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A COMPARATIVE STUDY OF FIVE CERRADO AREAS IN SOUTHERN MATO GROSSO, BRAZIL

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Quantitative descriptions of the woody flora and soil analyses are given for five areas of cerrado (savanna woodland) near Cuiabá, Mato Grosso state, Brazil. Comparisons are made of the floristic composition and community structure of these areas using polar ordination and hierarchical classification techniques.

Descrições quantitativas da flora lenhosa e anâlises de solos são apresentadas para cinco áreas de cerrado nas proximidades de Cuiabá, Mato Grosso. São realizadas comparações entre estas areas em composição florística e estrutura comunitária utilizando técnicas de ordenação polar e classificação hierárquica.

Cerrado is a savanna-like vegetation which covers about 2 million km^2, representing about one-fifth of Brazil's total area. In the state of Mato Grosso, it occupies about 28.5% (251085km^2) of the total area and abuts on the Amazonian forest (Hylaea) to the north and the Pantanal Matogrossense (the low-lying floodplain of the Rio Paraguai) to the south (Fig. 1). It is currently being destroyed very rapidly: in 1980, 12% or 30069km^2 of the Mato Grosso cerrado was already completely cleared for cattle-pasture and crops, particularly soya, and since then this area has probably more than doubled (Carneiro, 1982). The floristic knowledge of this vanishing vegetation is very incomplete. Few surveys of Mato Grosso cerrados are available in the literature. A number of taxonomists who participated in the first scientific expeditions to Mato Grosso (from 1790 to 1915) left some general descriptions and checklists for the regional flora (see Hoehne, 1923 for a review). Pioneer detailed studies of particular areas of cerrado were carried out by Ratter (1971), Ratter *et al.* (1973, 1977) and Furley *et al.* (1988) in northeastern Mato Grosso. Oliveira-Filho & Martins (1986) and Oliveira-Filho *et al.* (1989) provided floristic and phytosociological surveys of cerrados of the region of Cuiabá, the capital of the state. For the seasonally flooded cerrados of the Pantanal Matogrossense, Prance & Schaller (1982) gave a detailed floristic survey while Pott *et al.* (1986) contributed a detailed checklist and Ratter *et al.* (1988) a quantitative-floristic study of an important area.

The present communication is devoted to a quantitative study of the woody flora of five cerrado areas, on different soils, in the region of Cuiabá and the Chapada dos Guimarães, in central-southern Mato Grosso. Comparisons are made to evaluate dif-

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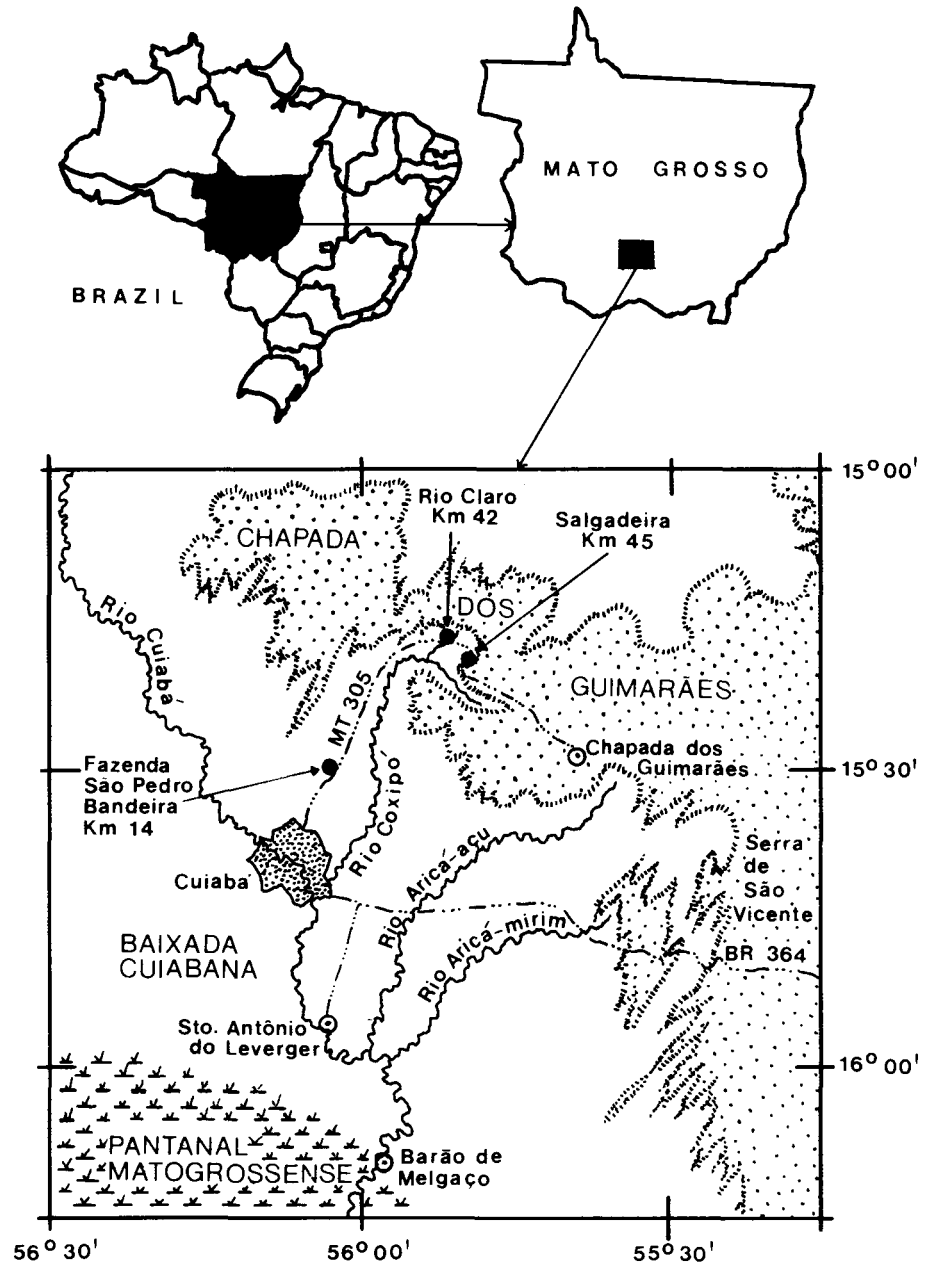

FIG. 1. Map of the region of Cuiabá and Chapada dos Guimarães showing the three study areas. The dotted area is above 400m in altitude; dense stipple = town; BR = federal road; MT = state road.

ferences in floristic composition and community structure of these areas related to variations in soil properties.

DESCRIPTION OF THE STUDY AREAS

The region of Cuiabá and the Chapada dos Guimarães comprises a wide low plain, the Baixada Cuiabana, and a higher plateau, the Chapada dos Guimarães (Fig. 1). The Baixada Cuiabana is a flattish surface with altitudes ranging from c.100m, in the southern border with the Pantanal Matogrossense, to c.350m, at the base of the Chapada dos Guimarães. This low plateau is the western tip of a large area of tablelands: the Planalto Central. The Chapada dos Guimarães is bounded by vertical escarpments of 50–300m and the relief at the top is relatively flat with altitudes ranging from 500 to 800m. This high plateau is composed of two layers of Devonian sandstone which overlie the Pre-Cambrian phyllite of the Baixada Cuiabana.

The climate is tropical and continental with high temperatures all year round and a rainy summer and dry winter, being classified as Köppen's 'Savanna Subtype' (Aw) of the tropical rain climate (A) (Eidt, 1968). Detailed climatic data are available only for Cuiabá where the mean annual air temperature is 25.6°C, with monthly means ranging from 22.8°C (July) to 27.2°C (October), and the mean annual rainfall of about 1420mm is concentrated during October-May (95% of the total rainfall) (Bombled, s.d.). The temperatures of the Chapada dos Guimarães, however, are 3–4°C lower than Cuiabá and the annual rainfall can reach 2000mm (EDIBAP, 1979).

The main vegetation type of the region is cerrado with its characteristic wide physiognomic variations. Forests are mostly restricted to galleries along the watercourses and to some patches at the top of the high plateau. Grasslands can be found in rocky and/or in poorly-drained sites. The vegetation is relatively well-preserved considering that the colonization of the region by Europeans goes back to the beginning of the 18th century: the very infertile soils have restricted the spread of cultivated areas throughout the region and human damage is caused principally by repeated fires and more localized gold mining and urban growth. In 1989 a part of the Chapada dos Guimarães was created a National Park.

The five areas of cerrado studied lie in three sites along the road (the MT 305) which connects Cuiabá to the Chapada dos Guimarães: Fazenda São Pedro-Bandeira (km 14)*, the Rio Claro region (km 42) and the Salgadeira region (km 45) (see Fig. 1).

Site A: Fazenda São Pedro-Bandeira (15°30'S, 56°02'W, c.190m alt.) This is a ranch where the cerrado is used as natural pasture for cattle at low density. Two areas were studied here:

Area 1 – Murundu cerrado: This type of cerrado occurs on round earthmounds (0.2–20.0m diameter, 0.1–2.0m high and usually bearing termitaria) scattered in a regular

* The kilometre numbers refer to the distance from Cuiabá. They are marked by roadsigns.

pattern over seasonally flooded grasslands: the campo de murundus (Portuguese: campo = grasslands, murundu = earthmound). The murundus of Fazenda São Pedro-Bandeira occur in a flat alluvial depression (5.06ha) surrounded by rocky crests that dam the water within during the rainy season, when a layer c. 10cm deep covers the whole grassland area leaving the murundus as true islands of cerrado. The physiognomy of the vegetation varies according to earthmound size, from closed scrub to dense forest. A detailed study of this cerrado is given by Oliveira-Filho (1988).

Area 2 – Pebble cerrado: this is the dominant type of cerrado on Fazenda São Pedro-Bandeira, occurring on the commonest type of soil which has a thick (1.5m) superficial layer of quartzitic pebbles arising from the decomposition of lodes of quartz intercalated within the phyllite. An area of pebble cerrado was studied in the peripheral crests around the campo de murundus. The physiognomy is of a dense scrub of shrubs and trees (cerrado *sensu stricto* of Goodland, 1971).

Site B: The Rio Claro region (15°20'S, 55°51'W): this is one of the highest parts of the Baixada Cuiabana, reaching about 270m in altitude. The slopes are steeper than is usual in the Baixada Cuibana and the phyllite bedrock outcrops over most of the area. A single area of cerrado was studied:

Area 3 – Phyllite cerrado: the cerrado occurs in this region mainly as open scrub with low and scattered trees. A less common physiognomic type, a true forest with open canopy ('cerradão' of Goodland, 1971) which occurs in patches, was chosen for study.

Site C: The Salgadeira region (15°21'S, 55°49'W): this is one of the sites where the Baixada Cuiabana meets the escarpments of the Chapada dos Guimarães. Altitudes range from 350m, at the base, to 680m, at the top of the plateau. Two areas of cerrado were studied in this region:

Area 4 – Interfluvial cerrado: this type of cerrado occurs in the sandy alluvial plain formed below the escarpments. It is restricted to the better-drained soils of the higher interfluvial sites and is bounded, on the valley-bottoms, by seasonal marshy campos or by gallery forests. It varies physiognomically from cerrado *sensu stricto* to 'cerradão' according to Goodland's (1971) classification. A detailed study of the interfluvial cerrado was provided by Oliveira-Filho *et al.* (1989).

Area 5 – Sandstone cerrado: this cerrado occurs on the top of the escarpments of the Chapada dos Guimarães as an open scrub with scattered trees ('campo cerrado' of Goodland, 1971). The landscape is dominated by sandstone outcrops and the soils, where present, are sandy and very shallow.

METHODS

A floristic survey was carried out at the sites described above by general observation and collecting on regular visits from January 1983 to June 1985. Special attention was given to woody species (subshrubs, shrubs and trees) and palms. Voucher specimens are lodged in the herbaria of Universidade Federal de Mato Grosso (CH) and the

Universidade Estadual de Campinas (UEC) with duplicates at the Escola Superior de Agricultura de Lavras (ESAL) and the Royal Botanic Garden, Edinburgh (E). A list of all species recorded is given in the Appendix.

In each of the five study areas, a number of 0.5 litre samples of soil were collected from the depth of 0–20cm and mixed up to form a compound sample. Chemical and granulometric analyses were made at the Soil Laboratory of the Universidade Federal de Mato Grosso.

Woody plants were sampled using the point-centred quarter method (PCQ), as described by Mueller-Dombois & Ellenberg (1974), in three areas of cerrado: the pebble cerrado (Area 2) with 140 points distributed in a 4 x 35 systematic grid, the phyllite cerrado (Area 3) with 60 points in a 5 x 12 grid, and the sandstone cerrado (Area 5) with 50 points in two 5 x 5 grids. Inter-point distances were of 10m. The interfluvial cerrado (Area 4) was sampled by 100 contiguous plots of 10 x 10m, arranged in a transect of 50 paired plots. The murundu cerrado (Area 1) was sampled on 80 earthmounds (0.5–22m diameter), comprising in total 0.3ha of murundus. In all surveys, species, height, and circumference at the stem base were recorded for all shrubs, trees and palms with a stem circumference of at least 9cm. The number of individuals, relative density, total basal area, relative dominance (based on basal area), relative frequency, importance value index (IVI = rel.dens. + rel.dom. + rel.freq.), and cover value index (CVI = rel.dens. + rel.dom.) were calculated for each species. The CVI was also calculated for each plant family. The Shannon-Wiener diversity index and the Pielou evenness index (Brower & Zar, 1984) were obtained for each sampled community.

The five cerrado communities were compared using three dissimilarity measures: the complemented coefficient of community (CC), the percentage difference (PD) and the Euclidian distance (ED), following Gauch (1982):

$$CC_{12} = 100 - \frac{200.sc}{s_1 + s_2}$$

$$PD_{12} = 100 - \frac{200. \sum \min\left[A_{i1}, A_{i2}\right]}{\sum\left[A_{i1} + A_{i2}\right]}$$

$$ED_{12} = \sqrt{\sum (Ai1 - Ai2)^2}$$

where s_1 and s_2 = number of species in communities 1 and 2; sc = number of species in common in the two communities; A_{i1}, A_{i2} = abundance of species i in communities 1 and 2; min $[A_{i1}, A_{i2}]$ = lowest value of abundance of species i in communities 1 and 2.

The abundance values used for the species in the calculations of PDs and EDs were their CVIs. ED is a measure determined mostly by larger abundance values while CC is determined only by the floristic composition. PD is intermediate, with linear weighting of species (Gauch, 1982). The dissimilarity matrices of CCs, PDs and EDs were used to

prepare both polar ordination diagrams (Gauch, 1982) and dissimilarity dendrograms drawn from cluster analysis by average grouping (Everitt, 1980).

RESULTS

The phytosociological data of the five cerrado areas are given in Tables 1 to 5; synthetic data for each community are given in Table 6. The cover value indices (CVIs) of the most important families are illustrated in Fig. 2. The results of soil analyses are shown in Table 7. Fig. 3 presents the comparative analysis of the cerrado communities on polar ordination diagrams and on dissimilarity dendrograms.

The murundu cerrado is characterized by the co-dominance of numerous small individuals: it presents the highest values of total absolute density and dominance, and also the lowest values of average height and diameter (see Table 6). The resulting physiognomy is of a closed scrub with emergent trees. The species diversity index (H) is the lowest: although sampled by 871 individuals, it shows only 48 species, much less than the neighbouring pebble cerrado, with 65 species in 560 sampled individuals. *Curatella americana* is the species with by far the highest values of density, dominance and frequency, being responsible for 34.4% of total IVI. Its predominance also explains much of the reason for the murundu cerrado having the lowest value of evenness (J, Table 6) which measures the degree of concentration of individuals in fewer species. The species *Dipteryx alata, Alibertia edulis, Andira cuyabensis* and *Tabebuia aurea* together account for 29.8% of total IVI. These species, except for *Albertia edulis* (a shrub <3m), are usually, by cerrado standards, tall trees (4–10m). *Curatella americana* occurs mainly as a multitrunked shrub (1–2m) and less frequently as a low to tall tree (2–7m). The CVIs are strongly concentrated in the families Leguminosae and Dilleniaceae (the latter entirely because of *C. americana*); the Vochysiaceae, which have high values of CVI in the other cerrados, are notably unimportant in the murundu cerrado (see Fig. 2). The soils of the murundus are characterized by lower pH, higher Al and K contents, finer texture and higher amounts of organic material than the other areas (Table 7).

The pebble cerrado has lower values of absolute density and dominance as well as higher values of average height and diameter (Table 6). In contrast to the neighbouring murundu cerrado, the Vochysiaceae are the most important family in CVI (Fig. 3): four species of this family - *Qualea parviflora, Salvertia convallariodora, Vochysia rufa* and *Qualea grandiflora* - are amongst the six with highest IVIs. The other two are *Curatella americana* and *Myrcia uberavensis* (Table 2). Except for *M. uberavensis*, all usually occur as trees of 4–8m as do *Dipteryx alata* and *Pouteria ramiflora*. *Myrcia uberavensis, Salacia crassifolia* and *Davilla elliptica* are abundant shrubs of 1–3m. The soils are characterized by an intermediate texture, by higher values of pH and of P K and Ca+Mg contents, and by the lower value of Al (Table 7). However, the most striking feature of these soils is the pebbles (1–3cm in diameter) that constitute about 75% of total solid volume.

The phyllite cerrado presents the highest value for average height due to the higher proportion of tall trees (Table 6). The Leguminosae and Vochysiaceae are the most

TABLE 1. Murundu cerrado: species sampled on 80 earthmounds (0.5–20.0m in diameter; 0.321ha in total area). n = number of individuals; ba = basal area (m^2); Rel.dens. = relative density; Rel.dom. = relative dominance; Rel.freq. = relative frequency; IVI = importance value index. Species in descending order of IVI.

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
1. Curatella americana	396	4.194	45.46	40.89	16.92	103.27
2. Dipteryx alata	46	2.053	5.28	20.02	8.33	33.63
3. Alibertia edulis	82	0.471	9.41	4.59	8.84	22.84
4. Andira cuyabensis	44	0.503	5.05	4.91	8.08	18.04
5. Tabebuia aurea	35	0.479	4.02	4.67	6.06	14.75
6. Hymenaea stigonocarpa	15	0.777	1.72	7.57	2.27	11.57
7. Eugenia aurata	33	0.135	3.79	1.32	5.30	10.41
8. Erythroxylum suberosum	29	0.112	3.33	1.10	5.81	10.23
9. Pseudobombax longiflorum	23	0.078	2.64	0.76	4.29	7.69
10. Simarouba versicolor	15	0.225	1.72	2.20	3.54	7.45
11. Vatairea macrocarpa	8	0.273	0.92	2.66	2.02	5.60
12. Matayba guianensis	17	0.022	1.95	0.21	3.28	5.44
13. Tabebuia caraiba	13	0.093	1.49	0.91	2.78	5.18
14. Sclerolobium aureum	8	0.047	0.92	0.45	2.02	3.39
15. Byrsonima pachyphylla	9	0.054	1.03	0.53	1.77	3.33
16. Jacaranda cuspidifolia	5	0.145	0.57	1.41	1.26	3.25
17. Astronium fraxinifolium	10	0.053	1.15	0.52	1.52	3.18
18. Abuta selloana	8	0.066	0.92	0.64	1.52	3.08
19. Cecropia pachystachya	7	0.142	0.80	1.39	0.76	2.95
20. Brosimum gaudichaudii	8	0.025	0.92	0.24	1.77	2.93
21. Copaifera martii	5	0.047	0.57	0.46	1.26	2.29
22. Pouteria ramiflora	4	0.040	0.46	0.39	1.01	1.86
23. *Diospyros coccolobifolia*	4	0.036	0.46	0.35	1.01	1.82
24. Cybistax antisyphilitica	5	0.021	0.57	0.21	1.01	1.79
25. Bowdichia major	6	0.028	0.69	0.27	0.51	1.46
26. Casearia sylvestris	4	0.022	0.46	0.22	0.76	1.44
27. Heteropterys byrsonimifolia	3	0.023	0.34	0.23	0.76	1.33
28. Qualea parviflora	3	0.014	0.34	0.13	0.76	1.23
29. Campomanesia eugenioides	7	0.013	0.80	0.13	0.25	1.19
30. Erythroxylum citrifolium	2	0.002	0.23	0.02	0.51	0.75
31. Simaba trichilioides	2	0.002	0.23	0.02	0.51	0.75
32. Zanthoxylum cinereum	1	0.031	0.11	0.30	0.25	0.67
33. Bauhinia bongardi	2	0.003	0.23	0.03	0.25	0.51
34. Myrcia formosiana	1	0.008	0.11	0.08	0.25	0.45
35. Himatanthus obovatus	1	0.004	0.11	0.04	0.25	0.40
36. Magonia pubescens	1	0.004	0.11	0.03	0.25	0.40
37. Rudgea viburnioides	1	0.003	0.11	0.03	0.25	0.40
38. Kielmeyera coriacea	1	0.002	0.11	0.02	0.25	0.39
39. Vernonia brasiliana	1	0.002	0.11	0.02	0.25	0.39
40. Ouratea hexasperma	1	0.002	0.11	0.02	0.25	0.38
41. Myrcia uberavensis	1	0.001	0.11	0.01	0.25	0.38
42. Cardiopetalum calophyllum	1	0.001	0.11	0.01	0.25	0.38
43. *Connarus suberosus*	1	0.001	0.11	0.01	0.25	0.38
44. Annona pygmaea	1	0.001	0.11	0.01	0.25	0.38
45. Tocoyena formosa	1	0.001	0.11	0.01	0.25	0.38
Totals	871	10.258	100	100	100	300

TABLE 2. Pebble cerrado: species sampled by point-centred quarter method in a systematic grid of 140 points. See Table 1 for abbreviations.

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
1. Qualea parviflora	81	1.212	14.46	15.11	13.15	42.73
2. Curatella americana	53	1.086	9.46	13.55	9.36	32.37
3. Salvertia convallariodora	48	0.663	8.57	8.27	7.57	24.42
4. Myrcia uberavensis	42	0.303	7.50	3.78	6.97	18.25
5. Vochysia rufa	27	0.645	4.82	8.04	4.18	17.04
6. Qualea grandiflora	26	0.384	4.64	4.79	4.78	14.22
7. Dipteryx alata	13	0.599	2.32	7.47	1.99	11.79
8. Pouteria ramiflora	19	3.325	3.39	4.06	3.59	11.04
9. Salacia crassifolia	17	0.209	3.04	2.61	3.19	8.83
10. Davilla elliptica	17	0.116	3.04	1.45	2.99	7.47
11. Bowdichia major	11	0.194	1.96	2.42	2.19	6.57
12. Pseudobombax longiflorum	9	0.219	1.61	2.73	1.79	6.13
13. Connarus suberosus	15	0.054	2.68	0.68	2.39	5.75
14. Andira cuyabensis	9	0.171	1.61	2.13	1.79	5.54
15. Tabebuia caraiba	10	0.134	1.79	1.70	1.99	5.48
16. Sclerolobium aureum	12	0.027	2.14	0.34	2.39	4.87
17. Byrsonima coccolobifolia	8	0.124	1.43	1.54	1.59	4.56
18. Byrsonima pachyphylla	8	0.098	1.43	1.22	1.59	4.24
19. Simarouba versicolor	7	0.114	1.25	1.42	1.39	4.07
20. Vatairea macrocarpa	4	0.197	0.71	2.46	0.80	3.97
21. Erythroxylum suberosum	8	0.063	1.43	0.79	1.59	3.81
22. Brosimum gaudichaudii	9	0.033	1.61	0.41	1.59	3.61
23. Diospyros coccolobifolia	9	0.024	1.61	0.30	1.59	3.50
24. Astronium fraxinifolium	6	0.087	1.07	1.09	1.20	3.36
25. Hymenaea stigonocarpa	4	0.145	0.71	1.80	0.80	3.31
26. Dimorphandra mollis	6	0.073	1.07	0.91	1.20	3.18
27. Tabebuia ochracea	6	0.058	1.07	0.73	1.20	2.99
28. Tabebuia aurea	6	0.051	1.07	0.63	1.20	2.90
29. Ouratea spectabilis	5	0.042	0.89	0.53	1.00	2.42
30. Annona coriacea	5	0.013	0.89	0.17	1.00	2.05
31. Himatanthus obovata	4	0.039	0.71	0.49	0.80	2.00
32. Lafoensia pacari	4	0.026	0.71	0.33	0.80	1.84
33. Agonandra brasiliensis	4	0.023	0.71	0.29	0.80	1.80
34. Magonia pubescens	3	0.053	0.54	0.66	0.60	1.80
35. Ouratea hexasperma	3	0.034	0.54	0.42	0.60	1.56
36. Ferdinandus elliptica	3	0.029	0.54	0.36	0.60	1.50
37. Strychnos pseudoquina	2	0.053	0.36	0.66	0.40	1.42
38. Matayba guianensis	3	0.015	0.54	0.19	0.60	1.32
39. Dilodendron bipinnatum	2	0.026	0.36	0.32	0.40	1.07
40. Eriotheca gracilipes	2	0.020	0.36	0.25	0.40	1.01
41. Pseudobombax tomentosum	2	0.013	0.36	0.16	0.40	0.91
42. Myrcia pallens	2	0.009	0.36	0.11	0.40	0.87
43. Kielmeyera coriacea	2	0.008	0.36	0.09	0.40	0.85
44. Diptychandra aurantiaca	2	0.005	0.36	0.06	0.40	0.85
45. Kielmeyera rubriflora	2	0.005	0.36	0.06	0.40	0.82
46. Acrocomia aculeata	1	0.034	0.18	0.42	0.20	0.80
47. Dalbergia miscolobium	1	0.030	0.18	0.37	0.20	0.75
48. Jacaranda cuspidifolia	1	0.022	0.18	0.28	0.20	0.66
49. Platypodium elegans	1	0.022	0.18	0.27	0.20	0.65
50. Aspidosperma macrocarpon	1	0.018	0.18	0.22	0.20	0.60
51. Alibertia edulis	1	0.011	0.18	0.14	0.20	0.51
52. Hancornia speciosa	1	0.010	0.18	0.12	0.20	0.50
53. Eugenia aurata	1	0.008	0.18	0.10	0.20	0.48
54. Stryphnodendron obovatum	1	0.006	0.18	0.08	0.20	0.46
55. Hirtella gracilipes	1	0.006	0.18	0.07	0.20	0.45
56. Rudgea viburnioides	1	0.005	0.18	0.06	0.20	0.45

TABLE 2 (Cont.)

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
57. Coccoloba mollis	1	0.005	0.18	0.06	0.20	0.43
58. Eugenia uniflora	1	0.004	0.18	0.05	0.20	0.43
59. Neea theifera	1	0.003	0.18	0.04	0.20	0.42
60. Coussarea hydrangeaefolia	1	0.003	0.18	0.04	0.20	0.41
61. Cardiopetalum calophyllum	1	0.003	0.18	0.03	0.20	0.41
62. Cybistax antisyphilitica	1	0.002	0.18	0.03	0.20	0.40
63. Acosmium dasycarpum	1	0.002	0.18	0.02	0.20	0.40
64. Casearia sylvestris	1	0.002	0.18	0.02	0.20	0.40
65. Tocoyena formosa	1	0.001	0.18	0.01	0.20	0.39
Totals	560	8.018	100	100	100	300

TABLE 3. Phyllite cerrado: species sampled by point-centred quarter method in a systematic grid of 60 points. See Table 1 for abbreviations.

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
1. Magonia pubescens	32	0.355	13.33	14.18	11.98	39.50
2. Callisthene fasciculata	22	0.330	9.17	13.20	7.83	30.20
3. Pseudobombax longiflorum	20	0.124	8.33	4.94	8.76	22.03
4. Dipteryx alata	11	0.254	4.58	10.16	4.15	18.89
5. Astronium fraxinifolium	10	0.215	4.17	8.60	4.61	17.37
6. Vatairea macrocarpa	11	0.111	4.58	4.42	4.61	13.62
7. Jacaranda cuspidifolia	7	0.185	2.92	7.38	3.23	13.53
8. Anadenanthera peregrina var. falcata	8	0.135	3.33	5.40	3.23	11.95
9. Curatella americana	9	0.090	3.75	3.62	3.69	11.05
10. Terminalia subsericea	11	0.031	4.58	1.25	3.69	9.52
11. Lafoensia pacari	8	0.033	3.33	1.33	3.23	7.89
12. Austroplenckia populnea	5	0.078	2.08	3.11	2.30	7.49
13. Byrsonima pachyphylla	7	0.026	2.92	1.03	3.23	7.17
14. Qualea parviflora	6	0.029	2.50	1.16	2.30	5.96
15. Bowdichia major	5	0.036	2.08	1.42	2.30	5.81
16. Byrsonima coccolobifolia	5	0.024	2.08	0.98	2.30	5.37
17. Kielmeyera rubriflora	5	0.020	2.08	0.81	2.30	5.20
18. Sclerolobium aureum	4	0.038	1.67	1.54	1.84	5.05
19. Dimorphandra mollis	4	0.022	1.67	0.89	1.84	4.40
20. Acrocomia aculeata	3	0.032	1.25	1.26	1.38	3.90
21. Campomanesia eugenioides	3	0.031	1.25	1.25	1.38	3.88
22. Eriotheca gracilipes	3	0.021	1.25	0.84	1.38	3.48
23. Aspidosperma nobile	3	0.021	1.25	0.82	1.38	3.46
24. Hymenaea stigonocarpa	3	0.020	1.25	0.81	1.38	3.44
25. Qualea multiflora	3	0.020	1.25	0.81	1.38	3.44
26. Machaerium acutifolium	2	0.041	0.83	1.64	0.92	3.40
27. Kielmeyera coriacea	3	0.008	1.25	0.30	1.38	2.94
28. Tabebuia ochracea	3	0.010	1.25	0.41	0.92	2.59
29. Guettarda viburnioides	2	0.018	0.83	0.72	0.92	2.48
30. Myrcia uberavensis	2	0.010	0.83	0.40	0.92	2.16
31. Himatanthus obovatus	2	0.009	0.83	0.36	0.92	2.11
32. Connarus suberosus	2	0.006	0.83	0.22	0.92	1.97
33. Luchea speciosa	1	0.023	0.42	0.93	0.46	1.81
34. Acosmium dasycarpum	1	0.015	0.42	0.59	0.46	1.47
35. Hancornia speciosa	1	0.015	0.42	0.59	0.46	1.47
36. Plathymenia reticulata	1	0.010	0.42	0.39	0.46	1.27

TABLE 3 (Cont.)

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
37. Peltogyne confertiflora	1	0.008	0.42	0.31	0.46	1.18
38. Pouteria ramiflora	1	0.007	0.42	0.29	0.46	1.16
39. Pseudobombax tomentosum	1	0.007	0.42	0.27	0.46	1.15
40. Annona coriacea	1	0.005	0.42	0.22	0.46	1.09
41. Qualea grandiflora	1	0.005	0.42	0.20	0.46	1.08
42. Diptychandra aurantiaca	1	0.005	0.42	0.20	0.46	1.08
43. Kielmeyera grandiflora	1	0.005	0.42	0.20	0.46	1.08
44. Aspidosperma subincanum	1	0.005	0.42	0.18	0.46	1.06
45. Roupala montana	1	0.003	0.42	0.11	0.46	0.99
46. Eugenia aurata	1	0.003	0.42	0.11	0.46	0.99
47. Casearia sylvestris	1	0.002	0.42	0.09	0.46	0.97+
48. Tocoyena formosa	1	0.001	0.42	0.05	0.46	0.92
Totals	240	2.501	100	100	100	300

TABLE 4. Interfluvial cerrado: species sampled in 100 quadrats (10 × 10m). See Table 1 for abbreviations.

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
1. Syagrus comosa	355	1.952	18.80	9.28	6.25	35.02
2. Qualea parviflora	211	2.689	11.18	12.78	5.61	29.57
3. Myrcia albotomentosa	153	1.269	8.10	6.03	6.56	20.70
4. Davilla grandiflora	152	0.736	8.05	3.50	6.66	18.21
5. Qualea grandiflora	70	1.584	3.71	7.53	4.28	15.52
6. Byrsonima verbascifolia	95	0.539	5.03	2.56	5.04	12.64
7. Hymenaea stigonocarpa	50	1.210	2.65	5.75	4.00	12.39
8. Kielmeyera rubriflora	73	0.742	3.87	3.53	4.38	11.77
9. Pouteria ramiflora	39	1.090	2.07	5.18	2.95	10.20
10. Licania humilis	36	0.881	1.91	4.19	2.57	8.66
11. Rourea induta	51	0.182	2.70	0.86	3.62	7.18
12. Vochysia rufa	45	0.383	2.38	1.82	2.47	6.68
13. Andira cuyabensis	33	0.532	1.75	2.53	2.38	6.66
14. Couepia grandiflora	28	0.538	1.48	2.56	2.38	6.42
15. Tabebuia caraiba	25	0.597	1.32	2.84	2.00	6.07
16. Aspidosperma tomentosum	32	0.295	1.70	1.40	2.76	5.86
17. Terminalia brasiliensis	23	0.515	1.22	2.45	1.62	5.28
18. Myrcia uberavensis	35	0.228	1.85	1.08	2.09	5.03
19. Dalbergia miscolobium	19	0.483	1.01	2.30	1.62	4.92
20. Psidium widgrenianum	24	0.353	1.27	1.68	1.71	4.66
21. Mouriri pusa	14	0.586	0.74	2.78	1.14	4.67
22. Salacia crassifolia	27	0.209	1.43	0.99	1.90	4.33
23. Lafoensia pacari	17	0.273	0.90	1.30	1.52	3.72
24. Vatairea macrocarpa	19	0.236	1.01	1.12	1.24	3.36
25. Kielmeyera coriacea	18	0.158	0.95	0.75	1.43	3.13
26. Eugenia punicifolia	18	0.090	0.95	0.43	1.52	2.90
27. Caryocar brasiliense	7	0.381	0.37	1.81	0.67	2.85
28. Mouriri elliptica	18	0.075	0.95	0.36	1.52	2.83
29. Peltogyne confertiflora	15	0.128	0.79	0.61	1.14	2.54
30. Roupala montana	12	0.131	0.64	0.62	1.05	2.31
31. Byrsonima coccolobifolia	14	0.087	0.74	0.41	1.14	2.30
32. Bowdichia virgilioides	8	0.224	0.42	1.06	0.76	2.25
33. Guapira noxia	10	0.179	0.53	0.85	0.86	2.24
34. Annona crassiflora	11	0.143	0.58	0.68	0.95	2.21
35. Andira inermis	12	0.091	0.64	0.43	0.95	2.02

TABLE 4 (Cont.)

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
36. Mezilaurus aff. lindaviana	6	0.203	0.32	0.96	0.57	1.85
37. Eriotheca gracilipes	10	0.114	0.53	0.54	0.76	1.83
38. Eugenia aurata	9	0.066	0.48	0.31	0.86	1.65
39. Diospyros coccolobifolia	7	0.076	0.37	0.36	0.67	1.40
40. Eugenia chrysantha	6	0.089	0.32	0.42	0.57	1.31
41. Syagrus petraea	9	0.024	0.48	0.11	0.67	1.26
42. Tabebuia aurea	5	0.068	0.26	0.32	0.48	1.06
43. Pterodon pubescens	4	0.098	0.21	0.47	0.38	1.06
44. Casearia sylvestris	6	0.027	0.32	0.13	0.57	1.02
45. Dimorphandra mollis	5	0.037	0.26	0.18	0.48	0.92
46. Eremanthus mattogrossensis	5	0.021	0.26	0.10	0.48	0.84
47. Bocageopsis mattogrossensis	3	0.024	0.16	0.11	0.28	0.75
48. Himatanthus phagendaenicus	4	0.025	0.21	0.12	0.38	0.71
49. Ouratea hexasperma	4	0.012	0.21	0.06	0.38	0.65
50. Sclerolobium paniculatum var. rubiginosum	3	0.036	0.16	0.17	0.28	0.62
51. Miconia albicans	4	0.029	0.21	0.14	0.19	0.54
52. Andira vermifuga	3	0.015	0.16	0.07	0.28	0.52
53. Tabebuia ochracea	3	0.010	0.16	0.05	0.28	0.49
54. Diptychandra glabra	3	0.020	0.16	0.10	0.19	0.44
55. Curatella americana	1	0.057	0.05	0.27	0.10	0.42
56. Hancornia speciosa	2	0.014	0.11	0.07	0.19	0.36
57. Aspidosperma macrocarpon	1	0.044	0.05	0.21	0.10	0.36
58. Connarus suberosus	2	0.011	0.11	0.05	0.19	0.35
59. Manihot tripartita	2	0.004	0.11	0.02	0.19	0.32
60. Alibertia edulis	1	0.035	0.05	0.17	0.10	0.31
61. Strychnos pseudoquina	1	0.033	0.05	0.16	0.10	0.31
62. Plathymenia reticulata	2	0.019	0.11	0.09	0.10	0.29
63. Emmotum nitens	1	0.012	0.05	0.06	0.10	0.20
64. Miconia rubiginosa	1	0.005	0.05	0.05	0.10	0.20
65. Agonandra brasiliensis	1	0.007	0.05	0.03	0.10	0.18
66. Himatanthus obovatus	1	0.007	0.05	0.03	0.10	0.18
67. Xylopia aromatica	1	0.006	0.05	0.03	0.10	0.18
68. Erythroxylum tortuosum	1	0.006	0.05	0.03	0.10	0.18
69. Palicourea rigida	1	0.001	0.05	0.01	0.10	0.15
70. Tocoyena formosa	1	0.001	0.05	0.01	0.10	0.15
Totals	1888	21.044	100	100	100	300

TABLE 5. Sandstone cerrado: species sampled by point-centred quarter method in a systematic grid of 50 points. See Table 1 for abbreviations.

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
1. Teminalia fagifolia	23	0.681	11.50	23.73	11.90	53.14
2. Vochysia petraea	41	0.187	20.50	8.17	17.26	45.93
3. Sclerolobium paniculatum var. subvelutinum	21	0.341	10.50	14.88	10.71	36.09
4. Kielmeyera rubriflora	18	0.064	9.00	2.81	8.93	20.74
5. Vellozia flavicans	16	0.086	8.00	3.74	6.55	18.28
6. Pterodon pubescens	8	0.181	4.00	7.91	3.57	15.48
7. Pouteria ramiflora	8	0.147	4.00	6.43	4.76	15.19
8. Qualea parviflora	7	0.161	3.50	7.01	2.98	13.49
9. Emmotum nitens	7	0.100	3.50	4.38	3.57	11.46
10. Davilla grandiflora	6	0.035	3.00	1.54	3.57	8.11

TABLE 5 (Cont.)

	n	Total ba	Rel. dens.	Rel. dom.	Rel. freq.	IVI
11. Micropholis rigida	5	0.051	2.50	2.23	2.98	7.71
12. Byrsonima pachyphylla	5	0.036	2.50	1.57	2.98	7.05
13. Myrcia uberavensis	4	0.010	2.00	0.45	2.38	4.83
14. Connarus suberosus	4	0.009	2.00	0.39	1.79	4.18
15. Heteropterys byrsonimifolia	3	0.020	1.50	0.88	1.79	4.17
16. Syagrus comosa	3	0.015	1.50	0.64	1.79	3.92
17. Byrsonima coccolobifolia	2	0.028	1.00	1.23	1.19	3.42
18. Mimosa xanthocentra	3	0.003	1.50	0.13	1.79	3.41
19. Ilex asperula	2	0.023	1.00	1.04	1.19	3.23
20. Miconia albicans	2	0.021	1.00	0.93	1.19	3.12
21. Caryocar brasiliense	1	0.023	0.50	1.01	0.60	2.11
22. Norantea goyazensis	1	0.014	0.50	0.61	0.60	1.71
23. Erythroxylum ambiguum	1	0.014	0.50	0.61	0.60	1.71
24. Ferdinandusa elliptica	1	0.009	0.50	0.38	0.60	1.47
25. Ouratea spectabilis	1	0.007	0.50	0.29	0.60	1.39
26. Ladenbergia chapadensis	1	0.005	0.50	0.22	0.60	1.31
27. Esenbeckia pumila	1	0.004	0.50	0.15	0.60	1.25
28. Aspidosperma macrocarpon	1	0.004	0.50	0.15	0.60	1.25
29. Eschweilera nana	1	0.003	0.50	0.13	0.60	1.22
30. Bredemeyera altissima	1	0.003	0.50	0.13	0.60	1.22
31. Styrax ferrugineus	1	0.003	0.50	0.11	0.60	1.21
32. Mouriri pusa	1	0.003	0.50	0.11	0.60	1.21
Totals	200	2.291	100	100	100	300

TABLE 6. Synthetic data for the vegetation of the five areas of cerrado studied. n = total number of individuals; S = number of species; TAD = total absolute density (indiv./ha); H = average height (m); D = average diameter (cm); TADo = total absolute dominance (m^2/ha); H_2 = Shannon–Wiener diversity index (with logs. in base 2); J_2 = Pielou evenness index (logs. in base 2).

Cerrado Area	nN	S	TAD	H	D	TADo	H_2	J_2
Murundu	871	45	2713.7	2.75	9.87	31.96	3.400	0.610
Pebble	560	65	1049.9	3.59	11.91	15.03	4.899	0.813
Phyllite	240	48	1546.4	4.24	10.39	16.12	4.850	0.868
Interfluvial	1888	70	1888.0	3.06	11.90	21.04	4.664	0.761
Sandstone	200	32	1187.0	3.38	10.36	13.60	4.057	0.811

TABLE 7. Analytical data for surface horizon (0–20cm) of soils of the five areas of cerrado studied.

	Chemical Properties						Texture		
Cerrado Area	pH in H_2O	P	K	Ca^+Mg	Al	O.M.	sand	silt	clay
		ppm		meq./100g		%		%	
Murundu**	4.7	5.0	110	1.0	1.9	2.3	47	26	27
Pebble**	5.5	10.0	59	2.2	0.5	2.0	77	7	16
Phyllite**	5.3	1.2	64	1.5	1.0	2.0	62	14	24
Interfluvial*	4.9	1.6	13	0.3	0.8	1.9	87	2	11
Sandstone*	5.2	0.6	8	0.4	0.2	0.6	89	2	9

Parent material: *Sandstone; **Phyllite. O.M. = Organic Material

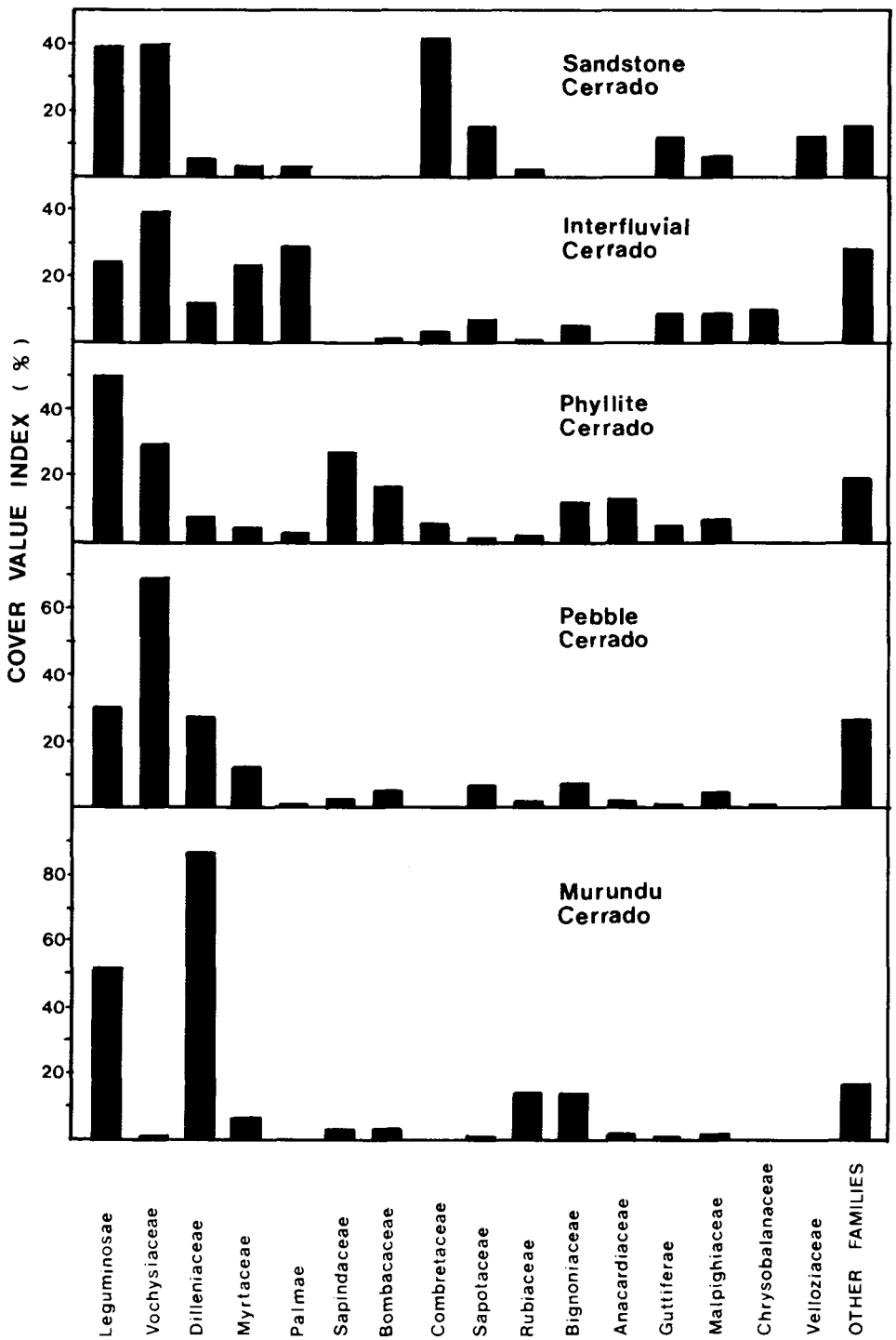

FIG. 2. Cover value indices of the 16 most important plant families in the five areas of cerrado surveyed.

important families in CVI, followed by the Sapindaceae (Fig. 2). The typical species are *Magonia pubescens*, *Callisthene fasciculata*. *Dipteryx alata* and *Astronium fraxinifolium*, which occur commonly as trees of 4–9m, and the shrub *Pseudobombax longiflorum* (1.5–2.5m). Other common species are the trees *Vatairea macrocarpa*, *Jacaranda cuspidifolia*, *Anadenanthera peregrina* var. *falcata*, *Curatella americana* and *Terminalia subsericea*. The soils present an intermediate texture, higher amounts of Ca + Mg, K and Al contents and a lower P content. The phyllite bedrock remains usually near or at the surface (0–40cm in depth).

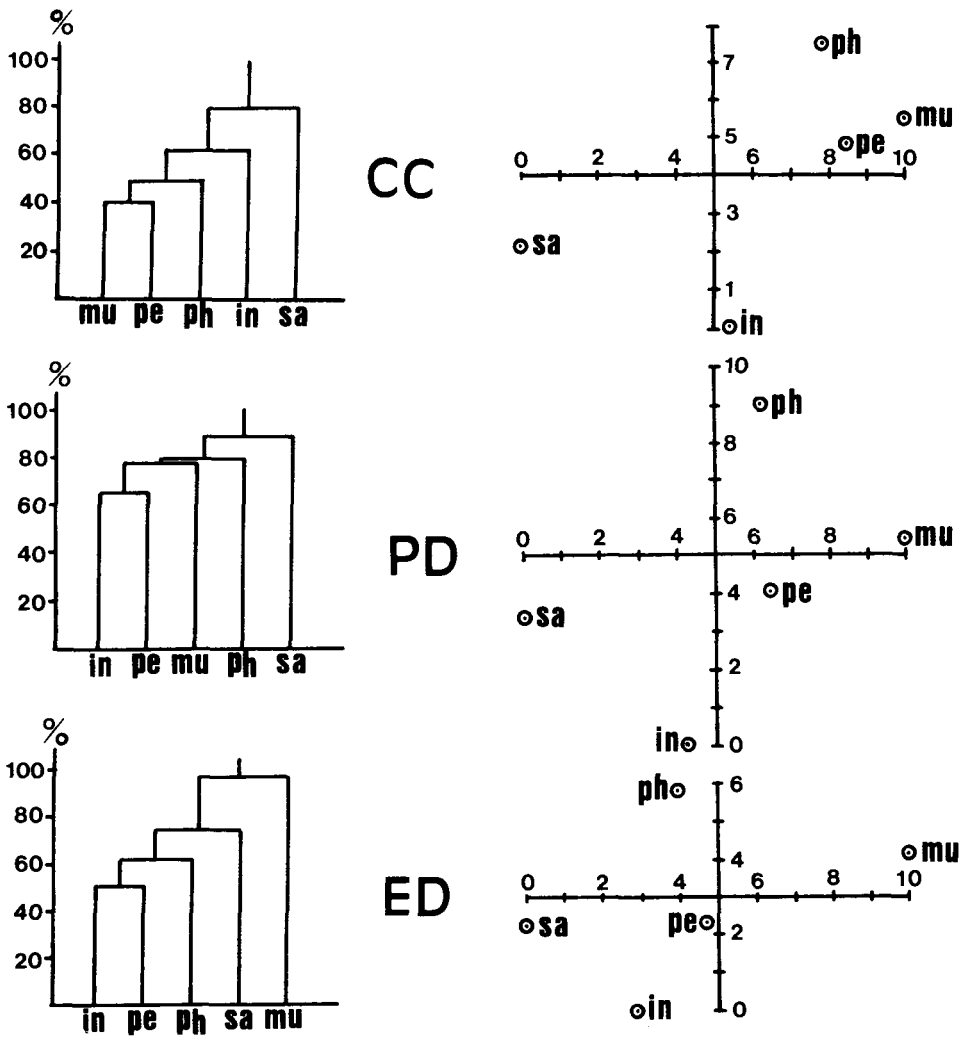

FIG. 3. Polar ordination diagrams (right) and corresponding dissimilarity dendrograms (left) of the five surveyed areas of cerrado: mu – murundu cerrado; pe – pebble cerrado; ph – phyllite cerrado; in – interfluvial cerrado; sa – sandstone cerrado. The resulting diagram-dendrogram pairs are based on the following dissimilarity measures: CC = complemented coefficient of community; PD = percentage difference; ED = euclidian distance.

The interfluvial cerrado has high values of absolute density and average diameter and also the highest value of absolute dominance (s Table 6). The Vochysiaceae and Leguminosae share the highest values of CVI with the families Palmae and Myrtaceae (Fig. 2). The species with the highest importance value is the dwarf-palm *Syagrus comosa* (0.5–1.5m), followed by the low-tree species *Qualea parviflora, Qualea grandiflora, Myrcia albotomentosa, Byrsonima verbascifolia* and *Kielmeyera rubriflora* (all 3–5m), and by the shrub species *Davilla grandiflora* (0.5–3m). Common and taller trees, of 4–11m, are *Hymenaea stigonocarpa, Pouteria ramiflora* and *Licania humilis*. The soils are deep, coarse-textured and with very low levels of P, K and Ca+Mg contents (Table 7). Although surveyed by different sample sizes, which limits the power of comparison, the interfluvial cerrado, the phyllite cerrado and the pebble cerrado are certainly the communities with the highest species diversity (H = 4.6–4.9, see Table 6). Nevertheless the degree of concentration of individuals in fewer species (given by J, Table 6) is higher in the interfluvial cerrado.

The sandstone cerrado is less diverse in species than all but the murundu cerrado (Table 6). It also presents the lowest absolute dominance and a low value of absolute density. The Leguminosae and the Vochysiaceae share the highest values of CVI with the Combretaceae (the last based on the presence of just one species: *Terminalia fagifolia*) (Fig. 2). The characteristic species are the trees (3–6m), *Terminalia fagifolia* and *Sclerolobium paniculatum* var. *subvelutinum* and the shrubs (0.5–3.5m) *Vochysia petraea, Kielmeyera rubriflora* and *Vellozia flavicans*. These five species constitute 58.05% of total IVI. As in the interfluvial cerrado, the soils are very sandy and poor, but present a lower level of organic material and are very shallow: the vegetation occurs only in the spaces and cracks among the rocks where some soil can accumulate. The resulting physiognomy is of shrubs and low trees scattered in an irregular pattern

DISCUSSION

The polar ordination diagrams (Fig. 3) show that the murundu cerrado and the sandstone cerrado represent the extremes of dissimilarity, and that the more the community structure is emphasized (CC-› PD-› ED diagrams) the more these cerrados are polarized. In both the polar ordination diagram and the dissimilarity dendrogram based on CC measures (first pair in Fig. 3; emphasis on floristic composition) the cerrados of the Baixada Cuiabana (murundu, pebble and phyllite cerrados) form a cohesive group, separated from the cerrados of the Chapada dos Guimarães (interfluvial and sandstone cerrados). In both cases the sandstone cerrado is the most different in terms of floristic composition. On the other hand, in terms of community structure, which is emphasized by EDs (lowest pair in Fig. 3), the murundu cerrado is shown quite isolated from the other cerrados in both the diagram and the dendrogram.

The main floristic dissimilarity between the cerrados of the Chapada dos Guimarães (interfluvial and sandstone cerrados) and those of the Baixada Cuiabana (murundu, pebble and phyllite cerrados) is probably due mostly to differences in soil properties. The sandstone bedrock of the Chapada dos Guimarães gives rise to coarse and very

infertile sediments while the soils of the Baixada Cuiabana are mainly influenced by the phyllite bedrock, which gives rise to finer and more fertile sediments.

The phyllite cerrado presents many species considered as indicators of the mesotrophic facies cerradão first described by Ratter (1971) in northeastern Mato Grosso and recognized later in many parts of Central Brazil (Ratter *et al.*, 1973, 1977, 1978, 1988). This type of cerradão (augmentative of cerrado in Portuguese) occurs mainly on soils with relatively high levels of Ca and Mg. The authors termed it '*Magonia pubescens/Callisthene fasciculata* cerradão', from the two main indicator species which are also the species with the highest importance values in the phyllite cerrado. Some other indicator species that could be found in abundance in this cerrado are *Pseudobombax longiflorum, Dipteryx alata, Astronium fraxinifolium, Jacaranda cuspidifolia* and *Anadenanthera peregrina* var. *falcata*. Some species occurring in small numbers - such as *Pseudobombax tomentosum, Acrocomia aculeata, Aspidosperma subincanum, Luehea speciosa* and *Guettarda viburnioides* – are also absolutely typical of this community.

The pebble cerrado is a widely dispersed type of cerrado that can be found throughout the Baixada Cuiabana in all sites where the soils are shallow and contain the layer of pebbles. These aspects favour higher rates of seepage and runoff in the groundwater regime and also reduce strongly the available volume for root growth and feeding. Despite having the highest levels of Ca+Mg and P, the apparent richness of these soils is due mainly to the high proportion of pebbles (c.75% of volume) which are removed before the analyses. Therefore, the figures in Table 7 really refer to a soil volume about four times greater than in the other cerrados. The plants therefore have available only about one-quarter of the apparent Ca+Mg content, which explains the presence of few indicator species of mesotrophic facies cerradão. *Dipteryx alata, Pseudobombax longiflorum* and *Astronium fraxinifolium*, however, do occur but only the first is among the 10 species with highest importance values. Four of the most important species are in the Vochysiaceae: *Qualea parviflora, Qualea grandiflora, Salvertia convallariodora*, and *Vochysia rufa*. These species, also common in wide areas of cerrado in all Central Brazil can be considered as amongst the most characteristic species of cerrado in a broad sense. *Curatella americana* (Dilleniaceae) which is very common in most cerrados of the Baixada Cuiabana is usually an indicator of soils with seasonally high water-table (Oliveira-Filho & Martins, 1986; Oliveira-Filho *et al.*, 1989: Ratter *et al.*, 1988).

The murundu cerrado is a very different community because of the special environmental conditions: the restricted growth-space permanently free of flooding on the earthmounds, which constitute true ecological islands (Diniz de Araujo Neto *et al.*, 1986; Oliveira-Filho, 1988). Although the flora of the murundus shows most species in common with the neighbouring cerrado (the pebble cerrado), its community structure is very different, with a strong concentration of the importance values in a few species, particularly *Curatella americana*. This species, as already mentioned, is an indicator of seasonal high water levels (floods or seepage) and is also typical of murundus of the Serra do Roncador (Ratter *et al.*, 1973), of the Ilha do Bananal (Ratter, 1987) and of the Pantanal Matogrossense (Prance & Schaller, 1982; Ratter *et al.*, 1988). Other cerrado species which commonly occur in many areas of murundus are *Dipteryx alata, Andira*

cuyabensis, *Simarouba versicolor* and *Matayba guianensis*. For typical cerrado to occur, the soils must be freely drained since the majority of species of the cerrado flora do not tolerate soil waterlogging, even during relatively short periods (Eiten, 1972: Oliveira-Filho *et al.*, 1989). So, the cerrado species successfully colonizing the murundus are those best able to tolerate high soil moisture. The less tolerant species do not succeed in colonizing the murundus and this seems to happen to the Vochysiaceae whose species are almost entirely absent in the murundu cerrado despite their abundance in the neighbouring pebble cerrado. The absence or rarity of the Vochysiaceae were also noticed by Ratter *et al.* (1988) in some areas of inundable cerrado of the Pantanal Matogrossense, although the same author (Ratter *et al.*, 1973) and Oliveira-Filho *et al.* (1989) noted *Qualea parviflora* as characteristic of the cerrado/wet campo transition in Mato Grosso.

The environmental limiting factors of the sandstone cerrado, at the top of the Chapada dos Guimarães represent the other extreme from those of the murundu cerrado. The vegetation can grow only where some soil accumulates within cracks or in the spaces among the rocks. The paucity of real soil is aggravated by its coarse texture, by the very low content of mineral nutrients and organic matter, and by the low water storage capacity. The species living in such a rigorous environment must have specialized adaptations. Thus, the species with the highest importance values – *Vochysia petraea*, *Terminalia fagifolia* *Sclerolobium paniculatum* var. *subvelutinum* and *Vellozia flavicans* - are characteristic of drier cerrado locations and are absent or very rare in all the neighbouring cerrados. However, species such as *Kielmeyera rubriflora*, *Pterodon pubescens* and many others with lower importance values also occur in the interfluvial cerrado 300m below, at the base of the escarpments.

The interfluvial cerrado also occurs on coarse-textured infertile soils which arose from the sandstone. Nevertheless, the soils are deeper and with higher water storage capacity than those of the sandstone cerrado. The environmental limitation of this cerrado is related principally to water table levels which rise in the rainy season so that water flushes on the valley sides. The highest level reached by seepage and runoff on the valley side corresponds to the border line between the cerrado and the marshy campo. The influence of water-table level within this cerrado is described in details by Oliveira-Filho *et al.* (1989).

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APPENDIX

Species recorded in the study areas of the Baixada Cuiabana (BC) and the Chapada dos Guimarães (CG)

+, present; -, not observed; br, bromeliad; li, liana; pl, palm; sc, succulent; sh, shrub; ss, sub shrub; tr, tree

The list contains all species collected and/or observed and not only those recorded in the sample areas. It is confined to cerrado vegetation (gallery forests and grasslands are excluded).

	growth form	regions	
		BC	CG
ANACARDIACEAE			
Anacardium humile St. Hil.	ss	+	+
Astronium fraxinifolium Schott	tr	+	-
A. urundeuva (Fr. All.) Engler	tr	+	-
Tapirira guianensis Aublet	tr	-	+
T. marchandii Engler	tr	-	+
ANNONACEAE			
Annona coriacea Mart.	sh	+	-
A. crassiflora Mart.	tr	-	+
A. dioica St. Hil.	ss	+	+
A. pygmaea Warm.	ss	+	-
Bocageopsis mattogrossensis R. E. Fr.	tr	-	+
Cardiopetalum calophyllum Schldl	tr	+	+
Duguetia furfuracea (St. Hil.) Benth. & Hook.	sh-ss	+	+
D. lanceolata St. Hil.	sh-ss	-	+
Xylopia aromatica (Lam.) Mart.	tr	+	+
X. sericea St. Hil.	tr	-	+

	growth form	regions	
		BC	CG
APOCYNACEAE			
Aspidosperma cylindrocarpon Müll. Arg.	tr	+	-
A. macrocarpon Mart.	tr	+	+
A. nobile Müll. Arg.	tr	+	+
A. subincanum Müll. Arg.	tr	+	+
A. tomentosum Mart.	tr	-	+
Hancornia speciosa Gomez	tr-sh	+	+
Himatanthus obovatus (M. Arg.) Woodson	tr-sh	+	+
H. phagendaenicus (Mart.) Woodson	tr	-	+
Odontadenia sp.	li	+	+
Rauwolfia sp.	ss	-	+
AQUIFOLIACEAE			
Ilex asperula Mart.	tr	-	+
I. cerasifolia Reiss.	tr	+	-
ARACEAE			
Taccarum weddellianum [Brong. ex] Schott	sc	+	-
ARALIACEAE			
Didymopanax macrocarpum (Cham. & Schldl.) Seem.	tr-sh	-	+
D. vinosum (Cham. & Schldl.) Marchand	sh	-	+
BIGNONIACEAE			
Anemopaegma glaucum Mart.	ss	+	+
Arrabidaea brachypoda (DC) Bureau. & K. Schum.	sh	+	+
A. corrallina (Jacq.) Sandw.	li	+	-
Cybistax antisyphilitica Mart.	tr-sh	+	-
Jacaranda cuspidifolia Mart.	tr	+	+
J. decurrens Cham.	ss	+	+
Memora pubescens (Sprengel) K. Schum.	ss	+	+
Tabebuia aurea Benth. & Hook.	tr	+	+
T. caraiba (Mart.) Bureau	tr	+	+
T. ochracea (Cham.) Standl.	tr	+	+
T. roseoalba (Ridley) Sandw.	tr	+	-
Zeyheria digitalis (Vell.) Hoehne	sh-ss	+	+
BOMBACACEAE			
Eriotheca gracilipes (K. Schum.) A. Robyns	tr	+	+
Pseudobombax longiflorum (Mart. & Zucc.) A. Robyns	tr-sh	+	-
P. tomentosum (St. Hil.) A. Robyns	tr-sh	+	+
BORAGINACEAE			
Cordia alliodora (Ruiz & Pav.) Oken	tr	+	+
C. insignis Cham.	ss	+	-
C. glabrata (Mart.) A. DC.	tr	+	+
BROMELIACEAE			
Ananas sp.	br	-	+
Bromelia balansae Mez	br	+	+
BURSERACEAE			
Protium almecega Marchand	tr	-	+
P. heptaphyllum (Aublet) Marchand	tr	+	+
P. ovatum Engler.	ss	-	+
CACTACEAE			
Cereus peruvianus (L.) Miller	sc	+	-
Melocactus sp.	sc	+	-

	growth form	regions	
		BC	CG
CARDYOCARACEAE			
Caryocar brasiliense Cambess.	tr	-	+
CELASTRACEAE			
Austroplenckia populnea (Reisseck) Lundell	tr	-	+
CHRYSOBALANACEAE			
Couepia grandiflora (Mart. & Zucc.) Benth.	tr	-	+
Hirtella glandulosa Mart. & Zucc.	tr	+	+
H. gracilipes (Hook.) Prance	tr	+	+
Licania hoehnei Pilger	tr	-	+
L. kunthiana Hook.	tr	-	+
L. humilis Cham. & Schldl.	tr	-	+
COCHLOSPERMACEAE			
Cochlospermum regium (Mart. & Zucc.) Pilger	sh-ss	+	+
COMBRETACEAE			
Buchenavia tomentosa Eichler	tr	-	+
Combretum discolor Taub.	ss	+	+
T. brasiliensis (Cambess.) Eichler	tr	+	+
T. fagifolia Mart. & Zucc.	tr	-	+
T. subsericeaa Eichler	tr	+	-
COMPOSITAE			
Eremanthus mattogrossensis Kuntze	tr-sh	-	+
Ichthyothere cunabi Mart.	ss	-	+
Piptocarpha rotundifolia (Less.) Baker	tr	-	+
Vernonia brasiliana (L.) Drude	sh	+	-
V. ruficoma Schldl.	sh	+	-
CONNARACEAE			
Connarus suberosus Planch. var. fulvus (Planchon) Forero	tr-sh	+	+
Rourea induta Planch.	sh	+	+
DILLENIACEAE			
Curatella americana L.	tr	+	+
Davilla elliptica St. Hil.	sh	+	+
D. grandiflora St. Hil. & Tul.	sh	+	+
EBENACEAE			
Diospyros coccolobifolia Mart.	tr	+	+
ERYTHROXYLACEAE			
Erythroxylum ambiguum St. Hil.	tr-sh	+	+
E. campestre St. Hil.	ss	+	+
E. citrifolium St. Hil.	tr-sh	+	+
E. cuneifolium (Mart.) E. Schulz	ss	-	+
E. deciduum St. Hil.	tr-sh	+	-
E. suberosum St. Hil.	sh	+	+
E. tortuosum Mart.	sh	+	+
EUPHORBIACEAE			
Cnidoscolus urens (L.) Arthur	li	+	-
Dalechampia sp.	li	+	-
Manihot tripartita Müll. Arg.	sh-ss	-	+
FLACOURTIACEAE			
Casearia sylvestris Sw.	tr-sh	+	+
GUTTIFERAE			
Kielmeyera coriacea (Spr.) Mart.	tr-sh	+	+
K. grandiflora (Wawra) Saddi	tr-sh	+	+

	growth form	regions	
		BC	CG
GUTTIFERAE (contd.)			
K. rubriflora Cambess.	tr-sh	+	+
HIPPOCRATEACEAE			
Peritassa campestris (Cambess.) A.C. Smith	ss	-	+
Salacia crassifolia (Mart.) Peyr.	tr-sh	+	+
ICACINACEAE			
Emmotum nitens (Benth.) Miers	tr	-	+
LAURACEAE			
Mezilaurus crassiramea (Meissn.) Taub.	tr	-	+
M. aff. lindaviana Schw. & Mez	tr	-	+
Ocotea sp.	sh-ss	-	+
LECYTHIDACEAE			
Eschweilera nana (Berg) Miers	tr-sh	-	+
LEGUMINOSAE CAESALPINIOIDEAE			
Bauhinia bongardi Steudel.	sh-ss	+	-
B. cuyabensis Steudel.	sh-ss	+	-
B. pulchella Mart.	sh-ss	+	+
B. rufa Steudel.	sh-ss	+	+
Cassia alata L.	sh	+	-
C. claussenii Benth.	sh-ss	-	+
C. desvauxii (Colladon.) Killip	sh	-	+
C. rugosa G. Don.	sh-ss	+	+
C. sylvestris Vell.	sh-ss	+	+
C. velutina Vogel	sh-ss	+	+
Cenostigma gardnerianum Tul.	sh	-	+
Copaifera elliptica Mart.	sh-ss	-	+
C. langsdorffii Desf.	tr	+	+
C. martii Hayne	tr-sh	+	+
Dimorphandra mollis Benth.	tr-sh	+	+
Diptychandra aurantaca Tul.	tr	+	-
D. glabra Benth.	tr	-	+
Hymenaea stigonocarpa Mart.	tr	+	+
Peltogyne confertiflora (Hayne) Benth.	tr	+	+
Sclerolobium aureum (Tul.) Benth. var. aureum (Tul.) Benth.	tr	+	-
S. paniculatum Vogel var. rubiginosum (Tul.) Benth.	tr	-	+
S. paniculatum Vogel var. subvelutinum Dwyer	tr	-	+
LEGUMINOSAE FABOIDEAE			
Acosmium dasycarpum (Vogel) Yakovlev	tr-sh	+	+
Andira cuyabensis Benth.	tr	+	+
A. inermis Kunth	tr	-	+
A. vermifuga Mart.	tr	-	+
Bowdichia major (Mart.) Benth.	tr	+	-
B. virgilioides Kunth	tr	-	+
Centrolobium tomentosum Benth.	tr	-	+
Dalbergia miscolobium Benth.	tr	+	+
Dioclea bicolor Benth.	sh-ss	+	+
Dipteryx alata Vogel	tr	+	-
Eriosema rufum E. Mayer	ss	+	+
Erythrina velutina Willd.	tr	+	-
Galactia glaucescens Kunth	sh-ss	+	+
Harpalyce brasiliana Benth.	sh-ss	+	+

	growth form	regions	
		BC	CG
LEGUMINOSAE FABOIDEAE (contd.)			
Machaerium acutifolium Vogel	tr	+	+
Platypodium elegans Vogel	tr	+	-
Pterodon pubescens Benth.	tr	+	+
Vatairea macrocarpa Benth.	tr	+	+
LEGUMINOSAE MIMOSOIDEAE			
Acacia plumosa Lowe	tr	+	-
Anadenanthera peregrina (L.) Speg. var. falcata (Benth.) Altschul	tr	+	-
Calliandra parviflora Benth.	sh-ss	+	+
Enterolobium contortisiliquum (Vell.) Morong	tr	+	-
Inga heterophylla Willd.	tr	-	+
Mimosa hirsuta Sprengel	sh	+	-
Mimosa pteridifolia Benth.	sh	+	+
Mimosa xanthocentra Mart. var. subsericea (Benth.) Barneby	sh-ss	-	+
Plathymenia reticulata Benth.	tr	+	+
Pithecellobium edwallii Hoehne	tr	+	-
Stryphnodendron obovatum Benth.	tr	+	+
LOGANIACEAE			
Antonia ovata Pohl	tr	-	+
Strychnos pseudoquina St. Hil.	tr	+	+
LYTHRACEAE			
Lafoensia pacari St. Hil.	tr	+	+
Physocalymma scaberrimum Pohl	tr	-	+
MALPIGHIACEAE			
Byrsonima coccolobifolia Kunth	tr-sh	+	+
B. coriacea DC.	tr-sh	-	+
B. crassa Niedenzu.	tr-sh	-	+
B. dealbata Gris.	ss	+	-
B. gaultherioides Gris.	sh	-	+
B. pachyphylla Juss.	tr-sh	+	+
B. subterranea Brade & Mark	ss	+	-
B. verbascifolia (L.) Rich. ex Juss.	tr-sh	+	+
Heteropterys byrsonimifolia A. Juss.	tr-sh	+	+
Heteropterys sp.	sh-ss	-	+
MALVACEAE			
Pavonia sp.	ss	+	-
MARCGRAVIACEAE			
Norantea goyazensis Camb.	sh	-	+
MELASTOMATACEAE			
Miconia albicans (Sw.) Triana	tr-sh	-	+
M. fallax DC.	tr-sh	-	+
M. ferruginata (DC.) Cogn.	tr-sh	-	+
M. guianensis Cogn.	tr	-	+
M. rubiginosa (Bonpl.) Tr.	sh	-	+
Mouriri elliptica Mart.	sh	-	+
M. pusa Gardn	tr	-	+
Tibouchina aff. aspera Aublet.	sh-ss	-	+
T. pogonanthera (Naud) Cogn.	sh	+	-
MELIACEAE			
Guarea guidonia (L.) Sleumer	tr	-	+

	growth form	regions	
		BC	CG
MENISPERMACEAE			
Abuta selloana Eichler	sh	+	+
MONIMIACEAE			
Siparuna guianensis Aublet	sh	-	+
MORACEAE			
Brosimum gaudichaudii Trécul	tr-sh	+	+
Cecropia cinerea Miq.	tr	-	+
C. pachystachya Trécul	tr	+	+
Ficus guianensis Aublet	tr	-	+
F. enormis (Mart. ex Miq.) Miq.	tr	+	-
MYRISTICACEAE			
Virola sebifera Aublet	ss	+	+
V. sessilis (A. DC.) Warb.	tr	-	+
MYRSINACEAE			
Rapanea guianensis Aublet	tr	-	+
MYRTACEAE			
Campomanesia eugenioides (Cambess.) Legr.	sh	+	+
Eugenia aurata Berg	tr-sh	+	+
E. bimarginata DC.	sh	-	+
E. chrysantha Berg	tr-sh	-	+
E. punicifolia (Kunth) DC.	tr-sh	-	+
E. uniflora L.	tr-sh	+	-
Myrcia albo-tomentosa Cambess.	tr-sh	+	+
M. formosiana DC.	tr-sh	-	+
M. intermedia (Berg) Kiaersk.	sh	+	-
M. aff. nivea Berg	ss	-	+
M. pallens DC.	tr-sh	+	+
M. suffruticosa Berg	ss	+	-
M. uberavensis Berg	tr-sh	+	+
M. variabilis DC.	sh-ss	-	+
Psidium multiflorum Camb.	ss	+	-
P. widgrenianum Berg	tr-sh	-	+
NYCTAGINACEAE			
Guapira noxia (Netto) Lundell	tr	-	+
Neea theifera Oersted	tr	+	+
OCHNACEAE			
Ouratea floribunda (St. Hil.) Engler	ss	+	+
O. hexasperma (St. Hil.) Engler	tr-sh	+	+
O. spectabilis (Mart.) Engler	tr-sh	+	+
OPILIACEAE			
Agonandra brasiliensis Miers	tr	+	+
PALMAE			
Allagoptera campestris (Mart.) Kuntze	pl	-	+
A. leucocalyx (Drude) Kuntze	pl	+	-
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	pl	+	-
Astrocaryum campestre Mart.	pl	-	+
Butia leiospatha (Mart.) Becc.	pl	-	+
Syagrus comosa (Mart.) Becc.	pl	-	+
S. petraea (Mart.) Becc.	pl	-	+
POLYGALACEAE			
Bredemeyera altissima Benth.	sh-ss	-	+

	growth form	regions	
		BC	CG
POLYGONACEAE			
Coccoloba mollis Casar.	tr-sh	+	-
C. cf. cordifolia Meissner	ss	-	+
PROTEACEAE			
Roupala montana Aublet	tr	+	+
RHAMNACEAE			
Rhamnidium elaeocarpum Reisseck.	tr	+	+
RUBIACEAE			
Alibertia concolor (Cham.) K. Schum.	sh	-	+
A. edulis Rich.	tr-sh	+	+
A. sessilis (Cham.) K. Schum.	sh	-	+
A. verrucosa Moore	tr-sh	+	+
Chomelia ribesioides Benth.	sh	-	+
Coussarea hydrangeaefolia Benth. & Hook.	tr-sh	+	-
Ferdinandusa elliptica Pohl	tr-sh	+	+
Guettarda viburnioides Cham. & Schldl.	tr-sh	+	+
Ladenbergia chapadensis Moore	tr-sh	-	+
Palicourea coriacea (Cham.) K. Schum.	ss	-	+
P. rigida Kunth	sh-ss	+	+
Rudgea viburnioides (Cham.) Benth.	tr-sh	+	+
Sabicea cana Hook.	ss	+	-
Tocoyena formosa (Cham. & Schl.) K. Schum.	sh-ss	+	+
RUTACEAE			
Esenbeckia pumila Pohl	tr-sh	-	+
Zanthoxylum arenarium Engl.	tr	+	-
Z. cinereum Engl.	tr	+	-
SAPINDACEAE			
Dilodendron bipinnatum Radlk.	tr-sh	+	-
Magonia pubescens St. Hil.	tr	+	-
Matayba guianensis Aublet	tr-sh	+	+
Serjania erecta Radlk.	ss	+	+
S. sp.	li	+	-
Talisia subalbens Radlk.	ss	-	+
SAPOTACEAE			
Chrysophyllum marginatum (Hook. & Arn.) Radlk.	tr	+	-
Micropholis rigida Pierre	tr	-	+
Pouteria lateriflora (Benth.) Radlk.	ss	-	+
P. ramiflora (Mart.) Radlk.	tr	+	+
SIMAROUBACEAE			
Simaba trichilioides St. Hil.	sh-ss	+	-
Simarouba versicolor St. Hil.	tr	+	+
SMILACACEAE			
Smilax sp.	li	+	+
SOLANACEAE			
Solanum lycocarpum St. Hil.	sh	-	+
STERCULIACEAE			
Guazuma tomentosa Kunth	tr	+	-
G. ulmifolia Lam.	tr	+	-
Helicteres sacarolha St. Hil.	ss	+	+
Waltheria sp.	ss	+	-

	growth form	regions	
		BC	CG
STYRACACEAE			
Styrax camporum Pohl	tr	-	+
S. ferrugineus Nees & Mart.	tr	-	+
TILIACEAE			
Luehea speciosa Willd.	tr-sh	+	-
ULMACEAE			
Trema micrantha Blume	tr	+	-
VELLOZIACEAE			
Vellozia flavicans Mart.	sh	-	+
VERBENACEAE			
Aegiphila sellowiana Cham.	tr	-	+
Vitex cymosa Bert.	tr	+	-
VITACEAE			
Cissus sp.	li	+	+
VOCHYSIACEAE			
Callisthene fasciculata (Spr.) Mart.	tr	+	-
Qualea grandiflora Mart.	tr	+	+
Q. multiflora Mart.	tr	+	+
Q. parviflora Mart.	tr	+	+
Salvertia convallariodora St. Hil.	tr	+	+
Vochysia divergens Mart.	tr	+	-
V. haenkeana Mart.	tr	-	+
V. petraea Warm.	sh	-	+
V. pyramidalis (Spr.) Mart.	tr	-	+
V. rufa (Spr.) Mart.	tr	+	+
V. tucanorum (Spr.) Mart.	tr	-	+