FLORISTIC SURVEY AND ITS GEOFUNCTIONALITY IN THE TOPOGRAPHIC GRADIENT RESPONSIBLE FOR THE VEGETATIVE DISTRIBUTION OF THE PARQUE DAS DUNAS SALVADOR-BA

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ABSTRACT: The vegetation Dunas Park presents a diverse flora belonging to different topographic zones and where there is an intercommunication of the different biological and geological characteristics. These species model these environments with different physiognomies where they act as a source of information about their environmental dynamics. This article aims to raise floristic diversity and to identify the distribution of vegetation formations that occur in various topographic levels, as well as to know the geofunctional mechanisms that act on the focal plant species that make up the restinga Dunas Park and understand the natural dynamics of this ecosystem. through the perpendicular transects to the beach line towards the airport Luiz Eduardo Magalhães is verified that the families Fabaceae, Myrtaceae Rubiaceae and Orchidaceae were the most representative. Being the family Fabaceae lots of species. Some families found in the floristic survey have species that have been influenced by the geomorphology of sandy soils. In this context, this geomorphological formation, which characterizes this dune system, formed different physiognomic aspects in the sandy landscape where they harbor a flora adapted to a certain characteristic pattern in which the area is submitted. In sites of low topographic altimetry, the predominance of a vegetative formation of herbaceous and shrub habit with great biological plasticity that favors its development in such places. This environment, which is oligotrophic and susceptible to periodic flooding, has allowed a greater geological functionality by many plants called facilitators and their functional performance has focused on the water and nutritional improvement of the dune sediment condition. In other, higher areas, there is a predominance of plant species of arboreal-shrub habitat that live in larger clumps with a greater plant density where it expresses its geological function to indicate the hydrogeological conditions of the areas where they are established. These conditions contributed to separation of plant formations in relation to the investigation of patterns of dominance and rarity found in this environment. Therefore, the results presented in this paper confirm that topographic conditions function as a filter selecting the species capable of establishing and persisting on certain specific habitats.

KEY WORDS: *Dunas Park, Environment, Physiognomy.*

1. INTRODUCTION

The restinga have a particular physiognomy of a vegetation growing on quartz sand soils covering the sandy coastal deposits (SANTOS-FILHO et al., 2015) with

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marine, fluvial-marine, and fluvial influence (ALMEIDA-JUNIOR & ZICKEL, 2012; MELO JUNIOR & BOEGUER, 2015) of Quaternary origin (MEDEANIC & CORREIA, 2010; SANTOS-FILHO et al., 2015). This vegetation, established geologically on recent sedimentary terrains, evolved from the last Holocene marine regression (SANTOS & SILVA, 2016; CERQUEIRA, 2000). when sandy deposits were formed along the Brazilian coast (SANTOS & SILVA,2016). The sea level variations played a key role in the genesis of these vegetative deposits. During the transgressions, the restinga area was drastically reduced, many parts were immersed, others with higher topographies, remained small islands of vegetation (CERQUEIRA, 2000; LIMA-FILHO et al., 1991 apud SANTOS & SILVA, 2016). However, during the regressions, when the naked soil was raised, subject to the external conditions of the environment, a new landscaping was modeled on the extensive sandy plains formed (GOMES et al., 1998 apud BARCELOS et al., 2016) islands "of existing vegetation (CERQUEIRA, 2000; LIMA-FILHO et al., 1991 apud SANTOS & SILVA, 2016). Thus, in this trial, these dune environments are being colonized by restinga, where vegetation formations cover extensive sandy deposits along these coastal areas.

In this context, the recent origin of these plains may explain the low endemism of the flora belonging to the restinga ecosystem, and there is not sufficient time for speciation in these plains (SCARANO, 2002; AMARAL et al., 2015). Due to this, these formations are, in general, constituted of vegetal species of other biomes like Mata Atlântica, Mata de Tabuleiro, Caatinga, Cerrado and Amazon Rainforest (ALVES et al., 2007; MARTINS et al., 2012; AMARAL et al., 2015). The soil, which formed over the years in the Holocene period (CERQUEIRA, 2000, SANTOS & SILVA, 2016), and allowed the development of such formations, are geologically recent for the formation of exclusive species. Thus, despite the psammophilous, most of the vegetation formations that make up these environments did not achieve a high adaptive capacity and, therefore, did not develop a high degree of endemism (ACOSTA et al., 2005; ANDRADE, 2012; MARTINS et al., 2013) high fidelity to these environments to the point of generating exclusive species and that would have the natural selection as the main mechanism of speciation (DARWIN, 2003 apud TEIXEIRA, 2009; COLLEY & FISHER, 2013). Thus, the restinga ecosystem favors an important recent vegetative community and it has high complexity and a significant flora of great scientific and conservation value.

The varied vegetation formations found in restinga ecosystems are closely linked to several environmental factors such as flood susceptibility, topography, marine and continental influences, among others that condition the Phyto-physiognomy distribution and diversity of these environments (MENEZES et al., 2010; MAGNAGO et al., 2011; In this article the topography has been shown to be an important factor in the vegetation distribution pattern along the coastal gradient (RODRIQUES et al., 2007; DAMICO, 2017), favoring a Phyto-physiognomy heterogeneity constituting a mosaic of plant formations from predominantly herbaceous to predominantly arboreal (DAMICO, 2017). The topographic position can determine soil drainage capacity (SOLLINS, 1999 apud HIGUSHI et al., 2014) and may influence the distribution and structure of the floristic composition (HIGUSHI et al., 2014). In the topographically higher areas, where most of the time they do not have a direct influence on the water table (MARTIN et al., 1997, apud MAGNAGO, 2010), a shrub vegetation occurs in thicker vegetation (DAMICO, 2017). However, in the areas of inter-cordons, with their topographically lower terrain, such vegetation formations may be subject to flooding periods (ANDRADE & DOMINGUEZ, 2002; DAMICO, 2017). In these areas, presenting open sand, favor the presence of herbaceous (DAMICO, 2017). This factor has the behavior as an environmental filter selecting the species capable of establishing (SANTOS, 2014).

This diverse vegetative community reflects the conditions of certain places by which they present themselves with a better development, often serving as a biological indicator. An example of this is the psamophilic communities, with their adaptive processes, which allow them to survive in oligotrophic environments with insipient pedogenic evolution, low pH, poor water retention, strong saline spray (MARTINS et al., 2013). Another species such as *Cupania oblongiolia* Mart, indicates hillside area (PARRINI & PACHECO, 2014), are exclusive of areas with slopes (PARRINI & PACHECO, 2014). Clarity that the *Lagenocarpus rigidus* (Kunth) Nees species cover extensive areas (SILVA, 2012) in areas of flat topography and subject to temporary flooding and Myrcia *splendens* (SW) DC indicator of well drained soils (TEIXEIRA and ASSIS, 2009; HIGUSHI et al., 2014). Therefore, many plants, which colonize certain coastal areas, can express the abiotic characteristics of such areas, and probably can function as a bioindicator of some geological, geomorphological and water factors.

In this context, the biotic interactions determine ecological processes essential for the maintenance of biodiversity, also acting as a filter in the selection of species (SILVA, 2012; WOLOWSKIET et al., 2016). It is clarity that there is a process of interaction between the plant species and the territory they occupy, serving as a mechanism that drives the dynamics and structure of plant communities (BROOKER et al., 2008; CASTANHO et al., 2015). The interactions in the plant community reflect the environmental conditions of a particular site. The more stressful the abiotic factors for the vegetation community, the more they will influence the balancing of numerous positive interactions (BROOKER et al., 2008; HE, et al., 2013; DALOTO et al., 2016), which have provided a greater expression of their geological functionality favoring positively the soil. In these environments, many herbaceous pioneers, stabilizers (GOMES & GUEDES, 2014) of between "*moitas*" (NOLASCO et al., 2012) and adult woody facilitators can modify the original conditions of the area of their influence, contributing to the improvement of water and nutrition (CAMARGO et al., 1999; ZALUAR & SCARANO, 2000; DALOTO et al., 2016), which contributes to the establishment of other species (SILVA, 2012). Therefore, interactions in vegetative communities, function as a powerful tool in the composition of floristic diversity and its structural organization along the coastal gradient.

The study of Brazilian restinga remains a challenge. Although many floristic, Phyto-physiognomic, and ecological studies are being conducted (SANTOS-FILHO et al., 2015; BRAZ et al., 2013; SILVA, 2012), many issues of these themes remain poorly understood. There are no ecological and physiognomic data vegetation of the Brazilian coast (ARAUJO 1992 apud MARTINS et al., 2012). The flora is little known, with scarce floristic work, in the North and Northeast Regions (QUEIROZ et al., 2012; BASTOS 1996 apud LIMA et al., 2014; OLIVEIRA et al., 2014). The ecological mechanisms of interactions involving focal plants remain unknown (SILVA, 2012). As well as the functional role of many plant species (SILVA, 2012). This fact becomes even more worrying when considering that this ecosystem is reflecting the effects of anthropogenic activities.

In Salvador, Bahia, Brazil, although coastal systems are also totally replaced by disordered urban fronts (BARBOSA et al., 2017), the Parque das Dunas region still preserves an important and last remaining of Mata de Restinga (SILVA, 2012; CARBANELLAS & MOREIRA, 2007). This area, despite being under intense pressure from the expansion of Luiz Eduardo Magalhães International Salvador Airport (SILVA, 2012), has been well resisted by such pressures and has been the scene of great concerns of social groups in the sense of their preservation (SILVA, 2012). This park represents one of the most important restinga ecosystems due to the high taxonomic diversity of the phanerogamic flora (BRITO et al., 1993; VIANA et al., 2006), being one of the richest in Brazil (ARAÚJO & HENRIQUES 1984 apud VIANA et al., 2006), and an apicultural flora with greater wealth than the similar ecosystems of the Brazilian Northeast (VIANA, 2006). In addition, the existence of many endangered species such as *Gomphrena duriuscula* Moq and many data deficient with regard to extinction like the *Allagoptera brevicalyx* M. Moraes, *Mitracarpus anthospermoides* K. Schum, *Protium bahianum* Daly, *Eriope blanchetii* (Benth.) Harley, *Byrsonima microphylla* A.Juss, *Calycolpus legrandii* Mattos, *Neomitranthes obtusa* Sobral & Zambom, (MMA, 2008), among others that further increase the importance of this forest remnant for the maintenance of the region. This phyto-physiognomic mosaic occurs in oligotrophic areas, swamps, perennial lagoons, and non-flooded areas (SILVA, 2012; HERMOSO, 2015) that extend over dune fields in the form of a “blowout” (PÊPE, 1979). These conditions function as a filter selecting the species capable of establishing themselves (SANTOS, 2014). Thus, it is urgent to preserve this area of rare scenic beauty and natural wealth.

This paper presents the study of floristic diversity and identifies the distribution and causes of vegetation formations that occur in different topographic levels, as well as to know the geo-functional mechanisms that act on the focal plant species that make up the restinga ecosystem of Dunas Park.

2. LOCALIZATION

The Dunas Park, inserted in the APA Lagoons and Dunes of Abaeté, has a rich environmental scene. This park, created in 2008 through Municipal Decree 19.093/08 (SILVA, 2012) houses a heterogeneous landscape with permanent lagoons, temporary lakes, ponds, streams, river, river source and fixed, mobile, and semi-mobile dunes. The climate classified according to the Köppen system is Tropical, hot humid and without dry season (MARTIN et al., 1980: FERNANDES et al., 2015) presenting an average annual precipitation of 1950mm. The Phyto-physiognomic mosaic is constituted by vegetation adapted to this environment. Thus, this place of rare scenic beauty, encompasses the study area located north of the municipality of Salvador between coordinates 12°56'59"S and 38°20'25" W in the coastal zone between the neighborhoods of Stella Mares and Flamengo, is bordered by Luís Eduardo Magalhães Salvador International Airport. It is noteworthy that, despite this relevance, there are few studies regarding the structure and distribution of plant communities in this area.

3. MATERIAL E MÉTODOS

The study of local topography and its effects on the distribution of plants species, as well as understanding which topographic environments favored the positive interactions and the geo-functional mechanisms that these species will resort to survive in this restinga environment, were considered. To increase knowledge about the behavior of plant formations in relation to abiotic and biotic factors to understand how this environment works in relation to its structure, composition, and natural dynamics. Therefore, aiming to favor future studies regarding the conservation, management, and recovery of degraded areas in restinga ecosystems.

The vegetation cover forms a diversified Phyto-physiognomic mosaic that stabilizes the dune system in of this environment (COSTA, 2006). These formations generally occupy herbaceous and shrub vegetation (SILVA, 2012; VIANA, 2006) that are distributed bare areas and in conjunction with other species, being this group, for the most part, grouping of shrubs called "*moitas*" (SILVA, 2012) The scarcity or disappearance of these plants can increase the risks of erosion in the dunes, which naturally susceptible to sand slide (MARTINS et al., 2013). Thus, this vegetation of restinga organized in clumps of diverse sizes colonize the varied sandy terrains of this natural environment.

The dune system of Dunas Park is made up of a very diversified relief. The topography is flat to gently undulating, where the highest stretches farther from the sea. This dune landscape features dune systems "*blowouts*" (PÊPE, 1979; SOUZA, 2015). Even if these sandy deposits are stabilized, for the most part vegetation (COSTA et al., 2006), everything indicates that they are unstable and ecologically fragile systems, in many points without vegetation (ARAÚJO & LACERDA, 1987 apud SILVA, 2012), because loose sand does not offer wind resistance that initiates blowouts by means of preferred paths of terrains (PEPE 1979). Thus, these sandy soils are potentially vulnerable to the dynamics of wind, if devoid of its vegetative cover.

This research was developed following the standard methodology for scientific work to follow:

i) Pre-Field Stage - which met consultation the literature, as well as the survey of existing literature in public bodies.
ii) Field Stage - for the collection of botanical material and observation of the species in transects perpendicular to the coastline, georeferenced with the use of GPS and their coordinates were plotted on the satellite images traced through ArcGIS, Geographic Information Systems (GIS) software.
iii) The Botanical Collection - the material over phenological conditions (flower and/or fruit) was collected by adopting the methods common in taxonomy (MORI et al, 1989). Subsequently, it was identified through specialized bibliography, consult the specialist, as well as by comparison with the existing material in the Herbarium collection Alexandre Leal Costa (ALCB). The spelling of the authors' names was verified in Brumitt & Powell (1992). The botanical material was incorporated into the herbaria Alexandre Leal Costa (ALCB) of the University Federal of Bahia and the RADAMBRASIL Herbarium of the Botanical Garden of Salvador (JBSSA). The system of Classification adopted was the APGIV.
iv) Data analysis - Multivariate Analysis Methodology - Classification Analysis The clustering patterns of the dune plant community were identified and analyzed through the Euclidean distance coefficient, using as a grouping strategy the minimum variance, also known as Ward's method. This method is based on the principle that in each stage of the clustering analysis the variance within the

groups is minimized in relation to the variance between groups (PIELOU, 1984). The two-dimensional representation of this process is the dendrogram, R mode (grouping of species) and Q-mode (grouping of sampling). This analysis was performed using the MVSP program.

4. RESULTS AND DISCUSSION

The analysis of the data revealed a floristic composition represented by 98 species; 83 genera distributed in 44 families found in the plots (Table 01). The most representative families were Fabaceae (10), Myrtaceae (07), Rubiaceae (07), Orchidaceae (06), Asteraceae (04), Malpighiaceae (04), Sapindaceae (04), Euphorbiaceae (04), Apocynaceae (03), Burseraceae (03) and Melastomataceae (03). These families account for 56,10% of the total species sampled in the plots (Figure 01). The families Fabaceae, Myrtaceae Rubiaceae and Orchidaceae are the most representative in relation to the number of species identified in the plots. components, using natural-scale photographs of the formations.

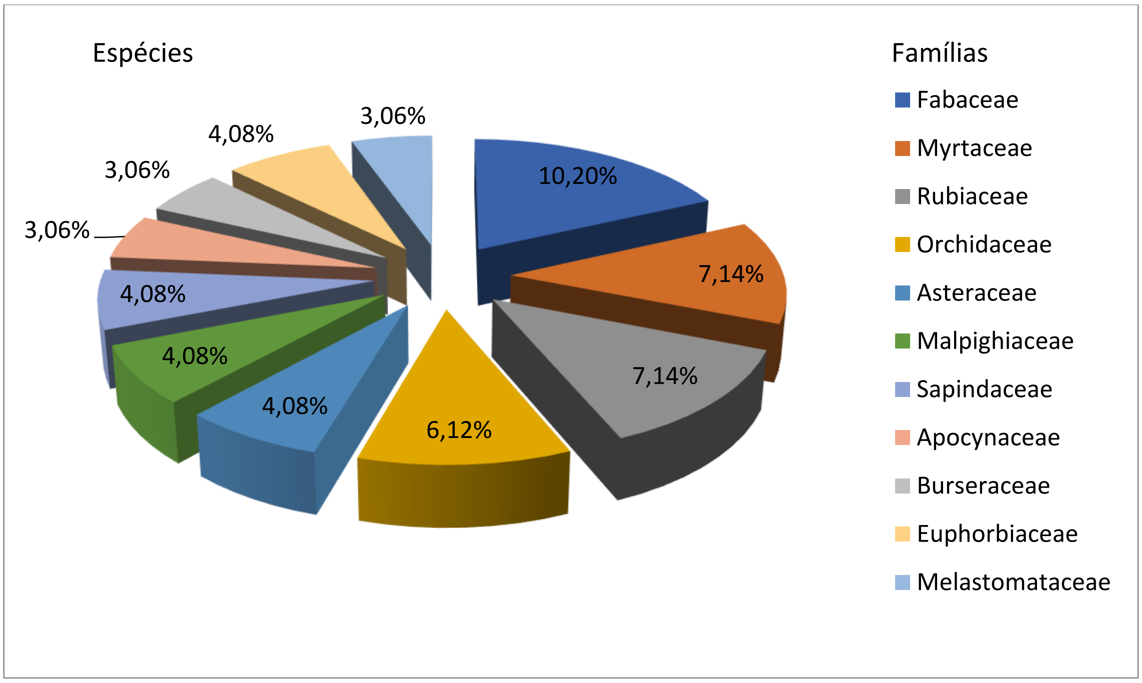

Figure 1. Distribution of families in the sampling plots of Dunas Park.

The families Fabaceae, Myrtaceous, Rubiaceous and Orchidaceous were the more represented among the others. Comparable results were found by Cantarelli et al (2012) when studying the restinga of Pernambuco; Magnago et al (2011) when they studied the restinga of Rio de Janeiro and Espírito Santo and by Viana et al (2006); Queiroz et al (2012); When studied the restinga of Bahia. It was found that, among these families, Fabaceae had the highest number of species in the study area. According to Polhill et al. (1981) apud Viana et al. (2006), this larger representativeness is due to the diversity of habits, ecological preferences and maintenance, defense, and reproduction. It was also contacted that, in relation to Orchidaceous, although it had a good representation in the State of Bahia, there was no significant in the works of Gomes and Guedes (2014) when they studied the APA Littoral North region. According to these authors, one of the possible reasons for this lower wealth was the fact that, from this region, rainfall and higher temperature throughout the year when compared to other areas of restinga. According to Pereira (2007); Barbosa & Cruz (2016) anthropogenic activities has led to the disappearance of key species in the coastal ecosystem. According to Queiroz (2012), the families Myrtaceous, Rubiaceous and Orchidaceous were also mentioned as the richest in several works along the Brazilian coast. Therefore, these results affirm that these families were the most common in the Brazilian restinga and the results obtained in the present study demonstrate that they are important in the vegetation that make up this ecosystem.

Table 01. Plant species of the Restinga Ecosystem of Parque das Duna.

Family	**Species**	**Plot**								***ALCB**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Acanthaceae	*Aphelandra nitida* Nees & Mart					x				126304
Amaranthaceae	*Gomphrena duriuscula* Moq					x		x		126293
Apocynaceae	*Ditassa crassifolia* Decne	x								126281
	Hancornia speciosa Gomes								x	126335
	Mandevilla moricandiana (A.DC.) Woodson		x							126327
Araceae	*Anthurium affine* Schott	x	x			x				126308
	Anthurium longipes N.E.Brown						x			126303
Arecaceae	*Allagoptera brevicalyx* M.Moraes	x	x	x	x	x	x	x	x	s/n
	Bactris soeiroana Noblick & Lorenzi					x	x	x	x	126365
Asteraceae	*Calea angusta* S.F.Blake	x								126337
	Lepdaploa mucronifolia	x			x					126301
	Mikania nitida (DC.)R.M.King & H.Rob.	x	x		x	x	x		x	126311
	Stilpnopappus scaposus DC	x		x		x		x		126302
Bignoniaceae	*Jacaranda obovata* Cham	x	x							s/n
	Tabebuia elliptica(DC.) Sandwith	x	x		x		x	x	x	s/n
Bromeliaceae	*Hohenbergia* sp	x	x	x	x	x	x	x	x	s/n
	Tillandsia recurvata (L.)L.	x	x							s/n
Burseraceae	*Protium bahianum* Daly	x		x	x	x	x	x	x	126360
	Protium heptaphyllum (Aubl.) Marchand	x					x		x	s/n
	Tetragastris occhonii (Rizzini) Daly				x	x			x	126312
Cactaceae	*Cereus fernambucensis* Lem	x	x		x	x				s/n
	Melocactus cf. *violaceus* subsp. *margaritaceus* N.P.Taylor			x	x	x				s/n
Calophyllaceae	*Kielmeyera argentea* Choisy			x			x	x		s/n
Celastraceae	*Maytenus distichophylla* Mart. ex Reissek				x					126331

Chrysobalanaceae	*Chrysobalanus icaco* L	x				x				126297
	Hirtella ciliata Mart. & Zucc				x			x		126334
Cleomaceae	*Dactylaena microphylla* Eichler			x		x				126336
Convolvulaceae	*Evolvulus maximiliani* Mart. ex Choisy	x								126284
Cyperaceae	*Lagenocarpus rigidus*(Kunth) Nees	x	x							126296
Dilleniaceae	*Davilla flexuosa* A.St.Hil.	x	x	x	x			x	x	126283
Ericaceae	*Agarista revoluta* (Spreng.) Hook.*ex* Nied	x				x		x	x	126357
Erythroxylaceae	*Erythroxylum rimosum* O.E.Schulz						x			126305
Euphorbiaceae	*Croton polyandrus* Spreng						x	x		126307
	Croton sellowii Baill		x							126330
	Euphorbia gymnoclada Boiss					x		x		126357
Fabaceae	*Maprounea brasiliensis* A. St. Hil.				x					s/n
	Abarema cochliacarpos (Gomes) Barneby & J.W.Grimes				x					s/n
	Andira fraxinifolia Benth			x						s/n
	Bauhinia sp			x			x			s/n
	Chamaecrista cf. *cytisoides* (DC. *ex* Collad.)H.S.Irwin & Barneby			x		x			x	126358
	Chamaecrista ramosa (Vogel)H.S.Irwin & Barneby	x	x	x	x	x		x	x	126290
	Leptolobium bijugum (Spreng.) Vogel							x	x	s/n
	Mimosa lewisii Barneby	x	x				x	x		126367
	Moldenhawera nutans L.P.Queiroz					x		x		126319
	Stylosanthes viscosus Sw	x	x	x	x			x		126291
	Swartzia apetala Radd	x	x	x	x	x			x	s/n
Humiriaceae	*Humiria balsamifera* (Aubl.) A.St.Hil							x		126321
Icacinaceae	*Emmotum affine* Miers					x				126371
Krameriaceae	*Krameria bahiana* B. Simpson	x	x		x			x	x	126286
Lamiaceae	*Eriope blanchetii* (Benth) Harley								x	126323
	Vitex cymosa Bertero *ex* Spreng	x	x	x	x		x	x		126320
Lauraceae	*Cassytha filiformis* L	x	x			x				126282
Lythraceae	*Cuphea flava* Spreng.		x		x	x	x		x	126333
	Cuphea sessifolia Mart					x				s/n
Malvaceae	*Waltheria cinerescens* A.St. Hil.				x				x	126361
Malpighiaceae	*Byrsonima microphylla* A.Juss.	x	x	x	x	x		x		126298
	Byrsonima dealbata Griseb								x	126317
	Byrsonima sericea DC	x							x	s/n
	Stigmaphyllum paralias A. Juss	x	x	x	x	x				126315
Melastomataceae	*Comolia ovalifolia*Triana	x	x			x		x		126300
	Miconia albicans(Sw) Triana								x	s/n
	Tibouchina bradeana Renner		x		x	x	x			126310
Moraceae	*Ficus bahiensis* C.C.Berg & Carauta		x		x					126363
Myrtaceae	*Calycolpus legrandii* Mattos					x			x	126318

	Myrcia bergiana O.Berg	x		x	x		x			126314
	Myrcia guianensis (Aubl.) DC.	x		x	x	x	x	x		126313
	Myrcia salzmannii O.Berg.							x	x	s/n
	Myrcia spendens (Sw.) DC						x			s/n
	Myrcia sp	x		x	x			x		126322
	Neomitranthes obtusa Sobral & Zambom					x				126316
Ochnaceae	*Ouratea crassa* Tiegh.	x			x	x				s/n
	Ouratea suaveolens (A.St.Hil.)Engl		x		x	x	x	x	x	s/n
Orchidaceae	*Catasetum roseoalbum* (Hook.)Lindl.		x	x						s/n
	*Cyrtopodium flavum*Link & Otto ex Rchb.f,				x	x	x			s/n
	Epidendrum cinnabarinum Salzm				x	x			x	s/n
	Epidendrum orchidiflorum (Salzm) Lindl.						x	x		s/n
	Vanilla bahiensis Hoehne		x			x	x			s/n
	Vanilla palmarum (Salzm. *ex* Lindl.) Lindl.					x				s/n
Pentaphylaceae	*Ternstroemia brasiliensis* Cambess								x	126287
Polygalaceae	*Polygala longicaulis* Kunth	x		x						126291
Polygonaceae	*Coccoloba laevis* casar	x				x	x	x	x	126288
	Coccoloba ramosissima Wedd	x		x	x	x	x			s/n
Primulaceae	*Myrsine parvifolia* A. DC								x	126324
Rubiaceae	*Chioccoca alba* (L.) Hitch.					x				s/n
	Cordiera obtusa (K. Schum.) Kuntze					x		x		126309
	Galianthe cymosa (Cham.) E.L. Cabral & Bacigalupo		x		x	x				126289
	Guettarda platypoda DC		x		x	x	x		x	s/n
	Mitracarpus strigosus (Willd. *ex* Roem.& Schult.) K. Schum	x	x			x				126292
	Mitracarpus anthospermoides K. Schum	x				x		x		s/n
	Rudgea crassifolia Zappi & E.Lucas				x	x		x		126306
Sapindaceae	*Allophylus pubescens* (Cambess.)Radlk					x				s/n
	Cupanea oblongifolia Mart					x				s/n
	Matayba guianensis Aubl.	x				x	x			126368
	Serjania sp			x						s/n
Sapotaceae	*Manilkara salzmannii* (A.DC.) H.J.Lam	x	x	x	x		x	x	x	126294
Smilacaceae	*Smilax campestris* Griseb		x	x	x		x		x	s/n
Velloziaceae	*Vellozia dasypus Seub*			x		x	x	x	x	126377
Verbenaceae	*Lantana salzmannii* Schauer				x	x			x	126338

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5. CLASSIFICATION ANALYSIS - WARD METHOD

The classification analysis was adopted for the 08 sampling plots (Figure 02) as well as for the 98 species (Figure 03). In this analysis, three groups were selected as follows: Group 01, formed by sampling plots 1, 2, 3 and 4, is represented by three subgroups a, b, c. with 43 species (Table 02). Group 02, formed by sampling plots 6, 7 and 8, is represented by three subgroups d, e, f with 30 species (Table 03) and Group 03, formed by the plot 05, is represented by two subgroups g and h has 25 species (Table 01).

Group 01 presented species with greater dominance in the study area and groups 02 and 03 lower frequency in the study area. Groups 01 and 02 showed greater similarity when compared to group 3 (Table 02). This similarity is tested in relation to the greater dominance of species in the study area. It is noted that groups 01 and 02, as compared to group 03, have species that have a higher occurrence among the plots (Table 02) showing good adaptation to colonization of these environments. Being the group 01 with species presenting better response anatomophysiological. However, group 03 selected species with less frequency in relation to other groups, being a greater part of such species belonging to plot 05. Damico (2017), studying this same region, found, through the morphological examination in the profile, that this parcel is the only one that almost there aren't indications of pedogenetic processes, being represented by sedimentary deposit of dunes indicating active erosive processes. Thus, this may be interfering with the number of selected species for group 03, since some species are peculiar to these areas. It can be observed that *Cupania oblongifolia*, found only in plot 05 (Table 02), represents an exclusive species of sloping areas in ecosystems disturbed by the activity anthropogenic (PARRINI & PACHECO, 2014). Thus, the distribution pattern adopted by the Ward was based on the number of times a particular species appears between the plots favoring the group 01 where a greater number of species was verified.

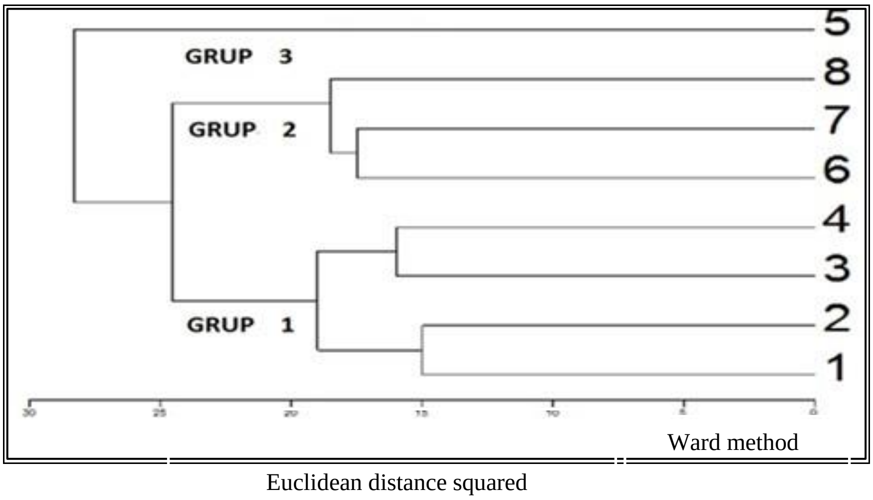


Figure 02 - Dendrogram in Q mode, showing the grouping of the sampling plots of Dunas Park

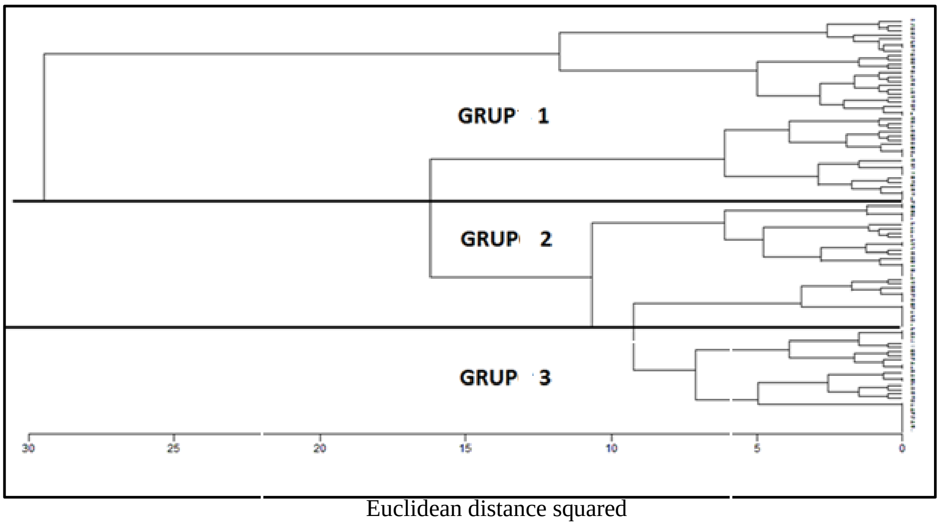


Figure 03 - Dendrogram in R mode, grouping of the species of the Dunas Park.

Table 02. List of Dominant Species in the Group 1 and subgroups of Parque das Dunas

Dominant Species – Group 1							
Subgroup a	**Plot**		**Subgroup b**	**Plot**		**Subgroup c**	**Plot**
Vanilla bahiensis	2, 5, 6		*Coccoloba ramosissima*	1, 3, 4, 5, 6		*Swartzia apetala*	1, 2, 3, 4, 5, 8
Cyrtopodium flavum	4, 5, 6		*Myrcia bergiana,*	1, 3, 4, 6		*Stigmaphyllum paralias*	1, 2, 3, 4, 5
Tibouchina bradeana	2, 4, 5, 6		*Myrcia guianensis*	1, 3, 4, 5, 6, 7		*Cereus fernambucensis*	1, 2, 4, 5
Smilax campestris	2, 3, 4, 6, 8		*Protium bahianum*	1, 3, 4, 5, 6, 7, 8		*Matayba guianensis*	1, 5, 6
Ouratea suaveolens	2, 4, 5, 6, 7, 8		*Myrcia sp*	1, 3, 4, 7		*Mitracarpus anthospermoides*	1, 5, 7
Guettarda platypoda	2, 4, 5, 6, 8		*Vitex cymosa*	1, 2, 3, 4, 6, 7		*Chrysobalanus icaco*	1, 5
Cuphea flava	2, 4, 5, 6, 8		*Stylosanthes viscosus*	1, 2, 3, 4, 7		*Comolia ovalifolia*	1, 2, 5, 7
Mikania nítida	1, 2, 4, 5,6, 8		*Byrsonima microphylla,*	1, 2, 3, 4, 5, 6		*Mitracarpus strigosus*	1, 2, 5
			Chamaecrista ramosa	1, 2, 3, 4, 5, 7, 8		*Cassytha filiformis*	1, 2, 5
			Davilla flexuosa	1, 2, 3, 4, 7, 8		*Anthurium affine*	1, 2, 5
			Krameria bahiana	1, 2, 4, 7, 8		*Mimosa lewisii*	1, 2, 6, 7
			Tabebuia elliptica	1, 2, 4, 6, 7, 8		*Lagenocarpus rigidus*	1, 2
			Manilkara salzmannii	1, 2, 3, 4, 6, 7, 8		*Tillandsia recurvata*	1, 2
			Hohenbergia sp	1,2, 3, 4, 5, 6, 7, 8		*Jacaranda obovata*	1, 2
			Allagoptera brevicalyx	1, 2, 3, 4, 5, 6, 7, 8		*Byrsonima sericea*	1, 8
						Protium heptaphyllum	1, 6, 8
						Polygala longicaulis	1, 3
						Evolvulus maximiliani	1
						Calea angusta	1
						Ditassa crassifolia	1

It was verified that the raised plant species, in the study area, have a distribution pattern influenced by topographic levels. This abiotic factor represents one of the main environmental characteristics that conditions the distribution and diversity of plant species in restinga ecosystems (EARLE & KERSHAW 1989 apud CORDEIRO et al., 2005; RODRIGUES et al., to 2007; SILVA et al., 2009; SANTOS, 2014). This can be explained by the fact that different topographic altimetry, found throughout the study area, favored the emergence of diversified site with species adapted to the environments by which they are colonizing. In this context, it could be observed that in lower lands (Figure 04), where the underdeveloped horizon predominates with low sedimentary aggregation, the water table is close to the surface, where it favors periodic flooding, in times of rainfall (SILVA, 2012; HERMOSO, 2015; DAMICO, 2017). This environment contributes to the appearance of herbaceous and shrub species (SILVA, 2012; HERMOSO, 2015) developing in transition gradients that vary with the intensity and duration of these floods. Thus, favoring a vegetation variation within the same area. These formations make up most of the area studied. In the higher sandy cords (Figure 04), presenting better drainage and a degree pedogenic development (DAMICO, 2017), shows an abundance of shrub species. Similar results were found by Silva (2012); Damico (2017). In this environment, the "*moitas*" are larger with vegetative densification, presenting shade tolerant species that make up the smallest part of the area studied. These environmental conditions are acting as a selective filter of species contributing to the separation of these plant formations from the dominance and rarity.

Group 01, formed by subgroups a, b and c, selected plots 01, 02, 03, 04 where 43 species, which also exist in other plots, which dominate most of the area of study (Table 02). Many of these species are also found in other Brazilian restinga being the majority found in the resting as of the northeast region (OLIVEIRA, 2014; ALMEIDA JUNIOR, 2011; MONTEIRO et al., 2014) possibly adapted to coastal environments. The most of these species are in a lower topography (Figure 04), when compared to the other species of groups 02 and 03, where the highest part colonize higher topography environments (Figure 04). This area, located between the level of the sea and approximately 20 meters of altitude presenting, in some areas, poor drainage where periodic flooding may occur due to the low slope of the terrain, in points where the groundwater surface appears (SILVA, 2012; HERMOSO, 2015; DAMICO, 2017). This natural setting is characterized

by different floodable and non-floodable landscapes (SILVA 2012, HERMOSO, 2015). Thus, the diversity of these environments reflects a vegetation with different characteristics, forming complex and dynamic vegetation physiognomy.

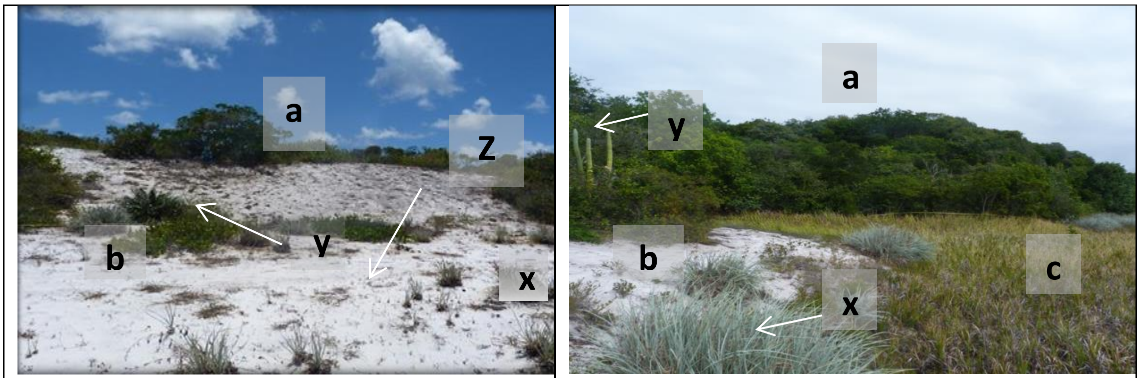
The differentiated floristic composition is distributed in most of the study area. That composition is characterized by a vegetative type where local environmental conditions favor formation of an open restinga (HERMOSO, 2015) with lower plant densities (DAMICO, 2017) providing a greater opening of the canopy and greater incidence of light. These vegetation patches predominantly exposed to low-aggregate bare sand, where low fertility (DAMICO, 2017) presenting an oligotrophic environment which favors the presence of species considered as facilitators such as *Manilkara salzmannii*, *Tabebuia elliptic*a, *Davilla flexuosa* (MENEZES et al., 2009; SILVA, 2012) and pioneers such as *Guettarda platypoda*, *Chamaecrista ramosa* and *Comolia ovalifolia* (LIMA et al., 2010; GOMES & GUEDES, 2014) that are strongly associated with this physiognomy (MENEZES et al., 2009; NOLASCO et al., 2012). The vegetation type that makes up group 01 also encompasses a larger number of species that best represent the sedimentary deposits predominantly quartz, which together with the wind action model morphological features of "blowout" (PÊPE 1979; SOUZA, 2015; DAMICO, 2017). Among these species we can highlight the *Davilla flexuosa*, *Manilkara salzmannii*, and *Ouratea suaveolans* of common occurrence in these fields' dunes (SILVA & MENEZES, 2012). These plants developing on sandy deposits sculpted by the wind rework, avoid the flow of sediments and favoring the stabilization of this dune system. These vegetation formations characterize the varied physiognomies of this environment and are important for understanding the different factors that influence them.

It was observed that in the islands of vegetation, non-flooded formations of the open restinga (HERMOSO, 2015), the species are organized in *"moitas"* representing most of the covering the morphodynamics of the dune system. Among the dominant species in *"moitas*" it is possible to emphasize the *Chamaecrista ramosa*, *Mikania nitida*, *Myrcia guianensis*, *Protium baianum*, *Swartzia apetala*, *Vitex cymosa*, *Byrsonima microphylla*, *Ouratea suaveolens*, *Allagoptera brevicalyx*, *Tabebuia elliptica*, *Hohenbergia* sp, *Davilla flexuosa*, *Myrcia guianensis* and *Manilkara salzmannii*. Menezes et al., (2012) also found similar results for the species *Myrcia guianensis*, *Manilkara salzmannii*. In relation to the vegetative organization in *"moitas*", Menezes et al., (2009); Queiroz et al., (2012); Silva (2012) also found similar results for species. It was found that many of these species, such as *Byrsonima microphylla* and *Allagoptera brevicalyx* also form monospecific *"moitas*" under constant insolation (Figure 04 - Plot 01). Similar results were found by Silva (2012). As it was also verified that the species *Ouratea suaveolens* and *Manilkara salzmannii* both make up the areas of canopy spaced with canopy open areas on the lower plains as they form the densest "*moitas"* of shading occupying higher topographies. A similar result was found by Menezes et al., (2009) in relation to the species *Manilkara salzmannii*. According to Gaburro (2013), *Manilkara salzmannii* has high phenotypic plasticity. It is a shade tolerant species and able to survive in highly illuminated environment. It has also been found that many of these species' areas of periodic flooding (GUARIM NETO, 1991; SILVA & MENEZES, 2012; MONTEIRO, 2014); Therefore, these vegetation formations are adapted to the conditions of the dynamics of this environment coastal.

In physiognomy where soil level is lower, non-perennial systems meet associated with deflation zones (SILVA & MENEZES, 2012), where there are occurrences of floods (SILVA, 2012; HERMOSO, 2015). Silva (2012) note that these floods are due to the presence of expressive underground water sources, which feed humid lands more (PINTO et al., 1984 apud SILVA, 2012). This is common during the rainy season (MONTEIRO, 2014). In these environments, *Byrsonima microphylla*, *Chamaecrista ramosa*, *Stylosanthes viscosa*, *Allagoptera brevicalyx* are arranged in the bands colonized by *Lagenocarpus rigidus* (Figure 04 - Plots 01 and 02). According to Martins (2012), this species is a hydrophilic herbaceae that can appear where the water table appears more. Results similar species were found for the species *Chamaecrista ramosa* and *Stylosanthes viscosa* at work of Valadares et al., (2011). In view of this, these species must endure periods of flooding varied. According to Hermoso (2015), this area has no water deficit because, according to Martin et al., (1980); Fernandes et al., (2015), although variability of annual rainfall occurs, it does not have a dry season. Thus, these species must distribute along the where they will adapt to a particular characteristic pattern in which the area is submitted.

It was found that, in the present study, the species, *Allagoptera brevicalyx*, *Byrsonima microphylla*, *Vitex cimosa*, *Swartzia apetala*, *Hohenbergia* sp, *Manilkara salzmannii*, Stigmaphyllum *paralias*, *Davilla flexuosa*, *Chamaecrista ramosa*, *Stylosanthes viscosa* presented great similarity between the plots of group 01 (Table 02) found mostly in subgroup b. This similarity may be represented by the adaptation mechanisms that confer high Eco physiological plasticity to colonize these coastal environments (SCARANO et al., 2005 apud SILVA 2012).

About this data indicates that many such species can be in both areas periodically flooded (Figure 04 - Plot 01 and 02) and in non-flooded areas, where the soil level is higher. The species *Byrsonima microphylla* was found occupying areas submitted to the periodic floods as well as occupying the shrub formations in "*moitas*". According to Hermoso (2015), these shrub formations in "*moitas*" in non-flooded areas. Martins (2012); Ribeiro (2014); Monteiro et al., (2014) found that the species *Vitex Cymosa*, *Swartzia apetala* and *Manilkara salzmannii* are tolerant to periodic flooding. In the case of the species *Stylosanthes viscosa*, *Stigmaphyllum paralias* were found both in flooded areas and in non-flooded areas (ALMEIDA JUNIOR et al., 2009). Data obtained also indicated that such species could establishment under constant sunshine and characterize the open sandbank (ZALUAR & SCARANO, 2000; MENEZES et al., 2009; SILVA, 2012). In addition, many papers find that most of these species, are facilitators (ZALUAR & SCARANO, 2000; SILVA, 2012). These facilitators are essential to direct the main ecological processes that regulate the dynamics of coastal ecosystems (CASTANHO et al., 2015). Therefore, such conditions seem to select these species as the most adapted to these coastal environments, favoring their dominance in group 01.



Plot.01: a- "*moitas*"; b- assorted plants with humid areas: X (*Lagencarpus rigidus),* Y-"*moitas*" (B*yrsonima microphylla*, *Allagoptera brevicalyx*) e Z- (*Chamaecrista ramosa*, *Stylosanthes viscosa*).

Plot.02: a- "*moitas*" :Y- *Cereus pernambucensis*; b- assorted plants with humid areas: x-*Lagencarpus rigidus*; c- swampo.

Plot.03: a-"*moitas*"; b- between "*moitas*"

Plot.04: a-"*moitas*" s; b- between "*moitas*"

Figure 04. Plots 01 to 04 presenting the physiognomic and phyto-physiognomic aspect existing in the Dunas Park.

6. SPECIES RELATED TO GEOLOGICAL FUNCTIONALITY

The species *Manilkara salzmannii*, *Swartzia apetala*, *Byrsonima microphylla*, *Davilla flexuosa*, were found forming islands of vegetation, called "*moitas*", interspersed by a vegetation shrub and herbaceae. These species have a positive association (SILVA, 2012) called facilitation (SILVA & MENEZES, 2007; SILVA, 2012). Facilitation is an important ecological process in stressful environments such as coastal areas (BROOKER et al., 2008). The literature on facilitation provides numerous examples of the importance of these interactions in terrestrial communities (BROOKER et al., 2008) to restinga area (ZALUAR & SCARANO, 2000; SILVA, 2012), where these facilitators plants attenuating extreme abiotic conditions, with positive consequences for the ecological

‘The presence of facilitators can improve the availability of water and nutrients from these coastal environments, where their geological functionality is of great importance.

Near the “*moitas*” and in the areas between “*moitas*”, it was verified the presence of species herbaceous vegetables like the species *Chamaecrista ramosa*, *Lagenocarpus rigidus*, *Comolia ovalifolia*, *Stylosanthes viscosa* and the *Cassita filiforme* creeper (SILVA, 2012) that present expressive geoecological functionality. Among the herbaceous ones, we can mention the *Cassita filiforme*, *Chamaecrista ramosa*, *Comolia ovalifolia* and *Lagenocarpus rigidus* are psamophiles that colonize pioneer the naked sand and are important components in the stabilization of this dune system (NOLASCO et al., 2012, GOMES & GUEDES 2014; MARTINS et al., 2013; BARBOSA & CRUZ, 2016). The *Chamaecrista ramosa* present as a specie of great dominance in the recomposition of form pioneer degraded areas (BRUNO et al., 2014). Silva (2012) states that this pioneer specie contribute to the additional input of organic matter from their dry leaves, under their influence, favoring the recruitment of new species. The genus *Stylosanthes,* also has good production of green and dry mass, with high nutritional value, contributing to the increase of forage where it is inserted (STACE & EDYE, 1984 apud RONALDO, 2015). Many species psammophilous, when in flooded areas, develop adventitious roots in the submerged portion of the stem, where they emerge and grow parallel to the surface of the water, near the more aerated region of the soil, and can guarantee some supply of oxygen (OLIVEIRA, 2011). Therefore, the efficient establishment of these species in nutrient-poor soils may favor greater colonization by other plant species contributing to the development of “*moitas*”.

Many facilitating species contribute to the geochemical and water improvement of the bush environment. Silva (2012) states that these facilitators present an important contribution to the litter supply (aporte de *serrapilheira*) contributing to a larger formation of microsites with greater availability of organic matter. The facilitating species can also contribute to the increase of the availability of certain nutrients in the soil (CALLAWAY & WALKER, 1997; DALOTO, 2016). Many species of the genus *Byrsonima* as well as the species *Chamaecrista ramosa* var.ramosa, considered facilitators (SILVA, 2012), have roots that are associated with mycorrhizae arbuculares (SANTOS et al., 1995; CARNEIRO et al., 1998; DALOTO, 2016). Arbuscular mycorrhizal symbiosis can increase root absorption surface, improving the acquisition of low mobility ions such as P, Zn and Cu (SMITH & READ 1997 apud OLIVEIRA et al., 2009). In relation to the water improvement, under the canopy of the facilitators there is also an increase in the availability of water in the soil, caused by the decrease of evapotranspiration (PRIETO et al., 2012, DALOTO, 2016) and, in extreme drought conditions, by water transport (DAWSON, 1993 apud ZALUAR & ESCARANO, 2000; PRIETO et al., 2012) Plants that do not reach the water table can be facilitated by hydraulic lift (DAWSON, 1993) apud ZALUAR & ESCARANO, 2000). Thus, these positive interactions generate a buffer effect in the "*moitas*", creating a positive feedback mechanism that favors all the species that coexist in these environments (SILVA, 2012), allowing the "*moitas*" to be representative of different successional stages (MORAWETZ, 1983 apud SILVA, 2012).

Some pioneer herbaceous species could germinate in bare sand (ZALUAR & SCARANO, 2000; SCARANO, 2002; DALOTO, 2016) where few species provide appropriate conditions for germination and growth (DALOTO, 2016). Some species of Cactaceae and Bromeliaceae are leading to an increase in vegetation patches, since they allow the colonization of other plant species (ZALUAR & SCARANO, 2000; SCARANO, 2002; DALOTO, 2016). It was observed the presence of a Cactaceae of the species *Cereus fernanbucensis* with a larger size in a clump with the presence of another shrub facilitator such as *Birsonima mycrophylla* (Figure 04 - Plot 02 -Y). This species of cactaceae is a pioneering herbaceae that colonizes bare sand and remains with the development of the "moitas" (RIBAS, 1992 apud ZALUAR & SCARANO, 2000). However, other herbaceous species such as the *Chamaecrista ramosa* and *Cuphea flava*, which also colonize the bare sand (NOLASCO et al., 2012; GOMES & GUEDES, 2014) tend to disappear during the development of the shrubs (RIBAS, 1992 apud ZALUAR & SCARANO, 2000). Zaluar & Scarano (2000) affirm that these "moitas" are the beginning of succession of bigger "*moitas*" dominated by woody. Thus, initial species can act as facilitators, recruiting woody species and favoring the transition from herbaceous to arboreal stratum. Therefore, in most cases, shrub nuclei of dominant species form a matrix of herbaceous vegetation (ZALUAR & SCARANO, 2000; DALOTO, 2016), sheltering on their canopy an expressive number of species belonging to several successional stages.

From the successional point of view, the formations of "*moitas*" comprise vegetal species with different ecological groups (DALOTO, 2016). The species of secondary successional stage, such as *Vitex cymosa*, *Myrcia bergiana*, *Byrsonima sericea*, *Myrcia guianensis* (BRANDÃO et al., 2009; MARMONTEL et al.,2013), colonized the islands of vegetation. It is observed that in the process of succession guided by facilitation there is the idea that some focal species behave as central to the establishment of others (CONNELL & SLATYER, 1977; DALOTO, 2016). It is noted that the presence of pioneer species as well as early secondary species shows that the canopy is sometimes not continuous, providing a high incidence of light in the lower strata (BUDOSWSKI, 1965 apud PAULA, 2006). This luminosity favors the development of species from the initial secondary group, which support not densely shaded forest (GANDOLFI, et al., 1995; BAYLÃO-JUNIOR, 2010). According to Connell & Slayer (1977), as it favors the recruitment of species of secondary succession, the abundance of pioneer species decreases. Therefore, although studies exist that prove that succession in restinga does not necessarily evolve to continuous patches of vegetation (DALOTO, 2016), these interactions may benefit their establishment (CARVALHO, 2013). These aggregations are a colonization strategy that the communities of the shrubs become more complex, increasing their diversity and their vegetal cover from a focal facilitating plant (ZALUAR & SCARANO, 2000; DALOTO, 2016) contributing to the regulation of the dynamics of the community (CASTANHO et al., 2015).

The plots of group 02 and 03 presented less frequent species when compared to the plots of group 01 (Table 02). In group 02, among the selected species, we can highlight the *Epidentrum orchidiflorum*, *Erythroxylum rimosum*, *Humiria balsamifera Miconia albicans*, *Myrcia splendens*, *Myrcia salzmannii Ternstroemia brasiliensis*, *Myrsine parvifolia*, *Anthurium longipes* (Table 3) that presented greater similarity occurring only in plots 06, 07 and 08, and among the species selected for group 03, it is possible to emphasize the importance of the *Cupanea oblongifolia*, *Allophylus pubescens*, Chioccoca Alba, *Vanilla palmarum*, *Neomiranthes obtusa*, *Cuphea sessifolia*, *Emotum affine*, *Apelandra nitida* that presented the highest similarity occurring only in plot 05 (Table 04). It is observed that the exclusivity of these species in these plots is associated with a better adaptation which suggests that they are more common in these environments and that they would have difficulties in occupying the neighboring environments. In addition, many species selected for groups 02 and 03 represented transitional species between the restinga areas and the forest areas. For example, *Cupanea oblongifolia* and *Neomiranthes obtusa* species, although supporting oligotrophic environments with environmental imbalances (BAYLÃO JUNIOR et al., 2013; FERREIRA & SILVA, 2014), present shade tolerance (LOPES et al., 2015). Another example is the species *Myrsine parvifolia*, located in both peat forests and sandy forests (DORNELLES & WAECHTER, 2004 apud LEAL et al., 2014). This focal plant in less stressful environments with good nutrient distribution decreases its facilitating behavior (CORNIA, 2016), which does not favor its geological functionality. Thus, these lower frequencies of such species are linked to the environmental conditions existing in such places.

The sandy soils that make up parcels 06, 07 and 08 of group 02 and part 05 of group 03 are covered by vegetation formations that are configured according to the wind dynamics for which they are associated. This dune system, represented morphologically by wind cuts, features in blowouts (HESP, 2002, FERNANDEZ et al., 2017), reveals the effective work of the prevailing winds in this region (PÊPE, 1979; SOUZA, 2015). In these features, gusts of wind partially remove the vegetation cover, exposing the accumulated sedimentation. These wind features are characterized by contain vegetation cover with immobile and mobile dunes portions.

The exposed sedimentary features are characterized as areas partially devoid of vegetation present in these dune segments. It was observed that in some points presented a bare deposit of sedimentary deposit (Figure 05- plots 05 and 07). Ramalho et al., (2013) stated that areas with little or no vegetation cover are exposed to erosion processes. It is noted that this environment, even associated with vegetation that stabilizes most of the dune system (COSTA et al., 2006), is still unstable and ecologically fragile. Costa e Souza

(2009); Ramalho et al., (2013) consider that dunes are unstable systems even when stabilized by vegetation.

Table 03. List of Less Frequent Species in the Group 2 of Dunes Park

Less frequent Species – Group 2					
Subgroup d	**Plot**	**Subgroup e**	**Plot**	**Subgroup f**	**Plot**
Epidendrum orchidiflorum	6, 7	*Myrcia salzmannii*	7, 8	*Calycolpus legrandii*	5, 8
Croton polyandrus	6, 7	*Leptolobium bijugum*	7, 8	*Chamaecrista cf. cytisoides*	3, 5, 8
Myrcia spendens	6	*Humiria balsamifera*	7	*Waltheria cinerescens*	4, 8
Erythroxylum rimosum	6	*Hirtella ciliata*	4, 7	*Lantana salzmannii*	4, 5, 8
Anthurium longipes	6	*Rudgea crassifolia*	4, 5, 7	*Epidendrum cinnabarinum*	4, 5, 8
Vellozia dasypus	3, 5, 6, 7, 8	*Cordiera obtusa*	5, 7	*Tetragastris occhonii*	4, 5, 8
Agarista revoluta	1, 5, 7, 8	*Moldenhawera nutans*	5, 7	*Myrsine parvifolia*	8
Coccoloba laevis	1, 5, 6, 7, 8	*Euphorbia gymnoclada*	5, 7	*Ternstroemia brasiliensis*	8
Bactris soeiroana	5, 6, 7, 8,	*Gomphrena duriuscula*	5, 7	*Miconia albicans*	8
				Byrsonima dealbata	8
				Eriope blanchetii	8
				Hancornia speciosa	8

The dune system, represented by wavy wind features, extends towards the interior of the continent, exhibiting a physiognomy with large vegetation cover occupying a topography that reaches altimetry between 25 and 30 meters (Figure 04). These similarities were found in the work of Calliari et al., (2005); Damico (2017); The results of this study were like those reported in the literature, Damico (2017); where they claim that higher dunes are associated with high plant density. Damico (2017); studying the same points, verified that the variation of the density of the vegetation in general accompanied changes in the pattern of the relief, being the convex areas, of greater slope and higher, with greater vegetal densification. Sobrinho (2004) states that dunes stabilized by high vegetation density are older presenting already evidence of pedogenetic processes, considered like sanded dunes. It can be observed that, for a greater evolution of these processes, a long evolutionary history happened. According to Cerqueira (2000); Damico (2017), this evolution is a result of climatic paleo events, regression cycles and marine transgression, which would have attracted higher points favoring, over the years, a greater vegetation cover in these places. In addition, these formations have found suitable means for their development by becoming denser in different topographies and characterizing the physiognomy of such environments. Thus, representing older dunes, there was time to form a larger vegetation, arboreal and shrub responsible for the establishment of such dunes.

Table 04. List of Less Frequent Species in the Group 3 of Dunes Park

Less frequent Species – Group 3			
Subgroup g	**Plot**	**Subgroup h**	**Plot**
Abarema cochliacarpos	4	*Bauhinia* s p	3, 6
Maprounea brasiliensis	4	*Dactylaena microphylla*	3, 5
Maytenus distichophylla	4	*Melocactus cf. violaceus* subsp. margaritaceus	3, 4, 5
Ouratea crassa	1, 4	*Kielmeyera argentea*	3, 6, 7
Lepdaploa mucronifolia	1, 4	*Stilpnopappus scaposus*	1, 3 5, 7
Galianthe cymosa	2, 4	*Cupanea oblongifolia*	5
Ficus bahiensis	2, 4	*Allophylus pubescens*	5
Catasetum rosealbum	2, 3	*Chioccoca alba*	5
Croton sellowii	2	*Vanilla palmarum*	5
Mandevilla moricandiana	2	*Neomitranthes obtusa*	5
		Cuphea sessifolia	5
		Emmotum affine	5
		Aphelandra nítida	5
		Serjania sp	3
		Andira fraxinifolia	3

The species *Miconia albican*, *Croton polyandros*, *Myrcia splendens*, *Ternstroemia brasiliensis*, *Myrsine parvifolia*, *Hancornia speciosa* and *Byrsonimia dealbata* are present exclusively in plots 06, 07, 08 (Table 02), these species occur in well drained environments besides show a better development in non-flooded areas (ARAUJO et al., 2002; POLLIPO, 2004; SILVA, 2007; PIRES, 2009;TEIXEIRA & ASSIS, 2009; MENEZES et al., 2010; FERNANDES, 2012; ARANHA, 2013; HIGUCHI et al., 2014; LÊDO et al., 2015; MELO JUNIOR et al., 2016). The species *Myrcia splendens* are bioindicator of well drained areas (HUGISHI et al., 2014). It is noted that the variation of the relief is of immense importance since it is always associated to changes in vegetation and drainage patterns (HIGUSHI et al., 2014; DAMICO, 2017). SCIPIONI et al., (2009); HIGUSCHI et al., (2014); DAMICO, (2017). The local relief is characterized as a convex slope and a high slope and present a peculiar spatial organization of plant community in function of the drainage existing in the different topographic regimes, this feature confirms a better water infiltration of the soil. This defined the effective ecological niche of these species expressing their geological functionality as far as it indicates the soil water conditions. Therefore, different topographic regimes and the morphological conditions of the relief of such environments are representing a determinant factor in the distribution of the plants in group 02.

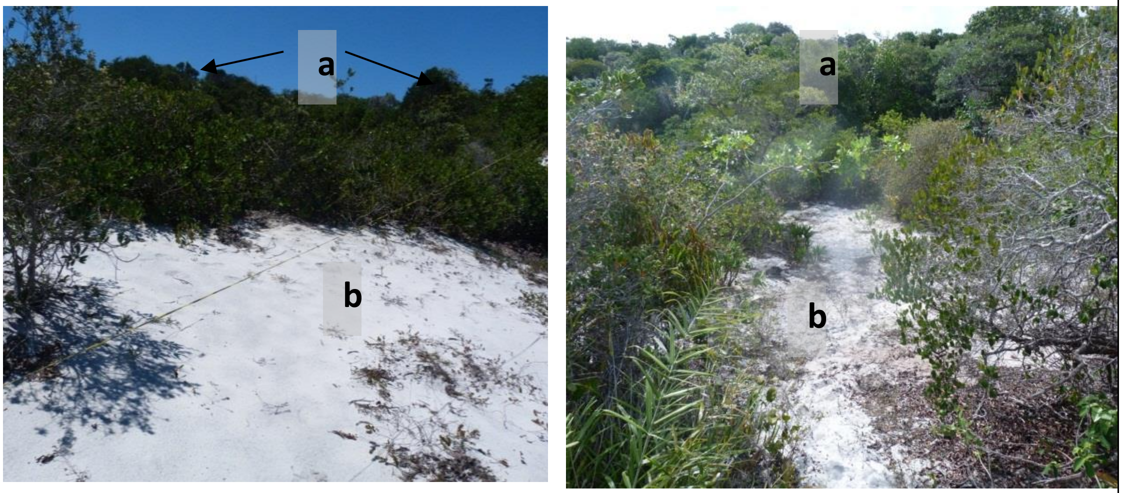
It can be observed that the exclusive species of plot 05 (table 02) belonging to group 03 are developing in sloping areas and submitted to erosive processes. *Vanilla palmarum*, *Cupanea oblongifolia and Chioccoca Alba* indicate declining environments. It is observed that these species develop in a hillside area (MACEDO et al., 2000; PEREIRA & BARBOSA, 2004; PARRINI & PACHECO, 2014). *Cupanea oblongifolia* is restricted to these environments (PARRINI & PACHECO, 2014). *Cupanea oblongifolia* and *Chioccoca Alba* are found on declivity lands with erosive processes, being used as biological measures of forest restoration (ZANELLA 2008; BAYÃO JUNIOR et al., 2013, PARRINI & PACHECO, 2014). It is also observed that *Neomitranthes obtusa* has been used for the regeneration of disturbed sandstone areas due to the loss of sandy material (FERREIRA & SILVA, 2014). Damico (2017), to same area, argued that the mobile dunes still not very fixed and with active erosive processes besides states that there is no evidence of pedogenetic processes, indicating an unconsolidated substrate. Unstable terrain was easily eroded (Figure 05- plot 05 b). Thus, these species present good adaptation to the erosive slopes that make up this environment, showing importance in the stabilization work of this area. In addition, due to the morphology of the relief, they are not influenced by the water table conditioning non-flooded plant formations (SCIPIONI et al., 2009; HIGUSCHI et al., 2014).

In this context, the effects of the various topographies and the morphological condition of the relief in the sandy features of plots 05, 06, 07 and 08 are favoring the formation of environmental filters, contributing to species selection and interfering in a distribution pattern of these plant formations (RODRIQUES et al., 2007; SANTOS et al., 2014) at these sites. In this context, these environments favored the emergence of a shrub-arboreal (SILVA, 2012; OLIVEIRA et al., 2014) extract of well-drained forest forming large "*moitas*" showing a greater vegetation density compared to group 01. Comparable results were found by Silva (2012); Damico (2017) when they studied the same area. According to Silva (2012), these large "*moitas*" are important sources of local diversity, since they increase the probability of occurrence of locally rare and infrequent species. Silva (2012) can explain this, in such "*moitas*", provide microhabitats for new species favoring a better redistribution of the nutrient flow. Thus, the contribution and accumulation of litter under the canopy of abundant phanerophytes in these shrubs may indicate a greater diversity of plants in these islands of vegetation (SCARANO, 2002; FERNANDEZ, 2012;) favoring the appearance of infrequent species found in areas.

Thus, the environmental conditions in the plots of groups 02 and 03 favored the appearance of shrub-tree species (SILVA 2012; OLIVEIRA et al 2014) that fit well in areas rich in organic matter. *Ternstroemia brasiliensis*, with a high importance value in forest on bog, is frequent in highland forests (PIRES et al., 2009). As well as *Myrcia splendens*, with high value of importance in forest with higher concentrations of organic matter, has occurrence in forest fragments (HIGUSCHI et al., 2014). The *Chioccoca Alba*, occurring in areas with greater vegetation cover, has great value of importance in Dense Ombrophylous Forest Submontana or Encosta (BATISTA, 2010). *Cupania oblongifolia*, endemic to the Atlantic Forest, occurs in secondary formations with fertile clayey soils (CONTO, 2013). Other species such as *Myrsine parvifolia*, *Croton polyandros* and *Hancornia speciosa*, although they are pioneer species (LEAL et al 2014; FERNANDES, 2012; MARTINOTTO et al., 2012) have had a good development in forest formations rich in organic matter. *Myrsine parvifolia* develops well in peat forests (DORNELLES & WAECHTER, 2004 apud LEAL et al., 2014). The species *Hancornia speciosa* has responded positively when grown on soils with clay and organic matter (VIEIRA NETO, 1994 apud QUEIROZ & BLANCHETTI, 2001)

Plots.05: a- "*moitas*"; b- assorted plants with humid areas:

Plots.06: a-"*moitas*" s; b- between "*moitas*"



Plots.07: a - "*moitas*"; b- assorted plants with humid areas

Plots.08: a-"*moitas*"; b- between "*moitas* "

Figure 05. Plots 05 to 08 presenting the physiognomic and phyto- physiognomic aspect existing in the Dunas Park.

The tree species *Myrcia splendens*, *Ternstroemia brasiliensis* (OLIVEIRA et al., 2014), *Neomitranthes obtusa* and *Cupania oblongifolia* (LOPES et al., 2015) can be found in the sub-forest of forest formations (PIRES, 2006; CALEGARI et al., 2011; LOPES et al., 2015) occupying distinct levels of shading. *Myrcia splendens* is typical of understorey forest fragments in initial stages, since the canopy of such formations presents many openings (CALEGARI et al., 2011). In the case of the species *Ternstroemia brasiliensis*, this species occupies the understory of forests and germinate with or without the presence of light, since they are photoblastic neutral or afotoblastic (PIRES, 2006). This author affirms that plants indifferent to light can germinate in the dark what may be important in the forest environment, because it allows the emergence in the understory of the forest. In relation to the species, *Neomitranthes obtusa and Cupania oblongifolia* are shade-tolerant inhabiting the mature forest understory (LOPES et al., 2015). Although *Cupania oblongifolia* is tolerant to shade (LOPES et al., 2015), Borgo et al., (2011) state that it does not tolerate continuous shading. Thus, the appearance of shade-tolerant species and understorey species may indicate that the clumps are becoming more complex. (TABARELLI & MANTOVANI, 1999; DARONCO et al., 2013). However, the process responsible for high wealth and diversity seems to be the simultaneous of not only shade-tolerant species but also pioneer species (LASKA, 1997 apud TABARELLI & MANTOVANI, 1999).

In the case of the pioneer species *Myrsine parvifolia*, *Miconia albicans* and *Cróton polyandros*, *Hancornia speciosa* colonize border areas and clearings within the forest, where the canopy allows greater light input, favoring a greater revegetation of these environments (HIGUSCHI et al., 2011; FERNANDES, 2012; MARTINOTTO et al., 2012, LEAL et al., 2014). These species are considered important for the conservation of forest fragments, since they are of great importance for the process of colonization and maintenance of populations of woody plants in their natural habitats (FERNANDES, 2012; MARTINS-CORDER & SALDANHA, 2006 apud LEAL et al., 2014) . The genus *Miconia* and *Croton* occur inside the forests mainly in secondary areas, edges or natural clearings (HIGUCHI et al., 2011, FERNANDES, 2012). Being the genus Croton that has the greatest ecological value in the forest recovery process. Thus, the role of these pioneers is especially important for cauterization of clearings, production of fruits to feed the fauna, maintenance of biodiversity and colonization of new areas.

7. CONCLUSION

The study of floristic diversity and identifies the distribution and causes of vegetation formations that occur in different topographic levels, as well as to know the geofunctional mechanisms were identified giving the following highlights:

i) At different topographic altimetry influenced the distribution of vegetation along the coastal area of Parque das Dunasand and divided into 03 groups: The group 01 dominant species with the presence of facilitators with great geofunctional potential facilitating the survival of the beneficiaries; groups 02 and 03 less frequent species with some tolerant to shading.

ii) In the higher plots topographically, where the rainwater infiltrated more, there was the formation of larger "*moitas*" and with greater diversity. In the less topographically high plots, where rainwater causes water unsaturation, with periodic and permanent flooding, there is formation of smaller "*moitas*".

iii) Cluster communities become more complex, increasing their diversity and plant cover from a facilitating focal plant.

iv) These results reinforce the idea that water is of great importance for the restinga ecosystem of the Parque das Dunas, and everything indicates that it is a regulating factor for the development of the vegetal communities.

v) In the lower and saturated areas, most of the time, there is an impediment to the formation of arboreal vegetation, predominating an adapted herbaceous shrub vegetation, whereas in the elevations, there is the appearance of a shade-tolerant tree stratum.

vi) The lack of knowledge of many plants mainly about their functionality in the restinga environment of the Parque das Dunas indicates that our understanding of its dynamics and development is still insufficient.

vii) It is observed that the species, located in a higher and well drained topography, function as bioindicators of the environmental conditions of these places, which may contribute to the development of predictions and interpretations of the reality of certain areas.

viii) At present, sufficient data are not available to explain the presence of exposed areas. The observations lead one to think of the hypothesis of the migration of sediments that, due to instability, move from the top of the dune, spreading through the vegetation. However, anthropogenic interference cannot be ruled out in this dune space, which, even if it is intended for preservation, depending on how they are processed, can cause a change in the landscape.

ix) The bare areas, observed in this study, can multiply with the frequency of trampling, thus compromising the permanence of the vegetation cover.

x) The presence of species threatened with extinction, high plant diversity and an apicultural flora with greater species richness when compared to apicultural flora belonging to the other restinga of the northeast makes Parque das Dunas a priority region for the preservation of the flora as well as the fauna that contribute to the maintenance of this ecosystem.

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