

Association of Anuran to *Cyathea delgadii* Sternb. (Cyatheaceae) in Cerrado from Brazil

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Abstract: The species of *Cyathea delgadii* Sternb. presents potential interaction with the flora and fauna, especially with the anuran fauna. Thus, the research aimed to verify the relationship between anuran amphibians and *C. delgadii* fern in two fragments in the Brazilian Cerrado. The method used was active collection. Eight species of anuran amphibians belonging to three families were recorded. Hylidae was the most representative, with six species, followed by Bufonidae and Leptodactylidae, which presented only one species each. Due to the lack of specific terms on species of anurans associated with arborescent ferns, especially with *C. delgadii*, the terms “*samambaicolous*” and “*samambaigenous*” were created, to guide future research that aims to know the ecology of anurans associated with ferns. For the anurans that use the ferns to shelter or for foraging activities, they will be called “*samambaicolous*” species, while the anuran species that use the ferns for breeding purposes will be called “*samambaigenous*”.

Keywords: *Samambaicolous*, *Samambaigenous*, *Anuran fauna*, *Ferns*.

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I. Introduction

The ferns, according with¹ present a potential of interactions with different groups of animals, although their life cycle is independent of the fauna as pollinating or dispersing agents.

Although of great morphological variation, with herbaceous and arborescent individuals², the arborescent ferns interact perfectly with the flora and fauna, since their structures are used as a substrate for the development of bryophytes, epiphytic ferns and orchids, well as for different species of animals and fungi, thus noting its importance in environmental balance^{3,4,5 and 6}.

In Brazil, the families Cyatheaceae and Dicksoniaceae are the most representative, since they encompass most arborescent ferns⁷. Cyatheaceae have four genera, to know: *Alsophila*, *Cnemidaria*, *Sphaeropteris* and *Cyathea*⁸, among the species of the genus *Cyathea*, is *C. delgadii* Sternb. This species is associated with the Semideciduous Forests, in humid sites and floodplain⁹.

Most species at some stage of their life cycle, according to¹⁰, need to integrate into at least one interspecific interaction. These interactions are of fundamental importance to the natural balance of an ecosystem¹¹.

In the world, about 6,882 species of anurans are known¹², these to the Brazil are registered 988 species, being the country with the greatest diversity and richness of this animal group^{13,14}.

Innumerable species of anurans use vegetables to shelter, foraging activities and for breeding purposes^{15,16}. Anurans have a relevant control in the density of plant predators and have a role in regulating the nutrient dynamics of the Forest^{17,18}. The loss of certain plants disfavours the occurrence of some species of this group¹⁹, since they do not occupy the total number of plants available in the areas²⁰, as the selection of the plants by these animals^{21,22} is associated with morphological variations of plants^{23,24,25 and 26}.

Although there are studies about the anuran fauna of Maranhão, there are no works that analyze exclusively the composition of anurans associated with the arborescent ferns, especially the Cyatheaceae. Due to the intense explorations in the Brazilian Cerrado, it is of particular importance to the realization of studies that reflect in the ecology of certain groups of animals and vegetables, for the purpose of subsidizing management plans. To this end, the study aimed to verify the relationship between anuran amphibians and the *C. delgadii* fern in two Cerrado fragments of Maranhão/Brazil.

II. Material and Methods

Study area

The study area are localized in East from Maranhão, in municipalities of São João do Sóter, in Pedras Village (04°58'43,98" S and 43°36'58" W) and the municipality of Matões, in Milagre Village (05°36'04,08" S e 43°11'56,79" W) (figure 1). The area are forest remaining, with semideciduous forest and present physiognomies belonging to the Cerrado domain.

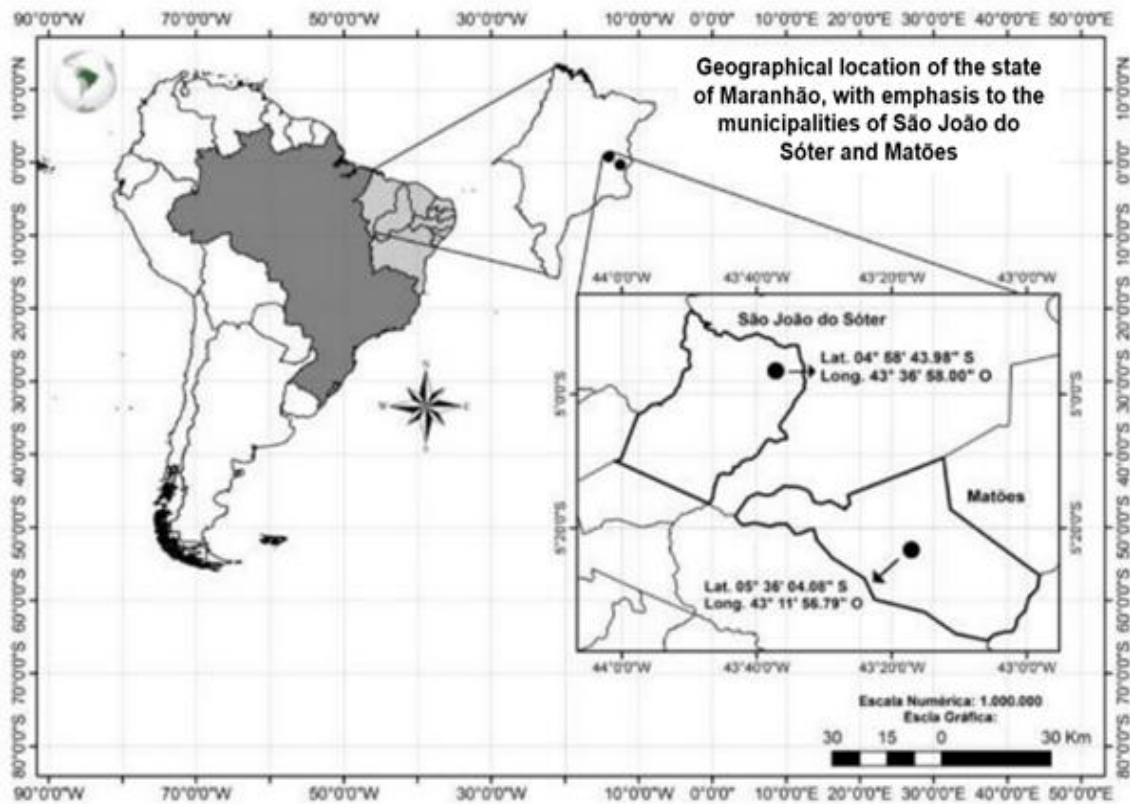


Figure 1. Location of study areas, in detail the state of Maranhão/Brazil and the municipalities of São João do Sóter and Matões. **Organization:** SILVA, W. F. N. 2016.



Figure 2. Village of Milagre/Matões, Maranhão, Brazil. **A and B)** *Cyathea delgadii* at the edge of the creek. **Photos:** SILVA, D.L.S., 2016



Figure 3. Pedras Village/São João do Sóter, Maranhão, Brazil. **A e B)** *Cyathea delgadii* on the bank of the creek. **Photos:** SILVA, D.L.S., 2016.

Amostragem delimitada

The anuran fauna collections associated with *C. delgadii* were carried out between August and October 2015, with monthly expeditions lasting an average of three days. In the study areas, 07 (Milagres Village) and 06 (Pedras Village) plots of 300 m² (30x10m), the drainage line of the watercourse was installed parallel with 20 m inter-distancing, in which all individuals from *C. delgadii* (Figure 4). In each plot, was used collect method active "auditory, visual and occasional encounters"^{27,28} with censuses performed at night by two people, in which the microhabitats of the associated anurans to *C. delgadii*.

The specimens were taken by hand using flashlights. The animals captured during the active searches were recorded in a field notebook, with the observation of the main characteristics specific to each individual, such as size, habitat, time, date and activity of each specimen. Following the observations, the amphibians were recorded in different photos representing the ventral and dorsal part to aid the identification of the animal and later returned to their environment, without sacrifice, being identified in the field, a method known as capture and release^{27,28,29 and 30}.

The sampling adequacy was analyzed through the species accumulation curve and the similarity dendrogram was obtained with the aid of the R.

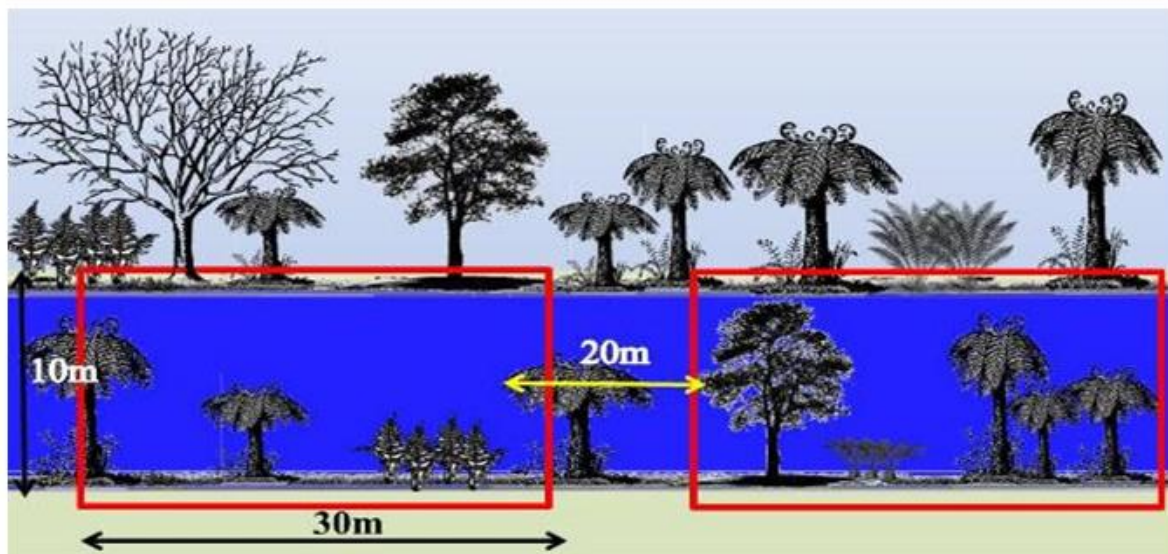


Figure 4. Illustrative scheme of the layout of the plots in the drainage line of the study areas, in Maranhão/Brazil. **Organization:** SILVA, D.L.S., 2016.

III. Results and Discussion

Were recorded eight species of anuran amphibians belonging to three families (Figure 5). Hylidae was the most representative family, with six species (75%), while Bufonidae and Leptodactylidae presented anonly species each (12.5%).

The most constant species associated with *C. delgadii* was *Dendropsophus minutus* (Peters, 1872), since of the seven plots of Milagre Village/Matões municipality was recorded in three, and of the six plots of the Pedras Village/municipality of São João do Sóter was collected in two plots (Table 1).

The accumulation curve of the species not showed a stabilization in the plots installed in the two study areas, demonstrating that the sampling effort was insufficient to record the abundance of anuran species associated with *C. delgadii*, necessitating larger numbers of collection campaigns achieve sample adequacy (Figure 6).

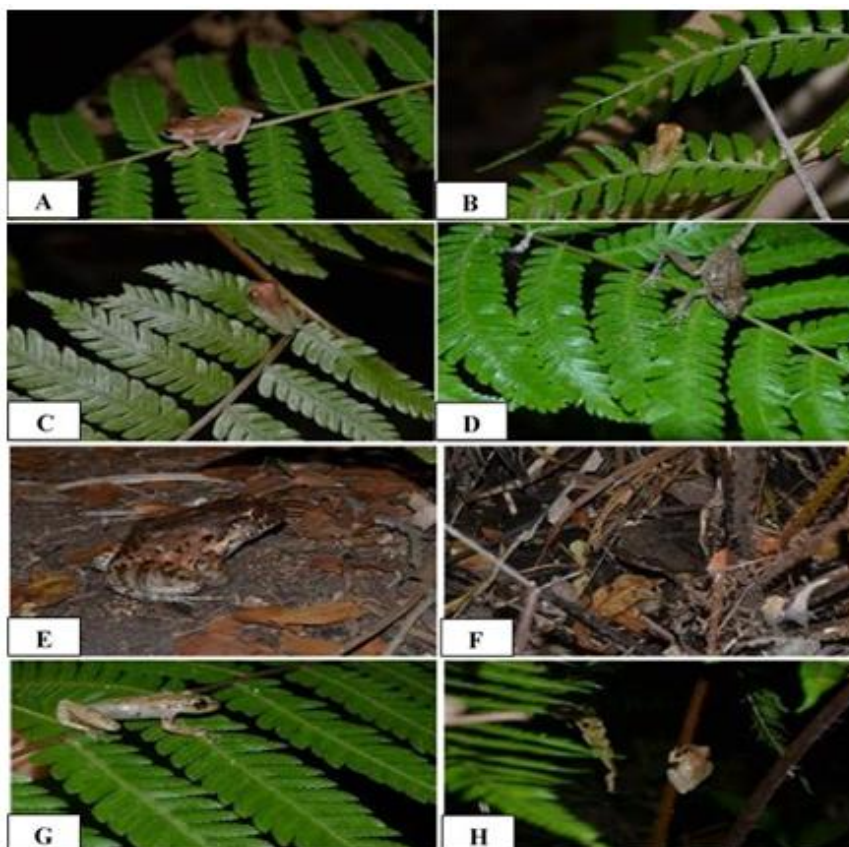


Figure 5. Species of anuran amphibians associated to *Cyathea delgadii* in two Cerrado fragments from Maranhão state/Brazil. **A)** *Dendropsophus minutus* (Peters, 1872); **B)** *Hysiboas punctatus* (Schneider, 1799); **C)** *Dendropsophus decipiens* (Lutz, 1925); **D)** *Scinax nebulosus* (Spix, 1824); **E)** *Leptodactylus vastus* (Lutz, 1930); **F)** *Rhinella marina* (Linnaeus, 1758); **G)** *Scinax x-signatus* (Spix, 1824); **H)** *Osteocephalus taurinus* (Steindachner, 1862). **Photos:** SILVA, D.L.S., 2016

Tabela 1. List of species of anuran amphibians in *Cyathea delgadii* found in the plots sampled in the two vegetation fragments of Cerrado do Maranhão/Brazil.

Family/Specie	Pedras Village (São João do Sóter)						Milagre Village (Matões)						
	01	02	03	04	05	06	07	08	09	10	11	12	13
Hylidae/ <i>Dendropsophus minutus</i>	1	1	0	0	0	0	1	1	1	0	0	0	0
Hylidae/ <i>Dendropsophus decipiens</i>	1	1	0	0	0	0	0	0	0	0	0	0	0
Hylidae/ <i>Hysiboas punctatus</i>	0	1	0	0	0	0	0	0	0	0	0	0	0
Hylidae/ <i>Scinax nebulosus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0
Hylidae/ <i>Scinax x-signatus</i>	0	0	0	0	0	0	0	0	0	0	0	1	0
Hylidae/ <i>Osteocephalus taurinus</i>	0	0	0	0	0	0	0	0	1	1	0	0	0
Bufonidae/ <i>Rhinella marina</i>	0	1	1	0	0	0	0	0	0	0	0	0	0
Leptodactylidae/ <i>Leptodactylus vastus</i>	0	0	0	1	0	0	0	0	1	0	0	0	0

Subtitle: (1) present; (0) absent.

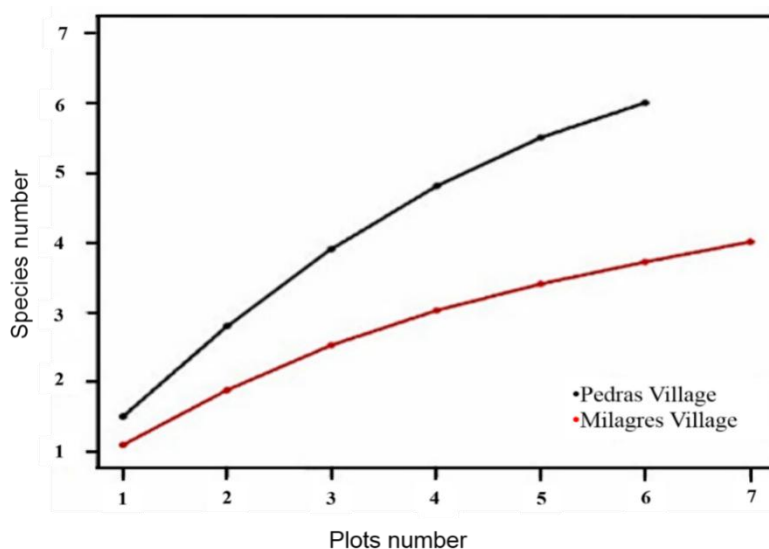


Figure 6. Curve of accumulation of *Cyathea delgadii* associated anurans species in the two study areas, Maranhão/Brazil.

The analysis of similarity revealed that, for the plots installed to register the anurans associated to *C. delgadii*, there was a qualitative differentiation, in which plots 4, 9 and 10 were grouped together, and in another branch plots 1, 2, 7 and 8 (Figure 7). The Plots 3 and 12 were the most dispersed in the analysis, in which plot 3 resembled the two clusters and plot 12 was isolated in the dendrogram, showing distinct from the others, being able to be highlighting the characteristics of the habitation sites of the species in the studied area.

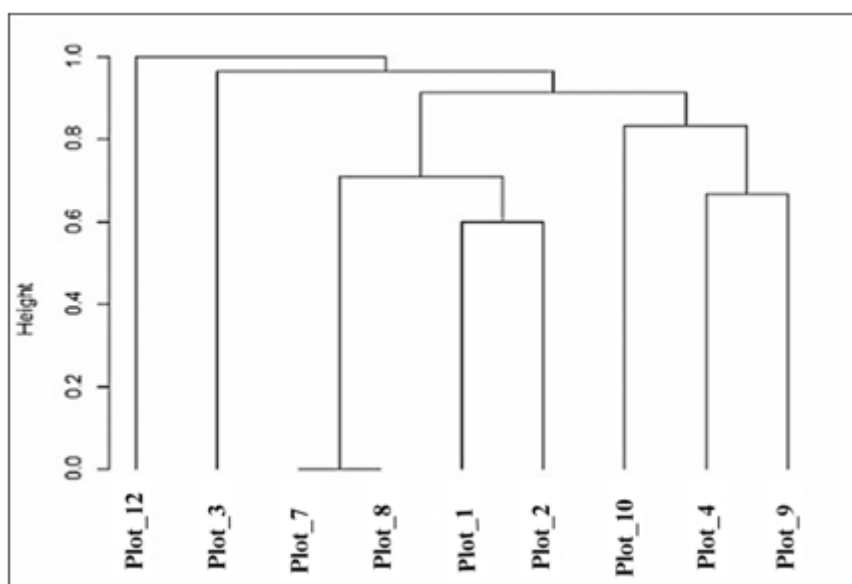


Figure 7. Jaccard similarity dendrogram of the composition of the anurans in the plots of the two study areas, Maranhão/Brazil.

The knowledge of the number of species of an area is the first step to know the diversity, being of paramount importance for ecological studies³¹. In Brazil, there is still little research about ecology of anurans, in view of the great specific richness of the group³², since studies of this nature are fundamental for conservation purposes³³.

In Brazil, studies about the importance of arboreal ferns, especially *C. delgadii* as microhabitats for anuran species are not documented, however, the research has observed the use of *C. delgadii* structures as nesting sites (at the apex of the caudice), feeding substrate (in the fronds) and shelter and/or refuge against predators (in the tangles of dried fronds and roots interlaces).

(Peixoto,1995)¹⁵, when investigating the associations between anurans and bromeliad, classified them in bromelicolous and bromeligenous, in which, the bromelicolous species, are anurans that are associated to bromeliads, but that reproduce in other places; and bromeligenous are species that depend of bromeliads to complement their life cycle.

With the purpose of guiding future ecological work on anurans associated with ferns, from this research, we classify here the species that use the ferns to house or for foraging activities as "**samambaicolous**", while the species of anurans that use the ferns for reproduction purposes will be called "**samambaigenous**".

From the cataloged species, it was observed that the specimens of the Hylidae family use *C. delgadii* structures for foraging and vocalization, and the interaction of insect predation on the *C. delgadii* fronds is perceptible. However, Bufonidae and Leptodactylidae species use the entanglements of *C. delgadii* roots for refuge and shelter, using them as a scar (Figure 8), known as occasional sowing species, since they have been observed in other vegetable sites.

As emphasized by³⁴, the anurans are opportunistic and generalist in their food habitat, being specialized in some groups^{35,36}. (Sabagh and Carvalho-e-Silva 2008)³⁷, discuss that Bufonidae are very generalist, attacking prey available in their environment. In addition, ^{35 and 36} affirm that these animals have an ant food preference. In the studies of³⁸, representatives of the Hylidae family present preference for arachnids and Hymenoptera, and³⁹ adds the insects, mainly of the order Diptera and Hemiptera. As for the diet of Leptodactylidae, they are considered non-specialists, feeding on arthropods, mainly spiders and orthopterans⁴⁰.

The association of the anurans with *C. delgadii* can be explained by the availability of resources that allow these activities, since a variety of arthropods use *C. delgadii* structures to perform vital activities and to complete their cycles, whether they are breeding, foraging and feeding.

Environmental disturbances in the two study areas are remarkable, as deforestation, burning and toxic waste are released into the watercourses by residents who use the streams to clean domestic utensils. These activities limit the supply of niches, resources and contribute to the decline of the wealth and abundance of anurans, and lacking the viable environments to perform their functions, the presence of *C. delgadii* contributes to the dynamics of occupation by environments appropriate to their activities.

Researching the relationships of species with their habitats contributes to understanding how ecosystem impacts reflect the dynamics of species occupation⁴⁰. According to⁴¹, the loss and destruction of habitats are responsible for the threat of extinction of about 30% of the species of this animal group.



Figure 8. Specimens of anurans using *Cyathea delgadii*. **A)** Bufonidae in rootinterlaces; **B, C and E)** Anurans in foraging and vocalization activities; **D)** Anuran able to prey on a Hemiptera; **Fand G)** Nesting of anurans.

Photos: SILVA, D.L.S., 2016.

IV. Conclusion

Anuran amphibians and *C. delgadii* fern in fragments of Cerrado do Maranhão/Brazil show the differences in the morphological structures of *C. delgadii*, which provide macro and micro environments for the anurans to perform their biological activities, the population densities of the studied plant species along the watercourses in the studied areas become the most abundant substrata in the areas and are therefore used by these species of anurans.

For the lack of specific terms about species of anurans associated with arborescent ferns, especially with *C. delgadii*, the terms “**samambaicolous**” and “**samambaigenous**” were created, to guide future works that aim to know the ecology of anurans associated with ferns. For the anurans that use the ferns to shelter or for foraging activities, they will be called “**samambaicolous**” species, while the anuran species that use the ferns for reproduction will be called “**samambaigenous**”.

Although there are gaps in information regarding the ecology of anurans associated with plants, the results presented here stand out as being pioneers. Thus, this research stimulates that future studies can be carried out with the intention of understanding the ecological roles of this animal group with the plants that interact in Cerrado areas in Brazil.

The direct and indirect anthropogenic action in the study areas should be minimized, as they alter the natural environments of the different species of flora and fauna present in the region. Thus, populations of *C. delgadii* present in the phytogeographical domain of Cerrado are important species for the maintenance of different species of anurans and other groups of vertebrates and invertebrates.

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