

# Structure and spatial distribution pattern of *Cyathea delgadii* Sternb. (Cyatheaceae) in two Cerrado areas, in the Northeast of Brazil

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**Abstract**— The research analyzed the population structure and spatial distribution pattern of individuals of two populations of *Cyathea delgadii* Sternb. (Cyatheaceae), occurring in Cerrado areas in the state of Maranhão/Brazil. The study areas are located in the East of Maranhão, in the Milagre village, municipality of Matões and in the Pedras Village in the municipality of São João do Sóter. In each area, seven contiguous plots of 30m x 10m (300m<sup>2</sup>) with 20m inter distribution between plots. Were sampled in the units all the individuals of *C. delgadii*, with height of the living caudex and diameter at the ground level (DNS). The height of the sampled individuals was distributed in classes and for analysis of the spatial distribution, the Morisita index and the variance/average ratio calculation were used. The statistical significance was verified through the Chi-squared. Were sampled 120 and 39 individuals in 100% and 90% of the plots in the Milagre and Pedras Villages, respectively, mostly in the first height classes (> 0-0,8m and > 0,8 - 1,6m). The distribution pattern of the two populations of *Cyathea delgadii* was aggregated with statistical significance. With the results are inferred some biotic and abiotic factors that can influence the distribution of *Cyathea delgadii* in its habitat and construction of its population niche. The data presented in the research made it possible to aggregate basic information for the management and preservation of this species in the Brazilian Northeast, contributing to the population knowledge of arborescent ferns.

**Keywords**— Pteridophytes, Maranhão plants, Ferns of thorns, Arborescent Ferns.

## I. INTRODUCTION

The study of the characteristics of the populations of a specific species of plant is important for the understanding of its ecology, besides helping in the decision making in the planning and design of areas for the management and/or preservation (NASCIMENTO et al., 2002; HUBBELL; FOSTER, 1986). These studies serve as models for the species under study to determine how the environment is being exploited and how it responds to disturbances (OLIVEIRA et al., 1989).

A plant group that provides responses to environmental variations from ecological analyzes are Ferns and Lycophytes (PPG I, 2016), which refers to the group of vascular plants with great diversity of habits (Terrestrial, climbing, epiphytic, hemi-epiphytes,

rupicolous, xerophytes, halophytes, aquatics, floating and arborescent) (TRYON, 1989), with distribution influenced by the physical aspects of the environment (Types of substratum), soil texture, temperature, evapotranspiration, relative humidity and vegetative structure (TUOMISTO; POULSEN, 1996; ZUQUIM et al., 2007; POULSEN; NIELSEN, 1995; BERNABE et al., 1999; PACIÊNCIA; PRADO, 2005).

In Brazil, knowledge of the pattern of the spatial distribution of most species of ferns, as well as factors influencing them, is still little studied, which generates several knowledge gaps on the subject (MALLMANN et al., 2013). It is known that arborescent individuals can spatially distribute themselves in a randomized or uniform way and that a number of factors interfere in these

patterns of distribution (BROWER; ZAR, 1984). In the aggregate distribution, the progenies tend to be close to the parents and the individuals occupy the most favorable parts of the habitat; at random, individuals undergo different pressures or have restricted progeny distribution; and uniform, when there are negative interactions between individuals (eg, competition for food or space) resulting in uniform spacing between the specimens (RICKLEFS; MILLER, 2000; LUDWIG; REYNOLDS, 1988).

According to Ludwig and Reynolds (1988), environmental, reproductive, social, intraspecific and stochastic interactions are the main factors that can lead to various forms of distribution. Thus, knowledge about how individuals of a plant species distribute themselves in a community is one of the first steps to understand their population dynamics (HAY et al., 2000).

Among the species of arborescent ferns, *Cyathea delgadii* Sternb. (Cyatheaceae) is a very frequent group of the Brazilian Cerrado, with main diagnostic characteristics: a caudex with aculeous and fronds tapering, it is a terrestrial plant, that presents erect stem, with visible scars, petiole brownish, grooved, with aculeus and scales (HIRAI; PRADO, 2014). *Cyathea delgadii* occurs officially in Costa Rica, Panama, in South American countries around the Amazon basin from Guyana to Bolivia, in Brazil in all states except Amapá, Alagoas, Paraíba, Rio Grande do Norte and Sergipe

(HIRAI; PRADO, 2014, FLORA DO BRASIL 2020 EM CONSTRUÇÃO, CRIA, 2019).

In order to fill knowledge gaps in the pattern of spatial distribution associated with arborescent ferns, the research analyzed the population structure and the spatial distribution pattern of individuals of a population of *Cyathea delgadii* Sternb. (Cyatheaceae), occurring in two Cerrado areas in the state of Maranhão/Brazil.

## II. MATERIAL AND METHODS

### Areas of Study

The research was carried out in the East of Maranhão, in the rural areas of two municipalities, Pedras settlement in the municipality of Matões (05°36'04.08" S and 43° 11'56.79" W) (Figure 1).

The municipality of São João do Sótér extends for 1438.1 km<sup>2</sup>, with approximately 150 villages, the village Pedras in the municipality is located to the margin of MA/127, that connects the municipality of Caxias to the municipality. The municipality of Matões has 2,107,403 km<sup>2</sup>, with an estimated 33,615 residents in the last census carried out, adds the Milagre Village located inside the municipality. The villages have two well defined climatic seasons in the year, one rainy (between November to April, with the highest peaks in March) and another dry (drought period, especially between May to October) (IBGE, 2017).

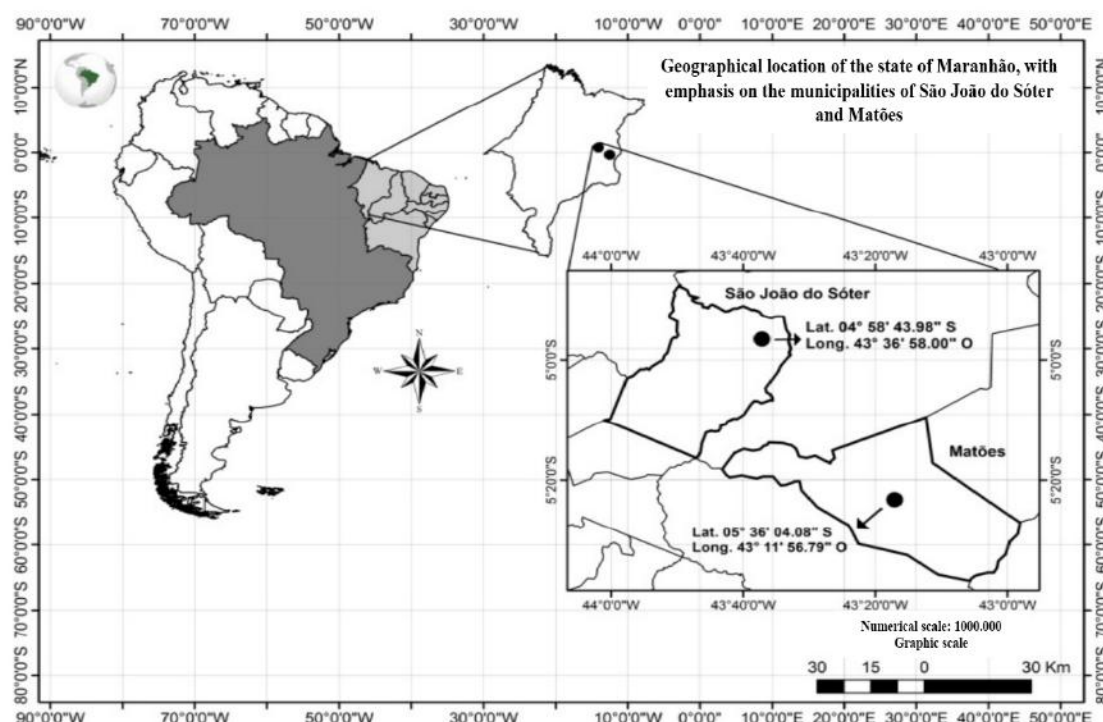


Fig.1: Characterization of the geographic area with Map with the geographical location of the collection areas (Milagre Village, Matões/MA, Pedras village, São João do Sótér, Maranhão/Brazil).

### Data Collection and Analysis

For the sampling of the *Cyathea delgadii* (Figure 2) population, seven contiguous plots of 30m x 10m (300m<sup>2</sup>) were installed in each study area, parallel to the drainage line of the watercourse of the villages, with 20m

inter distribution, and the size of the species populations. In each plot, all individuals were sampled and recorded the heights of the living caudex and the diameter at the ground level (DNS).

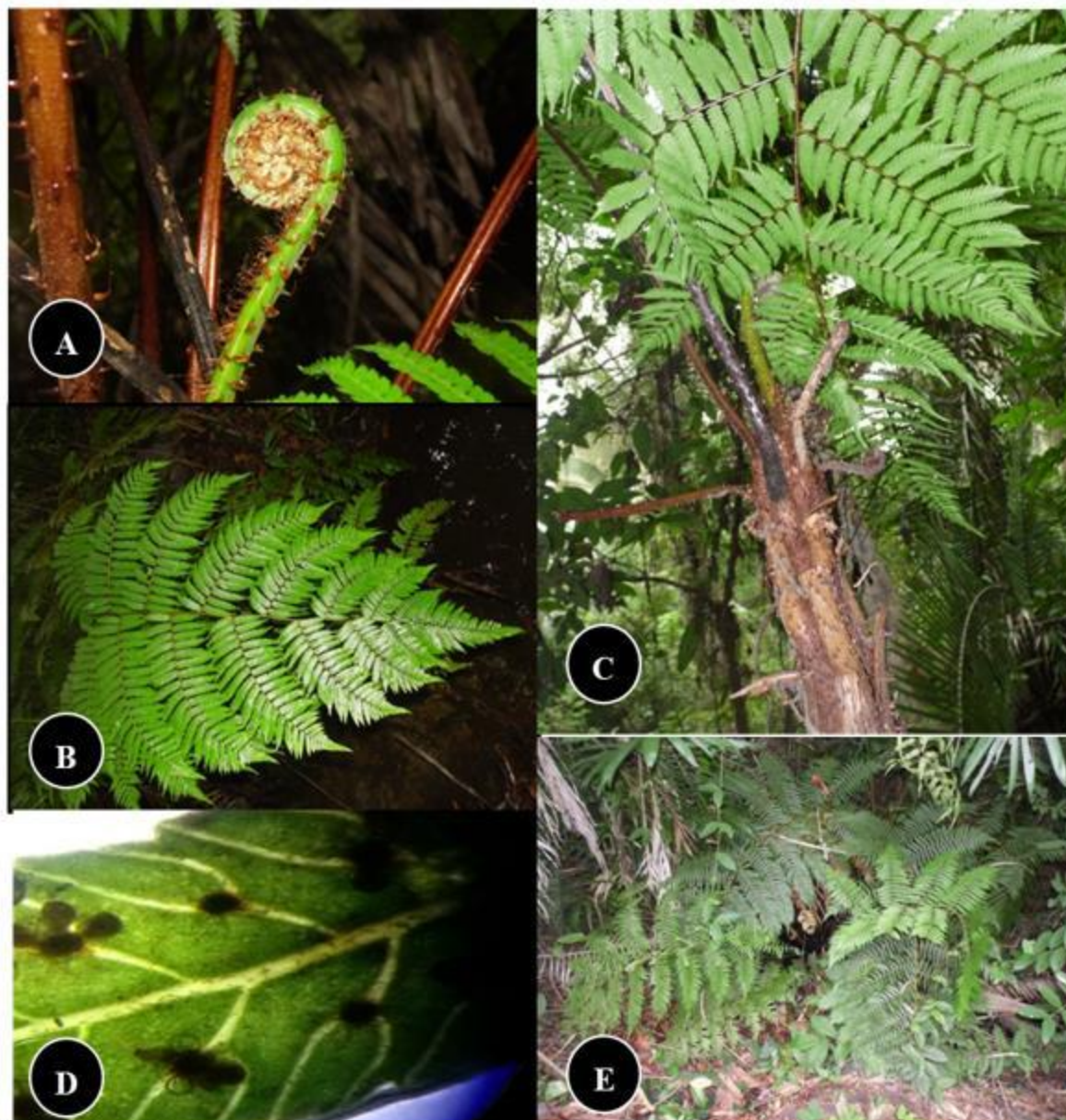


Fig.2: *Cyathea delgadii*. A) Crosier; B) Fronde of the individual in adulthood; C) Apex of caudex with the presence of scales and thorns; D) Free vein and disposal of sori; E) Natural habit.

Each aerial caudate of *Cyathea delgadii* was considered an adult individual, using Schmitt (2005) sampling methodology. For the height measurement, an 8 m long track was used, for individuals with heights greater than 2 m, a graduated pole. For the measurements of the caudal diameters at ground level, a pachymeter was used.

The total number of individuals sampled was distributed in size classes with height intervals, according to Tanner (1983) and Schmitt (2005): 0 to 0.8m (Class 1), > 0.8 to 1.6m (Class 2), > 1.6 to 2.4m (Class 3), > 2.4 to 3.2m (Class 4), > 3.2 to 4.0m (Class 5), > 4.0 to 4.8m (Class 6), > 4.8 to 5.6m (Class 7), > 5.6 to 6.4m (Class 8).

In the analysis of the spatial distribution, the Morisita index (IM) ( $IM = q \times \sum n(n-1) / N(N-1)$ ) was used, where q: number of plots sampled; n: and N (total number of individuals sampled) and the calculation of variance/mean ratio (R) (KREBS, 1989). Statistical significance was verified by the *Chi-squared* test ( $X^2$ ) ( $X^2 = SS/X$ , where SS:  $(n-1)(s^2)$ , n: number of plots studied,  $s^2$ : variance of number of individuals, X: mean number of individuals). IM and R values less than 1.0 indicate random distribution, equal to 1 uniform distribution and greater than 1 pooled distribution.

### III. RESULTS AND DISCUSSION

A total of 159 individuals of *Cyathea delgadii* were sampled in the two study areas. In the Milagre Village/Matões city, 120 individuals were sampled in the seven plots, equivalent to 2100 m<sup>2</sup>, with an average of 17 individuals per plots. The number of

individuals ranged from one to 33 in the sampled plots. In the

Pedras Village/municipality of São João do Sóter, 39 individuals were sampled in six plots, of the seven sampled, the population occupies the equivalent of 1800 m<sup>2</sup> of the study area, with a mean of 6.7 individuals per plots. The number of individuals ranged from four to 13 in the sampled plots (Figure 3). According to Harper (1990), one of the factors that determine the number of individuals in a population is the number of habitable sites, the resources available in the environment, numbers of germinated diaspores and the number of individuals in the reproductive phase. In the study areas, groupings of individuals of *Cyathea delgadii* were observed only in specific places, occurring in abundance in areas with greater availability of humid sites and with moderate canopy cover.

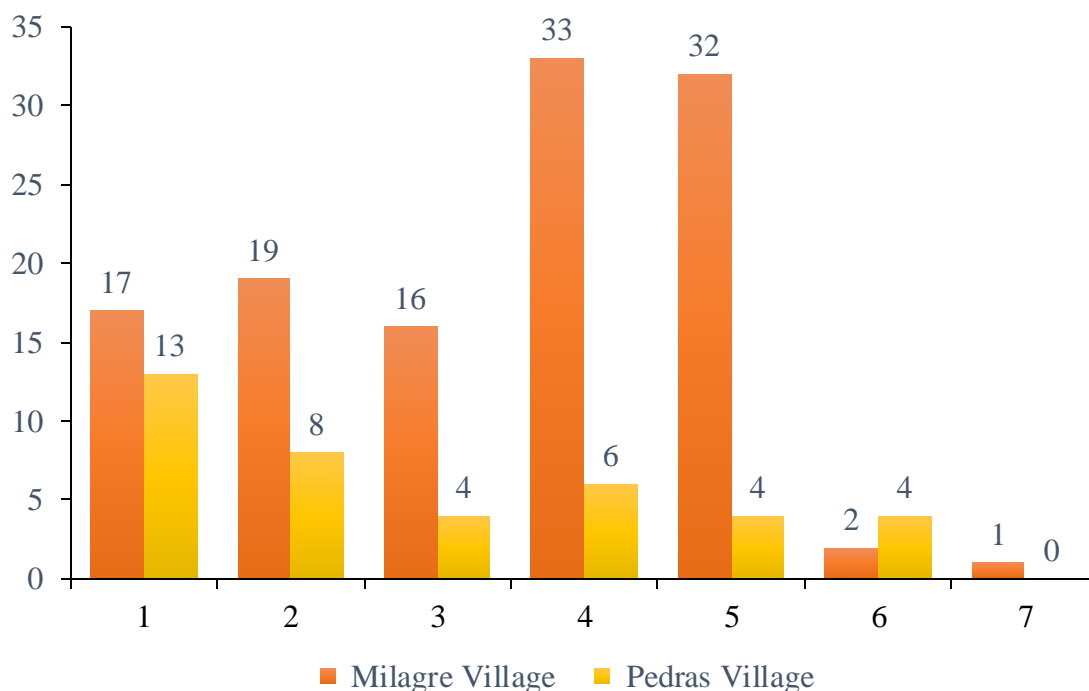


Fig.3: Number of *Cyathea delgadii* individuals by plots in the study areas, Maranhão / Brazil.

The behavior of the two populations of *Cyathea delgadii* is presented in aggregate form, confirmed by the Morisita index, as well as by the variance/mean ratio calculation

(Table 1). Statistical significance was verified using the *Chi-squared* values for the variance/mean ratio, as shown in the Table.

Table 1: Spatial distribution of *Cyathea delgadii* in the municipality of Matões/Milagre Village and in the municipality of São João do Sóter/Pedras Village in the state of Maranhão/Brazil. R: variance /mean; I.M.: Morisita Index; df.: Degrees of freedom.

Area	Index	Values	Spatial distribution	df
Milagre Village	R	9.400*	Aggregated	6
	I.M	1.424*	Aggregated	6
Pedras Village	R	1.954*	Aggregated	6
	I.M.	1.126*	Aggregated	6

\* values greater than 1.0 indicate an aggregated distribution

The tabulated values indicate that the population of *Cyathea delgadii* in the sampled units of Milagre Village Matões presents a higher aggregation pattern than the population sampled in the Pedras Village/São João do Sóter, which probably should be related to the structure of the areas. The population of *Cyathea delgadii* of Milagre Village/Matões shows a high frequency of the species due to the greater availability of moist and semi-shaded sites and being at a considerable distance from the anthropized fragments.

For the individuals of *Cyathea delgadii*, as well as for many species of arborescent ferns, the dispersion of spores is an important factor for their spatial distribution. Wolf et al. (2001), points out that easily the spores of the ferns can be dispersed by the wind at long distance, but Rosseto et al. (2005), states that plant species in which their diaspores are dispersed by the wind their distribution pattern presents in a random way, different from that found for *Cyathea delgadii*.

There are species of ferns that, by means of basal buds, form stolons, developing new individuals, reproducing themselves through ramifications of subterranean rhizomes (FERNANDES, 1997; LANGE and BRAINS, 2004). The populations of *Cyathea delgadii* in the studied areas compose a densification of young plants close to adult individuals in appropriate microhabitats for their development, suggesting that their reproduction can be carried out by ramifications of subterranean rhizomes, which may explain the pattern found and explain the difference to the suggestion of Rosseto et al. (2005). According to Begon et al. (2006), the aggregate distribution is due to conditions favorable to

the reproduction and survival of individuals, but other factors may influence this pattern of distribution, be they biotic, abiotic and/or anthropic (KERSHAW, 1973; MUELLER-DOMBOIS, ELLENBERG, 1974; BARBOUR et al., 1987).

According to the descriptive analysis of the data, the minimum heights found in the areas of the Milagre/Matões Village and the Pedras Village/São João do Sóter respectively were 1.5 and 0.05 m, and the maximum of 6.1 and 2.1. The mean height was 1.2 m in the Milagre Village/Matões and 0.62 m in the Pedras Village/ São João do Sóter, results different from those reported by Schmitt and Windisch (2007), that present a mean height of 3.6 m.

The heights of the individuals were distributed in eight size classes. The two populations had the highest number of individuals in class 1, where Milagre Village had a total of 50 individuals and Pedras Village presented 30 individuals, followed by class 2 with 33 individuals in Milagre Village and 7 individuals in Pedras, Village Class 3, 25 and two individuals in the Milagre and Pedras Villages, respectively, in Class 4 the Populations Milagre Village presented eight individuals and no individual to the Pedras village and Classes 5, 6, 7, and 8 were distributed with only one individual in the Milagre Village and in the Pedras Village did not present individuals (Figure 4). The individuals are concentrated in the classes of lower height, evidencing that the population is growing, guaranteeing the maintenance of the population's survival (ANTONINI; NUNES-FREITAS, 2004).

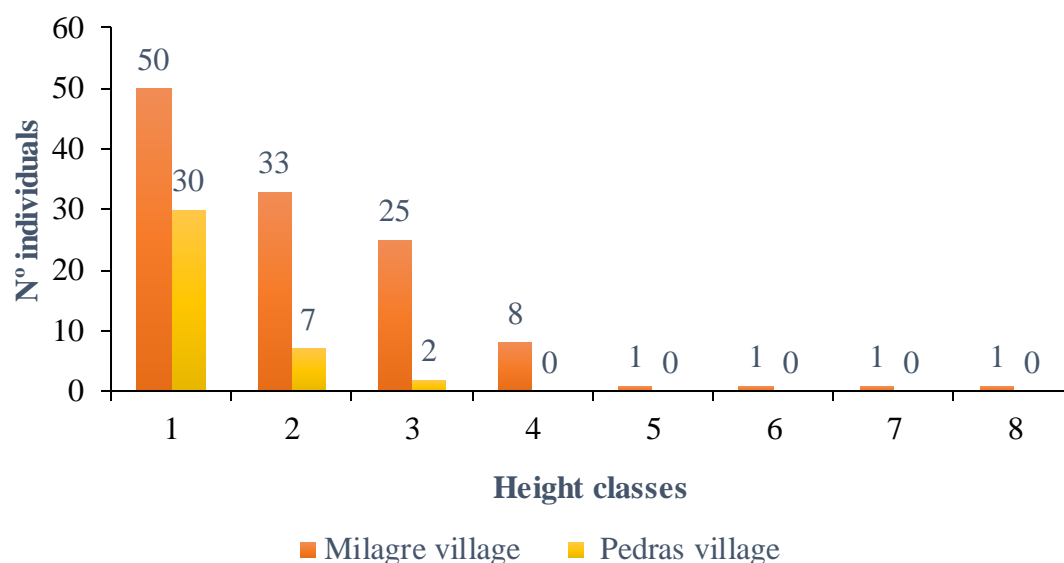


Fig.4: Distribution in height classes of the populations of *Cyathea delgadii* in the Municipality of Matões/Milagre Village and in the municipality of São João do Sóter/ Pedras Village in the State of Maranhão. Class 1:> 0-0,8m; Class 2:> 0,8a1,6m; Class 3:> 1.6 to 2.4m; Class 4:> 2.4 to 3.2m; Class 5:> 3.2 to 4m; Class 6:> 4 to 4.8m; Class 7:> 4.8 to 5.6m and Class 8:> 5.6m.

#### IV. CONCLUSION

The populations presented an aggregate distribution, thus, the data presented in this study provided basic and pioneering information for the management and preservation of this tree fern species in the East of Cerrado, Maranhão, in the Brazilian Northeast. It is expected that other researches will be carried out in the areas of studies to complement the presented results, such as anatomical studies and phenological behavior of the species, as well as, abiotic factors studies (soil analysis, soil water level, among others), since these studies will provide information on the development of the population in relation to the factors that surround them. Finally, the research contributed to the knowledge of the population structure of *Cyathea delgadii*, as well as its geographic distribution, since it had no record of occurrence for Maranhão.

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