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RESEARCH ARTICLE

Living among thorns: herpetofaunal community (Anura and Squamata) associated to the rupicolous bromeliad *Encholirium spectabile* (Pitcairnioideae) in the Brazilian semi-arid Caatinga

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ABSTRACT. Bromeliads are important habitats for reptiles and amphibians, and are constantly used as shelter, refuge, foraging or thermoregulation sites due to their foliar architecture, which allows for constant maintenance of humidity and temperature. This study aimed to identify the herpetofauna inhabiting the non-phytotelmata rupicolous bromeliad *Encholirium spectabile* Mart. ex Schult. & Schult.f. and to analyze the microhabitat usage of these bromeliads by different species in the Caatinga of northeastern Brazil. From January 2011 to August 2012, we collected data by active search throughout three paralel transects in a rock outcrop in the municipality of Santa Maria, state of Rio Grande do Norte. We recorded four species of anuran amphibians, six lizards, and seven snakes in the bromeliads. The average air temperature was lower and air humidity higher inside than outside the bromeliads, and bromeliads at the rock outcrop borders had lower temperatures and higher humidity than those at the center. We found a significant difference in the distribution of individuals throughout the rock outcrop, with most specimens found at the borders. We also found significant differences regarding the use of each microhabitat by the taxonomic groups, with lizards and snakes using green leaves and dry leaves evenly, along with fewer records in inflorescence stems, and anurans mainly using green leaves, with few records on dry leaves, and no records in the inflorescence stems. This study highlights rupicolous bromeliads as key elements in the conservation and maintenance of amphibians and reptiles in the rock outcrops of Brazilian semi-arid Caatinga.

KEY WORDS. Amphibians, associated fauna, Bromeliaceae, habitat use, reptiles.

INTRODUCTION

The Bromeliaceae family is characterized by terrestrial, epiphytic or rupicolous plants which have simple leaves organized in rosette shapes. Bromeliads are often used by animals as shelter to avoid excessive sun exposure or as a refuge against predators, due to their foliar architecture which enables relatively constant maintenance of internal humidity and temperature, creating a less stressful microhabitat when compared to the external environment (Rocha et al. 2000, 2004). Imbricated foliage architecture, called phytotelma, allows for accumulating water and organic debris in some species, which leads them to host large faunistic diversity (Leme 1984, Benzing 2000, Kitching 2000). Among the subfamilies of Bromeliaceae, the occurrence of phytotelma is more frequent in bromeliads of Bromelioideae and Tillandsioideae, and only occurs in a few Pitcairnioideae species (Benzing 2000). To date, studies on the fauna associated to bromeliads were focused on phytotelmata species of Bromelioidae and Tillandsioideae (e.g. Picado 1913, Laessle 1961, Frank 1983, Richardson 1999, Cruz-Ruiz et al. 2012, McCracken and Forstner 2014), while studies with non-phytotelmata Pitcairnioideae bromeliads are still scarce (e.g. Jorge et al. 2018).

Among vertebrates, anuran amphibians comprise the taxa most intimately associated to bromeliads, and have developed very unique relationships with these plants (Benzing 2000, Teixeira et al. 2006, Silva et al. 2011, Sabagh et al. 2017). Bromeligenous frogs spend their entire life cycles within the bromeliad host, while bromelicolous species use the plants as a shelter and foraging place, but seek out other places to use as breeding sites (Peixoto 1995). Sabagh et al. (2017) conducted a literature review and identified 99 bromeligenous frog species in the world associated to 69 bromeliad hosts, with 41% of the frogs listed as threatened, highlighting a conservation priority for these bromeliads, which by consequence should protect the associated animal species.

Regarding reptiles, information about their interactions with bromeliads is still scarce. Available data in South America consists of a few autoecological studies with some lizard species or studies that investigated the whole herpetofauna inhabitant of a single bromeliad species (Vrcibradic and Rocha 1995, 2002, Rocha and Vrcibradic, 1998, McCracken and Forstner 2014). These studies have identified bromeliads as suitable places for foraging, shelter, refuge from predators and for thermoregulation of lizards (Vrcibradic and Rocha 2002). Recently, Oliveira et al. (2019) demonstrated that bromeliads are the most important microhabitat for lizard communities in coastal sandy plains (restinga ecosystems) of southeastern Brazil. Regarding snakes, data about their relationship with bromeliads is even scarcer (Henderson and Nickerson 1976, Rocha and Vrcibradic 1998, Schaefer and Duré 2011).

Pitcairnioideae bromeliads of the *Encholirium* genus, popularly known as "macambiras-de-flecha" (arrow macambiras), are endemic to Brazil and occur in rock outcrops of the Caatinga and Cerrado regions. This genus presents a high diversity in the Cadeia do Espinhaço rock fields in the state of Minas Gerais, with exception of *Encholirium spectabile* Mart. ex Schult. & Schult.f., which occurs throughout the Caatinga in northeastern Brasil, and also in transitional areas between Caatinga and Atlantic Forest (Forzza 2005, Givnish et al. 2007, Forzza and Zappi 2011). Despite not having phytotelma, *Encholirium* bromeliads have strongly aculeated leaves and form large agglomerates (patches); these characteristics ensure the formation of tangled structures which may function as a refuge for local fauna, as potential predators tend to avoid persecution into these plants due to thorn injuries on their bodies (Rocha et al. 2004, Jorge et al. 2014, 2018).

Despite the remarkable abundance of *E. spectabile* patches in the semi-arid Brazilian Caatinga, and their potential as microhabitat for the herpetofauna, they have constituted poorly sampled habitats in previous studies with herpetofauna in this region, despite the local occurrence of these bromeliads in the study sites (e.g. Freire et al. 2009, Andrade et al. 2013, Caldas et al. 2016). In this perspective, this study sought to understand the ecological relevance of thorny bromeliads as a habitat to amphibians and reptiles in the Caatinga. Our objectives were: 1) to identify the species of the herpetofauna that use *E. spectabile* as habitat; and 2) to evaluate the microhabitat usage of these bromeliads patches by the different herpetofaunal species, as well as differences in the use of bromeliad patches in the center and borders of the rock outcrop.

MATERIAL AND METHODS

This study was conducted at Fazenda Tanques (5.853°S, 35.701°W; datum WGS84, 137 m above sea level), in the municipality of Santa Maria, state of Rio Grande do Norte, Brazil (Fig. 1), an area included in the "Depressão Sertaneja Setentrional" ecoregion of the Caatinga (Velloso et al. 2002). This ecoregion is characterized by irregular rainfall and a dry season from July to December. The climate is semi-arid, hot and dry, with an average annual precipitation of 500–800 mm/year (Velloso

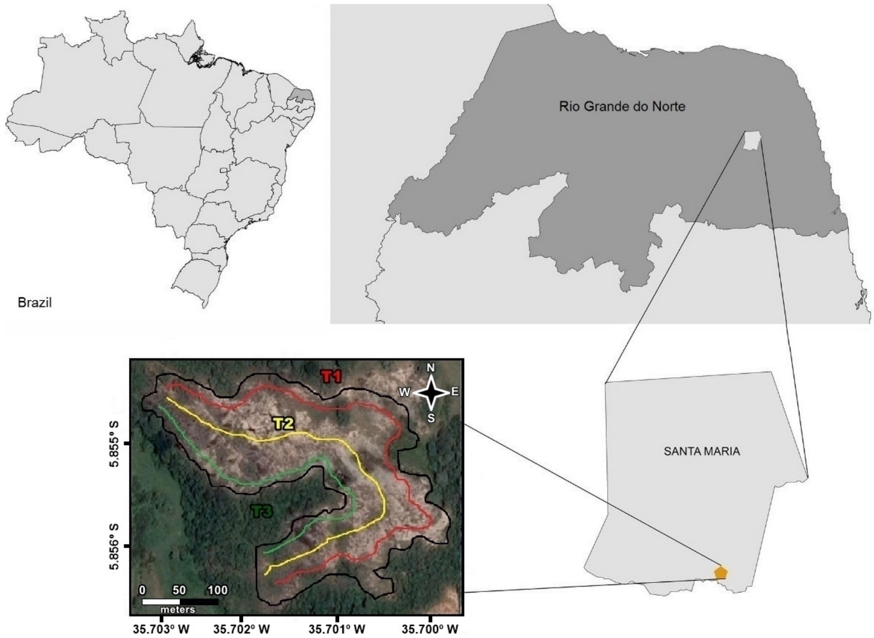


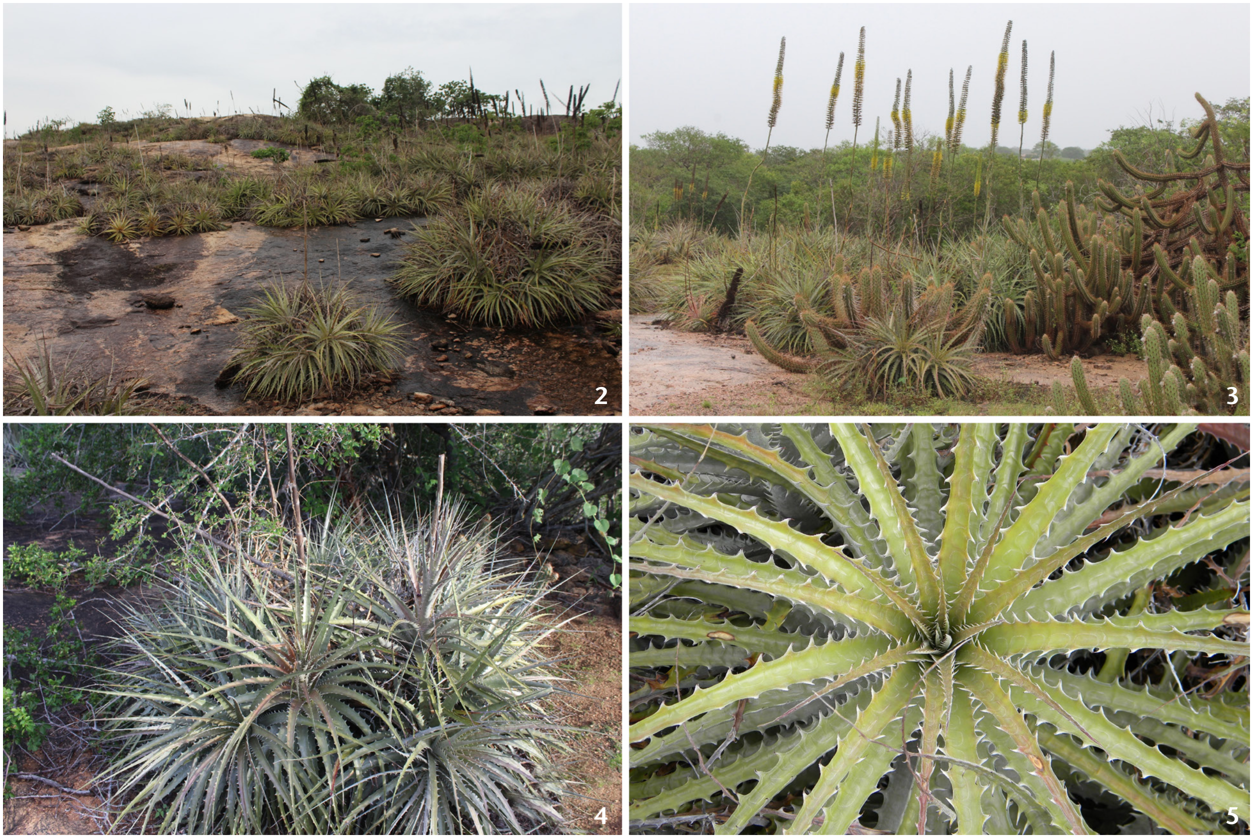
Figure 1. Location of the rock outcrop where this study was conducted at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte state, northeastern Brazil. The colored lines indicate the transects covered for data collection during the study. Red line: north border transect (T1); yellow line: center transect (T2); green line: south border transect (T3).

et al. 2002). The municipality of Santa Maria is located in the “Agreste” region, a transition zone between the Caatinga and the Atlantic Forest, with characteristics of both environments (Rizzini 1997). The rainy season in the “Agreste” usually extends from January to June (Velloso et al. 2002). The minimum monthly temperatures in Santa Maria range from 22–24 °C, and maximum monthly temperatures from 28–32 °C, with an average annual rainfall of 781 mm (Jorge et al. 2015). There is a common presence of rock outcrops with a large abundance of *E. spectabile* bromeliads in the study area (Figs 2–5).

The fieldwork was carried out in a large granite rock outcrop (5.855°S, 35.702°W; datum WGS84, 137 m asl) with around 5.8 ha (Fig. 1). The surroundings of this outcrop are covered by arboreal-shrubby vegetation, with the occurrence of Caatinga trees such as “juremas” (*Mimosa* spp.), “imburanas” (*Commiphora leptophloeos* (Mart.) J.B. Gillett), “cajueiros” (*Anacardium occidentale* L.) and “barrigudas” (*Ceiba glaziovii* (Kuntze) K. Schum.). Patches of *E. spectabile* in this rock outcrop occupy a large part of its extension (Figs 2–5). Aside from the bromeliads in the rock outcrop, the presence of “xique-xique” cactus, *Pilosocereus gounellei* is also common.

We sampled the rock outcrop monthly from January 2011 to August 2012, with a total of 360 hours of sample effort. Search and data collection occurred throughout three paralel transects of 12 m width and about 1500 m length, situated on the north border (T1), the center (T2) and on the south border (T3) of the outcrop (Fig. 1). All three transects were explored once per day during three consecutive days in each month by a single observer (JSJ) in the morning, afternoon, and night. Thus, each transect was surveyed once during each time of the day each month. All bromeliad patches along the transect were inspected by visual active seach, with the observer registering all specimens of the herpetofauna occupying the bromeliads in a field notebook. Each survey in the transects lasted about two hours. The absolute frequencies of each species were registered according to the number of specimens sighted. The time period that each species used the bromeliads was registered, as well as the microhabitat (see below) and behavior observed: in activity (moving through the bromeliad or motionless but with eyes open in vigilant posture) or inactive (resting and using the bromeliad as shelter).

The registered specimens were manually collected whenever possible (most cases), packed in plastic bags and identified



Figures 2–5. The *Encholirium spectabile* bromeliad in rock outcrops at the municipality of Santa Maria, Rio Grande do Norte state, northeastern Brazil: (2) panoramic view of bromeliad patches; (3) patch with inflorescence stems; (4) individual patch; (5) *E. spectabile* individual. Photos: JSJ.

with field numbers. In the lab, they were euthanized by cooling followed by freezing (Lillywhite et al. 2016), fixed in formaldehyde at 10%, preserved in 70% alcohol and deposited in the Herpetological Collection of the Universidade Federal do Rio Grande do Norte – UFRN (voucher numbers are in Table 1). The capture and killing of the specimens were authorized by the Biodiversity Information and Authorization System of Chico Mendes Institute for Biodiversity Conservation (SISBIO – ICMBio, Authorization #71469-1). When a specimen was observed but not captured, the bromeliad patch was noted and not inspected again for that particular species to avoid counting the same individual again. For eleven individuals that exceeded the collection permit limits – 6 *Tropidurus semitaeniatus* (Spix, 1825), 4 *Tropidurus hispidus* (Spix, 1825) and 1 *Hemidactylus agrius* Vanzolini, 1978 –, we relocated them to another rock outcrop with similar physiognomy (about 12 kilometers distant) in order to avoid pseudoreplication in the sample area. This rock outcrop was previously surveyed to confirm the presence of these species. Translocations are an important tool in wildlife conservation, but need experimental testing, preparation and monitoring before being performed (Germano and Bishop 2009). Although we recognize that this procedure was not the most appropriate in our study to avoid pseudoreplication, given the low number of translocated individuals, we believe that it did not compromise resident populations.

We ramdomly selected 90 bromeliad patches to evaluate the occurrence of differences in air temperature and humidity inside and outside the bromeliads and between border and center bromeliads: 30 on the north border, 30 on the south border and 30 in the center of the rock outcrop. External air temperature and humidity were measured at 1.5 m height above the bromeliad patch, and internal air temperature and humidity in the most central bromeliad of the patch, 5 cm above the rosette center using a digital thermohygrometer (0.1 °C precision; Instrutherm® model HTR-350) with an external sensor attached (Instrutherm® model S-02K). We used independent t-tests to evaluate differences between average air temperatures and humidity inside and outside the bromeliads, as well as to compare bromeliads located at the borders and the center of the outcrop regarding these aforementioned variables.

The two-tailed χ^2 test (Chi-squared test – Sokal and Rohlf 1995) was used to investigate differences in the bromeliad use in relation to their position in the rock outcrop (if on the borders

Table 1. Herpetofauna species recorded in patches of the rupicolous bromeliad *Encholirium spectabile* at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte, Brazil, from January 2011 to August 2012. N: number of specimens, F: relative frequency (%); microhabitats – GL: Green Leaf, DL: Dry Leaf, IS: Inflorescence Stem.

Taxon	N	F	Microhabitats			Voucher numbers
Anura/Hylidae			DL	GL	IS	
Boana raniceps (Cope, 1862)	10	5.2	1	9	–	UFRN 2888, 3356-3358
Dendropsophus nanus (Boulenger, 1889)	5	2.6	–	5	–	UFRN 3669-3672
Scinax x-signatus (Spix, 1824)	5	2.6	1	4	–	UFRN 3368-3372
Anura/Phyllomedusidae						
Pithecopus nordestinus (Caramaschi, 2006)	7	3.6	–	7	–	UFRN 2654, 3073, 3839
Squamata/Gekkonidae						
Hemidactylus agrius Vanzolini, 1978	28	14.5	9	11	8	UFRN 3354-3364
Squamata/Mabuyidae						
Psychosaura agmosticha (Rodrigues, 2000)	62	32.1	4	58	–	UFRN 2882-2883, 2933, 3765, 3925-3930
Squamata/Phyllodactylidae						
Gymnodactylus geckoides Spix, 1825	12	6.2	11	1	–	UFRN 2932, 5509
Phyllopezus pollicaris (Spix, 1825)	4	2.1	1	2	1	UFRN 2935, 3031, 3156
Squamata/Tropiduridae						
Tropidurus hispidus (Spix, 1825)	9	4.7	7	2	–	UFRN 3020-3028
Tropidurus semitaeniatus (Spix, 1825)	34	17.6	30	4	–	UFRN 2934, 3043, 3162, 3762, 3835-3845, 3157-3159
Squamata/Boidae						
Epicrates assisi Machado, 1945	4	2.1	2	2	–	UFRN 3764-3765
Squamata/Colubridae						
Leptodeira annulata (Linnaeus, 1758)	1	0.5	–	1	–	UFRN 5233
Lygophis dilepis Cope, 1862	1	0.5	–	1	–	UFRN 3150
Oxyrhopus trigeminus Duméril, Bibron & Duméril, 1854	4	2.1	2	2	–	UFRN 3120, 5222-5223
Philodryas olfersii (Lichtenstein, 1823)	3	1.6	1	1	1	UFRN 3364-3366
Thamnodynastes almae Franco & Ferreira, 2003	3	1.6	2	1	–	UFRN 3777-3778
Thamnodynastes phoenix Franco, Trevine, Montingelli & Zaher, 2017	1	0.5	1	–	–	UFRN 3044
Total individuals	193	100	72	111	10	

or the center). The Kolmogorov-Smirnov two-group test (Siegel 1956) was used to test for differences in amphibian and reptile species encountered in relation to the three locations (i.e. on the south border, north border or center) by pairs.

Microhabitat usage in the bromeliads by the amphibian and reptile species was analyzed. We previously identified that *E. spectabile* patches are composed of three main microhabitats: 1) Green leaves (living bromeliad leaves), 2) dry leaves (dead leaves usually situated in the base of the bromeliad), and 3) inflorescence stems. We used a loglinear analysis using the chi-squared test as the basis to analyze the different microhabitats usage of bromeliads by anuran amphibians, lizards and snakes. This analysis enables analyzing categorical data with more than two variables, constructing the interaction between such variables. The significance level assumed in all tests was 0.05.

RESULTS

We recorded 17 species of the herpetofauna inhabiting the rupicolous bromeliads (*E. spectabile*) at Fazenda Tanques: four anuran amphibians, six lizards, and seven snakes (Figs 6–19, Table 1). Lizards were more frequently recorded (77.2%, n = 149), followed by anurans (14.0%, n = 27) and snakes (8,8%, n = 17). The most frequent lizard species were the bromeliad specialist skink *Psychosaura agmosticha* (Rodrigues, 2000) (32.1%, n = 62), the rupicolous lava lizard *T. semitaeniatus* (17.6%, n = 34), and the leaf-toed gecko *H. agrius* (14.5%, n = 28) (Table 1).

The bromeliad usage rates by the herpetofauna on the rock outcrop borders and center revealed that the bromeliad patches located on the borders were more frequently used than the bromeliads located in the center ($\chi^2 = 7.02$, df = 1, p = 0.003). There were differences regarding the species distribution on the north border and the center (Kolmogorov-Smirnov, $D_{max} = 0.343$, $p < 0.001$), and the south border and the center (Kolmogorov-Smirnov, $D_{max} = 0.421$, $p < 0.001$). There was also a significant difference between the south and north borders (Kolmogorov-Smirnov, $D_{max} = 0.249$, $p < 0.001$), with most specimens registered on the north border. The species that most used the center of the rock outcrop were *P. agmosticha* (40%) and *T. semitaeniatus* (37%) lizards. All anuran specimens were found in bromeliads located at the borders, with a distance less than fifteen meters from the surrounding vegetation of the rock outcrop. Except for *Epicrates assisi* Machado, 1945, all other snake species were only found in the borders.

Figures 6–9. Anuran species registered in *Encholirium spectabile* patches at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte, Brazil: (6) *Boana raniceps*; (7) *Dendropsophus nanus*; (8) *Scinax x-signatus*; (9) *Pithecopus nordestinus*. Photos: JSJ.

Figures 10–15. Lizard species registered in *Encholirium spectabile* patches at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte, Brazil: (10) *Psychosaura agmosticha*; (11) *Hemidactylus agrius*; (12) *Gymnodactylus geckoides*; (13) *Phyllopezus pollicaris*; (14) *Tropidurus hispidus;* (15) *Tropidurus semitaeniatus*.

The average air temperature inside the bromeliads (32.5 ± 1.3 °C, range: 29.9–34.8) was significantly lower than the average air temperature outside the bromeliads (35.5 ± 1.2 °C, range: 32.2–38.9; t = -5.139, df = 29, p = 0.003). Air humidity was higher inside (68.5 ± 1.2%, range: 59.2–79.0) than outside the bromeliads (50.9 ± 1.1%, range: 42.3–61.0), also with a significant difference (t = -4.172, df = 29, p = 0.003). In addition, the bromeliads of the borders had lower temperatures (28.7 ± 1.7 °C, range: 26.5–31.4) than those of the center of the rock outcrop (33.1 ± 1.5 °C, range: 29.9–34.8; t = -3.263, df = 29, p = 0.009), and air humidity was higher in the bromeliads of the borders (70.3 ± 1.5%, range: 58.0–79.1) than those in the center of the rock outcrop (56.3 ± 1.4%, range: 42.1–75.3; t = -3.146, df = 29, p = 0.003).

Figures 16–19. Snake species registered in *Encholirium spectabile* patches at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte, Brazil: (16) *Epicrates assisi*; (17) *Oxyrhopus trigeminus*; (18) *Philodryas olfersii*; (19) *Thamnodynastes almae*. Photos: JSJ.

The loglinear analysis showed significant differences regarding the use of each microhabitat by the taxonomic groups ($\chi^2 = 16.363$, df = 4, p = 0.003; Likelihood Ratio = 20.121, df = 4, $p < 0.001$). Lizards mainly used green leaves (52.3%) and dry leaves (41.6%), with fewer records in inflorescence stems (6.1%). Similarly, snakes mainly used green leaves (47.1%) and dry leaves (47.1%), with only one record in inflorescence stems (5.9%). Anurans used mainly green leaves (92.6%), with few records on dry leaves (7.4%), and no records in inflorescence stems (Table 1, Fig. 20).

DISCUSSION

We registered four anuran amphibian species and thirteen squamate reptile species associated to *E. spectabile* during this study, which corresponds to 17.4% of amphibians and 31% of reptiles registered for the entire study site, also including other habitats (JSJ unpublished data). Most of these species were also recorded in other sites of the Caatinga region (e.g. Pedrosa et al. 2014, Pereira et al. 2015, Caldas et al. 2016, Castro et al. 2019), but some species that present a stronger relationship with bromeliads, such as *P. agmosticha* and *Thamnodynastes* spp., are not

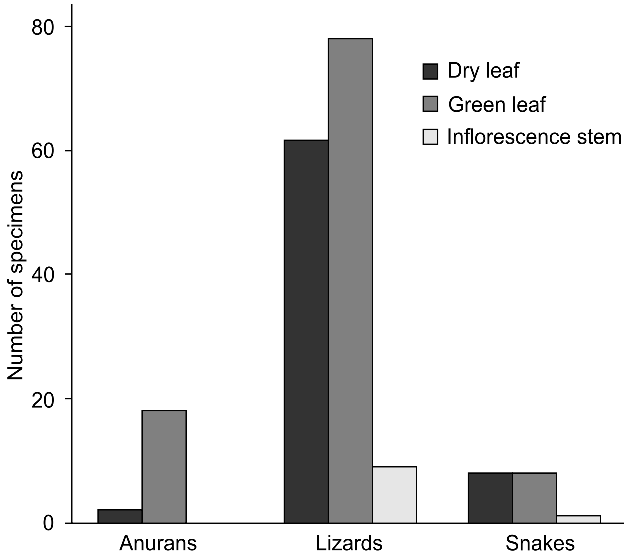


Figure 20. Use of the *Encholirium spectabile* microhabitats by the herpetofauna in a rock outcrop at Fazenda Tanques, municipality of Santa Maria, Rio Grande do Norte, Brazil.

so frequent in herpetofaunal inventories in the Caatinga, a fact that may be related to a subsampling of rupicolous bromeliads in previous studies. The four anurans registered in *E. spectabile* were tree frogs of the Hylidae (3 species) and Phyllomedusidae (1 species) families, which presented a richness of thirteen species in a Caatinga-Atlantic Forest ecotone site also in the state of Rio Grande do Norte (Magalhães et al. 2013). With respect to reptiles, we registered six of the ten lizard species of Gekkonidae, Phyllodactylidae, Tropiduridae and Mabuyidae, and six of the fifteen snake species of Boidae and Colubridae registered in all habitats of another Caatinga site of Rio Grande do Norte (Freire et al. 2009, Andrade et al. 2013). Our results, therefore, support the relevance of this non-phytotelmata rupicolous bromeliad as an important habitat for biological diversity in the Caatinga, as has been suggested for phytotelmata bromeliads in other ecosystems (Rocha et al. 1997, 2000, 2004, Jorge et al. 2018).

In the case of amphibians, the bromeliad patches were usually close to natural water bodies formed by water accumulating from rains in rock depressions. All anuran species recorded during this study were protecting themselves from sunlight during the day, or in foraging or vocalization activities during the night, which reinforces the hypotheses of the bromeliads acting as foraging site and also shelter from the sunlight, as reported for phytotelmata bromeliads (Picado 1913, Peixoto 1995, Giaretta 1996, Rocha et al. 1997, 2004, Armbruster et al. 2002, Oliveira et al. 2017). Aside from providing shelter, the bromeliads also function as a display arena for males during the anuran reproductive season, with the best territories defended from intruding males (JSJ personal observation). Defense of territories by males also occurs in other species of the Hylidae family (Pombal and Haddad 2007, Uetanabaro et al. 2008). In the study site, *E. spectabile* bromeliads grow on water body edges, which form naturally by the rock depressions, forming suitable sites for species that reproduce in these environments and creating conditions that would not exist without their presence. Many males of the four registered species focus on these bromeliads as perches to vocalize during the months of the reproductive season, forming large reproductive groups, and the presence of spawning and tadpoles in the ponds confirmed this hypothesis (JSJ, pers. obs.). Thus, although *E. spectabile* bromeliads cannot function as sites for depositing and developing eggs due to an absence of phytotelma, males use them as display sites.

Bromeliads provide relatively higher humidity than the external environment because they can retain water in their leaf axils, as well as forming a shaded region due to their foliar architecture (Picado 1913, Oliveira et al. 1994, Peixoto 1995, Rocha et al. 2004, Silva et al. 2011, Ferreira et al. 2012, Oliveira et al. 2017). Our results support the presence of this feature in *E. spectabile*, because the temperature inside the bromeliads was significantly lower and humidity was higher than in the external environment. Additionally, the bromeliads located in the rock outcrop borders presented milder temperatures than those in the center, as well as higher humidity. Besides the fact that most water bodies (ponds) were located at the borders, contributing to a higher humidity in these areas, the vegetation on the borders likely creates a less stressful environment for the herpetofauna because bromeliads located in the borders are usually in a shaded area. In this sense, the fact that all anuran specimens were occupying bromeliads in the rock outcrop borders is probably related to physiological characteristics of this group, since amphibians depend on relatively high humidity and water availability to perform their metabolic functions (Wells 2007). Regarding lizards, their distribution in the rock outcrop borders may be related to greater prey availability, since their diets are mainly based on arthropods (Pianka 1973, Vanzolini et al. 1980, Sales et al. 2012, Oliveira et al. 2019). Prey availability for lizards possibly come from the arboreal-shrubby vegetation present in the rock outcrop borders, leading the species to aggregate in these areas.

The lizard species recorded in *E. spectabile* during this study are similar to the families and genera recorded for tank bromeliads in other Brazilian ecosystems, demonstrating a tendency towards the use of bromeliads by these taxa (Vrcibradic and Rocha 2002, Santos et al. 2003, Rocha et al. 2004, Oliveira et al. 2017, 2019). For example, in the coastal Atlantic Forest restingas of northeastern and southeastern Brazil, there is common occurrence of the skink *Psychosaura macrorhyncha* (Hoge, 1946), a species which is very morphologically and phylogenetically close to *P. agmosticha* (Miralles and Carranza 2010), and both species share habitat specialization to bromeliads (Rodrigues 2000). The geckos *Gymnodactylus geckoides* Spix, 1825 and *Hemidactylus brasilianus* (Amaral, 1935) were recorded in the foliage of the tank bromeliads *Hohenbergia* and *Aechmea* in Atlantic Forest areas along the coast of Rio Grande do Norte (Freire 1996, Santos et al. 2003), as well as for lava lizards of the genus *Tropidurus* (Oliveira et al. 1994) and geckos of the genus *Phyllopezus* recorded in soil bromeliads of restingas (Vanzolini 1968).

A similar pattern was found for snakes, because the richness found in this study is very similar to that found in studies with tank bromeliads. *Lygophis dilepis* Cope, 1862, *Oxyrhopus petola* Linnaeus, 1758, *Philodryas olfersii* (Lichtenstein, 1823) and *Thamnodynastes* cf. *pallidus* were recorded in restingas of Rio de Janeiro state, southeastern Brazil, using bromeliads as a foraging site (Rocha and Vrcibradic 1998, Schaefer and Duré 2011), and *Leptodeira annulata* (Linnaeus, 1758) in epiphytic bromeliads in Ecuador (McCracken and Forstner 2014). Most snake species recorded in this study feed on small amphibians and lizards (Vitt and Vangilder 1983, Vanzolini et al. 1980, Mesquita et al. 2013). The concentration of amphibians and lizards in the borders possibly causes the snakes to remain in the bromeliads located in the borders as a foraging strategy. Some studies on snake diets in bromeliad habitats have confirmed the importance of bromeliads as a foraging site, and amphibian and lizards as prey for these species (Dunn 1937, Beebe 1946, Landry et al. 1966, Henderson and Nickerson 1976). The record of the boid snake *Epicrates assisi* deserves special mention, since it is a large snake widely distributed throughout the Caatinga and was registered for the first time in bromeliads. This species feeds on small mammals, birds and lizards (Vanzolini et al. 1980). A possible reason for occupying bromeliads by this species is the large number of small rodents that live among *E. spectabile* patches (JSJ, personal observation), such as the Brazilian guinea pig, *Galea spixii* (Wagler, 1831), and the common "punaré", *Thrichomys apereoides* (Lund, 1839), in addition to nests of the Picui ground-dove, *Columbina picui* (Temminck, 1813), which constitute potential prey items in the diet of *E. assisi* in the study area.

With respect to the use of microhabitats of *E. spectabile* by the herpetofauna, dry leaves, usually situated in the base of the bromeliads, seem to be used mainly as shelter from predators; for instance, lava lizards (*T. hispidus* and *T. semitaeniatus*), which used mainly this microhabitat (Table 1), usually run to the bases of bromeliads in response to human approach (JSJ personal observation). Green leaves, on the other hand, constitute the most used microhabitat by most species (Table 1, Fig. 20), functioning as foraging and thermoragulating sites by the herpetofauna, and also as display sites by males of anurans, as previously stated. Inflorescence stems were used only by a few species of lizards and snakes (Table 1), and probably function as foraging sites since the flowers attract several arthropod species (Jorge et al. 2018).

Oliveira et al. (2017) demonstrated the importance of bromeliads for anuran communities in restinga habitats of the southeastern Brazilian coast. The authors highlight that the presence of bromeliads promoted the structuring of the anuran community, mainly through the availability of spawning sites. Similar results were found by Silva et al. (2011) for anurans in coastal habitats, where they highlight the importance of accumulated water in phytothelma, mainly due to the characteristics of restingas, where the lack of water is a limiting factor, and the bromeliads provide such resource. In addition, Oliveira et al. (2019) demonstrated that bromeliads play a crucial role in the structuring of lizard communities by providing adequate sites for thermoregulation, and providing food (small invertebrates) and shelter for small species or juveniles. We suggest that similar factors may be acting in the herpetofauna of the Fazenda Tanques in the Caatinga of Rio Grande do Norte, but not due to a provision of water though phytotelma as in tank bromeliads of restingas, but because they offer other resources and conditions, such as shelter, thermoregulation sites and food availability (small invertebrates) for anurans and lizards, which eventually can attract snakes (predators of anurans and lizards). Thus, as proposed by Rocha et al. (2000, 2004) for tank bromeliads in the Atlantic Forest, we suggest that the rupicolous bromeliads in the Caatinga are key elements in the conservation and maintenance of a wide variety of organisms associated to it.

Encholirium deserves more prominence in the national conservation policies, not only because it is endemic to Brazil, which in itself should already guarantee special attention, but because it is vulnerable to extinction. According to Forzza et al. (2003), 20 of the 23 species of the genus do not occur inside protected areas, and their habitat (rock outcrops) is threatened by mining activities. Regarding the bromeliad characteristics as a key species for conservation (Rocha et al. 1997), the *Encholirium* genus fits in without question in this context, whereby conserving the species of this genus is also a way of conserving all the biodiversity that is interconnected to them. In the face of the strong pressure that the Caatinga has been facing, mainly due to the constant deforestation (Silva and Barbosa 2017), we draw attention to the need for conservation of this region and all the biota that inhabits it, including the rupicolous bromeliads and all the associated fauna.

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