, $P < 0.001$).

Table 1. The herbaceous component of the cerrado flora. The asterisk indicates those species related by Castro *et al.* (1999) as belonging to the woody component of the cerrado flora.

Family *Species*
Acanthaceae
Beloperone mollis Nees
Hygrophila brasiliensis (Spr.) Lindau
Justicia chrysotrichoma (Nees) Pohl
Justicia genistiformis Nees
Justicia lanstyakii Rizzini
Justicia nodicaulis (Nees) Pohl
Justicia pycnophylla Lindau
Justicia sarithroides Lindau
Lepidagathis floribunda (Pohl) Kameyama
Lophostachys cyanea Leonard
Lophostachys falcata Nees
Lophostachys montana Mart. ex Nees
Lophostachys sessiliflora Pohl
Lophostachys villosa Pohl
Poikilacanthus oncodes Lindau
Ruellia angustior (Nees) Lindau
Ruellia brevicaulis (Nees) Lindau
Ruellia capitata D. Don.
Ruellia dissitifolia (Nees) Hiern.
Ruellia eriocalyx Glaz. ex Wassh.
Ruellia flava Kunth
Ruellia geminiflora Kunth *
Ruellia glanduloso-punctata (Nees) Lindau
Ruellia hapalotricha Lindau
Ruellia helianthemum Nees
Ruellia hypericoides (Nees) Lindau
Ruellia incompta (Nees) Lindau
Ruellia multifolia (Nees) Lindau
Ruellia neesiana (Mart.) Lindau
Ruellia nitens (Nees) Wassh.
Ruellia pohlii Nees
Ruellia stenandrium Pohl ex Nees
Ruellia trachyphylla Lindau
Ruellia verbaciformis Nees
Ruellia villosa (Pohl ex Nees) Lindau
Sericographis macedoana Rizzini
Stenandrium hirsutum Nees
Stenandrium pohlii Nees
Alstroemeriaceae
Alstroemeria brasiliensis Spr.
Alstroemeria burchelii Bak.
Alstroemeria cunea Vell.
Alstroemeria foliosa Mart.
Alstroemeria gardneri Bak.
Alstroemeria plantaginea Mart.
Alstroemeria psittacina Lehm.
Alstroemeria pulchella L. f.
Alstroemeria scarlatina Rav.
Alstroemeria stenocephala Schenk
Alstroemeria zamioides Bak.
Bomarea brauniana Schenk.
Amaranthaceae
Alternanthera brasiliana (L.) Kuntze
Alternanthera martii (Moq.) R. E. Fries
Froelichia lanata (Kunth) Moq.
Froelichiella grisea (Lopr.) R. E. Fries
Gomphrena agrestis Mart.
Gomphrena aphylla Pohl ex Moq.
Gomphrena arborescens L. f.
Gomphrena celosioides Mart.
Gomphrena claussenii Moq.
Gomphrena decipiens Seub.
Gomphrena desertorum Mart.
Gomphrena gardnerii Moq.
Gomphrena graminea Moq.
Gomphrena hillii Susseng.
Gomphrena lanigera Pohl ex Moq.
Gomphrena leucocephala Mart.
Gomphrena macrocephala A. St-Hil. *
Gomphrena matogrossensis Susseng.
Gomphrena paranaensis R. E. Fries
Gomphrena pohlii Moq.
Gomphrena prostrata Mart.
Gomphrena regeliana Seub.
Gomphrena rudis Moq.
Gomphrena scapigera Mart.
Gomphrena vaga Mart.
Gomphrena velutina Moq.
Gomphrena virgata Mart.
Pfaffia denudata (Moq.) Kuntze
Pfaffia gnaphaloides (L. f.) Mart.
Pfaffia helichrysoides (Moq.) Kuntze
Pfaffia jubata Mart.
Pfaffia sericea (Spr.) Mart.
Pfaffia stenophylla (Spr.) Stuchl.
Pfaffia townsendii Pedersen
Pfaffia tuberosa (Spr.) Hick.
Pfaffia velutina Mart.

Amaryllidaceae
Amaryllis goiana Rav.
Habranthus robustus Herbert
Hippeastrum aulicum (Ker Gawl.) Herbert
Hippeastrum goianum Rav.
Hippeastrum puniceum (Lam.) Kuntze
Hippeastrum reticulatum Herbert
Zephyranthes franciscana Herbert ex Baker
Zephyranthes mesochloa Herbert

Anacardiaceae
Anacardium corymbosum B. Rodr.
Anacardium humile A. St-Hil. *
Anacardium nanum A. St-Hil.

Annonaceae
Annona campestris R. E. Fries *
Annona coriacea Mart. *
Annona dioica A. St-Hil. *
Annona monticola Mart.
Annona reticulata L. *
Annona warmingiana Mello-Silva & Pirani *
Duguetia glabriuscula (R.E. Fries) R.E. Fries

Apiaceae
Eryngium ciliatum Cham. & Schltndl.
Eryngium junceum Cham. & Schltndl.
Eryngium juncifolium (Urban) Math. & Const.
Eryngium marginatum Pohl
Eryngium megapotamicum Malme
Eryngium pristis Cham. & Schltndl.
Eryngium quiqueloba Ruiz & Pav.
Spananthe paniculata Jacq.

Apocynaceae
Allamanda angustifolia Pohl
Allamanda puberula A. DC.
Asclepias aequicornu Fourn.
Asclepias candida Vell.
Asclepias marginata Decne.
Asclepias mellodora A. St-Hil.
Astephanus carassensis Malme
Astephanus gardneri Four.
Barjonia cymosa Fourn.
Barjonia glazioui N. Marquete
Blepharodon bicolor Decne.
Blepharodon bicuspidatum Fourn.
Blepharodon hirsutum Goyder
Blepharodon lineare (Decne.) Decne.
Blepharodon nitidum (Vell.) Macbr.
Chtamalia purpurea Decne.
Condylocarpon ishtmicum (Vell.) A. DC.
Cynanchum morrenioides Goyder
Ditassa acerosa Mart.
Ditassa cordata (Turcz.) Fontella
Ditassa hoehnei Malme
Ditassa micromeria Decne.
Ditassa nitida Fourn.
Ditassa obcordata Mart.
Ditassa retusa Mart.
Ditassa virgata Fourn.
Forsteronia glabrescens Müll. Arg.
Forsteronia refracta Müll. Arg.
Hemipogon abietoides Fourn.
Hemipogon acerosus Decne.
Hemipogon irwinii Fontella & Paixão
Hemipogon setaceus Decne.
Macrosiphonia longiflora (Desf.) Müll. Arg.
Macrosiphonia martii Müll. Arg.
Macrosiphonia petraea (A. St-Hil.) K. Schum.
Macrosiphonia velame (A. St-Hil.) Müll. Arg.
Macrosiphonia virescens Müll. Arg.
Mandevilla coccinea (Hook. & Arn.) Woods.
Mandevilla erecta (Vell.) Woods. *
Mandevilla gentianoides (Mill.) Woods. *
Mandevilla illustris (Vell.) Woods.
Mandevilla moricandiana (A. DC.) Woods.
Mandevilla novacapilalis Marckg.
Mandevilla pohliana (Stadelm.) Gentry
Mandevilla rugosa (Benth.) Woods.
Mandevilla scabra K. Schum.
Mandevilla tenuifolia (J. C. Mikan) Woods.
Mandevilla velutina (Mart.) Woods.
Marsdenia altissima (Jacq.) Dugand.
Matelea mediocris Woods.
Matelea oxypetaloides (Fourn.) Fontella & E. A. Schw.
Matelea pedalis (A. Silv.) Fontella & E. A. Schw.
Mesechites mansoana (A. DC.) Woods.
Nautonia nummularia Decne.
Nephradenia asparagoides (Decne.) Fourn.
Odontadenia lutea (Vell.) Marckg. *
Odontadenia zuccariana (Stand.) K. Schum.
Oxypetalum aequaliflorum Fourn.
Oxypetalum appendiculatum Mart.
Oxypetalum banksii Roem & Schult.
Oxypetalum capitatum Mart.
Oxypetalum erectum Mart.
Oxypetalum foliosum Mart.
Oxypetalum molle Hook. & Arn.
Oxypetalum pachygynum Decne.

Oxypetalum stenophyllum Malme
Oxypetalum strictum Mart.
Plumeria drastica Mart.
Prestonia lindmanii (Malme) Hoechre
Prestonia riedellii (Müll. Arg.) Marckg.
Prestonia tomentosa R. Br.
Rauwolfia ternifolia Kunth *
Rauwolfia weddeliana Müll. Arg.
Rhodocalyx rotundifolius Müll. Arg.
Schubertia grandiflora Mart.
Secondatia densiflora A. DC.
Secondatia floribunda A. DC.
Stipecoma peltigera (Stadelm.) Müll. Arg.
Tassadia geniculata Fontella
Temnadenia violacea (Vell.) Miers

Araceae
Dracontium bongneri Zhu
Dracontium ulei Krause
Scaphispatha gracilis Brongn. ex Schott
Taccarum warmingii Engl.

Arecaceae
Acrocomia hassleri (B. Rodr.) W. J. Hahn *
Allagoptera campestris (Mart.) Kuntze *
Allagoptera leucocalyx (Mart.) Kuntze
Astrocaryum campestre Mart.
Attalea geraensis B. Rodr. *
Butia archeri (Glassm.) Glassm.
Syagrus flexuosa L. f. *
Syagrus graminifolia (Drude) Becc.
Syagrus microphylla Burret
Syagrus petraea (Mart.) Becc. *
Syagrus werdermannii Burret

Aristolochiaceae
Aristolochia arcuata Mast.
Aristolochia barbata Jacq.
Aristolochia claussenii Duch.
Aristolochia cynanchifolia Mart. & Zucc.
Aristolochia elegans Mart.
Aristolochia esperanzae Kuntze
Aristolochia filipendulina Planch.
Aristolochia galeata Mart. & Zucc.
Aristolochia giberti Hook.
Aristolochia gracilis Duch.
Aristolochia hians Willd.
Aristolochia labiata Willd.
Aristolochia loefgrenii Hoehne
Aristolochia smilacina Duch.
Aristolochia warmingii Mast.

Asteraceae
Acanthospermum australe (Loelf.) Kuntze
Achyrocline alata A. DC.
Achyrocline satureoides (Lam.) A. DC.
Actinoseris polymorpha (Less.) Cabrera
Ageratum conyzoides L.
Apopyros warmingii (Baker) Nesom
Aspilia attenuata (Gardner) Baker
Aspilia claussiana Baker
Aspilia cyindrocephala H. Rob.
Aspilia diniz-cruzaenae Santos
Aspilia discolor Santos
Aspilia elliptica Baker
Aspilia floribunda (Gardner) Baker
Aspilia foliacea (Spr.) Baker
Aspilia glabra Benth.
Aspilia goiazensis Santos
Aspilia heringeriana H. Rob.
Aspilia laevissima Baker
Aspilia leucoglossa Malme
Aspilia montevidensis (Spr.) Kuntze
Aspilia ovalifolia (A. DC.) Baker
Aspilia phyllostachya Baker
Aspilia platyphylla (Baker) Blake
Aspilia pseudoyedzea H. Rob.
Aspilia ramosissima (Gardner) Baker
Aspilia reflexa Baker
Aspilia riedelii Baker
Aspilia setosa Griseb.
Aspilia squarrosa Baker
Aster camporum Gardner
Austroeupatorium inulaefolium (Kunth) King & H. Rob.
Ayapana amygdalina (Lam.) King & H. Rob.
Baccharis aphylla (Vell.) A. DC.
Baccharis camporum A. DC.
Baccharis cinerea A. DC.
Baccharis discolor Baker
Baccharis dracunculifolia A. DC. *
Baccharis erigeroides A. DC.
Baccharis gracilis A. DC.
Baccharis humilis Sch. Bip. ex Baker
Baccharis intermixta Gardner
Baccharis leptophala A. DC.
Baccharis multisulcata Baker *
Baccharis pseudotenuifolia Teodoro
Baccharis punctulata A. DC.
Baccharis ramosissima Gardner *
Baccharis reticulata Pers.

Baccharis rufescens Spr.
Baccharis salzmanii A. DC.
Baccharis semiserrata A. DC.
Baccharis sessilifolia Vahl.
Baccharis subdentata A. DC.
Baccharis tenuifolia A. DC.
Baccharis tridentata Gaudich. *
Baccharis trimera A. DC. *
Baccharis virians Gardner
Bahianthus viscosus (Spr.) King & H. Rob.
Barnadesia caryophylla (Vell.) Blake
Bidens gardneri Baker
Bidens graveolens Mart.
Bidens pilosa L.
Bidens rubifolia Kunth
Bidens segetum Mart. ex Collad.
Bidens speciosa Gardner
Bidens subalternans A. DC.
Brasilia sickii G.M. Barroso
Calea chapadoensis Malme
Calea clausseniana Baker
Calea cuneifolia A. DC.
Calea cymosa Less.
Calea fruticosa Benth. & Hook. f.
Calea harleyi H. Rob.
Calea heringerii H. Rob.
Calea hymenolepsis Baker
Calea lantanoides Gardner
Calea monocephala Dusen
Calea multiplinervia Less.
Calea nervosa G. M. Barroso
Calea pilosa Baker
Calea platylepsis Sch. Bip.
Calea quadrifolia Pruski & Urban
Calea ramosissima Baker
Calea reticulata Gardner
Calea teucriifolia (Gardner) Baker
Calea villosa Sch. Bip.
Campuloclinium burchelli Baker
Campuloclinium chlorolepsis Baker
Campuloclinium hirsutum Gardner
Campuloclinium irwinii King & H. Rob.
Campuloclinium megacephalum (Mart.) King & H. Rob.
Centratherum punctatum Cass.
Chaptalia integerrima (Vell.) Burkart
Chromolaena anayana (Gardner) King & H. Rob.
Chromolaena asperrima (Baker) King & H. Rob.
Chromolaena chaseae (B. L. Rob.) King & H. Rob.
Chromolaena cinereo-viredis (Baker) King & H. Rob.
Chromolaena cryptantha (Baker) King & H. Rob.
Chromolaena cylindrocephala (Baker) King & H. Rob.
Chromolaena epaleacea Gardner
Chromolaena horminioides (Baker) King & H. Rob.
Chromolaena laevigata (Lam.) King & H. Rob.
Chromolaena leucocephala Gardner
Chromolaena matogrossensis (Hieron.) King & H. Rob.
Chromolaena maximiliani (Schrad.) King & H. Rob.
Chromolaena odorata (L.) King & H. Rob.
Chromolaena oxylepis A. DC.
Chromolaena pedalis (Sch. Bip. ex Baker) King & H. Rob.
Chromolaena pedunculosa (Hook. & Arn.) King & H. Rob.
Chromolaena ramosissima Gardner
Chromolaena squalida (A. DC.) King & H. Rob. *
Chromolaena stachyophylla (Spr.) King & H. Rob.
Chromolaena vindex (A. DC.) King & H. Rob.
Chromolaena xylorhiza (Sch. Bip.) King & H. Rob.
Chrysanthellum procumbens L. C. Rich.
Chrysolaena platensis (Spr.) H. Rob.
Clibadium armani Sch. Bip. ex Baker
Clibadium rotundifolium A. DC. *
Clibadium sylvestre (Aubl.) Baill.
Conyza bonariensis (L.) Cronq.
Conyza canadensis (L.) Cronq.
Dasyphyllum candoleanum (Gardner) Cabrera
Dasyphyllum donianum (Gardner) Cabrera
Dasyphyllum infundibulare (Gardner) Cabrera
Dasyphyllum orthacantum (A. DC.) Cabrera *
Dasyphyllum sprengelianum (Gardner) Cabrera
Dasyphyllum velutinum (Baker) Cabrera
Dimerostemma asperatum Blake
Dimerostemma brasilianum Cass.
Dimerostemma laevigata Mart.
Dimerostemma lippiodes (Baker) Blake
Dimerostemma vestitum (Baker) Blake
Disynaphia halimifolia (A. DC.) King & H. Rob.
Echinocoryne holosericea (Mart. ex A. DC.) H. Rob.
Echinocoryne pungens (Gardner) H. Rob.
Elephantopus biflorus (Less.) Sch. Bip. *
Elephantopus erectus Gleason
Elephantopus micropappus Less.
Elephantopus mollis Kunth
Elephantopus palustris Gardner
Elephantopus racemosus Gardner
Emilia coccinea (Sims.) Sweet
Erechtites hieracifolia (L.) Raf. ex A. DC.
Eremanthus argenteus MacLeish & K. Schum.
Eremanthus glomeratus Less. *
Eremanthus glomerulatus Less.
Eremanthus goyazensis (Gardner) Sch. Bip. *
Eremanthus graciellae MacLeish & K. Schum. *

Eremanthus matogrossensis Kuntze *
Eremanthus mollis Sch. Bip.
Eremanthus pannosus Baker
Eremanthus plantaginifolius Baker
Eremanthus pohlii (Baker) MacLeish
Eremanthus scapigerus Baker
Eremanthus sphaerocephalus Baker *
Eremanthus uniflorus MacLeish & K. Schum.
Eremanthus veadeiroensis H. Rob.
Erigeron bonariensis L.
Erigeron maximus (D. Don.) A. DC.
Eupatorium amphidyction A. DC.
Eupatorium barbacense Hieron. *
Eupatorium betonicaeforme A. DC.
Eupatorium blanchetti Sch. Bip.
Eupatorium campestre A. DC.
Eupatorium capillare Baker
Eupatorium clematidium Less.
Eupatorium congestum Hook. & Arn.
Eupatorium coriaceum Vahl.
Eupatorium gardnerianum Hieron.
Eupatorium grande Sch. Bip. ex Baker
Eupatorium intermedium A. DC.
Eupatorium lanigerum Hook.
Eupatorium molissimum Baker
Eupatorium myriocephalum Gardner
Eupatorium myrtillioides A. DC.
Eupatorium purpurascens Sch. Bip.
Eupatorium trigonum Gardner
Eupatorium trixioides Mart. ex Baker *
Eupatorium variegatum Malme
Eupatorium vauthierianum A. DC. *
Eupatorium vitalbe A. DC.
Glaziovianthus curumbensis (Phil.) MacLeish
Glaziovianthus purpureus G. M. Barroso
Gnaphalium cheirantifolium Lam.
Gochnatia barrosoae Cabrera *
Gochnatia blanchetiana (A. DC.) Cabrera
Gochnatia densicephala Cabrera
Gochnatia floribunda Cabrera *
Gochnatia paniculata (Less.) Cabrera
Gochnatia polymorpha (Less.) Cabrera *
Gochnatia pulchella Cabrera
Gochnatia pulchra Cabrera *
Gochnatia velutina (Bong.) Cabrera *
Grazielia dimorphis (Baker) King & H. Rob.
Grazielia multifida (A. DC.) King & H. Rob.
Hieracium commersonii Monn.
Hoehnephytum imbricatum (Gardner) Cabrera
Hoehnephytum trixioides (Gardner) Cabrera *
Ichthyothere agrestis (Mart.) Baker
Ichthyothere connata Blake
Ichthyothere cunabi Mart.
Ichthyothere hirsuta Gardner
Ichthyothere integrifolia (A. DC.) Baker
Ichthyothere latifolia Baker
Ichthyothere linearis (Benth.) Baker
Ichthyothere rufa Gardner
Ichthyothere sessilis (Spreng.) Blake
Ichthyothere terminalis (Spreng.) Malme
Inulopsis camporum (Gardner) Nesom
Inulopsis scaposa (Baker) Hoffm.
Isostigma megapotamicum Scherff
Koanophyllon adamantium (Gardner) King & H. Rob.
Lepidaploa aurea (Mart. ex A. DC.) H. Rob.
Lepidaploa remotiflora (L. C. Rich.) H. Rob.
Leptoclinium trichotomum Benth. ex Baker
Lessingianthus amnophilus (Gardner) H. Rob.
Lessingianthus argyrophyllus (Less.) H. Rob.
Lessingianthus desertorum (Mart. ex A. DC.) H. Rob.
Lessingianthus durus (Mart. ex A. DC.) H. Rob.
Lessingianthus eitenii (H. Rob.) H. Rob.
Lessingianthus elegans (Gardner) H. Rob.
Lessingianthus erythrophyllus (A. DC.) H. Rob.
Lessingianthus ligulaefolius (Mart.) H. Rob.
Lessingianthus monocephalus (Gardner) H. Rob.
Lessingianthus mysinites H. Rob.
Lessingianthus pseudopiptocarpha (H. Rob.) H. Rob.
Lessingianthus secundus (Sch. Bip. ex Baker) H. Rob.
Lessingianthus simplex (Less.) H. Rob.
Lessingianthus venosissimus (Sch. Bip.) H. Rob.
Lessingianthus xantophylla (Mart.) H. Rob.
Lucilia glomerata Baker
Lucilia lycopodioides (Less.) S. E. Freire
Lychnophora bahiensis Mattf.
Lychnophora ericoides Mart. *
Lychnophora salicifolia Mart.
Mikania bishopii King & H. Rob.
Mikania cordifolia (L. f.) Willd.
Mikania cynanchifolia Hook. & Arn. ex Baker
Mikania dessilifolia A. DC.
Mikania hirsutissima A. DC.
Mikania macedoi G. M. Barroso
Mikania macrodonta A. DC.
Mikania micrantha Kunth
Mikania microcephala A. DC.
Mikania microdonta A. DC.
Mikania microphylla Sch. Bip. ex Baker
Mikania oblongifolia A. DC.
Mikania officinalis Mart.

Mikania pohlii (Baker) King & H. Rob.
Mikania psilostachya A. DC.
Mikania purpurascens (Baker) King & H. Rob.
Mikania reticulata Gardner
Mikania salviaefolia Gardner
Mikania sessilifolia A. DC. *
Moquinia racemosa (Spreng.) A. DC.
Ophryosporus freyreissii (Thumb. & Dallm.) Baker
Orthopappus angustifolius (Sw.) Gleason
Pectis abodocephala Baker
Pectis brevipedunculata (Gardner) Sch. Bip.
Pectis elongata Kunth
Pectis oligocephala (Gardner) Sch. Bip.
Pectis stella Malme
Pectis uniaristata A. DC.
Piptocarpha obscurum (Spr.) A. DC.
Piptocarpha salviifolia Taub.
Planaltoa lychnophoroides G. M. Barroso
Podocoma hieracifolia Cass.
Porophyllum angustissimum Gardner
Porophyllum ellipticum Cass.
Porophyllum lanceolatum A. DC.
Porophyllum lineare A. DC.
Porophyllum obscurum (Spr.) A. DC.
Porophyllum riedelli Baker
Porophyllum ruderale (Jacq.) Cass.
Praxelis capillaris (A. DC.) Sch. Bip.
Praxelis clementidea (Griseb.) King & H. Rob.
Pseudelephantopus spiralis (Less.) Cronq.
Pseudobrickellia angustissima (Baker) King & H. Rob.
Pseudobrickellia brasiliensis (Spr.) King & H. Rob. *
Pseudogynoxys pohlii (Sch. Bip.) Leitão Filho
Pterocaulon rugosum (Vahl.) Malme
Pterocaulon virgatum (L.) A. DC.
Raulinoreitzia crenulata (Spr.) King & H. Rob.
Riencourtia oblongifolia Gardner
Riencourtia tenuifolia Gardner
Senecio brasiliensis Less. *
Senecio leptolobus A. DC.
Senecio oxyphyllus A. DC. *
Senecio pohlii Sch. Bip. ex Baker
Senecio trixoides Gardner
Sipolisia lanuginosa Glaz.
Soaresia velutina Sch. Bip.
Solidago chilensis Meyen
Sphagneticola trilobata (L.) Pruski
Sphareupatorium spharocephalum (Baker) King & H. Rob.
Spilanthes arnicoides A. DC.
Spilanthes caespitosa A. DC.
Spilanthes nervosa Chod.
Spilanthes urens Jacq.
Stenocephalum apiculatum (Mart. ex A. DC.) Sch. Bip.
Stenocephalum megapotamicum (Spr.) H. Rob.
Stevia cinerascens Sch. Bip.
Stevia collina Gardner
Stevia comixta Rob.
Stevia crenulata Baker
Stevia heptachaeta A. DC.
Stevia pavifolia Hassl.
Stevia urticaefolia Thumb.
Stevia veronicae A. DC.
Stilpnopappus glomerulatus Gardner
Stilpnopappus speciosus Baker
Stilpnopappus trichospiroides Mart. ex A. DC.
Stomatanthes dictyophyllum (A. DC.) King & H. Rob.
Stomatanthes pinitipartitum (Sch. Bip.) H. Rob.
Stomatanthes trigonus (Gardner) H. Rob.
Stylotrichium rotundifolium Mattf.
Symphyopappus compressus (Gardner) B. L. Robyns
Symphyopappus cuneatus Sch. Bip.
Symphyopappus polystachyus Baker *
Symphyopappus viscosus Baker
Tilesia baccata (A. DC.) Pruski
Trichogonia attenuata G. M. Barroso
Trichogonia campestris Gardner *
Trichogonia dubia (B. L. Robyns) King H. Rob.
Trichogonia grazielae King & H. Rob.
Trichogonia laxa Gardner
Trichogonia menthaefolia Gardner
Trichogonia prancei G. M. Barroso
Trichogonia salviaefolia Gardner
Trichogonia vautheri A. DC.
Tridax procumbens L.
Trixis glutinosa D. Don.
Trixis ophiorhiza Gardner
Trixis verbasciformis Less.
Verbesina sodescens A. DC.
Vernonanthura almeidae (H. Rob.) H. Rob.
Vernonanthura membranacea (Gardner) H. Rob.
Vernonia almedae H. Rob.
Vernonia anesiana Leitão Filho
Vernonia argentea Less.
Vernonia asterifolia Mart.
Vernonia aurea Mart.
Vernonia barbata Less.
Vernonia bardanoides Less. *
Vernonia brasiliana (L.) Druce
Vernonia brasiliensis Less. *
Vernonia brevifolia Less.
Vernonia brevipetiolata Sch. Bip. ex Baker

Vernonia buddleiaefolia Sch. Bip. ex Baker
Vernonia cardiroides Baker
Vernonia cephalotes A. DC.
Vernonia chamaedrys Less.
Vernonia chamissonis Less.
Vernonia compactiflora Mart. ex Baker
Vernonia cordigera Mart.
Vernonia coriacea Less.
Vernonia cotoneaster (Willd. ex Spr.) Less.
Vernonia cuiabensis Baker
Vernonia desertorum Mart.
Vernonia diffusa Less. *
Vernonia eremophylla Mart. ex A. DC.
Vernonia farinosa Baker
Vernonia ferruginea Less. *
Vernonia flexuosa Sims.
Vernonia floccosa Gardner
Vernonia foliosa Gardner
Vernonia fruticosa Sw.
Vernonia fruticulosa Mart. ex A. DC. *
Vernonia glabrata Less. *
Vernonia glomerata Sch. Bip.
Vernonia goyasensis S. B. Jones
Vernonia grandiflora Less. *
Vernonia grearii H. Rob.
Vernonia hangei H. Rob.
Vernonia herbacea (Vell.) Rusby
Vernonia holosericea Mart.
Vernonia ignobilis Less.
Vernonia irwinii G. M. Barroso
Vernonia kunthiana Gardner
Vernonia lacunosa Mart.
Vernonia laevigata Mart.
Vernonia lappoides Baker
Vernonia laxa Gardner
Vernonia linearis Spr.
Vernonia mansoana Baker
Vernonia micrantha Kunth
Vernonia missiones Gardner *
Vernonia molissima D. Don
Vernonia mucronulata Less. *
Vernonia nitens Gardner
Vernonia obscura Less.
Vernonia obtusata Less.
Vernonia oligactoides Less.
Vernonia oligolepsis Sch. Bip. ex Baker *
Vernonia onopordioides Baker
Vernonia oxylepsis Sch. Bip.
Vernonia pannosa (Baker) MacLeich
Vernonia petiolaris A. DC.
Vernonia platensis (Spr.) Less.
Vernonia polyanthes Less. *
Vernonia polyphylla Sch. Bip.
Vernonia propinqua Hieron.
Vernonia psilophylla A. DC.
Vernonia psilostachya A. DC.
Vernonia pungens Gardner
Vernonia radula Mart.
Vernonia rubricaulis Humb. & Bonpl.
Vernonia rubriramea Mart. ex A. DC. *
Vernonia ruficoma Schltndl. ex Mart. *
Vernonia salzmanii A. DC.
Vernonia scabra Pers.
Vernonia schwenkiaefolia Mart. ex A. DC.
Vernonia souzae H. Rob.
Vernonia stricta Gardner
Vernonia subverticillata Sch. Bip.
Vernonia tomentella Mart. ex A. DC.
Vernonia tragiaefolia A. DC.
Vernonia varroniaefolia A. DC. *
Vernonia venosissima Sch. Bip. ex Baker
Vernonia virgulata Mart. ex A. DC.
Vernonia viscidula Less.
Vernonia zuccariana Mart. ex A. DC.
Viguiera bakeriana Blake
Viguiera discolor Baker
Viguiera filifolia Sch. Bip.
Viguiera gardneri Baker
Viguiera grandiflora Gardner
Viguiera hispida Baker
Viguiera kuntheana Gardner
Viguiera linearifolia Chod. & Hassl.
Viguiera nervosa Gardner
Viguiera quinqueremis Blake
Viguiera radula Baker
Viguiera robusta Gardner
Viguiera squalida S. Moore
Wedelia bishopii H. Rob.
Wedelia glauca (Ort.) Hoffm. ex Hicken
Wedelia kirkbridei H. Rob.
Wedelia lundii A. DC.
Wedelia macedoi H. Rob.
Wedelia macrodonta A. DC.
Wedelia regis H. Rob.
Wedelia subvelutina A. DC.
Wedelia vathieri A. DC.
Wulffia maculata (Ker Gawl.) A. DC.
Xerxes edmaniana (Philip.) J. Grant.

Balanophoraceae

Helosia brasiliensis Schott. & Endl.
Langsdorffia hypogea Mart.
Lophophytum mirabile Schott. & Endl.

Bignoniaceae
Adenocalymma bracteatum (Cham.) A. DC.
Amphilophium paniculatum (L.) Kunth
Anemopaegma acutifolium A. DC.
Anemopaegma arvense (Vell.) Stellf. ex de Souza *
Anemopaegma chamberlaynii (Sims.) Bur. & K. Schum.
Anemopaegma glaucum Mart. ex A. DC. *
Anemopaegma goyazense K. Schum.
Anemopaegma leucopogon (Cham.) Sandw.
Anemopaegma longipetiolatum Sprague
Anemopaegma scabriusculum Mart. ex A. DC.
Arrabidaea brachypoda (A. DC.) Bur. *
Arrabidaea cinammomea (A. DC.) Sandw.
Arrabidaea craterophora (A. DC.) Bur.
Arrabidaea florida A. DC.
Arrabidaea inaequalis Baill.
Arrabidaea pulchra (Cham.) Sandw.
Arrabidaea sceptrum (Cham.) Sandw. *
Arrabidaea ulei Bur. & K. Schum.
Bignonia exoleta Vell.
Cuspidaria puberula Herbert ex A. DC.
Distictella elongata (Vahl.) Urban
Distictella mansoana (A. DC.) Urban *
Fridericia speciosa Mart. *
Jacaranda caroba (Vell.) A. DC. *
Jacaranda decurrens Cham. *
Jacaranda jasminioides (Thunb.) Sandw. *
Jacaranda morii A. Gentry
Jacaranda mutabilis Hassl.
Jacaranda oxyphylla Cham.
Jacaranda paucifoliata Mart. ex A. DC. *
Jacaranda racemosa Cham.
Jacaranda rufa Silva Manso *
Jacaranda simplicifolia K. Schum.
Jacaranda tomentosa R. Br.
Jacaranda ulei Bur. & K. Schum. *
Lundia gardneri Sandw.
Macfadyena unguis-cati (L.) A. Gentry
Mansoa hirsuta A. DC.
Mansoa hirta A. DC.
Mansoa schwakeii Bur. & K. Schum.
Memora axillaris Bur. & K. Schum. *
Memora cuspidata Hassl. *
Memora flacida (A. DC.) Bur. ex K. Schum.
Memora glaberrima (Cham.) K. Schum.
Memora nodosa (Silva Manso) Miers *
Memora pedunculata (Vell.) Miers
Memora peregrina (Miers) Sandw. *
Phryganocydia corymbosa (Vent.) Bur. ex K. Schum.
Piriadacus erubescens (A. DC.) Pichon
Pithecoctenium crucigerum (L.) A. Gentry
Pyrostegia venusta Miers
Styzophyllum perforatum (Cham.) Miers

Boraginaceae
Cordia calocephala Cham.
Cordia campestris Warm.
Cordia corymbosa (L.) G. Don
Cordia intonsa I. M. Johnston
Cordia mucronata Fresen
Cordia multispicata Cham.
Cordia sessilifolia Cham.
Heliotropium salicoides Cham.
Tournefortia breviflora A. DC.
Tournefortia syringaefolia Vahl.

Bromeliaceae
Acanthostachys strobilacea (Schult f.) Klotz
Aechmea bromeliifolia (Rudge) Baker
Aechmea disticantha Lem.
Aechmea maculata L. B. Smith
Ananas ananassoides (Baker) L. B. Smith
Bromelia balansae Mez
Bromelia glaziovii Mez
Bromelia interior L. B. Smith
Bromelia irwinii L. B. Smith
Dyckia aurea L. B. Smith
Dyckia brasiliana L. B. Smith
Dyckia eminens Mez
Dyckia leptostachya Baker
Dyckia linearifolia Mez
Dyckia pauciflora L. B. Smith & R. W. Read
Dyckia saxatilis Mez
Dyckia tuberosa (Vell.) Beer
Pitcairnia ensifolia Mez
Pseudoananas sagenarius (Arr. Campb.) Camaro
Tillandsia duratii Vis.
Tillandsia geminiflora Brongn.
Tillandsia mallemontii Glaz. ex Mez
Tillandsia recurvata (L.) L.
Tillandsia streptocarpa Baker
Tillandsia widgrenii Engl.
Vriesea friburgensis Mez
Vriesea oligantha (Baker) Mez

Buddlejaceae

Buddleja brasiliensis Jacq. f. ex Spr.

Cactaceae
Cereus calcirupicola (Ritt.) Rizzini
Cereus jamacaru Hort. Vindob. ex Salm-Dick.
Epyphyllum phyllanthus (L.) Haworth.
Melocactus paucipinus Heimen & R. Paul.

Campanulaceae
Lobelia camporum Pohl
Lobelia exaltata Pohl
Lobelia fistulosa Vell.
Lobelia organensis Gardner
Lobelia thapsoidea Shott.
Siphocampylus corymbiferus Pohl
Siphocampylus nitidus Pohl
Wahlenbergia linarioides (Lam.) A. DC.

Caryophyllaceae
Polycarpaea corymbosa (L.) Lam.

Chrysobalanaceae
Licania humilis Cham. & Schltndl. *
Parinari campestris Aubl. *
Parinari excelsa Sabine
Parinari obtusifolia Hook. f. *

Clusiaceae
Kielmeyera abdita Saddi *
Kielmeyera corymbosa Mart. *
Kielmeyera neriifolia Cambess.
Kielmeyera pumila Pohl
Kielmeyera sessilis Saddi
Kielmeyera variabilis Mart. *
Vismia cayennensis (Aubl.) Choisy *

Cochlospermaceae
Cochlospermum regium (Mart. ex Schrank.) Pilger *

Commelinaceae
Commelina elegans Kunth
Commelina erecta L.
Commelina obliqua Vahl.
Dichorisandra hexandra Standl.

Convolvulaceae
Cuscuta glomerata Choisy
Evolvolus aurigenius Mart.
Evolvolus barbatus C.F.W. Meisn.
Evolvolus chamaepitys Mart.
Evolvolus cressoides Mart.
Evolvolus elegans Moric.
Evolvolus ericaefolius Schrank.
Evolvolus filipes Mart.
Evolvolus franquenioides Moric.
Evolvolus fuscus C.F.W. Meisn.
Evolvolus glomeratus Nees & Mart.
Evolvolus gnaphalioides Moric.
Evolvolus helichrysoides Moric.
Evolvolus lagopodioides C.F.W. Meisn.
Evolvolus lagopus Mart.
Evolvolus linoides Moric.
Evolvolus macroblepharis Mart.
Evolvolus nivens Mart.
Evolvolus nummularis Nutt.
Evolvolus passerinoides C.F.W. Meisn.
Evolvolus pohlii C.F.W. Meisn.
Evolvolus pterocaulon Moric.
Evolvolus pterogophyllus Mart.
Evolvolus riedellii C.F.W. Meisn.
Evolvolus saxifragus Mart.
Evolvolus scoparioides Mart.
Evolvolus sericeus Sw.
Evolvolus tomentosus (C.F.W. Meisn.) Ootstr.
Evolvolus linarioides C.F.W. Meisn.
Ipomoea acutisepala O'Donnel
Ipomoea albiflora Moric.
Ipomoea angustifolia C.F.W. Meisn.
Ipomoea aprica House
Ipomoea argentea C.F.W. Meisn.
Ipomoea argyreia C.F.W. Meisn.
Ipomoea aurifolia Dammer ex Char.
Ipomoea bonariensis Hook.
Ipomoea campestris C.F.W. Meisn.
Ipomoea cuneifolia C.F.W. Meisn.
Ipomoea decora C.F.W. Meisn.
Ipomoea delphinioides Choisy
Ipomoea echioides Choisy
Ipomoea fiebrigii Hassl. ex O'Donnel
Ipomoea gigantea (Silva Manso) Choisy
Ipomoea goyazensis Gardner
Ipomoea graminiformis C.F.W. Meisn.
Ipomoea grandifolia (Dammer) O'Donnel
Ipomoea hederifolia L.
Ipomoea hirsutissima Gardner
Ipomoea kunthiana C.F.W. Meisn.
Ipomoea martii C.F.W. Meisn.
Ipomoea paludosa O'Donnel
Ipomoea parasitica (Kunth) G. Don
Ipomoea pinifolia C.F.W. Meisn.

Ipomoea procumbens Mart. & Choisy
Ipomoea procurrens C.F.W. Meisn.
Ipomoea pyrenea Taub.
Ipomoea quamoclit L.
Ipomoea saopaulista O'Donnel
Ipomoea sericophylla C.F.W. Meisn.
Ipomoea serpens C.F.W. Meisn.
Ipomoea squamisepala O'Donnel
Ipomoea verbasciformis (C.F.W. Meisn.) O'Donnel
Ipomoea virgata C.F.W. Meisn.
Jacquemontia agrestis (Mart. & Choisy) C.F.W. Meisn.
Jacquemontia cuyabana Hoehne
Jacquemontia densiflora (C.F.W. Meisn.) Hall. f.
Jacquemontia fusca (C.F.W. Meisn.) Hall. f.
Jacquemontia heterotricha O'Donnel
Jacquemontia lasioclados (Choisy) O'Donnel
Jacquemontia montana (Moric.) C.F.W. Meisn.
Jacquemontia pentantha (Jacq.) G. Don
Jacquemontia rufa (Choisy) Hall. f.
Jacquemontia sphaerocephala C.F.W. Meisn.
Jacquemontia sphaerostigma (Cav.) Rusby
Jacquemontia spiciflora (Choisy) Hall. f.
Jacquemontia tamnifolia (L.) Griseb.
Merremia aegyptia (L.) Urban
Merremia aturensis Hall. f.
Merremia cissoides (Lam.) Hall. f.
Merremia contorquens (Choisy) Hall. f.
Merremia digitata (Spr.) Hall. f.
Merremia flagellaris (Choisy) O'Donnel
Merremia macrocalyx (Ruiz & Pav.) O'Donnel
Merremia tomentosa (Choisy) Hall. f.
Turbina abutiloides (Kunth) O'Donnel

Cucurbitaceae
Cayaponia espelina (Cogn.) Silva Manso
Cayaponia tayuya (Vell.) Cogn.
Cayaponia weddelli Cogn.
Ceratosanthes hilariana Cogn.
Melancium campestris Naud.
Wilbrandia hibiscoides Silva Manso

Cyperaceae
Bulbostylis capillaris (L.) C.B. Clarke
Bulbostylis hirtella (Schrad.) Urban
Bulbostylis junciformis Kuntze
Bulbostylis juncoides (Vahl.) Künkenth
Bulbostylis laeta C.B. Clarke
Bulbostylis paradoxa (Spreng.) Lindm.
Bulbostylis scabra (Presl.) Lindm.
Bulbostylis spadicea Kunth
Bulbostylis sphaerocephala (Boeck.) C.B. Clarke
Bulbostylis truncata (Nees) M.T. Strong
Cyperus cayennensis Link.
Cyperus diffusus Vahl.
Cyperus ferax Benth.
Cyperus laetus J. & C.J.S. Presl.
Cyperus sesquiflorus (Torr.) Mattf. & Kükenth
Dichromena ciliata Vahl.
Dichromena consanguinea Kuntze
Eleocharis almensis D.A. Simpson
Eleocharis capillacea Kunth
Killinga odorata Vahl.
Lagenocarpus verticilatus (Spr.) T. Koyama & Maguire
Rhynchosphora diamantina (C.B.Clarke) Kükenth
Rhynchosphora emaciata Boeckm.
Rhynchospora albiceps Kunth
Rhynchospora barbata (Vahl.) Kunth
Rhynchospora consanguinea (Kunth) Böeckel
Rhynchospora corifolia Mart. ex Benth.
Rhynchospora corymbosa (L.) Britton
Rhynchospora exaltata Kunth
Rhynchospora glauca (Vahl.) Böeckel
Rhynchospora globosa (Kunth) Roem. & Schult.
Rhynchospora marcelo-guerrae Luceño & M. Alves
Rhynchospora nardifolia (Kunth) Böeckel
Rhynchospora nervosa (Vahl.) Böeckel
Rhynchospora patuligluma C.B. Clarke ex Lindm.
Rhynchospora pilosa (Kunth) Böeckel
Rhynchospora rigida (Kunth) Böeckel
Rhynchospora rugosa (Vahl.) Gale
Rhynchospora speciosa (Kunth) Böeckel
Rhynchospora tenuis Link.
Rhynchospora terminalis (Nees) Steud.
Scleria atroglumis D.A. Simpson
Scleria bracteata Cav.
Scleria cerradicola T. Koyama
Scleria comosa (Nees) Steud.
Scleria cyperina Kunth
Scleria lithosperma Sw.

Davalliaceae
Nephrolepis occidentalis Kuntze

Dilleniaceae
Davilla nitida (Vahl.) Kubitzki
Davilla rugosa Poir. *
Doliocarpus brevipedicellatus Garcke
Doliocarpus dentatus (Aubl.) Standl.
Doliocarpus glomeratus Eichl.

Dioscoreaceae

Dioscorea amaranthoides (Mart.) J.S. Presl.
Dioscorea argyrogyna Uline ex Kunth
Dioscorea bulbifera L.
Dioscorea cinnamomifolia Hook.
Dioscorea clausseni Uline
Dioscorea glandulosa Klotz. ex R. Knuth.
Dioscorea hastata Vell.
Dioscorea lagoa-santa Uline ex R. Knuth.
Dioscorea maianthemoides Uline ex R. Knuth.
Dioscorea microbotrya Griseb.
Dioscorea monandra Hauman
Dioscorea orthogeneura Uline ex Hochreutiner
Dioscorea ovata Vell.
Dioscorea platystemon Hauman
Dioscorea scabra Humb. & Bonpl. ex Willd.
Dioscorea sincorensis R. Knuth.
Dioscorea sinuata Vell.
Dioscorea stenophylla Uline
Dioscorea trachyandra Griseb.
Dioscorea trifida L.
Dioscorea trisecta Griseb.

Ericaceae

Agarista pulchella G. Don
Agarista serrulata G. Don *
Gaylussacia brasiliensis (Spr.) C.F.W. Meissn. *
Gaylussacia gaultheria Cham. & Schltndl.

Eriocaulaceae

Leiothrix flexuosa (Bong.) Ruhl.
Paepalanthus acanthophyllus Ruhl.
Paepalanthus barbulatus Herzog.
Paepalanthus claussenianus Koern.
Paepalanthus elongatus Mart. ex Mold.
Paepalanthus extremensis Alv. Silv.
Paepalanthus flacidus (Bong.) Kunth
Paepalanthus hilarei Koern.
Paepalanthus polyanthus (Bong.) Kunth
Paepalanthus ramosus (Wikstr.) Kunth
Paepalanthus scandens Ruhl.
Paepalanthus speciosus (Bong.) Koern.
Paepalanthus urbanianus Ruhl.
Syngonanthus densus (Koern.) Ruhl.
Syngonanthus gracilis (Bong.) Ruhl.
Syngonanthus nitens (Bong.) Ruhl.
Syngonanthus reclinatus (Koern.) Ruhl.
Syngonanthus xeranthemoides (Bong.) Ruhl.

Erythroxylaceae

Erythroxylum deciduum A. St-Hil. *
Erythroxylum loefgrenii C. Diogo
Erythroxylum nanum A. St-Hil.

Euphorbiaceae

Bernardia hirsutissima (Baill.) Müll. Arg.
Bernardia multicaulis Müll. Arg.
Bernardia similis Pax & Hoffm.
Bernardia spartioides (Baill.) Müll. Arg.
Chaetocarpus echinocarpus (Baill.) Ducke
Chamaesyce buxifolia (Lam.) Small
Chamaesyce coecorum (Mart. ex Boiss.) Croizat.
Chamaesyce hirta (L.) Millsp.
Chamaesyce hyssopifolia (L.) Small
Chamaesyce sessilifolia Klotz. ex Boiss.
Chamaesyce viscoides (Boiss.) Simmons
Cnidoscolus phyllacanthus (Müll. Arg.) Pax & Hoffm.
Cnidoscolus quercifolius Pohl
Cnidoscolus vitifolius (Miller) Pohl
Croton abaitensis Baill.
Croton aberrans Müll. Arg.
Croton adenodontus (Müll. Arg.) Müll. Arg.
Croton agoensis Baill.
Croton agrarius Baill.
Croton angustifrons Müll. Arg.
Croton antisyphiliticus Mart.
Croton campestris A. St-Hil.
Croton carinatus Müll. Arg.
Croton chaetocalyx Müll. Arg.
Croton corchoropsis Baill.
Croton cuyabensis Pilger
Croton desertorum Müll. Arg.
Croton didrichsenii Webster
Croton doctoris S. Moore
Croton eriocladoides Müll. Arg.
Croton eriocladus Müll. Arg.
Croton garckeanus Baill.
Croton glandulosus L.
Croton goyazensis Müll. Arg.
Croton gracilescens Müll. Arg.
Croton grandivelum Baill.
Croton horridulus (Baill.) Müll. Arg.
Croton intercedens Müll. Arg. ex Char.
Croton leptophyllus Müll. Arg.
Croton luetzelburgii Pax & Hoffm.
Croton lundianus Müll. Arg.
Croton megalocalyx Müll. Arg.
Croton microcarpus Müll. Arg.
Croton mucronifolius Müll. Arg.
Croton occidentalis Müll. Arg.

Croton paraffinis Müll. Arg. ex Char.
Croton pedicellatus Müll. Arg.
Croton petraeus Müll. Arg.
Croton pohlianus Müll. Arg. *
Croton radlkoferi Pax & Hoffm.
Croton salutaris Casar *
Croton schultesii Müll. Arg.
Croton sclerocalyx (Didr.) Müll. Arg.
Croton siderophyllus Baill.
Croton stoechadis Baill.
Croton subacutus (Baill.) Müll. Arg.
Croton trinitatis Millsp.
Croton verbenaefolius Müll. Arg.
Croton zehntneri Pax & Hoffm.
Dalechampia caperonioides Baill.
Dalechampia humilis Müll. Arg.
Dalechampia linearis Baill.
Euphorbia comosa Vell.
Euphorbia sessilifolia Klotz. ex Boiss.
Euphorbia setosa Boiss.
Jatropha elliptica (Pohl) Müll. Arg.
Jatropha gossypifolia L.
Julocroton humilis Didr.
Julocroton triqueter (Lam.) Didr.
Manihot alutacea Rogers & Appan
Manihot attenuata Müll. Arg.
Manihot bahiensis Ule
Manihot caerulescens Pohl *
Manihot esculenta Crantz.
Manihot fruticulosa (Pax) Rogers & Appan
Manihot gabrielensis Allem
Manihot gracilis Pohl
Manihot heptaphylla Ule
Manihot hilariana Baill.
Manihot irwinii Rogers & Appan
Manihot jacobinensis Müll. Arg.
Manihot longepetiolata Pohl
Manihot mossamedensis Taub.
Manihot nana Müll. Arg.
Manihot nogueirae Allem
Manihot oligantha Pax & Hoffm.
Manihot orbicularis Pohl
Manihot paviaefolia Pohl
Manihot peltata Pohl
Manihot pentaphylla Pohl
Manihot pruinosa Pohl *
Manihot pseudopruinosa Pax & Hoffm.
Manihot purpureo-costata Pohl
Manihot quiqueloba Pohl
Manihot sagittato-partita Pohl
Manihot salicifolia Pohl
Manihot sparsifolia Pohl
Manihot sparsifolia Pohl
Manihot stipularis Pax
Manihot stricta Baill.
Manihot tenerrima Pohl
Manihot tomentosa Pohl
Manihot tripartita (Spr.) Müll. Arg. *
Manihot triphylla Pohl
Manihot violacea Pohl *
Maprounea brasiliensis (Aubl.) A. St-Hil. *
Phyllanthus caroliniensis Walt.
Phyllanthus dawsonii Steyerm.
Phyllanthus flagelliformis Müll. Arg.
Phyllanthus klotzchianus Müll. Arg.
Phyllanthus minutulus Müll. Arg.
Phyllanthus niruri Thumb.
Phyllanthus orbiculatus L.C. Rich.
Sapium glandulatum (Vell.) Pax
Sebastiania anisodonta Müll. Arg.
Sebastiania bidentata (Mart.) Pax
Sebastiania brasiliensis Spr.
Sebastiania corniculata (Vahl.) Müll. Arg.
Sebastiania ditassoides (Didr.) Müll. Arg.
Sebastiania hispida (Mart.) Pax
Sebastiania myrtilloides (Mart.) Pax
Sebastiania revoluta Ule
Sebastiania salicifolia (Mart.) Pax
Sebastiania serrulata Müll. Arg.
Tragia bahiensis Müll. Arg.
Tragia uberabana Müll. Arg.

Fabaceae
Acacia langsdorfii Benth.
Aeschynomene americana L.
Aeschynomene brevipes Benth.
Aeschynomene evenia Wright
Aeschynomene falcata (Poir.) A. DC.
Aeschynomene filosa Mart. ex Benth.
Aeschynomene genistoides (Taub.) Rudd
Aeschynomene histrix Poir.
Aeschynomene irwinii Rudd
Aeschynomene marginata Benth.
Aeschynomene oroboides Benth.
Aeschynomene paniculata Willd. ex Vogel
Aeschynomene paucifolia Vogel
Aeschynomene selloi Vogel
Aeschynomene simplicifolia G.P. Lewis
Aeschynomene vogelii Rudd
Andira laurifolia Benth. *

Arachis archeri Krapov. & W.C. Gregory
Arachis benthamii Handro
Arachis brevipetiolata Krapov. & W.C. Gregory
Arachis burchelii Krapov. & W.C. Gregory
Arachis cryptopotamica Krapov. & W.C. Gregory
Arachis decora Krapov., W.C. Gregory & Valls
Arachis douradiana Krapov. & W.C. Gregory
Arachis glabrata Benth.
Arachis gracilis Krapov. & W.C. Gregory
Arachis guaranitica Chodat. & Hassl.
Arachis hatschbachii Krapov. & W.C. Gregory
Arachis hermanii Krapov. & W.C. Gregory
Arachis lutescens Krapov. & W.C. Gregory
Arachis macedoi Krapov. & W.C. Gregory
Arachis major Krapov. & W.C. Gregory
Arachis marginata Gardner
Arachis martii Handro
Arachis matiensis Krapov., W.C. Gregory & C.E. Simpson
Arachis oteroi Krapov. & W.C. Gregory
Arachis paraguariensis Chodat. & Hassl.
Arachis pietrarelii Krapov. & W.C. Gregory
Arachis pintoi Krapov. & W.C. Gregory
Arachis precox Krapov., W.C. Gregory & Valls
Arachis prostrata Benth.
Arachis repens Handro
Arachis retusa Krapov., W.C. Gregory & Valls
Arachis setinervosa Krapov. & W.C. Gregory
Arachis simpsonii Krapov. & W.C. Gregory
Arachis stenophylla Krapov. & W.C. Gregory
Arachis stenosperma Krapov. & W.C. Gregory
Arachis sylvestris (A. Chev.) A. Chev.
Arachis tuberosa Bong. ex Benth.
Barbieria pinnata (Pers.) Baill.
Bauhinia burchellii Benth.
Bauhinia campestris Malme
Bauhinia dumosa Benth.
Bauhinia malacotrichoides Cowan
Bauhinia pulchella Benth. *
Bauhinia tenella Benth. *
Calliandra dysantha Benth. *
Calliandra hirsuticaulis Harms
Calliandra longipes Benth.
Calliandra virgata Benth.
Calopogonium coeruleum (Benth.) Hemsl.
Calopogonium sericeum (Benth.) Chodat. ex Hassl.
Calopogonium velutinum (Benth.) Amsh.
Camptosema coriaceum (Nees & Mart.) Benth. *
Camptosema ellipticum (Desv.) Burkart
Camptosema scarlatinum (Mart. ex Benth.) Burkart
Camptosema spectabile (Tul.) Burkart
Centrosema angustifolium (Kunth) Benth.
Centrosema arenarium Benth.
Centrosema basifolia (Vogel) Irwin & Barneby
Centrosema bracteosum Benth.
Centrosema coriaceum Benth.
Centrosema pascuorum Mart.
Centrosema pubescens Benth.
Centrosema teresae Brandão & Costa
Centrosema venosum Mart. ex Benth.
Chaetocalyx brasiliensis Benth.
Chaetocalyx longiflora A. Gray
Chamaecrista acosmifolia (Benth.) Irwin & Barneby
Chamaecrista amiciella Irwin & Barneby
Chamaecrista aurivilla (Mart.) Irwin & Barneby
Chamaecrista azulana (Irwin & Barneby) Irwin & Barneby
Chamaecrista basifolia (Vogel) Irwin & Barneby
Chamaecrista benthamiana (Harms) Irwin & Barneby
Chamaecrista brachyrachis (Harms) Irwin & Barneby
Chamaecrista brevicalyx (Benth.) Irwin & Barneby
Chamaecrista burchelli (Benth.) Irwin & Barneby
Chamaecrista calyciodes (Collad.) Greene
Chamaecrista campestris Irwin & Barneby
Chamaecrista campicola (Harms) Irwin & Barneby
Chamaecrista camporum (Benth.) Irwin & Barneby
Chamaecrista cathartica (Mart.) Irwin & Barneby *
Chamaecrista catharticoides (Irwin & Barneby) Irwin & Barneby
Chamaecrista cavalcantina (Irwin & Barneby) Irwin & Barneby
Chamaecrista chaetostegia (Irwin & Barneby) Irwin & Barneby
Chamaecrista choriophylla (Vogel) Irwin & Barneby
Chamaecrista ciliolata (Benth.) Irwin & Barneby
Chamaecrista clausseni (Benth.) Irwin & Barneby *
Chamaecrista conferta (Benth.) Irwin & Barneby
Chamaecrista cotonifolia (G. Don.) Irwin & Barneby *
Chamaecrista cristalinae (Irwin & Barneby) Irwin & Barneby
Chamaecrista cromnyotricha (Harms) Irwin & Barneby
Chamaecrista dalbergiifolia (Benth.) Irwin & Barneby *
Chamaecrista dawsonii (Cowan) Irwin & Barneby
Chamaecrista debilis (Vogel) Irwin & Barneby
Chamaecrista decrescens (Benth.) Irwin & Barneby
Chamaecrista decumbens (Benth.) Irwin & Barneby
Chamaecrista densifolia (Benth.) Irwin & Barneby
Chamaecrista desvauxii (Collad.) Killip. *
Chamaecrista diphylla (L.) Greene
Chamaecrista ensiformis (Vell.) Irwin & Barneby *
Chamaecrista fagonioides (Vogel) Irwin & Barneby
Chamaecrista fasciculata (Michx.) Greene
Chamaecrista filicifolia (Benth.) Irwin & Barneby
Chamaecrista flexuosa (L.) Greene
Chamaecrista foederalis (Irwin & Barneby) Irwin & Barneby
Chamaecrista geminata (Benth.) Irwin & Barneby

Chamaecrista glandulosa (L.) Greene
Chamaecrista imbricans Irwin & Barneby
Chamaecrista jacobinea (Benth.) Irwin & Barneby
Chamaecrista kunthiana (Schltndl. & Cham.) Irwin & Barneby
Chamaecrista labouriaea (Irwin & Barneby) Irwin & Barneby
Chamaecrista lavradiiflora (Harms) Irwin & Barneby
Chamaecrista lundii (Benth.) Irwin & Barneby
Chamaecrista monticola (Benth.) Irwin & Barneby
Chamaecrista neesiana (Benth.) Irwin & Barneby
Chamaecrista nictitans (L.) Moench.
Chamaecrista nummularifolia (Benth.) Irwin & Barneby
Chamaecrista ochnacea (Vogel) Irwin & Barneby
Chamaecrista parvistipula (Benth.) Irwin & Barneby
Chamaecrista pascuorum (Benth.) Irwin & Barneby
Chamaecrista planaltona (Harms) Irwin & Barneby
Chamaecrista pohliana (Benth.) Irwin & Barneby
Chamaecrista ramosa (Vogel) Irwin & Barneby
Chamaecrista repens (Vogel) Irwin & Barneby
Chamaecrista roraimae (Benth.) Gleason
Chamaecrista rotundata (Vogel) Irwin & Barneby *
Chamaecrista rotundifolia (Pers.) Greene
Chamaecrista scabra (Benth.) Irwin & Barneby
Chamaecrista serpens (L.) Greene
Chamaecrista seticrenata (Irwin & Barneby) Irwin & Barneby
Chamaecrista setosa (Vogel) Irwin & Barneby
Chamaecrista supplex (Mart. ex Benth.) Britton
Chamaecrista trichopoda (Benth.) Irwin & Barneby
Chamaecrista venatoria (Benth.) Irwin & Barneby
Chamaecrista viscosa (Kunth) Irwin & Barneby
Clitoria densifolia (Presl.) Benth.
Clitoria falcata Lam.
Clitoria flavicoma Benth.
Clitoria glycenioides Benth.
Clitoria guianensis (Aubl.) Benth.
Clitoria laurifolia Poir.
Clitoria racemosa G. Don.
Clitoria rufescens Benth.
Collaea aschersoniana (Taub.) Burkart
Collaea speciosa (Gloes) A. DC.
Crotalaria acutiflora Benth.
Crotalaria bahiensis Windler & Skinner
Crotalaria brachystachia Benth.
Crotalaria breviflora A. DC.
Crotalaria flavicoma Benth.
Crotalaria grandiflora Benth.
Crotalaria harleyi Windler & Skinner
Crotalaria lanceolata E. Mey.
Crotalaria martiana Benth.
Crotalaria maypurensis Kunth
Crotalaria micans Link.
Crotalaria mohlenbrockii Windler & Skinner
Crotalaria nitens Benth.
Crotalaria otoptera Benth.
Crotalaria pallida Schrank.
Crotalaria pillosa Mil.
Crotalaria pohliana Benth.
Crotalaria pterocaula Desv.
Crotalaria sagittalis Desv.
Crotalaria stipularia Desv.
Crotalaria striata Schum. & Thonn
Crotalaria subdecurrens Mart.
Crotalaria unifoliolata Benth.
Crotalaria velutina Benth.
Crotalaria vitellina Ker Gawl.
Crotalaria zanzibarica Benth.
Deguelia nitidula (Benth.) Az.-Tozzi
Desmanthus depressus Humb. & Bonpl.
Desmodium asperum Desv.
Desmodium barbatum (L.) Benth.
Desmodium cuneatum Hook. & Arn.
Desmodium discolor Vogel
Desmodium guaraniticum (Schindl.) Malme
Desmodium incanum (Sw.) A. DC.
Desmodium pachyrhizum Vogel
Desmodium platycarpum Benth.
Desmodium procumbens (Mill.) Hitchc.
Desmodium sclerophyllum Benth.
Desmodium tortuosum (Swartz) A. DC.
Desmodium uncinatum A. DC.
Dioclea bicolor Benth. *
Dioclea coriacea Benth.
Dioclea glabra Benth. *
Dioclea huberii Ducke *
Dioclea latifolia Benth.
Dioclea paraguayensis Benth.
Eriosema benthamianum Mart. ex Benth.
Eriosema brachyrhachis Harms
Eriosema brevipes Grear
Eriosema campestre Benth.
Eriosema congestum Benth. *
Eriosema crinatum (Kunth) G. Don
Eriosema cupreum Harms
Eriosema defoliatum Benth.
Eriosema floribundum Benth.
Eriosema glabrum Mart. ex Benth.
Eriosema glaziovii Harms
Eriosema grewiaefolia (Benth.) Taub.
Eriosema heterophyllum Benth.
Eriosema irwiniii Grear
Eriosema longiflorum Benth.

Eriosema longifolium Benth.
Eriosema prorepens Benth.
Eriosema pycnanthum Benth.
Eriosema rigidum Benth.
Eriosema rufum Kunth
Eriosema simplicifolium (Kunth) G. Don.
Eriosema stenophyllum Harms
Eriosema stipulare Benth.
Eriosema strictum Benth.
Eriosema venulosum Benth.
Galactia boavista (Vell.) Burkart
Galactia braviata (Vell.) Burkart
Galactia crassifolia (Benth.) Taub.
Galactia decumbens (Benth.) Chod. & Hassl.
Galactia dimorpha Burkart
Galactia douradensis Taub.
Galactia eriosematoides Harms
Galactia glaucescens Kunth *
Galactia grewiaefolia (Benth.) Taub.
Galactia heringeri Burkart
Galactia irwinii Cowan
Galactia jussiaeana Kunth
Galactia martii A. DC.
Galactia neesii A. DC.
Galactia peduncularis (Benth.) Taub.
Galactia remansoana Harms
Galactia stereophylla Harms
Indigofera gracilis Bong.
Indigofera hirsuta L.
Indigofera lespedezioides Kunth
Indigofera pascuorum Benth.
Indigofera suffruticosa Mil. *
Lupinus compitus Benth.
Lupinus crotalarioides Mart. ex Benth.
Lupinus guaraniticus (Hassl.) C. P. Smith
Lupinus subsessilis Benth.
Lupinus vaginans Benth.
Lupinus velutinus Benth.
Macroptilium atropurpureum Urban
Macroptilium bracteatum (Nees & Mart.) Maréchal & Boudet
Macroptilium erythroloma (Mart. ex Benth.) Urban
Macroptilium gracile (Poepp. ex Benth.) Urban
Macroptilium lathyroides (L.) Urban
Macroptilium monophyllum (Benth.) Maréchal & Boudet
Macroptilium prostratum (Benth.) Urban
Macroptilium sabaraense (Hoehne) V. P. Barbosa-Fevereiro
Martiodendron mediterraneum (Mart. ex Benth.) Koeppen *
Mimosa albolanata Taub. *
Mimosa axillaris Benth.
Mimosa burchellii Benth.
Mimosa campicola Harms
Mimosa chaetosphera Barneby
Mimosa cryptothamnos Bonpl.
Mimosa cyclophylla Taub.
Mimosa debilis Humb. & Bonpl. ex Willd.
Mimosa demissa Bonpl.
Mimosa desnodioides Benth.
Mimosa dimidiata Benth.
Mimosa distans Benth.
Mimosa dollens Vell. *
Mimosa falcipina Benth.
Mimosa filipes Mart.
Mimosa foliolosa Benth. *
Mimosa gracilis Benth.
Mimosa guaranitica Chodat. & Hassl.
Mimosa heterotricha Burkart
Mimosa hirsuta Spreng.
Mimosa hirsutissima Mart.
Mimosa invisa Mart.
Mimosa irwinii Bonpl.
Mimosa lanuginosa (Glaz.) Burkart *
Mimosa leptocaulis Benth.
Mimosa meticulosa Mart.
Mimosa modesta Mart.
Mimosa nuda Humb. & Bonpl.
Mimosa obtusifolia Willd.
Mimosa papposa Benth.
Mimosa petiolaris Benth.
Mimosa pigra L.
Mimosa piptoptera Bonpl.
Mimosa platyphylla Benth. *
Mimosa polycephala Benth.
Mimosa pomnians Kunth
Mimosa procurrens Benth.
Mimosa pudica L.
Mimosa pyrenea Taub.
Mimosa quadrivalvis L.
Mimosa radula Benth.
Mimosa rixosa Mart.
Mimosa sensitiva Lodd.
Mimosa somnians Humb. & Bonpl. ex Willd. *
Mimosa speciosissima Taub.
Mimosa subenervis Benth.
Mimosa tremula Benth.
Mimosa vellozjana Mart.
Mimosa venatorum Barneby
Mimosa xanthocentra Mart. *
Mucuna pruriens (L.) A. DC.
Periandra coccinea (Schrad.) Benth.
Periandra densiflora Benth.

Periandra dulcis Benth.
Periandra gracilis Irwin & Arroyo
Periandra heterophylla Benth.
Periandra mediterranea (Vell.) Taub.
Phaseolus firmulus Mart.
Phaseolus lathyroides L.
Phaseolus uleanus Harms
Poiretia angustifolia Vogel
Poiretia coriifolia Vogel
Poiretia elegans C. Müller
Poiretia latifolia Vogel
Poiretia marginata C. Müller
Poiretia matogrossensis C. Müller
Poiretia scandens Vent.
Rhynchosia melanocarpa J.W. Grear
Rhynchosia minima (L.) A. DC.
Rhynchosia platyphylla Benth.
Schrankia leptocarpa A. DC.
Senna alata (L.) Roxb.
Senna bicapsularis (L.) Roxb. *
Senna mollicaulis (Harms) Irwin & Barneby
Senna occidentalis (L.) Link.
Senna pilifera (Vogel) Irwin & Barneby
Stylosanthes acuminata M.B. Ferr. & S. Costa
Stylosanthes angustifolia Vogel
Stylosanthes bracteata Vogel
Stylosanthes capitata Vogel
Stylosanthes gracilis Kunth
Stylosanthes guianensis (Aubl.) Sw.
Stylosanthes macrocephala M.B. Ferr. & S. Costa
Stylosanthes nunoi Brandão
Stylosanthes ruellioides Mart.
Stylosanthes scabra Vogel
Stylosanthes viscosa Sw.
Tephrosia adunca Benth.
Tephrosia cinerea Pers.
Tephrosia purpurea Pers. *
Tephrosia rufescens Benth.
Teramnus uncinatus (L.) Sw.
Vigna linearis Kunth
Vigna peduncularis (Kunth) Fawc. & Rendl.
Vigna speciosa (Kunth) Verdc.
Zornia crinita (Mohl.) Vanni
Zornia glaziovii Harms
Zornia latifolia Sm.
Zornia marajoara Huber
Zornia mitziana S. Costa
Zornia pardina Mohlenbr.
Zornia reticulata Sm.
Zornia sericea Moric.
Zornia vestita Mohlenbr.
Zornia virgata Moric.

Flacourtiaceae
Casearia altiplanensis Sleumer

Gentianaceae
Curtia tenuifolia (Aubl.) Knobl.
Deianira cordifolia (Lhotzky ex Prog.) Malme
Deianira cyathifolia B. Rodr.
Deianira erubescens Cham. & Schltndl.
Deianira foliosa (Griseb.) Guimarães
Deianira nervosa Cham. & Schltndl.
Irlbachia caerulascens (Aubl.) Griseb.
Irlbachia oblongifolia (Mart.) Maas
Irlbachia purpurascens (Aubl.) Maas
Irlbachia speciosa (Cham. & Schltndl.) Maas
Schultesia crenuliflora Mart.

Gesneriaceae
Gloxinia hirsuta Lindl.
Gloxinia ichthyostoma Gardner
Sinningia allagophylla (Mart.) Wiehler
Sinningia elatior (Kunth) Chautems
Sinningia splendens (Van Houte) Kuntze
Sinningia stricta (Hook. & Arn.) Wiehler

Heliconiaceae
Heliconia psittacorum L. f.

Herreriaceae
Herreria salsaparrilha Mart.

Hymenophyllaceae
Trichomanes cristatum Kaulf.

Iridaceae
Cipura flava Rav.
Cipura paludosa Aubl.
Cipura xanthomelas Mart. ex Klatt.
Gelosine gigantea Rav.
Sisyrinchium alatum Hook.
Sisyrinchium incurvatum Gardner
Sisyrinchium restioides Spr.
Sisyrinchium vaginatum Spr.
Sisyrinchium virgatum Spr.
Sisyrinchium weirii Back.
Trimezia cathartica (Klatt.) Benth. & Hook. f.
Trimezia juncifolia (Klatt.) Benth. & Hook. f.

Krameriaceae
Krameria argentea Mart. ex Spr.
Krameria tomentosa A. St-Hil.

Lamiaceae
Eriope complicata Mart. ex Benth.
Eriope crassipes Benth.
Eriope hypenioides Mart. ex Benth.
Eriope latifolia (Mart. ex Benth.) Harley
Eriope luetzelburgii Harley
Eriope montana Harley
Eriope parviifolia Mart. ex Benth.
Eriope tumidicaulis Harley
Eriope velutina Epling
Hypenia aristulata (Epling) Harley
Hypenia brachystachys (Pohl ex Benth.) Harley
Hypenia calycina (Pohl ex Benth.) Harley
Hypenia densiflora (Pohl ex Benth.) Harley
Hypenia irregularis (Benth.) Harley
Hypenia macrantha (A. St-Hil. ex Benth.) Harley *
Hypenia macrosiphon (Briq.) Harley
Hypenia niqueladiensis R. Atkinson
Hypenia paradisi (Harley) Harley
Hypenia reticulata (Mart. ex Benth.) Harley
Hypenia vitifolia (Pohl ex Benth.) Harley
Hyptidendron amethystoides (Benth.) Harley
Hyptidendron canum (Pohl ex Benth.) Harley *
Hyptis adpressa A. St-Hil. ex Benth.
Hyptis alutacea Pohl ex Benth.
Hyptis ampelophylla Epling
Hyptis angulosa Schott. ex Benth.
Hyptis arbuscula Epling
Hyptis brevipes Poit.
Hyptis caespitosa Benth.
Hyptis calycina (Pohl ex Benth.) Char.
Hyptis camporum Benth.
Hyptis caprariifolia Pohl ex Benth.
Hyptis cardiophylla Pohl ex Benth.
Hyptis carpinifolia Benth.
Hyptis caudata Epling & Sativa
Hyptis coccinea Mart.
Hyptis colligata Epling & Sativa
Hyptis conferta Pohl ex Benth.
Hyptis crassifolia Mart. ex Benth.
Hyptis crenata Pohl ex Benth.
Hyptis crinita Benth.
Hyptis cruciformis Epling
Hyptis cuneata Pohl ex Benth.
Hyptis densiflora Pohl ex Benth.
Hyptis desertorum Pohl ex Benth.
Hyptis duplicatodentata Pohl ex Benth.
Hyptis durifolia Epling
Hyptis eriophylla Pohl *
Hyptis ferruginosa Pohl ex Benth.
Hyptis foliosa A. St-Hil. ex Benth.
Hyptis frondosa S. Moore
Hyptis glomerata Mart. ex Schunk.
Hyptis glutinosa Benth.
Hyptis goyanensis A. St-Hil. ex Benth.
Hyptis halinifolia Mart. ex Benth.
Hyptis heterophylla Benth.
Hyptis hilarii Benth.
Hyptis hirsuta Kunth
Hyptis imbricata Pohl
Hyptis interrupta Pohl ex Benth.
Hyptis irregularis Benth.
Hyptis lanuginosa Glaz. ex Epling
Hyptis lavandulacea Pohl
Hyptis linarioides Pohl ex Benth.
Hyptis lippioides Pohl ex Benth.
Hyptis lutescens Pohl ex Benth.
Hyptis lythroides Pohl ex Benth.
Hyptis malacophylla Benth.
Hyptis marruboides Epling
Hyptis martusii Benth.
Hyptis microphylla Pohl ex Benth.
Hyptis molissima Benth.
Hyptis multibracteata Benth.
Hyptis multiflora Pohl ex Benth.
Hyptis multiseta Benth.
Hyptis mutabilis (Rich.) Briq.
Hyptis nudicaulis Benth.
Hyptis obtecta Benth.
Hyptis orbiculata Pohl ex Benth.
Hyptis oriophylla Pohl ex Benth.
Hyptis ovalifolia Benth.
Hyptis pachyphylla Epling
Hyptis passerina Mart. ex Benth.
Hyptis pauliana Epling *
Hyptis pectinata Poit.
Hyptis peduncularis Benth.
Hyptis penaeoides Taub.
Hyptis plataniifolia Mart.
Hyptis plectranthoides Benth.
Hyptis pyonocephala Benth.
Hyptis racemulosa Mart. ex Benth.
Hyptis ramosa Pohl ex Benth.
Hyptis recurvata Poit.
Hyptis remota Pohl ex Benth.
Hyptis reticulata (Mart. ex Benth.) Harley

Hyptis rhabdocalyx Mart.
Hyptis rubicunda Pohl ex Benth.
Hyptis rubiginosa Mart.
Hyptis rugosa Benth.
Hyptis saxatilis A. St-Hil. ex Benth.
Hyptis selaginifolia Mart. ex Benth.
Hyptis suaveolens (L.) Poit.
Hyptis subrosea Harley
Hyptis subrotunda Pohl ex Benth.
Hyptis tagetifolia Harley
Hyptis tenuifolia Epling
Hyptis tetragona Pohl ex Benth.
Hyptis velutina Pohl ex Benth.
Hyptis villosa Pohl ex Benth.
Hyptis violacea Pohl ex Benth.
Hyptis virgata Benth.
Keithia nitida Benth.
Leonotis nepetifolia (L.) R. Br.
Marsipianthes chamaedrys (Vahl) O. Kuntze
Marsipianthes foliolosa Benth.
Marsipianthes montana Benth.
Ocimum micranthum Willd.
Ocimum selloi Benth.
Peltodon pusillus Pohl
Peltodon tomentosus Pohl
Rhabdocaulon denudatum (Benth.) Epling
Salvia brevipes Benth.
Salvia cerradicola dos Santos
Salvia grawiifolia S. Moore
Salvia nervosa Benth.
Salvia rigida Benth.
Salvia scabrida Pohl
Salvia tomentella Pohl

Lauraceae
Cassytha filiformis L.
Cinnamomum hanaknechtii Mez

Loganiaceae
Spigelia blanchetiana A. DC.
Spigelia pulchella Mart.
Strychnos bicolor Progel
Strychnos brasiliensis (Spreng.) Mart.

Loranthaceae
Dendrophthora tepuiana (Steyerm.) Kuijt
Phoradendron apiciflorum Rizzini
Phoradendron bathyoryctum Eichl.
Phoradendron coriaceum Mart.
Phoradendron crassifolium (A. DC.) Eichl.
Phoradendron dipterum Eichl.
Phoradendron distans Rizzini
Phoradendron falcifrons (Hook. & Arn.) Eichl.
Phoradendron hexastichum (A. DC.) Griseb.
Phoradendron microphyllum (Pohl) Trelease
Phoradendron mucronatum (A. DC.) Krug. & Urban
Phoradendron orbiculare Rizzini
Phoradendron piauhyanum Trelease
Phoradendron pteroneuron Eichl.
Phoradendron rubrum (L.) Griseb.
Phoradendron strongylocladus Eichl.
Phoradendron triplinervum Rizzini
Phoradendron tunaeforme (A. DC.) Eichl.
Phoradendron undulatum (Pohl) Eichl.
Phoradendron warmingii Eichl.
Phrygilanthus acutifolius (Ruiz & Pav.) Eichl.
Phrygilanthus eugenioides (Kunth) Eichl.
Phthirusa abdita S. Moore
Phthirusa ovata (Pohl) Eichl.
Phthirusa stelis (L.) Kuijt
Psittacanthus biternatus (Hoffm.) Bl.
Psittacanthus cinctus Eichl.
Psittacanthus cordatus (Hoffm.) Bl.
Psittacanthus cuneifolius (Ruiz & Pav.) Engl.
Psittacanthus dichrous Mart.
Psittacanthus flexicaulis Mart.
Psittacanthus piauhyensis Rizzini
Psittacanthus plagiophyllus Eichl.
Psittacanthus robustus Mart.
Psittacanthus warmingii Eichl.
Struthantus confertus (Mart.) Mart.
Struthantus elegans Mart.
Struthantus flexicaulis Mart.
Struthantus marginatus (Desr.) Blume
Struthantus polyanthus Mart.
Struthantus salicifolius (Mart.) Mart.
Struthantus syringifolius Mart.
Struthantus vulgaris Mart.

Lycopodiaceae
Lycopodiella alopecuroides (L.) Cranfill
Lycopodiella camporum B. Ollg. & P.G. Wind.

Lythraceae
Cuphea calophylla Cham. & Schltndl.
Cuphea carthagenensis (Jacq.) Macbr.
Cuphea crulsiana Koehne
Cuphea cunninghamiifolia T. Cavalcanti
Cuphea ericoides Cham. & Schltndl.
Cuphea glariosa T. Cavalcanti

Cuphea gracilis Kunth
Cuphea grandiflora Koehne
Cuphea ingrata Cham. & Schltndl.
Cuphea laricoides Koehne
Cuphea linarioides Cham. & Schltndl.
Cuphea lutescens Koehne
Cuphea micrantha Kunth
Cuphea polymorpha A. St-Hil.
Cuphea remotifolia A. St-Hil.
Cuphea retrorsicapilla Koehne
Cuphea rubrovirens T. Cavalcanti
Cuphea sessilifolia Mart.
Cuphea spermacoce A. St-Hil.
Cuphea teleandra Lourt.
Cuphea thymoides Cham. & Schltndl. *
Cuphea xanthosepala S. Graham & T. Cavalcanti
Diplusodon aggregatifolius T. Cavalcanti
Diplusodon alatus T. Cavalcanti
Diplusodon argyrophyllus T. Cavalcanti
Diplusodon astictus Lourt.
Diplusodon bolivianus T. Cavalcanti & S. Graham
Diplusodon bradei Pilger
Diplusodon burchelii Koehne
Diplusodon ciliatiflorus T. Cavalcanti
Diplusodon ciliiflorus Koehne
Diplusodon cordifolius Lourt.
Diplusodon divaricatus Pohl
Diplusodon epilobioides A. DC.
Diplusodon ericoides Lourt.
Diplusodon floribundus Pohl
Diplusodon glaucescens A. DC.
Diplusodon gracilis Koehne
Diplusodon helianthemifolius A. DC.
Diplusodon hexander A. DC.
Diplusodon imbricatus Pohl
Diplusodon incannus Gardner
Diplusodon lanceolatus Pohl
Diplusodon leucocalycinus Lourt.
Diplusodon matogrossensis T. Cavalcanti
Diplusodon nigricans Koehne
Diplusodon nitidus A. DC.
Diplusodon oblongus Pohl
Diplusodon ovatus Pohl
Diplusodon paraisoensis Lourt.
Diplusodon plumbens T. Cavalcanti
Diplusodon puberulus Koehne
Diplusodon punctatus Pohl
Diplusodon quintuplinervis (Nees) Koehne
Diplusodon ramosissimus Pohl *
Diplusodon rosmarinifolius A. St-Hil.
Diplusodon sessiliflorus Koehne
Diplusodon sordidus Koehne
Diplusodon speciosus (Kunth) A. DC.
Diplusodon strigosus Pohl
Diplusodon thymifolius A. DC.
Diplusodon trigintus T. Cavalcanti
Diplusodon uninervis Koehne
Diplusodon villosissimus Pohl
Diplusodon villosus Pohl
Diplusodon virgatus Pohl *
Heimia myrtifolia Cham. & Schltndl.
Pleurophora anomala A. St-Hil.

Malpighiaceae
Aspicarpa pulchella (Griseb.) O. Dorr. & Lourt.
Banisteriopsis acerosa (Nied.) B. Gates
Banisteriopsis adamantium A. Juss.
Banisteriopsis adenopoda (A. Juss.) B. Gates
Banisteriopsis angustifolia (A. Juss.) B. Gates
Banisteriopsis anisandra (A. Juss.) B. Gates
Banisteriopsis argyrophylla (A. Juss.) B. Gates *
Banisteriopsis campestris (A. Juss.) Little *
Banisteriopsis clausseniana (A. Juss.) W. Anderson & B. Gates *
Banisteriopsis gardneriana (A. Juss.) W. Anderson & Sattl.
Banisteriopsis harleyi B. Gates
Banisteriopsis hatschbachii B. Gates
Banisteriopsis hirsuta B. Gates
Banisteriopsis irwinii B. Gates *
Banisteriopsis laevifolia (A. Juss.) B. Gates *
Banisteriopsis latifolia (A. Juss.) B. Gates *
Banisteriopsis longipilifera B. Gates
Banisteriopsis lutea (Griseb.) Cuatr.
Banisteriopsis malifolia (Nees & Mart.) B. Gates *
Banisteriopsis megaphylla (A. Juss.) B. Gates *
Banisteriopsis nummifera (A. Juss.) B. Gates
Banisteriopsis oxyclada (A. Juss.) B. Gates *
Banisteriopsis prancei B. Gates
Banisteriopsis pubipetala (A. Juss.) Cuatrec. *
Banisteriopsis schizoptera (A. Juss.) B. Gates *
Banisteriopsis stellaris (Griseb.) B. Gates
Banisteriopsis variabilis B. Gates *
Banisteriopsis vernoniifolia (A. Juss.) B. Gates
Byrsonima basiloba A. Juss. *
Byrsonima dealbata Griseb.
Byrsonima gautherioides Griseb. *
Byrsonima guilleminiana A. Juss. *
Byrsonima oblongifolia A. Juss.
Byrsonima pachyphylla Griseb. *
Byrsonima rigida A. Juss.
Byrsonima subcordata Nied.

Byrsonima subterranea Brade & Marckg.
Byrsonima viminifolia A. Juss.
Camarea affinis A. St-Hil.
Camarea ericoides A. St-Hil.
Heteropterys aliciae W. Anderson
Heteropterys anoptera A. Juss.
Heteropterys campestris A. Juss.
Heteropterys coriacea A. Juss.
Heteropterys umbellata A. Juss. *
Hiraea cuiabensis Griseb.
Janusia christianeae W. Anderson
Mascagnia cordifolia (A. Juss.) Griseb.
Peixotoa goiana C. Anderson
Peixotoa hirta Mart. ex A. Juss.
Peixotoa magnifica C. Anderson
Peixotoa parviflora A. Juss. *
Peixotoa reticulata Griseb.
Peixotoa tomentosa A. Juss.
Stigmaphyllon lalandianum A. Juss.
Stigmaphyllon paraense C. Anderson
Stigmaphyllon sagittatum A. Juss.
Stigmaphyllon tomentosum A. Juss.
Tetrapteris ambigua (A. Juss.) Nied.
Tetrapteris chalcophylla A. Juss.
Tetrapteris chamaecerasifolia A. Juss.
Tetrapteris humilis A. Juss.
Tetrapteris jussieuana Nied.
Tetrapteris longibracteata A. Juss.
Tetrapteris racemulosa A. Juss.
Tetrapteris ramiflora A. Juss. *
Tetrapteris salicifolia (A. Juss.) Nied.

Malvaceae
Althaea heringerii Krapov.
Ayenia angustifolia A. St-Hil. & Naud.
Ayenia blanchetiana K. Schum.
Byttneria elliptica Pohl
Byttneria jaculifolia Pohl
Byttneria melastomaefolia A. St-Hil.
Byttneria oblonga Pohl
Byttneria sagittifolia A. St-Hil.
Byttneria scabra L.
Byttneria scalpellata Pohl
Byttneria subsessilis Crist. ex Char.
Cienfuegosia affinia (Kunth) Hocker
Cienfuegosia ituiutabensis Brandão & Laca-Buendia
Cienfuegosia rodrigoana Brandão & Laca-Buendia
Cienfuegosia uberabensis Brandão & Laca-Buendia
Corchorus hirtus L.
Helicteres andersonii Crist.
Helicteres aspera A. St-Hil. & Naud.
Helicteres baruensis Jacq.
Helicteres brevispira A. St-Hil. *
Helicteres cidii Crist.
Helicteres corylifolia Nees & Mart.
Helicteres denticulenta Crist.
Helicteres eitenii Leane
Helicteres krapovickasii Crist.
Helicteres melastomaefolia A. St-Hil.
Helicteres mucosa Mart.
Helicteres pilgeri R.E. Fries
Helicteres sacarolha A. St-Hil., A. Juss. & Cambess. *
Helicteres vallsii Crist.
Helicteres velutina K. Schum.
Hibiscus cucurbitaceus A. St-Hil.
Hibiscus pohlii Guerke
Hibiscus wilsonii Fryxell
Krapovickasia macrodon (A. DC.) Fryxell
Luehea crispa Krapov.
Melochia graminifolia A. St-Hil.
Melochia spicata (L.) Fryxell
Melochia villosa (Mill.) Fawc. & Rendl.
Pavonia angustifolia Benth.
Pavonia aschernioides Fryxell
Pavonia aschersoniana Guerke
Pavonia biflora Fryxell
Pavonia blanchetiana Miq.
Pavonia cancellata (L.) Cav.
Pavonia communis A. St-Hil.
Pavonia garckeana Guerke
Pavonia grandiflora A. St-Hil.
Pavonia grazielae Krapov.
Pavonia guerkeana R. E. Fries
Pavonia hexaphylla (S. Moore) Krapov.
Pavonia immitis Fryxell
Pavonia krapovickasii Fryxell
Pavonia luetzelburgii Ulbrich
Pavonia macrostyla Guerke Guerke
Pavonia malacophylla (Link. & Otto) Garcke *
Pavonia malvaviscoides A. St-Hil.
Pavonia martii Colla
Pavonia pohlii Guerke
Pavonia rosa-campestris A. St-Hil.
Pavonia sagittata A. St-Hil.
Pavonia sidifolia Kunth
Pavonia viscosa A. St-Hil.
Peltaea acutifolia (Guerke) Krapov. & Crist.
Peltaea casiantha Krapov.
Peltaea edouardii Krapov. & Crist.
Peltaea heringerii Krapov. & Crist.

Peltaea lasiantha Krapov. & Crist.
Peltaea macedoi Krapov. & Crist.
Peltaea polymorpha (A. St-Hil.) Krapov. & Crist.
Peltaea riedelii (Guerke) Standl.
Peltaea speciosa (Kunth) Krapov. & Crist.
Phragmocarpidium heringeri Krapov.
Sida aurantiaca A. St-Hil.
Sida cordifolia Forsk.
Sida glaziovii K. Schum.
Sida linifolia Cav.
Sida macrodon A. DC.
Sida rhombifolia L.
Sida spinosa L.
Sida tuberculata R. E. Fries.
Sida ulmifolia Cav.
Sida urens L.
Waltheria communis A. St-Hil.
Waltheria douradinha A. St-Hil.
Waltheria indica L. *

Marantaceae
Ischnosiphon ovatus Koern.
Maranta incrassata L. Anderson

Melastomataceae
Acisanthera alsinaefolia (Mart. & Schr. ex A. DC.) Triana
Cambessedesia atropurpurea A. B. Martins
Cambessedesia espora A. DC. *
Cambessedesia glaziovii Cogn. ex A. B. Martins
Cambessedesia hilariana (Kunth) A. DC.
Cambessedesia ilicifolia (A. DC.) Triana
Cambessedesia semidecandra A. St-Hil. ex A. B. Martins
Chaetostoma luetzelbergii Markg.
Comolia lanceaeflora Triana
Desmocelis villosa (Aubl.) Naud.
Lavoisiera fragilis Cogn. ex Munhoz & Proença
Lavoisiera ordinata Wurdack
Lavoisiera pulchella Cham.
Marcetia harleyi Wurdack
Miconia alata A. DC.
Miconia albicans (Sw.) Triana
Miconia ciliata Benth.
Miconia fallax A. DC.
Miconia rufescens (Aubl.) A. DC.
Microlepsis olaefolia Triana
Microlicia crebropunctata Pilger
Microlicia cryptandra Naud.
Microlicia euphorbioides Mart.
Microlicia fasciculata Mart. ex Naud.
Microlicia insignis Cham.
Microlicia psammophilla Wurdack
Microlicia selaginela Naud.
Microlicia sinocorensis (A. DC.) Mart.
Microlicia virgata Cogn.
Pterolepis glaziovii Pilger
Pterolepis repanda (A. DC.) Triana
Rhynchanthera verbenoides Cham.
Siphanthera dawsonii Wurdack
Siphanthera foliosa (Naud.) Wurdack
Tibouchina aepogon (Naud.) Cogn.
Tibouchina arenaria Cogn.
Tibouchina aspera Aubl.
Tibouchina exasperata Cogn.
Tibouchina gracilis (Bonpl.) Cogn.
Tibouchina sebastiononapolitana Cogn.

Menispermaceae
Cissampelos glaberrima A. St-Hil.
Cissampelos ovalifolia A. DC.
Cissampelos pareira L.

Metaxiaceae
Metaxia rostrata (Humb. & Bonpl. ex Willd.) C. Presl.

Moraceae
Dorstenia brasiliensis Lam.
Dorstenia cayapia Vell.
Dorstenia heringerii Carauta
Dorstenia opifera Mart.
Dorstenia tenuis Bonpl. ex Burkart
Dorstenia tubicina Ruiz & Pav.

Myrsinaceae
Weigeltia densiflora (Miq.) Mez

Myrtaceae
Eugenia angustana Kiaersk.
Eugenia angustissima O. Berg
Eugenia cristaensis O. Berg
Eugenia linearifolia O. Berg
Eugenia livida O. Berg *
Eugenia lutescens Cambess.
Eugenia myrcianthes Nied.
Eugenia stricta Pranch. ex Bronq.
Myrcia amethystina Kiaersk.
Myrcia anomala Cambess.
Myrcia corumbensis Glaz.
Myrcia cuspidata O. Berg
Myrcia decrescens O. Berg
Myrcia decussatum A. DC.

Myrcia hiemalis Cambess.
Myrcia linearifolia Cambess.
Myrcia pinifolia Cambess.
Myrcia rhodosepala Kiaersk.
Myrcia rimosa Cambess.
Myrcia scutulifera A. DC.
Myrcia stricta Kiaersk. *
Myrcia suffruticosa O. Berg
Myrcia sylvatica A. DC.
Myrcia torta A. DC.
Myrcia vestita A. DC.
Psidium australe Cambess. *
Psidium cinereum Mart. ex A. DC. *
Psidium cupreum O. Berg
Psidium grandifolium Mart.
Psidium luridum (Spr.) Burkart

Ochnaceae
Ouratea floribunda Engl. *
Ouratea nana (A. St-Hil.) Engl. *

Onagraceae
Ludwigia goiazensis Ramamoorthy

Orchidaceae
Bulbophyllum micranthum B. Rodr.
Bulbophyllum nemorosum Cogn.
Bulbophyllum rupicolum B. Rodr.
Catasetum barbatum Lindl.
Catasetum fimbriatum (Morren.) Lindl.
Catasetum spitzii Hoehne
Cattleya nobilior Rchb. f.
Cleistis bella Rchb. f. & Warm.
Cleistis paranaensis (B. Rodr.) Schltr.
Cleistis uliginosa Pabst
Cycnoches pentadactylum Lindl.
Cyrtopodium andersonii Rchb. f.
Cyrtopodium blanchetii Rchb. f.
Cyrtopodium brandonianum B. Rodr.
Cyrtopodium cristatum Lindl.
Cyrtopodium dusenii Schltr.
Cyrtopodium eugenii Rchb. f.
Cyrtopodium pallidum Rchb. f. & Warm.
Cyrtopodium poecilum Rchb. f. & Warm.
Cyrtopodium saint-legerianum Rchb. f.
Cyrtopodium triste Rchb. f. & Warm.
Cyrtopodium urens Rchb. f. & Warm.
Cyrtopodium vernum Rchb. f. & Warm.
Cyrtopodium virescens Rchb. f. & Warm.
Encyclia fragans (Sw.) Dressl.
Epidendrum amblostomoides Hoehne
Epidendrum denticulatum B. Rodr.
Epidendrum ellipticum Grah.
Epidendrum elongatum Jacq.
Epidendrum nocturnum Jacq.
Epistephium laxiflorum B. Rodr.
Epistephium parviflorum Lindl.
Epistephium sclerophyllum Lindl.
Eulophia alta (L.) Fawc. & Rendl.
Galeandra graminoides B. Rodr.
Galeandra junceoides B. Rodr.
Galeandra montana B. Rodr.
Galeandra paraguayensis Cogn.
Galeandra styllomisantha (Vell.) Hoehne
Habenaria achmantha Rchb. f.
Habenaria allemanii B. Rodr.
Habenaria ammabaiensis Schltr.
Habenaria armata Rchb. f.
Habenaria brevidens Lindl.
Habenaria coxipensis Hoehne
Habenaria culicina Rchb. f. & Warm.
Habenaria curti-bradei Hoehne
Habenaria curvilabia B. Rodr.
Habenaria depressifolia Hoehne
Habenaria duckeana Schltr.
Habenaria glazoviana Kraenzl.
Habenaria goyazensis Cogn.
Habenaria gracilis Lindl.
Habenaria gustavi-edwallii Hoehne
Habenaria hamata B. Rodr.
Habenaria heringeri Pabst
Habenaria hexaptera Lindl.
Habenaria hydrophila B. Rodr.
Habenaria juruenensis Hoehne
Habenaria leprieurii Rchb. f.
Habenaria leptoceras Hook.
Habenaria longipedicellata Hoehne
Habenaria montis-wilhelminae Renz
Habenaria nasuta Rchb. f. & Warm.
Habenaria obtusa Lindl.
Habenaria ornithoides B. Rodr.
Habenaria pseudocaldensis Krzl.
Habenaria rupicola B. Rodr.
Habenaria schwackei B. Rodr.
Habenaria setacea Lindl.
Habenaria trifida Kunth
Ionopsis paniculata Lindl.
Ionopsis utricularioides (Sw.) Lindl.
Lyroglossa bradei Schltr.
Mesadenella cuspidata (Lindl.) Garay

Oncidium fuscopetalum (Hoehne) Garay
Oncidium macropetalum Lindl.
Pelexia cuculligera (Rchb. f. & Warm.) Schltr.
Pelexia laminata Schltr.
Pelexia longicornu Cogn.
Pelexia minarum (Krzl.) Schltr.
Pelexia orthosepala (Rchb. f. & Warm.) Schltr.
Pleurothallis campestris B. Rodr.
Pleurothallis renipetala Cogn.
Pteroglossa eustachya Rchb. f.
Sarcoglottis biflora (Vell.) Shltr.
Sarcoglottis heringeri Pabst
Sarcoglottis homalogastra (Rchb. f. & Warm.) Schltr.
Sarcoglottis rupestris B. Rodr.
Sarcoglottis sagittata (Rchb. f. & Warm.) Schltr.
Scaphyglottis cuneata Schltr.
Sophronitella violacea (Lindl.) Schltr.
Stenorrynchus acianthiformis (Rchb. f. & Warm.) Schltr.
Stenorrynchus giganteus Cogn.
Stenorrynchus lanceolatus (Aubl.) L. C. Rich.
Stenorrynchus pedicellatus Cogn.

Oxalidaceae
Oxalis alstonii Lourt.
Oxalis barrelieri L.
Oxalis ciliata Spr.
Oxalis condensata Mart. & Zucc.
Oxalis conorrhiza (Feuillé) Jacq.
Oxalis cordata A. St-Hil.
Oxalis densifolia Mart. ex Zucc.
Oxalis diamantinae Knuth
Oxalis euphorbioides A. St-Hil.
Oxalis gardneriana Progel
Oxalis goyasensis Turcz.
Oxalis grisea A. St-Hil.
Oxalis hirsutissima Mart. & Zucc. *
Oxalis nigrescens A. St-Hil.
Oxalis physocalyx Zucc. ex Progel
Oxalis pilulifera Progel
Oxalis pyrenea Taub.
Oxalis suborbiculata Lourt.
Oxalis veadeiroensis Lourt.

Passifloraceae
Mitostemma brevifilis Gontsch.
Passiflora capsularis L.
Passiflora cincinnata Mart.
Passiflora clatharata Mart.
Passiflora edulis Sims.
Passiflora kermesiana Link & Otto
Passiflora lepidota Mart.
Passiflora mansoi (Mart.) Mast.
Passiflora mucronata Lam.

Pedaliaceae
Craniolaria integrifolia Cham.

Piperaceae
Peperomia tetraphylla (Forst.) Hook & Arn.
Piper aduncum L.

Poaceae
Acroceras fluminensis (Hack.) Zuloada & Morrone
Acroceras zizanoides (Kunth) Dandy
Actinocladum verticillatum (Nees) McClure & Soderstrom *
Agenium goyasense (Hack.) Clayton
Agenium villosum (Nees) Pilger
Andropogon angustatus (J. S. Presl.) Steud.
Andropogon bicornis L.
Andropogon carinatus Nees
Andropogon crispifolius Guala & Filgueiras
Andropogon fastigiatus Sw.
Andropogon hirtiflorus Nees
Andropogon lateralis Nees
Andropogon leucostachys (Hack.) Hack.
Andropogon macrothrix Trin.
Andropogon pohlianus Hack.
Andropogon selloanus (Hack.) Hack.
Anthaenatiopsis perforata (Nees) Parodi
Anthaenatiopsis trachystachya (Nees) Mez
Apoclada arenicola McClure
Aristida adscencionis L.
Aristida capillacea Lam.
Aristida eckmaniana Herter
Aristida elliptica (Nees) Kunth
Aristida gibbosa (Nees) Kunth
Aristida glaziovii (Nees) Kunth
Aristida implexa Trin.
Aristida jubata (Arech.) Herter
Aristida longifolia Trin.
Aristida megapotamica Spr.
Aristida pendula Longhi-Wagner
Aristida recurvata Kunth
Aristida riparia Trin.
Aristida sanctae-luciae Trin.
Aristida setifolia Kunth
Aristida tincta Trin.
Arthropogon villosus Nees
Arundinaria cannavieira A. Silveira *
Arundinella berteroniana (Schult.) Hitchc.

Axonopus aureus Beauv.
Axonopus barbigerus (Kunth) Hitchc.
Axonopus capillaris (Lam.) Chase
Axonopus chrysoblepharis (Lag.) Chase
Axonopus compressus (Sw.) Beauv.
Axonopus derbyanus Black.
Axonopus equitans Hitchc. & Chase
Axonopus excavatus (Nees ex Trin.) Henrd.
Axonopus extenuatus (Nees) Kulhm.
Axonopus fastigiatus (Nees) Kulhm.
Axonopus longicilius (Hack.) Parodi
Axonopus marginatus (Trin.) Chase
Axonopus pellitus (Nees ex Trin.) Hitchc. & Chase
Axonopus polydactylus (Steud.) Dedecca
Axonopus pressus (Nees ex Steud.) Parodi
Axonopus siccus (Nees) Kulhm.
Axonopus suffultus (Mikan ex Trin.) Parodi
Bothriochloa exaristata (Nash) Henr.
Calamagrostis viridiflavescens (Poir.) Steud.
Cenchrus brownii Roem. & Schult.
Cenchrus echinatus L.
Chloris barbata (L.) Sw.
Chloris distichyophylla Lag.
Chloris polydactyla (L.) Sw.
Ctenium brachystachium (Nees) Kunth
Ctenium chapadense (Trin.) Doell
Ctenium cirrhosum (Nees) Kunth
Ctenium polystachium Balansa
Digitaria adscendens (Kunth) Henr.
Digitaria corynotricha (Hack.) Henr.
Digitaria dioica Killen & Rúgolo
Digitaria insularis (L.) Mez ex Ekman
Digitaria neesiana Henr.
Echinolaena inflexa (Poir.) Chase
Echinolaena oplismenoides (Munro ex Doell) Stieber
Elionurus adustus (Trin.) Ekman
Elionurus bilinguis (Trin.) Hack.
Elionurus latiflorus Nees ex Steud.
Elionurus muticus Kuntze
Elionurus polytricha Nees
Elionurus rufescens Schrad. ex Schult.
Elionurus secundiflora Presl.
Elionurus tripsacoides Willd.
Elionurus viridulus Hack.
Eragrostis airoides Nees
Eragrostis articulata (Schrank) Nees
Eragrostis glomerata (Walt.) L.H. Dewey
Eragrostis inconstans Nees
Eragrostis lugens Nees
Eragrostis maypuriensis (Kunth) Steud.
Eragrostis perennis Doell.
Eragrostis pilosa (L.) Beauv.
Eragrostis reptans (Michx.) Nees
Eragrostis solida Nees
Eragrostis trichocoleae Hack.
Eriochloa distachya Nees
Eriochrysis cayanensis Beauv.
Gymnopogon burchelii (Munro ex Doell) Ekman
Gymnopogon doelii Boechat & Valls
Gymnopogon foliosus (Willd.) Nees
Gymnopogon spicatus (Spr.) Kuntze
Hyparrhenia bracteata (Humb. & Bonpl.) Stapf.
Ichnanthus calvescens (Nees) Doell
Ichnanthus camporum Sw.
Ichnanthus inconstans (Trin. ex Nees) Doell
Ichnanthus nuprechii Doell
Ichnanthus procurrens (Nees ex Trin.) Sw.
Ichnanthus ruprechtii Doell
Ichnanthus sericeus Hack.
Ichnanthus tenuis (Presl.) Hitchc. & Chase
Imperata brasiliensis Trin.
Imperata contracta Hitchc.
Isachne goyasensis Renv.
Leptocloa filiformis (Lam.) Beauv.
Leptocloa virgata (L.) Beauv.
Leptocoryphium lanatum (Kunth) Nees
Loudetiopsis chrysothrix (Nees) Conert.
Mesosetum agropyroides Mer.
Mesosetum cayenensis Steud.
Mesosetum ferrugineum (Trin.) Chase
Mesosetum latifolium Sw.
Mesosetum loliiforme (Hochst.) Chase
Mesosetum longiaristatum Filgueiras
Mirochloa indica Hack.
Olyra latifolia L.
Olyra micrantha Hunth
Olyra sarmentosa Doell
Ophiochloa hydrolithica Filgueiras, Davidse & Zuloaga
Oplismenus hirtellus (L.) Beauv.
Otachyrium grandiflorum Sendulsky & Soderstrom
Otachyrium piligerum Sendulsky & Soderstrom
Otachyrium succisum (Sw.) Sendulsky & Soderstrom
Otachyrium versicolor (Doell) Henr.
Panicum arvicatum Chase
Panicum campestre Nees ex Trin.
Panicum cayennense Lam.
Panicum cervicatum Chase
Panicum chapadense Sw.
Panicum cyanescens Nees
Panicum decipiens Nees

Panicum exiguum Mez
Panicum helodes Hauman
Panicum laxum Sw.
Panicum ligulare Nees ex Trin.
Panicum millegrana Poir.
Panicum mystosipus Zuluoaga & Morrone
Panicum olyroides Kunth
Panicum parvifolium Lam.
Panicum peladoense Henr.
Panicum piauiense Sw.
Panicum pilosum Sw.
Panicum procurrens Nees
Panicum pseudiachne Mez
Panicum quadriglume (Doell) Hitchc.
Panicum repens L.
Panicum rudgei Roem. & Schult.
Panicum sellowii Nees
Panicum stenodes Griseb.
Panicum stenophyllum Hack.
Panicum stipiflorum Renv.
Panicum subulatum Spr.
Panicum trichantum Nees
Panicum tricholaenoides Endl.
Panicum versicolor Doell
Panicum wettsteinii Hack.
Paspalum acutifolium Leon.
Paspalum ammodes Trin.
Paspalum atratum Sw.
Paspalum barbatum Nees
Paspalum barbinode Hack.
Paspalum bertonii Hack.
Paspalum biaristatum Filgueiras & Davidse
Paspalum burchelii Munro ex Oliver
Paspalum burmanii Filgueiras, Morrone & Zuloaga
Paspalum carinatum Humb. & Bonpl. ex Flueg.
Paspalum ciliatus Presl.
Paspalum cinerascens (Doell) Burman & Bastos
Paspalum conspermum Schrad.
Paspalum cordatum Hack.
Paspalum crispulum Sw.
Paspalum ellipticum Doell
Paspalum erianthum Nees
Paspalum eucomum Nees ex Trin.
Paspalum falcatum Nees ex Steud.
Paspalum fasciculatum Nees ex Steud.
Paspalum fimbriatum Kunth
Paspalum gardnerianum Nees
Paspalum guttatum Trin.
Paspalum lanciflorum
Paspalum lineare Trin.
Paspalum maculosum Trin.
Paspalum mandiocanum Trin.
Paspalum melanospermum Desv. ex Poir.
Paspalum multicaule Poir.
Paspalum multinervium Burman
Paspalum neesii Kunth
Paspalum paniculatum L.
Paspalum pectinatum Nees
Paspalum pilosum Lam.
Paspalum plicatulum Mich.
Paspalum polyphyllum Nees
Paspalum pulchellum Kunth
Paspalum rectum Nees
Paspalum reduncum Nees ex Steud.
Paspalum rojasii Hack.
Paspalum sanguineolentum Trin.
Paspalum stellatum Flueg.
Paspalum subsesquiglume Doell
Paspalum suppultum Mikan
Paspalum trachycoleon Steud.
Paspalum trachytomum Hack.
Paspalum trichostomum Hack.
Paspalum urvillei Steud.
Paspalum virgatum L.
Pennisetum setosum (Sw.) L. C. Rich.
Raddiella nana (Doell) Sw.
Sacciolepis vilvoides (Trin.) Chase
Schyzachirium condensatum (Kunth) Nees
Schyzachirium imberbe (Hack.) Herter
Schyzachirium lactiflorum (Hack.) Herter
Schyzachirium microstachyum (Desv.) Roseng. Arr. & Isag.
Schyzachirium sanguineum (Retz.) Alston
Schyzachirium spicatum (Spr.) Herter
Schyzachirium tenerum Nees
Setaria adhaerens (Forskal) Chiov.
Setaria gracilis Kunth
Setaria parviflora (Poir.) Kerguelen
Setaria poiretiana (Schult.) Kunth
Setaria scabrifolia Zuloaga
Setaria tenacissima (Schrad.) Schult.
Sorgastrum minarum (Nees) Kunth
Sorgastrum nutans (L.) A. Gray
Sorghum stipicideum (Ew. & White) Gardner
Sporolobus acuminatus (Trin.) Hack.
Sporolobus aeneus (Trin.) Kunth
Sporolobus apiculatus Boechat & Longhi-Wagner
Sporolobus ciliatus Presl.
Sporolobus cubensis Hithcoc.
Sporolobus eximius (Nees) Ekman
Sporolobus indicus (L.) R. Brown

Sporolobus monandrus Ros
Sporolobus pseudarioides Parodi
Sporolobus recurvatus Boechat & Longhi-Wagner
Sporolobus reflexus Boechat & Longhi-Wagner
Streptostachys asperifolia Desv.
Streptostachys macrantha (Trin.) Zuloaga & Soderstrom
Streptostachys ramosa Zuloaga & Soderstrom
Thrasya glaziouvii Burman
Thrasya paspaloides (Trin.) Chase
Thrasya petrosa (Trin.) Chase
Thrasya thrasyoides (Trin.) Chase
Trachypogon canescens Nees
Trachypogon macroglossus Trin.
Trachypogon mollis Nees
Trachypogon montufari Nees
Trachypogon plumosus (Kunth) Nees
Trachypogon spicatus (L. f.) Kuntze
Trachypogon vestitus Anderss.
Tridens brasiliensis Nees ex Steud.
Tridens flaccidus (Doell) Parodi
Tristachya leiostachya Nees

Polygalaceae
Monnina cuneata A. St-Hil.
Monnina escarlata Benn.
Monnina exaltata Benn.
Monnina richardiana A. St-Hil.
Monnina stenophylla A. St-Hil. & Moq.
Polygala angulata A. DC.
Polygala apressa Benth.
Polygala atropurpurea A. St-Hil.
Polygala bracteata Benn.
Polygala carphoides Chodat
Polygala cuspidata A. DC.
Polygala galioides Poir.
Polygala glochidiata Kunth
Polygala grazielae Marq.
Polygala hebeclada Benn.
Polygala hygrophila Kunth
Polygala leptocaulis Torr. & Gray
Polygala minima Pohl ex Benn.
Polygala opina Wurdack
Polygala pseudoerica A. St-Hil.
Polygala regnalii Chodat
Polygala remansoensis Chodat
Polygala remota Benn.
Polygala rhodoptera Mart.
Polygala subtilis Kunth
Polygala tenuis A. DC.
Polygala timoutoides Chodat
Polygala timoutou Aubl.
Polygala variabilis Kunth
Polygala violacea Aubl.
Securidaca rivinaefolia A. St-Hil. & Moq.
Securidaca tomentosa A. St-Hil.

Polygonaceae
Coccoloba ochreolata Wedd.
Polygonum meissnerianum Cham. & Schltndl.

Polypodiaceae
Acrostichum macrophyllum (Mett.) C. Chr.
Adiantum deflectens Mart.
Adiantum glareosum Lindm.
Adiantum latifolium Lam.
Adiantum lorentzii Hieron.
Adiantum platyphyllum Sw.
Adiantum tetraphyllum Humb. & Bonpl. ex Willd.
Adiantum triquetrum C. Presl.
Blechnum asplenioides Sw.
Blechnum blechnoides (Sw.) C. Chr.
Blechnum confluens Schltndl. & Cham.
Blechnum glandulosum L.
Blechnum gracile Kaulf.
Blechnum lanceola Sw.
Blechnum minutulum C. Chr.
Blechnum occidentale L.
Blechnum schomburgkii (Kl.) C. Chr.
Blechnum serrulatum L.C. Rich.
Blechnum unilaterale Sw.
Doryopteris collina (Raddi) J. Smith
Doryopteris concolor (Langsd. & Fisch.) Kuhn
Doryopteris lomariacea (Kuntze) Kl.
Doryopteris ornithopus (Mett. ex Hook. & Baker) J. Smith
Dryopteris oppositica (Vahl.) Urban
Dryopteris setigera (Bl.) Kuntze
Elaphoglossum aubertii (Desv.) Moore
Elaphoglossum blanchetii (Mett.) C. Chr.
Elaphoglossum burchellii (Bak.) C. Chr.
Elaphoglossum coimbra-buenoi Brade
Elaphoglossum lingua (Raddi) Brack
Elaphoglossum pachydermum (Fée) Moore
Elaphoglossum scalpellum (Mart.) Moore
Elaphoglossum schwackeanum Brade
Elaphoglossum scolopendrifolium (Raddi) J. Smith
Elaphoglossum sellowianum (Kl.) Moore
Elaphoglossum spathulatum (Kl.) Moore
Gleichenia flexuosa (Schrad.) Mett.
Gleichenia furcata (L.) Spr.
Gleichenia gracilis (Mart.) Moore

Gleichenia linearis (Burm.) Clark.
Gleichenia nervosa (Kaulf.) Spr.
Gleichenia pectinata (Willd.) Pr.
Gleichenia rigida Sw.
Lindsaea guianensis (Aubl.) Dryand.
Lindsaea lancea (L.) Bedd.
Lindsaea stricta (Sw.) Dryand.
Microgramma squamulosa (Kaulf.) de la Sota
Notholaena pohliana Kuntze
Pellaea pinnata (Kaulf.) Prantl.
Pityrogramma calomelanos (L.) Link.
Pityrogramma trifoliata (L.) Tryon
Pleopeltis angusta Willd.
Polypodium angustifolium Sw.
Polypodium attenuatum (Humb. & Bonpl.) Willd.
Polypodium aureum L.
Polypodium bombycinum Maxon
Polypodium catharinae Langsd. & Fisch.
Polypodium crassifolium L.
Polypodium felicula Kaulf.
Polypodium gladulosissimum Brade
Polypodium hirsutissimum Raddi
Polypodium intermedium Fée
Polypodium lactum Raddi
Polypodium lapathifolium Poir.
Polypodium latipes Langsd. & Fisch.
Polypodium loriceum L.
Polypodium meniscifolium Langsd. & Fisch.
Polypodium paradisease Langsd.
Polypodium pleopeltifolium Langsd. & Fisch.
Polypodium polypodioides (L.) Watt.
Polypodium robustum Fée
Polypodium triseriale Sw.
Pteridium aquilinum (L.) Kunh.
Thelypteris angustifolium (Willd.) Proctor
Thelypteris opposita (Vahl.) Ching
Thelypteris quadrangularis (Fée) Schelpl.

Portulacaceae
Portulaca hirsutissima Cambess.
Portulaca mucronata Link.
Portulaca pilosa L.
Talinum paniculatum (Jacq.) Gaertn.

Primulaceae
Anagalis pumila Sw.

Pteridaceae
Adiantum cayennense Willd. ex Klotz

Rafflesiaceae
Pilostyles goyasensis Ule
Pilostyles ulei Solms. & Laub.

Rhamnaceae
Crumenaria chorethroides Mart. ex Reiss.
Crumenaria erecta Reiss.
Crumenaria glaziovii Urban
Crumenaria polygaloides Reiss.
Gouania mollis Reiss.
Gouania velutina Reiss.
Rhamnus sectipetala Mart.
Rhamnus sphaerosperma Sw. *

Rubiaceae
Alibertia elliptica (Cham.) K. Schum. *
Alibertia sessilis (Vell.) K. Schum. *
Amaioua corymbosa Kunth
Borreria angustifolia Cham. & Schltndl.
Borreria brachystemonoides Cham. & Schltndl.
Borreria capitata (Ruiz & Pav.) A. DC.
Borreria eryngioides Cham. & Schltndl.
Borreria gracillima A. DC.
Borreria latifolia (Aubl.) K. Schum.
Borreria linearis Fourn.
Borreria lutescens (Pohl) A. DC.
Borreria ocimoides (Burm.) A. DC.
Borreria poaya (A. St-Hil.) A. DC.
Borreria reflexa Kirkbr. Jr.
Borreria simplicaulis K. Schum.
Borreria suaveolens G.F.W. Meyer
Borreria tenuis A. DC.
Borreria verbenoides Cham. & Schltndl.
Borreria vulpina Standl.
Borreria warmingii K. Schum.
Borreria wunschmannia K. Schum.
Borreria poaya (A. St-Hil.) A. DC.
Coccocypselum aureum (Spreng.) Cham.& Schultr.
Coccocypselum canescens Willd.
Coccocypselum guianense (Aubl.) K. Schum.
Coccocypselum hasslerianum Chodat.
Coccocypselum hirsutum Bartl.
Coccocypselum lanceolatum (Ruiz & Pav.) Pers. *
Coccocypselum pedunculare Cham. & K. Schum.
Declieuxia cacuminis Müll. Arg.
Declieuxia chiococcoides Müll. Arg.
Declieuxia cordigera K. Schum ex Glaz.
Declieuxia deltoidea Müll. Arg.
Declieuxia diamantinae Kirkbr. Jr.
Declieuxia fruticosa (Willd. ex Ruiz & Pav.) Kuntze

Declieuxia gracilis Kirkbr. Jr.
Declieuxia lancifolia Kirkbr. Jr.
Declieuxia lysimachioides Zucc. *
Declieuxia mucronulata Mart.
Declieuxia oenanthoides Mart. ex Zucc. ex Schult. & Schult.
Declieuxia satureoides Mart. ex Zucc. ex Schult. & Schult.
Declieuxia spergulifolia Mart. ex Zucc. ex Schult. & Schult.
Diodia alata Nees & Mart.
Diodia apiculata (Willd. ex Roem. & Schult.) K. Schum.
Diodia brasliensis Spr.
Diodia eximifolia Willd. ex Roem. & Schult.
Diodia macrophylla K. Schum.
Diodia multiflora A. DC.
Diodia radula Cham. & Schltndl.
Diodia rosmarinifolia Pohl ex A. DC.
Diodia schumannii Standl. ex V. M. Bacig.
Diodia teres Walt.
Galianthe corymbosa (Ruiz & Pav.) Cabral
Galianthe eupatorioides (Cham. & Schltndl.) Cabral
Galianthe grandifolia Cabral
Galianthe valerianoides (Cham. & Schltndl.) Cabral
Galium hypocarpium L.
Galium noxium (A. St-Hil.) Dempster
Manettia ignita K. Schum.
Mitracarpus frigidus (Willd. ex Roem. & Schult.) K. Schum.
Mitracarpus hirtus (L.) A. DC.
Mitracarpus parvulus K. Schum.
Mitracarpus pusillus Steyerm.
Mitracarpus villosus (Sw.) Cham. & Schltndl.
Palicourea coriacea (Cham.) K. Schum.
Palicourea hoehnei Krause
Palicourea officinalis Mart.
Palicourea rigida Kunth *
Palicourea squarrosa (Müll. Arg.) Standl.
Perama hirsuta Aubl.
Perama hirsutissima Aubl.
Psychotria barbiflora A. DC.
Psychotria capitata Ruiz & Pav.
Psychotria carthaginensis Jacq. *
Psychotria deflexa A. DC.
Psychotria mapourioides A. DC.
Psychotria prunifolia (Kunth) Steyerm.
Psychotria tricholoba Müll. Arg.
Psyllocarpus asparagoides Mart. & Zucc.
Psyllocarpus goiasensis Kirkbr.
Psyllocarpus phyllocephalus K. Schum.
Relbunium hirtum K. Schum.
Richardia brasiliensis Gomez
Richardia grandiflora (Cham. & Schltndl.) Steud.
Richardia humistrata (Cham. & Schltndl.) Steud.
Richardia pedicellata (K. Schum.) O. Kuntze
Richardia rosea Schult. f.
Richardia scabra L.
Rudgea parviflora (Cham.) Müll. Arg.
Sabicea brasiliensis Wernhm.
Sipania hispida Benth. ex Wernhm.
Sipania pratensis Aubl.
Spermacoce verticilata L.
Staelia aurea Willd. ex R.
Staelia capitata K. Schum.
Staelia chynoides Cham. & Schltndl.
Staelia thymoides Cham. & Schltndl.
Staelia virgata (Willd. ex Roem. & Schult.) K. Schum.
Uncaria guianensis (Aubl.) Gmel.

Rutaceae
Esenbeckia pumila Pohl
Spiranthera odoratissima A. St-Hil.

Santalaceae
Thesium brasiliense A. DC.

Sapindaceae
Matayba juglandifolia (Cambess.) Radlk.
Paullinia elegans Cambess.
Paullinia pinnata L.
Serjania acutidentata Radlk.
Serjania caracasana (Jacq.) Willd.
Serjania comata Radlk.
Serjania erecta Radlk. *
Serjania fuscifolia Radlk.
Serjania gracilis Radlk.
Serjania lethalis A. St-Hil.
Serjania mansiana Mart.
Serjania multiflora Cambess.
Serjania ovalifolia Radlk.
Serjania paradoxa Radlk.
Serjania reticulata Cambess.
Serjania velutina Cambess.
Talisia angustifolia Raddi
Talisia pygmaea Radlk.
Talisia subalbens Radlk.
Toulicia tomentosa Radlk.

Sapotaceae
Pouteria subcaerulea Pierre ex Dubard
Pradosia brevipes (Pierre) Penn.

Schizeaceae
Anemia anthriscifolia Sw.

Anemia buniifolia (Gardner) Moore
Anemia ciliata C. Presl.
Anemia elegans (Gardner) Pr.
Anemia eximia Taub.
Anemia ferruginea Kunth
Anemia filiformis (Sav.) Sw.
Anemia flexuosa (Sav.) Sw.
Anemia fulva Sw.
Anemia glareosa Gardner
Anemia hirsuta (L.) Sw.
Anemia humilis Sw.
Anemia millefolium Gardner ex C. Presl.
Anemia nervosa Pohl
Anemia oblongifolia (Cav.) Sw.
Anemia pastinacaria Moritz ex Prantl.
Anemia presliana Prantl.
Anemia raddiana Link.
Anemia rutifolia Mart.
Anemia tenella Sw.
Anemia trichorhiza Gardner
Anemia villosa Humb. & Bonpl. ex Willd.
Lygodium venustum Sw.

Scrophulariaceae
Agalinis hispidula (Mart.) D'Arcg.
Angelonia alternifolia V.C. Souza
Angelonia arguta Benth.
Angelonia crassifolia Benth.
Angelonia tomentosa Moric ex Benth.
Buchnera juncea Cham. & Schltndl.
Buchnera lavandulacea Cham. & Schltndl.
Buchnera lobeliodes Cham.
Buchnera palustris Spr.
Buchnera rosea Kunth
Buchnera ternifolia Kunth
Buchnera virgata Kunth
Escobedia grandiflora (L. f.) Kuntze
Esterhazia petiolata Barr.
Esterhazia splendida Mikan
Stemodia pratensis (Aubl.) C.C. Cowan

Selaginellaceae
Selaginella flagellata Spring
Selaginella flexuosa Spring
Selaginella jungermannioides (Gaudich.) Spring
Selaginella kochii Hieron.
Selaginella sulcata (Poir.) Spring
Selaginella tenuinima Fée

Simaroubaceae
Picramnia campestris Rizzini & Occhioni
Picramnia oreadica Pirani
Simaba glabra Engl.
Simaba suffruticosa Engl. ex Char.

Smilacaceae
Smilax brasiliensis Spr.
Smilax campestris Griseb.
Smilax cissoides Mart. ex Griseb.
Smilax cognata Kunth
Smilax coriifolia A. DC.
Smilax fluminensis Steud.
Smilax goyazana A. DC.
Smilax irrorata Mart.
Smilax polyantha Griseb.
Smilax quinquenervia Vell.
Smilax syringoides Griseb.

Solanaceae
Cestrum intermedium Sendt.
Cestrum obovatum Sendt. *
Cestrum pedicellatum Sendt.
Cestrum schlechtendalii G. Don
Cestrum sendtenerianum Mart. ex Sendt. *
Schwenckia americana D. Royen ex L.
Solanum agrarium Sendt.
Solanum americanum Mill.
Solanum biceps Dunal
Solanum erianthum D. Don
Solanum foederale M. Nee
Solanum lanigerum Dunal
Solanum lycocarpum A. St-Hil. *
Solanum palinacanthum Dunal
Solanum paniculatum L.
Solanum platanifolium Hook.
Solanum sisymbriifolium Lam.
Solanum subumbellatum Roem. & Schult.

Turneraceae
Piriqueta araguaiana Arbo
Piriqueta aurea (Cambess.) Urban *
Piriqueta breviseminata Arbo
Piriqueta caiapoensis Arbo
Piriqueta carnea Urban
Piriqueta cistoides (Cambess.) Urban
Piriqueta cristobaliae Arbo
Piriqueta densiflora Urban
Piriqueta dentata Arbo
Piriqueta douradinha Arbo
Piriqueta duarteana Urban

Piriqueta hapala Arbo
Piriqueta lourteigiae Arbo
Piriqueta nitida Arbo
Piriqueta rosea (A. St-Hil., A. Juss. & Cambess.) Urban
Piriqueta sidifolia Urban
Piriqueta sulfurea Urban & Rolfe
Piriqueta tamberlikii Urban
Turnera arcuata Urban
Turnera brasiliensis Willd. ex Schult.
Turnera cuneiformis Poir.
Turnera discolor Urban
Turnera grandiflora (Urban) Arbo
Turnera incana A. St-Hil., A. Juss. & Cambess.
Turnera lamiiflora Cambess.
Turnera longiflora Cambess.
Turnera melochioides Cambess.
Turnera nana Cambess.
Turnera oblongifolia Cambess.
Turnera odorata L.C. Rich.
Turnera opifera Mart.
Turnera orientalis (Urban) Arbo
Turnera pumilea L.
Turnera purpurascens Arbo
Turnera subnuda Urban
Turnera subulata Sm.
Turnera tenuicaulis Urban
Turnera trigona Urban
Turnera uleana Urban
Turnera ulmifolia L.

Velloziaceae
Barbacenia andersonii L. B. Smith & Ayensu
Barbacenia cilindrica L. B. Smith & Ayensu
Vellozia albiflora Pohl
Vellozia glochidea Pohl
Vellozia pumila Goeth. & Henr.
Vellozia sessilis Mello Silva
Vellozia tubiflora Kunth

Verbenaceae
Aegiphila lanata Mold.
Amasonia campestris (Aubl.) Mold.
Amasonia hirta Benth.
Casselia chamaedryfolia Cham.
Casselia confertiflora (Mold.) Mold.
Casselia glaziovii (Briq. & Mold.) Mold.
Lantana aristata (Schauer) Briq.
Lantana camara L. *
Lantana fucata Lindl. *
Lantana hassleri Briq.
Lantana hypoleuca Briq.
Lantana lundiana Schauer
Lantana montevidensis (Spr.) Briq.
Lantana tiliaefolia Cham.
Lantana trifolia Cham. *
Lippia balansae Briq.
Lippia candida Cham.
Lippia corymbosa Cham. *
Lippia elegans Cham.
Lippia glandulosa Schauer *
Lippia glazoviana Loes.
Lippia gracilis Schauer *
Lippia grandiflora Mart. & Schauer
Lippia hirta Schauer
Lippia hoehnei Mold.
Lippia lacunosa Mart. & Schauer *
Lippia lasiocalycina Cham. *
Lippia lupulina Cham. *
Lippia martiana Schauer *
Lippia mattogrossensis Mold.
Lippia micrantha Cham.
Lippia obscura Briq.
Lippia oxycnemis Schauer
Lippia primulina S. Moore
Lippia rigida Schauer
Lippia rotundifolia Cham. & Schltndl.
Lippia salviaefolia Cham. *
Lippia sericea Cham.
Lippia sidoides Cham.
Lippia stachyoides Cham.
Lippia turnerifolia Cham.
Lippia vernonioides Cham.
Petrea volubilis Vell.
Stachytarpheta candida Mold.
Stachytarpheta cayennensis Schauer
Stachytarpheta chamissois Walb.
Stachytarpheta claussenii Turcz
Stachytarpheta elatior Schrad.
Stachytarpheta gesnerioides Cham.
Stachytarpheta hispida Nees & Mart.
Stachytarpheta maximilliani Schauer
Stachytarpheta rhomboidalis (Pohl) Walp.
Stachytarpheta schawerii Mold.
Stachytarpheta sericea Loes. ex Glaz.
Vitex cymosa Bertero *

Violaceae
Hybanthus calceolaria (L.) G. K. Schult.
Hybanthus lanatus (A. St-Hil.) Baill.
Hybanthus poaya (A. St-Hil.) Baill.

Vitaceae
Cissus campestris (Baker) Planch.
Cissus duarteana Cambess.
Cissus erosa L.C. Rich.
Cissus inundata (Baker) Planch.
Cissus subrhomboidea (Baker) Planch.

Xyridaceae
Xyris aurea L.B. Smith & Downs
Xyris dawnsonii L.B. Smith & Downs
Xyris filifolia Alb. Nilsson
Xyris lacerata Seub.
Xyris metallica Klotsch. ex Seub.
Xyris sororia Kunth

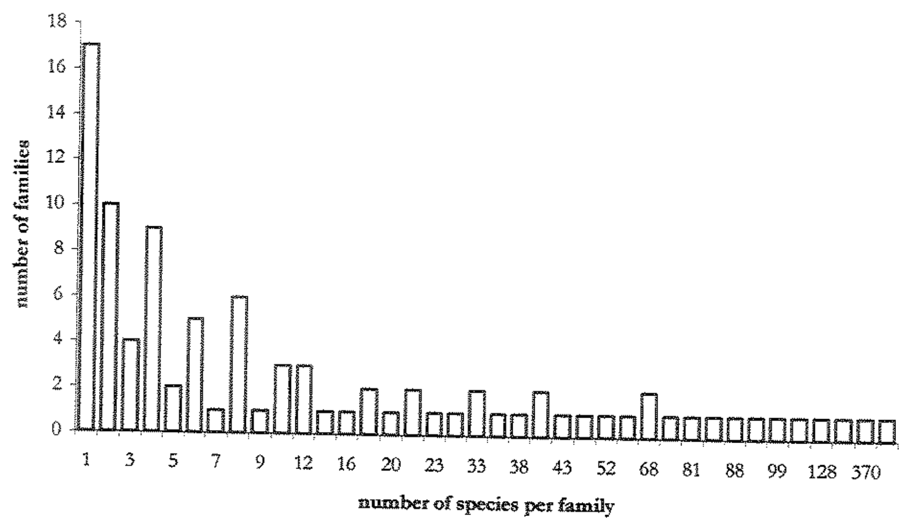

Figure 1. Frequency distribution of family sizes in the vascular herbaceous flora of the Brazilian cerrado.

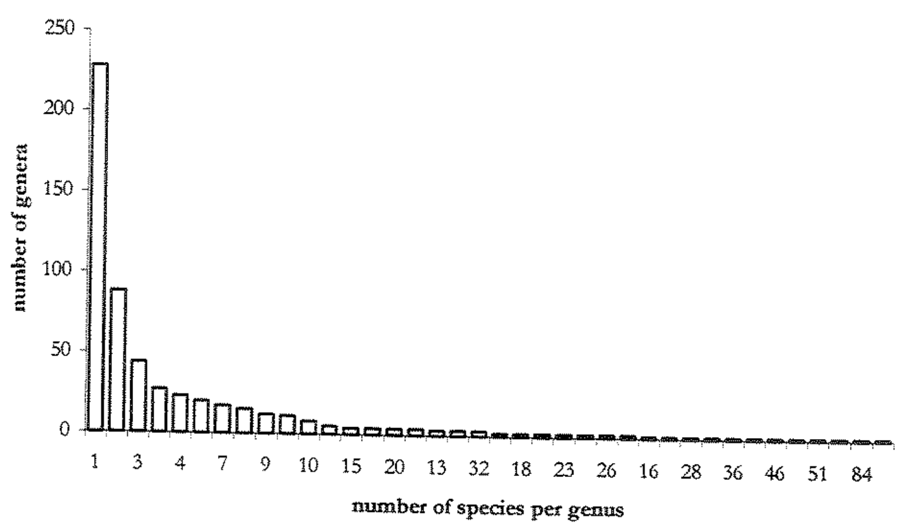

Figure 2. Frequency distribution of genus sizes in the vascular herbaceous flora of the Brazilian cerrado.

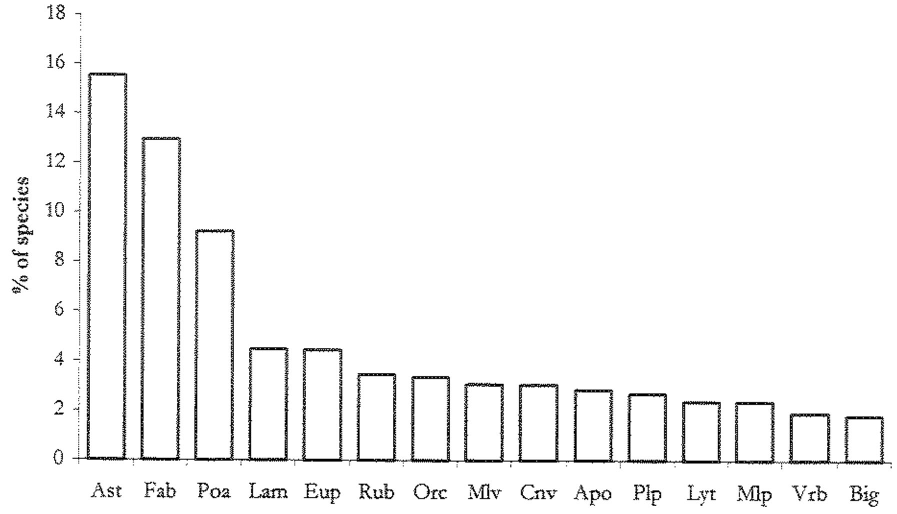

Figure 3. Percentage of species in the richest families of the herbaceous component of the cerrado flora. Other families accounted for 26.37% of the total number of species. Family names were abbreviated according to Weber (1982).

Table 2. Number of species per family in the herbaceous and in the woody components of the cerrado flora. Family names were abbreviated according to Weber (1982).

	number of species			
	herbaceous component		woody component	
family	observed	expected	observed	expected
Ast	444	372.94	56	127.06
Fab	370	405.76	174	138.24
Poa	263	197.66	2	67.34
Lam	128	98.46	4	33.54
Eup	127	112.63	24	38.37
Rub	99	105.17	42	35.83
Orc	96	71.61	0	24.39
Mlv	88	67.13	2	22.87
Cnv	87	66.38	2	22.62
Apo	81	78.32	24	26.68
Others	1073	1279.94	643	436.06

Discussion

The 2,856 herbaceous species related for the cerrado flora represented more than the lower limit of ca. 2,000 species, estimated by Castro *et al.* (1999) for the herbaceous component. Yet, the number of related species was still far from their estimated upper limit of 5,000 species. The figure found by us is probably an underestimation of the actual number of herbaceous species in the cerrado, due to our decision to include only taxa identified to species level and the low number of papers dealing with the herbaceous component.

The almost complete absence of studies on the herbaceous component (Castro *et al.* 1999) became evident in some surveys carried out recently in cerrado sites, such as Brasília (Pereira *et al.* 1993) and Emas National Park (Chapter 2), when several undescribed herbaceous species were found. When more surveys and collections are available, the number of herbaceous species recorded for the cerrado flora will certainly increase and get closer to the upper limit set by Castro *et al.* (1999).

Both genus and family sizes showed skewed distributions, although not as skewed as those found, for example, by Turner (1994, 1997) in southeastern Asia. Sarmiento (1983), based on several woody species that belong to some monospecific genera and are abundant in cerrado sites, hypothesized that the cerrado is isolated from the neighboring vegetation types. According to him (Sarmiento 1983), this taxonomic isolation reflects an evolution within the cerrado, which has continued long enough to allow differentiation at generic level and probably represents a floristic paleoelement.

However, since high proportions of monospecific families and genera are also found in other vegetation types (Turner 1994, 1997), there is no evidence in support of Sarmiento's (1983) hypothesis, due solely to the alleged high number of genera with one or few species in the cerrado vegetation. To test his hypothesis, one should compare the frequency distribution of species per genus and family between the cerrado and the neighboring forest floras, as those of the Amazon and Atlantic rain forests. If the number of monospecific genera were higher in the cerrado than in the neighboring forests, then Sarmiento's (1983) hypothesis would be corroborated.

As expected due to their different life-forms, the richest families in the herbaceous component were not the same as in the woody component. Only Apocynaceae, Asteraceae, Euphorbiaceae, and Fabaceae were well represented in both components, but their relative values were different. One of the richest families in the herbaceous components, Orchidaceae, had no species at all included in the woody component. Similarly, Poaceae, Rubiaceae, and Malvaceae appeared with only two woody species and Lamiaceae with only four.

If the geographic distribution of the herbaceous species in the cerrado region were random, then we would expect the distribution of species in families in a site under study to be the same as those found for the whole cerrado. Thus, by comparing the distribution of species per family in a certain site with those in the whole cerrado, one could find some families over or under-represented that would then characterize it. Occasionally, these differences could point out some phytogeographic patterns when observed on larger scales.

Our inclusion criterion, that is, non-phanerophyte species, could have made us exclude some species which would otherwise be included, and vice-versa. For instance, in Castro's *et al.* (1999) checklist, there are 183 species also included in ours. Some of these species were considered by us either chamephytes or lianas and thus members of the herbaceous component. To decide whether to include a certain species in their list, Castro *et al.* (1999) adopted as many inclusion criteria as appeared on the papers they compiled. So, they ended up using several criteria, such as stem diameter, height, or life-form. If they had used our criteria, they should have included only the phanerophyte species and the number of species on their list would be lower.

Besides, in the cerrado, a consirable number of species vary in habit, from small, herbaceous plants to tall, large trees (Castro *et al.* 1999). In sites where burnings are frequent, some of them appear in a dwarf-form (Coutinho 1982). For example, *Caryocar brasiliense* Cambess., excluded from our list because it normally is a tall tree, can be found as a dwarf plant in frequently burned sites, as in an outlying southern site in Pirassununga (Batalha *et al.* 1997), where it appears as a chamaephyte.

All of the genera with the highest number of species belonged to one of the richest families. The phylogeny of many groups are being currently studied and some of the richest genera are being subdivided, as for example, *Vernonia* and *Hyptis* (Harley & Reynolds 1992, Bremer 1994, Hind *et al.* 1995). When phylogenetics analyses are completed, the relative importance of some of these genera can change. Many genera among the richest ones in the herbaceous component of the cerrado flora are economically important, such as *Manihot* (manioc) and *Arachis* (peanut). As such, the cerrado species of these genera represent important genetic resources, which should be conserved.

There are some limitations to our checklist: some species could have been identified incorrectly or assigned as occurring in the cerrado incorrectly, and thus they would be misplaced in our list. Rizzini (1963) called those species that occur exclusively or preferentially in cerrado "characteristic" species. Other species, called "accessory" species by (Rizzini 1963), are typical from other vegetation types (such as, seasonal forest, riparian forest, or rocky field), but occur sporadically in the cerrado. One could argue that only the "characteristic" species should be included in a checklist of the herbaceous component of the cerrado flora. However, the fact that a species grows and reproduces succesfully in an area shows that it is adapted to the local conditions and, therefore, the distinction between "characteristic" and "accessory" species is rather artificial, lacking any ecological meaning (Castro *et al.* 1999).

Good taxonomy depends on good collecting, and much work remains to be done in the cerrado (Castro *et al.* 1999). If we wish to compile a checklist of the herbaceous component of its flora, future survey cannot be restricted anymore to woody species. Another promising approach in the analysis of the herbaceous component concerns its phytogeographic patterns: Does the phytogeographic distribution of the herbaceous species follow those of the woody component (Castro 1994, Ratter *et al.* 1996)? Are there centers of diversity or endemisms of the herbaceous component within the cerrado region?

Of course, our list is simply a first tentative to compile a checklist of the herbaceous component of the cerrado flora. Additions, updatings, and corrections are welcome, especially from taxonomists.

The cerrado ecosystem is now the second Brazilian vegetation type more threatened by human activities, being transformed into agriculture, pasture, or urban area (Spellerberg 1992). Morevoer, the herbaceous component of the cerrado flora is extremely vulnerable to plant invasion, especially African grasses (Pivello *et al.* 1999). Frequently, open cerrado areas are used as a natural pasture by farmers for cattle ranching, which favors the dissemination of invader grasses even more and contribute to diminish the richness of the native vegetation (Pivello *et al.* 1999).

Since the destruction of the cerrado is increasing steadily (Ratter *et al.* 1997), knowledge of the herbaceous species is essential to conserve the biodiversity of the cerrado at a reasonable level.

Aknowledgements – We are grateful to Fapesp, for financial support (process 97/13.697-5).

References

BATALHA, M. A.; ARAGAKI, S. & MANTOVANI, W. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo. 16*: 49-64.

BATALHA, M. A. & MANTOVANI, W. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparison between the herbaceous and the woody floras. *Revista Brasileira de Biologia 60*: 129-145.

BOURLIÈRE, F. & HADLEY, M. 1983. Present-day savannas: an overview. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Amsterdam, Elsevier. p. 1-17.

BREMER, K. 1994. *Asteraceae: cladistics and classification*. Portland, Timber.

CASTRO, A. A. J. F. 1994. *Comparação florística-geográfica (Brasil) e fitossociológica (Piauí – São Paulo) de amostras de cerrado*. PhD. Thesis, State University of Campinas.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y. & SHEPHERD, G. J. 1999. How rich is the flora of the Brazilian cerrados? *Annals of the Missouri Botanical Garden 86*: 192-224.

COUTINHO, L. M. 1978. O conceito do cerrado. *Revista Brasileira de Botânica 1*: 17-23.

COUTINHO, L. M. 1982. Ecological effects of fire inthe Brazilian cerrado. *In* HUNTLEY, B. J. & WLAKER, B. H. (eds). *Ecology of tropical savannas.* Berlin, Springer. p. 273-291.

CRISTÓBAL, C. L. 2001. Taxonomía del género *Helicteres* (Sterculiaceae). Revisión de las especies americanas. *Bonplandia 11*: 1-206.

CRONQUIST, A. 1988. *The evolution and classification of flowering plants.* New York, New York Botanical Garden.

DURIGAN, G.; BACIC, M. C.; FRANCO, G. A. D. C. & SIQUEIRA, M. F. DE. 1999. Inventário florístico do cerrado na Estação Ecológica de Assis, SP. *Hoehnea 26*: 149-172.

EITEN, G. 1963. Habitat flora of Fazenda Campininha, São Paulo, Brazil. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado.* São Paulo, Edusp & Edgard Blücher. p. 157-202.

ESTEVES, L. M. & MELHEM, T. S. 1992. Morfologia de esporos de pteridófitas do cerrado da Reserva Biológica de Moji-Guaçu. *Revista Brasileira de Botânica 15*: 73-83.

FONSECA, G. A. B. DA; MITTERMEIER, R. A.; CAVALCANTI, R. B. & MITTERMEIER, C. G. 2000. Brazilian Cerrado. *In* MITTERMEIER, R. A.; MYERS, N.; GIL, P. R. & MITTERMEIER, C. G. (eds). *Hotspots, Earth's biologically richest and most endangered terrestrial ecoregions.* Chicago, Conservation International. p. 148-159.

FRYXELL, P. A. 1999. *Pavonia* Cavanilles (Malvaceae). *Flora Neotropica 76*: 1-284.

GOODLAND, R. J. A. & FERRI, M. G. 1979. *Ecologia do cerrado.* Belo Horizonte, Itatiaia; São Paulo, Edusp.

HARLEY, R. M. & REYNOLDS, T. 1992. *Advances in Labiatae science.* Kew, Royal Botanical Garden.

HERINGER, E. P.; BARROSO, G. M.; RIZZO, J. A. & RIZZINI, C. T. 1977. A flora do cerrado. *In* FERRI, M. G. (coord). *IV Simpósio sobre o cerrado.* Belo Horizonte, Itatiaia; São Paulo, Edusp. p.

211-233.

HIND, D. J. N.; JEFFREY, C. & POPE, G. V. 1995. *Advances in Compositae systematics.* Kew, Royal Botanical Garden.

HOEHNE, F. C. 1942. Aristolochiaceas. *In* HOEHNE, F. C. (coord). *Flora Brasilica.* São Paulo, Secretaria da Agricultura, Indústria e Comércio. v 15.

JUDD, W. S.; CAMPBELL, C. S.; KELLOG, E. A. & STEVENS, P. F. 1999. *Plant systematics: a phylogenetic approach.* Sunderland, Sinauer.

KAMEYAMA, C. 1995. Flora da Serra do Cipó, Minas Gerais: Acanthaceae. *Boletim de Botânica da Universidade de São Paulo 14*: 181-206.

LEITÃO-FILHO, H. DE F. 1972. *Contribuição ao conhecimento da tribo Vernonieae no estado de São Paulo.* PhD. Thesis. University of São Paulo.

MANTOVANI, W. & MARTINS, F. R. 1993. Florística do cerrado na reserva biológica de Moji Guaçu, SP. *Acta Botanica Brasilica 7*: 33-60.

MENDONÇA, R. C. DE; FELFILI, J. M.; WALTER, B. M. T.; SILVA JÚNIOR, M. C. DA; REZENDE, A. V.; FILGUEIRAS, T. S. & NOGUEIRA, P. E. 1998. A flora vascular do cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora.* Planaltina, Embrapa. p. 289-556.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology.* New York, John Willey & Sons.

PEREIRA, B. A. S.; SILVA, M. A. & MENDONÇA, R. C. 1993. *Reserva Ecológica do IBGE, Brasília – DF: lista de plantas vasculares.* Rio de Janeiro, IBGE.

PEREIRA, J. F.; VALENTE, M. DA C. & SILVA, N. M. F. DA. 1995. Flora da Serra do Cipó, Minas Gerais: Asclepiadaceae. *Boletim de Botânica da Universidade de São Paulo 14*: 131-179.

PIVELLO, V. R.; SHIDA, C. N. & MEIRELLES, S. T. 1999. Alien grasses in Brazilian savannas: a threat to the biodiversity. *Biodiversity and Conservation, 8*: 1281-1294.

RATTER, J. A.; BRIDGEWATER, S.; ATKINSON, R. & RIBEIRO, J. F. 1996. An 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.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography*. Oxford, Claredon.

RIZZINI, C. T. 1963. A flora do cerrado. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado*. São Paulo, Edusp & Edgard Blücher. p. 105-153.

RIZZINI, C. T. 1971. Árvores e arbustos do cerrado. *Rodriguésia 38*: 63-77.

SALLES, A. E. H. & LIMA, I. V. 1990. *Orquidário regional dos cerrados*. Brasília, Jardim Botânico.

SANAIOTTI, T. M.; BRIDGEWATER, S. & RATTER, J. A. 1997. A floristic study of the savanna vegetation of the State of Amapá, Brazil, and suggestions for its conservation. *Boletim do Museu Paraense Emílio Goeldi, série Botânica 13*: 4-29.

SARMIENTO, G. 1983. The savannas of tropical America. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Berlin, Elsevier. p. 245-288.

SEMA. SECRETARIA DE ESTADO DO MEIO AMBIENTE. 1997. *Cerrado: bases para conservação e uso sustentável das áreas de cerrado do Estado de São Paulo*. São Paulo, SEMA.

SILVA, B. A. DA; MECENAS, V. V.; LEITE, F. Q. & CARDOSO, E. S. 1996. *APA de Cafuringa. O retrato do cerrado*. Brasília, Pararelo 15.

SIQUEIRA, J. C. DE. 1992. O gênero *Gomphrena* L. (Amaranthaceae) no Brasil. *Pesquisas (Botânica) 43*: 5-197.

SPELLERBERG, I. F. 1992. *Evaluation and assessment for conservation*. London, Chapman & Hall.

TURNER, I. M. 1994. The taxonomy and ecology of the vascular plant flora of Singapore: a statistical analysis. *Botanical Journal of the Linnean Society 114*: 215-227.

TURNER, I. M. 1997. A tropical flora summarized – a statistical analysis of the vascular plant diversity of Malaya. *Flora 192*: 157-163.

VINCENT, R. DE C., MIYAZAKI, S. L., GOMES, E. P. C. & MANTOVANI, W. 1992. Estrutura e composição florística do cerrado de Emas, Pirassununga, SP. *In* CONGRESSO DA SOCIEDADE BOTÂNICA DE SÃO PAULO *8*, Campinas, 1992. *Anais*. Sociedade Botânica de São Paulo, Campinas, p. 139-151.

WEBER, W. A. 1982. Mnemonic three-letter acronyms for the families of vascular plants: a device for more effective herbarium curation. *Taxon 31*: 74-88.

ZAR, J. H. 1999. *Biostatiscal analysis*. Upper Saddle River, Prentice Hall.

III – Conclusão geral

Conclusão geral

Com este trabalho, pudemos chegar às seguintes conclusões:

- a flora do cerrado *sensu lato* no Parque Nacional das Emas (PNE) é composta por, no mínimo, 601 espécies, pertencentes a 303 gêneros e 80 famílias;
- as sete espécies novas encontradas em nosso levantamento mostram que o cerrado ainda é subamostrado;
- as fisionomias intermediárias de cerrado, campo sujo e campo cerrado, foram as mais ricas no PNE, com 439 e 419 espécies, respectivamente. As fisionomias intermediárias de cerrado parecem ser mais ricas do que as extremas, pois nelas ambos os componentes da flora do cerrado estão bem representados;
- a razão entre espécies herbáceo-subarbustivas e arbustivo-arbóreas foi de 3,03:1, valor este não significativamente maior do que o máximo esperado (3:1), mas que evidencia o predomínio de fisionomias abertas no PNE;
- as famílias mais ricas na flora do cerrado no PNE foram Asteraceae, Fabaceae, Poaceae, Myrtaceae, Lamiaceae, Malpighiaceae, Euphorbiaceae, Apocynaceae, Malvaceae, Rubiaceae e Convolvulaceae;
- assumindo que o número de espécies no cerrado está entre 3.000 e 7.000, a flora do cerrado no PNE representa de 8 a 20% aproximadamente da flora de todo o cerrado, o que ressalta a importância do PNE para a conservação dessa formação vegetal;
- as distribuições de freqüências de espécies por gêneros e famílias foram deslocadas para a menor classe, com os gêneros e famílias monoespecíficos perfazendo, respectivamente, 64% e 36% do número total de gêneros e famílias;
- esse tipo de distribuição também é encontrado em floras de outras formações vegetais. Assim,

em relação à proporção de gêneros e famílias monoespecíficos, até o momento, não há evidências que corroborem a hipótese do cerrado como um paleoelemento florístico;

- as distribuições de espécies por famílias no PNE e no Domínio do Cerrado foram significativamente diferentes entre si. O cerrado no PNE se caracterizou pela maior proporção de famílias com muitas espécies herbáceo-subarbustivas, como Asteraceae, Lamiaceae e Malvaceae.
- a similaridade florística foi maior entre as áreas disjuntas de cerrado do que entre as áreas disjuntas e o PNE, que se localiza na área nuclear do cerrado. Provavelmente, isso é conseqüência das maiores distâncias geográficas entre o PNE e as demais áreas;
- em relação aos sítios disjuntos, as famílias que caracterizaram o PNE foram Convolvulaceae e Lamiaceae. Parece haver também em nível de família diferenças entre os sítios nucleares de cerrado e os disjuntos;
- as distribuições de espécies arbustivo-arbóreas por famílias no PNE e no cerrado como um todo foram significativamente diferentes, embora ressalvas devam ser feitas devido às espécies identificadas sem confiança e aos critérios de inclusão diferentes;
- a flora arbustivo-arbórea do PNE pertence ao grupo das áreas de cerrado caracterizado pela presença de *Piptocarpha rotundifolia* e pode ser incluída, de acordo com espécies indicadoras, em um dos grupos do Planalto Central da divisão fitogeográfica proposta;
- as distribuições de espécies herbáceo-subarbustivas por famílias no PNE e no cerrado como um todo foram significativamente diferentes, principalmente devido à maior proporção no PNE de Myrtaceae e à menor proporção de Lythraceae e Orchidaceae;
- a distribuição de espécies em famílias é mais heterogênea no componente herbáceo-subarbustivo do que no componente arbustivo-arbóreo;
- no espectro biológico do cerrado no Parque Nacional das Emas, os hemicriptófitos e os

fanerófitos foram as formas de vida predominantes, com, respectivamente, 49,92% e 24,79% do número total de espécies. Essas duas formas de vida foram também as mais bem representadas em outros sítios de cerrado para os quais foram construídos espectros biológicos;

- o espectro biológico do PNE foi significativamente diferente do espectro normal de Raunkiaer, devido principalmente à super-representação de hemicriptófitos e a subrepresentação de terófitos;
- de acordo com o sistema original, o fitoclima hemicriptofítico corresponde a um clima frio e úmido, ao contrário do clima de cerrado, que é quente e estacional. Portanto, deve haver fatores ambientais análogos ao frio que favoreçam os hemicriptófitos nas áreas de cerrado;
- a ordenação dos sítios de cerrado refletiu a variação fisionômica entre eles. As áreas em que fisionomias abertas predominam tiveram autovalores próximos aos dos hemicriptófitos e geófitos; já as áreas em que fisionomias fechadas prevalecem tiveram autovalores relacionados aos dos fanerófitos, lianas, epífitos, semiparasitas vasculares e parasitas vasculares;
- na análise de correspondência, os sítios de cerrado formaram um grupo distinto das demais formações vegetais, inclusive das outras savanas, com autovalores próximos daqueles dos hemicriptófitos e fanerófitos;
- no diagrama de ordenação, pareceu existir um gradiente de locais úmidos para secos, com as florestas pluviais em um extremo e os desertos em outro;
- quanto aos padrões reprodutivos da comunidade vegetal do cerrado no PNE, encontramos dois picos de floração, um correspondente ao componente arbustivo-arbóreo, no começo da estação chuvosa, e outro correspondente ao componente herbáceo-subarbustivo;
- os padrões de floração e frutificação dos dois componentes da flora do cerrado foram muito diferentes entre si, pois as ervas e subarbustos possuem mais restrições hídricas na estação

seca;

- do número total de espécies, 30,45% foram anemocóricas; 37,94%, autocóricas; e 31,61%, zoocóricas;
- as espécies anemo e autocóricas frutificaram no final da estação chuvosa e por toda a estação seca, quando a dispersão dos seus diásporos é mais eficiente, enquanto que as zoocóricas frutificaram principalmente na estação chuvosa, quando seus frutos podem se manter atrativos por mais tempo;
- de modo geral, os padrões reprodutivos da comunidade vegetal do cerrado no PNE foram semelhantes àqueles encontrados em outras áreas de cerrado e estiveram fortemente relacionados à estacionalidade do clima, especialmente, os do componente herbáceo-subarbustivo, para o qual a deficiência hídrica na seca é mais pronunciada;
- relacionamos 2.856 espécies para o componente herbáceo-subarbustivo da flora do cerrado, valor este maior do que a estimativa mínima disponível para esse componente de 2.000 espécies, mas ainda distante da estimativa máxima de 5.000;
- o número de espécies relacionadas para esse componente está provavelmente subestimado devido às espécies identificadas apenas em nível de gênero ou família e ao pequeno número de levantamentos em que as espécies herbáceo-subarbustivas tenham sido coletadas;
- as famílias e os gêneros monoespecíficos representaram, respectivamente, 18,28% e 41,53% do número total, valores semelhantes àqueles encontrados em formações florestais tropicais;
- as famílias mais ricas foram Asteraceae, Fabaceae, Poaceae, Lamiaceae, Euphorbiaceae e Rubiaceae. A distribuição dos tamanhos das famílias no componente herbáceo-subarbustivo foi diferente daquela encontrada no componente arbustivo-arbóreo. Muitas das famílias mais ricas no componente herbáceo-subarbustivo não estão bem representadas no componente arbustivo-arbóreo, e vice-versa;

- a distribuição do tamanho das famílias no componente herbáceo-subarbustivo encontrada para o cerrado como um todo pode ser usada como um modelo-nulo, com o qual uma determinada área de cerrado pode ser comparada. Diferenças entre as duas distribuições podem ser usadas para caracterizar o sítio em questão;
- alguns dos gêneros mais ricos possuem espécies não-nativas do cerrado que são cultivadas, como *Manihot* (mandioca) e *Arachis* (amendoim). As espécies nativas do cerrado representam, pois, recursos genéticos importantes, que devem ser conservados;
- dadas a sua riqueza e a sua importância, o componente herbáceo-subarbustivo não pode mais ser ignorado em levantamentos florísticos e fitossociológicos, como vem sendo até agora.

Nosso trabalho é apenas uma pequena contribuição ao conhecimento da vegetação do Parque Nacional das Emas. Se aqui algumas perguntas foram respondidas, muitas outras surgiram e merecem investigações posteriores. Por exemplo:

- No PNE, a riqueza nas áreas de cerrado com e sem o capim-flecha é significativamente diferente?
- Qual é a composição florística dos demais tipos vegetacionais existentes no PNE, isto é, a floresta estacional semidecídua, a floresta ripícola, a vereda de buritis, o campo úmido e o campo de murundus?
- Os sítios disjuntos de cerrado são mais ricos do que os nucleares?
- A proporção de famílias e gêneros monoespecíficos é maior no cerrado do que nas florestas pluviais atlântica e equatorial?
- Considerando-se mais sítios de cerrado, a diferença em nível de família entre os sítios nucleares e os disjuntos se mantém?
- Os grupos fitogeográficos reconhecidos para o cerrado se mantêm em nível de família?
- Por que os terófitos estão subrepresentados no cerrado?

- Como o espectro biológico varia ao longo do gradiente fisionômico do cerrado?
- Em áreas de cerrado, há diferenças significativas entre o espectro biológico florístico e espectros biológicos quantitativos, que usem, por exemplo, a freqüência ou a abundância para ponderar cada classe de forma de vida?
- Em uma análise de correspondência canônica, quais são as variáveis ambientais mais relacionadas a cada forma de vida?
- Quando analisados de maneira quantitativa, os padrões fenológicos da comunidade vegetal de cerrado, encontrados na análise qualitativa, se repetem?
- Há diferenças nos padrões reprodutivos, em nível de comunidade, entre áreas queimadas e não-queimadas?
- Há padrões supra-anuais nos eventos reprodutivos da comunidade vegetal do cerrado?
- Os grupos fitogeográficos reconhecidos para as espécies arbustivo-arbóreas do cerrado são os mesmos para as espécies herbáceo-subarbustivas?
- Há centros de endemismos e diversidade para o componente herbáceo-subarbustivo na área de ocorrência do cerrado?

IV – Referências bibliográficas

Referências bibliográficas

AOKI, H. & SANTOS, J. R. 1980. *Estudo da vegetação de cerrado na área do Distrito Federal, a partir de dados orbitais*. Dissertação de Mestrado. Instituto Nacional de Pesquisas Espaciais.

AUGSPURGER, C. K. & FRANSON, S. E. 1987. Wind dispersal of artificial fruits varying in mass, area and morphology. *Ecology 68*: 27-42.

BATALHA, M. A. 1997. *Análise da vegetação da ARIE Cerrado Pé-de-Gigante*. Dissertação de Mestrado. Universidade de São Paulo.

BATALHA, M. A.; ARAGAKI, S. & MANTOVANI, W. 1997. Florística do cerrado em Emas (Pirassununga, SP). *Boletim de Botânica da Universidade de São Paulo. 16*: 49-64.

BATALHA, M. A. & MANTOVANI, W. 2000. Reproductive phenological patterns of cerrado plant species at the Pé-de-Gigante Reserve (Santa Rita do Passa Quatro, SP, Brazil): a comparison between the herbaceous and the woody floras. *Revista Brasileira de Biologia 60*: 129-145.

BATALHA, M. A.; MANTOVANI, W. & MESQUITA JR., H. N. DE. 2001. Vegetation structure in cerrado physiognomies in southeastern Brazil. *Revista Brasileira de Biologia 61*: in press.

BEAMAN, J. H. & ANDERSEN, J. W. 1966. The vegetation, floristics and phytogeography of the summit of Cerro Potosi, Mexico. *The American Midland Naturalist 75*:1-33.

BEGON, M.; HARPER, J. L. & TOWNSEND, C. R. 1996. *Ecology: individuals, populations and communities*. Oxford, Blackwell.

BIANCO, S. & PITELLI, R. B. 1986. Fenologia de quatro espécies de frutíferas nativas dos cerrados de Selvíria, MS. *Pesquisas Agropecuárias Brasileiras 21*: 1229-1232.

BOURLIÈRE, F. & HADLEY, M. 1983. Present-day savannas: an overview. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Amsterdam, Elsevier. p. 1-17.

BOX, E. U. 1981. *Macroclimate and plant forms: an introduction to predictive modeling in phytogeography*. The Hague, Dr. W. Junk.

BRAUN-BLANQUET, J. 1928. *Pflanzensoziologie*. Berlin, Springer.

BREMER, K. 1994. *Asteraceae: cladistics and classification*. Portland, Timber.

BUELL, M. F. & WILBUR, R. L. 1948. Life-form spectra of the hardwood forests of the Itasca Park region, Minnesota. *Ecology 29*: 352-359.

CAIN, S. A. 1950. Life-forms and phytoclimate. *The Botanical Review 16*: 1-32.

CAIN, S. A.; CASTRO, G. M. DE O.; PIRES, J. M. & SILVA, N. T. DA. 1956. Application of some phytosociological techniques to Brazilian rain forests. *American Journal of Botany 43*: 911-941.

CASTRO, A. A. J. F. 1994. *Comparação florística-geográfica (Brasil) e fitossociológica (Piauí – São Paulo) de amostras de cerrado*. Tese de Doutorado, Universidade Estadual de Campinas.

CASTRO, A. A. J. F.; MARTINS, F. R.; TAMASHIRO, J. Y. & SHEPHERD, G. J. 1999. How rich is the flora of the Brazilian cerrados? *Annals of the Missouri Botanical Garden 86*: 192-224.

CHAREST, R.; BROUILLET, L.; BOUCHARD, A. & HAY, S. 2000. The vascular flora of Terra Nova National Park, Newfoundland, Canada: a biodiversity analysis from a biogeographical and life form perspective. *Canadian Journal of Botany 78*: 629-645.

CHRISTODOULAKIS, D. 1996. The flora of Ikaria (Greece, E. Aegean Islands). *Phyton 36*: 63-91.

COLE, M. M. & BROWN, R. C. 1976. The vegetation of the Ghanzi area of Western Botswana. *Journal of Biogeography 3*: 169-196.

CONSERVATION INTERNATIONAL. 1999. *Ações prioritárias para a conservação do Cerrado e do Pantanal*. Brasília, Conservation International.

COUTINHO, L. M. 1976. *Contribuição ao conhecimento do papel ecológico das queimadas na floração de espécies do cerrado*. Tese de Livre-Docência. Universidade de São Paulo.

COUTINHO, L. M. 1977. Aspectos ecológicos do fogo no cerrado. II. As queimadas e a dispersão em algumas espécies anemocóricas do estrato herbáceo-subarbustivo. *Boletim de Botânica da. Universidade de São Paulo 5*: 57-64.

COUTINHO, L. M. 1978. O conceito do cerrado. *Revista Brasileira de Botânica 1*: 17-23.

COUTINHO, L. M. 1980. As queimadas e seu papel ecológico. *Brasil Florestal 10:* 15-23.

COUTINHO, L. M. 1982. Ecological effects of fire inthe Brazilian cerrado. *In* HUNTLEY, B. J. & WLAKER, B. H. (eds). *Ecology of tropical savannas.* Berlin, Springer. p. 273-291.

COUTINHO, L. M. 1990. Fire in the ecology of the Brazilian cerrado. *In* GOLDAMMER, J. G. (ed). *Fire in the tropical biota.* Berlin, Springer. p. 82-105.

CRISTÓBAL, C. L. 2001. Taxonomía del género *Helicteres* (Sterculiaceae). Revisión de las especies americanas. *Bonplandia 11*: 1-206.

CRONQUIST, A. 1988. *The evolution and classification of flowering plants.* New York, New York Botanical Garden.

DANIN, A. & ORSHAN, G. 1990. The distribution of Raunkiaer life forms in Israel in relation to the environment. *Journal of Vegetation Science 1*: 41-48.

DIMOPOULUS, P. & GEORGIADIS, T. 1992. Floristic and phytogeographical analysis of Mount Killini (NE Peloponnisos, Greece). *Phyton 32*: 283-305.

DURIGAN, G.; BACIC, M. C.; FRANCO, G. A. D. C. & SIQUEIRA, M. F. DE. 1999. Inventário florístico do cerrado na Estação Ecológica de Assis, SP. *Hoehnea 26*: 149-172.

EITEN, G. 1963. Habitat flora of Fazenda Campininha, São Paulo, Brazil. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado.* São Paulo, Edusp & Edgard Blücher. p. 157-202.

EITEN, G. 1977. Delimitação do conceito Cerrado. *Arquivos do Jardim Botânico 21*: 125-134.

EL-DEMERDASH, M. A.; HEGAZY, A. K. & ZILAY, A. M. 1994. Distribution of the plant communities in Tihamah coastal plains of Jazan region, Saudi Arabia. *Vegetatio 112*: 141-151.

EL-GHANI, M. M. A. 1998. Environmental correlates of species distribution in arid desert ecosystems of eastern Egypt. *Journal of Arid Environments 38*: 297-313.

ESTEVES, L. M. & MELHEM, T. S. 1992. Morfologia de esporos de pteridófitas do cerrado da Reserva

Biológica de Moji-Guaçu. *Revista Brasileira de Botânica 15*: 73-83.

FERRI, M. G. 1944. Transpiração de plantas permanentes dos "cerrados". *Boletim da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo, Botânica 4*: 155-224.

FIGUEIREDO, R. C. L. & DIETRICH, S. M. C. 1981. Variações estacionais nos compostos de reserva e no metabolismo do xilopódio de *Ocimum nudicaule* Benth. var. *anisifolia* Giul. (Labiatae). *Revista Brasileira de Botânica 4*: 73-82.

FONSECA, G. A. B. DA; MITTERMEIER, R. A.; CAVALCANTI, R. B. & MITTERMEIER, C. G. 2000. Brazilian Cerrado. *In* MITTERMEIER, R. A.; MYERS, N.; GIL, P. R. & MITTERMEIER, C. G. (eds). *Hotspots, Earth's biologically richest and most endangered terrestrial ecoregions.* Chicago, Conservation International. p. 148-159.

FRANKIE, G. W., BAKER, H. G. & OPLER, P. A. 1974. Comparative phenological studies of trees in tropical wet and dry forest in the lowlands Costa Rica. *Journal of Ecology 62*: 881-919.

FRYXELL, P. A. 1999. *Pavonia* Cavanilles (Malvaceae). *Flora Neotropica 76*: 1-284.

GAO, X. & CHEN, L. 1998. The revision of plant life-form system and an analysis of the life-form spectrum of forest plants in the warm temperate zone of China. *Acta Botanica Sinica 40*: 553-559.

GENTRY, A. H. 1993. *A field guide to woody plants of northwest South America.* Chicago, University of Chicago.

GENTRY, A. H. & DODSON, C. H. 1987. Diversity and biogeography of Neotropical vascular epiphytes. *Annals of the Missouri Botanical Garden 74*: 205-233.

GOODLAND, R. J. A. & FERRI, M. G. 1979. *Ecologia do cerrado.* Belo Horizonte, Itatiaia; São Paulo, Edusp.

GOTTSBERGER, G. & SILBERBAUER- GOTTSBERGER, I. 1983. Dispersal and distribution in the cerrado vegetation of Brazil. *Sonderbildung Naturwissenschaft Ver. Hamburg 7*: 315-352.

HAMMOND, P. M. 1992. Species inventory. *In* GROOMBRIDGE, B. (ed). *Global biodiversity.* London, Chapman & Hall. p. 17-39.

HARLEY, R. M. & REYNOLDS, T. 1992. *Advances in Labiatae science.* Kew, Royal Botanical Garden.

HERINGER, E. P.; BARROSO, G. M.; RIZZO, J. A. & RIZZINI, C. T. 1977. A flora do cerrado. *In* FERRI, M. G. (coord). *IV Simpósio sobre o cerrado.* Belo Horizonte, Itatiaia; São Paulo, Edusp. p. 211-233.

HIND, D. J. N.; JEFFREY, C. & POPE, G. V. 1995. *Advances in Compositae systematics.* Kew, Royal Botanical Garden.

HOEHNE, F. C. 1942. Aristolochiaceas. *In* HOEHNE, F. C. (coord). *Flora Brasilica.* São Paulo, Secretaria da Agricultura, Indústria e Comércio. v 15.

HUMBOLDT, A. VON. 1806. *Ideen zu einer Physiognomik der Gewächse.* Stuttgart, Cotta.

IBAMA. INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS. 1989. *Unidades de Conservação do Brasil.* Brasília, Ministério do Interior. v1.

IBDF. INSTITUTO BRASILEIRO DE DESENVOLVIMENTO FLORESTAL. 1981. *Plano de manejo - Parque Nacional das Emas.* Brasília, IBDF.

ISEJIMA, E. M. & FIGUEIREDO-RIBEIRO, R. C. L. 1993. Frutcan variations in tuberous roots of *Viguiera discolor* Baker (Asteraceae): the influence of phenology. *Plant Cell Physiology 34*: 723-727.

JACKSON, P. C.; MEIZNER, F. C.; BUSTAMANTE, M.; GOLDSTEIN, G.; FRANCO, A. RUNDEL, P. W.; CALDAS, L.; IGLER, E. & CAUSIN, F. 1999. Partitioning of soil water among trees species in a Brazilian Cerrado ecosystem. *Tree Physiology 19*: 717-724.

JÁCOMO, A. T. A. & SILVEIRA, L. 1998. Serpentes: *Eunectes murinus* (Green Anaconda). Diet. *Herpetological Review 29*: 241-241.

JANZEN, D. H. 1980. *Ecologia vegetal nos trópicos.* EPU & Edusp, São Paulo.

JONGMAN, R. H. G.; TER BRAAK, C. J. F. & VAN TONGEREN, O. F. R. 1995. *Data analysis in community and landscape ecology.* Cambridge, Cambridge University.

JUDD, W. S.; CAMPBELL, C. S.; KELLOG, E. A. & STEVENS, P. F. 1999. *Plant systematics: a phylogenetic approach.* Sunderland, Sinauer.

KAMEYAMA, C. 1995. Flora da Serra do Cipó, Minas Gerais: Acanthaceae. *Boletim de Botânica da Universidade de São Paulo 14*: 181-206.

KÖPPEN, W. 1948. *Climatología.* México, Fondo de Cultura Económica.

LEITÃO-FILHO, H. DE F. 1972. *Contribuição ao conhecimento da tribo Vernonieae no estado de São Paulo.* Tese de Doutorado. Universidade de São Paulo.

LENTHALL, J. C.; BRIDGEWATER, S. & FURLEY, P. A. 1999. A phytogeographic analysis of the woody elements of the New World savannas. *Edinburgh Journal of Botany 56*: 293-305.

LOPES, A .S. & COX, F. R. 1977. Cerrado vegetation in Brazil: an edaphic gradient. *Agronomy Journal 69*: 828-831.

MAGURRAN, A. E. 1988. *Ecological diversity and its measurement.* Princeton, Princeton University.

MANTOVANI, W. 1983. *Composição e similaridade florística, fenologia e espectro biológico do cerrado da Reserva Biológica de Moji Guaçu, Estado de São Paulo.* Dissertação de Mestrado. Universidade Estadual de Campinas.

MANTOVANI, W. & MARTINS, F. R. 1988. Variações fenológicas das espécies do cerrado da Reserva Biológica de Moji Guaçu, Estado de São Paulo. *Revista Brasileira de Botânica 11*: 101-112.

MANTOVANI, W. & MARTINS, F. R. 1993. Florística do cerrado na reserva biológica de Moji Guaçu, SP. *Acta Botanica Brasilica 7*: 33-60.

MATTHES, L. A. F., LEITÃO-FILHO, H. F. DE, MARTINS, F.R. 1988. Bosque dos Jequitibás (Campinas, SP): Composição florística e estrutura do estrato arbóreo. *In* CONGRESSO DA SOCIEDADE DE BOTÂNICA DE SÃO PAULO *5*, Botucatu, 1988. *Anais.* Sociedade de Botânica de São Paulo, Campinas, p. 55-76.

MENDONÇA, R. C. DE; FELFILI, J. M.; WALTER, B. M. T.; SILVA JÚNIOR, M. C. DA; REZENDE, A. V.;

FILGUEIRAS, T. S. & NOGUEIRA, P. E. 1998. A flora vascular do cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora.* Planaltina, Embrapa. p. 289-556.

MERA, G. DE; HAGEN, M. A. & ORELLANA, J. A. V. 1999. Aerophyte, a new life form in Raunkiaer's classification? *Journal of Vegetation Science 10*: 65-68.

MIRANDA, I. S. 1995. Fenologia do estrato arbóreo de uma comunidade de Alter-do-Chão, PA. *Revista Brasileira de Botânica 18*: 235-240.

MORELLATO, L. P., RODRIGUES, R. R., LEITÃO-FILHO, H. F. DE & JOLY, C. A. 1989. Estudo comparativo da fenologia de espécies arbóreas de floresta de altitude e floresta mesófila semidecídua na Serra do Japi, Jundiaí, São Paulo. *Revista Brasileira de Botânica 12*: 85-98.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. *Aims and methods of vegetation ecology.* New York, John Willey & Sons.

PEREIRA, B. A. S.; SILVA, M. A. & MENDONÇA, R. C. 1993. *Reserva Ecológica do IBGE, Brasília – DF: lista de plantas vasculares.* Rio de Janeiro, IBGE.

OLIVEIRA, P. E. 1998. Fenologia e biologia reprodutiva das espécies de cerrado. *In* SANO, S. M. & ALMEIDA, S. P. (eds). *Cerrado: ambiente e flora.* Planaltina, Embrapa. p. 289-556.

OLIVEIRA, P. E. & SAZIMA, M. 1990. Pollination biology of two species of *Kielmeyera* (Guttiferae) form Brazilian cerrado vegetation. *Plant Systematics and Evolution 172*: 35-49.

PEREIRA, J. F.; VALENTE, M. DA C. & SILVA, N. M. F. DA. 1995. Flora da Serra do Cipó, Minas Gerais: Asclepiadaceae. *Boletim de Botânica da Universidade de São Paulo 14*: 131-179.

PIJL, L. van der. 1972. *Principles of dispersion in higher plants.* Springer-Verlag, Berlin.

PIVELLO, V. R.; CARVALHO, V. M. C.; LOPES, P. F.; PECCININI, A. A. & ROSSO, S. 1999. Abundance and distribution of native and alien grasses in a "cerrado" (Brazilian savanna) Biological Reserve. *Biotropica 31*: 71-82.

PIVELLO, V. R.; SHIDA, C. N. & MEIRELLES, S. T. 1999. Alien grasses in Brazilian savannas: a threat to the biodiversity. *Biodiversity and Conservation, 8*: 1281-1294.

PRANCE, G. T.; BEENTJE, H.; DRANSFIELD, J. & JOHNS, R. 2000. The tropical flora remains undercollected. *Annals of the Missouri Botanical Garden 87*: 67-71.

PROENÇA, C. E. B. & GIBBS, P. E. 1994. Reproductive biology of eight sympatric Myrtaceae from Central Brazil. *New Phytologist 126*: 343-354.

RAWITSCHER, F. 1942. Algumas noções sobre a transpiração e o balanço de água de plantas brasileiras. *Anais da Academia Brasileira de Ciências 14*: 7-36.

QADIR, S. A. & SHEVTY, O. A. 1986. Life form and leaf size spectra and phytosociology of some Lybian plant communities. *Pakistan Journal of Botany 18*: 271-286.

RAMOS-NETO, M. B. 1997. Natural occurence of fire in Emas National Park, central Brazil. *Proceedings Australian Bushfire.* Darwin, CSIRO Tropical Ecosystem Research Centre.

RAMOS-NETO, M. B. 2000. *O Parque Nacional das Emas (GO) e o fogo: implicações para a conservação biológica.* Tese de Doutorado. Universidade de São Paulo.

RAMOS-NETO, M. B. & PINHEIRO-MACHADO, C. 1996. O capim-flecha (*Tristachya leiostachya* Nees) e sua importância na dinâmica do fogo no Parque Nacional das Emas. *In* MIRANDA, H. S.; SAITO, C. H. & DIAS, B. F. S. (orgs). *Impactos de queimadas em áreas de cerrado e restinga.* Brasília, Universidade de Brasília. p. 68-75.

RAMOS-NETO, M. B. & PIVELLO, V. R. 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environmental Management 26*: 675-684.

RATTER, J. A. 1980. *Notes on the vegetation of Fazenda Água Limpa (Brasília – DF, Brasil).* Edinburgh, Royal Botancial Garden.

RATTER, J. A.; BRIDGEWATER, S.; ATKINSON, R. & RIBEIRO, J. F. 1996. An 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.

RATTER, J. A.; RIBEIRO, J. F. & BRIDGEWATER, S. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany 80*: 223-230.

RAWITSCHER, F. 1942. Algumas noções sobre a transpiração e o balanço de água de plantas brasileiras. *Anais da Academia Brasileira de Ciências 14*: 7-36.

RAUNKIAER, C. 1934. *The life forms of plants and statistical geography*. Oxford, Claredon.

REDFORD, K. H. 1983. Lista preliminar de mamíferos do Parque Nacional das Emas. *Brasil Florestal 55*: 29-33.

RIBEIRO, J. F.; GONZALES, M. I. & OLIVEIRA, P. E. 1982. Aspectos fenológicos de espécies nativas de cerrado. *In* CONGRESSO NACIONAL DE BOTÂNICA *32*, Teresina, 1981. *Anais*. Sociedade de Botânica do Brasil, Teresina, p. 181-198.

RIZZINI, C. T. 1963. A flora do cerrado. *In* FERRI, M. G. (coord). *I Simpósio sobre o cerrado*. São Paulo, Edusp & Edgard Blücher. p. 105-153.

RIZZINI, C. T. 1971. Árvores e arbustos do cerrado. *Rodriguésia 38*: 63-77.

RODRIGUES, F. H. G. & MONTEIRO, E. L. A. 1996. Comensalistic relation between pampas deer, *Ozotocerus bezoarticus* (Mammalia: Cervidae) and rheas, *Rhea americana* (Aves: Rheidae). *Brenesia 45*: 187-188.

RODRIGUES, F. H. G. & MONTEIRO, E. L. A. 2000. Home range and activity patterns of pampas deer in Emas National Park, Brazil. *Journal of Mammalogy 81*: 1136-1142.

RODRIGUES, F. H. G.; SILVEIRA, L.; JACOMO, A. T. A. & MONTEIRO-FILHO, E. L. A. 1999. Partial albinism in the pampas deer and a critical analysis about albino mammals. *Revista Brasileira de Zoologia 16*: 1229-1232.

SALLES, A. E. H. & LIMA, I. V. 1990. *Orquidário regional dos cerrados*. Brasília, Jardim Botânico.

SANAIOTTI, T. M.; BRIDGEWATER, S. & RATTER, J. A. 1997. A floristic study of the savanna vegetation of the State of Amapá, Brazil, and suggestions for its conservation. *Boletim do Museu Paraense Emílio Goeldi, série Botânica 13*: 4-29.

SARMIENTO, G. 1983. The savannas of tropical America. *In* GOODALL, D. W. (ed). *Ecosystems of the world – tropical savannas*. Berlin, Elsevier. p. 245-288.

SARMIENTO, G. 1984. *The ecology of Neotropical savannas*. Cambridge, Harvard University.

SARMIENTO, G. & MONASTERIO, M. 1983. Life forms and phenology. *In* GOODAL, D. W. (ed). *Ecosystems of the world: tropical savannas*. Berlin, Elsevier. p.79-108.

SCHAIK, C. P. VAN, 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.

SCHOLES, R. J. & ARCHER, S. R. 1997. Tree-grass interactions in savannas. *Annual Review of Ecology and Systematics 28*: 517-544.

SEGHIERI, J.; FLORET, C.; PONTAINER, R. 1995. Plant phenology in relation to water availability: herbaceous and woody species in the savannas of northern Cameroon. *Journal of Tropical Ecology 11*: 237-254.

SEMA. SECRETARIA DE ESTADO DO MEIO AMBIENTE. 1997. *Cerrado: bases para conservação e uso sustentável das áreas de cerrado do Estado de São Paulo*. São Paulo, SEMA.

SHANKAR, U.; TRIPATHI, R. S. & PANDEY, H. N. 1991. Structure and seasonal dynamics of humid tropical grasslands in Meghalaya, India. *Journal of Vegetation Science 2*: 711-714.

SHIMABUKURO, Y. E.; SANTOS, J. R. DOS; LEE, D. C. L. & PEREIRA, M. D. 1991. Sensoriamento remoto para monitorar e estimar áreas queimadas – o caso do Parque Nacional das Emas. *Pesquisa Agropecuária Brasileira 26*: 1589-1598.

SILVA, B. A. DA; MECENAS, V. V.; LEITE, F. Q. & CARDOSO, E. S. 1996. *APA de Cafuringa. O retrato do cerrado*. Brasília, Pararelo 15.

SILVEIRA, L.; JÁCOMO, A. T. A.; RODRIGUES, F. H. G. & DINIZ-FILHO, J. A. F. 1998. Bush dogs (*Speothos venaticus*) in Emas National Park, Central Brazil. *Mammalia 62*: 446-449.

SILVEIRA, L.; JÁCOMO, A. T. A.; RODRIGUES, F. H. G. & CRAWSHAW, P. G. 1997. Hunting association between the Aplomado Falco (*Falco femoralis*) and the Maned Wolf (*Chrysocyon brachyurus*) in Emas National Park, central Brazil. *Condor 99*: 201-202.

SILVEIRA, L.; RODRIGUES, F. H. G.; JÁCOMO, A. T. A. & DINIZ-FILHO, J. A. F. 1999. Impact of wildfires on the megafauna of Emas National Park, central Brazil. *Oryx 33*: 108-114.

SIQUEIRA, J. C. DE. 1992. O gênero *Gomphrena* L. (Amaranthaceae) no Brasil. *Pesquisas (Botânica) 43*: 5-197.

SPELLERBERG, I. F. 1992. *Evaluation and assessment for conservation.* London, Chapman & Hall.

STALTER, R.; KINCAID, D. T. & LAMONT, E. E. 1991. Life forms of the flora at Hampstead Plains, New York, and a comparison with four other sites. *Bulletin of the Torrey Botanical Club 118*: 191-194.

TAREEN, R. B. & QADIR, S. A. 1993. Life form and leaf size spectra of the plant communities of diverse areas ranging from Harani, Sinjawi to Duki regions of Pakistan. *Pakistan Journal of Botany 25*: 83-92.

TENÓRIO, E. C. 1969. Fenologia de gramíneas. *In* CONGRESSO NACIONAL DE BOTÂNICA *20*, Goiânia, 1969. *Anais.* Sociedade de Botânica do Brasil, Goiânia, p. 231-241.

TURNER, I. M. 1994. The taxonomy and ecology of the vascular plant flora of Singapore: a statistical analysis. *Botanical Journal of the Linnean Society 114*: 215-227.

TURNER, I. M. 1997. A tropical flora summarized – a statistical analysis of the vascular plant diversity of Malaya. *Flora 192*: 157-163.

VIEIRA, C. C. J. & FIGUEIREDO-RIBEIRO, R. C. L. 1993. Fructose-containing carbohydrates in the tuberous root of *Gomphrena macrocephala* St.-Hil. (Amaranthaceae) at different phenological phases. *Plant, Cell and Environment 16*: 919-928.

VINCENT, R. DE C., MIYAZAKI, S. L., GOMES, E. P. C. & MANTOVANI, W. 1992. Estrutura e composição florística do cerrado de Emas, Pirassununga, SP. *In* CONGRESSO DA SOCIEDADE BOTÂNICA DE SÃO PAULO *8*, Campinas, 1992. *Anais.* Sociedade Botânica de São Paulo, Campinas, p. 139-151.

VIVIANI, V. R. & BECHARA, E. J. H. 1997. Bioluminescence and biological aspects of Brazilian railroad-worms (Coleoptera: Phengodidae). *Annals of the Entomological Society of America 90*: 389-398.

WALTER, H. 1986. *Vegetação e zonas climáticas.* São Paulo, EPU.

WARMING, E. 1892. Lagoa Santa, contribuição para a geografia fitobiológica. *In* WARMING, E. & FERRI, M. G. 1973. *Lagoa Santa e a vegetação dos cerrados brasileiros.* Belo Horizonte, Itatiaia; São Paulo, Edusp. p.1-282.

WEBER, W. A. 1982. Mnemonic three-letter acronyms for the families of vascular plants: a device for more effective herbarium curation. *Taxon 31*: 74-88.

WILLIAMS, R. J.; MYERS, B. A.; MULLER, W. J.; DUFF, G. A. & EAMUS, D. 1997. Leaf phenology of woody species in a north Australian tropical savanna. *Ecology 78*: 2542-2558.

WILLIAMS, R. J.; MYERS, B. A.; EAMUS, D. & DUFF, G. A. 1999. Reproductive phenology of woody species in a north Australian tropical savanna. *Biotropica 31*: 626-636.

ZAR, J. H. 1999. *Biostatiscal analysis.* Upper Saddle River, Prentice Hall.