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FLORISTIC COMPOSITION IN ROCKY OUTCROPS IN AGRESTE PARAIBANO

Composição florística em afloramentos rochosos no agreste paraibano

Composición florística en afloramientos rocosos en agreste paraibano

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ABSTRACT

The Caatinga is part of the Intertropical dry and deciduous forests complex; rock outcrops are lithological structures that stand out in the landscape due to their high altitudes, they are widespread in tropical regions, have striking and peculiar characteristics, and are adaptable to soil and climate conditions. The present study aimed to carry out a floristic survey in two areas of rocky outcrops in the municipalities of Esperança and Olivedos - PB. Monthly visits were carried out between 2017 and 2018 to collect botanical material in a fertile, flowering/fruiting state. The classification of botanical families occurred through the Angiosperm Phylogeny Group and the identification of the material was carried out by specialist taxonomists and through consultations with virtual herbaria: Tropics - Angiosperm Phylogeny Website (Missouri Botanical Garden); INCT- Virtual Herbarium of Flora and Fungi-species Link, and Reflora (Flora and Funga of Brazil). The floristic checklist carried out on the rocky outcrops of Esperança and Olivedos-PB resulted in 52 botanical families, with the identification of 127 genera and 150 species. The families with the largest number of species represented were Fabaceae, Asteraceae, Euphorbiaceae, Malvaceae and Convolvulaceae. We concluded that despite being located in the same geomorphological unit and in similar climatic conditions, the microclimate of the areas in-line with the relief and orographic position contributes to the distinction of the flora in the rocky outcrops.
Keywords: Caatinga; Rocky Outcrops; Floristics.

RESUMO

A Caatinga está inserida no complexo de Florestas Secas e Decíduas Intertropicais. Os afloramentos rochosos são estruturas litológicas que se destacam na paisagem devido suas elevadas altitudes, amplamente difundidos nas regiões tropicais e possuem características marcantes e peculiares, adaptáveis às condições edafoclimáticas. O presente estudo tem como objetivo realizar um levantamento florístico em duas áreas de afloramentos rochosos nos municípios de Esperança e Olivedos - PB. Foram realizadas visitas mensais entre os anos de 2017 e 2018 para coleta do material botânico em estado fértil, florido/frutificado. A classificação das famílias botânicas ocorreu por meio do Angiosperm Phylogeny Group e a identificação do material foi efetuada por taxonomistas especialistas e através de consultas aos herbários virtuais: Trópicos - Angiosperm Phylogeny Website (Missouri Botanical Garden); INCT- Herbário Virtual da Flora e dos Fungos-speciesLink e Reflora (Flora e Funga do Brasil). O checklist florístico realizado nos afloramentos rochosos de Esperança e Olivedos-PB resultou em 52 famílias botânicas, com identificação de 127 gêneros e 150 espécies. As famílias com maior número de espécies representadas foram Fabaceae, Asteraceae, Euphorbiaceae, Malvaceae e Convolvulaceae. Concluímos que apesar de estarem inseridos na mesma unidade geomorfológica e em condições climáticas semelhantes, o microclima das áreas em consonância com o relevo e a posição orográfica contribui para uma distinção da flora nos afloramentos rochosos.

Palavras chave: Caatinga; Afloramentos Rochosos; Florística.

RESUMEN

La Caatinga está integrada en el complejo de Bosques Secos y Deciduos Intertropicales. Los afloramientos rocosos son estructuras litológicas que destacan en el paisaje debido a sus altitudes elevadas, ampliamente distribuidos en regiones tropicales y poseen características distintivas y peculiares, adaptables a las condiciones edafoclimáticas.El presente estudio tiene como objetivo realizar un levantamiento florístico en dos áreas de afloramientos rocosos en los municipios de Esperança y Olivedos - PB. Se realizaron visitas mensuales entre 2017 y 2018 para colectar material botánico en estado fértil, floración/fructificación. Las familias botánicas se clasificaron utilizando el Angiosperm Phylogeny Group y el material fue identificado por taxonomistas especialistas y mediante consultas con los herbarios virtuales: Trópicos - Angiosperm Phylogeny Website (Missouri Botanical Garden); INCT- Herbario Virtual de Flora y Hongos-speciesLink y Reflora (Flora y Hongos de Brasil). El cotejo florístico realizado en los afloramientos rocosos de Esperança y Olivedos-PB resultó en 52 familias botánicas, con la identificación de 127 géneros y 150 especies. Las familias con mayor número de especies representadas fueron Fabaceae, Asteraceae, Euphorbiaceae, Malvaceae y Convolvulaceae. Concluimos que a pesar de estar insertos en la misma unidad geomorfológica y en condiciones climáticas similares, el microclima de las áreas acorde con el relieve y posición orográfica contribuye a una distinción de la flora en los afloramientos rocosos.

Palabras clave: Caatinga; Afloramientos Rocosos; Florística.

1 INTRODUCTION

The Caatinga phytogeographic domain is part of the Intertropical Dry and Deciduous Forests complex (Seasonally Dry Tropical Forests - SDTFs) and is mostly composed of xerophytic, deciduous and therophytic plants, characterized as succulent and thorny, which

have a morphophenology based on the rainfall conditions of the environment (Bastin *et al.,* 2017; Fernandes; Queiroz, 2018).

The rocky outcrops located in the Caatinga domains are lithological structures that stand out in the landscape due to their high altitudes and are widely spread in tropical regions and form the so-called “xeric islands” (Groger; Barthlott,1996; Oliveira; Godoy, 2007; Silva, 2016; Fitzsimons; Michael, 2017). These formations have striking and peculiar characteristics, act as environmental filters, and provide the existence of ecosystems composed of a biota fully adapted to their edaphoclimatic conditions, such as high thermal amplitude, low relative air humidity and poorly developed soils (Pereira *et al.,* 2018; Correia *et al.,* 2021).

The Caatinga, as well as its biodiversity, is under constant threat as a result of human disturbances, mainly driven by the removal of vegetation cover for domestic purposes, charcoal manufacturing, mineral exploration and use of space for agricultural practices (Silva, 2016; MapBiomas 2021).

The flora regeneration process in the Caatinga requires a period of around 15 to 20 years (Gariglio, 2010); Alves *et al.,* 2018) and the suppression of this flora can result in the extinction of species, mainly endemic, resulting in the reduction of local biodiversity, intensifying the desertification process and compromising ecosystem services (Souza *et al.,* 2015).

Rocky outcrops are environmental filters that shelter highly adapted biodiversity, and are occupied by endemic species that are under constant threat as a result of human actions and the disordered use of natural resources. Surveys of the flora of these environments are crucial for obtaining data and understanding the plant diversity that occupy them. Studies like this are necessary to support preservation and conservation policies for the Caatinga and its local biodiversity. Therefore, the present study aimed to inventory the flora of two rocky outcrops located in the Agreste mesoregion in the state of Paraíba.

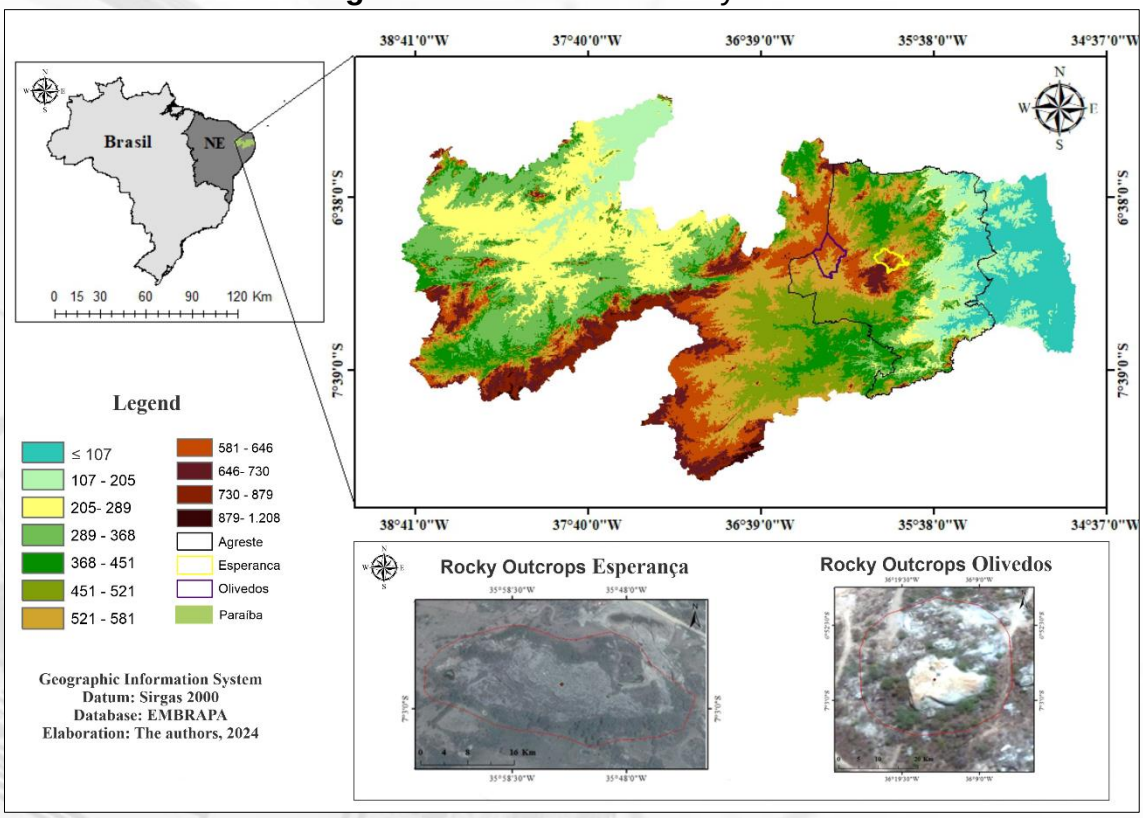
2 MATERIAL AND METHODS

2.1 Characterization of the study area

The study area comprises two granite rocky outcrops in the municipalities of Esperança and Olivedos under the respective coordinates (07° 03’ 11” S and 35° 86’ 92” W) and (06° 98’ 86” S and 36° 24’ 36” W) (Figure 01). The outcrops are located in the agreste

mesoregion of Paraíba, in the current and immediate region of Campina Grande-PB (IBGE, 2017; Brasil-IBGE 2021). The study municipalities are located under the morphostructural domain of the Borborema Plateau with its geological base composed of granite-gneissic rocks and orthogneisses (Pereira *et al.,* 2019).

Figure 01 – Location of study areas



Source: Produced by the authors (2024).

Both municipalities are located on the same geological base, the Borborema Plateau, within the phytogeographical domain of the caatinga, however, they have different characteristics. Esperança is located at an altitude of 650 m, with relief that varies from gently undulating to strongly undulating and steep and the presence of rocky outcrops, and the predominant climate is BSh of the Hot and Humid Tropical type (Francisco *et al.,* 2015; Pereira et al., 2018). The proximity to the Paraíba marsh microregion favors rainfall that amounts to around 800 mm annually, and an average temperature that varies between 25ºC and 30ºC (Pereira; Silva; Silva-Filho, 2014). The predominant soil classes are Planosols, Argisols and Litholic Neosols in areas of higher elevation (Serviço Geológico do Brasil - CPRM, 2005).

The municipality of Olivedos, despite also being located on the Borborema Plateau, differs from the environmental conditions presented by Esperança. Olivedos is located in the drought polygon, in Curimataú in Paraíba and has an altitude of around 559 m. The relief has features that range from smooth to moderately undulating with some strongly undulating points and a considerable presence of rocky outcrops (Batista; Almeida; Melo, 2009). The climate is Bhs, Hot and Dry Tropical, Semi-Arid (Francisco et al., 2015). Precipitation rates are 400 mm annually and the average annual temperature is 28.8ºC (Fernandes, 2017). The main soil class is Neossolos, characterized as shallow and poorly developed, typical of semi-arid regions (Fernandes, 2017).

2.2 Collections and identifications of angiosperm species

The botanical material was collected throughout monthly visits to the two areas from September to December 2017 and from March to September 2018, totaling 12 months. Fertile specimens were collected throughout the outcrop area, from the base to the top. All collected material was herbalized according to the techniques used in taxonomic studies, described by Peixoto and Maia (2013). The APG (Angiosperm Phylogeny Group) IV (2016) was adopted for the classification of botanical families. The collected samples were incorporated into the Manuel de Arruda Câmara Herbarium collection (HACAM, not indexed to Index Herbariorum), Universidade Estadual da Paraíba (UEPB), Campus I.

Individuals were identified with the help of taxonomists, as well as through consultations in virtual herbaria: Tropics - Angiosperm Phylogeny Website (Missouri Botanical Garden); INCT- Virtual Herbarium of Flora and Fungi - speciesLink and Reflora (Flora and Funga of Brazil).

The species were classified phytoecologically in their different habitats as trees, shrubs, subshrubs, herbs and lianas, with the classification being used based on data obtained from the Flora and Funga of Brazil http://floradobrasil.jbrj.gov.br/.

The data obtained to verify rainfall indices were acquired from the AESA-PB database, available at: http://www.aesa.pb.gov.br/aesa-website/.

3 RESULTS AND DISCUSSION

The floristic checklist carried out on the rocky outcrops of Esperança and Olivedos-PB resulted in 52 botanical families, with identification of 127 genera and 150 species. The

species of Bromeliaceae (*Encholirium spectabile* Mart. Ex. Schult), *Melocactus zehntneri* (Britton & Rose) Luetzelb, and Cactaceae (*Pilosocereus chrysostele* (Vaupel) Byles & G. D. Rowley) were only observed, and not collected, in the two areas, but quantified and entered into the database (Table 01).

Table 01 – Floristic survey of angiosperms found in rocky outcrops in Esperança e Olivedos-PB

Taxons	Collection site	Habit
Acanthaceae		
Ruellia asperula (Mart. ex Nees) Lindau	Olivedos	Shrub
Ruellia geminiflora Kunth	Esperança	Subshrub
Amaranthaceae		
Alternanthera brasilian (L.) Kuntze	Esperança	Subshrub
Alternanthera tenella Colla	Olivedos	Subshrub
Amaranthus retroflexus L.	Esperança	Herb
Amaranthus spinosus L.	Esperança	Herb
Dysphania ambrosioides (L.) Mosyakin & Clemants	Esperança	Shrub
Gomphrena vaga Mart.	Olivedos	Subshrub
Anacardiaceae		
Astronium urundeuva (M. Allemão) Engl.	Esperança	Tree
Apocynaceae		
Aspidosperma pyrifolium Mart. & Zucc.	Olivedos	Tree
Allamanda blanchetii A.DC.	Esperança	Shrub
Ibatia marítima (Jacq.) Decne.	Esperança	Subshrub
Mandevilla tenuifolia (J.C.Mikan) Woodson	Esperança	Liana
Ruehssia caatingae (Morillo) F.Esp.Santo & Rapini	Esperança	Shrub
Araceae		
Anthurium affine Schott	Esperança	Herb
Spathicarpa gardneri Schott	Esperança	Herb
Asparagaceae		
Agave sisalana Perrine ex Engelm.	Esperança	Herb
Asteraceae		
Aspilia pascalioides Griseb.	Esperança	Herb
Bidens pilosa L.	Olivedos	Herb
Centratherum punctatum Cass.	Esperança/Olivedos	Subshrub
Chresta pacourinoides (Mart. ex DC.) Siniscalchi & Loeuille	Esperança	Erva

Conocliniopsis prasiifolia (DC.) R.M.King & H.Rob.	Esperança	Subshrub
Conyza bonariensis (L.) Cronquist	Esperança	Subshrub
Eclipta prostrata (L.) L.	Esperança	Herb
Emilia (sp.)	Esperança	Herb
Erechtites valerianifolius (Link ex Spreng.) DC.	Esperança	Herb
Hypochaeris brasiliensis (Less.) Benth. & Hook.f. ex Griseb.	Esperança	Herb
Lepidaploa chalybaea (Mart. ex DC.) H.Rob.	Esperança	Subshrub
Porophyllum Guett.	Esperança	Subshrub
Tagetes minuta L.	Esperança	Herb
Tridax procumbens L.	Esperança	Herb
Wedelia goyazensis Gardner	Esperança	Shrub
Begoniaceae		
Begonia lealii Brade	Esperança	Subshrub
Begonia saxicola A.DC.	Esperança	Subshrub
Boraginaceae		
Euploca procumbens (Mill.) Diane & Hilger	Esperança/Olivedos	Herb
Heliotropium angiospermum Murray	Olivedos	Herb
Heliotropium elongatum (Lehm.) I.M.Johnst.	Esperança	Subshrub
Varronia leucocephala (Moric.) J.S.Mill.	Olivedos	Shrub
Bromeliaceae		
Dyckia spectabilis (Mart. ex Schult. & Schult.f.) Baker	Esperança	Herb
Hohenbergia catingae Ule var. *catingae*	Esperança	Herb
Orthophytum disjunctum L.B.Sm.	Esperança	Herb
Tillandsia bulbosa Hook.f.	Esperança	Herb
Tillandsia recurvata (L.) L.	Esperança/Olivedos	Herb
Cactaceae		
Cereus jamacaru DC.	Esperança	Tree
Melocactus zehntneri (Britton & Rose) Luetzelb.	Olivedos	Subshrub
Melocactus ernestii Vaupel	Esperança	Subshrub
Pilosocereus chrysostele (Vaupel) Byles & G.D.Rowley	Esperança	Shrub
Tacinga inamoena (K.Schum.) N.P.Taylor & Stuppy	Olivedos	Subshrub
Tacinga palmadora (Britton & Rose) N.P.Taylor & Stuppy	Esperança/Olivedos	Subshrub
Cleomaceae		
Tarenaya aculeata (L.) Soares Neto & Roalson	Olivedos	Herb

Tarenaya spinosa (Jacq.) Raf.	Olivedos	Subshrub
Commelinaceae		
Commelina erecta L.	Esperança	Herb
Commelina obliqua Vahl	Esperança	Herb
Convolvulaceae		
Distimake aegyptius (L.) A.R. Simões & Staples	Esperança	Liana
Evolvulus (sp.)	Esperança	Herb
Ipomoea nil (L.) Roth	Esperança	Liana
Ipomoea longeramosa Choisy	Olivedos	Liana
Ipomoea asarifolia (Desr.) Roem. & Schult.	Olivedos	Liana
Ipomoea pes-caprae subsp. *brasiliensis* (L.) Ooststr.	Olivedos	Herb
Jacquemontia densiflora (Meisn.) Hallier f.	Esperança	Liana
Jacquemontia nodiflora (Desr.) G.Don	Esperança	Liana
Jacquemontia tamnifolia (L.) Griseb.	Esperança	Liana
Operculina (sp.)	Esperança	Liana
Cyperaceae		
Cyperus brevifolius (Rottb.) Endl. ex Hassk.	Esperança	Herb
Cyperus surinamensis Rottb.	Esperança	Herb
Rhynchospora (sp.)	Olivedos	Herb
Eriocaulaceae		
Paepalanthus magistrae Sano, F.N.Costa, Trovó & Echtern.	Olivedos	Herb
Erythroxylaceae		
Erythroxylum caatingae Plowman	Esperança	Shrub
Euphorbiaceae		
Euphorbia comosa Vell.	Esperança	Tree
Cnidoscolus urens (L.) Arthur	Esperança/Olivedos	Subshrub
Croton blanchetianus Baill.	Olivedos	Shrub
Croton heliotropiifolius Kunth	Esperança/Olivedos	Shrub
Croton jacobinensis Baill.	Olivedos	Shrub
Dalechampia sp	Esperança	Liana
Jatropha molíssima (Pohl) Baill.	Esperança/Olivedos	Shrub
Jatropha ribifolia (Pohl) Baill.	Esperança/Olivedos	Shrub
Microstachys A.Juss.	Esperança	Shrub
Poinsettia (sp.)	Esperança	Shrub
Tragia volubilis L.	Esperança	Liana

Sapium glandulosum (L.) Morong	Esperança	Shrub
Fabaceae		
Aeschynomene (sp.)	Esperança/Olivedos	Herb
Bauhinia cheilantha (Bong.) Steud.	Esperança	Shrub
Canavalia brasiliensis Mart. ex Benth.	Esperança	Liana
Cenostigma nordestinum Gagnon G.P.Lewis	Esperança/Olivedos	Shrub
Cenostigma pyramidale (Tul.) Gagnon & G.P.Lewis	Olivedos	Shrub
Centrosema brasilianum (L.) Benth.	Esperança/Olivedos	Liana
Chamaecrista desvauxii (Collad.) Killip	Esperança/Olivedos	Herb
Chamaecrista repens (Vogel) H.S.Irwin & Barneby	Esperança	Subshrub
Crotalaria bahiensis Windler & S.G.Skinner	Esperança	Arbusto
Crotalaria incana L.	Esperança	Subshrub
Crotalaria pallida Aiton	Esperança	Subshrub
Crotalaria vitellina Ker Gawl.	Esperança	Subshrub
Dahlstedtia araripensis (Benth.) M.J. Silva & A.M.G. Azevedo	Olivedos	Tree
Indigofera suffruticosa Mill.	Esperança/Olivedos	Subshrub
Luetzelburgia auriculata (Allemão) Ducke	Olivedos	Tree
Macropsychanthus grandiflorus (Mart. ex Benth.) L.P.Queiroz & Snak	Esperança	Liana
Mimosa borboremae Harms	Olivedos	Herb
Mimosa candollei R.Grether	Esperança	Herb
Mimosa paraibana Barneby	Olivedos	Shrub
Mimosa pudica L.	Olivedos	Herb
Piptadenia retusa (Jacq.) P.G.Ribeiro, Seigler & Ebinger	Esperança/Olivedos	Shrub
Senna alata (L.) Roxb.	Esperança/Olivedos	Shrub
Senna martiana (Benth.) H.S.Irwin & Barneby	Esperança/Olivedos	Shrub
Senna splendida (Vogel) H.S.Irwin & Barneby	Esperança	Liana
Stylosanthes viscosa (L.) Sw.	Esperança/Olivedos	Subshrub
Zornia brasiliensis Vogel	Esperança/Olivedos	Subshrub
Gentianaceae		
Gentianaceae (sp.)	Esperança	Herb
Lamiaceae		
Leonotis nepetifolia (L.) R.Br.	Esperança	Herb
Mesosphaerum pectinatum (L.) Kuntze	Olivedos	Herb
Linderniaceae		

Ameroglossum manoel-felixii L. P. Felix & E. M. Almeida	Esperança	Arbusto
Loasaceae		
Aosa rupestris (Gardner) Weigend	Olivedos	Subshrub
Mentzelia áspera L.	Esperança	Subshrub
Lythraceae		
Cuphea sp	Esperança	Subshrub
Malvaceae		
Melochia tomentosa L.	Esperança/Olivedos	Subshrub
Herissantia crispa (L.) Brizicky	Esperança/Olivedos	Subshrub
Herissantia tiubae (K.Schum.) Brizicky	Esperança/Olivedos	Subshrub
Pavonia cancellata (L.) Cav.	Esperança	Herb
Sida ciliares L.	Olivedos	Subshrub
Sida cordifolia L.	Esperança/Olivedos	Herb
Sida spinosa L.	Olivedos	Subshrub
Sida galheirensis Ulbr.	Esperança/Olivedos	Subshrub
Triumfetta semitriloba Jacq.	Esperança	Subshrub
Waltheria indica L.	Olivedos	Subshrub
Melastomataceae		
Pleroma heteromallum (D.Don) D.Don	Esperança	Shrub
Myrtaceae		
Campomanesia eugenioides (Cambess.) D.Legrand ex Landrum	Esperança	Shrub
Nyctaginaceae		
Boerhavia coccínea Mill.	Esperança/Olivedos	Herb
Onagraceae		
Ludwigia sp	Esperança/Olivedos	Herb
Orchidaceae		
Cyrtopodium flavum Link & Otto ex Rchb.f.	Esperança	Herb
Epidendrum cinnabarinum Salzm.	Esperança	Herb
Oxalidaceae		
Oxalis frutescens L.	Esperança/Olivedos	Herb
Papaveraceae		
Argemone mexicana L.	Esperança	Herb
Passifloraceae		
Passiflora sp	Esperança	Herb
Phytolaccaceae		

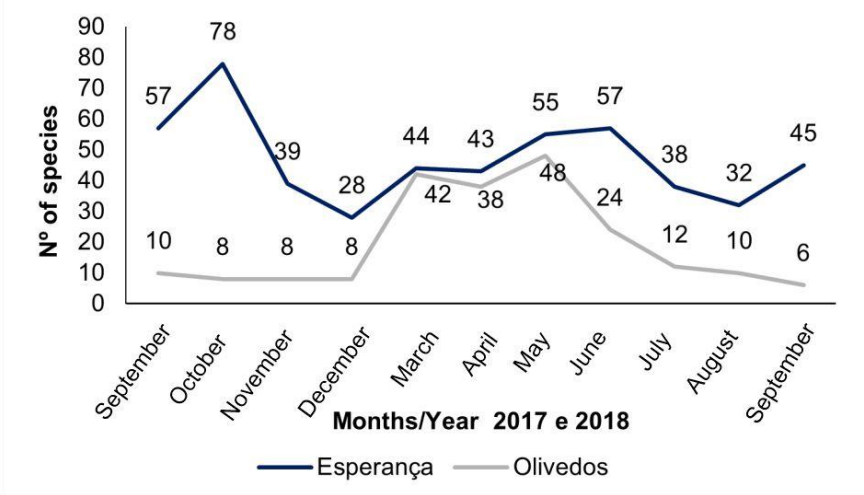
Phytolaccaceae sp	Esperança	Herb
Plantaginaceae		
Scoparia dulcis L.	Esperança /Olivedos	Herb
Stemodia marítima L.	Olivedos	Herb
Plumbaginaceae		
Plumbago scandens L.	Esperança/Olivedos	Substrato
Poaceae		
Chloris barbata Sw.	Olivedos	Herb
Eragrostis plana Nees	Esperança	Herb
Melinis repens (Willd.) Zizka	Esperança/Olivedos	Herb
Paspalum sp	Esperança	Herb
Polygalaceae		
Asemeia violácea (Aubl.) J.F.B.Pastore & J.R.Abbott	Esperança	Herb
Polygonum sp	Esperança	Herb
Pontederiaceae		
Eichhornia paniculata (Spreng.) Solms	Esperança	Herb
Portulacaceae		
Portulaca elatior Mart. ex Rohrb.	Olivedos	Herb
Portulaca halimoides L.	Esperança/Olivedos	Herb
Portulaca oleracea L.	Olivedos	Subshrub
Rubiaceae		
Borreria verticillata (L.) G.Mey.	Esperança/Olivedos	Herb
Mitracarpus longicalyx E.B.Souza & M.F.Sales	Olivedos	Herb
Richardia grandiflora (Cham. & Schltdl.) Steud.	Esperança	Herb
Tocoyena formosa (Cham. & Schltdl.) K.Schum.	Esperança	Subshrub
Sapindaceae		
Serjania glabrata Kunth	Olivedos	Herb
Selaginellaceae		
Selaginella convoluta (Arn.) Spring	Esperança/Olivedos	Herb
Simaroubaceae		
Simaroubaceae sp	Esperança	Subshrub
Smilacaceae		
Smilax L.	Esperança	Liana
Solanaceae		
Nicandra physalodes (L.) Gaertn.	Esperança	Shrub

Nicotiana glauca Graham	Olivedos	Shrub
Physalis sp	Olivedos	Herb
Talinaceae		
Talinum fruticosum (L.) Juss.	Esperança	Herb
Turneraceae		
Turnera subulata Sm.	Esperança/Olivedos	Shrub
Verbenaceae		
Lantana câmara L.	Esperança	Shrub
Lippia grata Schauer	Olivedos	Subshrub
Lippia origanoides Kunth	Olivedos	Subshrub
Stachytarpheta indica (L.) Vahl	Esperança	Subshrub
Vitaceae		
Cissus verticillata (L.) Nicolson & C.E.Jarvis	Olivedos	Liana
Zygophyllaceae		
Kallstroemia tribuloides (Mart.) Steud.	Esperança	Shrub
Vochysiaceae		
Callisthene microphylla Warm.	Olivedos	Shrub

Source: The authors (2020).

The collection effort resulted in 730 specimens:516 in Esperança and 214 in Olivedos. As the flora of these areas is influenced by rainfall variability, the results of the sampling effort carried out in these areas are evident (Graph 01).

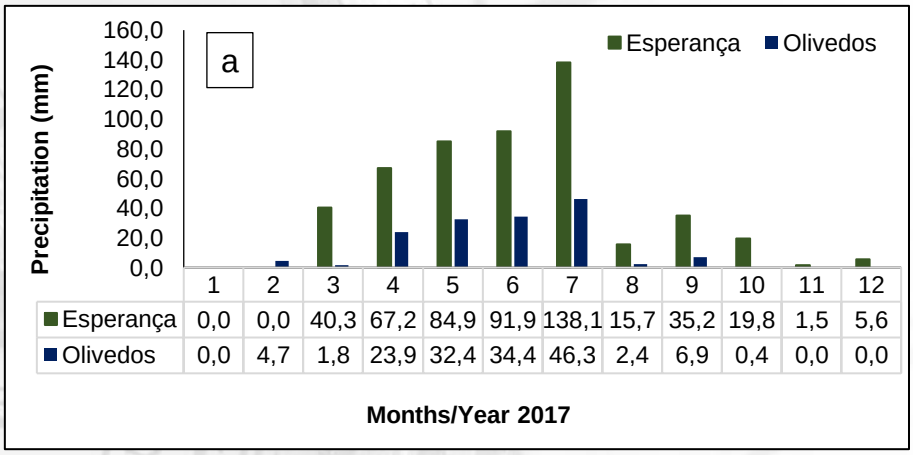
Graph 01 – Sampling collection effort



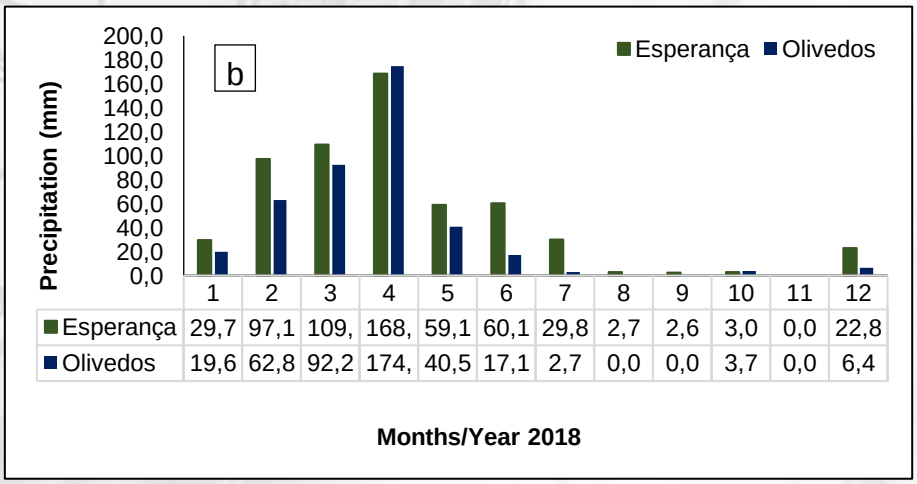
Source: The authors,(2018).

With regard to precipitation indices, during the collection period in 2017 an accumulation of 500.2mm was recorded for Esperança and 153.2 mm for Olivedos (Graph 02 a). The year 2017 was affected by the occurrence of prolonged droughts, due to the Southern Oscillation (ENSO) - El Niño (Sena *et al.,* 2019). The year 2018 showed an increase in the number of specimens collected, when this coincided with rainy periods, being controlled by the La Niña event, which favors the formation of clouds and precipitation in the Northeast Region (Graph 02 b). This event interfered with the physiological cycle of herbaceous and shrubby species, intensifying their reproductive process (Oliveira; Prata; Siqueira Pinto, 2018).

Graph 02 – Accumulated precipitation of the municipalities Esperança and Olivedos



	1	2	3	4	5	6	7	8	9	10	11	12
Esperança	0,0	0,0	40,3	67,2	84,9	91,9	138,1	15,7	35,2	19,8	1,5	5,6
Olivedos	0,0	4,7	1,8	23,9	32,4	34,4	46,3	2,4	6,9	0,4	0,0	0,0



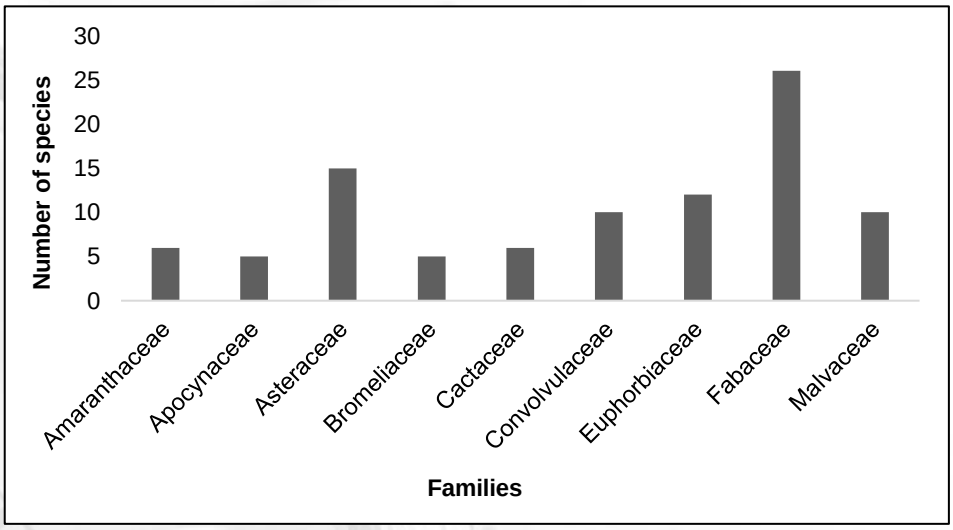
	1	2	3	4	5	6	7	8	9	10	11	12
Esperança	29,7	97,1	109,	168,	59,1	60,1	29,8	2,7	2,6	3,0	0,0	22,8
Olivedos	19,6	62,8	92,2	174,	40,5	17,1	2,7	0,0	0,0	3,7	0,0	6,4

Database: AESA (2018). **Elaboration:** The authors (2023).

The botanical families with the highest number of species were Fabaceae (26); Asteraceae (15); Euphorbiaceae (12); Malvaceae and Convolvulaceae (10);

Amaranthaceae and Cactaceae (6); Apocynaceae and Bromeliaceae (5). The remaining families had four or fewer species (Graph 03).

Graph 03 – Families with high number of species



Fonte: The authors, (2023).

When analyzing the most represented families in the study areas, Fabaceae was shown to represent more than 35% of the flora collected from the two municipalities. This pattern was already expected, since species from this family are dominant in deciduous areas and presented greater diversity in the genera *Senna* and *Mimosa* (Queiroz, 2009). Although there are different microclimatic and geomorphological situations, as is the case in the two study areas, this result makes sense because it is a family with a wide distribution (Rodrigues *et al.,* 2020).

The Asteraceae family was the second most significant during the collection period; it is a family that is quite adaptable to dry and open areas, being considered the largest family of angiosperms on the globe (Silva; Barbosa; Barros, 2014). Therefore, it was largely represented by *Aspilia pascalioides, Centratherum punctatum, Chresta pacourinoides, Conocliniopsis prasiifolia, Hypochaeris brasiliensis, Lepidaploa chalybaea and Wedelia goyazensis.*

The third largest family represented in number of species was Euphorbiaceae. Euphorbiaceae and Fabaceae are the botanical families that present great richness and abundance in the Caatinga (Leal *et al.,* 2018). Euphorbiaceae has a Pantropical distribution and is the second largest botanical family in Brazil (Nascimento *et al.,* 2017). The Malvaceae family was also well represented, with a predominance of the genus *Sida*. This study corroborates the results described by Moro *et al.* (2014) and Pereira *et al.* (2019) for floristic

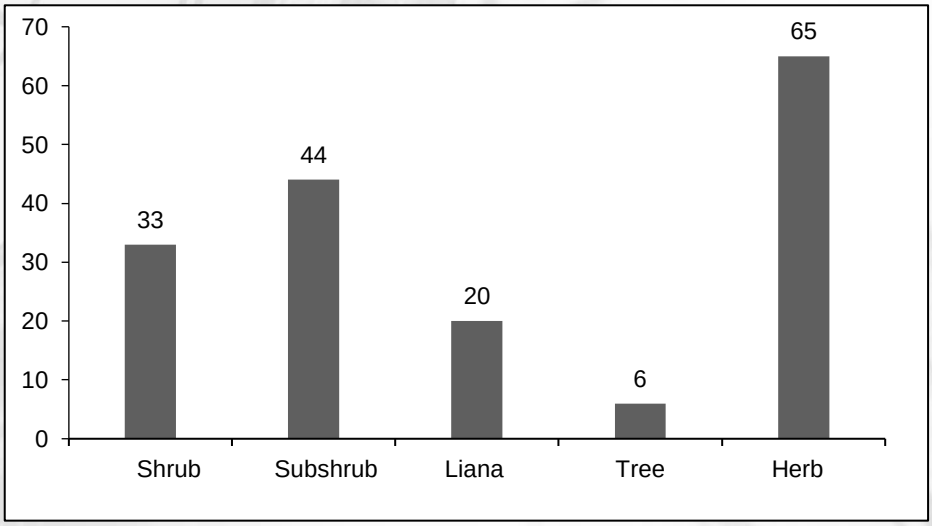
surveys of the Caatinga that resulted in Fabaceae, Malvaceae and Euphorbiaceae as the majority of represented families.

Regarding phytoecological categories, the herbaceous extract was the most represented, with 43 species. Herbaceous plants predominate in the Asteraceae family. The subsequent phytoecological categories were subshrubs (28) and shrubs (22), which were mostly represented by Malvaceae, Fabaceae and Asteraceae. These categories include vegetation in both areas.

As previously stated, the herbaceous habitat was the most dominant (47.8%) of the species, followed by shrubs and sub-shrubs (35.1%) (Graph 04). In general, these species are therophytes and rupicolous, with a root system adaptable to temperature ranges and climatic seasonality, managing to develop and settle on substrates in dissolution basins (gnammas) formed in the rock.

The Caatinga sensu stricto vegetation occurs in the lowlands of the Sertaneja Depression, as well as on the Borborema Plateau. However, in areas of rocky outcrops, the vegetation presents itself in microhabitats, forming islands comprising phytophysiognomies, floristic composition, and phenology adapted to the rock. In this way, when associating the pedological or lithological base with the vegetation existing on the rocky outcrops, a herbaceous rocky physiognomy is observed, with a predominance of herbs, lianas, shrubs and sub-shrubs that cover the rocky substrates, regardless of the water deficit.

Graph 04 – Percentage of Phytoecological Categories in Esperança and Olivedos-PB

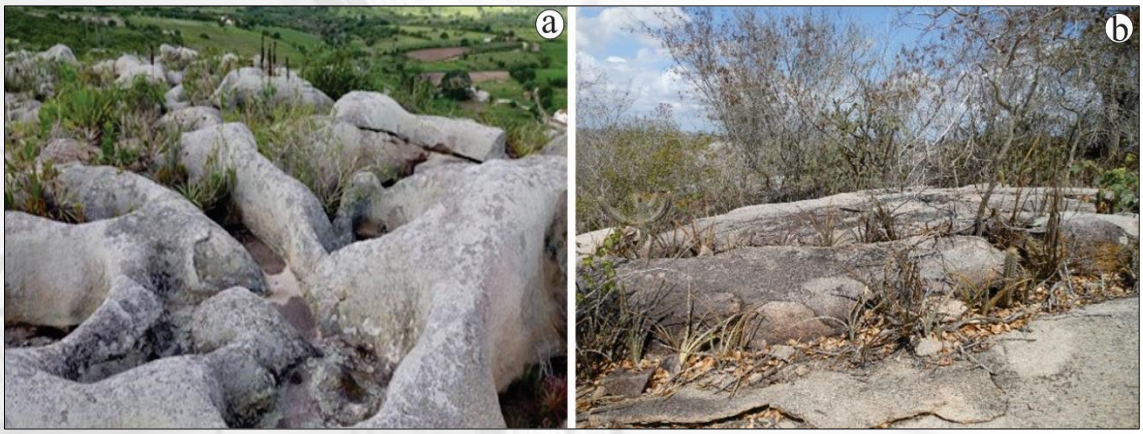


Source: The Authors, (2018).

The rock flora is determined through the fixation of species, which will be in different habitats, due to the size and depth of the dissolution basins, as well as the type of substrate

where they are settled (Figure 02 a). Because these spaces absorb water and sediment, they therefore determine the root system of individuals and their habitats. In dissolution basins with poorly developed substrate, species of Bromeliaceae - *Encholirium spectabile* and *Neoglaziovia variegata can be found*. These species have water reservoirs in their rosettes, allowing them to store water for longer periods of time. However, in areas with diaclases in the rock, shrub and sub-shrub species develop (Figure 02 b).

Figure 02 – Overview of different habitats, a: dissolution basins (gnammas); b: diaclases on the rock in Esperança and Olivedos-PB



Source: The authors, (2018).

Individuals of shrub and herbaceous species were frequent in both municipalities, collected both in deep dissolution basins and in diaclases. There was also the occurrence of tree species mainly in the base areas of the outcrops. In these rocky environments, shrubs and small trees developed, such as *Aspidosperma pyrifolium* (Pereiro), *Bauhinia cheilanta* (Mororó), and *Pleroma heteromallum* (Quaresmeira).

In Esperança, the presence of Orchidaceae was recorded, a family represented by the species *Cyrtopodium flavum* (Figure 03 a) and *Epidendrum cinnabarinum* (Figure 03 b), therefore, soil and climate conditions are favorable to this flora that requires greater humidity. Due to the municipality's proximity to the Paraiba marsh microregion, this area tends to prevail with greater humidity, high rainfall and milder temperatures due to humid air masses originating from the coast. (Porto *et al.,* 2008, Sales-Rodrigues, Brasileiro and Melo 2014).

Figure 03 – Orchidaceae in rocky outcrops in Esperança-PB

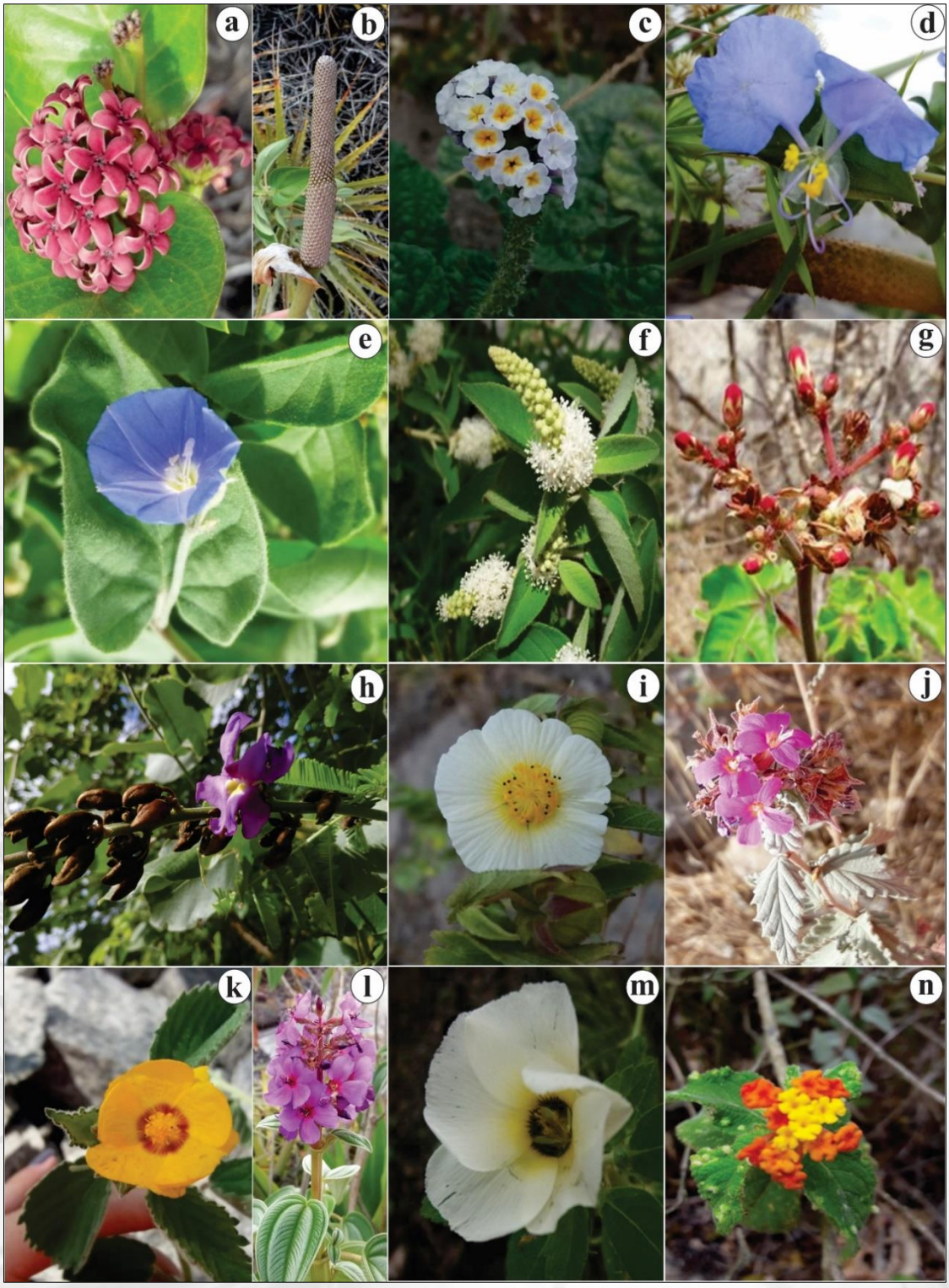
Source: The authors, (2018).

The areas studied are made up of granite and gneisses. Regarding the vegetation of the areas, it was found that there is considerable richness and rock floristic diversity due to the distinct soil and climate characteristics (Figure 04).

The rock vegetation collected at the outcrop in Olivedos is typical of Caatinga and usually found in open, cosmopolitan and ruderal areas, while in Esperança, both Caatinga species and species from humid forest formations were recorded, such as *Begonia lealii, Begonia saxicola, and Pleroma heteromallum*. Studies carried out in rocky environments in the Caatinga, such as in Cordeiro, Souza and Felix (2018) and Pereira *et al.* (2019), corroborate the direct influence of edaphoclimatic factors on the mosaic and distribution of plant communities that make up the outcrops, capable of supporting species from the Caatinga, as well as from different domains.

Figure 04 – Species of angiosperms registered in the outcrops in Esperança and Olivedos

a) Ruehssia caatingae; **b)** *Anthurium affine;* **c)** *Heliotropium elongatum;* **d)** *Commelina erecta;* **e)** *Jacquemontia densiflora;* **f)** *Croton jacobinensis;* **g)** *Jatropha molíssima;* **h)** *Macropsychanthus grandiflorus;* **i)** *Herissantia crispa;* **j)** *Melochia tomentosa;* **k)** *Sida galheirensis;* **l)** *Pleroma heteromallum;* **m)** *Turnera subulata;* **n)** *Lantana câmara.*



Source: author's personal collection, (2018) and (2019).

Pereira *et al.* (2019) highlights the direct influence of climatic factors, associated with the poorly weathered soils that characterize the outcrop areas and which corroborate the occurrence of plant species that develop in the substrate, as well as shrub and sub-

shrub species that tend to settle in the fissures of the rocks and on small islands of soil, thus selecting a biota fully adapted to such conditions.

4 FINAL CONSIDERATIONS

From the analysis of the floristic composition of the rocky outcrops of Esperança and Olivedos, it was possible to conclude that in the areas studied, the rock flora was rich and diverse. Fifty-two botanical families and 127 genera were found in these areas. The families with the highest number of species were Fabaceae, Asteraceae, Euphorbiaceae, Malvaceae and Convolvulaceae. The strong presence of the Fabaceae family was already expected, as it is a cosmopolitan family and its appearance is common in environments with rocky outcrops, and the dominant habitats are shrubs and sub-shrubs.

Despite being located in the same geomorphological unit and in similar climatic conditions, the microclimate of the areas in-line with the relief and orographic position possibly contributes to a distinction between the flora in the rocky outcrops.

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