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LISTS OF SPECIES

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Woody flora of natural forest gaps in a bamboo-dominated forest remnant in southwestern Amazonia

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Abstract: Forest gaps, created by the falling of one or more trees, have been seen as a key factor for the maintenance of local plant diversity in tropical forests. In this study, our goal was to determine the floristic composition of woody plants colonizing natural gaps and in the understory of an open, bamboo-dominated (*Guadua weberbaueri* Pilg.) forest in southwestern Amazonia, Acre, Brazil. We sampled and identified woody plants (≥1 m tall and DBH≤10 cm) in 20 forest gaps and nine adjacent understories. In total, 1656 plants were identified in 159 species, 116 genera and 45 families. A list of species was created, containing habitat, habit, functional group, threat status (Brazilian Flora Red List) and abundance data for each species.

Key words: alpha diversity; forest regeneration; functional group; *Guadua*; treefall gaps

INTRODUCTION

Tropical forests have the greatest plant diversity in our planet (Dirzo and Raven 2003). Recent estimates point that the Amazon is the home for approximately 16,000 tree species (DBH ≥ 10 cm), from which 227 are superdominant, because they are much more abundant the other species (Ter Steege et al. 2013). Despite this information and knowledge, few studies address species richness during regeneration in Amazonian forests.

Canopy gaps formed by one or more falling trees (Runkle 1992) are the most common and studied type of forest disturbance (Schliemann and Bockheim 2011) and are also thought to be one of the major drivers of species diversity at the local scale (Connell 1978). Nevertheless, recent studies have shown some divergence in the application of this hypothesis, suggesting that canopy gaps play a relative neutral role in the maintenance of diversity, mediating the limitation effect upon recruitment (Hubbell et al. 1999; Sheil and Burslem 2003; Obiri and Lawes 2004; Fox 2013). Other studies also associate gap area and heterogeneity with tree species composition (Brokaw 1985; Denslow 1987; Brokaw and Scheiner 1989).

Bamboo (*Guadua* spp.) dominated forests cover more than half of southwestern Amazonia (Carvalho et al. 2013). These are considered uncommon and differ structural and floristically from closed canopy forests in central and eastern Amazonia (Torezan and Silveira 2000; Griscom and Ashton 2003, 2006; Griscom et al. 2007). Still, although these studies address regeneration patterns under the influence of bamboo, there is still little information about composition and diversity in natural gaps in these bamboo-dominated forests.

Our goal in this paper was to identify the floristic composition and to analyze the structure of regenerating woody plants in natural forest gaps and adjacent understory in a bamboo dominated forest remnant in southwestern Amazonia, Acre, Brazil. Our findings will increase the knowledge of the composition of species after gap opening in such forests, where there is scant literature about it.

MATERIALS AND METHODS

This study was carried out at the Catuaba Experimental Farm (FEC; Figure 1), a forest fragment with ca. 1,200 ha located in the state of Acre, Brazil (10°04′ S, 067°37′ W). It has a gently rolling topography with predominance of oxisols and ultisols (Acre 2006); horizons A and B are predominantly sandy (62 and 47%, respectively); pH approximately 4.0 (Sousa et al. 2008). Its altitude is 214 m above sea level and is 0.8 to 7.4 km away from neighboring remnants. The area is covered by bamboo (*Guadua weberbaueri* Pilg.) dominated open rainforest. The dominant trees are *Hevea brasiliensis* (Willd. ex A. Juss.) Müll.Arg. (Euphorbiaceae), *Bertholletia excelsa*

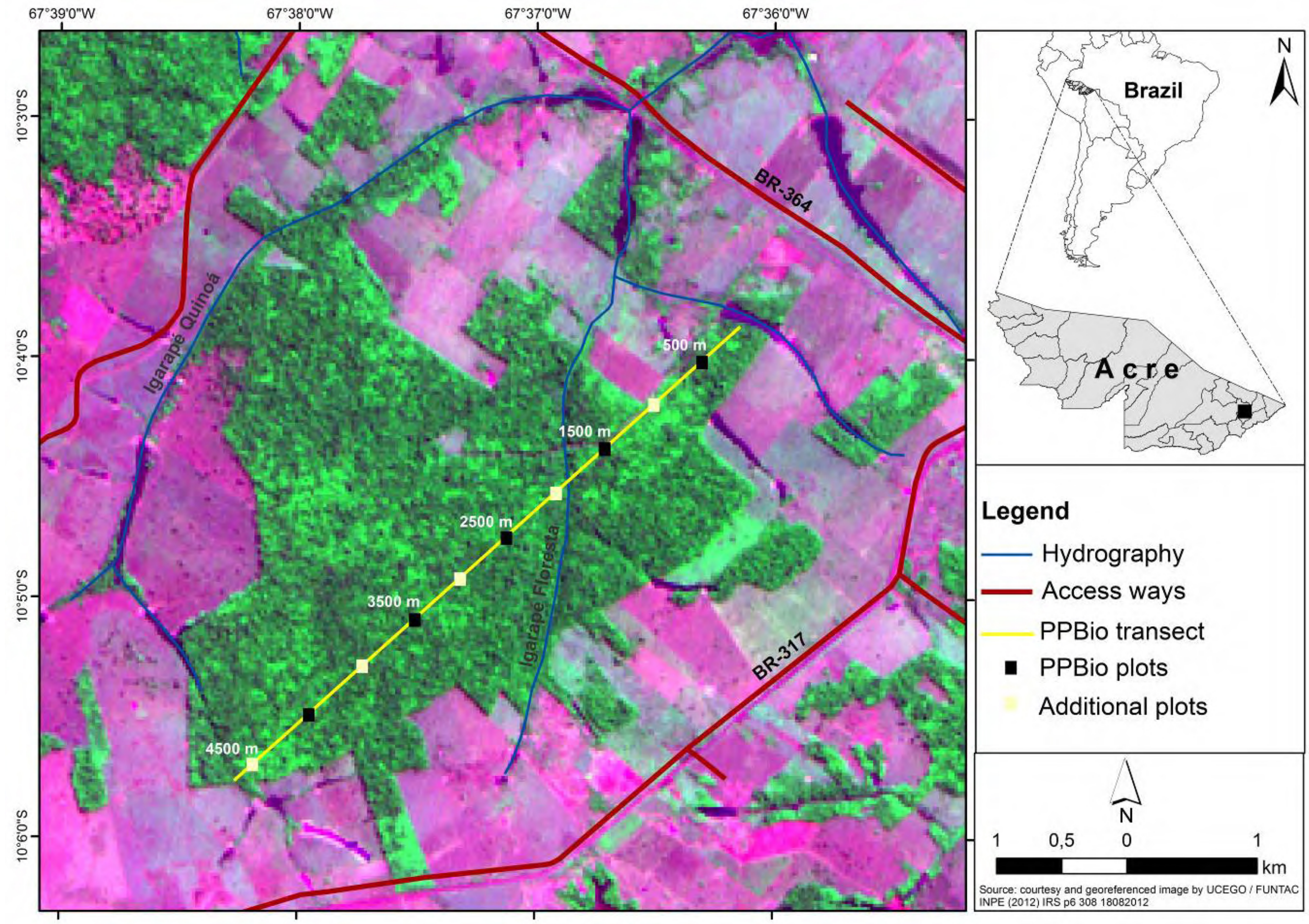

Figure 1. PPBio's plots following RAPELD protocol, in the Fazenda Experimental Catuaba. Each black dot identifies a 250m trail/plot (following RAPELD's protocol for PPBio) and addition trails are yellow dot between the black dots.

Humb. & Bonpl. (Lecythidaceae), *Tetragastris altissima* (Aubl.) Swart (Burseraceae) and *Carapa guianensis* Aubl. (Meliaceae). Canopy height varies from 20 to 40 m, with emergent trees up to 45 m (Silveira 2005). Mean annual rainfall is 1,958 mm and average annual temperature is 25°C (Duarte 2006). We surveyed forest gaps in this fragment and walked through 10 km of trails, following Runkle's method (1992). All gaps formed by the fall of one or more trees in a PPBio module (Programa de Pesquisas em Biodiversidade), established at FEC, following RAPELD protocols (Magnusson et al. 2005). Only gaps ≥ 100 m^2 were included in our study.

We applied Runkle's operational definition of a gap, which includes the soil area under the canopy opening, extending to the trunk of the adjacent trees. We surveyed 20 gaps. In each gap, we established eight subplots (2 × 4 m) following Brandani et al. (1988). For the understory, we randomly selected nine gaps (from the initial 20) and about 20 m away from each gap edge, we plotted a 2 × 32 m plot, divided in eight subplots of 2 × 4 m.

In each subplot (both gaps and understory) all woody plants ≥ 1 m tall and with DBH≤10 cm were sampled. Each plant was marked with a numbered tag. Plant identification was first made in the field with the aid of an experienced parataxonomist. Also, we sampled from all morphotypes identified in the field as a species for identification in the herbarium, based on the Angiosperm Phylogeny Group (APG III 2009). In order to check for proper species names spelling, we used the Brazilian Flora List (Flora do Brasil 2020, under construction, 2016). All fertile samples had their vouchers incorporated in the collection of the Botany and Plant Ecology Laboratory (LABEV) of the Federal University of Acre, Rio Branco, Acre, Brazil. Sterile specimens were not incorporated at the herbarium.

All species were classified in four functional groups, mainly due to its light necessity, which are: pioneers, early and late secondary species and "unclassified" (Budowski 1965; Denslow 1980). A description of each of these categories can be accessed in Gandolfi (2000). The classification of each species was made by literature consultation (Amaral et al. 2009; Denslow 1980; Gandolfi 2000; Gargiullo et al. 2008; Lorenzi 2008; 2009; Oliveira 2011; Santos 2013; Silva 2011) and also by the use of a functional group list, developed by the Botany and Plant Ecology Laboratory of the Federal

University of Acre (LABEV), based on forest inventories and species identification and classification under the project "Casadinho" (unpublished data, CNPq grant number 620236/2006-0).

Species were also classified into conservation or threat status in agreement with the Brazilian Flora Red List (Martinelli and Moraes 2013).

To analyze the structure of regeneration in both environments abundance of species distribution curves were constructed (species abundance distribution: SAD), through the rank of the most abundant species for rarer (McGill et al. 2007; Matthews and Whittaker 2014). The length of the curves allows analyzing the species richness using the x-axis; and the slope allows an analysis of evenness among species, by reading the axis of ordinates. In this sense more inclined curves and smaller have fewer species and most dominant (Magurran 2005). To test whether there are differences between the SAD curves we used the Kolmogorov-Smirnov test.

Analyzes were performed with R software (R Core Team, 2013), using Vegan 2.2 package (Oksanen et al. 2013).

RESULTS

The average gap area was 521 ± 347 m^2, ranging from 108 to 1,413 m^2, median 353 m^2. Total gap area was 10,429 m^2. The average canopy openness was 49%, while for small, medium and large gaps it was 50%, 47% and 52% respectively. Forest understory showed an average of 14% of canopy openness and was significantly ($F=11.05$; $p<0.001$) different from gaps, which did not differ among each other.

We sampled 1,656 shrubs and trees, 159 species, 116 genera and 45 families in both gaps and understory (Table 1). Sixty-two species were found only in gaps and 14 only in the understory. Eighty-six species co-occurred in gaps and understory. Eighty-three percent of the species are trees, 11% are shrubs and 6% were not classified in any habit due to lack of species identification. Many species were rare, with 41 sampled only once and 23 just twice.

The most specious families were Fabaceae (27 species, from all three subfamilies) comprising 17% of species richness; Rubiaceae (13); Moraceae (12); Lauraceae, Malvaceae and Sapotaceae (7). Four families were represented by two species and 19 families had only one species each. Piperaceae showed the highest number of individuals, comprising 15% of total abundance. Together, Piperaceae, Fabaceae, Moraceae and Rubiaceae hold 49% of all plants sampled.

For the forest as a whole (gaps and understory), the species with highest relative abundance were *Piper* sp. 1 (13.0%), *Faramea capillipes* Müll. Arg. (5.1%), *Tachigali setifera* (Ducke) Zarucchi & Herend. (3.5%), *Brosimum guianense* (Aubl.) Huber (3.2%), *Eugenia* sp. 2 (3.1%), *Guarea* sp. (2.5%), *Pseudolmedia laevis* (Ruiz & Pav.) J.F.Macbr. (2.4%), *Inga* sp. 4 (2.4%), *Amphirrhox* sp. (2.3%), *Siparuna guianensis* Aubl. (2.2%), *Neea floribunda* Poepp. & Endl. (2.2%) and *Celtis schippii* Trel. ex Standl. (2.1%). From these most abundant species, three were also found to be the most frequent genera regenerating in the same forest fragment: *Neea*, *Guarea* and *Celtis* (Silva 2011).

Some of the species showed gap dependence for regeneration, showing a much greater abundance in gaps. *Piper* sp. 1 had 93% of its individuals in gaps, *Faramea capillipes* 83%, *Tachigali setifera* and *Brosimum guianense* with 69% of their individuals in gaps as well. On the other hand, only two species were found mainly or solely in the understory, *Compsoneura ulei* Warb. (63%) and *Randia armata* (Sw.) DC. (100%). Nevertheless, most species did not present any pattern or preference for either gaps or understory (Table 1).

Table 1 shows also the threat status of each species sampled at FEC. Only three species are classified as "vulnerable VU", which according to the Red List (Martinelli and Moraes 2013), face a high risk of extinction in the wild. Six other species were classified as "least concern LC", which means there is lack of information available now, but could be included in VU with further studies (Martinelli and Moraes 2013).

Figure 2 shows the species abundance distribution (SAD) within the gaps and the understory. The Kolmogorov-Smirnov test showed that there is a structural difference between the two environments ($p<0.001$).

DISCUSSION

The results shown here for Fabaceae are characteristic of Amazonian forests, where the family presents the highest diversity and abundance (Steege et al. 2013). For the genus *Piper*, such high relative abundance in gaps was expected since species from this genus are known to be light dependent, have higher growth rates and more abundant in natural gaps (Denslow et al. 1990; Daws et al. 2002; Bernades and Costa 2011).

Differences in abundance and dominance of species rank (Figure 2) will indicate structural differences, which are modified on the environment and their colonization by different species, caused by disturbance when the formation of natural gaps (Connel 1978; Connel and Green 2000; Denslow 1987, 1995). The curve of species distribution that occurred in clearings is steeper than the abundance curve of the understory. This shows that the dominance is higher in gaps, caused by the abundance of the species *Piper* sp. 1 and *Faramea capillipes*. In understory only *Eugenia* sp. 2 has mild dominance. In this sense, the distribution of abundances of species of understory is more evenness compared with clearings.

The three vulnerable species (Table 1; *Apuleia leiocarpa*

Table 1. Tree and Shrub flora and abundance, occurring in natural gaps and understory in a forest fragment in the Fazenda Experimental Catuaba, Senador Guiomard, Acre Brazil.

Family	Species	Common names	Abundance	Habitat[1]	Habit	Functional groups[2]	Threat status[3]	Voucher
Acanthaceae	*Justicia* sp.		4	G	Shrub	UN		A.S. Maranho 6209
Achariaceae	*Lindackeria paludosa* (Benth.) Gilg		3	G & U	Shrub	UN		A.S. Maranho 6249
Annonaceae	*Anaxagorea brevipes* Benth.		1	G	Tree	ES		A.S. Maranho 6243
	Duguetia hadrantha (Diels) R.E.Fr.	Ata	2	G & U	Tree	UN		A.S. Maranho 6231
	Guatteria olivacea R.E.Fr.	Envira fofa	10	G & U	Tree	UN		A.S. Maranho 6223
	Malmea sp.	Envireira	16	G & U	Shrub	UN		A.S. Maranho 6232
	Xylopia sp.	Envira fofa	2	G & U	Tree	UN		
Apocynaceae	*Aspidosperma parvifolium* A.DC.	Amarelão	23	G & U	Tree	ES		A.S. Maranho 6199
	Aspidosperma rigidum Rusby	Carapanaúba amarela	6	G & U	Tree	ES		A.S. Maranho 6200
	Geissospermum sericeum Miers	Quina quina amarela	3	G & U	Tree	ES		A.S. Maranho 6307
	Himatanthus sucuuba (Spruce ex Müll.Arg.) Woodson	Sucuuba	7	G & U	Tree	ES		H. Medeiros 1743
Bignoniaceae	*Handroanthus serratifolius* (A.H.Gentry) S.Grose	Pau d'arco amarelo	2	G & U	Tree	ES		
Boraginaceae	*Cordia alliodora* (Ruiz & Pav.) Cham.	Freijó preto	2	G	Tree	ES		A.S. Maranho 6295
	Cordia nodosa Lam.	Freijó branco	8	G & U	Tree	P		A.S. Maranho 6296
Burseraceae	*Protium subserratum* (Engl.) Engl.	Breuzinhdo de capoeira	2	G	Tree	ES		A.S. Maranho 6313
	Protium unifoliolatum Engl.	Breu	1	U	Tree	ES		H. Medeiros 1687
	Tetragastris altissima (Aubl.) Swart	Breu vermelho	28	G & U	Tree	LS		A.S. Maranho 6293
Cannabaceae	*Celtis schippii* Trel. ex Standl.	Farinha seca	34	G & U	Tree	UN		R.S. Saraiva 3925
Caricaceae	*Jacaratia spinosa* (Aubl.) A.DC.	Jaracatiá	3	G	Tree	P	LC	A.S. Maranho 6260
Celastraceae	*Cheiloclinium* sp.		1	G	Tree	UN		
	Salacia sp.		1	G		UN		A.S. Maranho 6312
Chrysobalanaceae	*Hirtella racemosa* var. *racemosa* Lam.	Macucu mirim	25	G & U	Tree	LS	LC	D.C. Daly 5544
	Licania caudata Prance	Macucu	5	G & U	Tree	LS		A.S. Maranho 6304
Clusiaceae	*Vismia guianensis* (Aubl.) Choisy	Lacre	1	G	Tree	P		A.S. Maranho 6208
Combretaceae	*Terminalia amazonia* (J.F.Gmel.) Exell	Mirindiba amarela	3	G	Tree	LS		A.S. Maranho 6252
Ebenaceae	*Diospyros* sp.	Sete camadas	5	G & U	Tree	UN		A.S. Maranho 6280
Elaeocarpaceae	*Sloanea guianensis* (Aubl.) Benth.	Urucuruana	13	G & U	Tree	ES		A.S. Maranho 6242
Euphorbiaceae	*Acalypha macrostachya* Jacq.		1	G	Shrub	P		A.S. Maranho 6214
	Aparisthmium cordatum (A.Juss.) Baill.	Marmelo	1	U	Tree	P		A.S. Maranho 6302
	Conceveiba guianensis Aubl.	Breu branco	1	G	Tree	LS		A.S. Maranho 6206
	Hevea brasiliensis (Willd. ex A.Juss.) Müll.Arg.	Seringueira	10	G & U	Tree	LS		M. Silveira 3120
	Nealchornea sp.		14	G	Tree	UN		A.S. Maranho 6319
Fabaceae: Caesalpinioideae	*Apuleia leiocarpa* (Vogel) J.F.Macbr.	Cumaru cetim	2	G	Tree	ES	VU	A.S. Maranho 6215
	Barnebydendron riedelii (Tul.) J.H.Kirkbr.	Guaribeiro	1	G	Tree	LS		A.S. Maranho 6248
	Dialium guianense (Aubl.) Sandwith	Tamarindo	15	G & U	Tree	LS		A.S. Maranho 6269
	Hymenaea parvifolia Huber	Jutaí	1	G	Tree	LS	VU	A.S. Maranho 6203
	Poeppigia procera C.Presl	Pintadinho	1	G	Tree	ES		A.S. Maranho 6236
	Tachigali sp.	Tachi peludo	1	U	Tree	UN		A.S. Maranho 6305
	Tachigali setifera (Ducke) Zarucchi & Herend.	Tachi vermelho	59	G & U	Tree	ES		A.S. Maranho 6233
Fabaceae: Faboideae	*Amphiodon effusus* Huber	Sucupira mirim	30	G & U	Tree	LS		A.S. Maranho 6281

Continued

Table 1. *Continued.*

Family	Species	Common names	Abun-dance	Habitat[1]	Habit	Functional groups[2]	Threat status[3]	Voucher
	Bowdichia sp.	Sucupira preta	2	G	Tree	UN		A.S. Maranho 6198
	Erythrina sp.	Mulungu vermelho	4	G	Tree	UN		
	Myroxylon balsamum (L.) Harms	Bálsamo	1	G	Tree	ES		A.S. Maranho 6286
	Ormosia sp.	Mulungu vermelho	5	G & U	Tree	UN		A.S. Maranho 6278
	Pterocarpus amazonum (Benth.) Amshoff	Pau sangue de casca fina	4	G	Tree	ES		A.S. Maranho 6210
	Swartzia oraria R.S.Cowan	Pitaíca	8	G & U	Tree	LS		A.S. Maranho 6265
	Swartzia sp.		2	G	Tree	UN		A.S. Maranho 6266
	Vatairea fusca (Ducke) Ducke	Amargoso	1	G	Tree	UN		A.S. Maranho 6211
Fabaceae: Mimosoideae	*Abarema laeta* (Benth.) Barneby & J.W.Grimes		1	G	Tree	P		A.S. Maranho 6283
	Anadenanthera sp.	Fava branca	1	G		UN		
	Enterolobium maximum Ducke	Timbaúba	1	G	Tree	UN		A.S. Maranho 6193
	Inga cylindrica (Vell.) Mart.	Ingá cilíndrica	1	G	Tree	P		A.S. Maranho 6235
	Inga sp. 1	Ingá	1	G	Tree	UN		
	Inga sp. 2	Ingá ferro	16	G & U	Tree	UN		A.S. Maranho 6320
	Inga sp. 3	Ingá preta	4	G	Tree	UN		A.S. Maranho 6196
	Inga sp. 4	Ingá vermelha	40	G & U	Tree	UN		
	Stryphnodendron guianense (Aubl.) Benth.	Baginha	1	G	Tree	P		A.S. Maranho 6258
Lauraceae	*Endlicheria* sp.	Louro peludo	1	G	Tree	UN		A.S. Maranho 6221
	Mezilaurus itauba (Meisn.) Taub. ex Mez	Itaúba	2	U	Tree	LS	VU	A.S. Maranho 6303
	Mezilaurus sprucei (Meisn.) Taub. ex Mez	Louro itaúba	10	G & U	Tree	UN		A.S. Maranho 6212
	Ocotea bofo Kunth		1	U	Tree	LS		A.S. Maranho 6306
	Ocotea oblonga (Meisn.) Mez	Louro abacate	1	G	Tree	LS		A.S. Maranho 6297
	Ocotea sp. 1	Louro preto	8	G & U	Tree	UN		A.S. Maranho 6254
	Ocotea sp. 2	Louro	12	G & U	Tree	UN		A.S. Maranho 6317
Lecythidaceae	*Couratari guianensis* Aubl.	Tauari	20	G & U	Tree	LS	LC	A.S. Maranho 6234
	Eschweilera coriacea (DC.) S.A.Mori	Matá matá	5	G & U	Tree	LS		W. Castro 5329
	Eschweilera truncata A.C.Sm.	Matá matá preto	8	G & U	Tree	UN	LC	A.S. Maranho 6225
	Gustavia augusta L.	Castanharana	24	G & U	Tree	ES		A.S. Maranho 6253
Malvaceae	*Herrania nitida* (Poepp.) R.E.Schult.	Cacau jacaré	2	G	Tree	LS		A.S. Maranho 6279
	Lueheopsis sp.		1	U		UN		
	Pseudobombax munguba (Mart. & Zucc.) Dugand	Munguba	2	G	Tree	ES		A.S. Maranho 6207
	Quararibea guianensis Aubl.	Envira sapotinha	31	G & U	Tree	LS		A.S. Maranho 6267
	Sterculia sp.	Xixá	3	G & U	Tree	UN		A.S. Maranho 6244
	Theobroma obovatum Klotzsch ex Bernoulli	Cacaurana	22	G & U	Tree	UN		A.S. Maranho 6230
	Theobroma sp.	Cacau jacaré	1	U	Tree	UN		
	Huberodendron swietenioides (Gleason) Ducke		3	G & U	Tree	UN		A.S. Maranho 6213
Melastomataceae	*Miconia affinis* DC.	Buxixu	4	G & U	Shrub	P		A.S. Maranho 6259
	Miconia sp.	Buxixu	4	G		P		
	Mouriri myrtifolia Spruce ex Triana	Murirí	7	G	Tree	LS		A.S. Maranho 6216
	Mouriri sp.	Murirí	1	U	Tree	UN		
Meliaceae	*Carapa guianensis* Aubl.	Andiroba	1	U	Tree	LS		D.C. Daly 2450

Continued

Table 1. *Continued.*

Family	Species	Common names	Abundance	Habitat[1]	Habit	Functional groups[2]	Threat status[3]	Voucher
	Guarea sp..	Jitó	42	G & U	Tree	UN		A.S. Maranho 6322
	Trichilia pleeana (A.Juss.) C.DC.	Maraximbé	4	G & U	Tree	UN		A.S. Maranho 6247
Moraceae	*Brosimum alicastrum* Sw.	Inharé mole	2	U	Tree	LS		H. Medeiros 3957
	Brosimum guianense (Aubl.) Huber	Inharé	54	G & U	Tree	ES		A.S. Maranho 6264
	Brosimum lactescens (S.Moore) C.C.Berg	Manitê	7	G & U	Tree	LS	LC	A.S. Maranho 6224
	Castilla ulei Warb.	Caucho	1	G	Tree	LS		H. Medeiros 3924
	Clarisia ilicifolia (Spreng.) Lanj. & Rossberg	Janita	25	G & U	Tree	LS		A.S. Maranho 6276
	Clarisia racemosa Ruiz & Pav.	Guariúba amarela	9	G & U	Tree	LS		A.S. Maranho 6239
	Naucleopsis glabra Spruce ex Pittier	Muiratinga	13	G & U	Tree	UN		A.S. Maranho 6270
	Perebea mollis (Poepp. & Endl.) Huber	Pama caucho	19	G & U	Tree	LS		A.S. Maranho 6268
	Pseudolmedia laevis (Ruiz & Pav.) J.F.Macbr.	Pama	40	G & U	Tree	LS		A.S. Maranho 6323
	Pseudolmedia macrophylla Trécul	Pama grande	2	G	Tree	LS		A.S. Maranho 6299
	Sorocea muriculata Miq.		1	G	Tree	UN		A.S. Maranho 6192
	Sorocea sp.	Jaca brava	32	G & U	Tree	UN		A.S. Maranho 6238
Myristicaceae	*Compsoneura ulei* Warb.	Ucuuba	8	G & U	Tree	UN		A.S. Maranho 6277
	Iryanthera juruensis Warb.	Ucuuba sangue de boi	3	G & U	Tree	LS		A.S. Maranho 6255
	Virola minutiflora Ducke	Ucuuba	1	G	Tree	UN		A.S. Maranho 6257
	Virola multinervia Ducke	Ucuuba preta	7	G & U	Tree	UN		A.S. Maranho 6227
	Virola sp.	Ucuuba vermelha	1	G	Tree	UN		A.S. Maranho 6191
Myrtaceae	*Eugenia acrensis* McVaugh	Araçá	2	G & U	Tree	LS		A.S. Maranho 6300
	Eugenia sp. 1	Araçá	1	G & U	Tree	UN		
	Eugenia sp. 2	Araçá	51	G	Tree	UN		A.S. Maranho 6282
Nyctaginaceae	*Neea floribunda* Poepp. & Endl.	João mole	36	G & U	Tree	ES		W. Castro 5676
	Neea sp. 1	João mole	2	G	Tree	UN		
	Neea sp. 2		3	G & U	Tree	UN		A.S. Maranho 6217
Olacaceae	*Aptandra tubicina* (Poepp.) Benth. ex Miers	Castanha de cotia	3	G & U	Tree	ES		A.S. Maranho 6226
	Chaunochiton kappleri (Sagot ex Engl.) Ducke	Casca roxa	2	G	Tree	ES		A.S. Maranho 6195
	Heisteria duckei Sleumer	Itaubarana	3	G & U	Tree	LS		A.S. Maranho 6263
	Minquartia guianensis Aubl.	Aquariquara	3	G & U	Tree	LS		A.S. Maranho 6205
Piperaceae	*Piper arboreum* Aubl.	Pimenta longa amarela	5	G	Shrub	P		L. Coêlho 14
	Piper hispidinervum C.DC.	Pimenta longa amarela	7	G	Shrub	P		A.S. Maranho 6289
	Piper sp. 1	Pimenta longa	216	G & U	Shrub	P		A.S. Maranho 6273
	Piper sp. 2	Pimenta longa	15	G & U	Shrub	P		A.S. Maranho 6315
	Piper sp. 3	Pimenta longa preta	5	G & U	Shrub	P		A.S. Maranho 6314
Polygonaceae	*Triplaris* sp.	Tachi preto	7	G	Tree	ES		
Primulaceae	*Cybianthus guyanensis* subsp. *pseudoicacoreus* (Miq.) Pipoly		1	G	Tree	UN		A.S. Maranho 6251
Putranjivaceae	*Drypetes amazonica* Steyerm.		7	G & U	Tree	ES		A.S. Maranho 6308
Rubiaceae	*Alibertia claviflora* K.Schum.	Apuruí	3	G & U	Tree	UN		A.S. Maranho 6294
	Alibertia sp.		1	U	Tree	UN		A.S. Maranho 6309
	Alseis sp.	Pau de remo	1	G		UN		

Continued

Table 1. *Continued.*

Family	Species	Common names	Abun-dance	Habitat[1]	Habit	Functional groups[2]	Threat status[3]	Voucher
	Amaioua guianensis Aubl.	Canela de veado	3	G & U	Tree	ES		A.S. Maranho 6311
	Capirona decorticans Spruce	Mamaluco	4	G	Tree	ES		A.S. Maranho 6262
	Faramea capillipes Müll. Arg.	Taboquinha	84	G & U	Tree	UN		A.S. Maranho 6229
	Palicourea sp.		8	G	Tree	LS		A.S. Maranho 6285
	Psychotria hoffmannseggiana (Willd. ex Schult.) Müll.Arg.		16	G & U	Shrub	UN		A.S. Maranho 6197
	Psychotria lupulina Benth.		1	G	Shrub	UN		A.S. Maranho 6190
	Psychotria sp. 1		16	G & U	Shrub	UN		
	Psychotria sp. 2	Chacrona	2	G	Shrub	UN		A.S. Maranho 6201
	Randia armata (Sw.) DC.	Espinho de judeu	3	U	Shrub	ES		A.S. Maranho 6288
	Indet. 4		3	G		UN		
Rutaceae	*Metrodorea flavida* K.Krause	Pirarara	2	G	Tree	LS		A.S. Maranho 6261
Salicaceae	*Banara nitida* Spruce ex Benth.	Cabelo de cotia	2	G	Tree	ES		A.S. Maranho 6194
	Casearia gossypiosperma Briq.	Laranjinha	5	G & U	Tree	ES	LC	A.S. Maranho 6202
	Lunania sp. Hook.		1	U		UN		
Sapindaceae	*Allophylus pilosus* (J.F.Macbr.) A.H.Gentry	Vela branca	23	G & U	Tree	LS		A.S. Maranho 6237
	Talisia cerasina (Benth.) Radlk.	Breu pitomba	6	G & U	Shrub	LS		A.S. Maranho 6290
Sapotaceae	*Pouteria caimito* (Ruiz & Pav.) Radlk.	Abiu amarelo	17	G & U	Tree	LS		A.S. Maranho 6272
	Pouteria campanulata Baehni	Abiurana ferrugem	2	G & U	Tree	LS		A.S. Maranho 6204
	Pouteria hispida Eyma	Abiurana casca fina	10	G & U	Tree	LS		A.S. Maranho 6291
	Pouteria sp. 1	Abiurana dura	3	G & U	Tree	UN		A.S. Maranho 6298
	Pouteria sp. 2	Abiurana peluda	2	G & U	Tree	UN		
	Pouteria sp. 3	Abiu amarelo	1	U	Tree	UN		
	Pradosia atroviolacea Ducke	Massarandubinha	8	G	Tree	UN	DD	A.S. Maranho 6245
Siparunaceae	*Siparuna guianensis* Aubl.	Capitiú	36	G & U	Tree	ES		A.S. Maranho 6274
Solanaceae	*Brunfelsia grandiflora* D.Don	Manacá	7	G & U	Shrub	UN		A.S. Maranho 6241
Thymelaeaceae	*Schoenobiblus peruviana* Standl.	Envira seda	2	G	Tree	UN		A.S. Maranho 6301
Ulmaceae	*Ampelocera* sp.	Envira iodo	10	G & U	Tree	UN		
Urticaceae	*Pourouma cecropiifolia* Mart.	Torém	1	G	Tree	ES		A.S. Maranho 6287
	Pourouma guianensis Aubl.	Torém	7	G	Tree	P		A.S. Maranho 6292
	Pourouma minor Benoist	Torém mapati	20	G & U	Tree	ES		A.S. Maranho 6275
	Urera sp.	Cansanção	2	G		UN		
Violaceae	*Amphirrhox* sp.		38	G & U	Tree	UN		A.S. Maranho 6271
	Leonia glycycarpa Ruiz & Pav.	Fruto de macaco	12	G & U	Tree	UN		A.S. Maranho 6218
	Rinoreocarpus ulei (Melch.) Ducke	Estalador	20	G & U	Tree	ES		A.S. Maranho 6222
Vochysiaceae	*Qualea grandiflora* Mart.	Catuaba roxa	7	G & U	Tree	LS		A.S. Maranho 6256

[1]Habitat: G = gaps and U = understory; [2]Functional groups: P = pioneers species, ES = early secondary species, LS = late secondary species, and UN = "unclassified; [3]Status available only for the species present in the Brazilian Flora Red List, where: VU = vulnerable, LC = least concern, DD = data deficient.

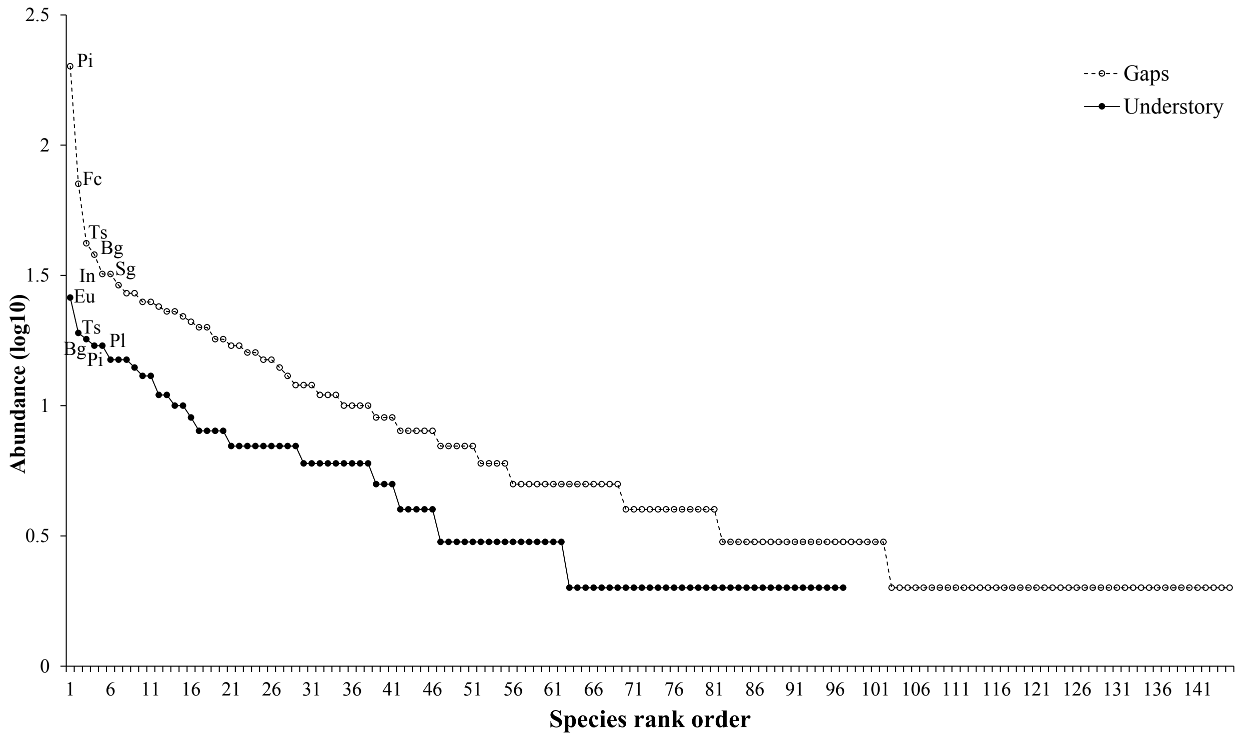

Figure 2. Species abundance distribution curves (SAD) for gaps and understorey. Pi=*Piper* sp.1; Fc=*Faramea capillipes*; Ts=*Tachigali setifera*; Bg=*Brosimum guianense*; In=*Inga* sp.4; Sg=*Siparuna guianensis*; Eu=*Eugenia* sp.2; Pl=*Pseudolmedia laevis*.

(Vogel), *Hymenaea parvifolia* Huber and *Mezilaurus itauba* (Meisn.) Taub. ex Mez) are commercially exploited in the Amazon, mainly for timber. Such a status for these species mean that more attention is needed when harvesting permits are granted from government.

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