Inventory of medicinal species employed by IEPA, Macapá-AP

https://doi.org/10.56238/sevened2024.018-017

Maria Aparecida Corrêa dos Santos[1] and Márlia Coelho-Ferreira[2]

ABSTRACT

The IEPA (Institute of Scientific and Technological Research of the State of Amapá), through the Center for Medicinal Plants and Natural Products, has been dedicated to the production of herbal medicines and phytocosmetics from regional raw material, selecting species based on ethnopharmacological information and the absence of reports of toxicity. In this context, Amapá takes an innovative path, with research and development of products from Amazonian biodiversity as priorities, aimed at meeting social and economic demands, but seeking to follow the guidelines recommended by the World Health Organization/WHO, regarding encouraging the use of medicinal plants in Primary Health Care/PHC. However, in order for this pioneering work to give economic return to the region and gain visibility outside the limits of this State, it must meet the requirements of the National Health Surveillance Agency/ANVISA, established in RDC 17, which provide for the registration of herbal medicines. Hence the importance of this work which, using conventional methodology, collected botanical information on thirteen species of the Amapá phytopharmacopoeia, used by the IEPA.

Keywords: Ethnobotany, Medicinal plants, Amapá, IEPA

[1] Master in Botany, Researcher, Center for Medicinal Plants and Natural Products, Institute of Scientific and Technological Research of the State of Amapá.
E-mail: santosmac@yahoo.com
[2] Doctor in Biological Sciences, Researcher, Botany Coordination, Emílio Goeldi Museum of Pará.
E-mail: mcoelho@museu-goeldi.br

INTRODUCTION[3]

The association between biological diversity and cultural diversity has been the basis for the development of several disciplines that have as a background the knowledge of traditional populations about the biological and physical environment. One of the products of this association is present in health care, represented by traditional medicine, whose main aspect refers to the use of natural remedies. However, in general, the raw material to produce these medicines comes from extractivism, which is very old in the Amazon and has increased with the growing demand for products of natural origin. This fact leads to the need to modernize extractive activity, which must aim to protect natural resources and ensure the permanence of local communities in the areas they traditionally inhabit, offering conditions for improving their quality of life (AMAPÁ, 1999).

In a simplified way, the natural environments of Amapá can be grouped into two major physiognomic categories: 1) forested forms, a category that includes mangroves, along the coastline; floodplain forests, directly linked to riverine environments; upland forests, with the largest representation in the state; and transition forests, in areas of ecological tension; 2) non-forested or grassland forms, which includes the cerrado and floodplain or floodplain fields in depressed areas of the alluvial plain (ZEE, 2002). In addition to all these ecosystems, the state has a very diverse ethnic composition, consisting of six indigenous ethnic groups and one Afro-American ethnic group that preserves their customs and traditions in an important way (AMAPÁ, 1999), in addition to the caboclo population that develops a particular way of life.

According to the IBGE (*apud* BRASIL-MMA/SCA, 1998), in the Legal Amazon there are approximately 650 plant species of economic value with pharmacological activity, with Amapá occupying the fourth place with 380 species. In this case, species such as andiroba (*Carapa guianensis*) and copaiba (*Copaifera* spp.), which are widely spread regionally and nationally, deserve to be highlighted.

Through the IEPA, Amapá takes an innovative path, assuming as priorities the research and development of products from Amazonian biodiversity, aimed at meeting social and economic demands, but seeking to follow the guidelines recommended by the World Health Organization/WHO (AKERELE, 1992), about encouraging the use of medicinal plants in Primary Health Care/PHC. However, for this pioneering work of providing services to the Amapá community to give economic return to the region and gain visibility outside the limits of this State, it must meet the requirements of the National Health Surveillance Agency/ANVISA, established in RDC 48 (BRASIL, 2004), which provide for the registration of herbal medicines.

[3] Article originally published in Amazônia magazine: Ci. & Desenv., Belém, v.1, n.1, jul. /ten. 2005.

This study aimed to map and inventory the extractive species used in the production of herbal medicines and/or phytocosmetics, in the areas where they have been collected, with a view to controlling the origin of the plant raw material and adding value to IEPA products.

MATERIAL AND METHODS

This work was developed in the main areas of origin of the raw material used by IEPA. These areas are in the municipalities of Macapá (in the Bailique Archipelago District), Porto Grande and Mazagão, in the state of Amapá, and Ilha do Pará, in Pará, which include floodplain forests and upland and cerrado.

The locations of the inventories were defined based on information collected from the production team, in the Division of Phytotherapy/DF of the IEPA. The geographic coordinates of these areas were obtained using GPS and the placement of the points on the map was done by the Amapá Economic Ecological Zoning team (ZEE, 1998).

The inventory was made based on observation and collection and started from the location of specimens of the target species. Using the plot method proposed by Muller-Dombois and Ellenberg (1974), the species (Table 1) were sampled in continuous plots of 20m *x* 50m or 20m *x* 30m, according to the characteristics of the area. For veronica, which has a different habit from the others (it is a liana while the other species are trees or shrubs), sub-plots of 10m *x* 20m were used. For the study of the occurrence of the species, bibliographic reviews and consultations were made to the herbaria of the IEPA itself, EMBRAPA/CPATU, MPEG and IRD-Cayenne, indexed as HAMAB, IAM, MG and CAY, respectively (HOLMGREN et al., 1990).

As for the biological form, the species were classified as trees, shrubs, subshrubs, lianas or herbs, according to Vidal and Vidal (1992). The individuals were counted and, from each sampled specimen, the circumference at breast height (PAC, in centimeters), standardized at 1.30m from the ground, the total height (in meters) and, whenever possible, their phenological status was verified. In addition, a brief description of the area was made.

With the use of the FITOPAC software (a set of programs that allow the calculation of phytosociological parameters and the analysis of vegetation survey data), developed by Dr. Shepherd, from UNICAMP, the basal area, density, frequency and absolute dominance of each species were evaluated.

The material for the herbarium was collected according to the techniques defined by Fidalgo and Bononi (1984). Exsiccates were deposited at the Herbarium Amapaense/HAMAB, located at IEPA, and duplicates are available for exchange.

RESULTS AND DISCUSSION

13 of the 14 extractive species used by the IEPA were inventoried, whose habits, habitats and inventory numbers per municipality are shown in table 1. The inventories carried out along the highways, BR 156 and BR 210, are added to those of Porto Grande, as they are located close to this municipality.

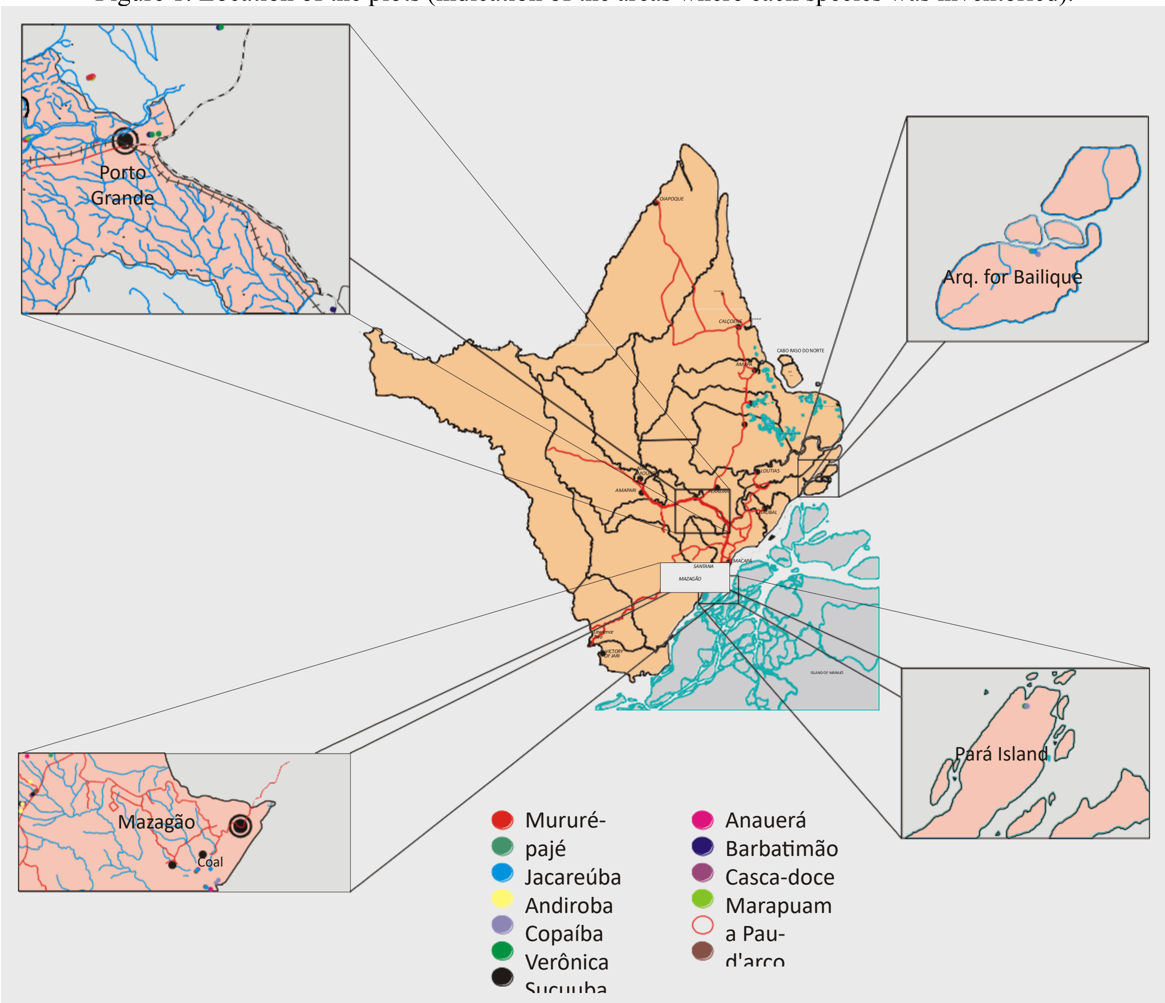
Table 1: Habit, habitat and number of inventories carried out for each species, by municipality.

POPULAR NAME	**SCIENTIFIC NAME**	**HABIT**	**HABITAT**	**NUMBER OF INVENTORIES BY MUNICIPALITY**				
				MACAPÁ	**MAZAGÃO**	**PORTO GRANDE**	**PARÁ ISLAND**	**TOTAL**
Anauerá	*Licania macrophylla* Bentham	Tree	FV		3	1		4
Andiroba	*Carapa guianensis* Aublet	Tree	FV	1	4			5
Barbatimão	*Ouratea hexasperma* (St. Hil.) Baill.	Bush	Ce			3		3
Sweet shell	*Pradosia huberi* Ducke (Ducke)	Tree	TF		2	2		4
Copaiba	*Copaifera guianensis* Desfontaines	Tree	TF		3			3
Faveiro	*Vatairea guianensis* Aublet	Tree	FV		3			3
Jacareúba	*Calophyllum brasiliense* Cambessedes	Tree	FV	1	1		1	3
POPULAR NAME	**SCIENTIFIC NAME**	**HABIT**	**HABITAT**	**NUMBER OF INVENTORIES BY MUNICIPALITY**				
				MACAPÁ	**MAZAGÃO**	**PORTO GRANDE**	**PARÁ ISLAND**	**TOTAL**
Jatoba	*Hymenaea courbaril* L.	Tree	TF		2	2		4
Marapuama	*Ptychopetalum olacoides* Bentham	Tree	TF			3		3
Mururé-pagé	*Brosimum* cf. *utile* (Kunth) Pittier	Tree	TF			2		2
Pau-d'arco	*Tabebuia* sp.	Tree	TF			1		1
Sucuuba	*Himatanthus articulatus* (Spruce ex Müller-Argovensis) Woodson	Bush	Ce			3		3
Veronica	*Dalbergia monetaria* L. f.	Liana	FV	1	2		1	4

Habitats considered: FV: Lowland Forest; TF: Terra Firme Forest; Ce: Cerrado.

From the geographic coordinates, distribution maps of the 13 species were generated in the areas studied. The maps with the location of the inventories, by species, are shown in figure 1. The vegetation of these areas includes floodplain forest, terra firme forest, and cerrado.

Figure 1: Location of the plots (indication of the areas where each species was inventoried).



MAPPING AND INVENTORY

Table 2 presents a summary of the results obtained in the inventories. The averages obtained with the FITOPAC program, for each species, in the different areas are presented.

Table 2: Synthesis of the results obtained in the inventories.

Species	Inventory number/location	Number/size of plots	FA (%)	OF (IND/ha)	DBH		AB	Height	
					Medium	Standard deviation	(m2/ha)	Average	Standard deviation
Licania macrophylla Bentham	1- Mazagão	10 (20x50)	70	11	9,35	6,05	0,104	10,36	4,31
	2- Mazagão	10 (20x50)	50	15	15,79	13,68	0,5	13,07	7,56
	3- Mazagão	1 (10x1000)	100	27	22,31	11,55	1,32	15,59	8,4
	4- Porto Grande	10 (20x50)	50	16	26,35	19,97	1,34	23,29	15,86
Carapa guianensis Aublet	1- Macapá	10 (20x50)	70	7	17,6	18,73	0,33	17,43	4,79
	2- Mazagão	10 (20x50)	80	19	24,23	13		18,26	7,12
	3- Mazagão	10 (20x50)	60	15	17,72	12,92	0,55	13,47	6,85
	4- Mazagão	10 (20x50)	80	26	32,15	14,98	2,55	22,15	4,3
	5- Mazagão	10 (20x50)	60	8	32,75	8,5	0,71	21,13	3,27

Ouratea hexasperma (St. Hil.) Baill.	1- Porto Grande	10 (20x50)	100	102	11,12	9,95	1,77	2,43	0,78
	2- Porto Grande	10 (20x50)	40	4	26,02	24,6	0,35	2,75	0,95
	3- Large Proto	10 (20x50)	10	1	1,59	0	0,0002	1,25	0
Pradosia huberi Ducke (Ducke)	1- Mazagão	10 (20x50)	20	2	20,06	20,25	0,095	26,5	26,16
	2- Mazagão	10 (20x50)	20	2	26,26	0,226	0,108	21	1,41
	3- Large Proto	10 (20x50)	10	1	63,98	0	0,32	30	0
	4- Porto Grande	10 (20x50)	10	1	56,97	0	0,25	30	0
Copaifera guianensis Desfontaines	1- Mazagão	10 (20x50)	10	1	64,93	0	0,33	40	0
	2- Mazagão	10 (20x50)	20	2	59,68	15,52	0,578	31,5	2,12
	3- Mazagão	10 (20x50)	70	10	28,41	25,8	1,1	19,84	16,6
Vatairea guianensis Aublet	1- Mazagão	10 (20x50)	40	4	42,42	14,28	0,613	26,25	4,92
	2- Mazagão	10 (20x50)	20	2	48,23	8,32	0,37	26	2,82
	3- Mazagão	1 (10x1000)	100	18	31,88	10,36	1,58	21,78	7,3
Calophyllum brasiliense Cambessedes	1- Macapá	10 (20x50)	10	1	49,33		0,19	20	
	2- Pará Island	10 (20x50)	60	6	29,82	12,33	0,479	20,83	6,73
	3- Mazagão	10 (20x50)	40	5	26,67	19,13	0,39	20,2	6,05
Hymenaea courbaril L.	1- Mazagão	10 (20x50)	10	1	36,92		0,107	25	
	2- Mazagão	10 (20x50)	50	6	64,83	21,55	2,16	32	9,89
	3- Large Proto	10 (20x50)	10	1	89,76	0	0,63	34	0
	4- Porto Grande	10 (20x50)	10	1	62,07	0	0,302	32	0
Species	**Inventory number/location**	**Number/size of plots**	**AF (%)**	**ALSO (ind/ha)**	**DBH**		**OFF**	**Height**	
					Medium	**Standard deviation**	**(m2/ha)**	**Average**	**Standard deviation**
Ptychopetalum olacoides Bentham	1- Porto Grande	1 (20x30)	100	400	1,58	3,8	0,51	1,38	1,83
	2- Porto Grande	1 (20x30)	100	450	2,27	2,62	0,41	2,48	3,94
	3- Large Proto	10 (20x50)	70	13	9,94	9,74	0,19	9,65	6,62
Brosimum cf. *utile* (Kunth) Pittier	1- Porto Grande	4 (20x50)	50	7,5	34,59	20,67	0,87	35,67	13,65
	2- Porto Grande	10 (20x50)	10	1	56,97	0	0,25	30	0
Tabebuia sp.	1- Porto Grande	10 (20x50)	30	6	80,06	12,144	3,07	38,17	2,85
Himatanthus articulatus (Spruce ex Müller-Argovensis)	1- Porto Grande	10 (20x50)	90	66	12,28	16,52	2,05	2,51	1,98
	2- Porto Grande	10 (20x50)	80	21	14,41	8,31	0,451	3,94	1,93
	3- Large Proto	10 (20x50)	20	6	6,47	6,37	0,036	2,22	0,94

Woodson									
Dalbergia monetaria L. f.	1- Mazagão	25 (10x20)	40	30	5,11	2,54	0,076		
	2- Mazagão	25 (10x20)	52	54	4,97	1,98	0,061		
	3- Ilha do Pará	12 (10x20	91,7	112	4,64	1,53	0,211		
	4- Macapá	50 (10x20)	28	37	4,66	2,87	0,087		

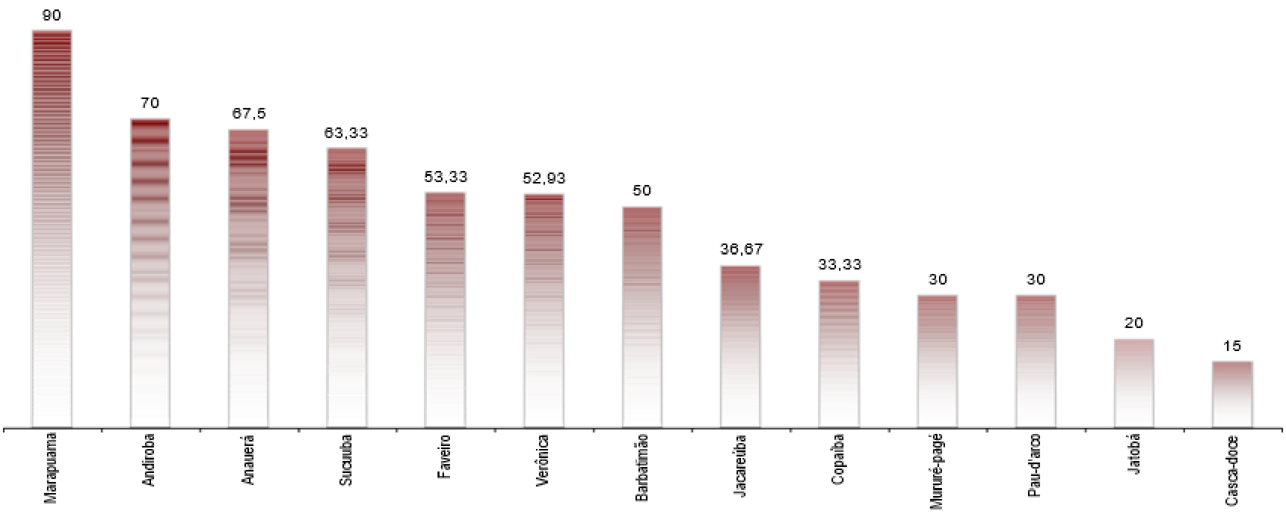
AF: absolute frequency; DA: absolute density; DBH: diameter at chest height; AB: basal area.

ABUNDANCE STRUCTURE

Abundance can refer to both the number of individuals in a population and the number of species in a community. In this study, for the estimation of species abundance, absolute frequency and density were defined as parameters.

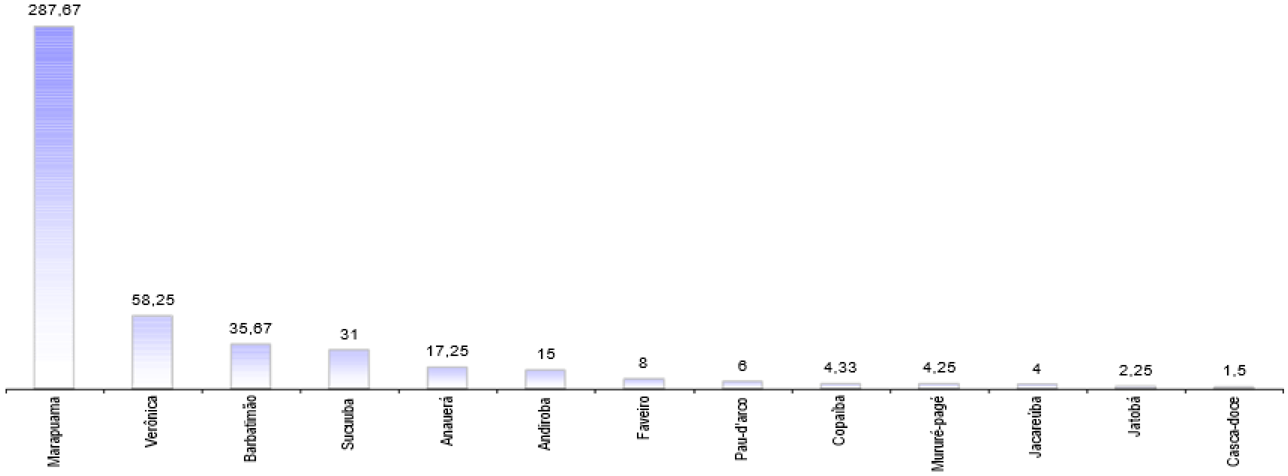
Absolute frequency (FA) is understood as the number of sampling units that a given species occupies (PIRES-O'BRIEN; O'BRIEN, 1995) and is used to express its distribution in the area (RABELO et al., 2001). According to Ferreira et al. (1997), three classes were defined: 1) common—present in almost all plots; 2) regular—present in 50% of the installments; and 3) rare—with occasional presence in the plots. Thus, the following were considered common species: marapuama, andiroba, anauerá and sucuuba; Regulars: Faveiro, Verônica and Barbatimão; and rare: jacareúba, copaiba, mururé-pagé, pau-d'arco, jatobá and casca-doce (Figure 2).

Figure 2: Absolute frequency of species (mean, %).



Absolute density is commonly defined as the number of individuals of a given species, per unit area (PIRES-O'BRIEN; O'BRIEN, 1995) and explains characteristics such as absence and rarity. In relation to this parameter, the species were defined as: rare —with an average of 1 to 4 individuals per hectare; intermediate — with between 5 and 39 individuals per hectare; and abundant —with more than 39 individuals per hectare (LISBOA et al., 1997). Thus, the following were considered abundant: marapuama and veronica; intermediate: barbatimão, sucuuba, anauerá, andiroba, feveiro and pau-d'arco; and rare: copaiba, mururé-pagé, jacareúba, jatobá and casca-doce. (Figure 3). It should be noted that, in the survey, no minimum height or diameter were defined.

Figure 3: Distribution of average absolute densities of species (in terms of individuals per hectare).



SIZE STRUCTURE

The size structure is expressed by DBH and/or height. Tree species in a state of dynamic equilibrium generally have an inverted J-shaped frequency distribution , decreasing from a lower DBH size class or height to another of higher size (ARAGÃO et al., 1997).

Figures 4 to 16 show the distributions of species by DBH classes. The species that were presented as in equilibrium, whose distribution forms an inverted J, were: anauerá, although irregularly, barbatimão, marapuama, sucuuba and veronica. Andiroba, copaiba, jatobá, mururé-pagé and pau-d'arco showed a distribution in which the largest number of individuals is concentrated in the classes of larger diameter. For sweet bark, faveiro and jacareúba the distribution was more or less random among the DBH classes.

Figure 4: Anauerá. Distribution by DBH classes.

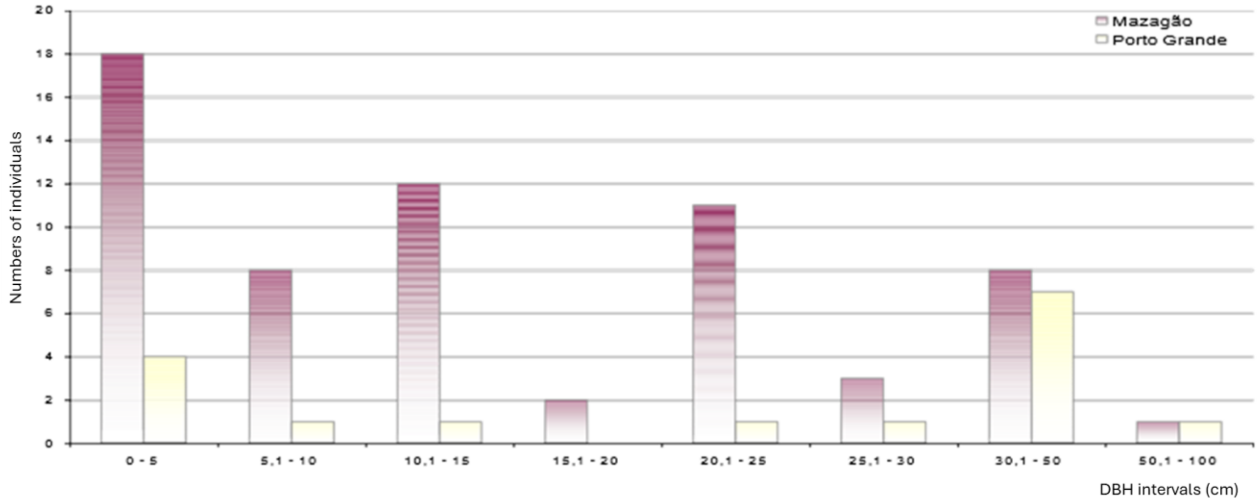


Figure 5: Andiroba. Distribution by DBH classes.

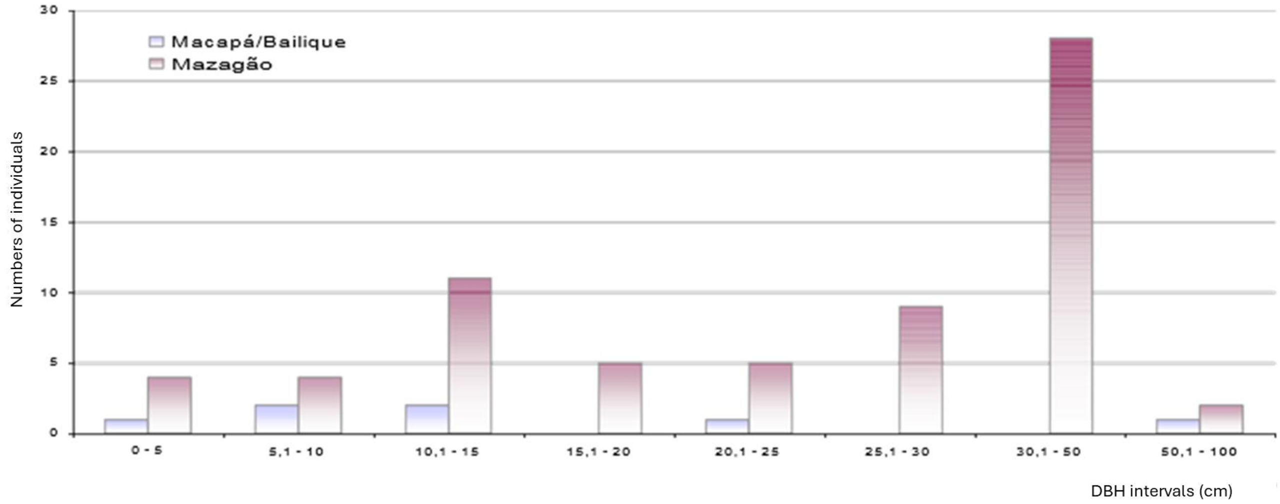


Figure 6: Barbatimão. Distribution by DBH classes.

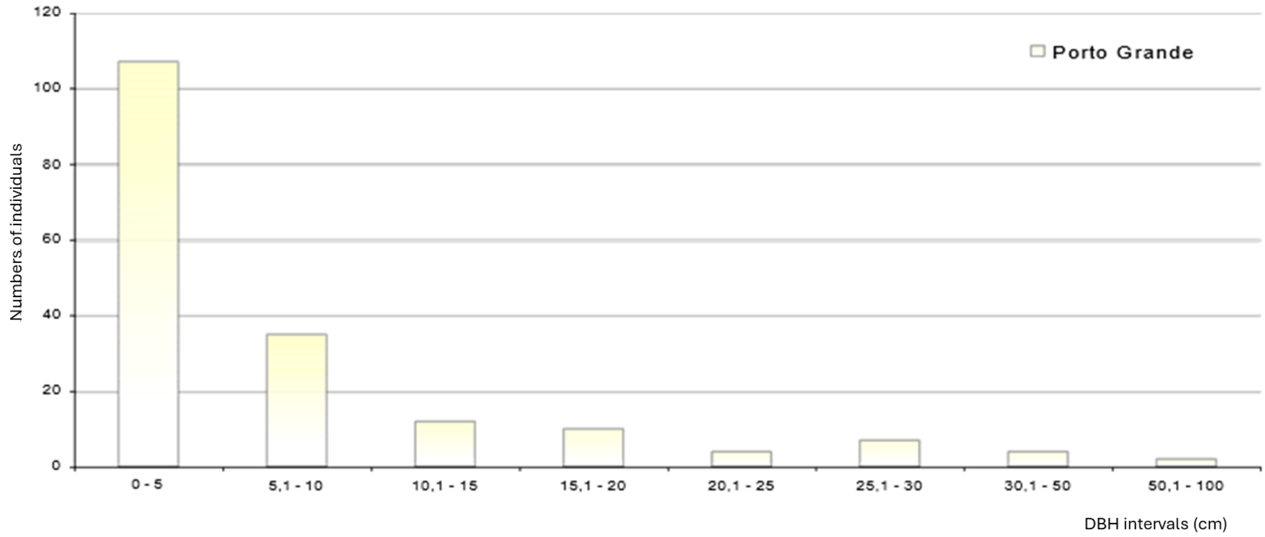


Figure 7: Sweet bark. Distribution by DBH classes.

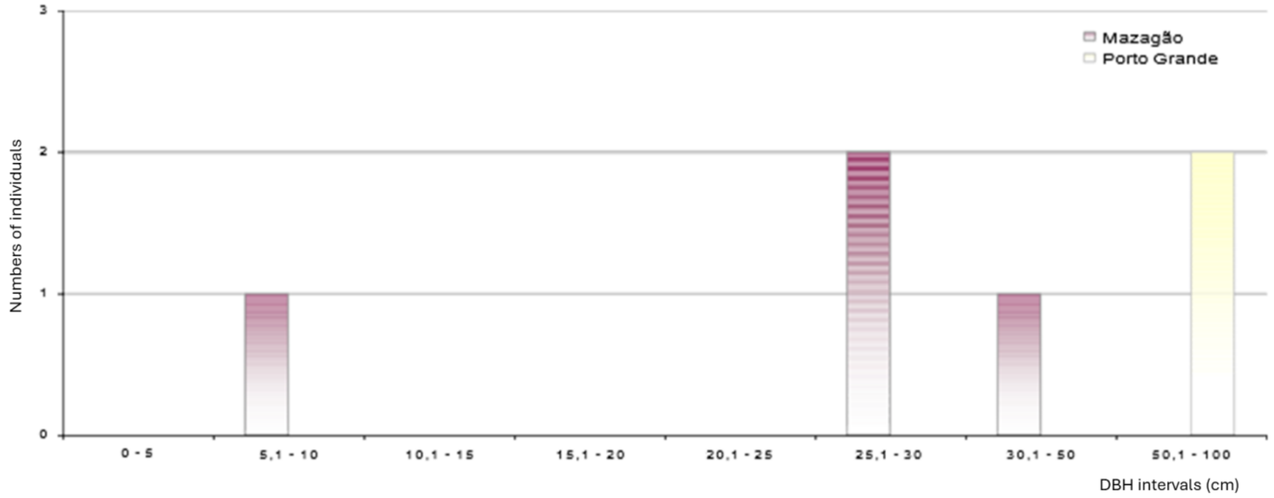


Figure 8: Copaiba. Distribution by DBH classes.

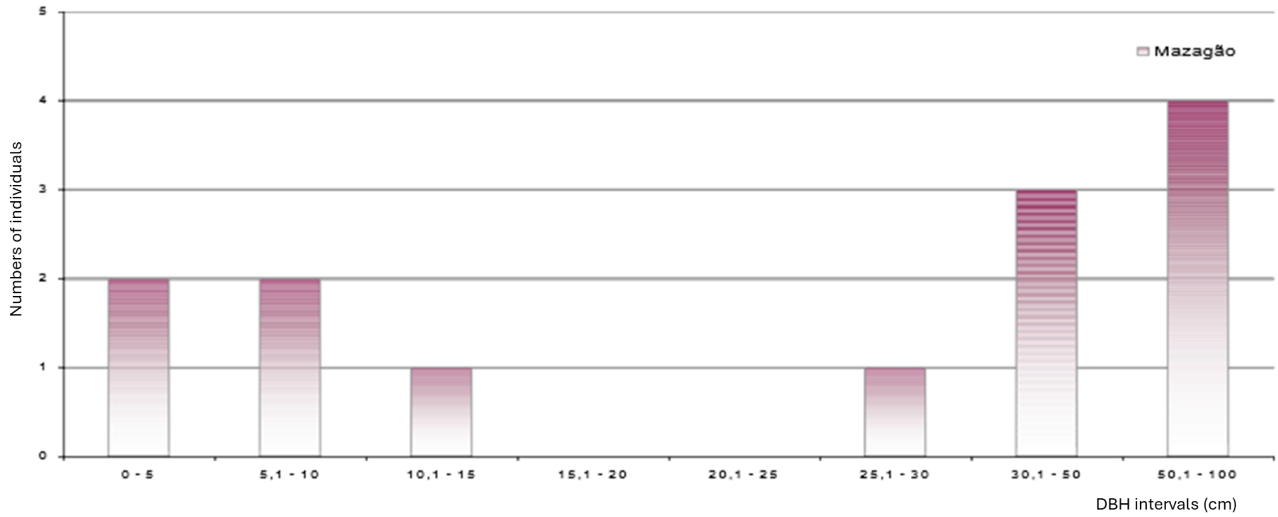


Figure 9: Faveira. Distribution by DBH classes.

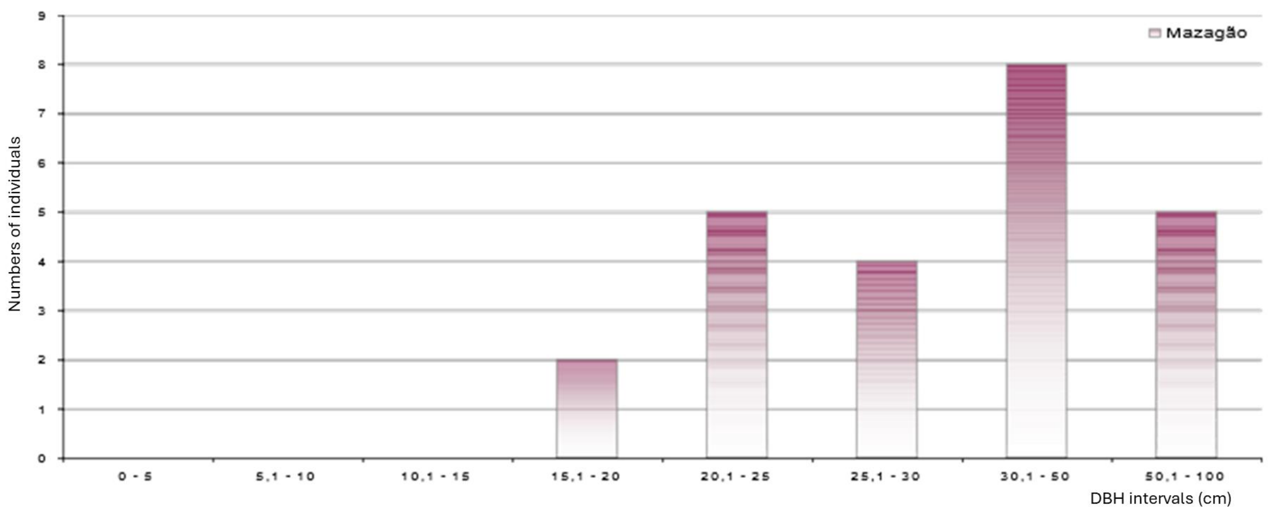


Figure 10: Jacareúba. Distribution by DBH classes.

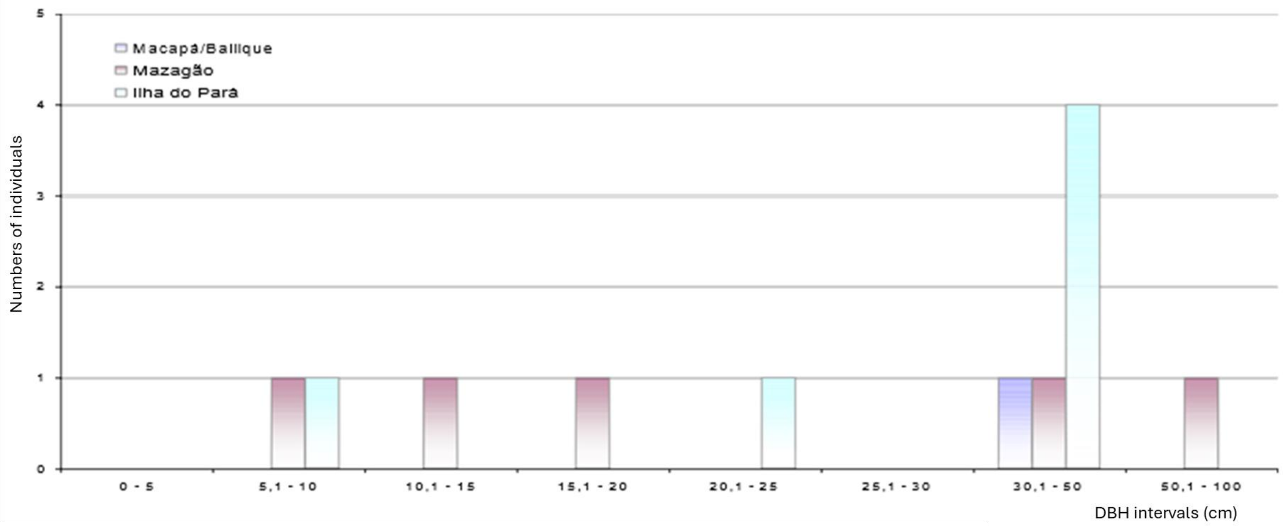


Figure 11: Jatobá. Distribution by DBH classes.

Figure 12: Marapuama. Distribution by DBH classes.

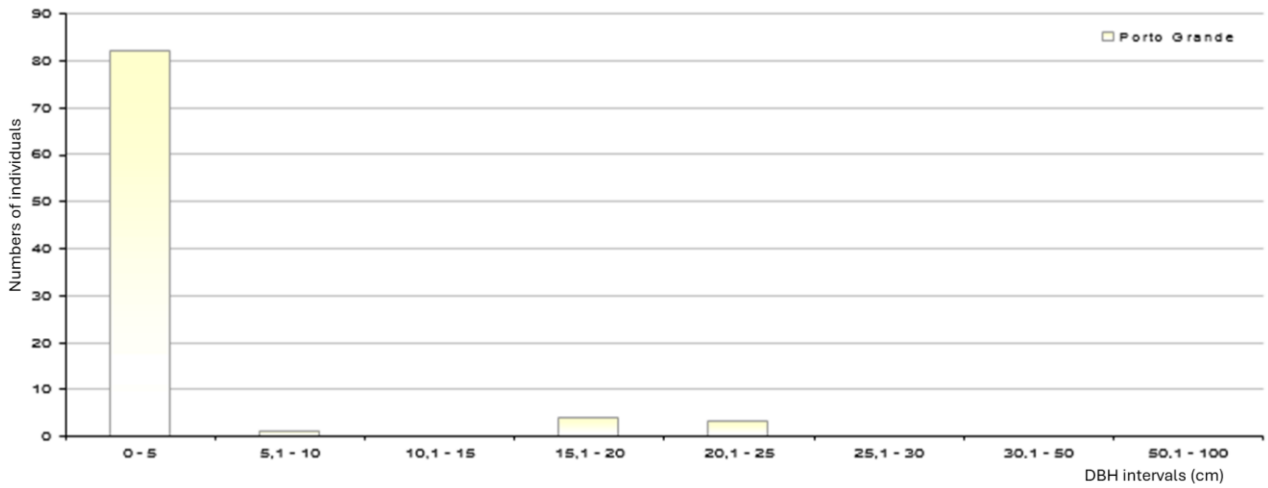


Figure 13: Mururé-pagé. Distribution by DBH classes.

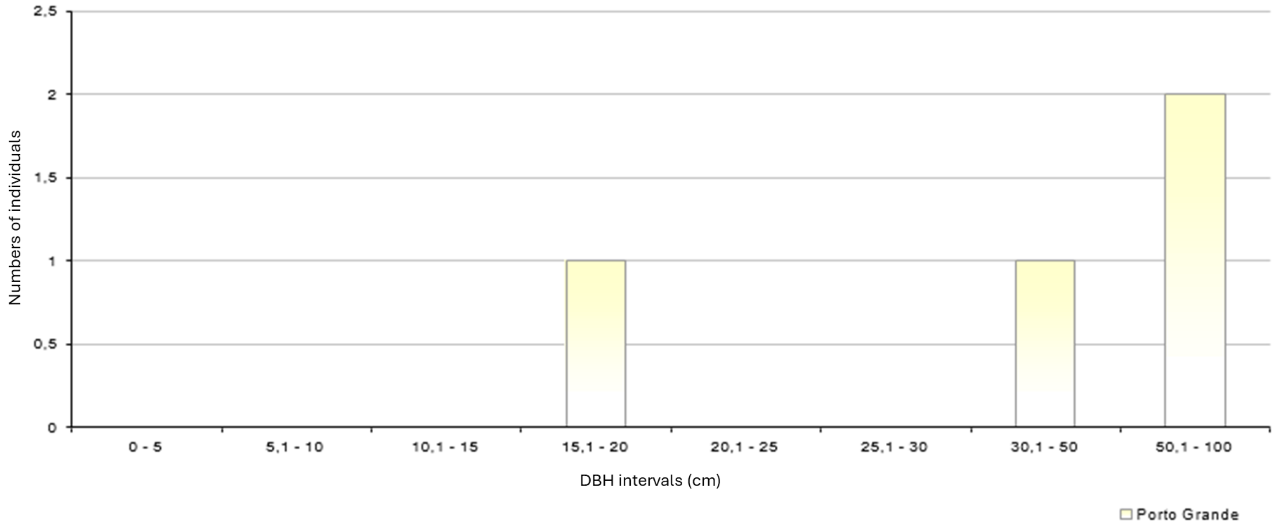


Figure 14: Pau-d'arco. Distribution by DBH classes.

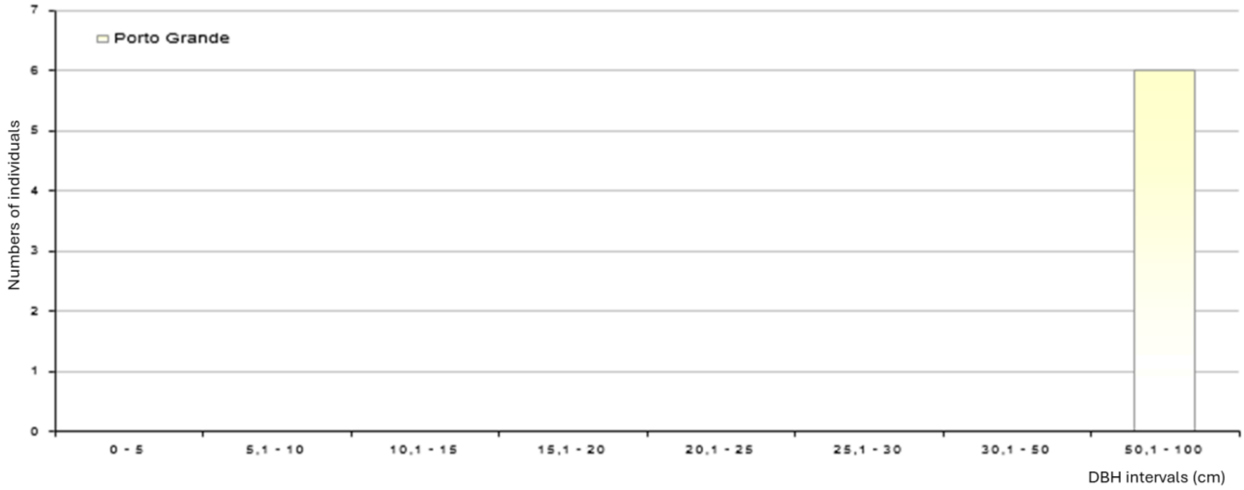


Figure 15: Sucuuba. Distribution by DBH classes. The class with the highest number of representatives was, in Porto Grande, from 0 to 5 centimeters.

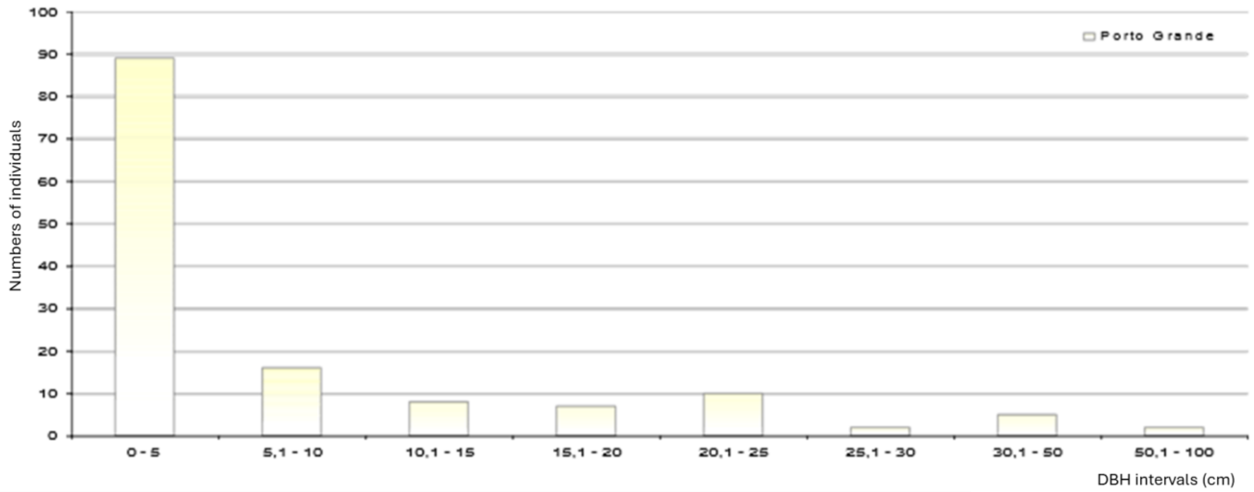
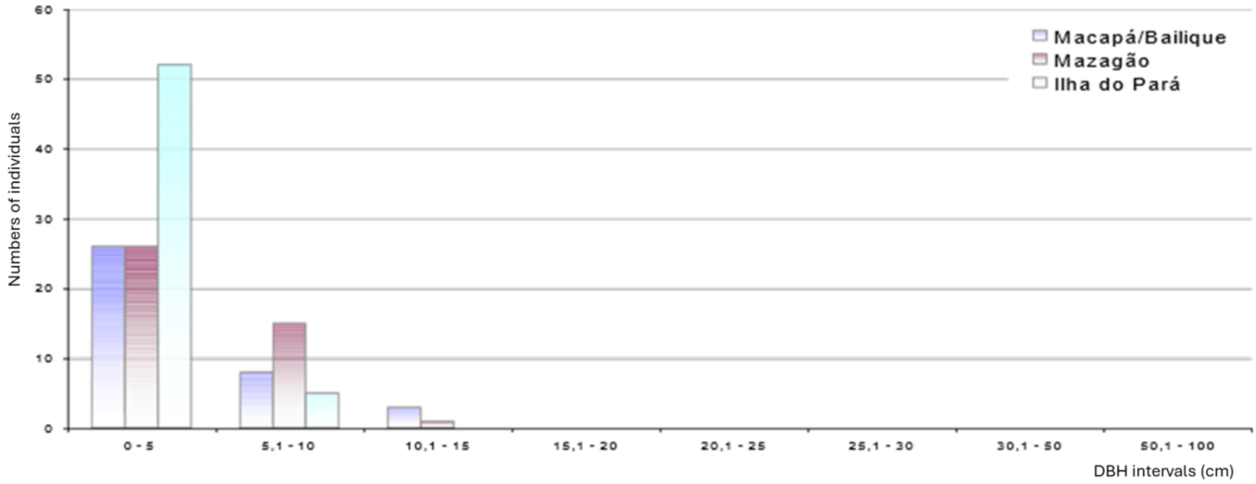


Figure 16: Veronica. Distribution by DBH classes. The class with the highest number of representatives was, on Pará Island, from 0 to 5 centimeters.



Figures 17 to 28 show the distributions of species by height classes. Anauerá presents the inverted **J** distribution more clearly in the inventories of Mazagão; the same happens with jatobá, but the curve starts from the fifth class (21 to 25m); andiroba, faveiro and jacareúba present a similar distribution pattern, in which there is a concentration of individuals in the central classes; casca-doce, copaíba and mururé-pagé are distributed in such a way that some classes are left without representatives; for barbatimão, Marapuama and Sucuuba individuals are concentrated in the first height class (0 to 5m); and all the individuals of pau-d'arco are between 31 and 40m.

Figure 17: Anauerá. Distribution by height classes.

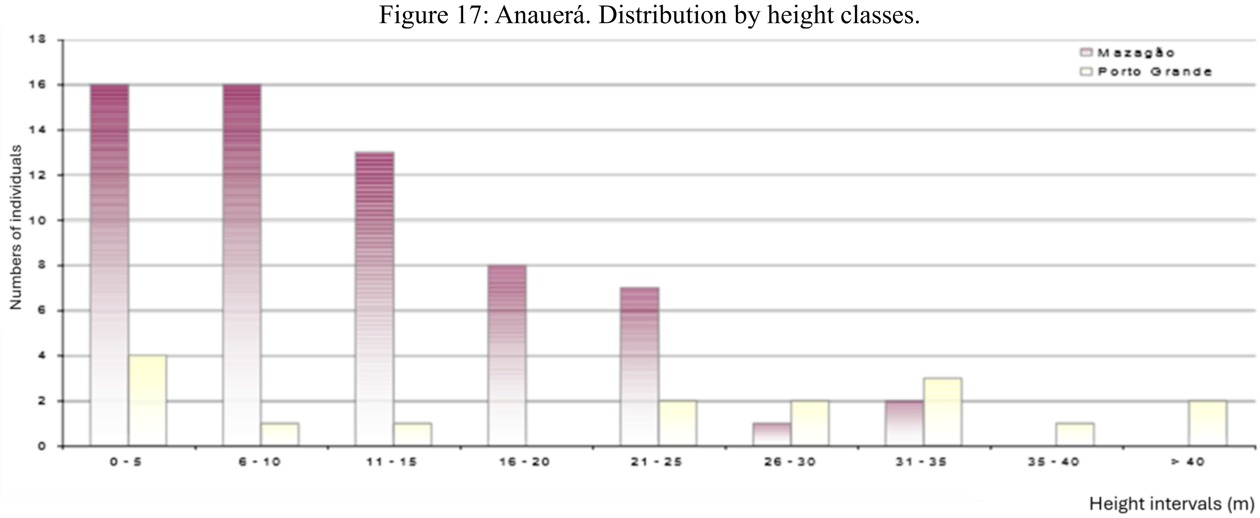


Figure 18: Andiroba. Distribution by height classes.

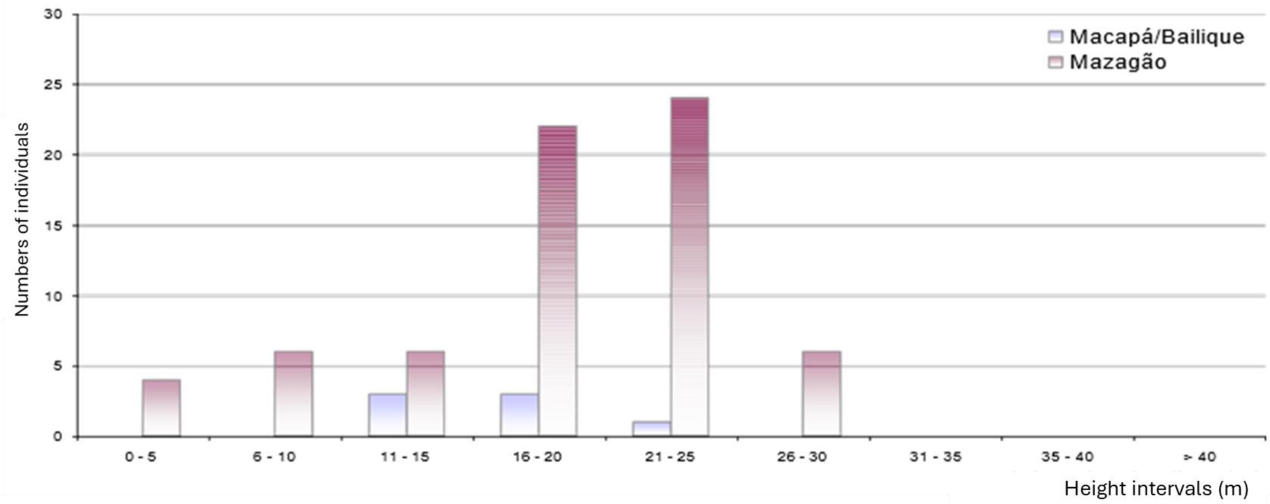


Figure 19: Barbatimão. Distribution by height classes

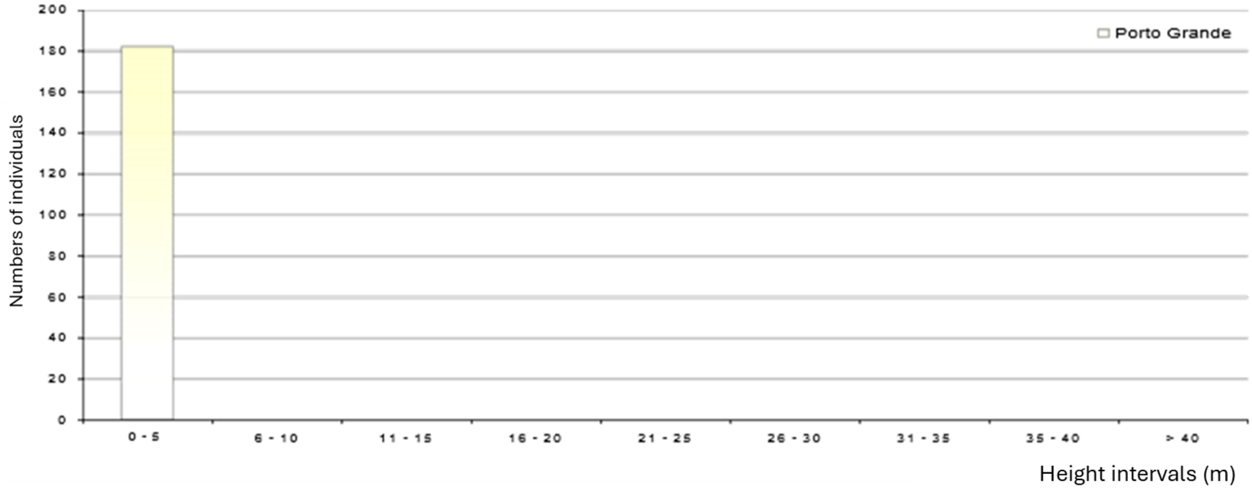


Figure 20: Sweet bark. Distribution by height classes.

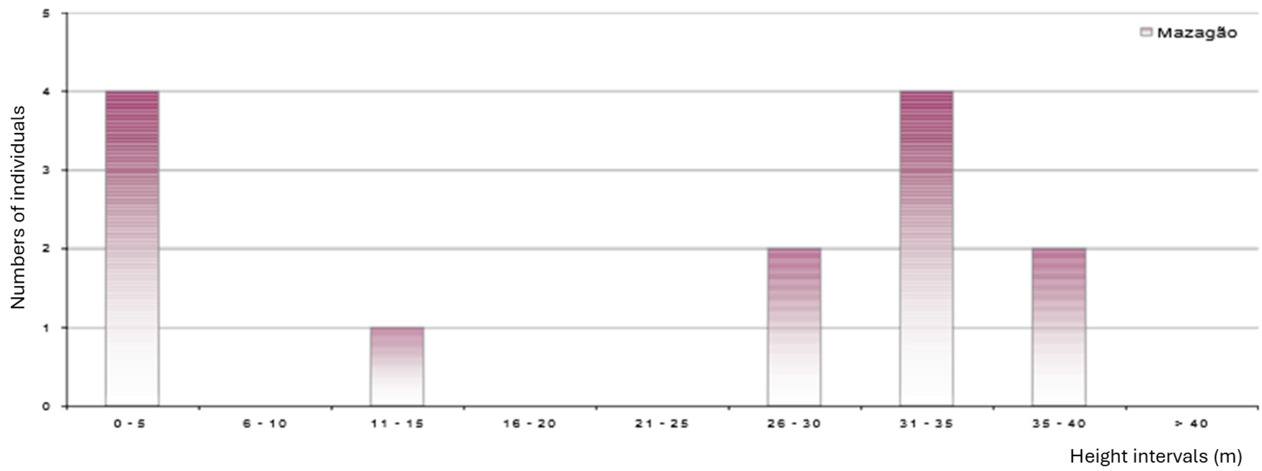


Figure 21: Copaiba. Distribution by height classes.

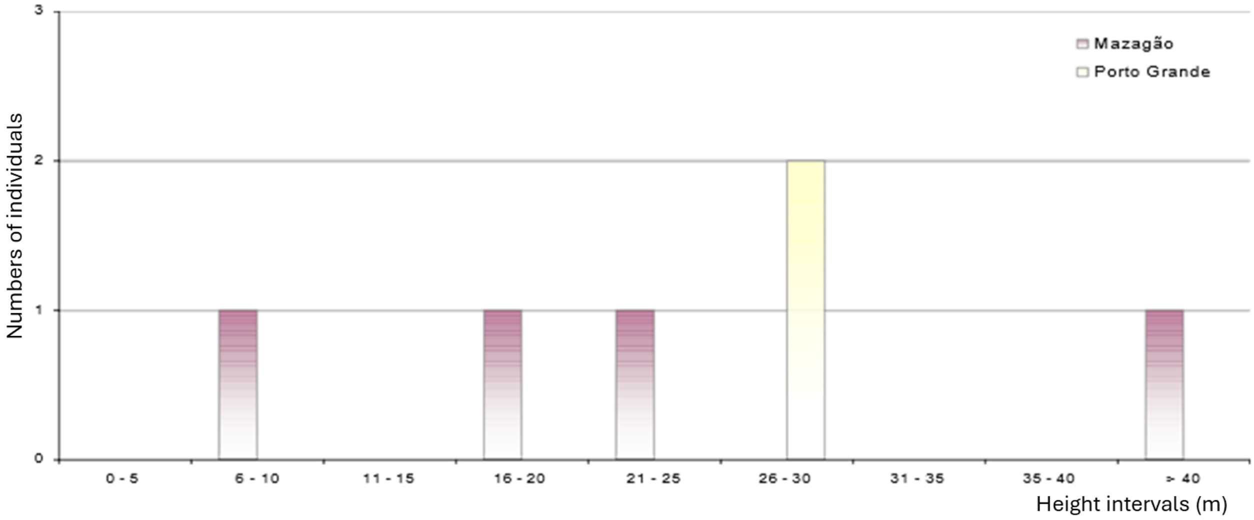


Figure 22: Faveira. Distribution by height classes.

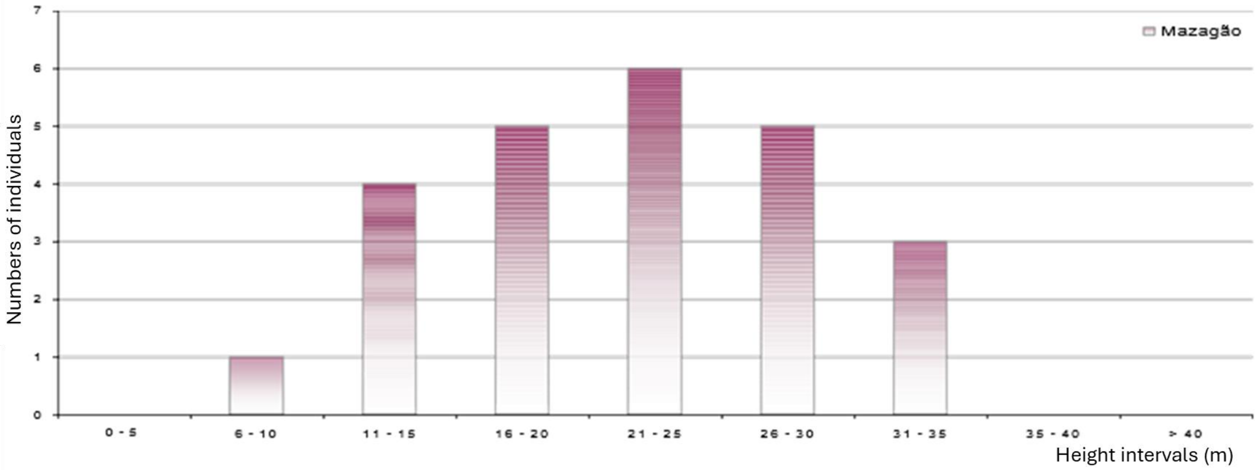


Figure 23: Jacareúba. Distribution by height classes.

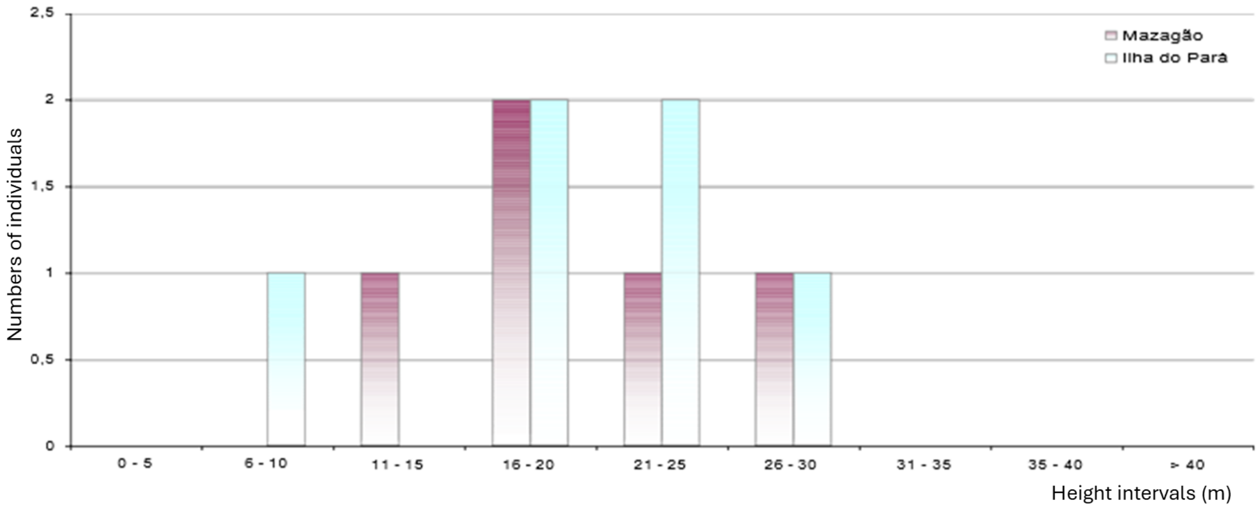


Figure 24: Jatobá. Distribution by height classes.

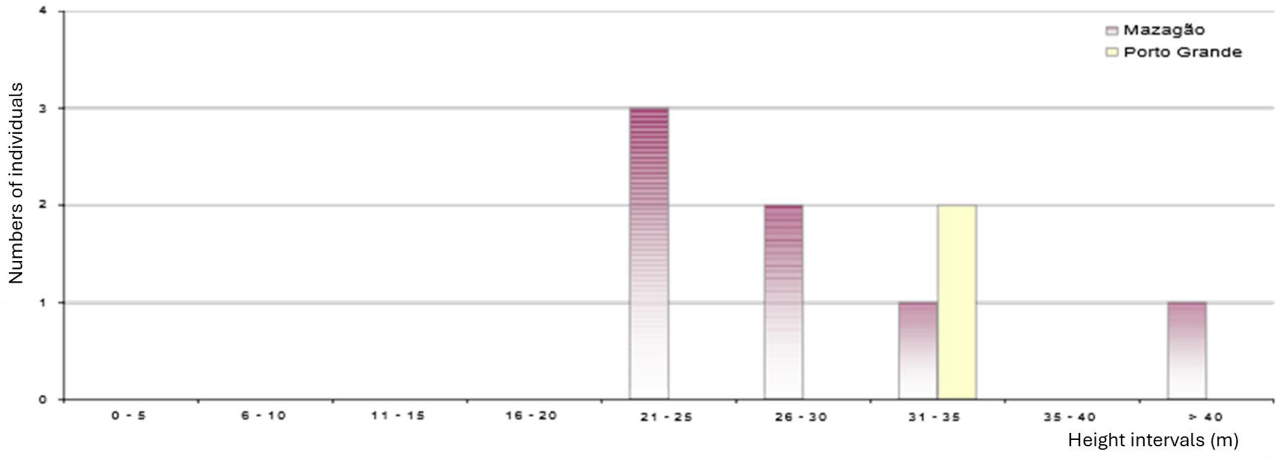


Figure 25: Marapuama. Distribution by height classes.

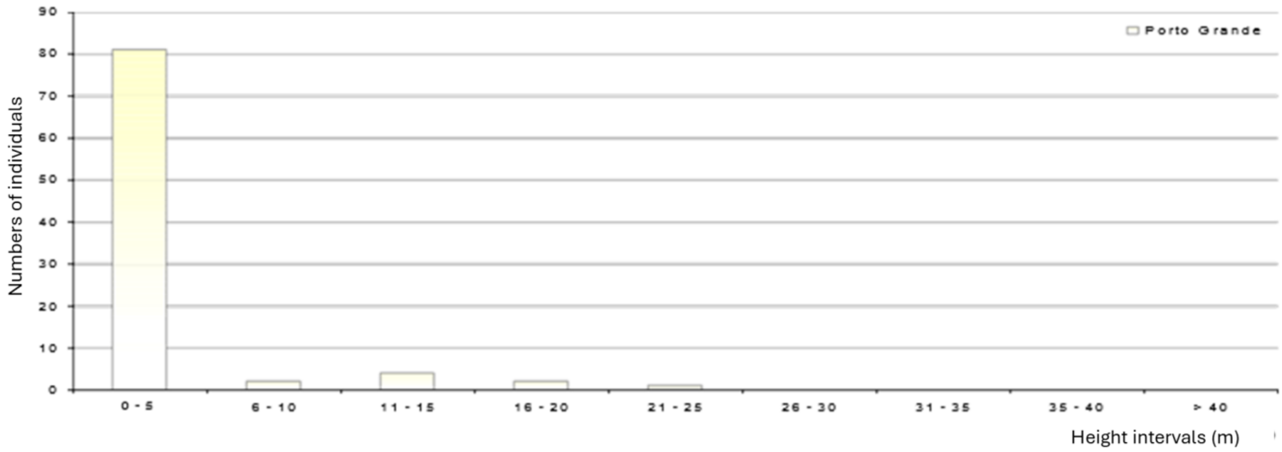


Figure 26: Mururé-pagé. Distribution by height classes.

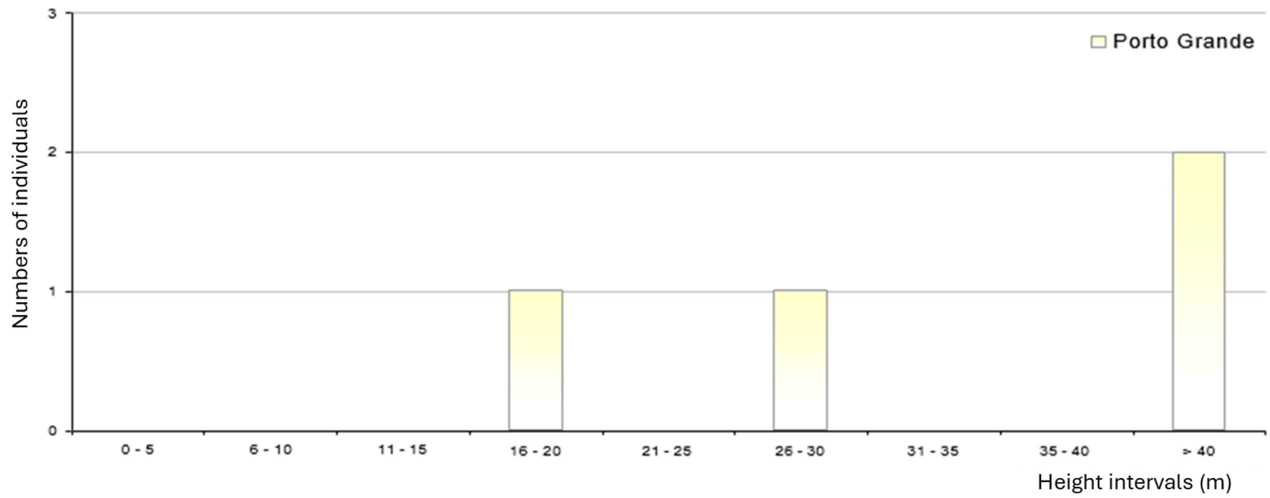


Figure 27: Pau-d'arco. Distribution by height classes.

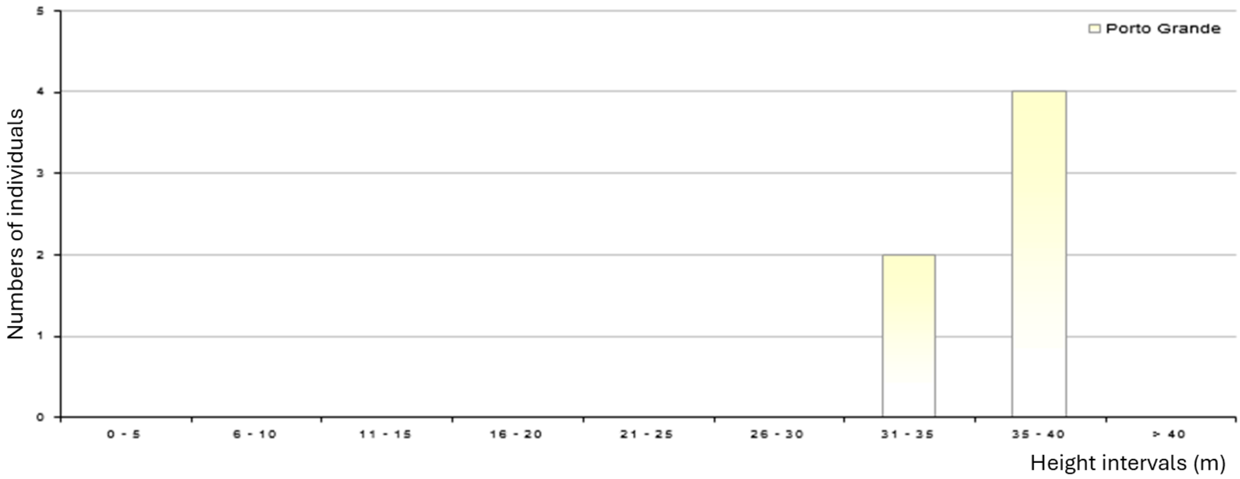
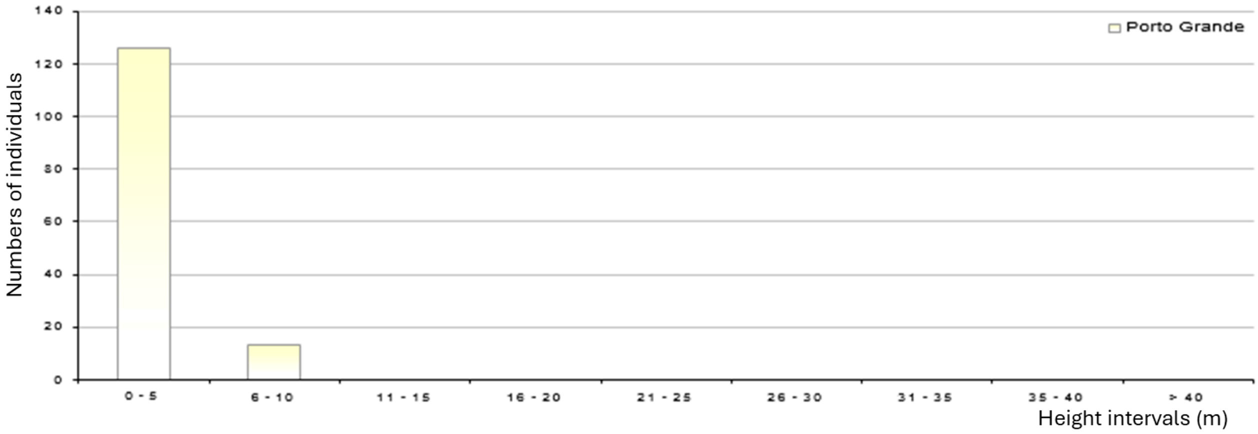
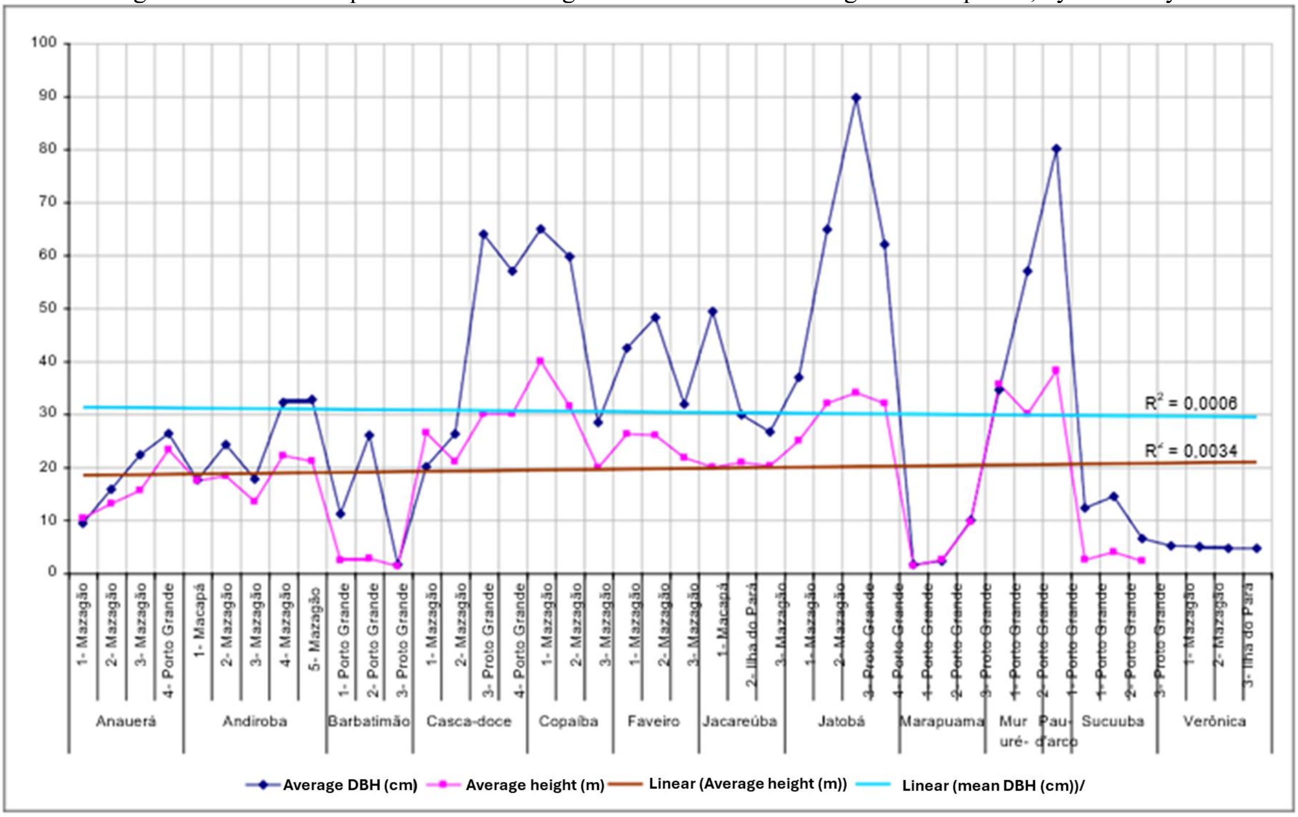


Figure 28: Sucuuba. Distribution by height classes.



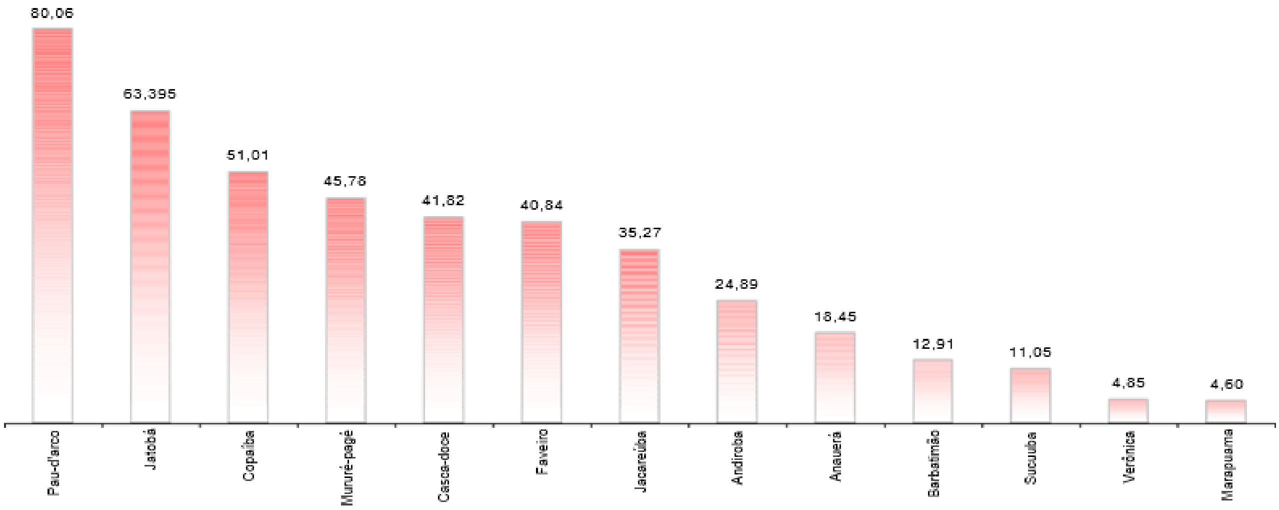
In figure 29, where the average values obtained for each inventory are shown, there is a tendency for correspondence between the diameter and height of the species, indicating their size and, indirectly, the amount of raw material available, although it is necessary to analyze other factors inherent to the part of the plant used in production.

Figure 29: Relationship between the average values of DBH and Height of the species, by inventory.



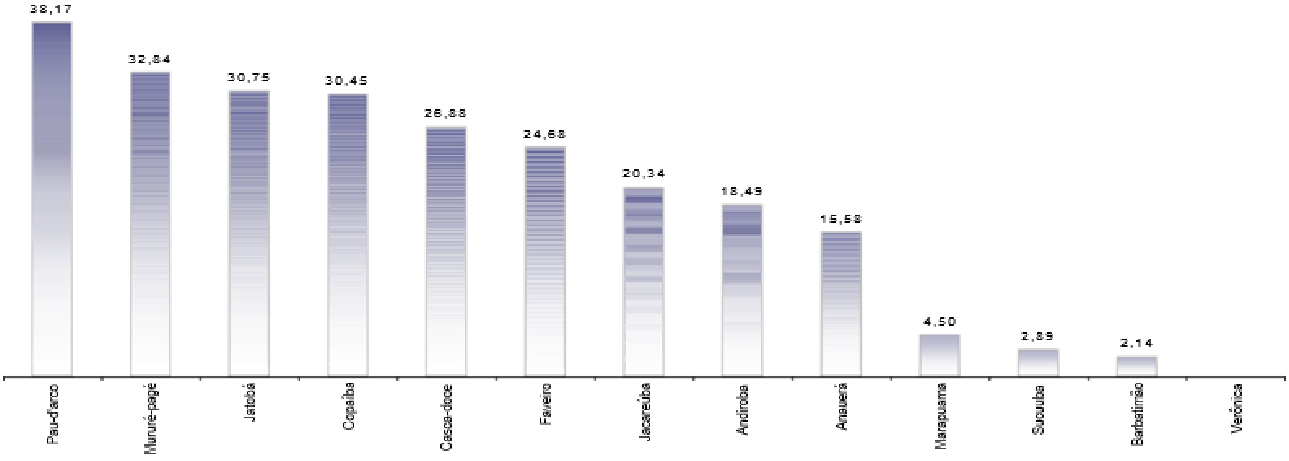
In the calculation of the DBH, individuals with very low values decreased the average of the species. Thus, the largest diameters were obtained for pau-d'arco, jatobá, copaiba, mururé-pagé and casca-doce, with values greater than 40cm (Figure 30).

Figure 30: Mean DBH values (cm).



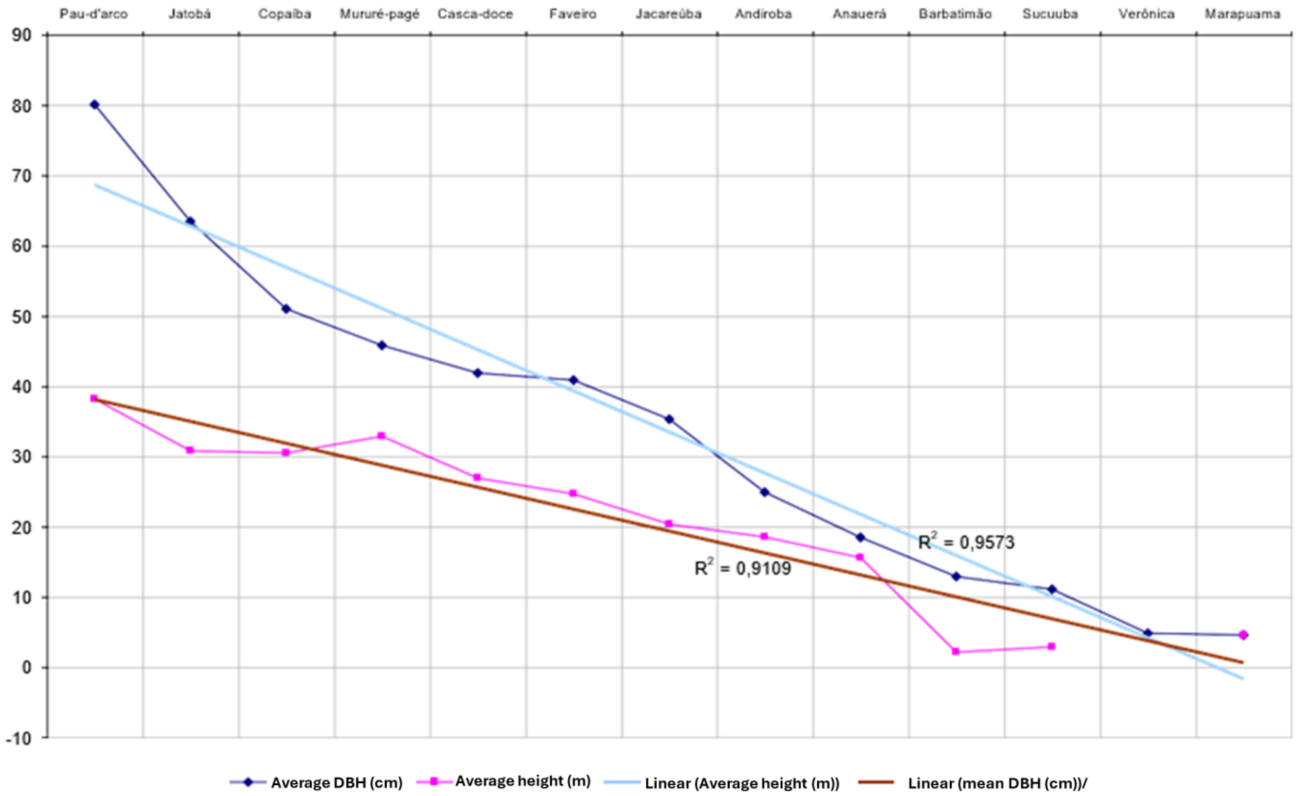
The highest heights were measured for pau-d'arco, mururé-pagé, jatobá, copaiba and casca-doce, all with an average greater than 25m (Figure 31).

Figure 31: Average heights of the sampled individuals (m).



The relationship observed in the inventories (shown in figure 35), for DBH and Height, is maintained in the analysis of the general averages obtained for the species, as shown in figure 32.

Figure 32: Relationship between average DBH and average height of the species.



From the analysis of the measured parameters, it can be inferred that the species with the greatest potential for extraction are: anauerá, andiroba, copaíba, faveira and verônica, as they are represented in almost all classes, both DBH (Figures 4, 5, 8, 9 and 16) and height (Figures 17, 18, 21 and 22). Although it has a low frequency (Figure 2) and density (Figure 3), the scale and form of extraction of copaiba oil gives a certain tranquility to its use.

On the other hand, the following inspires greater care regarding exploitation: casca-doce, mururé-pagé, jatobá, pau-d'arco, which are present in low frequency and density (Figures 2 and 3, respectively) and which are almost not represented in the initial size classes, which indicates a low regeneration rate for these species. Cases are jacareúba, which despite being represented in almost all size classes (Figures 10 and 23), is present in low density (Figure 3), and marapuama, which, despite the indication of having a good increase (Figures 12 and 25), the form of extraction definitively compromises the young individual, from which the root is removed.

Barbatimão and sucuuba, because they are shrub species, or are small trees, and veronica, which is a liana, deserve an analysis considering DBH classes and height different from the others.

CONCLUSIONS

The results of this research are important because they indicate that, in order to produce more significant information on stock, it is necessary to expand the inventory areas, making a greater coverage of the state, and to determine, in a more precise way, the demand for the vegetable raw material. It is also recommended to carry out more specific studies involving, for example, floral biology, spatial distribution, population structure, growth, regeneration, recruitment and biomass estimation. In this way, it will be possible to expand the range of information on the species used by the IEPA and give greater security to their exploitation in the natural environment.

ACKNOWLEDGMENT

The authors would like to thank Banco da Amazônia for financing the project *Botanical/Ecological Study and Qualitative Analysis of Extractive Medicinal Species Used in the Production of Herbal Medicines and/or Phytocosmetics by IEPA*; IEPA for supporting the trips; technicians Lindomar Chagas, Jonas Cardoso and Antônio Viana for helping with fieldwork; and local residents, who guided us in the areas visited.

REFERENCES

1. Akerele, O. (1992). WHO guidelines for assessment of herbal medicines. *Fitoterapia, 63*(2), 99-107.

2. Amapá. (1999). *Programa de Desenvolvimento Sustentável do Amapá*. Macapá.

3. Brasil. Ministério da Saúde. Secretaria de Vigilância Sanitária. (2004). Resolução no 48, de 16 de março de 2004. Dispõe sobre o registro de fitoterápicos. *Diário Oficial da República Federativa do Brasil*, Brasília.

4. Brasil. (1998). *Produtos potenciais da Amazônia: plantas medicinais*. Brasília: MMA/SCA.

5. Ferreira, L., Lisboa, P. L. B., & Muller-Dombois, D. (1997). As áreas de inundação. In P. L. B. Lisboa (Org.), *Caxiuanã* (pp. 195-211). Belém: Museu Paraense Emílio Goeldi.

6. Fidalgo, O., & Bononi, V. L. R. (1984). *Técnicas de coleta, preservação e herborização de material botânico*. São Paulo: Instituto de Botânica.

7. Holmgren, P. K., Holmgren, N. H., & Barnett, L. C. (1990). *Index Herbariorum* (8th ed.). New York: The Herbarium of the World.

8. Lisboa, P. L. B., Ferreira, L., & Muller-Dombois, D. (1997). Florística e estrutura dos ambientes. In P. L. B. Lisboa (Org.), *Caxiuanã* (pp. 163-193). Belém: Museu Paraense Emílio Goeldi.

9. Muller-Dombois, D., & Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. New York: Wiley & Sons.

10. Pires-O'Brien, M. J., & O'Brien, C. M. (1995). *Ecologia e modelamento de florestas tropicais* (p. 126). Belém: FCAP. Serviço de Documentação e Informação.

11. Rabelo, F. G. (2001). *Levantamento florístico na Micro-bacia do Igarapé Arapiranga*. Macapá: SEMA.

12. SUDAM, C&T, GENAMAZ. (2000). *Estudo do potencial de mercado de fármacos (medicamentos e cosméticos) fitomedicamentos, bancos de extratos e compostos e serviços de patenteamento e certificação: relatório final*.

13. Vidal, W. N., & Vidal, M. R. R. (1992). *Botânica – organografia: quadros sinóticos ilustrados de fanerógamos* (3rd ed.). Viçosa: UFV, Impr. Univ.

14. ZEE. (2002). *Macrodiagnóstico do Estado do Amapá: primeira aproximação do Zoneamento Ecológico Econômico* (p. 140). Macapá: IEPA - ZEE.

15. ZEE. (1998). *Relatório final (versão simplificada)* (p. 104).

16. ZEE. (2002). *Primeira aproximação do zoneamento ecológico-econômico do Amapá* (p. 140). Macapá: IEPA-ZEE.