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Research Paper

Control of Vegetation in Coastal Evolution of Dune Frontal in Parque Das Dunas, Salvador, Bahia, Brazil.

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ABSTRACT: *This article aims to present what the biological mechanisms that plants use to control the genesis and evolution of the frontal dunes. The morphological and physiological mechanisms are crucial in the capture and retention of sand carried by the wind as well as favoring the developing of these species in this environment subjected to water stress, salt and strong winds. Among such mechanisms, we can cite some morphological changes such as increased juiciness (such as high salinity response in the soil solution, the presence of rhizomes and stolons which have an active role in the development of vegetable favoring the sand deposition as well as the growth of roots. regarding physiology, osmotic gradients in plant tissues that are processed with accumulation of substances in the cytoplasm in response to salt and water stress favoring the maintenance of turgor and cell volume, ensuring the growth of these plants. the burial, induces greater absorption of CO_2 by the plant which favors a greater root growth. Therefore, if there exists an adaptation process between the species and the area they occupy facilitating the development of foredune.*

Keywords: *Foredunes, evolution, vegetation, adaptation*

I. INTRODUCTION

This article relate physiology and morphology of the sandbank with the genesis of the dune ridges in Parque das Dunas, Salvador, Bahia, Brazil. The physiology of these species has a solute accumulation mechanism and chemical elements in their vacuoles that allows the permanence of the same in those first saline areas. In addition, these vegetables with creeping growth habit, multiplying by rhizomes and stolons are very important for fixation and retention sand. Therefore, this research emphasized that the vegetation with their biological mechanisms plays a crucial role in the development of the frontal dune.

Foredunes are sandy dune crests with the presence of plants located in nearby areas of the sea in post-beach tracks (HESP 2002). These vegetated dunes are characterized as oligotrophic and dynamic environments being subjected to lower salinity than the beach areas (MARTINS et al., 2013). In this environment, are found plant species with high tolerance: salinity, wind and mobility of sand (MARTINS et al, 2013).These vegetated dunes can be formed in a variety of coastal environments: on the beach strip in the open sea, bays semi-closed, estuaries, lakes and ponds (HESP, 2002), in almost all kinds of climates, from tropical areas to the Arctic (HESP 2002). Such forms are called by a variety of terms: embryonic dunes (dunes embryo), retention ridges (retention ridges), beach ridges (beach ridges), and transverse dunes (transverse dunes) (HESP 2002).

The study of the frontal dunes is of great importance because it plays important services in the coastal zone. Among many services, serve as a barrier that prevents or hinders the work or the impact of hangovers from the sea and the waves in the spring tide, favoring the protection and stabilization of the coast (LIMA & AMARAL 2013). The psammophile species that colonize these dunes, cause the stabilization of sludge and maintenance of natural drainage, as well as the preservation of living animals emigration lying under this environment and food (MARTINS et al., 2013). Moreover, to interpret the frontal dunes can provide important information on how to how the coast is evolving, that is if it is stable in erosion or accretion (REBÊLO & BRITO, 2002). These authors also claim that the geological environment is favorable it is possible to reconstruct the evolution of the recent past of the coastline and thus characterize the coastal evolution. Thus, the study of this dune system proves to be of great importance, particularly with regard to its vegetation where it plays a fundamental role in its genesis and evolution.

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The first colonizing born in a transition area between the middle and upper beach and are vital for the formation of frontal dunes (MARTINS et al.2013). It is because of this initial accumulation of sand begin to different environments in relation to the wind transport and exposure to sea breezes loaded salt, causing the appearance of other species (REBÊLO & BRITO, 2002). These species include significant contributions to the setting of sand and ground water retention favoring the evolution of dune system over time. These predominantly herbaceous vegetation existing in these dune areas have developed several biological adaptations that allowed them to colonize these saline environments (GAO et al., 2007, BRAGA, 2014). Souza (2010), states that the colonization of sand by pioneer species requires a great expertise of this vegetation.

Williams et al. (2001), state that are the morphological and physiological characteristics that determine the effectiveness of these plants in the capture and retention of sand carried by the wind. There are many biological mechanisms that facilitate adaptation and sand fixation by the halophilic and psammophile species. Among these mechanisms, we can mention some morphological changes such as the presence of rhizomes and stolons that has an active role in the formation of the dunes (ANGULO, 1993, GOMES et al., 2002); or physiological as the osmotic adjustment that takes place with accumulation of organic substances in the cytoplasm in response to salt and water stress (HARE et al., 1999; GAO et al, 2007). Therefore, there is there is a constant adaptation process between plant species and the territory they occupy facilitating the evolution of the dunes. Any change occurring in vegetation can influence the process of formation of these dunes (REBÊLO & BRITO, 2004).

It has been noted that the coastal dune systems around the world are under enormous pressures (WILLIANS, 2001). In addition to the predictions of many scientists about the future scenario where occur climate change, global warming, sea level rise and other (MARTINS et al, 2013), these areas are being abruptly damaged. Many coastal ecosystems are vulnerable to disruptions caused by various anthropogenic sources. As Williams, et al (2001), these environments are losing areas for industry Construction Builder, military use, golf courses, etc. According to this author, the frontal dunes in many parts of the world are being affected by these activities. All of this can contribute to the reduction of biodiversity, changes in the chemical composition of the substrate, and the absence of key species in certain communities in this environment. (SIMONELLI & FRAGA, 2007).

This article aims to increase knowledge of biological mechanisms which appropriates the vegetation to act to control the development of the frontal dunes in Salvador, Bahia, Brazil. To overcome all the limitations and survive in such a harsh environment, the plants had to adapt to different strategies, responding mechanisms of morphological and physiological nature (SOUZA, 2010). Such adaptive characters were naturally selected and genetically fixed, so that the current form is the end product of the genotype-environment interaction over time. Thus, this study aims to understand how plants control the genesis and evolution of the frontal dunes considering physiological and morphological features used by them.

II. ROLE OF VEGETATION

There are many variables that affect the formation of the frontal dune. The relationship between the beach and the amount of sediments over time is the basis for the development of foredune (MARTINS et al., 2013). Rebelo & Brito (2004) call attention to wind transport from the beach to the interior of the continent, and sand retention capacity by the coastal vegetation, which will trap the sediment. Williams et al., (2001) state that the vegetation is an important parameter in studies of coastal dunes. Rebelo & Brito (2004) emphasize that the vegetation is essential for the genesis and maintenance of frontal dunes, as if the vegetation disappear, the wind drag the sand inland giving rise to other types of dunes.

The genesis of the frontal dune cords begins as small accumulations of sand to meet the first lines of vegetation (ANGULO, 1993). It is due to this first accumulation that begins to form another area of beach called high, characterized by sporadic penetration of winter waves where one can find the embryonic dunes or nebkas (MARTINS et al., 2013). Often these small dunes begin to be occupied by more tolerant species to sand deposition such as psammophile grasses, so that more sand is accumulated, thus increasing dune height to form the crests of foredune (SEELIGER et al., 2004). Thus, this diverse vegetative physiognomy, supporting different stresses, are carriers of various strategies (HENTSHEL, 2008) which facilitates colonization by these species of different geomophologic gradients. The dunes of Parque das Dunas are an overview of the dominant plant communities along the gradient of psammophile in geomophological stability conditions (MARTINS et al., 2013).

In the region of Parque das Dunas Beach, Salvador, Bahia, Brazil, the first vegetation occurs in an area of transition between middle and upper beach in according to Martins et al. (2013). This environment, determined by environmental factors such as proximity to the sea, strong winds, mobility of sand and high salinity requires adapted plant species (HESP, 1991; SCARANO, 2002;). According to Martins et al., (2013), these pioneers and annual species, existing in this transition area, are predominantly succulent grasses (halonitrophile) because develop during the summer (GARCÍA-MORA et al., 1999), where salinity the soil is higher. The juiciness is a characteristic of halophytes considered to be a morphological adaptation to reduce the internal salt concentration (EISA, 2012). This reduction can occur through the vesicle and secreting glands of Na^+ and Cl^- shoot located in the leaf epidermis in response to the high salinity of the soil. This strategy indicates a major removal mechanism salts of the sensitive metabolic sites of the sheets particularly young leaves (EISA 2012). Contributing to the osmotic adjustment and avoiding problems for the development of the plant.

Solutes Na^+ and Cl^- are associated with osmotic adjustment (EISA et al, 2012). Mendes et al. (2009) state the ions Na^+ and Cl^- are compartmentalized in the plant vacuoles that according Silva et al., (2008) to maintain the salt concentration within the cell at low levels and, thus, excess salts can not intervene in the hydration of proteins and enzymatic and metabolic mechanisms of the plant. This physiological process of osmotic adjustment is performed by raising the concentration of solutes, both organic and inorganic, in the cytoplasm of the plant (EISA et al. 2012). The osmotic adjustment favors the maintenance of turgor and cell volume, ensuring the growth of these plants (MUNNS, 2005, MUNNS et al, 2002).

Solutes Na^+ and Cl^- associated with osmotic adjustment (EISA et al, 2012) has contributed to the growth of the root system providing vegetable development that saline environment. The accumulation of solutes, such as ions Na^+ and Cl^- in the plant used for osmotic adjustment may lead to imbalances of some minerals often being ion deficiency such as potassium, calcium, magnesium, phosphorus and nitrate. As Costa et al 2013, nitrogen restriction, it leads to poor utilization of fixed carbon in the leaves and, consequently, to an increased carbon flow to the underground organs, which would provide more energy for root absorption and cell division, thereby encouraging the growth of such root succulent species.

The rhizomes of many existing species in the transition area between middle and upper beach extend quickly by considerable extensions colonizing the entire beach (GOMES et al, 2002). The rhizomes are morphological formations, found in many halophytes and help in fixing the dunes, facilitates regeneration of the fragments. According to Silva (2008), these rhizomatous grasses have great regenerative capacity. This is due to the fact that rhizomes are below the soil surface, and thus with its protected renewal buds. These grasses come accompanied by other annual plants such as Salsola kali (GOMES et al., 2002). These plants, in spite of being able to accumulate considerable amounts of sand, little contributes to the increase in height and stabilization of these sands in this environment (GOMES et al., 2002). Because they are annuals, its effect is felt during their active growth. After his disappearance, the sand is moved by the wind (GOMES et al., 2002). According to Martins et al., (2013) are important for stabilizing the sediment, contributing to the formation of the next dune features.

Near to the beach line, above the average level of high tides and characterized by sporadic penetration of winter waves (MARTINS et al., 2013), this environment mainly have a perennial vegetation with a network of roots developing below ground and leaves with adaptations to coastal environmental stress (MARTINS et al, 2013). These vegetative adaptations of these species occur in response to marine influence, which receives the wave storms which occur in winter and the presence of deflation winds mounds formations which appear embryonic dunes or nebkas formed by progressive accumulation of sand around plant (MARTINS et al., 2013). Thus, halopsammophile species that colonize that environment, are well adapted to salt stress conditions having osmotic adjustment (halophytes) and burial (psammophile) (HENRIQUES & NETO, 2002).

Martins et al., (2013) state that the colonizing species like Ammophila arenaria subsp. *Arundinacea and otanthus maritimus* constitute natural barriers to grains of sand carried by the wind. These species can cause these grains are aggregated forming micro-irregularities in these areas by building the embryonic dunes (MARTINS et al., 2013). This process is possible because the plants to colonize these environments possess mechanisms to adapt the burial allowing these plants occupy these areas. According Pixão (2013), in this environment, the tides organic debris deposited on the sand which provides shelter and nutrients necessary for the growth of some pioneer herbaceous plants that colonize those areas.

The halophile-psammophile communities (halo psammophile), inhabiting the embryonic dunes may be predominantly composed of morphological adaptations both stoloniferous habit as rhizomatous (BRAGA, 2014), and are well adapted to the burial (HENRIQUES & NETO, 2002). According to Kuster (2010), stem habits shaped stolons and rhizomes have active role in the formation of these dunes. The stoloniferous formations existing in the vegetables increase the effective surface roughness and consequently the thickness of the air layer with zero speed, favoring sand deposition (ANGULO 1993). The rhizomes of many existing species above the average level of high tides extend quickly by considerable extensions colonizing the entire beach. (GOMES et al, 2002) .The that favors a burial by such vegetation.

According Perumal & Maun (2006), each species has a certain limit of tolerance with regard to their ability to survive the burial. The rhizomatous formations blutaparon portulacoides retains the sand and gradually form small elevations of up to one meter high, known as "incipient dune" or "embryonic dunes" (SEELIGER et al., 2004). These authors also suggest that although the incipient dunes play an important role in the initial uptake of sand due to the habit of creeping blutaparon portulacoides, most of the sand continues to be blown towards the mainland. The intercept of this flow and a more efficient and permanent deposition is performed by the grass-dunes (Panicum racemosum), which is a much more adapted to the burial species (SEELIGER et al., 2004). According to these authors the Panicum Racemosum responds better to the beach sand flow than blutaparon portulacoides and shows strong growth of stems and leaves, providing around the new sand capture that stimulates new growth. Therefore, the continuous deposition of sand in embryonic dunes, fixed by the dense network of roots of these species is slowly building the frontal dunes.

The frontal dunes are formed from the union of several embryonic dunes or nebkas where salinity is lower and the formations are holigotrophile and dynamic (HESP, 2002), creating a succession of crests beaches and interdune corridors (MARTINS et al., 2013) . These crests foredune are areas with high levels of physical stress and are usually dominated by species psammophile grasses (Martins et al., 2013) and also consists of stoloniferous habit and rhizomatous (SCUSSEL, 2012) According to this author these psammophile species have high tolerance to mobility of sand and burial, in addition also to withstand wind, salt spray, water deficiency and oligotrophile conditions of the coastal environment.

The psammophile species are adapted to different environmental conditions of the frontal dunes (MARTINS et al., 2013). This high specialization restricts their migration to different types of ecosystem resulting in a number of restricted coastal rate, endemic and unique plant communities (MARTINS et al, 2013). Thus, Perumal & Maun (2006) state that the level of existing community in these dunes, sand accumulation to act as a filter eliminating the most susceptible species, reducing the abundance of the least tolerant species and increasing abundance of more tolerant species or dependent species sand accumulation

Perumal & Maun (2006) studied species colonizing foredune found that these plants reacted positively to the deposition of sand. The deposition of sand increases the intensity of light and temperature on plant microhabitat contributing to its growth (PERUMAL & MAUN, 2006). According Perumal & Maun, (2006), after burial, the total area mesophyll cells per unit leaf area increases which facilitates the plant's capacity to absorb more CO_2 and possess photosynthetic active radiation. According to these authors, these plants showed an increase in biomass, photosynthetic efficiency and fluorescence of chlorophyll-a because of the higher energy content in its roots, rhizomes and underground stems when suffered burial. These authors also found that the main reasons for the stimulation of growth were the increase in leaf area, leaf thickness and root biomass.

III. CONCLUSIONS

The biological mechanisms of morphological and physiological character used by the plants have an important contribution to the evolution of the frontal dune process. The first beach environment requires species with morphological characteristics predominantly annual succulent that appears only in the summer due to the high salinity of the soil in this period. This strategy contributes physiologically to maintain turgor and cell volume ensuring the growth of these non-tolerant plants the deposition of sand, but important for fixing the same contributing to the formation of the next dune features. The other feature, subject to the winter waves and winds of deflation, has a perennial and tolerant vegetation burial. This vegetation consists morphologically of rhizomatous shoot habits, estoloniphiles and leaves adapted to salinity where the sand rich in nutrients promotes the growth of these species. These small embryonic dunes begin to be occupied by other species more tolerant to burial, the psammophile grasses. These grasses depend physiologically and morphologically sand deposition. The burial increases the total area mesophyll cells per unit leaf area thus increasing the plant's capacity to absorb more CO_2 and possess photosynthetic active radiation causing a higher energy content in roots, rhizomes and underground stems. Thus, this diverse vegetative physiognomy, supports different stresses, are carriers of various adaptations which facilitates colonization by these species of different gradients geomofological contributing to the evolution of frontal dunes.

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REFERÊNCIAS

[1]. Angulo, R, J. Morfologia e gênese das dunas frontais do litoral do estado do Paraná Revista Brasileira de Geociências. 23(1):68-80, março de 1993.

[2]. BRAGA, L. G. Riqueza e Estrutura de uma Comunidade halófila-psamófila de restinga no município de Presidente Kennedy, ES **.** Monografia apresentada ao Departamento de Ciências Florestais e da Madeira da Universidade Federal do Espírito Santo, comorequisito parcial para obtenção do título de Engenheiro Florestal. 2014

[3]. Eisa, S. Hussin, N. Geissler, H. W. Koyro. Effect of NaCl salinity on water relations, photosynthesis and chemical composition of Quinoa (Chenopodium quinoa Willd.) as a potential cash crop halophyte. Australian journal of Crop Science 6(2):357-368 (2012).

[4]. Costa, T. S. Aoyama, E. M; Falqueto,A. R. Superação de Dormência e Salinidade na Germinação de Sementes e Vigor de plântulas de Canalia rósea (S.W.)Dc. Revista de Ciência Agro-Ambientais, Alta Floresta. M.T., v11,n 1 p 77-87,2013.

[5]. Gao, Ji-P.; Chao, Dai-Y. & Lin, Hong-X..Understanding abiotic stress tolerancemechanisms: recent studies on stress response in rice. Jounal of Integrative Plant Biology 49: 742-750, 2007.

[6]. García-Mora, R, M, Gallego-Fernández Jb, García-Novo F. Plant functional types in coastal foredunes in relation to environmental stress and disturbance. J Veg Sci 10:27–34,1999.

[7]. Gomes, P, T. Botelho, A C., Carvalho G, S. de. Sistemas dunares do litoral de Esposende. Universidade do MinhoI. Ministério da Ciência e da Tecnologia, 2002

[8]. HARE, P. D. and CRESS, W. Metabolic implications of stressinduced proline acumulation in plants. Plant Growth Regul, v 21, n2, P. 79-102, 1997.

[9]. HESP, P. A. Ecological processes and plant adaptations on coastal dunes. J Arid Environ 21:165–191, 1991.

[10]. Hesp, P. A (A). A gênese de cristas de praias e dunas frontais. Mercator - Revista de Geografia da UFC, ano 01, número 02, 2002.

[11]. Henriques, M. V. Neto, C. Caracterização geoecológica dos sistemas de cordões dunares da estremeadura. Finisterra XXXVII 74, p-p 5-31, 2002

[12]. Hentschel, R. L. Gradiente vegetacional, variáveis ambientais e restauração da restinga da praia do Ouvidor Garoupa, Santa Catarina. Garoupa – Santa Catarina, Dissertação. Instituto Biociências Programa de Pós-Graduação em Botânica. Universidade Federal do Rio Grande do Sul, 76p, 2008.

[13]. Kuster, V. C. Anatomia e aspectos ecológicos de espécies vegetais ocorrentes na restinga do parque estadual Paulo césar Vinha (ES). Dissertação apresentada à Universidade Federal de Viçosa como parte das exigências do programa de pós graduação em botânica para a obtenção do título de Magister Scientiae. Viçosa, 2010

[14]. LIMA, E. Q. & AMARAL, R. F. do. Vulnerabilidade da Zona Costeira de Pititinga/RN, Brasil. Mercator**,** Universidade Federal do Ceará. Fortaleza, v. 12, n.28, p. 141-153, mai./ago. 2013.

[15]. Martins M. C., Neto C S., Costa, J. C. Received: The meaning of mainland Portugal beaches and dunes'psammophilic plant communities: a contribution to tourism management and nature conservation J Coast Conserv 17:279–299, 2013.

[16]. MENDES, B. S. da Silva. Efeitos Fisiológicos e bioquímicos do Estresse Salino em Ananas porteanus Hort veitch ex C. Koch. Dissertação apresentada ao programa de Pós-Graduação em Química (PPGQ). Recife 50p. 2009.

[17]. MUNNS R Genes and salt tolerance: bringing them together. New Phytol 167: 645–63, 2005

[18]. Munns, R.; Husain, S. Rivelli, A. R.; Richard, A. J.; Condon, A. G.;Megan, P. L.; Evans, S. L.;Schachtman, D. P.; Hare, R.A. Avenues for

[19]. increasing salt tolerance of crops, and the role of physiologically based selection traits. Plant and Soil, v.247, p. 93-105, 2002.

[20]. Paixão, R Caracterização Morfo -Ecológica do Sistema Dunar de Peniche- Baleal (Costa Ocidental Portuguesa) Finisterra**,** XLViii, 95, Pp. 41 ‑6401 2013.

[21]. Perumal, V.J. And Maun, M.A. Ecophysiological response of dune species to experimental burial under field and controlled conditions. Plant Ecology 184: 89-104.2006

[22]. Rabelo, L. P. & Brito, A. P. O. Importância das dunas frontais na avaliação da evolução da linha de costa – O caso da Praia da Manta Rota. V Encontro de Professores de Geociências do Algarve Vila Real de Santo António – Outubro de 2002.

[23]. Scarano, F.R. 2002. Structure, function and floristic relationships of plant communities in stressful habitats marginal to the Brazilian Atlantic rainforest. Annals of Botany, 90:517-524.

[24]. Scussel, C. A. Recuperação Ambiental Das Dunas Frontais De Um Trecho Da Praia De Morro Dos Conventos, Araranguá **(SC)** Monografia apresentada ao curso de Pós-Graduação Lato Sensu em Ecologia e Manejo de Recursos Naturais da Universidade do Extremo Sul Catarinense (UNESC), para a obtenção de título de Especialista em Ecologia.P.43, 2012.

[25]. Seeliger, U. Cordazzo C. Barcellos, L. Areias do Albardão: um guia ecológico ilustrado do litoral no extremo sul do Brasil. Rio grande: Ecoscientia, 96p Il,2004.

[26]. SILVA, C. M. K. Morfofisiologia de Gramas Ornamentais e Esportivas: Aspectos natômicos, Morfológicos e de Manejo. Dissertação apresentada ao curso de Pós – Graduação em Agronomia da Universidade de Passo Fundo - Rio Grande do Sul. Faculdade De Agronomia E Medicina Veterinária, 101p. 2008.

[27]. Simonelli, M. & Fraga, C. N. Espécies da Flora Ameaçadas de Extinção no Estado do Espírito Santo. Vitória: Ipema, 2007. 144 p.

[28]. SOUSA C. V. P. de. Vulnerabilidade dos Sistemas Dunares da Praia do Meco. Dissertação apresentada na Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa para obtenção do grau de Mestre em Engenharia do Ambiente, 61p. 2010.

[29]. Williams, A. T., Alveirinho-Dias, J., Garcia-Novo, F., García-Mora, M. R., Curr, R., Pereira, A. Integrated Coastal Dune Management: Checklists. Continental Shelf Research. 21: 1937-1960, 2001.

[30]. Willadino, L; Camara, T. R. Tolerância das Plantas à salinidade: aspectos fisiológicos e bioquímicos. Enciclopédia Biosfera Centro científico conhecer Goiania, v6, n11 p1-23. 2010.