

## **Diversity of anura amphibians in an anthropic lake in the state of Paraíba, Brazil: distribution and temporal variation**

**Diversidade de anfíbios anuros em uma lagoa antropizada na Paraíba, Brasil: distribuição e variação temporal**

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### **Abstract**

The Caatinga is highly heterogeneous, many species being found in their regions. Much of anurofauna this area is commonly found in many open environments. In the present study both the diversity and the temporal occurrence of frogs were determined to Bela Vista Lagoon, located in the municipality of Cuité, Paraíba. 4 areas for sampling were marked, these being covered slowly by hiking. The naturalistic observations were conducted from May 2012 until April 2013. Methods of visual and auditory search were used to simultaneously capture and frequency of species. 6 frog species belonging to 4 genera were found distributed in three families: Bufonidae (2 species), Hylidae (2 species) and Leptodactylidae (2 species). Site 1 showed a wealth of three species, the other areas had a wealth equivalent of 5 species each. The anurofauna recorded high occupancy presented to water bodies and low associations zones altered by man. Nonparametric estimators, calculated for the 36 surveys for the pond Bela Vista, not reached its asymptote, but the Bootstrap model showed a tendency toward stabilization. Among the four sampled areas, Area 2 was the one with the highest diversity, areas 3 and 4 presented the lowest diversity, this fact being related to high dominance of species *Rinnella jimi*. Regarding the temporal distribution, amphibians showed up influenced by temperature and rainfall record for the region.

**keywords:** Anurofauna; Human action; Richness.

### **Resumo**

A Caatinga apresenta alta heterogeneidade, sendo encontradas várias espécies endêmicas em suas regiões. Grande parte da anurofauna dessa área é comumente encontrada em vários ambientes abertos. No presente estudo tanto a diversidade como a ocorrência temporal de anuros foram determinadas para a lagoa Bela Vista, localizada no município de Cuité, Paraíba. Foram demarcadas 4 áreas para as amostragens, sendo estas percorridas lentamente por caminhadas. As observações naturalísticas ocorreram no período de maio de 2012 até abril de 2013. Os métodos de busca visual e auditivo foram utilizados simultaneamente para captura a frequência das espécies. Foram encontradas 6 espécies de anuros, pertencentes a 4 gêneros, distribuídas em 3 famílias: Bufonidae (2 espécies), Hylidae (2 espécies) e Leptodactylidae (2 espécies). A área 1 apresentou uma riqueza de 3 espécies, as demais áreas tiveram uma riqueza equivalente de 5 espécies cada. A anurofauna registrada apresentou alta ocupação aos corpos d'água e baixa associações as zonas alteradas pelo homem. Os estimadores não paramétricos, calculados para as 36 vistorias para a lagoa Bela Vista, não atingiram sua assíntota, porém o modelo Bootstrap apresentou uma tendência à estabilização. Entre as 4 áreas amostradas, a área 2 foi a que apresentou a maior diversidade, as áreas 3 e 4 apresentaram as menores diversidades, estando esse fato relacionado a alta dominância da espécie *Rinnella jimi*. Em relação à distribuição temporal, os anfíbios anuros mostraram-se influenciados pela temperatura e a pluviometria registrada para região.

**Palavras-chave:** Anurofauna; Ação antrópica; Riqueza.

## Resumen

La Caatinga es muy heterogénea, con varias especies endémicas que se encuentran en sus regiones. Gran parte de la anurofauna en esta área se encuentra comúnmente en varios entornos abiertos. En el presente estudio se determinó tanto la diversidad como la ocurrencia temporal de anuros para la laguna Bela Vista, ubicada en el municipio de Cuité, Paraíba. Se delimitaron 4 áreas para muestreo, las cuales fueron recorridas lentamente por caminatas. Las observaciones naturalistas se llevaron a cabo entre mayo de 2012 y abril de 2013. Se utilizaron simultáneamente métodos de búsqueda visual y auditiva para capturar la frecuencia de las especies. Se encontraron seis especies de anuros, pertenecientes a 4 géneros, distribuidos en 3 familias: Bufonidae (2 especies), Hylidae (2 especies) y Leptodactylidae (2 especies). El área 1 tenía una riqueza de 3 especies, las otras áreas tenían una riqueza equivalente de 5 especies cada una. La anurofauna registrada mostró alta ocupación de cuerpos de agua y baja asociación con áreas alteradas por el hombre. Los estimadores no paramétricos, calculados para los 36 levantamientos para la laguna Bela Vista, no alcanzaron su asíntota, pero el modelo Bootstrap mostró una tendencia a la estabilización. Entre las 4 áreas muestreadas, el área 2 tuvo la mayor diversidad, las áreas 3 y 4 tuvieron la menor diversidad, y este hecho está relacionado con la alta dominancia de la especie *Rinnella jimi*. En cuanto a la distribución temporal, los anfibios anuros se vieron influenciados por la temperatura y las precipitaciones registradas para la región.

**Palabras clave:** Anurofauna; Acción antrópica; Riqueza.

## 1. Introduction

Amphibians are the most threatened vertebrates on the planet (Hoffmann et al. 2010). Lately a marked slope has been observed in their populational structures in tropical regions, extremely serious situation (Rovito et al. 2009, D'avilla et al. 2020). Some authors (Curcio et al. 2010, D'avilla et al. 2020) have mentioned in their work a serious populational decline of amphibians in Brazil. The reduction is related to: increased ultraviolet radiation, global warming, pollution and, change and destruction of natural areas (Silvano & Segalla 2005).

Currently, 7,423 amphibian species are registered in the world (Frost 2021), in Brazil the greatest diversity: 1188 species (Sbh 2021). However it holds a high rate of endemism (Sbh 2021). Anurans, in relation to their distribution, are widely diverse and distributed worldwide, these organisms have a permeable skin and mostly have two stages in their life cycle, (Becker et al. 2007). Given this set of features frogs are considered to be an excellent model for ecological studies (Navas & Otani 2007); since the main purpose of these is the relationship between groups of organisms and the environment (Begon et al. 2007, 2009), making them targets of interests and concerns (Hoffmann et al. 2010, Chaves et al. 2021, Carneiro et al. 2021).

Despite the level of knowledgement of the caatinga biome, have increased in recent years in terms of conservation and biodiversity, thanks to several diagnoses produced by the MMA and partners (MMA 2013), the total data number of frog species in the biome is still limited to the works such as Robinson et al. (2003). Thus, despite of the impossibility to describe, clearly, all the processes that determine the structure of a community (Ernst & Rodel 2005, Gotelli et al. 2009). It may be mentioned as some of them: the atmosphere (Duarte et al. 2012, Conte & Rossa-feres 2006); the characteristics of the habitat (Cushman 2006); biotic processes as the dispersion (Pilliod et al. 2010, Nori et al. 2011), and pollution (Carvalho & second Izecksohn-e-Silva 2001). Both factors will lead to differences in the distribution and diversity (Leibold et al. 2004).

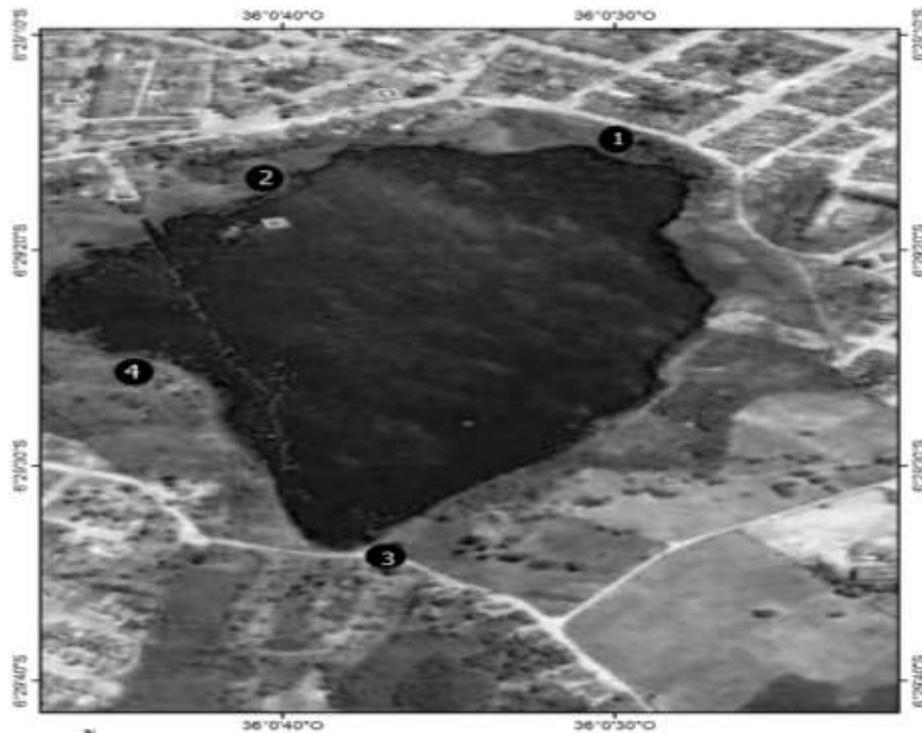
The way of how species will distribute in the environment is valuable for many studies including the conservation of habitat (Dajoz 2005, D'avilla et al. 2020). Researches that are based on observations and sampling in the environment should continue, because only then natural patterns are detected and assumptions continue to be performed (Romero et al. 2010, Thome et al. 2010). Studies on, community structure of frogs, due to high vulnerability they have to anthropogenic factors and seasonal variations, are also relevant (Vitt & Caldwell 2001, Chan et al. 2022). Therefore, the present study aims to determine the composition and distribution of anuran fauna in Bela Vista lake, CUIITE-PB. As well as describing its diversity because of variations in the environment.

## 2. Material and Methods

### Area of study

The present study was conducted in the town of CUITÉ-PB ( $06^{\circ} 29'06''$  S and  $36^{\circ} 09'25''$  W), in the state of Paraíba, which is located in the west microregion called Curimataú and in the middle of an area called Agreste Paraibano. It has a total area of 741,840 km<sup>2</sup>, and an estimated population of 19,978 inhabitants (IBGE 2010) population. It is inserted into the unit geoenvironmental Borborema Plateau where the vegetation consists of deciduous forests to sub-deciduous (CPRN 2005). The climate is hot and dry and the temperature ranges from  $17^{\circ}$  to  $28^{\circ}$  C, the rainfall rate is 916.30 mm and the monthly average is 76.35 mm, the relative humidity of the surrounding air is of 70%, Figure 1, (Costa 2005).

**Figure 1.** Map with the aerial view of the Bela Vista lagoon and the demarcation of the 4 sampled areas.



Source: Personal archive.

Bela Vista lake has a water surface area of 136,324.38 m<sup>2</sup> (A.E. Cuité cityhall/ Infrastructure Department, personal communication, 2013). The drainage pattern is dendritic and watercourses of the pond have an intermittent regime. Effluent discharges are found in several spots, as well as sites with a high degree of wear by anthropogenic factors. The water is unfit for human and animal use for bathing, and fishing practices such as irrigation and vegetables. The vegetation consists of bush and arboreal caatinga and in many places around the pond there is a use of land for the extensive agricultural practice (Junior 2011).

In order to conduct the research of the anuran species, Bela Vista lake was demarcated into four areas with the aid of a GPS (Figure 1).

Area 1 ( $S 06^{\circ} 29' 12.4''$ ,  $H 36^{\circ} 09'06.6''$ ) has several streams near the water, with several local landfills, presence of pastures for livestock and a particular perimeter used as cattle corrals. The vegetation is represented by the following families: Caparidaceae, Leguminosae, Musaceae, Malvaceae, Portulacaceae, Poaceae, Solanaceae,

Area 2 (S 06 ° 29'12.1 "H 036 ° 09 '08.3") is characterized by the presence of iselbergs on points with buildings and residences and effluent recede in places near the lake. Botanical specimens that constitute this point are: Anacardiaceae and Cyperaceae, Caparidaceae, Leguminoseae, Musaceae, Malvaceae, Portulacacea, Poaceae, Solanaceae.

Area 3 (S 06 ° 29'31.7 "36 ° 09'08.2 H") has the edge of the lagoon partially surrounded by a dense tree formation, shrubs and herbaceous a common feature of Caatinga biome. Plant families that make up the area are: Anacardiaceae, Cactaceae Cyperaceae, Leguminoseae, Malvaceae, Poaceae, Sapinidaceae.

Area 4 (S 06 ° 29'23.5 "36 ° 09'14.1 H") is used almost entirely for production of pastures, there are effluents that flow both in the pastures as well as in the pond. A strong smell of sewer was felt in the area. The families of plants found at this point are: Anacardiaceae, Araceae, Cactaceae, Caparidaceae, Leguminoseae, Poaceae, Portulacaceae, Solanaceae.

### **Data collecting**

Data collection in nature followed the procedures for obtaining quantitative and qualitative data to verify the spatial and temporal distribution of anurans (Maffei et al. 2011). Samplings were performed monthly, within a period of three days, from May 2012 to April 2013. Months with the highest levels of rainfall were: May to June (2012), and February to April (2013). From August 2012 to January 2013, the drought was evident for the region. The collecting would start at approximately 6 P.M (with twilight) and end around 10 P.M. 36 visits were made, split into 12 monthly field expeditions, totalizing about 144 hours of sampling effort. The visual and auditory method were used for both naturalistic observations (Crump & Scott 1994, Zimmerman 1994).

The areas demarcated for the collections were walked through slowly, and materials such as: flashlights, pulsars and field notebook, were used in the registration of individuals. The trajectory of was not performed linearly since individuals could be found both in the central areas as well as outside the margins of the pond (Rossa-Feres & Jim 2001, Maffei et al. 2011). In order to check the use of the environment by species, the location of their habitats was registered (streams, peridomiciles mirror and puddles of water). Frogs found during displacements (roads and some urban districts), on paths which served as access to other areas, were not recorded.

### **Procedure in the laboratory**

Voucher species were collected, added to plastic bags with water, place inside Styrofoam boxes and transported to the Zoology Laboratory at the Federal University of Campina Grande - UFCG, CUIE campus. In the laby, the animals were photographed, anesthetized with lidocaine hydrochloride, and after both were unconscious, were killed by hypothermia, where there was a rapid cooling to 4 ° C, reducing its metabolism. Thus, following the standard guidelines for the practice of Euthanasia by CONCEA (National Council for the Control of Animal Experimentation). Each subject received a numbered label that was posted on its body. After identification, the specimens were prepared and fixed with formaldehyde solution 10%. After 24 hours, they were placed inside vials which contained 70% alcohol (McDiarmid. 1994). The specimens were included in the Teaching of Vertebrate Collection, part of the amphibians of this lab. Identification followed the naming pattern of Frost (2013). The collection of specimens was conducted with the permission of the Chico Mendes Institute for Biodiversity Conservation - ICMBio / Number: 23024-2, due to its scientific purposes.

### **Data Analysis**

The constancy of rate of occurrence of Dajos (1972) was used, where the species are considered: common ( $C > 50\%$ ), relatively common ( $25\% \leq C \leq 50\%$ ) and occasional ( $C < 25\%$ ). The principal coordinates analysis (PCO), where the

eigenvalues are taken from a distance or similarity matrix (Manly 1994), was used for micro habitats. Prime + 6.0 PERMANOVA program was used to perform these calculations.

The sampling effort was assessed with species accumulation curves obtained from data of presence and absence of species, in each month, from a total of 36 visits. Nonparametric first order models, Bootstrap and Jackknife, were used. The graphical curves were generated by EstimateS 1000 randomizations 9.1.0 program (Cowell 2005).

The diversity index of Shannon-Wiener and Pielou evenness (Krebs 1999) were calculated for each area. The statistical software Prime PERMANOVA + 6.0 was used to do so. The relative abundance, which is the percentage of the number of individuals of a species relative to the total percentage of the number of other species (Magurran 1988), was calculated for each of the areas studied. Absolute abundance of species between the sampling areas was recorded. The temporal variation of species was made from the principal component analysis (PCA), which is indicated for measurement sets that are linearly correlated (Manly 1994). The environmental parameters were yielded by (AESAs- PB), Executive Agency of Water Management of the State of Paraíba, data were generated from Prime + 6.0 PERMANOVA program.

### 3. Results

Six species of anura amphibians, belonging to 4 genera, distributed in three families, were recorded Bufonidae (two species), Hylidae (two species) and Leptodactylidae (two species) (Table 1). Among the six species recorded, two were considered common ( $C > 50\%$ ), which were observed in more than 16 visits: *Rhinella jimi* (Stevaux, 2003) and *Leptodactylus macrosternum* (Miranda-Ribeiro 1926). The species *Hypsiboas crepitans* (Wied-Neuwied 1824) was considered relatively common ( $25\% \leq C \leq 50\%$ ), observed between 9 and 16 visits, and three species were occasional ( $C < 25\%$ ), *Scinax x-signatus* (Spix 1824), *Rhinella granulosa* (Spix 1824), *Leptodactylus vastus* (Lutz 1930); observed in less than nine visits. Among the areas covered, the one that showed a low number of species was the first area, with three individuals, the others were quite equivalent with five species, each.

**Table 1.** List of anuran species recorded for the Bela Vista lagoon in the municipality of Cuité PB and their richness by area. FC= Frequency of occurrence, IC= constancy index- C (Constant), RC (relatively constant), O (Occasional). A1= Area 1, A2= Area 2, A3= Area 3, A4= Area 4.

Family / species	FC	IC	A 1	A 2	A 3	A 4
<b>Bufonidae</b>						
<i>Rhinella granulosa</i> (Spix, 1824)	0,16%	O	0	1	1	1
<i>Rhinella jimi</i> (Stevaux, 2002)	100%	C	1	1	1	1
<b>Hylidae</b>						
<i>Hypsiboas crepitans</i> (Wied-Neuwied, 1824)	33,30%	RC	1	1	1	1
<i>Scinax x-signatus</i> (Spix, 1824)	0,02%	O	0	0	0	1
<b>Leptodactylidae</b>						
<i>Leptodactylus</i>						
<i>macrosternum</i> (Miranda-Ribeiro, 1926)	97,20%	C	1	1	1	1
<i>Leptodactylus vastus</i> (A. Lutz, 1930)	0,50%	O	0	1	1	0
<b>Total richness</b>			3	5	5	5

Source: Personal archive.

In the analysis of the uses of habitats by the anura fauna studied, it was found that the first axis corresponded to 62.81% of work in the year. The cumulative values of the first and second axis answered satisfactorily using microhabitats for specimens recorded 90.97% (Table 2). The streams on the first axis (-86.081) and the water surface (-21.952) mirror in the second, had the highest values for the use of micro-habitat for frogs in lake Bela Vista, while for the use of surrounding habitats it showed up a low ratio in the analyzed axis (Table 3).

**Table.2.** PCO analysis with the values of the individual and cumulative axes for the use of micro-habitat by the anurofauna records in the Bela Vista lagoon.

Axes	Eigenvalue	Individual%	Cumulative%
1	940,1	62,81	62,81
2	421,56	28,16	90,97
3	135,13	9,03	100

Source: Personal archive.

**Table.3.** PCO analysis with the values of the micro-habitats that had the greatest influence on the anurofauna recorded in the Bela Vista lagoon.

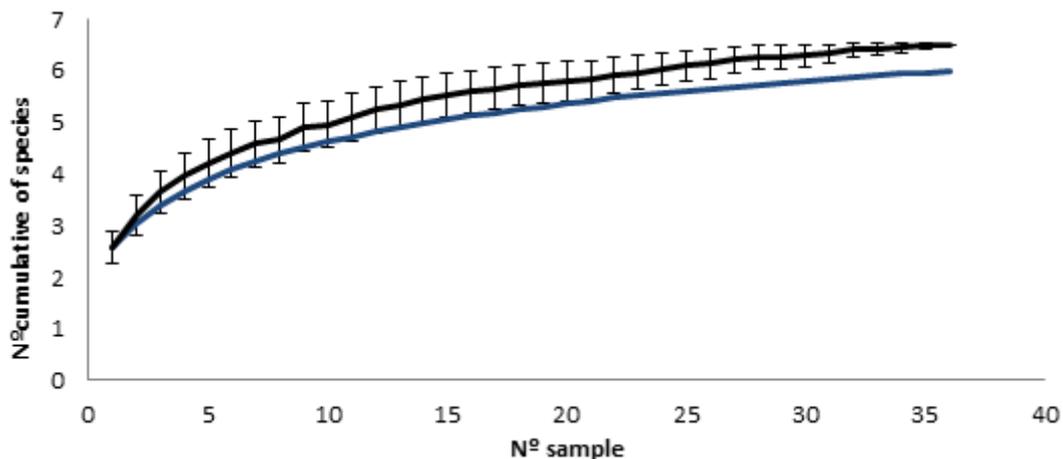
Groups	Axes 1	Axes 2	Axes 3
Corregos	-86,081	15,086	42,123
Domicile	-13,788	-13,728	36,898
Water mirror	25,777	-21,952	2,072
puddles	-33,812	0,83684	-99,741

Source: Personal archive.

### Estimates of wealth

The cumulative curve of species observed and estimated for 36 visits through 1 year of collection, using nonparametric method (Bootstrap I), did not reach its asymptote. However, the Bootstrap estimator had a tendency to stabilize. The estimated richness was 6.49 for (Bootstrap). Despite the overestimation, the result shown between model in species richness at the end of the visits suggest that most species were recorded during the study (Figures 2).

**Figure 2.** Cumulative curves of observed (blue) and estimated (black) species by the non-parametric Bootstrap model with vertical bars indicating the standard deviations for the 36 days of sampling.



Source: Personal archive.

### Diversity

The Shannon Wiener diversity ( $H'$ ) and Pielou evenness  $J'$  lagoon Bela Vista was  $H' = 0.66$  and  $J' = 0.60$  for cluster 1,  $H' = 0.82$  and  $J' = 0.51$  for area 2,  $H' = 0.48$  and  $J' = 0.30$  for area 3,  $H' = 0.57$  and  $J' = 0.35$  for area 4.

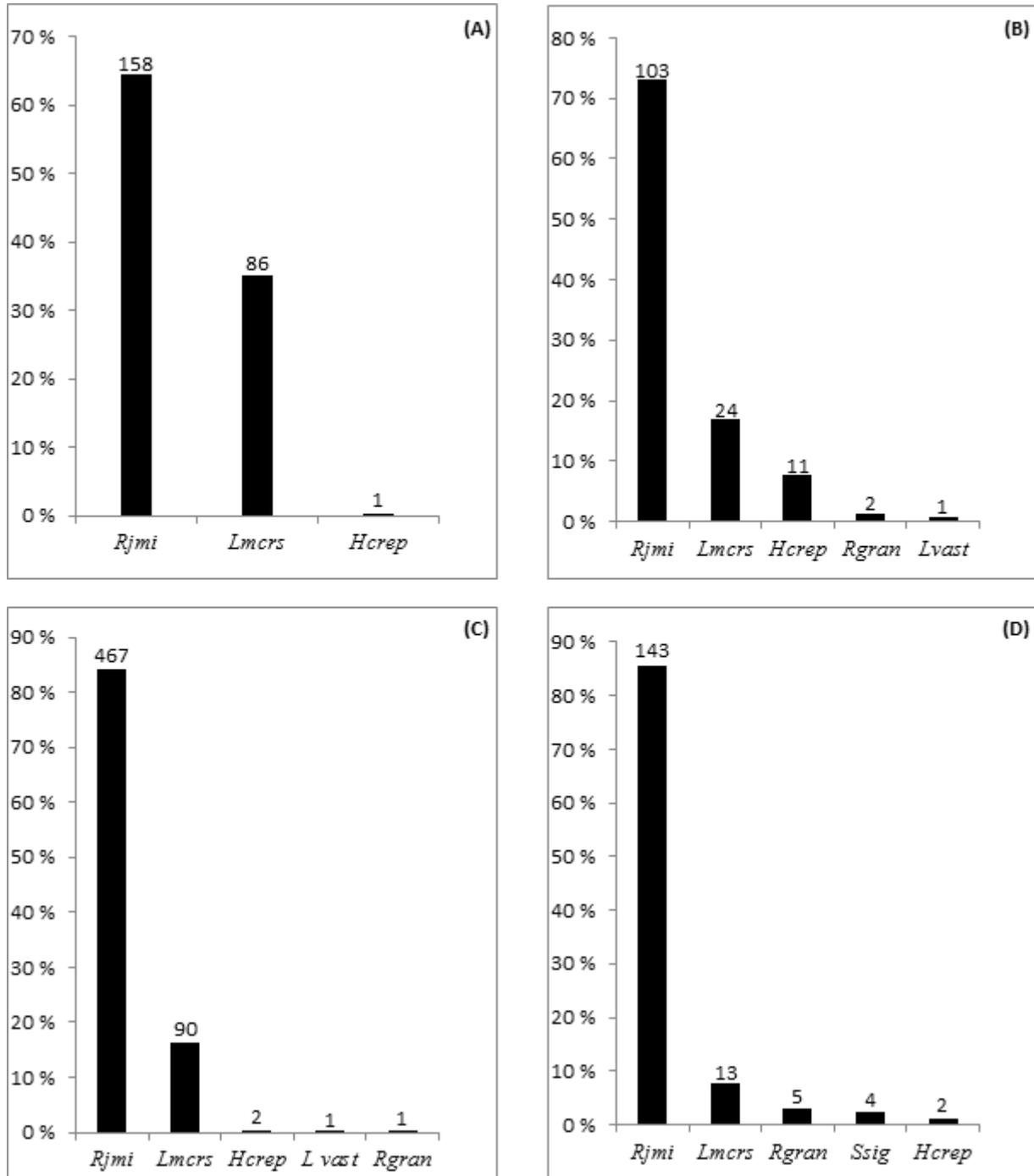
Area 1 was the site which had the highest equitabilites, this fact being related to lower dominance of *Rinnella jimi* 64.4%. Despite the wealth of areas 2, 3 and 4 being equal, and the greater abundance of species having occurred in area 3, the lowest diversities and equitabilites registered areas for areas 3 and are linked to larger species *Rinnella jimi* with 83.2 % and 85.6% respectively. Area 2 had the highest diversity with  $H' = 0.82$  and a considerable  $J' = 0.51$ . The number of individuals in areas ranged from 141 to 561 sighted frogs (Table 4). The relative and absolute abundance calculated for the four areas of study highlight the high dominance that *Rinnella jimi* species has on other species. (Figure 3).

**Table 4.** Diversity of anuran amphibians in the 4 areas observed for the Bela Vista Cuité lake-PB. Shannon Wiener diversity ( $H'$ ), Pielou evenness ( $J'$ ), Number of individuals, dominant species, observed dominance and richness.

	Area 1	Area 2	Area 3	Area 4
<b>Shannon Wiener diversity (<math>H'</math>)</b>	0,66	0,82	0,48	0,57
<b>Pielou evenness (<math>J'</math>)</b>	0,60	0,51	0,30	0,35
<b>Number of individuals</b>	245	141	561	167
<b>dominant species</b>	<i>R.jimi</i>	<i>R.jimi</i>	<i>R.jimi</i>	<i>R.jimi</i>
<b>Observed dominance</b>	64,40%	73,00%	83,20%	85,60%
<b>Richness</b>	3	5	5	5

Source: Personal archive.

**Figure 3.** Relative and absolute abundance for the sampled areas of the Bela vista lagoon. Relative abundance is represented by bars (green) and the values at the top represent absolute abundance. Area 1(A), Area 2(B), Area 3(C), Area 4(D). *Rinnella jimi* (Rjimi), *Leptodactylus macrosternum* (Lmcrcs), *Hypsiboas crepitans* (Hcrep), *Rinnella granulosa* (Rgran) and *Leptodactylus vastus* (Lvast) and *Sicrix x-signatus* (Ssig).



Source: Personal archive.

### Seasonal distribution

The first and second axis considered for this analysis showed a high response to temporal variation in anurans spotted in Bela Vista lake, with the cumulative value of 97.7% (Table 5). The temporal distribution of frogs throughout the study period was related to the maximum temperature and rainfall in the region, which is observed on the first axis, the maximum

temperature achieved the highest values (-0.594), while for the second axis, the rainfall (-0.718) responded well the distribution of subjects during the 12 months of the study (Table 6).

**Table 5.** PCA values showing the variation of individual axes and their accumulation.

PC	Eigenvalue	Variation%	Cumulation of Variation %
1	2,54	63,4	63,4
2	1,37	34,3	97,7
3	7,24E-02	1,8	99,5
4	1,99E-02	0,5	100

Source: Personal archive.

**Table 6.** PCA values showing the abiotic variables that had the highest relationship for the anurofauna distribution from the Bela Vista lagoon. Maximum temperature (Tep. max), Minimum temperature (Tep. min), Relative humidity (Humid), Rainfall (Pluv).

Variáveis	PC1	PC2	PC3	PC4
Tep max.	-0,594	-0,24	-0,517	0,567
Tep min.	-0,456	-0,581	0,057	-0,671
Umid.	0,575	-0,298	-0,737	-0,196
Pluv	0,33	-0,718	0,432	0,435

Source: Personal archive.

#### 4. Discussion

The species present in Bela Vista lake are common in areas of caatinga (Rodrigues et al. 2003). According to Duellman (1990) - areas that have similar vegetation and weather conditions tend to have a similar fauna.

However, some areas sampled had a number of species way below the regular average for this ecosystem. Vieira et al. (2007) recorded 14 species of frogs in the Paraíba Cariri already Arzabe et al. (2005) in two regions of Paraíba Curimataú, recorded 20 species. Loebmann and Haddad (2010), in an extremely diverse area of caatinga domain Plateau Ibiapa-CE, found 37 species of frogs. This fact might be associated with the high degree of human disturbance. Since, several studies have warned about the negative influence that these actions have on the community of frogs (Santos et al. 2007, Armstrong & Conte 2010, D'avilla et al. 2020).

All four areas demarcated at Bela Vista lake showed signs of wear by pollution, being the first local area more influenced by this action, the less evident wealth in that area, possibly related to this high degree of disturbance. This group is extremely damaged when their natural habitats are used as dumps for sewage (SOS Atlantic Forest in 2008), being considered bioindicators of pollution due to their highly permeable skin (Curcio et al. 2010, D'avilla et al. 2020, Chaves et al. 2021,). Izecksohn and Carvalho-e-Silva (2001) and Avila and Ferreira (2004), which address anuran communities that suffer from pollution, are under serious threat of local extinction, especially in urban areas. Some studies argue for greater protection for water resources in animal bioindicators of pollution (Duellman & Trueb 1994, Hecnar & Closkey 1996, Goulart & Callisto 2003, D' avilla et al. 2020).

Frogs tend to use temporary water pools during their foraging activities and reproductions, which explains the need for conservation boundaries of these areas (Conte & Rossa-Feres 2007). The use of these sites by wetland species analyzed corroborates the results of Vieira et al (2007), in a research conducted in the caatinga areas, where it was found a high ratio of specimens found with the waterpools.

The low association of anuran fauna studied with the surrounding areas, in the perimeter, is explained by the high anthropic concentration in the location. Changes and loss of habitats is already strongly linked to population declines in amphibians (Beebe 1996, Alford & Richards 1999, Carneiro et al. 2021), due to losses of: shelters, reproductive microhabitats and breeding areas (Lips et al. 2005, Carneiro et al. 2021)

Despite the Bootstrap model have shown a tendency to stabilization, the overestimation seen between the model can be linked to the variations that the environment can introduce over the years. Works such as Maffei et al. (2011) address the low number of studies in a well regarded area sampled may reflect a lack of new records. This fact is proven by the city of Botucatu-SP, which has decades of studies on the anuran, and new records of species occurring in this region, in recent years of the study (Jim 2003, Rolim 2009).

The species like *Hypsiboas raniceps* and *Corythomantis greeningi* seen in several regions of Paraíba (Arzabe et al. 2005, Vieira et al. 2007, Abrantes et al. 2011) and *Physalaemus cuvieri*, which is highly generalist and has been seen in several areas disturbed (Haddad & Prado 2005, Conte & Rossa-Feres 2006), can not be ruled out in new jobs for the area sampled.

The largest number of individuals had little influence on diversity among the studied areas of the lake Bela Vista. Oda et al. (2009) studying the diversity of anuran fauna, for the town of Niquelândia, have obtained similar results. According to the author, the high abundance of an area, as evidenced to the area 3 of this study (Table 4), may not be associated with a greater diversity as dominant species may interfere with the distribution of individuals.

The diversity of disturbed areas tend to decrease towards the preserved areas (Morocco & Lucas 2011). The low level of diversity found in the present study corroborates these authors to emphasize the importance of preserved areas for the development of anuran diversity.

Less affected regions tend to have a better balance for wildlife (Scott-jr. 1976, D'avilla et al. 2020), with the smallest species diversity in a related slowness anthropic environment they have with adaptations to the environment, making room for species open areas (Heinen 1992). Mitchell et al. (2007) discuss that frogs from disturbed areas suffer a serious threat of substitution of local diversity, due to the changes of the natural resources, the homogenization of an area can affect their diversity. (Olden et al. 2004, Vasconcelos & Rossa-Feres 2005, Carneiro et al. 2021).

The *Rinnella Jimi* was the species that showed dominance among the four studied areas, this species is typical of open areas, being seen in several regions of the Caatinga (Rodrigues et al. 2003, Santana et al. 2008). According to Henderson and Powell (2001) disturbed areas provide shelter and sites for reproduction, thus favoring the generalist species. These areas tend to have a dominant population that best fits the conditions offered (Heinen 1992, Giaretta et al. 1999), as evidenced in the sampled areas of lake Bela Vista, specially between areas 3 and 4. Moraes et al. (2007) found this same dominance between areas for the species *Hypsiboas albopunctatus* in the city of Miguel Arcanjo- SP, which corroborates the present work.

Working on amphibian communities at a local scale have been extending over patterns of temporal and spatial distributions (Rossa Feres et al. 2011). In regions with a well-defined seasonality, distribution of communities of frogs is highly linked to volumes of rainfall, and temperature (Bertoluci & Rodrigues 2002, and Prado et al. 2004). Its explanation is due to reproductive period of these species, which are influenced by these variables (Duellman & Trueb 1986, Prado et al. 2004, Chaves et al. 2021). The rainfall and temperature have been observed as an enabler for other areas such as the Brazilian Cerrado (Oda & Lima 2009), the authors have found a high correlation of these variables with the distribution of individuals and their vocalizations.

Abiotic changes in open areas may limit the species of frogs (Blaustein et al. 1994, D'avilla et al. 2020), this pattern is seen in the work of Vasconcelos and Rossa-Feres (2005), where in the northeastern region of the state of São Paulo, Brazil, 27 frog species were registered, where most are traditionally found in open habitats. In the region of Paraíba Curimataú,

Abrantes et al. (2011) reported a high abundance of species during rainy periods for typical species of the morphoclimatic area called Caatinga .

## 5. Conclusion

The low richness of anurans in the Bela Vista lagoon indicates the need for areas with a greater degree of preservation for the development of the anuran, regarding the use of habitats, despite the dominance of *Rinnella Gimi*, a species found in several urban centers, the variable that the best response to the distribution of individuals were water bodies, places close to anthropic areas had few associations with the studied anurofauna.

The approximate number that the Bootstrap estimator presented in the final species richness suggests that the anuran fauna of the Bela Vista Lagoon was sampled practically in its entirety, however, the presence of species seen in several regions of Paraíba, especially the ones, is not discarded in new studies. who show generalist habits. The diversity and evenness evidenced for the 4 study areas highlights that altered areas tend to have a low diversity, making more heterogeneous habitats necessary.

Temporal variation had a high influence on the distribution of anuran fauna present in this study, showing seasonal species, seen in specific periods of the year. The use of complementary methods such as pitfall traps in future studies for the Bela Vista lagoon deserves to be tested, and may have more satisfactory results in terms of richness and abundance found.

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