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Phytogeography and floristics of the arbor component in União do Vegetal territories intended for the cultivation of *Banisteriopsis caapi* and *Psychotria viridis* in Rondônia

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Abstract

The territorial expansion of Amazonian religions that make ritual use of Ayahuasca / Hoasca, in Rondônia, has been associated to the maintenance of forested areas and recovery of degraded areas associated with the cultivation of *Banisteriopsis caapi* [(SpruceexGriseb.) CV Morton] and *Psychotria virid*is (Ruiz & Pav.) in agroforestry systems (AFS). The present research had as objective to carry out the floristic survey and to analyze the composition and structure of the arboreal component of the forest fragments and agroforestry of territorial areas of *União do Vegetal*, one of the Hoasca religious matrices, in each phytoecological region of its comprehension in Rondônia. For this, non-probabilistic samples were performed on 08 rural properties in the delimited territory. In the selected areas, disjoint plots of 50 x 20 m (0.1 ha) were plotted, totaling 23 plots and 2.3 ha of area sampled, and then phytosociological parameters were calculated in the FITOPAC 2.1 application. Floristic surveys and phytosociological parameters presented satisfactory results regarding the conservation of phytodiversity in these areas according to the phytoecological region in which they are found. The occurrence of species in the Near Threatened and Vulnerable (VU) status by RedList shows the importance of these territories to conservation. In the case of samples in cultivated areas of the ritual species, these results were superior to other Agroforestry Systems, and in 75% of the samples better than the own areas of forest destined to the Legal Reserve of the same property.
Keywords:Ayahuasca; Hoasca; Religious territory; Amazônia; Conservation.

Resumo

A expansão territorial de religiões amazônicas que fazem uso ritual da Ayahuasca/Hoasca, em Rondônia, tem estado associado à manutenção de áreas florestadas e recuperação de áreas degradadas, associados ao cultivo das espécies *Banisteriopsis caapi* [(SpruceexGriseb.) C. V. Morton] e *Psychotria viridis* (Ruiz &Pav.) em sistemas agroflorestais (SAFs). A presente pesquisa teve como objetivo realizar o levantamento florístico e analisar a composição e estrutura do componente arbóreo dos fragmentos florestais e agroflorestais de áreas territoriais da União do Vegetal, uma das matrizes religiosas hoasqueiras, em cada região fitoecológica de sua abrangência em Rondônia. Para isso, foram realizadas amostras não probabilísticas em 08 propriedades rurais do território delimitado. Nas áreas selecionadas foram demarcadas parcelas disjuntas de 50 x 20 m (0,1 ha), totalizando 23 parcelas e 2,3 ha de área amostrada, e em seguida calculados parâmetros fitossociológicos no aplicativo FITOPAC 2.1. Os levantamentos florísticos e parâmetros fitossociológicos apresentaram resultados satisfatórios quanto à conservação da fitodiversidade nessas áreas de acordo com a região fitoecológica em que se encontram. A ocorrência de espécies em status Quase Ameaçada (NT) e Vulnerável (VU), pela RedList, evidencia a importância desses territórios à conservação. No caso das amostras em áreas de cultivo das espécies ritualísticas, esses

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resultados foram superiores a outros Sistemas Agroflorestais, e em 75% das amostras melhores que as próprias áreas de floresta destinadas à reserva legal da mesma propriedade.
Palavras-chave: Ayahuasca; Hoasca; Território religioso; Amazônia; Conservação.

I. INTRODUTION

The Amazonian rainforest is the largest natural reservoir of the planet's plant diversity, and each of its different forest environments has a rich and varied floristic contingent, often exclusive to a particular environment, that composes highly complex ecosystem sets with extremely fragile ecological balance (OLIVEIRA; AMARAL, 2004). In addition, this forest is still little known floristically: large geographic knowledge gaps and the small number of collections available in herbarium prevent accurate mapping of plant distribution and biodiversity and identification of regions of endemism, making planning difficult suitable for the conservation and sustainable use of regional biota (HOPKINS, 2007).

The *Banisteriopsis caapi* vine and the *Psychotria viridis* tree of the botanical families Malpighiaceae and Rubiaceae*,* respectively, are considered endemic plants of the Amazon rainforest and have been used for centuries by indigenous peoples not only in Brazil, but also in different countries that have part of this biome. Its use occurs through the Hoasca/Ayahuasca[1] tea, which´s composed by the decoction of these two plants, popularly called Mariri or Jagube *(B. caapi)* and Chacrona or Queen *(P. viridis).*

From the phytogeographic point of view, the natural occurrence area of these species in the Amazon rainforest is still little known, being a gap in scientific studies. In studying *B. caapi*, although such a claim may also be valid for *P. viridis*, Gates (1982) considers it a challenge to recognize the center of dispersion of this plant, since indigenous peoples in regions of Bolivia, Peru, Ecuador, Colombia and the Brazilian Amazon historically cultivate it.

The Malpighiaceae family, of which the Banisteriopsis is a member, is composed of approximately 77 genera and 1,300 tree species, shrubs, perennial herbaceous and vines, occurring in neo and paleotropical regions (ANDERSON; DAVIES, 2007). Of these, approximately 38 genera and 300 species can be found all over

[1]In Brazil, from the contact between indigenous and extractive groups, mainly rubber tappers, Hoasca is used as a sacrament in three religious matrices, namely *Santo Daime*, *Barquinha* and *União do Vegetal* (UDV). Its legitimacy is legally regulated for religious use in Brazil by the National Anti-Drug Council - CONAD, in Resolution No. 01 of January 25, 2010. Its religious freedom has also been recognized, among other countries, by the Supreme Court of United States, on November 1, 2005. Countless are the denominations used to designate the Hoasca tea, like for example: Ayahuasca, *Daime*, *Vegetal*, *Cipó*, *Mariri*, *Yagé* or *Kamarampi*. Although, as Bernadino-Costa e Silva (2011) affirms, the term Ayahuasca ("vine of souls" in Quechua) has been the most used in the academic bibliography to refer to tea and related cultural practices. In this research, we will use the term Hoasca because it is the common use of our object of study, the UDV, and for a closer approximation to our language.

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Brazil, especially on the edges of the forest (SOUZA; LORENZI, 2005). According to Gates (1982), among the genera of this family, *Banisteriopsis*´s considered one of the most complex due to the high number of species of vines, ninety-two, which have similar floral morphology. According to this author, the genus *Banisteriopsis* has a restricted distribution to the American continent and, although there are some species occurring in Mexico, Paraguay and Argentina, the greatest diversity´s found in the tropics, two thirds of the endemic species of Brazil, especially in the cerrado(Savannah) of the Brazilian Central Plateau.

P. viridis belongs to Rubiaceae, one of the largest families of cosmopolitan distribution, and covers approximately 12,000 species distributed in 650 genera (YOUNG; BOYLE; BROWN, 1996). Of these, about 130 genera and 1,500 speciesoccur in all Brazilian biomes, being the genus *Psychotria* most commonly found in the subforest of humid forests (SOUZA; LORENZI, 2005).

The natural occurrence of these ritualistic species and their genetic variability have been threatened by the loss and fragmentation of habitats, especially in the states of Pará, Mato Grosso and Rondônia. Of the 780,967 km² deforested until 2017 in the Legal Amazon, 568,619 km² belonged only to the states of Pará, Mato Grosso and Rondônia (INPE, 2019), equivalent to approximately 73% of all deforestation in the region during this period. It is precisely in these three states that the so-called "deforestation arc" is concentrated, mainly driven by logging, mining, cattle ranching and agribusiness.

In view of such scenarios, the need for Hoasca religions to cultivate ritual species and to conserve forest fragments has increased, not only for the ritual use of Hoasca tea, but also for the conservation of matrices that allow the maintenance of their genetic variabilities.

Thevenin and Piroli (2017, 2018) based on field research, geoprocessing and landscape ecology have shown that the territorial expansion of the hoasqueiras religions in Rondônia is related to the conservation of forested areas and to the recovery of degraded areas associated with the cultivation of *B. caapi* and *P. viridis* in agroforestry systems (AFS).

According to these authors, such pro-ecological behaviors have been constituted since the origin of these religions, due to the natural needs of plants - such as shading for *P. viridis*, a sub-woods, and tree support for *B. caapi*, which is a vine - and also by the spiritual connection with nature amplified with the use of Hoasca and its doctrinal system of Amazonian *caboclo* roots[2].

[2]Formed by the ethnic, cultural and religious miscegenation of whites, indigenous and afrodescendants who have been in the northern region of Brazil, from their diverse economic cycles, and that strongly mark the Amazon region.

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Among the results, obtained by Thevenin e Piroli (2018), by means of object-oriented classification techniques, 92.5% of 24 rural properties analyzed in the Hoasca religions territory in Rondônia are covered by arboreal phytophysiognomies intermediate or advanced succession (81.4% only in the advanced stage), some of these fragments were thinned and/or recovered for agroforestry purposes, and many of them suffer strong edge effects, mainly due to the number of areas transformed into pasture in the surrounding area properties.

In view of results such as these is that the present scientific research begins. It is questioned here what state of conservation of the arboreal component in the multiple forest fragments of these territories and in the agroforestry systems of *B. caapi* and *P. viridis*. In this sense, floristic studies and of the vegetation structure´re considered basic for the knowledge of the flora in each region and its diverse potentials, the relationships between plant communities and environmental factors (SILVA-JÚNIOR, 2005). This knowledge is fundamental to increasingly urgent programs for the recovery of degraded areas and the of Brazilian vegetable formations (FELFILI *et al*., 2001; SILVA-JÚNIOR, 2001).

This work aimed at describing and analyzing the richness and structure of the tree component in eight UDV rural properties in Rondônia, located in different phytoecological regions: open and closed dense ombrophylous forest; semideciduous seasonal forest; and contact savannah/ombrophilous forest. Based on the method of plots and phytosociological parameters applied to both the forest fragments and the agroforestry areas evidenced, the objective was not only to increase knowledge about the floristic composition of these regions, an essential condition for the conservation of their high diversity, but mostly to analyze the value of these religious territories and their practices of cultivation and management for the conservation of phytodiversity.

II. MATERIAL AND METHODS

Study area

Rondônia is located in the western portion of the Brazilian Amazon, bordering Bolivia and border with the states of Acre, Amazonas and Mato Grosso. According to IBGE (2012a), its territory covers an area of 237,590,864 km², being that originally had 208,000 km ² of its territory covered by dense tropical forests (PEDLOWSKI; DALE; MATRICARDI, 1999). Another part of its territory covers part of the transition zone between the Amazon plain and the Brazilian Central Plateau, between the ombrophylous forest and the Cerrado (Savannah).

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As for the climate, it is equatorial with tropical transition, due to the southern position of the state, in the southwest of the Amazon, which gives it, from the regional point of view, some differential characteristics. It corresponds to the type Aw of the classification of KÖPPEN, it is humid with a strong decrease of precipitation in winter (03 ecologically dry months - June, July and August - on average) and hot, since in any month the average temperature stays above 18°C, remaining even above 20°C.In addition, it is subject to severe seasonal rain gaps over the years and has insignificant annual thermal amplitude, as well as remarkable daily thermal amplitude, especially in winter, when the nightly lows fall, often below 18°C in the plains and below 9°C in the highlands this of Chapadas (RONDÔNIA, 2000).

The survey was carried out in 08 rural properties belonging to the Beneficent Spiritist Center *União do Vegetal* (CEBUDV), located in the municipalities of Porto Velho, Itapuã do Oeste, Campo Novo de Rondônia, Alta Floresta do Oeste, Candeias do Jamari and Vilhena. For the selection of properties, the typology of vegetation in the 24 rural properties (23 CEBUDV) of the Hoasca religions territory, mapped by Thevenin and Piroli (2018), in the state of Rondônia, was considered. Two criteria were used in random selection: minimum size of 3 hectares (ha) per property; minimum number of two rural properties per phytoecological region, except for regions that had only one property located within their domain.

The Map of the "Hoasca religions Territory in Rondônia-BR" was super imposed on the "Map of Vegetation of the State of Rondônia", elaborated by the Brazilian Institute of Geography and Statistics - IBGE, during the 2006 SIVAM Project - Amazon Surveillance System, obtaining in this way the phytoecological regions corresponding to each property of the territory in analysis, as listed in Table 1.

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Table 1: Phytoecological region, historical handling and structure of the surrounding landscape, by rural property.

Rural property	County	Area (ha)	Vegetal cover (Original formation)	Historical handling[3]	Structure of the surrounding landscape
1	Porto Velho	12,37	Savannah Contact/ Ombrophilous Forest	Original forest with selective cutting and stretches in regeneration due to fires in the surroundings; and deforested area restored with forest and AFS	Pasture domain with a small forest fragment that connects on part of one of the sides of the property
2	Porto Velho	20,07	Open Lowland Ombrophilous Forest with Palm Trees	Original forest with selective cutting	Domain of forest fragments, except in front of the property, where it limits with pastures and to the bottom with the river
3	Candeias do Jamari	52,33	Open Lowland Ombrophilous Forest with Palm Trees	Original forest with part in regeneration due to fires in the surroundings; Small area of AFS	Domain of forest fragments, except in front of the property, where it limits with river and in a short stretch of the lateral where there is occurrence of pasture
4	Itapuã do Oeste	99,38	Sub Mountain Open Ombrophilous Forest with Palm Trees	Original forest with part in regeneration due to fires in the surroundings; 20 ha of deforested area restored with forest and AFS	Domain of forest fragments, except in the background and in smaller stretch on the sides of the property
5	Candeias do Jamari	68,19	Sub Mountain Open Ombrophilous Forest with Palm Trees	Original forest with selective cutting; Short stretch of AFS; and areas in regeneration, due to the burning in the surroundings	Domain of pasture with forest fragments, which connect in part to one of the sides and the bottom of the property
6	Campo Novo de Rondônia	5,65	Sub Mountain Dense Ombrophylous Forest With Emergent Canopy	Original forest with selective cutting; small area with vegetation in regeneration (capoeira) and another with thinning of the under story for planting	Domain of forest fragments, except in front of the property, where it limits with pasture
7	Alta Floresta	4,22	Dense Ombrophylous	Original forest with selective cutting	Domain of forest fragments on one side and bottom; and

[3] The selectivecuts and deforested areas that are currently in regenerationpredate the acquisition of theseproperties by CEBUDV.

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	do Oeste		Forest		pasture / agriculture domain on the otherside and in front of the property
8	Vilhena	3,1	Semideciduous Sub Mountain Seasonal Forest with Emergent Canopy	Original forest with selective cutting	Domain of original forest delimited to the bottom and on one side, by unpaved road and with small agricultural stretch in the surroundings of the front of the property

Source: AUTHORS, 2017; IBGE, 2006.

This vegetation mapping follows the key phytogeographic classification elaborated by the RADAMBRASIL - Radar Project in the Amazon that was later reordered and consolidated in the document entitled Classification of Brazilian Vegetation, adapted to a universal system published by IBGE in 1991. This classification system has a physiognomy-ecological character, based on major types of vegetation, corresponding to the phytoecological regions and their structural variations, hierarchically configuring the formations and sub-formations. The understanding of the variations of such structures has been important for the classification of the land cover of the studied areas, as well as for the phytosociological analyzes in the definition of the sample universe.

Floristic survey and phytosociological parameters

The plots method was used to characterize the composition and floristic structure of the delimited areas. This method is the most used in phytosociology works, usually the plot is a square or rectangle (although other forms may also be used) with a known area that is established in the vegetation, restricting the area of data collection, and can be applied to studies with herbaceous or woody species (MORO and MARTINS, 2011).

Non-probabilistic samples were collected from the 08 rural properties selected for this study. In each selected area, with the exception of one[4], three disjoint plots of 50 x 20 m (0.1 ha) were demarcated, totaling 23 plots and 2.3 ha of area sampled. The plots were installed parallel to the areas, with random distances

[4]In property 5 only 02 plots were sampled (one in AFS and another in secondary vegetation). This occurrence was justified by the difficulty of access in vegetation areas in the successional stage of shrub-tree regeneration, with a high sub-forest forming *capoeirões* (vegetation at an early stage of regeneration), due to the strong edge effect suffered by this property aggravated by the spread of fires from the surrounding pastures. The fact that this property is under phytoecological domain already sampled by another property also contributes to this exception, as well as the observation of a stabilization in the number of species between these plots.

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between them. Within each plot, all arboreal individuals with diameter at breast height - DBH (1.30 m) greater than 10 cm were identified and measured for DBH, and total height was estimated.

The size of the sample units was defined in order to establish comparisons with other phytosociological studies carried out in the region, since plots with dimensions of 1,000 m² (0.1 ha) have been commonly used in Amazonia. In the search to determine ideal sizes of plots for the evaluation of different diametric categories of arboreal species in the Amazon, Oliveira *et al.* (2014) tested 23 sizes ranging from 100 to 10,000 m², and obtained the best results were plots of 1,000 m², 800 m², 1,200 m², 2,000 m², and 10,000 m², respectively, for the minimum DAP of 5, 10, 20, 25 and 45cm.

The typology of the vegetation and the extension of the rural properties were determining factors in the choice of the properties and the spatial arrangement of the plots. The minimum sample considered for comparative purposes was 03 plots per vegetation typology, one in the Agroforestry System area (AFS) and two in the native Forest area and/or successor formations.

Three systems of implantation were observed in the areas, considered here as AFS: from the thinning of the vegetation, with cut of some trees of canopy and shallow of the sub-forest; from forest restoration in areas at the early stage of vegetation; and without cutting the vegetation in areas with vegetation in intermediate or advanced stages of regeneration. In addition, forest densification withendemictreespeciespioneer, secondary and climax are commonly performed in these three systems.

For Zeide (1980), the efficiency of a sample is determined by the cost-accuracy relation and is generally measured on the basis of comparisons between samples, and therefore their relative values. In the case of tropical forests, different authors consider that there is not a point of stabilization of the collector curve in terms of the number of species that are observed as the sample size increases (CAIN; CASTRO, 1959; MUELLER DOMBOIS; ELLEMBERG, 1974).

In this sense, Schilling and Batista (2008) consider that if the cost is not fixed (whether in fieldwork days, number of trees sampled, etc.) the sample size tends to infinity. This cost, pointed out by the authors, was also determinant in the selection of the sample, which could not be extended to all rural properties in the study area, which led to the definition of the criteria presented.

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The identification of the species in the field was performed by an experienced parataxonomist[5], and the unidentified individuals in the field had their botanical material collected for later identification, supported by bibliography and specialized botanists, in the INPA (National Institute of Amazonian Research) herbarium in Manaus - AM. In each plot, the geographic coordinates (through the GPS device) were obtained from it and the characteristics of the area were identified according to systematic observation.

FITOPAC 2.1 was used to calculate phytosociological parameters. Among the calculated parameters, from the spreadsheet elaborated in the Microsoft Office Excel 2007 program containing data collected in the field (families, species, individuals, DAP, height per plot) are: density, dominance, relative and absolute frequency; basal area; average height; average diameter; value index of importance and coverage value index for species and families; in addition to the diversity index Shannon and Weaver (H ').

III. RESULTS AND DISCUSSION

Floristics and Phytosociology

The 1,037 arboreal individuals with DBH ≥ 10 cm sampled in 2.3 ha (23 plots of 0.1 ha) are distributed in 203 species and 55 botanical families. Although DAP ranged from 10.0 to 233.1 cm, most individuals (50.4%) presented DBH below 20 cm and only 5.7% presented DBH above 50 cm (Figure 1). Such a diametric structure portrays the predominance of young individuals, showing that although most of these areas have been classified in the dominant arboreal succession stage, they are mainly fragments of secondary forests.

[5] Employee at the Herbarium of the Federal University of Acre - UFAC, which works since 1995 with botanical identification, as well as climbing and field sampling. In addition, Edilson Consuelo de Oliveira worked on floristic surveys projects with the New York Botanical Garden, the National Institute of Amazonian Research (INPA), the Government of Acre and the Brazilian Agricultural Research Corporation (EMBRAPA). Edilson was nominated by INPA botanists in Manaus-AM as one of the best parataxonomists in the Amazon region.

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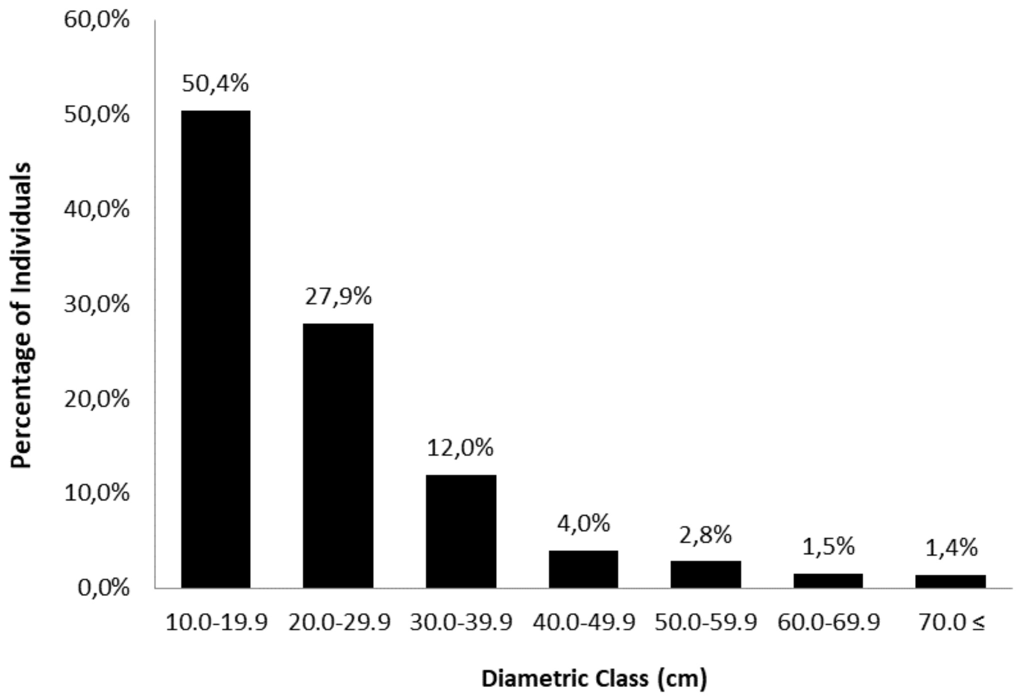

Figure 1: Percentage of individuals per diameter class in total sampling.

The family with the greatest number of species was Fabaceae (37), followed by Moraceae (13), Malvaceae (12), Burseraceae (8), Apocynaceae (8), Annonaceae (7), Sapotaceae (7), Euphorbiaceae (7), Anacardiaceae (7), Lecythidaceae (5). The ten families with the highest number of species together represent 54.6% of the total inventories, which corroborates the results obtained by Ribeiro *et al.* (1999a), Yared *et al.* (2000), Almeida *et al.* (2012) that few botanical families represent the largest number of species in mainland forests.

According to Oliveira (2000), botanical families such as Fabaceae, Lecythidaceae, Moraceae, Burseraceae, Sapotaceae generally excel in studies of floristic composition in Amazonian mainland forests. In areas of Ombrophilous Forest in the state of Rondônia, studies such as that of Lima Júnior *et al.* (2013) and Moser (2013) identified a larger number of species belonging to the families Fabaceae and Sapotaceae, respectively.

In this study, the Fabaceae family appears not only as the largest number of species, but also in number of individuals (239) and basal area, being one more fact that confirms the supremacy of this family in the Amazon Forest, as Ribeiro *et al.* (1999), including secondary succession processes (GAMA *et al.*, 2002, BAAR *et al.*, 2004).

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Still considering all the sampling, the species that registered the highest IVI in the community were *Attalea tessmannii*, with an IVI of 9.72; followed by *Piptadenia duckeana*, with 9.68; *Brosimum Guianense*, 8.38; *Licania caudata*, 7.41; *Tachigali paniculata*, 7.11; *Pseudolmedia laeves*, 6.79; *Schefflera coriácea*, 6.69; *Qualea paraensis*, 6.3; *Peltogyne paniculata*, 6.01; *Protium sp.5*, 5.73.

The species *Tachigali paniculata, Brosimum guianense, Pseudolmedia laeves, Licania caudata, Schefflera coriacea* appear as the ones with the highest absolute frequency (AbsFe), with values of 52.17%, 47.83%, 47.83% 43.48%, 43%, 48% occurrence in the total of the plots, respectively. While the species *Attalea tessmannii* excelled by its relative and absolute dominance (2,22 and 7,54), considering its basal area, since its density and frequency are smaller when compared to other species that presented higher IVI.

Of the 11 individuals of this species, 8 occur only in property 1, in the Savannah/Ombrophilous Forest contact region, in a landscape highly dominated by pasture. In this property, its IVI reaches 56.31 and although it stands out in Value of Importance also in the total of the sample this species does not appear among those of greater Value of Importance in the other properties.

The *Piptadenia duckeana* species, of initial secondary successional class (Si), even occurring only in 26.09% of the plots, presented the highest absolute density (AbsDe) of the total sampling, 24,8. The 57 individuals of this species are located in areas of regenerating secondary forest, mainly in properties 1 and 5.

Another species of secondary succession that deserves to be highlighted is *Cordia alliodora*, because although it presents a smaller number of individuals in the study areas (27), they are concentrated in three cultivated areas of *B. caapi* and *P. viridis*, in properties 4, 5 and 7, with 4 and 5 having the highest IVI of these plots, with 73.57 and 70.14.

Among the botanical families considered by Oliveira and Jardim (1998) and Baar *et al.* (2004) as typical of secondary succession, some of them, such as Flacourtiaceae and Lacistemaceae, are absent in the study area, while others, such as Clusiaceae, are not very representative. The typical secondary succession family that stood out in the survey was Melastomataceae, which appears as an Octave in Import Value Index (IVI), represented by 4 species and 49 individuals, occurring in 47.83% of the sampling areas. This family, however, only appears with *Bellucia pentamera* and *Miconia ferruginea* species among the highest IVI in three properties 2, 7 and 8, in the case of the first two *Bellucia pentamera* presents the highest IVI in the areas of AFS.

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Species such as *Qualea paraensis* had the occurrence restricted to property 8, in Vilhena-RO. However, in this property, it was the species that obtained the highest IVI with 77.64 (plot 21) and 61.99 (plot 22), and the second largest in plot 23, with 57.59. Although the geographical distribution of *Qualea paraensis* is broader, with confirmed occurrences in national and foreign herbariums[6], not only in the state of Rondônia, but also in the states of Amazonas, Amapá, Mato Grosso, Pará, Roraima (Brazil) and Colombia, Ecuador, French Guiana and Peru. In the study area, its distribution was restricted to the Submontane Semidecidual Seasonal Forest with Emergent Canopy, according to the Vegetation Map of IBGE (2006).

This occurrence corroborates, as described in the Technical Manual on Vegetation of IBGE (2012b), when it states that the genus Qualea characterizes the submountains formations, being predominantly submountain, althoug hit is distributed to the southern end of the Savannah (*Cerrado*). In this sense, the only other occurrence of the genus in the study area was a single individual of the species *Qualea tesmannii*, in the region classified as contact savannah/ombrophylous forest, in the municipality of Porto Velho-RO. Other species were also restricted to the aforementioned phytoecological region: *Ocotea sp. 2; Aspidosperma sp.; Caryocar glabrum; Couma sp.; Drypetes amazonica; Eugenia sp. 2;Humiria sp.; Inga sp. 7;Krameria lappacea; Mezilaurus itauba; Sterigmapetalum obovatum; Trichilia sp.*

Another important fact is that 66 species (32.5% of the total) occurred in the study area with only one individual (rare species), and another 51 species (25.1% of the total) had two or three individuals. These data also demonstrate the heterogeneity of tropical forests and the difficulty in obtaining a sample stabilization point in the number of species even in fragmented areas. Thus, in a diverse tree community with a large proportion of rare species, the sample effort curve method may not be satisfactory (CARIM, SCHWARTZ; SILVA, 2007).

In numerical terms, based on studies with a large space-time scale rare species is defined, according to Hubbell and Foster (1986), as the one that presents average density of 1 individual per hectare. Negrelle (2001) warns that the protection of rare species is important for environmental conservation efforts, as they´re considered especially vulnerable to extinction, compared to the so-called abundant ones.

Among the species found in the survey, eight are listed in the IUCN Red List of Threatened Species (RedList). Among these, one – *Poecilanthe parviflora* - has insufficient data (DD) to assess its risk of extinction; four – *Cordia alliodora*, *Hymenaea courbaril*, *Samanea tubulosa*, *Tachigali paniculata* - are of minor concern

[6] Consulted in the network speciesLink (http://www.splink.org.br), on April 25, 2019.

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(LC); one, *Minquartia guianensis*, is in the category Nearly Threatened (NT); and two - *Cedrela odorata* and *Bertholletia excelsa*, appear in the Vulnerable category (VU). Among these species, *Cedrela odorata* and *Bertholletia excelsa* are also listed in the Official List of Brazilian flora species threatened with extinction (MMA, 2014).

In the case of the *Cedrela odorata*, its status of vulnerability has been mainly due to its logging, while the *Bertholletia excelsa*, according to the IUCN (2016), has had a decline in its population due to deforestation of the Amazon forest, although it, in addition to nutritional uses (among others), is still used illegally by the timber industry.

A total of 4 individuals of *Cedrela odorata*, all young, with DAP varying between 17.2 and 32.2 cm and height 12 and 18 m, were identified in properties 6, 7 and 8, since this species can reach the DAP of 170 cm and height of 40 m. The measured growth stage, together with the fact that they are located in areas of AFS, are signs of tree regeneration in these areas.

It is also worth mentioning the identification of 5 individuals of the species *Bertholletia excelsa* in 5 different plots, in 4 properties (1, 3, 4, and 7), with DBH and mean height of 43.2 cm and 20.6 m. In the three plots located in AFS, the individuals of this species presented lower heights of 10 to 15 m and DAP of 12.4 to 26.2 cm, while in the other two, located in areas of Open Ombrophylous Forest, the heights were approximately 25 and 40 and the DAPs of 76.4 and 77.0 cm. The initial growth of these individuals in AFS serves as confirmation of the reforestation practices of this species by these hoasqueiras communities.

In addition to these species, the parataxonomist identified in the study areas the presence of other species included in the Official National List of Threatened Species of Flora (MMA, 2014), such as *Amburana acreana* and *Swietenia macrophylla*.

Another relevant aspect for the analysis of the conservation of these fragments is the occurrence of the Sapotaceae family, which appears among the 6 families with the largest number of species (7) and with a number of 20 individuals, which contributes to this family being in 12th place in IVI (7.18) in total sampling. This is a common family in primary forests, important for the conservation of the fauna because it has in general fleshy zoocoric fruits, which has several species adapted to microclimatic conditions different from those found in young secondary forests (SILVA *et al*., 1992; OLIVEIRA, AMARAL, 2004).

It is worth noting that the Sapotaceae family appears among the ten families with the highest IVI in properties 2, 4 and 6, mainly the genera *Ecclinusa* and *Pouteria*, with occurrences in both native forest and

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AFS areas, although it also appears in the three plots of property 7. What is common among these four properties is that they are all in regions classified as Open or Dense Ombrophilous Forest; they are not in isolated fragments in the landscape; and are among the five that presented the highest values in total basal area (7.93 to 10.89 m²) and in the Shannon-Wiener (H ') diversity index, from 3.70 to 3.86 nats. $ind.^{-1}$.

Diversity of species in the areas shown

Although the Shannon index of total sampling was high (H'=4.73), in relation to the limits mentioned by Knight (1975) in the Amazon forest, which normally vary from 3.83 to 5.85 nats. $ind.^{-1}$, this value does not reveal the real diversity parameters of the properties in the phytoecological regions in which they´re inserted.

According to the Neutral Theory, floristic similarity decreases with increasing geographic distance between sites, regardless of the environmental differences between them, but because of the limited space dispersion (HUBBELL, 2001, 2006). In this sense, the distance between the analyzed localities, which cover different phytoecological regions, contributes to a significant increase in floristic diversity data, which leads us to the need for an analysis of diversity by property (Table 2) and portion.

In property 8, the only one inserted in the domain of Seasonal Semideciduous Forest, the index presented a lower value of 2.95 nats. $ind.^{-1}$, which may appear to be a contradiction, since this sampling is in an area with no vegetation thinning in a landscape dominated by native forest and less fragmented than the others. In this case, it should be considered that this phytoecological region presents less floristic diversity than the others analyzed. In an analysis of a fragment of 3,000 ha preserved, of Submontane Semi-deciduous Forest with Emerging Canopy in Marcelândia-MT, with 18.5 ha of sample area, Ferreira Júnior *et al.* (2008) obtained Shannon's index 3.35 considering based on other studies the well conserved fragment.

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Table 2: Individuals, species, average diameter, Shannon-Wiener index by rural property sampled in hoasqueiro territory in Rondônia.

Property Rural	Number of Individuals	Number of Species	Average Diameter (cm)	Shannon-Wiener (H') Index	Sampling (ha)
4	137	63	23,41	**3,86**	0,3
3	138	60	22,13	**3,83**	0,3
6	130	61	26,92	**3,77**	0,3
7	149	65	24,45	**3,73**	0,3
2	111	51	27,52	**3,70**	0,3
1	120	44	25,29	**3,14**	0,3
5	109	35	20,06	**2,97**	0,2
8	143	36	23,36	**2,95**	0,3

The properties 4, 3, 6, 7 and 2 presented the highest indexes of species diversity, with variation between H'= 3.86 and H' = 3.70, of the study areas. Some common features may be among the factors that contribute to the maintenance of these indices in these properties: they are located in phytoecological regions classified as Dense or Open Ombrophylous Forest; although only three are larger than 20 ha, all are inserted in forest fragments of more than 30 ha; and dominant vegetation predominates in its surroundings, which diminishes the edge effects.

It should be noted that properties 4 and 3, in which the highest Shannon-Wiener indexes (H'=3.86 and H'=3.83) were recorded, are among the three with the land extension, they have the areas covered by phyto physiognomy of dominant tree size and are among those that suffer less edge effect due to the predominance of forest fragments around their limits.

The Property 5, the second largest in extent, appears with one of the lowest indices of 2.97 nats. $ind.^{-1}$, which confirms the state of conservation found in the field. Such state was one of the reasons that led to the reduction of sample size in this property, due to the difficulty of access provided by closed *capoeirões* (vegetation in regeneration).

This property, although mostly covered by successor formations (shrub cover and/or dominant arboreal cover), is among the most affected with edge effect: due to its shape, with average patterns of 150 m wide by 4,000 m of lenght; and for its surroundings, because not infrequently the fires in the neighboring pastures reached the property. Situation reaffirmed by the average diameter of the arboreal individuals 20.06 cm, the lowest among the properties.

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According to Metzger (1999), on the edges it is common the increase of generalist species that tend to exclude, by competition or predation, the species of interior. This assertion is confirmed in property 5, with the high absolute density presented by the species *Piptadenia duckeana* and *Cordia alliodora*, as was previously seen.

A similar situation occurs in property 1, where its landscape matrix is dominated by pastures and the isolation of the native vegetation of the property, of only 12.37 ha, is what has in fact generated a reduction in tree diversity. The classification of the phytoecological region - Contact Savannah/Ombrophylous Forest – should also be considered as having an index (H=3.14) among the lowest found. Although, in a similar analysis of an isolated fragment (in this case of 41.28 ha), in sample units implanted in Open Ombrophylous Forest in the experimental field of Embrapa in Porto Velho (same municipality), this index presented of 3.63 (Bentes-Gama *et al.*, 2009).

In the case of properties 5, 7 and 8 it is interesting to note that its parts AFS (14, 18 and 21) have greater diversity indices than their portions in areas of dense forest (13, 20, 22 and 23) (Table 3). However, this result may be explained by planting forestry areas *B.Caapi* and *P. viridis*, as well as a greater precaution so that the fires of the neighborhood do not spread to these areas, which also occurs in other properties such as 1, 2 and 6, for only one parcel.

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Table 3: Ecological phyto-region, Shannon-Wiener index and average diameter per plot sampled in the hoasqueiro territory in Rondônia.

Property	Ecological phyto-region	Porcion	Type of vegetation	Shannon-Wiener Index	Average Diameter
1	Savannah Contact/Ombrophilous Forest	1	AFS	2.737	24,54
	Savannah Contact/Ombrophilous Forest	2	FOREST	1.798	24,84
	Savannah Contact/Ombrophilous Forest	3	AFS	3.202	26,41
2	Open Lowland Ombrophilous Forest with Palm Trees	4	AFS	3.076	31,24
	Open Lowland Ombrophilous Forest with Palm Trees	5	FOREST	3.061	25,05
	Open Lowland Ombrophilous Forest with Palm Trees	6	AFS	2.780	27,33
3	Open Lowland Ombrophilous Forest with Palm Trees	7	FOREST	3.230	21,49
	Open Lowland Ombrophilous Forest with Palm Trees	8	FOREST	3.337	20,52
	Open Lowland Ombrophilous Forest with Palm Trees	9	AFS	2.644	26,97
4	Sub Mountain Open Ombrophilous Forest with Palm Trees	10	FOREST	3.204	27,85
	Sub Mountain Open Ombrophilous Forest with Palm Trees	11	FOREST	3.308	23,55
	Sub Mountain Open Ombrophilous Forest with Palm Trees	12	AFS	2.694	19,3
5	Sub Mountain Open Ombrophilous Forest with Palm Trees	13	FOREST	2.303	22,81
	Sub Mountain Open Ombrophilous Forest with Palm Trees	14	AFS	2.448	16,59
6	Sub Mountain Dense Ombrophylous Forest with Emergent Canopy	15	FOREST	2.646	30,17
	Sub Mountain Dense Ombrophylous Forest with Emergent Canopy	16	FOREST	3.192	24,79
	Sub Mountain Dense Ombrophylous Forest with Emergent Canopy	17	AFS	2.868	26,42
7	Dense Ombrophylous Forest	18	AFS	3.306	29,43
	Dense Ombrophylous Forest	19	AFS	2.600	21,09
	Dense Ombrophylous Forest	20	FOREST	2.959	24,3
8	Semideciduous Sub Mountain Seasonal Forest with Emergent Canopy	21	AFS	2.816	24,93
	Semideciduous Sub Mountain Seasonal Forest with Emergent Canopy	22	FOREST	2.500	22,29
	Semideciduous Sub Mountain Seasonal Forest with Emergent Canopy	23	FOREST	2.385	22,97

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Thus, 75% of the sampled properties presented better conservation status in AFS than the Legal Reserve areas, with native vegetation and successor formations. This result proves not only the low environmental impact of *B. caapi* and *P. viridis* plantations, but also their contribution to conservation, especially considering that among the tree species sampled in these AFS only *Mangifera indica* is exotic.

In order to have a comparison parameter, in a study conducted by Silva (2013), in 20 AFS also in small rural properties in the Central Amazon, Shannon indices were obtained from 1.44 to 2.85. In addition, Rodrigues (2005), in 12 AFS in the Acre River Valley, obtained indices (H ') ranging from 0.4 to 1.39. It is worth noting that, unlike the results obtained here, the studies cited still present a higher number of commercial species with lower value for the conservation of phytodiversity.

On the other hand, the Shannon indices obtained in this study varied in the 11 plots in AFS between 2.44 and 3.3, and in the 12 plots in Mata ranged from 1.79 to 3.33. Thus, the presence of hoasqueiras communities in the areas of AFS and their management make them less susceptible to edge effects, mainly burned, in relation to the more isolated forest areas of the property, which presented greater variations in the their indexes. In addition, reforestation practices (more concentrated on AFS) have been of significant importance in these results.

IV. CONCLUSIONS

From the analysis of the composition and structure of the tree component, in UDV territories in Rondônia, the predominance of young individuals was verified, which confirms that most of these fragments are in regeneration, even those classified in the dominant arboreal stage, being secondary forests. This is due to the fact that these areas are located in regions of high anthropogenic pressure, many of which have undergone selective cuts and/or pastures even before the acquisition of property by these groups.

The occurrence of species in a Near Threatened and Vulnerable (VU) status by RedList or even threatened with extinction by the Official List of Brazilian Flora, such as *Minquartia guianensis*, *Bertholletia excelsa*, *Cedrela odorata*, *Amburana acreana* and *Swietenia macrophylla*, mainly in the cultivation systems of *B. caapi* and *P. viridis*, shows the importance of these territories for conservation.

The frequency of individuals in the Sapotaceae family, being the 12th among the 55 in Importance Value Index (7,18) in the total sample, is another indication of the relevance of these fragments for

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conservation, since they are common in primary forests and have species that are not adapted to the microclimatic conditions of young secondary forests.

However, it is noteworthy that these occurred in both native forest and AFS areas, but predominated in regions classified as Open or Dense Ombrophylous Forest, in four of the properties that have less fragmented forests and that presented higher values in basal area total and Shannon-Wiener diversity index (H').

In the context of the phytoecological regions where the properties are located, most of them presented floristic diversity indexes close to the limits normally found for their respective regions. Due to the shape and size of the fragments, some presented lower indexes, which can be reversed by the continuity of reforestation practices and initiatives that attenuate edge effects.

Finally, floristic surveys and phytosociological parameters presented satisfactory results regarding the conservation of phytodiversity in these areas. In the case of samples in cultivated areas of ritualistic species, these results were superior to other Agroforestry Systems and, in 75% of the samples, better than the same forest areas destined to the Legal Reserve of the same property.

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