



PHYTOSOCIOLOGICAL ANALYSIS OF THE THICKET'S VEGETATION IN TWO 'RESTINGA' SITES ON THE NORTH COAST OF BAHIA STATE, BRAZIL

Elizania Peixoto Rios¹, Gabriela dos Santos Amorim³, Samuel Diniz Barroso de Oliveira², Eduardo Bezerra de Almeida Jr.² and Valdira de Jesus Santos^{1*}

Abstract – This study aimed to define the floristic and structure composition of the thickets' vegetation in two sites of 'restingas' (coastal sand vegetation) in the beaches of Santo Antônio and Massarandupió, both located on the north coast of Bahia. In the thickets evaluated, we collected 44 species from 28 genera, and 23 botanic families. Fabaceae, Myrtaceae, and Nyctaginaceae presented the highest specific richness. In the first site, *Manilkara decrescent* T. D. Penn (32.52%), followed by *Tabebuia elliptica* (DC.) Sandwith (28.18%) and *Myrcia ramuliflora* (O.Berg) N. Silveira (28.14%), were the species with the highest importance value (IV), and in the second site, *Emmotum nitens* (Benth.) Miers (91.73%) and *Doliocarpus sellowianus* Eichler. (31.88%) were the species with the highest IV. For Santo Antônio beach, the thickets sampled showed Shannon diversity indices $H' = 3.024$ nats/m², and in the Massarandupió beach, the diversity index found was $H' = 2.423$ nats/m².

Keywords: Bahia state, floristic, restinga, thickets.

ANÁLISE FITOSSOCIOLÓGICA DA VEGETAÇÃO DE MOITA EM DUAS ÁREAS DE RESTINGA NO NORTE DO ESTADO DA BAHIA, BRASIL

Resumo – Este estudo visou definir a composição florística e estrutural da vegetação de moitas em dois locais de restingas (vegetação de área arenosa costeira), nas praias de Santo Antônio e Massarandupió, no litoral norte da Bahia. Nas moitas avaliadas, foram coletadas 44 espécies de 28 gêneros e 23 famílias botânicas. Fabaceae, Myrtaceae e Nyctaginaceae apresentaram a maior riqueza específica. No primeiro

1. Universidade do Estado da Bahia, Campus VII Senhor do Bonfim, - Rodovia Lomanto Junior, BR 407, km 127 CEP 48970-000, Senhor do Bonfim, Bahia, Brasil.

2. Universidade Federal do Maranhão, Departamento de Biologia, Laboratório de Estudos Botânicos, Avenida dos Portugueses 1966, Campus do Bacanga, CEP 85080-805, São Luís, MA, Brasil.

3. Programa de Pós-graduação em Biologia Vegetal, Universidade Federal de Pernambuco, Av. Prof. Moraes Rego, 1235 – Cidade Universitária, 50670-901, Recife – PE, Brazil.

*Autor correspondente: valjsantos@gmail.com

local, *Manilkara decrescent* T. D. Penn (32,52%), seguida por *Tabebuia elliptica* (DC.) Sandwith (28,18%) e *Myrcia ramuliflora* (O.Berg) N. Silveira (28,14%), foram as espécies com maior valor de importância (IV), e no segundo local, *Emmotum nitens* (Benth.) Miers (91,73%) e *Doliocarpus sellowianus* Eichler. (31,88%) foram as espécies com o maior IV. Para a praia de Santo Antônio, as moitas amostradas apresentaram índices de diversidade de Shannon $H' = 3,024 \text{ nats/m}^2$, e na praia de Massarandupió, o índice de diversidade encontrado foi $H' = 2,423 \text{ nats/m}^2$.

Palavras-chave: Bahia, florística, restinga, moitas.

INTRODUCTION

‘Restingas’ are littoral ecosystems composed of vegetation from adjacent ecosystems, such as the Atlantic Forest, Central Brazilian Savanna (‘Cerrado’), and Caatinga (Freire, 1990). This vegetation reflects on the influence of soil conditions, exposure level to sea breezes, and abundant sunlight (Sampaio et al., 2005). In Brazil, this type of vegetation represents a mosaic of forest, shrubland and herbaceous along the coast (Medeiros et al., 2010; Almeida Jr. et al., 2011; Almeida Jr. & Zickel, 2012; Cantarelli et al., 2012, Vicente et al., 2014; Medeiros et al., 2014; Santos et al., 2015).

In ‘restinga’, the shrub formations can be composed of dense tangles of shrub, or thickets, intercalated by spaces with exposed sand (Zickel et al., 2004). The thickets are fragments of vegetation separated by the bare soil, where their succession occurs through the colonization of pioneer species, such as herbs and/or woody plants (Sampaio et al., 2005). In forming thickets, there are positive and negative interactions between plants, and the greater the level of abiotic stress in the environment, the greater the possibility of new positive interactions (Bertness & Hacker, 1994).

In the ‘restingas’, the thickets occur due to the discontinuity in the cover of the landscape and to the physiognomy and/or floristic composition, forming a mosaic configuration in open shrub formations (Rocha et al., 2015). According to Matos et al. (2017), the open shrub formation in thickets from the North Coast of Bahia corresponds to the non-flooded open scrub physiognomy, according to the classification of Silva & Britez (2005). This formation features, and presents shrubs and small atrophied trees, with common species including *Manilkara salzmannii* (A. DC.) H.J. Lam and *Tabebuia elliptica* (A. DC.) Sandwith.

The coast of Bahia is the largest in northeastern Brazil, covering 1,120 km in length and ca. 20 km wide (Santos et al., 2021). According to Queiroz (2007), the coast of Bahia is under an accelerated process of human occupation due to real estate speculation. Some studies were carried out on the composition of the vegetation on the coast of Bahia (Menezes et al., 2009; Menezes et al., 2012; Queiroz

et al., 2012; Fernandes & Queiroz, 2015; Santos et al., 2015; Silva et al., 2019; Santos et al., 2021), however there is not enough information about the vegetation structure of the entire coast of the state, mainly for the north coast.

In this context, the present study aimed to analyze the structure of the vegetation in two areas of open shrub 'restinga', specifically within the thickets, on the north coast of Bahia. We tested the following hypothesis: the thicket's vegetation of 'restinga' on the north coast of Bahia state has high richness and diversity. In addition, we aimed to answer the following questions: (1) What is the structural composition of the thicket's vegetation regarding the north coast of Bahia state? (2) Are the species that presented the highest importance value in the thicket vegetation on the north coast of Bahia also found in other 'restingas' along the northeastern coast of Brazil? We also propose expanding studies on the north coast of the Bahia state and contributing information about the vegetation to support future actions that intend to mitigate the impacts caused by human occupation.

MATERIAL AND METHODS

Area of study

The study was carried out in two 'restinga' sites in the north coast of Bahia, Santo Antônio Beach (Site 1 - 12°26'28"S, 37°56'02"W), in the municipality of Mata de São João, and Massarandupió Beach (Site 2 - 12°18'54"S; 37°49'53"W), in the municipality of Entre Rios. Both areas are located in the North Coast of Bahia Environmental Protection Area (EPA) (Figure 1), created by State Decree nº 1.046 of March 17, 92, as a conservation strategy of the National Environmental Policy. This EPA is the second largest in the Bahia state and covers five municipalities with 142 hectares (Menezes et al., 2012).

The climate type (according to Köppen climate classification) along the narrow strip of marine lowland and coastal upland in Bahia is the Af' (Tropical without dry season), a transition between the climate Aw' (Tropical with monsoon) in the south and As' (Tropical with dry summer) in the north (Alvares et al., 2014). Annual rainfall varies spatially from south to north, reaching values between 2.000 mm and 1.200 mm, respectively. The Spodosols and Quartzarenic Neosols, typical of Quaternary deposits, are the major soil classes, characterized by being dystrophic and formed from deposits of fluvial-marine sediments from the Quaternary period (Martin et al., 1980).

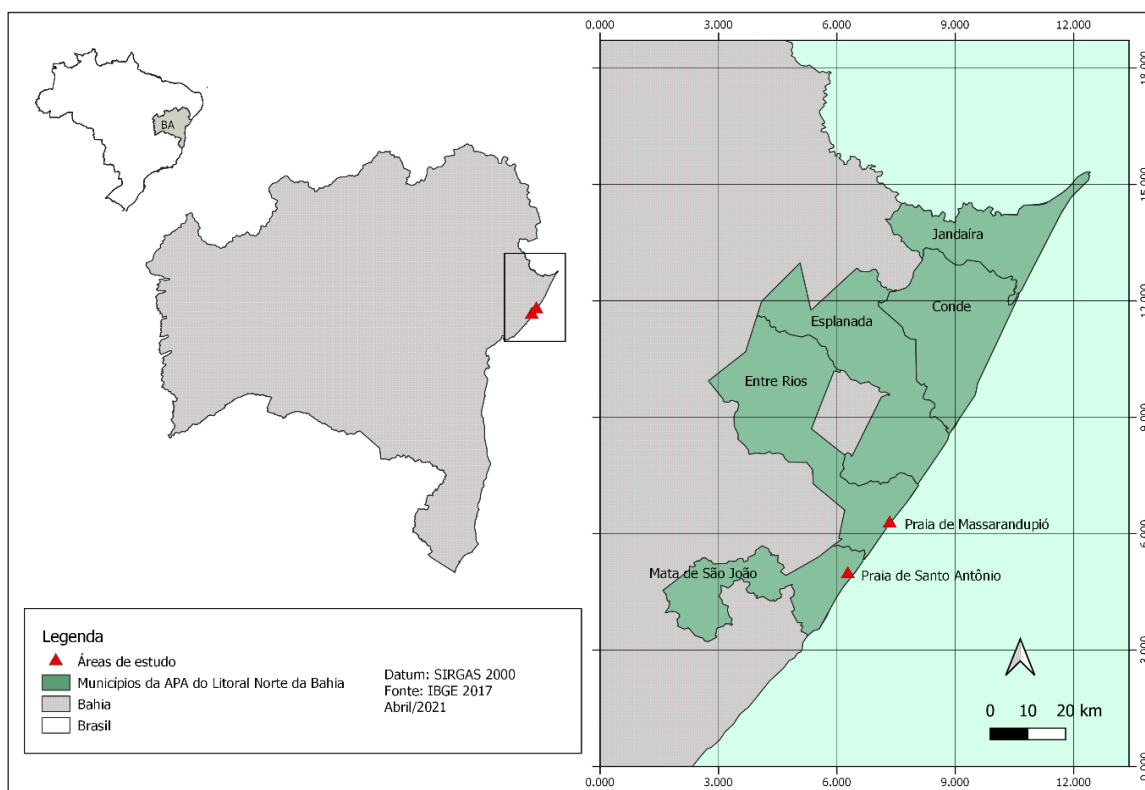


Figure 1. Location of the study areas in the North Coast of Bahia Environmental Protection Area.

Site 1 is composed of thickets of continuous herbaceous-shrub vegetation and extensive areas without vegetation (Figure 2). This beach is accessible and visited by locals and tourists. Site 2 is characterized by a continuous strip of thickets along its extension, with shrub-arboreal and herbaceous-shrub vegetation reaching the tide (Figure 2). The dunes form a barrier to the wind, which arises from the ocean. Tourist exploitation is frequent, with trails for access by "off-road" vehicles used for sports practice; in addition, there is a flow of people in some stretches that are intended for naturism.

Sampling and data analysis

For the phytosociological survey, 10 thickets were randomly selected in each of the studied areas, with every thicket having a perimeter of 250 m² or less, totaling 20 samples. Each thicket is equivalent to a parcel. For the phytosociological analysis, the dimensions of the thicket (width and length) were measured, and to understand their development, only woody plants were analyzed. The diameter and the height of all woody individuals within the thicket were collected. The diameter was measured 1.5 m above the ground. The plant samples were collected, prepared and identified according to the usual

methods in botanical studies (Mori et al., 1989), in the Laboratório de Botânica do Departamento de Educação da Universidade do Estado da Bahia (UNEB) - Campus VII.

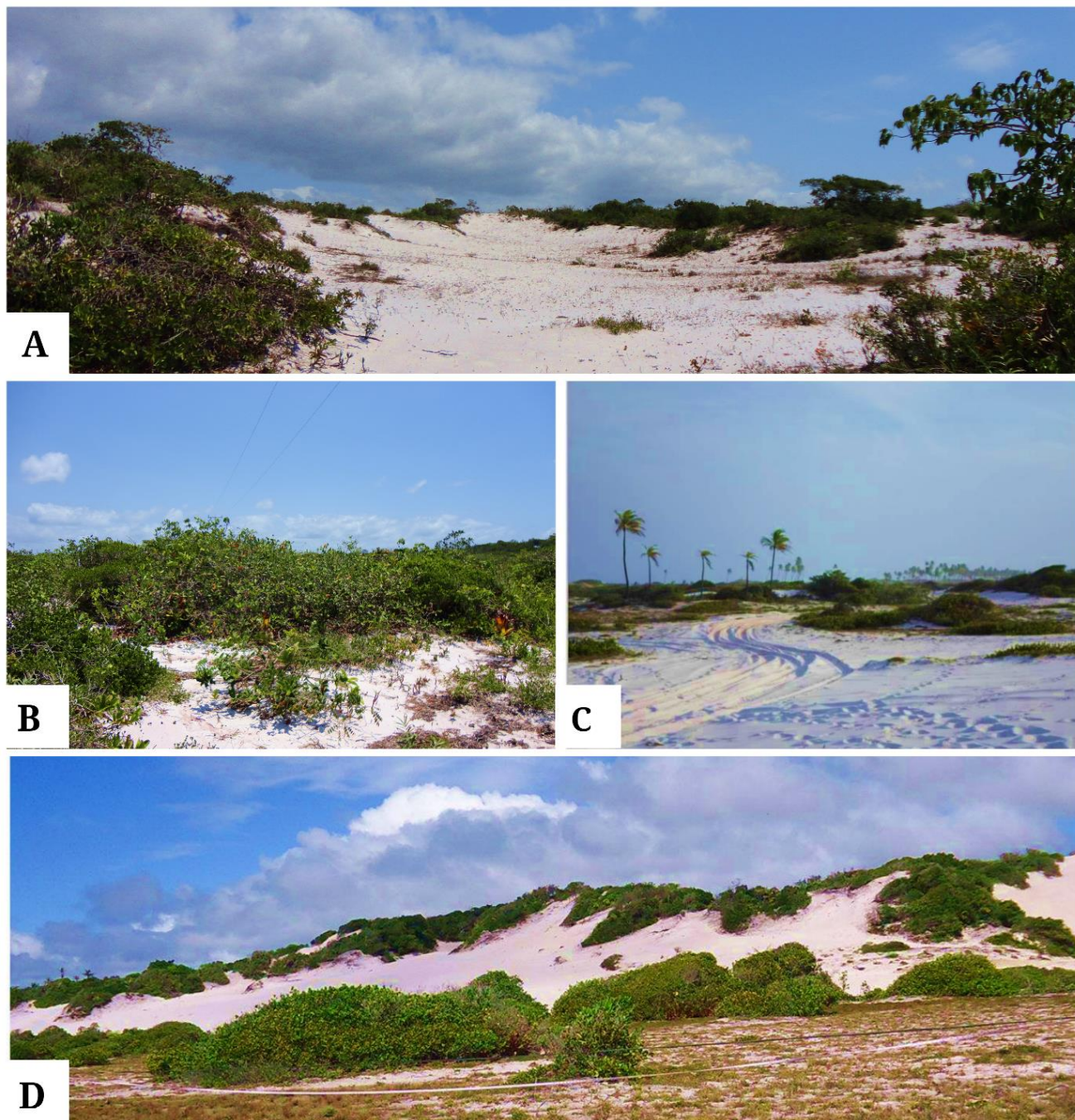


Figure 2. Open shrub formations of thickets in the North Coast of Bahia Environmental Protection Area. A-B. Santo Antonio Beach (Site 1). C-D. Massarandupió Beach (Site 2) (Author: Elizania P. Rios).

The material was identified with the support of specific literature and comparison with specimens from the collections of the Herbarium of the Universidade do Estado da Bahia (HUNEB) and Alexandre Leal Costa Herbarium (ALCB). The organization of families followed the classification system proposed by APG IV (2016).

The following phytosociological parameters were calculated using the Fitopac package (Shepherd, 2005): basal area (BA), relative density (RD), relative frequency (RF), relative dominance (RDo), and importance value (IV). The Shannon (H') and total richness (S). It should be noted that the Fitopac package is a program for phytosociological analysis that allows calculating parameters and analyzing data from vegetation surveys.

RESULTS

In the 20 thickets, there were sampled a total of 1,528 individuals distributed in 44 species from 28 genera, and 23 families (Table 1). For Site 1, the richest families in species were Fabaceae (five species), Myrtaceae and Nyctaginaceae (three species each) representing 31% of the total species. In Site 2, the richest families in species were Myrtaceae e Nyctaginaceae (three species each) and Dilleniaceae (two species each), representing 20% of the total species (Figure 3).

At Site 1, sample of 36 species were found. *Manilkara decrescens* (32.52%), *Tabebuia elliptica* (28.18%), *Myrcia ramuliflora* (28.14%) and *Croton campestris* (20.70%), represent 13% of the total species for this site, with highest importance value, due to their frequency and density (Table 1). Additionally, both *Manilkara decrescens* and *Myrcia ramuliflora* also presented the highest number of individuals.

In Site 2, sample of 20 species were included. *Emmotum nitens* (91.73%), *Doliocarpus sellowianus* (31.88%), *Myrsine guianensis* (29.30%), *Protium bahianum* (25.8%), *Clusia nemorosa* (23.4%) and *Coccoloba laevis* (20.1%) presented the highest importance value. The first two of them presented the highest number of individuals, while *Emmotum nitens* was the most frequency and dominance species (Table 1).

The Shannon diversity index for Site 1 was $H' = 3.024$ nts/m², and for Site 2 it was $H' = 2.42$ nts/m². The similarity analysis demonstrated low rates of similarity between the areas.

Table 1. Phytosociological parameters for the species sampled in the thickets in Santo Antônio beach – Site 1 = S 1, and Massarandupió beach – Site 2 = S 2. NI = number of individuals; RD = relative density; RF = relative frequency; RDo = Relative dominance; IV = Importance value. Species are sorted in ascending order according to IV.

Site 1 - 'Restinga' of Santo Antônio - Mata de São João							
Species	Family	Area	NI	RF%	RD%	RDo%	IV %
<i>Manilkara decrescens</i> T.D.Penn	Sapotaceae	S1	125	7.46	12.25	12.80	32.52
<i>Tabebuia elliptica</i> (DC.) Sandwith	Bignoniaceae	S1	75	5.97	7.25	14.85	28.18
<i>Myrcia ramuliflora</i> (O.Berg) N. Silveira	Myrtaceae	S1	100	6.72	9.80	11.62	28.14
<i>Croton campestris</i> A.St.-Hil.	Euphorbiaceae	S1	84	4.48	8.24	7.98	20.70
<i>Ouratea suaveolens</i> (A.St.-Hil.) Engl.	Ochnaceae	S1	86	5.97	8.43	3.72	18.12
<i>Alchornea</i> sp.	Euphorbiaceae	S1	63	3.73	6.18	3.97	13.87
<i>Erythroxylum passerinum</i> Mart.	Erythroxylaceae	S1	45	5.22	4.41	4.04	13.67
<i>Protium bahianum</i> Daly.	Burseraceae	S1	31	5.97	3.04	4.64	13.65
<i>Byrsonima microphylla</i> A.Juss	Malpighiaceae	S1	64	4.48	6.27	2.75	13.50
Fabaceae 2	Fabaceae	S1	36	2.24	3.53	3.80	9.57
Indet 2	-	S1	22	2.99	2.16	4.25	9.39
<i>Mimosa somnians</i> Humb. & Bonpl. ex Willd.	Fabaceae	S1	27	2.99	2.65	3.33	8.96
<i>Calycolpus legrandii</i> Mattos	Myrtaceae	S1	27	2.99	2.65	2.60	8.23
<i>Davilla flexuosa</i> A.St.-Hil.	Dilleniaceae	S1	29	3.73	2.84	1.42	8.00
<i>Trichilia hirta</i> L.	Meliaceae	S1	29	3.73	2.84	1.18	7.75
<i>Guettarda platypoda</i> DC.	Rubiaceae	S1	23	3.73	2.25	1.43	7.41
<i>Coccoloba ramosissima</i> Wedd.	Polygonaceae	S1	35	2.24	3.43	1.62	7.29
<i>Guapira opposita</i> (Vell.) Reitz	Nyctaginaceae	S1	27	2.99	2.65	1.09	7.25
Indet 3	-	S1	10	2.99	0.98	1.22	5.05
Fabaceae 1	Fabaceae	S1	7	2.99	0.69	1.44	4.89
<i>Eriope blanchetii</i> (Benth.) Harley	Lamiaceae	S1	10	2.24	0.98	1.44	4.66
<i>Dolioscarpus sellowianus</i> Eichler.	Dilleniaceae	S1	16	1.49	1.57	0.90	3.96
<i>Coccoloba laevis</i> Casar.	Polygonaceae	S1	7	1.49	0.69	1.61	3.78
<i>Schefflera</i> sp.	Araliaceae	S1	6	1.49	0.59	1.57	3.65
<i>Myrcia splendens</i> (Sw.) DC.	Myrtaceae	S1	7	1.49	0.69	0.74	2.92
Melastomataceae	Melastomataceae	S1	6	0.75	0.59	0.90	2.23
Erythroxylaceae	Erythroxylaceae	S1	5	0.75	0.49	0.99	2.23
<i>Guapira pernambucensis</i> (Casar.) Lundell	Nyctaginaceae	S1	6	0.75	0.59	0.35	1.69

<i>Ocotea</i> sp.	Lauraceae	S1	3	0.75	0.29	0.50	1.54
<i>Pouteria grandiflora</i> (A.DC.) Baehni	Sapotaceae	S1	2	0.75	0.20	0.29	1.23
<i>Macrobium latifolium</i> Vogel.	Fabaceae	S1	2	0.75	0.20	0.18	1.12
<i>Clusia nemorosa</i> G.Mey.	Clusiaceae	S1	1	0.75	0.10	0.20	1.04
Nyctaginaceae	Nyctaginaceae	S1	1	0.75	0.10	0.18	1.03
Indet 1	-	S1	1	0.75	0.10	0.17	0.01
<i>Xylopia laevigata</i> (Mart.) R.E.Fr.	Annonaceae	S1	1	0.75	0.10	0.03	0.88
<i>Bauhinia</i> sp.	Fabaceae	S1	1	0.75	0.10	0.02	0.87

Site 2 - 'Restinga' of Massarandupió - Entre Rios

Species	Family	Area	NI	FR%	DR%	DoR%	VI %
<i>Emmotum nitens</i> (Benth.) Miers	Metteniusaceae	S2	87	14.29	17.09	94.17	91.7
<i>Dolioscarpus sellowianus</i> Eichler.	Dilleniaceae	S2	114	4.29	22.40	8.11	31.8
<i>Myrsine guianensis</i> (Aubl.) Kuntze	Primulaceae	S2	58	11.43	11.39	10.14	29.3
<i>Protium bahianum</i> Daly.	Burseraceae	S2	45	12.86	8.84	6.53	25.8
<i>Clusia nemorosa</i> G.Mey.	Clusiaceae	S2	22	10.00	4.32	14.30	23.4
<i>Coccoloba laevis</i> Casar.	Polygonaceae	S2	44	5.71	8.64	9.03	20.1
<i>Manilkara decrescens</i> T.D.Penn	Sapotaceae	S2	34	10.00	6.68	2.23	18.1
<i>Ouratea suaveolens</i> (A.St.-Hil.) Engl.	Ochnaceae	S2	21	7.14	4.13	1.22	12.0
<i>Chrysobalanus icaco</i> L.	Chrysobalanaceae	S2	16	4.29	3.14	2.24	8.87
<i>Davilla flexuosa</i> A.St.-Hil.	Dilleniaceae	S2	19	2.86	3.73	0.58	6.96
<i>Guapira</i> sp.	Nyctaginaceae	S2	15	1.43	2.95	0.64	4.78
<i>Guettarda platypoda</i> DC.	Rubiaceae	S2	7	2.86	1.38	0.36	4.46
<i>Myrcia ramuliflora</i> (O.Berg) N. Silveira	Myrtaceae	S2	5	2.86	0.98	0.94	4.44
Indet 2	-	S2	1	1.43	0.20	3.28	3.73
<i>Byrsonima macrophylla</i> (Pers.) W.R.Anderson	Malpighiaceae	S2	8	1.43	1.57	0.78	3.50
Nyctaginaceae 1	Nyctaginaceae 1	S2	3	1.43	0.59	0.75	2.50
<i>Myrcia acuminatissima</i> O.Berg	Myrtaceae	S2	3	1.43	0.59	0.43	2.29
Myrtaceae 1	Myrtaceae	S2	3	1.43	0.59	0.22	2.16
<i>Guapira opposita</i> (Vell.) Reitz	Nyctaginaceae	S2	2	1.43	0.39	0.02	1.83
Indet 1	-	S2	1	1.43	0.20	0.07	1.67

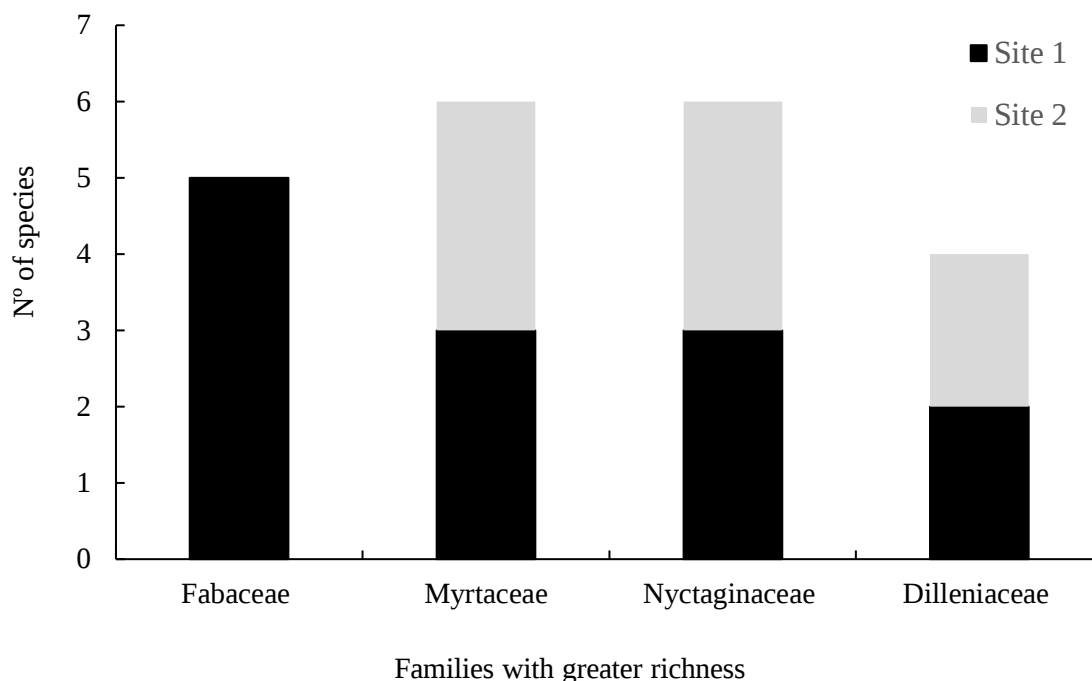


Figure 3. Comparison between families with greater species richness in the North Coast of Bahia Environmental Protection Area. Santo Antonio Beach (Site 1), and Massarandupió Beach (Site 2) (Author: Elizania P. Rios).

DISCUSSION

The families that stood out in the present study are the most common in restinga areas, which aid to understand the distribution pattern of these groups in the coastal areas of the Northeast. The richness for the Site 1 and 2 was low when compared with other restingas along the northeastern coast of Brazil, such as Baía Formosa-Bahia (Menezes et al., 2014), Maracaípe-Pernambuco (Almeida Jr. et al., 2011), Cabedelo-Paraíba (Vicente et al., 2013), and Refúgio da Vida Silvestre do Rio dos Frades-Bahia (Santos et al., 2015). According to Menezes et al. (2014) one of the factors behind the variation in richness between northeastern restingas of Brazil may be levels of anthropogenic impact and different forms of interferences. The anthropization of these areas could potentially facilitate the establishment of ruderal species (Guterres et al., 2019).

The family Fabaceae is well represented on the littoral of Bahia state (Menezes et al., 2009; Menezes et al., 2012; Queiroz et al., 2012; Fernandes & Queiroz, 2015; Santos et al., 2015, Silva et al., 2019; Santos et al., 2021). Myrtaceae has floristic importance in littoral areas, where it is one of the richest families, mainly in woody species (Peixoto & Gentry, 1990; Almeida Jr. et al., 2011; Almeida Jr. & Zickel, 2012; Medeiros et al., 2014; Fernandes & Queiroz, 2015).

Myrcia ramuliflora and *Manilkara decrescens* also were reported with highest importance value for Diego's 'restinga' (Santos et al., 2021), located in the North Coast of Bahia Environmental Protection Area. *Protium bahianum* also had the highest importance value for "Refúgio da Vida Silvestre do Rio dos Frades" (Santos et al., 2015), in the South Coast of Bahia. *Tabebuia elliptica*, that had a high IV in Site 1, often appears in the central area of the thicket, in a prominent position, and may play a facilitating role for other species, as suggested by Menezes et al. (2009).

In terms of diversity, Site 1 ($H' = 3.024$) presented values close to those reported by Menezes et al. (2012) ($H' = 3.835$), who studied a shrubby site at Praia do Forte Beach on the north coast of Bahia, as well as by Santos et al. (2015) ($H' = 3.553$), who analyzed shrub-tree stratum of a restinga in southern Bahia. The diversity index for Site 2 was notably lower compared to Site 1 and the other studies conducted on shrub-tree vegetation along the Bahia coast (Menezes et al., 2012; Santos et al., 2015; Santos et al., 2021).

Although they are geographically close areas, they present significant differences in flora and vegetation structure, which may be related to the intense human pressure on the 'restinga' (Santos et al., 2021). This situation results in microhabitats decrease, leading to environmental homogeneity, the establishment of pioneer species and predominance of species to economic interest (Zickel et al., 2015; Santos et al., 2021). This poses a risk to native species that thrive in coastal environments.

Massarandupió Beach has more tourist exploitation and more frequency of people; different from Santo Antônio Beach, which has low flow of people. Therefore, in addition to ecological studies on thicket vegetation, more analyzes are needed to evaluate the levels of anthropization, with a view to actions for conservation and preservation of restingas, and the management and recovery of degraded areas.

CONCLUSION

The thickets on the restingas on the Santo Antônio and Massarandupió Beach are structurally and floristically distinct; and the thickets of Santo Antônio Beach have greater diversity. The areas also present differences in terms of species composition, total density and IV. These differences may be associated with different conditions of anthropic influence.

Furthermore, the floristic richness allows us to suggest that these areas should be considered as a "vegetation complex", given the unique characteristics and anthropic factors affecting each area. However, it is necessary for new floristic surveys to be carried out to associate soil and ecological factors.

Finally, we conclude that the restingas of northern Bahia have a rich floristic composition, which highlights the importance of conserving this vegetation.

ACKNOWLEDGMENTS

The authors are grateful to the Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB), for granting a scholarship to the first author, and the Universidade do Estado da Bahia (UNEB) for the structure for the development of the study.

REFERENCES

- ALMEIDA, JR., E.B.; SANTOS-FILHO, F.S.; ARAUJO, E.L.; ZICKEL, C.S. Structural characterization of the woody plants in restinga of Brazil. **Journal of Ecology and the Natural Environment**, v. 3, n. 3, p. 95–103, 2011.
- ALMEIDA JR., E.B.; ZICKEL, C.S. Análise fitossociológica do estrato arbustivo-arbóreo de uma floresta de restinga no Rio Grande do Norte. Universidade Federal Rural de Pernambuco. **Revista Brasileira de Ciências Agrárias**, v. 7, n. 2, p. 286–291, 2012.
- APG IV - Angiosperm Phylogeny Group. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. **Botanical Journal of the Linnean Society**, v. 181, n. 1, p. 1–20, 2016.
- ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C.; GONÇALVES, J.D.M.; SPAROVEK, G. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, v. 22, n. 6, p. 711–728, 2013.
- BERTNESS, M.D.; HACKER, S.D. Physical stress and positive associations among marsh plants. **The American Naturalist**, v. 144, n. 3, p. 363–372, 1994.
- CANTARELLI, J.R.R.; ALMEIDA JR., E.B.; SANTOS-FILHO, F.S.; ZICKEL, C.S. Tipos fitofisionômicos e florística da restinga da APA de Guadalupe, Pernambuco, Brasil. **Insula**, v. 41, p. 95–117, 2012.

FERNANDES, M.F.; QUEIROZ, L.P. Floristic surveys of Restinga Forests in southern Bahia, Brazil, reveal the effects of geography on community composition. **Rodriguésia**, v. 66, n. 1, p. 51–73, 2015.

FREIRE, M.S.B. Levantamento Florístico no Parque Estadual das Dunas de Natal. **Acta Botanica Brasilica**, v. 4, p. 41–59, 1990.

GUTERRES, A.V.F.; AMORIM, I.F.F.; DA SILVA, A.F.C.; ALMEIDA JR., E.B. Flora do estrato herbáceo da restinga da Praia do Caúra, São José de Ribamar, Maranhão. **Boletim do Laboratório de Hidrobiologia**, v. 29, n. 2, p. 1–10, 2019.

MARTIN, L.; BITTENCOURT, A.C.S.P.; VILAS BOAS, G.S.; FLEXOR, J.M. **Mapa geológico do quaternário costeiro do Estado da Bahia**. Escala: 1:250.000. Texto explicativo. Bahia: Secretaria das Minas e Energia, Coordenação da Produção Mineral (CBPM), 1980. 60p.

MATOS, M.R.B.; QUEIROZ, E.P.; BAUTISTA, H.P. Fitogeografia. In: NUNES, J.M.C.; MATOS, M.R.B. (Org.). **Litoral norte da Bahia**: caracterização ambiental, biodiversidade e conservação. Salvador: EDUFBA, p. 63–92, 2017.

MEDEIROS, D.P.W.; SANTOS-FILHO, F.S.; ALMEIDA JR., E.B.; PIMENTEL, R.M.M.; ZICKEL, C.S. Estrutura do componente lenhoso de uma restinga no litoral Sul de Alagoas, Nordeste, Brasil. **Revista Brasileira de Geografia Física**, v. 3, n. 3, p. 146–150, 2010.

MEDEIROS, D.P.W.; ALMEIDA JR., E.B.; ABREU, M.C.; SANTOS-FILHO, F.S.; ZICKEL, C.S. Riqueza e caracterização da estrutura lenhosa da vegetação de restinga de Baía Formosa, RN, Brasil. **Pesquisas. Botânica**, v. 65, p. 183–199, 2014.

MENEZES, C.M.; AGUIAR, L.G.P.A.; ESPINHEIRA, M.J.C.L.; SILVA, V.I.S. Florística e Fitossociologia do componente arbóreo do município de Conde, Bahia, Brasil. **Revista Biociências**, v. 15, n. 1, p. 44–55, 2009.

MENEZES, C.M.; SANTANA, F.D.; SILVA, V.S.A.; SILVA, V.I.S.; ARAUJO, D.S.D. Florística e fitossociologia em um trecho de restinga no Litoral Norte do Estado da Bahia. **Biotemas**, v. 25, n. 1, p. 31–38, 2012.

MENEZES, C.M.; NOLASCO, A.P.; SILVA, V.I.S. Aspectos florísticos e fitossociológicos da vegetação de entremontas em um trecho de uma restinga de Praia do Forte, município de Mata de São João, litoral norte do Estado da Bahia. **Revista Biociências**, v. 18, n. 1, p. 42–48, 2012.

MORI, S.A.; SILVA, L.A.M.; LISBOA, G.; CORADIN, L. **Manual de manejo do herbário fanerogâmico**. 2. ed. Ilhéus: Centro de Pesquisas do Cacau, 1989. 44p.

PEIXOTO, A.L.; GENTRY, A. Diversidade e composição florística da mata de tabuleiro na Reserva Florestal de Linhares (Espírito Santo, Brasil). **Revista Brasileira de Botânica**, v. 13, n. 1, p. 9–25, 1990.

QUEIROZ, E.P.; CARDOSO, D.B.O.S.; FERREIRA, M.H.S. Composição florística da vegetação de restinga da APA Rio Capivara, Litoral Norte da Bahia, Brasil. Universidade Estadual de Feira de Santana. **Sitientibus**, série Ciências Biológicas, v. 12, n. 1, p. 66–73, 2012.

QUEIROZ, E.P. Levantamento florístico e georreferenciamento das espécies com potencial econômico e ecológico em restinga de Mata de São João, Bahia, Brasil. **Biotemas**, v. 20, n. 4, p. 41–47, 2007.

ROCHA, R.T.; BRUNO, A.S.; SILVA, A.G. O ponto quadrante na descrição da vegetação entre as moitas de uma formação arbustiva aberta inundável numa restinga do Espírito Santo, sudeste do Brasil. **Natureza Online**, v. 13, n. 2, p. 56–62, 2015.

SAMPAIO, M.C.; PICO, F.X.; SCARANO, F.R. Ramet Demography of a nurse Bromeliad in Brazilian Restingas. **American Journal of Botany**, v. 92, n. 4, p. 674–681, 2005.

SANTOS, V.J.; ZICKEL, C.S.; ALMEIDA JR., E.B. Composição estrutural do estrato arbustivo-arbóreo de uma floresta de restinga no sul da Bahia, Brasil. **Pesquisas Botânicas**, v. 68, p. 257–269, 2015.

SANTOS, V.J.; CAMPOS, J.R.P.; SOUSA, F.C.; ALVES, L.G.C.; ZICKEL, C.S.; ALMEIDA JR., E.B. Avaliação fitossociológica da vegetação lenhosa de duas restingas no litoral Norte da Bahia, Brasil. **Revista Ibero-Americana de Ciências Ambientais**, v. 12, n. 8, p. 139–150, 2021.

SHEPHERD, G.J. **FITOPAC 1**:Manual do usuário. Departamento de Botânica. Unicamp, 1995.

SILVA, L.P.; AMORIM, I.F.F.; ALMEIDA JR, E.B.; SANTOS, V.J. Levantamento fitossociológico da vegetação herbácea-subarbustiva das dunas da praia de Massarandupió, município de Entre Rios, Bahia. **Boletim do Laboratório de Hidrobiologia**, v. 29, n. 2, p. 1–9, 2019.

SILVA, S.M.; BRITEZ, R.M. A vegetação da Planície Costeira. In: MARQUES, M.C. M.; BRITEZ, R.M. (Org.). **História Natural e conservação da Ilha do Mel**. Curitiba: Universidade Federal do Paraná, 2005. pp. 49–84.

VICENTE, A.; ALMEIDA JR., E.B.; SANTOS-FILHO, F.S.; ZICKEL, C.S. Composição estrutural da vegetação lenhosa da restinga de Cabedelo, Paraíba. **Revista de Geografia (UFPE)**, v. 31, n. 1, p. 89–99, 2014.

ZICKEL, C.S.; VICENTE, A.; ALMEIDA JR., E.B.; CANTARELLI, J.R.R. Flora e vegetação das restingas no Nordeste Brasileiro. In: ESKINAZI-LEÇA, E.; NEUMANN-LEITÃO, S.; COSTA, M.F. (Org.). **Oceanografia**: um cenário tropical. Recife: Bargaço, 2004. pp. 689–701.