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Spatial distribution and associated flora of *Alcantarea nahoumii*, a vulnerable endemic species to rocky outcrops of the Serra da Jibóia, Bahia, Brazil

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Abstract
The objective of this study was to characterize the spatial distribution pattern at different altitude gradients as well as to investigate the flora associated with *A. nahoumii*, considered to be endemic and vulnerable. The study was carried out in Serra da Jibóia, Santa Teresinha, Bahia, Brazil. An inventory was conducted of young and adult *A. nahoumii* specimens along with taxonomic identification and quantification of the associated species. The cover percentage of *A. nahoumii*, rock slope, organic matter percentage and exposed rock percentage were calculated, as well as the following phytosociological parameters: absolute density, relative density, absolute frequency, relative frequency, and dominance of *A. nahoumii*. For the spatial distribution, three indices were tested (Morisita, McGuinnes and Payandech). Canonical correspondence analysis was also applied to test the association of the environmental variables with the species in the community. A total of 1,660 individuals were encountered and classified according to taxonomy in 17 families, 25 genera and 28 species. The spatial distribution pattern of the *A. nahoumii* population is aggregate. The results demonstrate that the population structure of *A. nahoumii* is stable, but events such as fires and extractive exploitation make the species vulnerable, along with the other species that inhabit the area.
Key words: Bromeliaceae, conservation, endemism, dispersion index, floristic survey, plant diversity.

Resumo
O objetivo deste trabalho foi caracterizar o padrão de distribuição espacial da *A. nahoumii* em diferentes gradientes de altitudes, bem como realizar o levantamento florístico da vegetação associada a A. nahoumii, considerada endêmica e "Vulnerável". O estudo foi realizado na Serra da Jibóia, Santa Teresinha, Bahia, Brasil. Foi realizado um inventário de plantas jovens e adultas da *A. nahoumii*, bem como a identificação taxonômica e quantificação das espécies associadas, percentagem de cobertura da vegetação, percentagem de cobertura da *A. nahoumii*, inclinação da rocha, percentagens de matéria orgânica e rocha exposta. Foram calculados os parâmetros fitossociológicos: densidade absoluta, densidade relativa, frequência absoluta, frequência relativa e dominância da *A. nahoumii*. Para a distribuição espacial foram testados três índices: Índice de Morisita, McGuinnes e Payandech. Também foi realizada uma Análise de Correspondência Canônica para as variáveis ambientais com as espécies da comunidade. Um total de 1.660 indivíduos foram encontrados e classificados taxonomicamente em 17 famílias, 25 gêneros e 28 espécies. O padrão de distribuição espacial da população de *A. nahoumii* é agregado. Os resultados demonstram que a estrutura populacional da *A. nahoumii* está estável, mas eventos como queimadas e exploração extrativista, as tornam vulnerável, juntamente com as demais espécies que habitam a área.
Palavras-chave: Bromeliaceae, conservação, endemismo, índice de dispersão, inventário florístico, diversidade de plantas.

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Introduction

Positive ecological interactions such as mutualism, facilitation and commensalism between plants are important because the presence of associated plants reduces environmental stress. This can be particularly important during the establishment of new seedlings of existing species and new species, mainly those that have few mechanisms to face unfavorable environmental conditions (Aguiar & Sala 1999; Godinez-Alvarez *et al.* 2003; Badano *et al.* 2015). Just as the interaction between plants can be favorable, abiotic factors can also positively influence the maintenance of a species in a given place, such as interaction with rocks (Peters 2008). In arid areas, climate changes, intense predatory extraction and dry soils subject to high temperatures can hamper the survival of new seedlings and species, which can only develop in the micro-environmental conditions under the canopy of nurse plants, such as bushes, grass tufts, succulents and trees (Armas & Pugnaire 2005; Barchuk & Diaz 2005; Cares 2013).

Species that are endemic to small areas, especially at high altitudes, are more susceptible to climate changes and are thus more exposed to the risk of extinction (Parmesan 2006; Schwartz *et al.* 2006). On the other hand, in these areas the heterogeneity of habitats caused by the diverse topography serves as a buffer against this risk, since climate changes can have a lesser effect than in flat areas (Luoto & Heikkinen 2008; Willis & Bhagwat 2009). Nevertheless, the area suitable for growth declines steadily with increasing height, posing a higher risk of disappearance of species (Leal *et al.* 2003).

The altitudinal patterns observed regarding richness of species can be explained by climatic, biological, geographic and/or historical factors (Lomolino 2001; Siqueira & Rocha 2013). Altitude can be considered a substitute for a set of biotic and abiotic factors that influence the structure of communities, especially plants (Ferraz *et al.* 2003; Rahbek 2005). As altitude increases, there is a decrease in temperature, primary productivity and available area for occupation, causing changes in habitat complexity, interspecific interactions, amount of food resources, water balance, humidity and partial pressure of O_2 and CO_2, besides a higher intensity of ultraviolet radiation (Ferraz *et al.* 2003; Monteiro & Fisch 2005; Siqueira & Rocha 2013). Studies of altitude gradients are thus fundamental for a better understanding of this vulnerable community of plants.

Spatial distribution studies can provide important data to support conservation programs, in particular information on the variation in the number of individuals in a population. In this respect, the relation between young and adult individuals is fundamental to understand the population patterns of each species, as well as the reproduction, establishment, growth and survival over generations, mainly regarding species that are endemic to highly specialized habitats, because of their high vulnerability (Martínez-Peralta & Mandujano 2011; Zappi *et al*. 2011; Fabricante & Oliveira 2013).

Alcantarea nahoumii (Leme) J.R. Grant belongs to the family Bromeliaceae. It has epilithic habit, growing on rocky outcrops and in shallow rocky soils, preferably where sunlight is strong. The species can reach a height of 3.5 meters, meaning it is considered to have intermediate growth (Versieux & Wanderley 2010; 2015). It is classified as endemic to the Serra da Jibóia and as being vulnerable regarding risk of extinction (Versieux & Wanderley 2007; Forzza *et al.* 2013). The frequency of forest fires and anthropic actions, mainly involving predatory exploitation of the species for ornamental purposes (Versieux 2009), has increased this vulnerability in recent years.

In Brazil, plant inventories in rocky outcrops have mainly been conducted in the Espinhaço mountain range, in the states of Minas Gerais and Bahia, which includes the country's largest rupestrian biome, especially in areas with quartzitic soils. Despite the research focus on this region, studies about the flora of rocky outcrops and fields are still scarce (Conceição & Giulietti 2002; Conceição & Pirani 2005, Bitencourt & Rapini 2013; Bitencourt *et al.* 2016). The richness and diversity of species that grow in rocky outcrops are associated with factors such as structure of the habitat, slope of the terrain, plant cover and microclimate, all of which can contribute to high percentages of endemism (Begon *et al.* 2006; Conceição *et al.* 2007; Messias *et al.* 2011).

Serra da Jibóia is among the priority areas defined for conservation of biodiversity by the Brazilian Ministry of the Environment (MMA 2002; Marques *et al.* 2008), due to the wide diversity and endemism of plant and animal species, besides the likely presence of new species not yet described by science. Because of this situation, the conduction of biological inventories in this region was recommended by the Ministry.

To understand the ecological role of the species present in a particular habitat and how they are distributed and associated, it is necessary to obtain quantitative data regarding the phytosociological structure of the habitat. Therefore, the aim of this study was to characterize the spatial distribution pattern in three degrees of altitude of *A. nahoumii* individuals and conduct a floristic survey of the vegetation associated with this species, which is considered endemic and vulnerable, to support future proposals for conservation and public policies to help preserve the region's biodiversity.

Materials and Methods

Study area

The study was carried out in the Serra da Jibóia (Jibóia Range), in the municipality of Santa Teresinha, Bahia, Brazil, in an Atlantic Forest fragment. The entire range has altitude varying from 748 m to 840 m and extends in the North-South direction, with crest of 26 km in length and area of 59.28 km^2, covering parts of five municipalities making up the Recôncavo Sul region of Bahia (Santa Teresinha, Castro Alves, Elísio Medrado, Varzedo and São Miguel das Matas) (Fig. 1). The Serra da Jibóia is located in a transition zone, with climate varying from humid tropical in the southeast and east to semi-humid tropical in the north and west. The average yearly temperature is 21 ^{o}C, with rainfall of 1,200 mm and average humidity of 80%. The vegetation varies from ombrophilous forest and seasonal deciduous forest to Caatinga (shrubland) interspersed with palms, and rocky fields at the highest altitudes (Queiroz *et al.* 1996). As described by these authors, at the top of the Serra da Jibóia there are transmission towers (telephone and TV) on a gneissic-granitic outcrop with steep and convex slopes, with highly degraded vegetation that appears in herbaceous-shrub clumps. The soil is shallow and in some places the rock is bare, only covered by lichens, whereas on the eastern face there is a greater accumulation of organic matter and the soil is deeper.

Floristic and structural survey

The study was carried out from August 2014 to March 2015, with weekly visits to a rocky outcrop area located in the western part of the Serra da Jibóia. One hundred plots were demarcated with size of 4 m^2 (2 × 2 m), within the coordinates 12°51'12.27" S to 39°28'34.24"W and 12°51'09.75"S to 39°28'39.86"W, arranged along level curves parallel to the trail allowing access to the population of *A. nahoumii*, spaced 5 m apart. The parcels were demarcated in areas not degraded and distant from transmission towers.

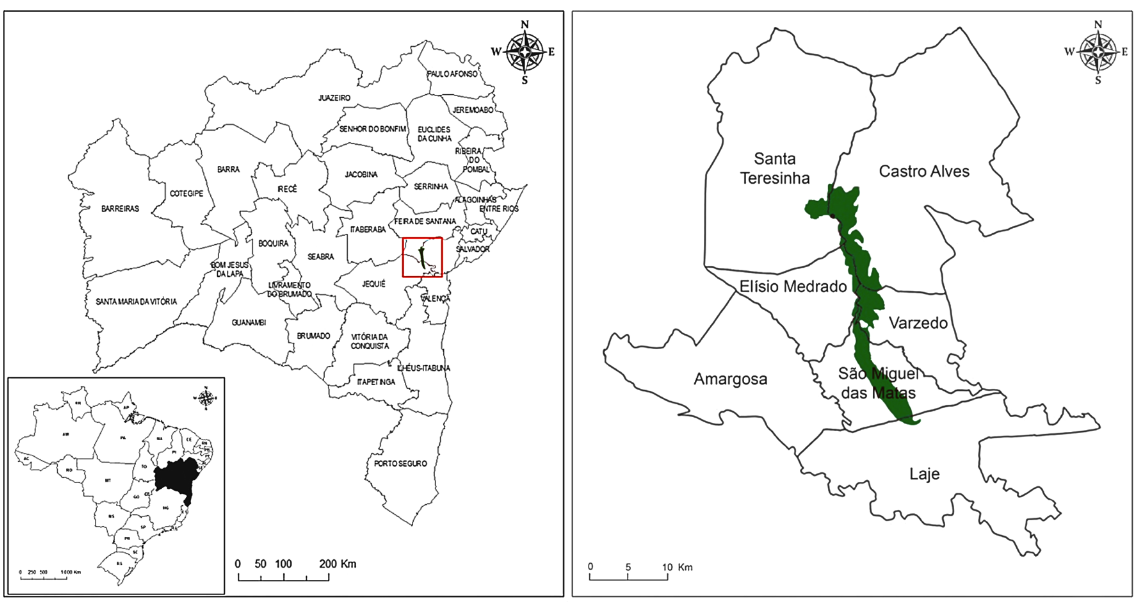

Figure 1 – Location of Serra da Jibóia, Santa Teresinha, Bahia, Brazil – a. map of the state of the state of Bahia with Serra da Jibóia in green, detail of the map of Brazil with the state of Bahia in green; b. Expanded magnification red square of the right showing the Serra da Jibóia regions in green, encompassing five municipalities.

The study area was divided into three sub-areas according to altitude (high - 818 m, medium - 784 m and low - 754 m).

An inventory was conducted in each plot of all young and adult *A. nahoumii* plants, as well as a floristic survey of all associated species. For the spatial distribution, plants were classified as "adult" that presented inflorescence or indications of impending inflorescence (change in color of the foliar rosette bracts). Plants belonging to all the other ontogenetic stages were classified as "young", regardless of size. Because this species is considered cespitose, the lateral shoots emitted from the mother plant were also quantified as young plants, since the emission of these shoots only happens after the flowering and fruiting of the mother plant.

For the floristic survey, specimens of all the species growing in each plot were collected for taxonomic identification, and the following parameters were recorded: number of plants per species, percentage of cover of *A. nahoumii*, rock slope (angle) and the estimated organic matter and exposed rock, as a percentage.

We also calculated the following phytosociological parameters: absolute density (individuals ha^{-1}), relative density (%), absolute frequency (%), relative frequency (%) of all species found, and dominance (m^2) of *A. nahoumii* (Mueller-Dombois & Ellenberg 1974).

The taxonomic identification of the species was initially performed in the field, followed by consultations with specialists of the Herbarium of Recôncavo da Bahia (HURB). A dried voucher specimen of each species found in the plots associated with *A. nahoumii* was deposited with the herbarium.

Data analysis

Three indices were tested to determine the spatial distribution pattern, those of Morisita (IM_i) (Morisita 1959), McGuinnes (IGA_i) (McGuinnes 1934) and Payandeh (P_i) (Payandeh 1970). The statistical significance was ascertained by the X^2 (Chi square) test, using the Genes program (Cruz 2006). For all the indices, values higher than 1.0 indicate an aggregate distribution, while a value equal to 1.0 indicates a uniform distribution and values lower than 1.0 mean a random distribution. To analyze the relationship between *A. nahoumii* and other species, the young and adult specimens were counted along with the occurrence of other species in the three sub-areas.

Finally, canonical correspondence analysis (CCA) was applied using the PAST software (Hammer *et al.* 2001) to associate the environmental variables with the species of the community. The environmental data expressed in different units were standardized by comparable equivalences and weights, and the positions of the plots were expressed in metric units.

Results and Discussion

In the three sub-areas demarcated according to altitude, 1,660 individuals were found, 1,173 of *A. nahoumii*, with average of 11.73 individuals per plot, of them 1,113 young plants and 60 adult plants (Tab. 1; Fig. 2). With respect to the floristic survey, 17 families, 25 genera and 28 species were encountered. Regarding absolute density, *A. nahoumii* presented 29,325 individuals per hectare, 27,825 individuals being young and 1,500 adults. The absolute frequency was 98%, denoting high species density in the overall area studied, with dominance of 349.76 m^2.

The spatial distribution of *A. nahoumii* was clustered, as confirmed by the three indices calculated: Morisita (IM_i = 1.10), McGuinnes (IGA_i = 2.99) and Payandeh ($P_{i=}$ 2.05) for the total population, with X^2 = 223.05. The populations of young plants (IM_i = 1.36, IGA_i = 2.84, P_i = 1.56 and X^2 = 387.18) and adult specimens (IM_i = 1.22, IGA_i = 1.21, P_i = 1.75 and X^2 = 337.69) also presented aggregate distributions.

The three indices of the spatial distribution pattern showed the same behavior, indicating an aggregate spatial distribution. These methods used as a test of adhesion to compare frequency distributions have a certain robustness, as reported by Lima-Ribeiro & Prado (2006), due to the larger amount of data generated, they are also more reliable, making them suitable for statistically detecting the pattern of spatial distribution of individuals in a population with a certain level of significance. The use of different indices to calculate the spatial distribution is very common in the literature (Nascimento *et al*. 2001, Marangon *et al.* 2013, Lima-Ribeiro & Prado 2006). Lima-Ribeiro & Prado (2006) report that the different methods are complementary and support the results presented.

This clustered overall distribution, with formation of thickets, can be a survival strategy resulting from interactive processes, possibly intensified by the species' long reproductive cycle (4 to 5 years on average, data not presented).

Table 1 – Phytosociological parameters of the species sampled in rocky outcrops of Serra da Jibóia, Santa Teresinha, Bahia, Brazil, 2015. Nat = native; End = endemic; NEnd = non-endemic; Am = Americas; Exot = exotic; BR = Brazil; BA = Bahia; MG = Minas Gerais; AF = Atlantic Forest; Indet = indeterminate; A1 = high altitude (818 m); A2 = middle altitude (784 m); A3 = low altitude (754 m); AD = absolute density (individuals ha^{-1}); RD = relative density (%), AF = absolute frequency (% of plots with species occurrence); RF = relative frequency (%); DO = dominance (m^2).

Family / Species	Voucher HURB	Category	Number of individuals				AD	RD	AF	RF	DO
			A1	A2	A3	Total					
Bromeliaceae											
Alcantarea nahoumii (Leme) J.R. Grant	9416	Nat/End/BA	316	482	375	1.173	29,325	70.66	98	33.56	349,76
Young			295	457	361	1.113	27,825	67.04	98	33.56	-
Adults			27	25	8	60	1,500	3.61	39	13.35	-
Vriesea bahiana Leme	13606	Nat/End/BA	15	-	-	15	375	0.90	5	1.71	-
Amaryllidaceae											
Hippeastrum sp.	10452	Indet	5	-	2	7	175	0.42	3	1.71	-
Apocynaceae											
Mandevilla tenuiflora (J.C. Mikan) Woodson	10444	Nat/NEnd	6	1	2	9	225	0.54	5	1.36	-
Mandevilla sancta (Stadelm.) Woodson	10450	Nat/End/BA	8	-	-	8	200	0.48	4	0.68	-
Asteraceae											
Ageratum conyzoides Sieber *ex* Steud.	9406	Nat/ NEnd	8	-	-	8	525	1.26	3	1.36	-
Asteraceae sp[1]	9408	Indet	-	3	4	7	175	0.42	2	1.02	-
Mikania sp.	8767	Indet	7	2	0	9	225	0.54	6	2.05	-
Sphagneticola trilobata (L.) Pruski	9407	Nat/ NEnd	21	0	0	21	200	0.48	4	1.36	-
Cactaceae											
Melocactus ernestii Vaupel	9419	Nat	3	-	18	21	525	1.26	5	1.71	-
Clusiaceae											
Clusia melchiorii Gleason	9412	Nat/End/BA	1	5	-	6	150	0.36	4	1.36	-
Cyperaceae											
Scleria secans (L.) Urb.	-	Nat/ NEnd	8	2	-	10	250	0.60	5	1.71	-
Genticianaceae											

Family / Species	Voucher HURB	Category	Number of individuals				AD	RD	AF	RF	DO
			A1	A2	A3	Total					
Chelonanthus purpurascens (Aubl.) Struwe, S.Nilsson & V.A. Albert	-	Nat/ NEnd	3	-	2	5	125	0.30	2	0.68	-
Heliconiaceae											
Heliconia psittacorum Sw.	20187	Nat/Am	12	-	-	12	300	0.72	4	1.36	-
Lytharaceae											
Cuphea pulchra Moric.	10448	Nat/BR	12	2	3	17	450	1.02	8	2.74	-
Malpighiaceae											
Byrsonima sericea SC.	9405	Nat	1	-	-	1	25	0.06	1	0.34	-
Melastomateceae											
Tibouchina tomentulosa Wurdack	10447	Nat/End/BR	37	11	17	65	1,625	3.91	42	14.38	-
Orchidaceae											
Epidendrum secundum Vell.	9413	Nat/BR	19	-	-	19	475	1.14	6	2.05	-
Oncidium flexuosum (Kunth) Lindl.	10445	Nat/Am	7	11	26	44	1,100	2.65	6	2.05	-
Rodriguezia venusta Rchb.f.	9414	Nat/MA	5	-	-	5	125	0.30	2	0.68	-
Sobralia lilliastrum Lindl.	10443	Nat	82	-	-	82	2,050	4.93	9	3.09	-
Stenohynchus lanceolatus L.C. Rich	9415	Nat/MA	7	-	-	7	175	0.42	3	1.02	-
Vanilla phaeantha Rchb.f.	-	Exot	5	-	-	5	125	0.30	2	0.68	-
Poaceae											
Melinis minutiflora P.Beauv.	-	Exot	6	9	4	19	475	1.14	10	3.42	-
Smilaceae											
Smilax sp.	-	Indet	1	-	2	3	75	0.18	2	0.68	-
Urticaceae											
Pilea microphylla Griseb.	-	Exot	5	-	-	5	125	0.30	2	0.68	-
Velloziaceae											
Vellozia variegata Goethart & Henrard	10451	Nat/Am	59	-	-	59	1,475	3.55	8	2.73	-
Vellozia sp.	-	Indet	18	-	-	18	450	1.08	2	0.68	-

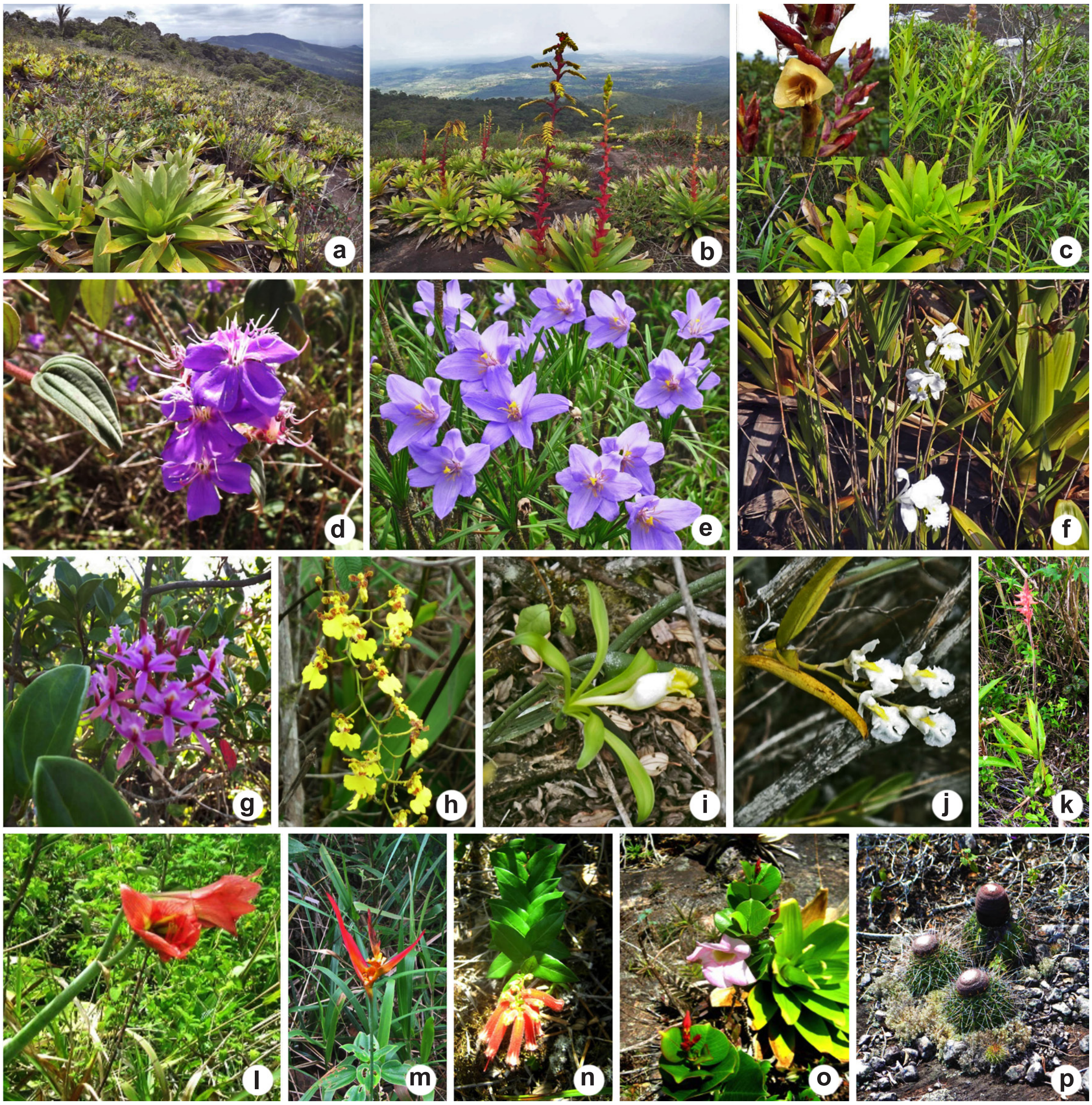

Figure 2 – Partial view of the rocky outcrop area, showing a large number of *Alcantarea nahoumii* plants with associated species – a. *A. nahoumii* plants in the vegetative stage. b. *A. nahoumii* plants in the blooming stage. c. *Vriesia bahiana*. d. *Tibouchina tomentulosa*. e. *Vellozia variegata*. f. *Sobralia lilliastrum*. g. *Epidendrum secundum*. h. *Oncidium flexuosum*. i. *Vanilla phaeantha*. j. *Rodriguezia venusta*. k. *Stenohynchus lanceolatus*. l. *Hippeastrum* sp. m. *Heliconia psittacorum*. n. *Cuphea pulchra*. o. *Epidendrum secundum* in association with *Mandevilla sancta*. p. *Melocactus ernestii*.

After flowering, bromeliads emit shoots that develop from axillary buds around the mother plant, resulting in a large clustering of plants. This species' survival capacity is related to the ability of its seeds (filiform seeds with feathery appendage) to disperse, generally carried by air currents in dry periods of the year, whereby those deposited in cracks in rocks find ideal conditions for germination (Pereira *et al*. 2008). These appendages also help the seeds attach to the trunks and bark of trees, cracks in rocks and substrates in the soil, where they also find suitable germination conditions. This dispersion mechanism is used by various species of Bromeliaceae, mainly in Tillandsioideae subfamily (Scatena *et al*. 2006).

We also noted that many seeds germinated directly in the capsules when falling in the soil and finding favorable conditions for development. Abiotic factors like soil type, texture, fertility, water availability, luminosity and temperature, among others, directly influence the distribution of plants in space. Carmo & Jacobi (2013) reported that a clustered vegetation pattern in the Iron Ore Quadrilateral region of Minas Gerais occurs in the entrances to caves and in large depressions and cracks in the substrate. This characteristic was also observed in this study, where the clusters generally were observed in cracks and depressions in rocks.

With respect to the associated flora of *A. nahoumii*, we observed 17 native species, of which two are endemic species of the state of Bahia (*Vriesea bahiana* and *Mandevilla sancta*) (Tab. 1, Fig. 2). The species *Tibouchina tomentulosa,* belonging to the family Melastomateceae, is native to Brazil and was found with greatest frequency (41%), having density of 1.625 individuals per hectare in the three sub-areas studied. *Sobralia lilliastrum* was the species with the highest density (2.050 individuals per hectare), but with low frequency (9%). The other species observed had low frequency and density (Tab. 1).

The five families with the highest species richness were Orchidaceae (6 spp.), Asteraceae (4 spp.), Apocynaceae (2 spp.), Bromeliaceae (2 spp.) and Velloziaceae (2 spp.), which together corresponded to 87.80% to all the species identified (Tab. 1; Fig. 2). Besides the species observed in this study, the database of the Herbarium of Recôncavo da Bahia Federal University (available online at http//www.splink.org.br) indicates the occurrence of other species in the area studied, such as *Phragmipedium sargentianum* (Rolfe) Rolfe (Orchidaceae) and *Mandevilla scabra* K.Schum. (Apocynaceae), both with strong ornamental potential. The absence of these species during the floristic survey might have been related to predatory extraction activities, to obtain specimens for sale, as occurs with *A. nahoumii* at roadside stands in the region, according to Versieux & Wanderley (2010). When prospecting the area to start the study, we observed only one clump of *P. sargentianum*, which was no longer found during the survey. The families found with the greatest richness were the same ones found in rocky outcrops, both those associated with the Atlantic Forest Phytogeographical Domain (Queiroz *et al.* 1996; Paula *et al.* 2017) and the Caatinga Phytogeographical Domain (Conceição & Giulietti 2002; Conceição & Pirani 2005; Conceição *et al.* 2007).

The dispersion diagram obtained from the canonical correspondence analysis (CCA) explained 99.84% of the cumulative variance, with axis 1 accounting for 71.88% and axis 2 for 27.96% (Fig. 3). Axis 1 is associated with the slope (angle) of the rock, axis 2 with the percentage of rock exposed, and axis 3 with the percentage of organic matter. The plots at the highest altitude showed greater dispersion between axes 2 and 3, while those at the middle and lower elevations were near each other between axes 1 and 2, a result related to the higher slope percentage and percentage of exposed rock. The largest quantity and concentration of species occurred at the high elevation because its plots had less declivity and greater concentration of organic matter in the cracks of the rocks. According to Pedersoli & Martins (1972), several species are more prone to develop on flat surfaces of the rock outcrops due to the accumulation of humus that lodges in the cracks of the rocks. Benites *et al.* (2003) report that some species develop directly on the rock or in microsites where there are conditions for root fixation and sometimes thin layers of soil. In the rock complexes on igneous rocks, there are more rounded and homogeneous geoforms, whereas on quartzite rocks there are numerous microclimatic sites, represented by cracks and pontoons, as well as valleys and depressions where there is deposition of sand resulting from the decomposition of rocks and accumulation of organic matter, thus favoring a greater diversity of species.

The percentages of plant cover in the three sub-areas studied – high (68.59%), middle (67.98%) and low (66.76%) (Tab. 1) – were similar to those found in rocky fields in the Chapada Diamantina region of Bahia, of 64.10% in Mucugezinho (Neves & Conceição 2010), but greater than that recorded on Mount Pai Inácio (50.50%) (Conceição & Giulietti 2002) and the Sincorá Range (51.8%), even though these areas are at lower altitudes (Neves & Conceição 2007). A possible explanation is because the area we studied is located on the western side of the Serra da Jibóia, in a transition zone of Atlantic Forest and Caatinga, it is subject to less influence of biotic factors compared to the rocky outcrops of the Chapada Diamantina region, which is a semiarid region.

Among the 25 genera found in the Serra da Jibóia, seven (*Cyperus*, *Epidendrum, Sobralia, Tibouchina, Mandevilla, Melinis* and *Vellozia*) are also found in rocky fields of the Sincorá Range in Bahia, (Neves & Conceição 2007), on Morro do Forno, São Paulo (Oliveira & Godoy 2007),

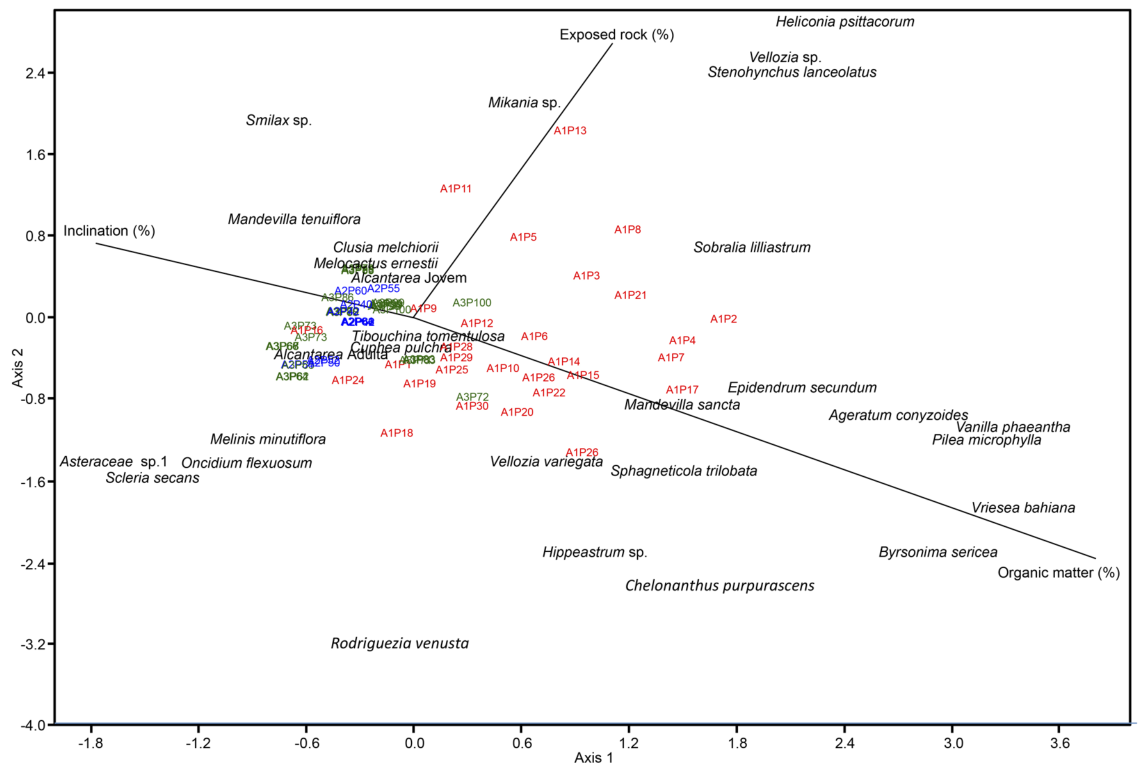

Figure 3 – Dispersion diagram from canonical correspondence analysis (CCA) applied on 100 plots measuring 2 × 2 m (4m^2), species recorded and environmental variables in Serra da Jibóia, Santa Teresinha, Bahia, Brazil. High area (red), middle area (green) and low area (blue).

Quixadá, Ceará (Araujo *et al*. 2008) and some regions of Minas Gerais (Carmo & Jacobi 2013).

Rocky outcrops are naturally vulnerable to temporal and environmental disturbances and are likely to be affected by climate change (Fernandes *et al*. 2004; Pugliesi & Rapini 2015; Bitencourt *et al.* 2016). Therefore, the structuring role of *A. nahuomii* in the community is related to its role in the colonization and secondary succession reported in Bromeliaceae species in rocky outcrops. They are plants with resistance to mechanical impacts and able to propagate by vegetative reproduction (Conceição & Pirani 2007; Conceição *et al.* 2016). This structuring role may reflect the richness of the outcrops, both in the diversity of species and functional diversity that allows the occupation of species in distinct and diversified environments, with a large proportion of endemic genera. Among these, the genus *Tibouchina* is most common and also stood out the most in these rocky field areas (Romero & Martins 2002; Silva & Romero 2008).

After the study period, once again the vegetation studied was affected by a fire (January 2017). Fire is considered as one of the main factors that changes the dynamics and structure of ecosystems, including rocky outcrops, as it directly affects the sexual and vegetative reproduction, the establishment of new seedlings, and the development, growth and mortality of individuals. Species respond differently to fire, and it is a mitigating factor of the vegetation in several biomes of the planet (Hoffman 1999; Neves & Conceição 2010).

Although the results found for the population structure demonstrate that *A. nahoumii* is stable, events such as fires that have occurred in the area, which does not present fire history, associated with large extractive exploitation focused on this species, make them vulnerable, along with the other species that inhabit the area. The result of the balance between biotic potential and environmental resistance is that it allows a stable population in nature.

Rapid deforestation, predatory extractivism, disordered tourism and frequent fires all have a negative effect on the biodiversity of rocky outcrops in the Serra da Jibóia, posing a risk for the preservation of this ecosystem. The results of this study can support future research to develop conservation measures and public policies to help preserve the region's biodiversity.

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