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# Composition, structure and floristic diversity in dense rain forest in the Eastern Amazon, Amapá, Brazil

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**ABSTRACT.** This study aims to evaluate the phytosociology and floristic composition of tree species in the eastern Amazon, at the Iratapuru River Sustainable Development Reserve (RDS), State of Amapá. Fouteen quarters with dimensions of 100 m x 100 m were randomly inventoried, and 50 sub-plots of 10 m x 20 m were established. In each sub-plot all living individuals were sampled, being taken from the height data and DAP (breast height diameter) for tree species ≥ 10 cm. A total of 5,233 individuals belonging to 33 families and 184 species were registered. The families with the largest number of species were Fabaceae (32), Lauraceae (17), Sapotaceae (12), Moraceae (10), Lecythidaceae (8) and Annonaceae (8). The six most abundant families (18.18% of total families) in the present study were responsible for more than half (57.92%) of the total number of species. The floristic structure of the area studied was diverse, with species of varied interests, including: medicinal, timber and oil-producing.

**Keywords:** biodiversity, Laranjal do Jari, vegetation.

## Composição, estrutura e diversidade florística em floresta ombrófila densa na Amazônia Oriental, Amapá, Brasil

**RESUMO.** Este trabalho objetiva avaliar a composição florística e a fitossociologia de espécies arbóreas na Amazônia Oriental, Reserva de Desenvolvimento Sustentável do Rio Iratapuru, Estado do Amapá. Foram inventariados 14 quadrantes de 100 m x 100 m distribuídos aleatoriamente, onde se estabeleceram 50 sub-parcelas de 10 m x 20 m. Em cada sub-parcela foram amostrados todos os indivíduos vivos, sendo tomados dados de altura e DAP (diâmetro a altura do peito) para espécies arbóreas ≥10 cm. Foram registrados 5.233 indivíduos distribuídos em 33 famílias e 184 espécies. As famílias com maior número de espécies foram Fabaceae (17), Lauraceae (17), Sapotaceae (12), Moraceae (10), Lecythidaceae (8) e Annonaceae (8). Essas seis famílias mais abundantes (18,18% total das famílias) presentes no estudo foram responsáveis por mais da metade (57,92%) do número total de espécies. A estrutura florística da área estudada mostrou-se diversificada, apresentando espécies de interesses variados, como medicinal, madeireira e oleífera.

**Palavras-chave:** biodiversidade, Laranjal do Jari, vegetação.

## Introduction

Brazil, with approximately one third of the tropical forests in the world, is one of the most important repositories of the global biodiversity (SILVA et al., 2008). The Amazon biome represents about 30% of all remaining tropical forests in the world (SFB, 2010). Its importance is recognized nationally and internationally mainly due to its large extension, with almost 4.2 million km$^2$ and enormous diversity of environments, with 53 major ecosystems (SAYRE et al., 2008).

The State of Amapá is located at the north end of the country, with more than 143,000 square kilometers of area; its predominant vegetation consists of dense rain forest. The state has several areas protected by the law, totaling 19 (nineteen), of which 2 are municipal, 5 state and 12 federal. The Sustainable Development Reserve of the Iratapuru River was created by the State Law No. 0392 of 11 December 1997 and covers a total area of 6174.80 km$^2$ (RABELO et al., 2004), having as primary objective to preserve, maintain the ecological balance and promote the sustainable exploitation of natural resources in the region.

The floristic survey is justified by the scarcity of data on the flora and the importance to expand the list of species in that region, thus contributing to the development of management activities and supporting projects with the purpose of area conservation.

The present study aims to characterize the phytosociology and floristic composition in the native forest of the Iratapuru River Sustainable Development Reserve, in the extreme north of Brazil, associating aspects of diversity, structure and conservation condition.

## Material and methods

### Study Area

The specific condition of the floristic studies, is connected with the path along the Iratapuru River (Iratapuru River RDS), in the municipality of Laranjal do Jari, which entirely crosses the reserve in the direction north / south and constitutes the most important water stream. Their geographical boundaries include the following coordinates: latitude 00°52'36" N and 00°20'12" S; and longitude 52° 07'15” W and 52° 09'45" E.

The location area is under the hot and humid tropical climate domain, characterized by temperatures that vary between 27 and 30°C, with annual rainfall index around 2400 mm. The rainy season extends from December to July, and the dry period occurs from August to November. The hydrography is constituted by the Iratapuru River watershed, affluent of the Jari River.

This environment is also characterized by its richness in biodiversity, high-scale structural formation, frequency of essences of high economic value, complex functional chain, among others (ZEE, 2002). The soils predominant in the area are yellow latosol and in some areas there is the presence of red podzolic and also clayey. (RADAM, 1974). It is constituted by lithological sets that are part of the lithostratigraphic units belonging to the Vila Nova group, Tumucumaque complex, in the Mapuera Intrusive and Sedimentary Suites of the Amazon River basin. It is part of the Curuá Shale formation with dark gray and black color and whitish red siltstones, having been raised strongly as a rugged terrain. The soil present formations with natural depressions found in Northern Amazon, dissected plateaus of the sedimentary basin standing out that are predominant in the area; a type of elongated hill characterizes the land relief; and the hills are composed of recessed and dissected surfaces (ZEE, 2002)

### Data Collection

In the study area, 50 sub-plots of 10 m x 20 m in quadrants of 100 m x 100 m were allocated, with a total of 14ha inventoried. The 14 parcels are located at coordinates - Datum SAD 69 (P1 - W 52°31’50”/S 0°25’44.185”; P2 - W 52°32’45.712”/S 0°26’50.202”; P3 - W 52°34’19.304”/S 0°29’0.934”; P4 - W 52°34’14.161”/S 0°28’57.875”; P5 – W 52°31’5.644”/S 0°0’41.773”; P6 - W 52°30’11.117”/S 0°0’0.488”; P7 – W 52°30’ 34.209”/S 0°0’0.847”; P8 - W 52°31’19.390”/S 0°2’23.974”; P9 - W 52°32’1.402”/S 0°3’32.770”; P10 - W 52°29’28.977”/S 0°1’6.518”; P11 - W 52°29’19.857”/S 0°0’7.196”; P12 - W 52°29’22.932”/S 0°0’7.321”; P13 - W 52°29’33.020”/N 0°0’30.443” and P14 - W 52°29’9.540” / N 0°0’37.801”).

It was sampled all living individuals in each sub-plot, with collection of height and DBH (diameter at breast height) from the individuals higher than 10 cm of the tree species. The species were identified in the field and the unidentified specimens were subsequently recognized in the Amapaense Herbarium (HAMAB - IEPA). It was used the system APG III (2009) with the purpose of classifying the plants.

The phytosociological parameters for the horizontal structure were estimated according to Mueller-Dombois and Ellenberg (1974). The diametric structure was characterized by the distribution of the number of trees, basal area by hectare, species and the diameter class. In order to analyze the vertical structure, the forest was classified into three vertical total height strata (HT), as described by Souza et al. (2003): lower stratum (EI) – trees with $HT < (Hm - 1\sigma)$; middle stratum (EM) – trees with $(Hm - 1\sigma) \leq HT < (Hm + 1\sigma)$; upper stratum (ES) – trees with $HT \geq (Hm + 1\sigma)$, where Hm is the average and $\sigma$ is the standard deviation of the total height (HT) of the individuals sampled.

The floristic diversity was evaluated through the Shannon-Wiener Diversity Index. The similarity matrix was obtained using the Sorensen Similarity Index that originated the dendogram grouping based on the group average. The program Fitopac 2.1 was used to classify the communities analyzed (SHEPHERD, 2009). A specific software, the Mata Nativa 2 (CIENTEC, 2006), processed the data collected in the field. The variables estimated were: relative frequency, relative density, relative abundance and importance value index, as Mueller-Dombois and Ellenberg (1974).

## Results and discussion

The stabilization of the collector’s curve (Figure 1) showed that the species sampled within the 14 hectares inventoried are representative of the floristic composition for the tree strata of the forest studied, showing that the treatment was sufficient to express the vegetal diversity of this ecosystem. This observation confirms the stability and state of conservation (undisturbed) for the vegetation of the study area.

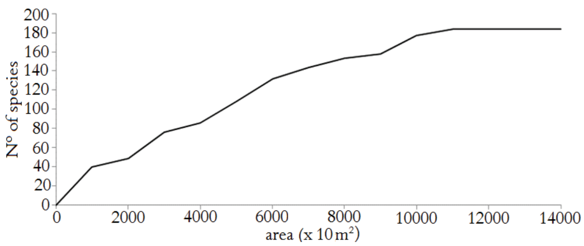
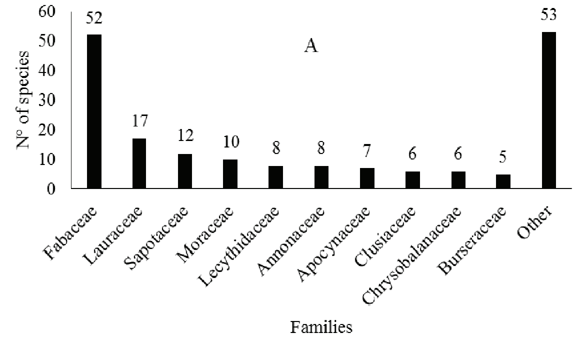



**Figure 1.** Species-area curve for 14 ha sampled in dense forest of solid land in Eastern Amazon, Amapá, Brazil.

Rgarding the 14 hectares sampled, it was recorded 5,233 trees distributed into 33 families and 184 species. Families with large number of species were Fabaceae (32); Lauraceae (17); Sapotaceae (12); Moraceae (10); Lecythidaceae (8); Annonaceae (8); Apocynaceae (7); Clusiaceae (6); Chrysobalanaceae (6) and Burseraceae (5). These 10 families account for approximately 61% of the total number of species, indicating that the diversity of plants concentrates in few botanical families, in line with other studies (OLIVEIRA et al., 2008; PEREIRA et al., 2011; SILVA et al., 2014). On the other hand, around 5% of the families (9 families) totaled only a single species, not because they are monospecific, but they are constituted by few species in the sites studied, therefore, they are more difficult to be found (Figure 2A).

The most abundant families based on individual numbers were: Fabaceae with around 20% of the total, followed by Sapotaceae (12.1%), Burseraceae (11.89%), Quiinaceae (10.34%), Lauraceae (7.45%), Myristicaceae (6.96%), Lecythidaceae (5.87%), Moraceae (5.66%) Malvaceae (4.47%) and Annonaceae (2.66%) (Figure 2B).

According to H. Ter Steege et al. (2013) these families have a proportion of hyperdominance in the Amazon and exist throughout all types of forests presenting a singular dominance pattern, in line with the results of the present study. The same authors consider that the family Fabaceae assumes major importance in the typology of the Amazon forests, corroborating the publications reported by Carim, 2007; Pereira et al. (2011); Carim et al. (2013); H. Ter Steege et al. (2013); Condé and Tonini (2013) and Silva et al. (2014). It seems evident that exists a hierarch among families in the Amazon and possibly these hierarch are responsible for the physiognomic elements of the flora.



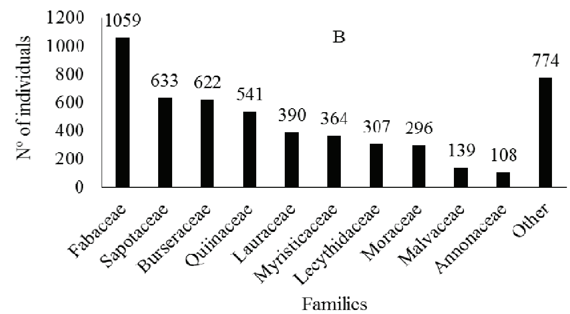




**Figure 2.** Distribution of the number of species (A) and individuals (B) of the 10 major botanical families sampled in dense forest of dry land in Eastern Amazon, Amapá, Brazil.

Approximately 24% of the species occur with a single individual, unlike the results presented by Silva et al. (2008) and Oliveira et al. (2008) who found this in 49 and 44% of the species, respectively. It is evident that the sampling effort in the present study tends to minimize the sampling errors that do not reflect the minimum necessary.

The diametric structure indicated that approximately 74% of the individuals are distributed in the first two classes, which group individuals from 10 to 30 cm in diameter. Only 1.06% of the sampled individuals occupy the last two classes of diameter, above 120 cm (Figure 3). The distribution follows the J-inverted pattern, possibly influenced by the dynamics of natural mortality and new individuals recruited in the community that reflects on the local diversity of species (GONÇALVES; SANTOS, 2008).

Another explanation for the small DBH of the species observed is the occurrence of palm trees and pioneers colonizing clear areas, relatively frequent in this typology of forest. To Oliveira et al. (2008), the behavior of the descending curve indicates absence or low anthropic pressure on the forest environment, which is ratified by the high floristic diversity found. With the exception of species legally protected such as *Bertholletia excelsa* Bonpl. and *Hevea brasiliensis* (Willd. ex A.Juss.) Müll. Arg., around 3.5% of the individuals are above 80 cm in diameter, which correspond to approximately 13 ind $ha^{-1}$.

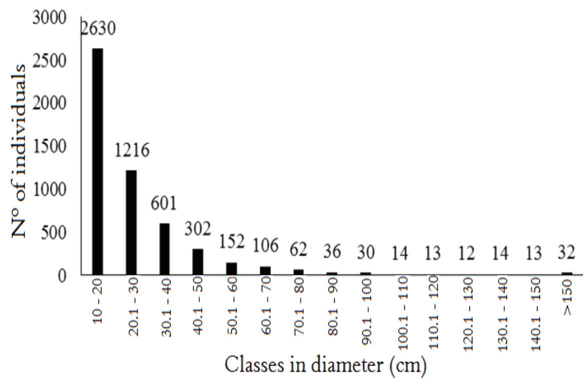



**Figure 3.** Diameter Classes (DBH ≥ 10 cm) of the individuals sampled in dense forest of solid land in Eastern Amazon, Amapá, Brazil

The Figure 4 (A and B) shows the individual distribution in different height classes, reflecting the sociological structure of the species and their formed strata. It was verified the formation of three strata; the first is composed of individuals higher than 24.62 m in height corresponding to about 15% of the total of trees sampled. They are individuals with high treetops, formed by occasional trees, emergent, always arranged above the canopy. According to Marangon et al. (2008), this is a peculiar situation in primary forests.

The second stratum, considered intermediary, composed of individuals between 11.04 and 24.62 m in height, composing the upper canopy and primary forest, accounting for about 72% of the trees sampled, characterizing the environment of the phytocenoses. As for the first layer, composed of trees with heights lesser than 11.03 m and that permeate the lowest canopy of the forest, it holds approximately 14% of the individuals sampled. In any case, we have a uniform canopy showing a landscape with median height, with emerging plants standing out in the canopy, being the main representatives (*Bertholletia excelsa*, *Dinizia excelsa*, *Caryocar villosum, Tachigali myrmecophyla*). The lower stratum, featuring sub-canopy trees of smaller size, commonly pressured by the lack of light, maintains close relationships with the canopy, sharing individuals in two stratum, including *Rinorea racemosa* (Mart.) Kuntze, *Inga stipularis* DC, *Gustavia augusta* L. *Goupia glabra* Aubl., *Protium apiculatum* Swart., *Sterculia pruriens* (Aubl.) K. Schum, among others. This composition in the vertical structure of the individuals shows a forest of median canopy, mainly formed by mesophanerophytes of up to 25 meters in height, where few emergent dominate the phytosociology, among them, *B. excelsa*, *Pouteria sp*. and *Dipteryx odorata* (Aubl.) Willd.

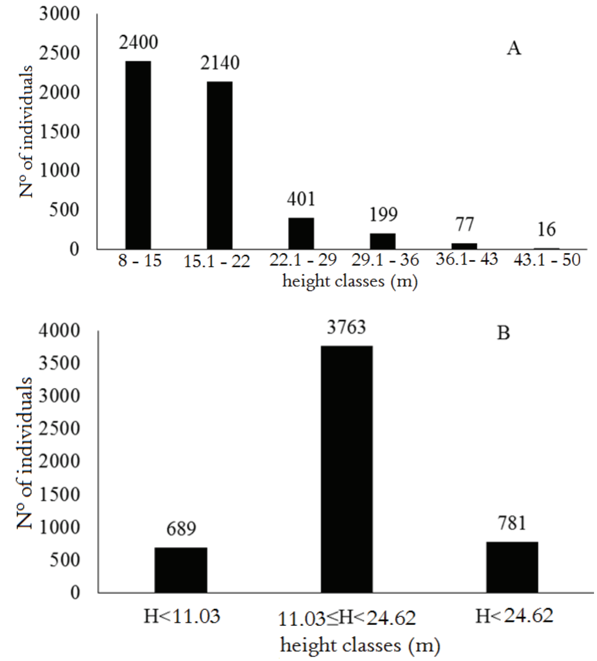



**Figure 4.** Distribution of height classes of individuals sampled in dense forest of solid land in Eastern Amazon, Amapá, Brazil.

Considering the main species with their respective importance values, *B. excelsa* was the most important with 29.2 of Importance Value Index (IVI), occupying the 14th position related to the number of individuals (93); *Geissospermum vellosii* Allemão*,* with the highest number of individuals (541) assumed the second position of IVI with 19.78 of importance. *Pouteria guianensis* Aubl. was placed third in sociological importance, with 17 of IVI, assuming the second position in number of individuals (474). *Protium decandrum* (Aubl.) Marchand and *Protium pallidum* Cuatrec., with 281 and 269 individuals ranked the fourth and fifth positions of importance value index with 9.1 and 8.5, respectively. In Table 1, it is listed the 100 main species in order of IVI.

The species *Licania heteromorpha, Manilkara huberi, Aniba guianensis, Pouteria* sp, *Hymenolobium excelsum* and *Inga* sp., among others, are commonly cited in most studies developed in ecosystems of dry land of the Amazon (OLIVEIRA et al., 2008; CARIM et al., 2013), where they represent the ten most important species, considering the index. Among all sampled species, *Bertholletia excelsa, Geyssospermum vellosi*, *Pouteria guianensis, Protium decandrum, Protium sagotianum, Theobroma. subincanum*, *Eschweilera odora* and *Licaria canella* appeared in all parcels. *Bertholletia excelsa, Eschweilera odora* stand out due to the size of their individuals, yielding high dominance. On the other hand, *Geyssospermum vellosi, Pouteria guianensis, Protium decandrum, Theobroma subincanum* and *Licaria canella,* possess higher density, justifying their elevated index recorded in the present study.

**Table 1.** Phytosociological parameters in descending order of the 100 species of greatest importance in the RDS.

| Species | N | AB | DR | FR | DoA | DoR | IVI |
|---|---|---|---|---|---|---|---|
| *Bertholletia excelsa* Bonpl | 93 | 143.2 | 1.7 | 1.41 | 10.23 | 26.12 | 29.2 |
| *Geissospermum vellosii* Alemão | 541 | 47.2 | 9.8 | 1.41 | 3.369 | 8.6 | 19.8 |
| *Pouteria guianensis* Aubl. | 474 | 38.3 | 8.6 | 1.41 | 2.734 | 6.98 | 17.0 |
| *Protium decandrum* (Aubl.) | 281 | 14.2 | 5.1 | 1.41 | 1.017 | 2.6 | 9.1 |
| *Protium pallidum* Cuatrec. | 269 | 12.4 | 4.9 | 1.41 | 0.886 | 2.26 | 8.5 |
| *Cecropia peltata L.* | 206 | 2 | 3.9 | 1.14 | 0.155 | 1.87 | 7 |
| *Theobroma subincanum* Mart. | 190 | 6.3 | 3.4 | 1.41 | 0.45 | 1.15 | 6.0 |
| *Osteophloeum platyspermum* (A.DC.)Warb. | 130 | 6.4 | 2.4 | 1.31 | 0.454 | 1.16 | 4.8 |
| *Eschweilera odora* (Poepp. ex O.Berg) Mier | 107 | 6.4 | 1.9 | 1.41 | 0.456 | 1.16 | 4.5 |
| *Minquartia guianensis* Aubl. | 105 | 6.6 | 1.9 | 1.31 | 0.473 | 1.21 | 4.4 |
| *Iryanthera sagotiana* (Benth.) Warb. | 123 | 5.3 | 2.2 | 1.21 | 0.377 | 0.96 | 4.4 |
| *Pentaclethra macroloba* (Wild.) O. Kuntze | 137 | 6.6 | 2.5 | 0.71 | 0.474 | 1.21 | 4.4 |
| *Inga paraensis* Ducke | 91 | 7.3 | 1.6 | 1.31 | 0.519 | 1.32 | 4.3 |
| *Vouacapoua americana* Aubl. | 119 | 6.1 | 2.2 | 0.91 | 0.437 | 1.12 | 4.2 |
| *Swartzia racemosa* Benth. | 75 | 7.9 | 1.4 | 1.31 | 0.563 | 1.44 | 4.1 |
| *Dipteryx odorata* (Aubl.) Willd. | 48 | 10.2 | 0.9 | 1.21 | 0.731 | 1.87 | 3.9 |
| *Tachigali myrmecophila* (Ducke) Duck | 73 | 8.2 | 1.3 | 1.01 | 0.586 | 1.5 | 3.8 |
| *Licaria canella* (Meisn.) Kosterm | 78 | 5.0 | 1.4 | 1.41 | 0.354 | 0.9 | 3.7 |
| *Manilkara huberi* (Ducke) Standl. | 37 | 8.4 | 0.7 | 1.21 | 0.603 | 1.54 | 3.4 |
| *Ocotea nusiana* (Miq.) Kosterm | 74 | 4.1 | 1.3 | 1.31 | 0.29 | 0.74 | 3.4 |
| *Ocotea rubra* Mez. | 61 | 4.7 | 1.1 | 1.01 | 0.333 | 0.85 | 3.0 |
| *Lecythis poiteaui* O. Berg | 41 | 7.6 | 0.7 | 0.81 | 0.544 | 1.39 | 2.9 |
| *Carapa guianensis* Aubl. | 67 | 4.3 | 1.2 | 0.91 | 0.308 | 0.79 | 2.9 |
| *Sacoglottis guianensis* Benth. | 46 | 4.7 | 0.8 | 1.21 | 0.337 | 0.86 | 2.9 |
| *Aspidosperma carapanauba* Pichon. | 43 | 4.8 | 0.8 | 1.21 | 0.34 | 0.87 | 2.9 |
| *Dinizia excelsa* Ducke | 16 | 9.3 | 0.3 | 0.81 | 0.664 | 1.69 | 2.8 |
| *Vataireopsis speciosa* Ducke | 30 | 5.6 | 0.5 | 1.21 | 0.401 | 1.02 | 2.8 |
| *Inga cinnamomea* Spruce ex Benth. | 66 | 1.9 | 1.2 | 1.21 | 0.138 | 0.35 | 2.8 |
| *Hymenolobium petraeum* Ducke | 34 | 5.9 | 0.6 | 1.01 | 0.424 | 1.08 | 2.7 |
| *Alexa grandiflora* Ducke | 47 | 4.5 | 0.9 | 1.01 | 0.318 | 0.81 | 2.7 |
| *Goupia glabra* Aubl. | 26 | 6.3 | 0.5 | 1.01 | 0.45 | 1.15 | 2.6 |
| *Rinorea racemosa* (Mart.) Kuntze | 71 | 1.2 | 1.3 | 1.01 | 0.088 | 0.23 | 2.5 |
| *Myrciaria floribunda* O. Berg | 61 | 1.4 | 1.1 | 1.11 | 0.098 | 0.25 | 2.5 |
| *Parinari excelsa* Sabine | 20 | 4.8 | 0.4 | 1.21 | 0.341 | 0.87 | 2.4 |
| *Virola surinamensis* (Rol. ex Rottb.) Warb. | 50 | 3.0 | 0.9 | 0.91 | 0.211 | 0.54 | 2.4 |
| *Ficus maxima* Mill. | 48 | 1.9 | 0.9 | 1.11 | 0.135 | 0.34 | 2.3 |
| *Pouteria gongripii* Eyma | 56 | 3.8 | 1.0 | 0.61 | 0.269 | 0.69 | 2.3 |
| *Inga sp* | 57 | 3.0 | 1.0 | 0.71 | 0.214 | 0.55 | 2.3 |
| *Cupania hispida* Radlk. | 59 | 0.9 | 1.1 | 1.01 | 0.066 | 0.17 | 2.2 |
| *Mezilaurus itauba* (Meisn.) Taub. ex Mez | 36 | 2.3 | 0.7 | 1.11 | 0.163 | 0.42 | 2.2 |
| *Protium neglectum* Swart. | 40 | 1.8 | 0.7 | 1.01 | 0.128 | 0.33 | 2.1 |
| *Sterculia pruriens* (Aubl.) K. Schum. | 29 | 1.8 | 0.5 | 1.21 | 0.131 | 0.33 | 2.1 |
| *Mezilaurus synandra* (Mez) Kostermans | 49 | 1.7 | 0.9 | 0.81 | 0.119 | 0.3 | 2.0 |
| *Duguetia echinophora* R. E. Fries | 45 | 2.3 | 0.8 | 0.71 | 0.167 | 0.43 | 1.9 |
| *Pithecellobium racemosum* Ducke | 30 | 3.8 | 0.5 | 0.71 | 0.273 | 0.7 | 1.9 |
| *Ormosia grossa* Rudd. | 32 | 3.1 | 0.6 | 0.71 | 0.221 | 0.56 | 1.8 |
| *Platonia insignis* Mart. | 24 | 1.6 | 0.4 | 1.11 | 0.112 | 0.29 | 1.8 |
| *Bombax paraensis* Ducke | 20 | 1.7 | 0.4 | 1.11 | 0.123 | 0.31 | 1.8 |
| *Eperua falcata* Aubl. | 14 | 5.0 | 0.3 | 0.61 | 0.357 | 0.91 | 1.8 |
| *Bocageopsis multiflora* (Mart.) R.E. Fr. | 35 | 1.0 | 0.6 | 0.91 | 0.074 | 0.19 | 1.7 |
| *Licania heteromorpha* Benth. | 26 | 1.5 | 0.5 | 0.81 | 0.108 | 0.28 | 1.6 |
| *Pouteria sp* | 25 | 2.1 | 0.5 | 0.71 | 0.15 | 0.38 | 1.5 |
| *Sclerolobium melanocarpum* Ducke | 26 | 3.1 | 0.5 | 0.5 | 0.221 | 0.57 | 1.5 |
| *Hymenolobium excelsum* Ducke | 10 | 3.9 | 0.2 | 0.61 | 0.28 | 0.72 | 1.5 |
| *Odontospermum sp* | 19 | 1.4 | 0.3 | 0.91 | 0.1 | 0.25 | 1.5 |
| *Simarouba amara* Aubl. | 19 | 1.7 | 0.3 | 0.81 | 0.123 | 0.31 | 1.5 |
| *Manilkara paraensis* (Huber) Standl. | 17 | 1.7 | 0.3 | 0.81 | 0.12 | 0.31 | 1.4 |
| *Ocotea guianensis* Aubl. | 24 | 0.9 | 0.4 | 0.81 | 0.063 | 0.16 | 1.4 |
| *Anemopaegma mirandum* (Cham.)Mart. ex DC | 47 | 0.7 | 0.9 | 0.4 | 0.05 | 0.13 | 1.4 |
| *Qualea paraensis* Ducke | 21 | 1.0 | 0.4 | 0.81 | 0.072 | 0.18 | 1.4 |
| *Simarouba glauca* DC. | 19 | 1.3 | 0.3 | 0.81 | 0.095 | 0.24 | 1.4 |
| *Diplotropis martiusii* Benth, | 21 | 1.0 | 0.4 | 0.81 | 0.069 | 0.18 | 1.4 |
| *Symphonia globulifera* L.f. | 24 | 1.8 | 0.4 | 0.61 | 0.127 | 0.33 | 1.4 |
| *Terminalia obovata* Cambess. | 22 | 0.8 | 0.4 | 0.81 | 0.058 | 0.15 | 1.4 |
| *Caryocar villosum* (Aubl.) Pers. | 9 | 4.4 | 0.1 | 0.4 | 0.313 | 0.8 | 1.3 |
| *Cordia tetrandra* Aubl. | 12 | 1.1 | 0.2 | 0.91 | 0.076 | 0.19 | 1.3 |
| *Maquira calophylla* (Poepp. & Endl.) C.C. Berg | 18 | 1.1 | 0.3 | 0.81 | 0.079 | 0.2 | 1.3 |
| *Vochysia máxima* Ducke | 15 | 4.0 | 0.3 | 0.3 | 0.285 | 0.73 | 1.3 |
| *Hymenaea oblongifolia* Huber. | 11 | 1.4 | 0.2 | 0.81 | 0.1 | 0.26 | 1.3 |
| *Ocotea glomerata* (Nees) Mez | 12 | 2.9 | .0.2 | 0.5 | 0.206 | 0.53 | 1.2 |
| *Sclerolobium densiflorum* Benth. | 21 | 1.0 | 0.4 | 0.71 | 0.068 | 0.17 | 1.3 |
| *Himatanthus sucuuba* (Spruce) Woodson | 20 | 0.6 | 0.4 | 0.71 | 0.045 | 0.12 | 1.2 |
| *Alibertia edulis* Rich. | 13 | 0.5 | 0.2 | 0.81 | 0.036 | 0.09 | 1.1 |

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| Species | N | AB | DR | FR | DoA | DoR | IVI |
|---|---|---|---|---|---|---|---|
| *Aniba guianensis* Aubl. | 16 | 0.6 | 0.3 | 0.71 | 0.043 | 0.11 | 1.1 |
| *Hymenaea courbaril* L. | 6 | 2.1 | 0.1 | 0.61 | 0.15 | 0.38 | 1.1 |
| *Theobroma cacao* L. | 14 | 0.2 | 0.3 | 0.81 | 0.014 | 0.04 | 1.1 |
| *Brosimum acutifolium* Huber. | 9 | 2.3 | 0.2 | 0.5 | 0.164 | 0.42 | 1.1 |
| *Cecropia peltata* L. | 31 | 1.3 | 0.6 | 0.3 | 0.091 | 0.23 | 1.1 |
| *Ephedranthus amazonicus* R.E. Fr. | 16 | 0.4 | 0.3 | 0.71 | 0.03 | 0.08 | 1.1 |
| *Mouriri acutiflora* Naudin. | 17 | 0.3 | 0.3 | 0.71 | 0.023 | 0.06 | 1.1 |
| *Xylopia sp* | 21 | 0.5 | 0.4 | 0.61 | 0.039 | 0.1 | 1.1 |
| *Nectandra cuspidata* Ness. | 14 | 0.4 | 0.3 | 0.71 | 0.026 | 0.07 | 1.0 |
| *Cassia scleroxylon* Ducke | 9 | 0.7 | 0.2 | 0.71 | 0.05 | 0.13 | 1.0 |
| *Quararibea guianensis* Aubl. | 19 | 0.8 | 0.3 | 0.5 | 0.061 | 0.15 | 1.0 |
| *Parahancornia amapa* (Huber) Ducke | 12 | 1.3 | 0.2 | 0.5 | 0.09 | 0.23 | 1.0 |
| *Eschweilera longipes* Miers. | 15 | 0.4 | 0.3 | 0.61 | 0.026 | 0.07 | 0.9 |
| *Ocotea fragrantissima* Ducke | 10 | 0.3 | 0.2 | 0.71 | 0.022 | 0.06 | 0.9 |
| *Sarcaulus brasiliensis* (A.DC) Eyma | 10 | 0.3 | 0.2 | 0.71 | 0.022 | 0.06 | 0.9 |
| *Vochysia haenkeana* Mart. | 17 | 1.2 | 0.3 | 0.4 | 0.087 | 0.22 | 0.9 |
| *Gustavia hexapetala* (Aubl.) Sm | 33 | 0.6 | 0.6 | 0.2 | 0.039 | 0.1 | 0.9 |
| *Qualea multiflora* Mart. | 5 | 2.2 | 0.1 | 0.4 | 0.155 | 0.4 | 0.9 |
| *Couratari pulchra* Sandwith. | 10 | 1.5 | 0.2 | 0.4 | 0.105 | 0.27 | 0.9 |
| *Parkia nitida* Miq. | 4 | 1.9 | 0.1 | 0.4 | 0.139 | 0.35 | 0.8 |
| *Tachigalia alba* Ducke | 14 | 0.5 | 0.3 | 0.5 | 0.036 | 0.09 | 0.8 |
| *Zollernia paraensis* Huber | 13 | 0.8 | 0.2 | 0.4 | 0.058 | 0.15 | 0.8 |
| *Trattinnickia burseraefolia* (Mart.) W | 17 | 0.8 | 0.3 | 0.3 | 0.054 | 0.14 | 0.7 |
| *Apeiba echinata* Gaertn. | 10 | 0.3 | 0.2 | 0.5 | 0.019 | 0.05 | 0.7 |
| *Protium spruceanum* (Benth.) Engl. | 15 | 0.3 | 0.3 | 0.4 | 0.023 | 0.06 | 0.7 |
| *Xylopia aromatica* (Lam.) Mart | 9 | 0.1 | 0.2 | 0.5 | 0.011 | 0.03 | 0.7 |
| *Inga barbata* Benth. | 5 | 0.3 | 0.1 | 0.5 | 0.022 | 0.06 | 0.7 |
| *Oneocarpus bacaba* Mart. | 11 | 0.2 | 0.2 | 0.4 | 0.017 | 0.04 | 0.6 |

The relative dominance is an important parameter to evaluate the participation percentage of each species inside the community and implies in defining the status in which each species plays in the horizontal structure of the community. The most abundant species not always reflect the superiority in dominance and vice-versa.

To Rossi and Higuchi (1998), the spatial distribution pattern of some of the tree species in the Amazon obeys the random arrangement. In this study, the spatial distribution pattern for most species showed an aggregated pattern. The prevalence of this spatial distribution pattern can suggest greater influence of the abiotic factors (soil, light and/or water) associated with a strong bio-ecological pressure (intra and interspecific competition, reproductive behavior of species, fruit dispersal or herbivory), on the horizontal distribution of the populations.

It was verified that the first ten species demonstrated a meaningful participation in the structure and dynamics of the community, thus, showing that the performance of these species will be the approximate representation on how the ecological mechanisms operate inside the community. To summarize, for all phytosociogical parameters analyzed, only some species can be pointed out. However, most species exhibit low and similar values for these parameters, showing small contribution of each species to the structure of the forest investigated.

The total basal area was of 548.2 $m^2$ over the 14 hectares; the largest basal area occurred in the parcel 12, with 60 $m^2$ $ha^{-1}$ and, in the parcel 4, occurred the lowest value with 23.4 $m^2$ $ha^{-1}$, totaling an average of 39.15 $m^2$ $ha^{-1}$. The average registered in this study was very close to that found by Silva et al. (2014) and Pereira et al. (2011), corresponding to averages ranging from 39 to 36 $m^2$ $ha^{-1}$, values considered high for primary forests, with occurrences of many large individuals.

It was noticed that the most important species indicated by the other phytosociological parameters maintained the expressiveness for the basal area in the 14 hectares of the forest studied. *Bertholletia excelsa* assumed the first position, with 143.2 $m^2$, followed by *Geyssospermum vellosi,* with 47.2 $m^2$ and *Pouteria guianensis*, with 38.3 $m^2$. It is worth observing that *B. excelsa* exceeds in almost three times the basal area value of the second position, a fact considered common for an emergent species of large size, used exclusively as a fruit supplier by the fauna and local community. It is common to observe in the Brazilian Amazon the dominance of few species, regarding them as the most important in the forest.

The parcels 2 and 12 were those with the highest number of individuals. In general, no parcels presented significant differences related to the number of individuals obtained. The specific richness among parcels did not have significant variations; the parcels 4 and 13, with 54 and 58 species, respectively, had the lowest diversity values. In contrast, the parcels 2 and 12 presented the highest values for this parameter. The difference in the richness of species among parcels, in the same environment, can be associated with a variety of factors, such as: sampling intensity, biogeochemical interactions and randomized-like parcels.

It was found that the range of values among plots are very close to each other, corroborating the results presented for the type of richness. Oliveira and Amaral (2004) states that for rainforests the Shannon-Wiener Diversity Index varies from 3.83 to 5.85, amounts considered high for any type of vegetation. The diversity found in this study was (H') 4.16 and the evenness (J') was 0.79, which suggests a distribution tending to uniformity regarding the ratios of individuals/species within the plant community.

These results of diversity and equitability can be considered similar to those found for the same typology in the Amazon, which are mainly characterized by the high richness and diversity of species (LIMA FILHO et al., 2001; OLIVEIRA et al., 2008; CARIM et al., 2013). According to Saporretti Jr. et al. (2003), values of Shannon-Wiener Index above 3.11 indicate well-conserved vegetal formation, and this definition is adequate to describe the study area investigated.

The results presented in this study are in agreement with those reported by the pioneer studies on the Amazon of Black et al. (1950) and Prance et al. (1976). The authors described that those forests presented high diversity, high percentage of rare species and low floristic similarities, even in neighboring locations. Generally speaking, the parcels sampled had high floristic similarities, unlike the values pointed by Campbell (1994) who documented values from 10 to 36% for the dry-land forest in the Amazon.

In this study, the parcels 12 and 13 were the most similar showing the maximum floristic similarity on the basis of the Sorensen Index (78.3%), sharing 31 species in common; some of them: *Aspidosperma carapanauba* Pichon, *Bertholletia excelsa, Bocageopsis multiflora* (Mart.) R.E. Fr, *Caryocar villosum* (Aubl.) Pers., *Dinizia excelsa* Ducke, *Dipteryx odorata* (Aubl.) Willd, *Eschweilera odora, Hymenaea oblongifolia* Huber and *Hymenolobium petraeum* Ducke, are species with recognized economic value.

It was verified that the parcel 3 was unique and presented the highest dissimilarity related to the other parcels with Sorensen Index below 50%. The dendogram (Figure 5) showed a tendency for the formation of four parcel groups: a (5 and 6); b (7, 2 and 1); c (12, 13 and 14) and d (9, 10 and 8). The formation of these groups happened by the proximity among parcels. As for the groups a, c and d, the parcels were installed near from each other, in the same position or in contiguous position. In the second group (b), the parcel 7 did not correspond to this tendency, being positioned in the more distant points from the other two parcels. The rest of the parcels did not present significant relationships, showing once again the heterogeneity of this forest environment. Moreover, in this study, it can be verified that the lesser the geographical distance among parcels, the greater the similarity estimated.

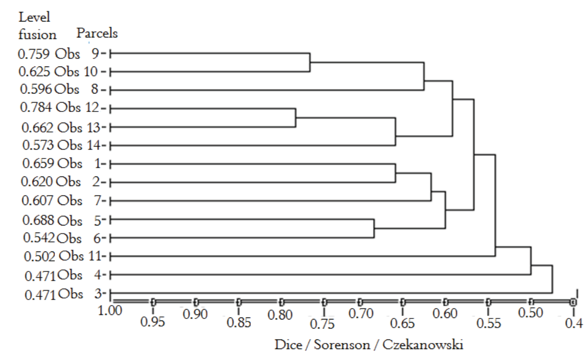


**Figure 5.** Cluster Analysis of the parcels inventoried in the Iratapuru RDS, using the classification method WPGMA and metric of the Sorensen coefficient.

## Conclusion

The dry-land primary forest presented high floristic diversity when compared with other areas in the Amazon. In each class sampled, the individual distribution in circumference occurs gradually, indicating some balance in the communities in terms of distribution. Species appear systematically in various size classes or the population renewal is constant, which characterizes the stability in the community and high diversity.

Few species present high values for the basal area, a common characteristic of the tropical forests; however, they tend to assume a significant importance in the population, which often give rare or less frequent status.

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