SPATIAL VARIATION IN THE STRUCTURE OF LIZARD ASSEMBLAGE IN A SAVANNA ENCLAVE IN THE ATLANTIC FOREST IN NORTHEASTERN BRAZIL.

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ABSTRACT

Spatial variation in the structure of a lizard assemblage at the Atlantic Rain Forest was studied, considering the richness and abundance of species, and their relationships with the microhabitat use. The work was carried out in a savanna patch inside Atlantic Rain Forest biome. Variation in the microhabitat use was assessed by quantifying structural variables of the habitats adjacent to the pitfall traps which were used to determine the composition and diversity of species. We found 958 individuals from 10 species, *Ameivula ocellifera* was the most abundant and *Psychosaura macrorhyncha* the least. Rarefaction and species accumulation curves were based on individuals, with the curve reaching an asymptote around 140 individuals collected. Canonical Correspondence Analysis (CCA) was applied to examine the relationship between species of lizards and the characteristics of the microhabitat. The CCA showed an absence of relationship between species and the physical structure of the habitat, hence indicating the possibility of absence or reduction in local competitive forces, possibly linked to the hypothesis of ecological release.

Key words: Ecology, lizard community, habitat structure, microhabitat, richness.

INTRODUCTION

Communities are generally defined as associations among the populations of different species that coexist at the same place and same time in a defined location (1). A community can be described considering, species richness, composition, abundance and spatial distribution, as well as ecological aspects and specific phenotypical properties (18). Several hypothesis have attempted to explain the community structural patterns, both at the local (ecological factors, such as inter-specific interactions and disturbs) (5) and regional (historical factors, such as phylogeny, extinction events and speciation) levels (10), as stochastic events, also known as neutral events (2).

At the local level, variations in the composition and in the richness and distribution patterns of the species can be explained either by the occurrence of specific habitats, or as influenced by the physical structure of the environment (9). Vitt *et al*. (2007) in the Brazilian Cerrado, showed a close relationship between lizard species occurrence and the physical structure of the environment, giving evidence of the strong link that exists between such characteristics. Currently, many studies in communities tend to focus on assemblages, groups of related phylogenetically species that coexist in the same area (19). Lizard assemblages in the

Cerrado may have their distribution and diversity influenced by local environmental characteristics, such as the availability of termite nest, trees, fallen logs, and burrows in the ground (23).

The Atlantic Rain Forest is characterized by constituting a vegetal complex that includes several forest and non-forest ecosystems (7), as well as presenting open formations, or areas of ecological tension. In northeastern Brazil, these formations present floristic similarity with the Brazilian Cerrado, and occur within the forest (16), and are locally known as 'Tabuleiros' or Savanna enclaves (26). These formations occur as dispersed islands inside forest areas, as, for example, in the Amazonian and Atlantic Rain forests (18).

The aim here was to test whether the lizard assemblage in a savanna enclave of the Guaribas Biological Reserve varied on a microgeographic scale, and whether its distribution on such a scale is predictable, when based on habitat structure.

MATERIAL AND METHODS

The Guaribas Biological Reserve is located on the northern coast of Paraíba State, Brazil (6º40'- 6º48' S and 35º06'-35º12' W). The reserve comprises three discontinuous fragments, SEMA 1, SEMA 2 and SEMA 3, located in the Mamanguape and Rio Tinto municipalities, which together make up a total area of 4.028,55 ha. The present work was undertaken in SEMA 2, comprising an area of 3.016,09 ha. (15).

The Guaribas Biological Reserve presents two main types of phytophysiognomies, namely: savanna enclaves (Tabuleiros Forest), confined to 'Tabuleiros' areas formed mainly by neosoils, and the seasonal semideciduous forests of the lowlands that occupy the arid areas at a higher level than the medially deep soils of the type alisoil, predominant in the reserve (15). The study was carried out in only one area of savanna enclave. According to Köppen's classification, the climate on the reserve is the As type, characterized as being hot and humid, with a dry season in the summer, and a rainy season in the autumn and winter (15). The temperature varies between 24ºC and 36ºC, with the hottest period from December to February. The influence of the soft southeast winds is felt throughout the year. The study area is situated between the isohyets 1.750 and 2.000 milimeters|year, with the rainy period beginning in February, reaching the highest levels in April, May and June, and continuing until July. The dry season lasts between two and three months, and occurs in October, November (the driest) and December (15).

Collection was carried out during a period of 2 years and 5 months, from August 2008 to January 2011. Sampling was made with pitfall traps. The area used for data collection was defined taking into consideration the phytophysionomic characteristics of the savanna enclave present in the area. 25 pitfall traps points were then installed, each comprising 4 trapdoors, arranged in three lines 5 meters long, and forming angles of 120°, starting from the same central point, and connected by metal plates. The trapdoors were made of plastic buckets of 60 liters and the metal plates were fixed by wooden stakes. The pitfall traps were inspected at least twice a week. During monitoring, the species of each lizard captured was identified; with notes relating the day and the number of the pitfall trap.

Structural variables of the habitat were measured in each pitfall traps: (a) leaf litter mass; b) percent open ground; (c) percent of surface open air (d) number of plants stem contacts; (e) number of burrows in ground; (f) number of fallen logs; (g) number of termite nests within a radius of 6 meters from the center bucket; (h) distance to bromeliads; (i) distance to nearest tree; (j) trunk circumference of the nearest tree (Table1). For measuring the variables (a), (b) and (c), was made a 0.5

m^2 square frame (densiometer), with slats and strands tied at 10 cm intervals one side to another, resulting in 25 square plots of equal size. For (a), in each point of the pitfall trap, the densiometer was thrown over the shoulder, and where it fell was considered as the sampling site. The leaf litter thus enclosed was collected, previously air dried, and then placed in plastic bags and measuring the mass with a Pesola (precision scale). In (b) and (c), the number of square plots with up to 50% in open ground, the first case, or in the canopy cover, the second, were counted. To perform the measurement at (b), the densiometer was put above the head, and in (c) put at 1 meter from the ground. For (d) a one meter rod was rotated at an angle of 360º, and quantified the stems that clashed with her. In (e), (f) and (g), were counted in a 6 meters radius from the central bucket. To (h), (i) and (j) we used a tape measure.

These environmental variables were used for checking the association between species concerning abundance of lizards in the traps and habitat structure variables.

To evaluating sampling quality, rarefaction curves based on individuals were calculated (8) with the EstimateS 8.2 program (5), with 1.000 random set ups of original data without replacement. As prescribed by Gotelli and Colwell (2001), the Sobs Mao Tao index and the (Chao 2) diversity estimator were used for this. The existence of correlations between the species of lizards and microhabitat characteristics at each pitfall trap point was certified by Canonical Correspondence Analysis (CCA). This is a procedure of multivariate arrangement that directly associates variation in one matrix (lizard assemblage as the dependent variable) to variation in another matrix (habitat characteristics as the independent variable) (20 and 21). In addition, the procedure of Monte Carlo test with 9.999 permutations in first canonical axis was used to test whether the assemblage structure is actually established by environmental factors or merely to chance.

RESULTS

A total of 958 specimens, belonging to 11 species were collected. *Ameivula ocellifera* was the most abundant species with 335 individuals, followed by *Kentropyx calcarata* (166) and *Micrablepharus maximilliani* (151). The least abundant species were *Psychosaura macrorhyncha* with only 14 individuals (Figure 1) and *Salvator merianae*, with only one, thereby excluding it of the analysis due to the impossibility of association with any environmental variable.

Table 1 – Averages and standard deviation of habitat structure characteristics from the 25 points with pitfall traps.

Environmental variable	Average	Standard deviation
Canopy cover	17.23	7.164
Density of plants	6.267	4.29
Leaf litter	176.6	90.447
Burrows	1.16	1.599
Fallen logs	1.16	1.929
Distance to nearest tree	1.942	3592.058
Tree circumference	38.64	21.623
Nr. of bromeliads	0.96	2.071

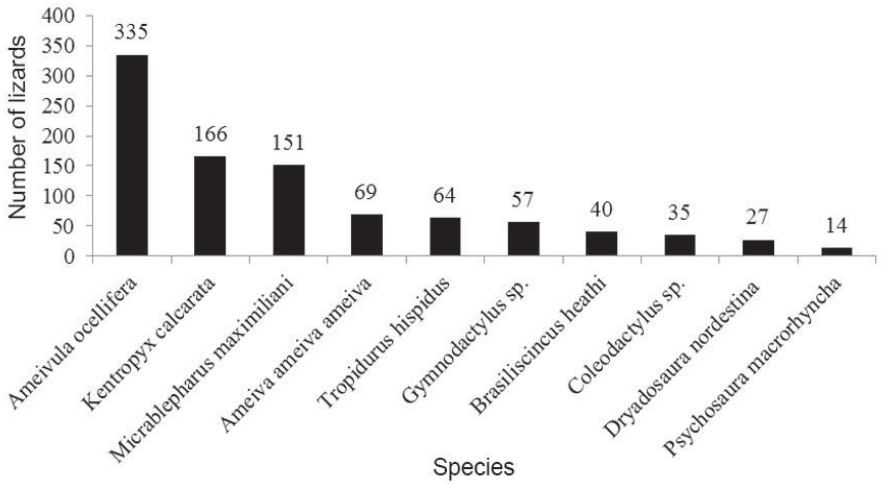

Figure 1 – Number of specimens by lizards' species in the Biological Reserve of Guaribas, Mamanguape – Paraíba State., during the period August, 2008 to January, 2011.

The species accumulation curve reached the asymptote when approximately 140 individuals were collected, with the estimate of 10 species in the study area. These were *Ameivula ocellifera, Micrablepharus maximiliani*, *Kentropyx calcarata*, *Brasiliscincus heathi*, *Psychosaura macrorhyncha*, *Coleodactylus sp.*, *Gymnodactylus geckoides*, *Tropidurus hispidus*, *Ameiva ameiva ameiva* and *Dryadosaura nordestina* (Figure 2).

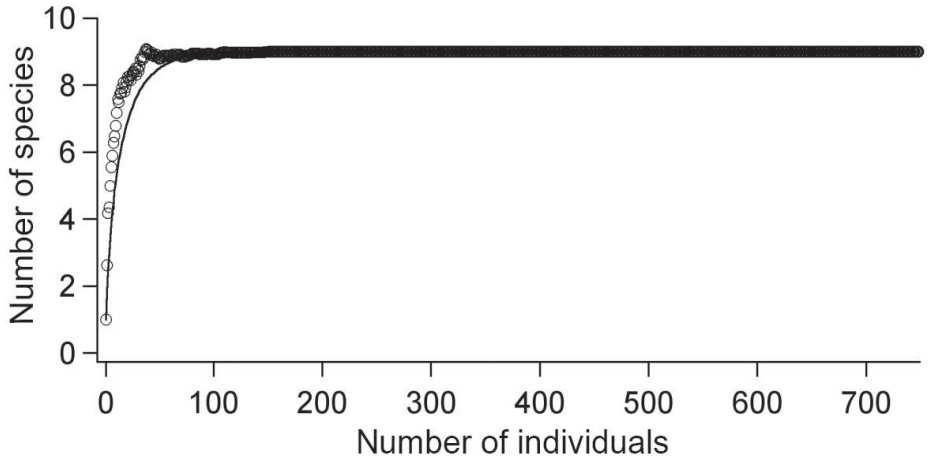

Figure 2 – Rarefaction and species accumulation curves based on individuals collected in the Guaribas Biological Reserve, Mamanguape – Paraíba St., during the period August, 2008 to January, 2011.

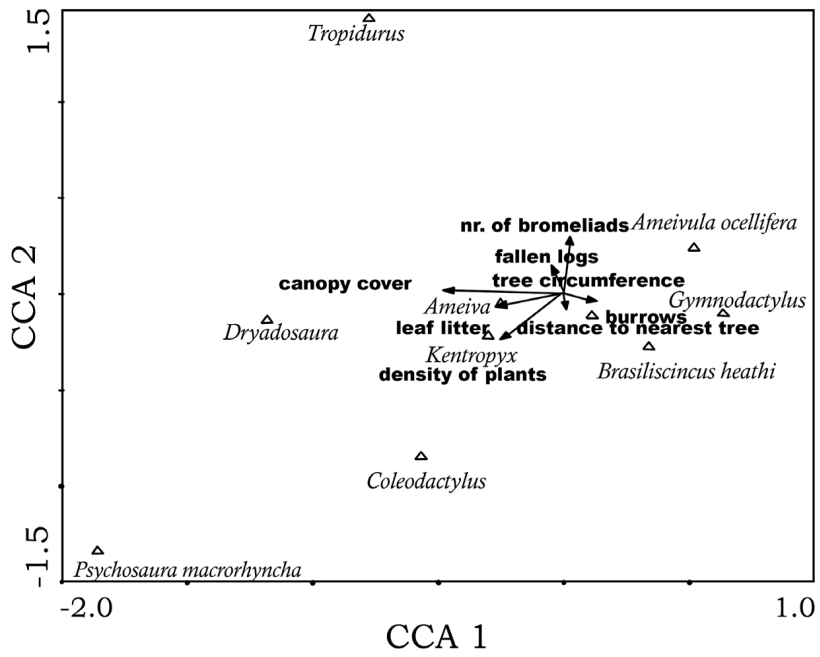

Figure 3- Canonical Correspondence Analysis of lizard abundance and the matrices of environmental structural characteristics on the two canonical axes (CCA 1 and CCA2).

From the collected data, it could be observed that *Ameivula ocellifera* was more commonly distributed in areas with open vegetation, *Micrablepharus maximilliani* more often in areas with coverage and burrows in the ground, *Gymnodactylus* sp. in burrows in the ground, *Ameiva ameiva ameiva*, in areas with leaf litter and *Kentropyx calcarata* in areas with shrubs (Figure 3). However, correlations between distribution of species assemblage and these environmental variables were not significant. Based on the 9.999 permutations of the Monte Carlos test, and the first canonical axis, no significant relationship was found between the habitat structure in each pitfall traps and the species found there (eigenvalue = 0.076; F-rati = 3.201; *P*- value = 0.2497). Furthermore, even when based on all the canonical axes, correlations were still insignificant (Trace= 0.147; F-ratio = 0.954; *P*- value = 0.5629).

DISCUSSION

Although the CCA show that the lizard species would be dependent on microhabitat at a local level. It was not found, in this study, significant relationship between these variables. The absence of a structure related to the microhabitat use for the lizard species has already been described in the literature. Lister (1976) studied the ecological consequences of the lack of competition among lizards of the genus *Anolis* on the Caribbean islands, and found that there is a greater ecological niche breadth used by them. It was also observed that lizards expanded their habitats due to the absence of regional competitors, hence species not only used specialized environments, such as leaf litter, fallen logs etc., but became habitat-generalists. A similar result was shown in work with assemblage structure of lizards in Brazil (13).

Due to the isolation, the islands often present low species diversity. Animals living on islands may encounter greater availability of resources, as well as the absence of competitors, making them fewer specialists than residents in continuous areas (11). Competition restricts either the amount of resources as the abundance of species. Thus, it can be said that populations on islands can present a more elevated density and a greater niche breadth than, would be the case, in continental areas (9).

Although lizard assemblages in savanna enclaves present low diversity, there are a large amount of endemic species (4). According to the phenomenon, density compensation, isolated areas present lower richness of species, when compared to continuous ones (12). On the other hand, island species present greater niche expansion (6) and greater density (12). To these two phenomena, taken together, is given the term "relaxation" or "Ecological Release". In other words, species that live in isolated areas, with fewer species, can expand their habitats (habitat expansion) and occupy the vacant niches that would have been occupied by other species (6, 12).

The random use of microhabitats encountered in this lizard assemblage, possibly indicate the absence of competitive interactions that play an important role in microhabitat use (3), and which are possibly related to ecological release events.

'Tabuleiros' regions are savanna enclave into the Atlantic Rain Forest. Other areas of savanna enclave in other biomes, such as the Amazonian savannas, present lower lizard richness than is the case in continuous areas in central Brazil (e.g., 13). This low diversity related to an effective number of microhabitats, can lead to a reduction in competition between species of lizards, and therefore reflect the structure of the assemblage. Mesquita *et al.* (2007) indicated that despite the reduced number of lizard species in assemblages of Amazonian savannas, many of the structure was derived from historical factors, not showing niche expansion and density compensation, with the exception of the Tropiduridae family. However, a more recent isolation linked to intense anthropogenic pressure that have fragmented the Atlantic Rain Forest, can intensify the importance of ecological factors and may lead to ecological release and the lack of structure related to the use of microhabitat in the lizard assemblage present in 'Tabuleiros' area. Thus, this hypothesis just can be tested, by using a higher number of areas and other characteristics, such as the breadth and overlap of niche ecological characteristics in species of lizards.

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RESUMO

Foi estudada a variação espacial na estrutura de uma taxocenose de lagartos da Floresta Atlântica, considerando a riqueza e abundância de espécies e suas relações com o meio em que habitam. O trabalho foi desenvolvido em uma região de isolados de cerrado no estado da Paraíba. Analisamos se a estrutura da taxocenose de lagartos é influenciada pela estrutura do hábitat a nível local detectando se existe variação no microhábitat utilizado pelas espécies. Nós utilizamos armadilhas de interceptação e queda para determinar a composição e diversidade das espécies. Foi encontrado um total de 958 indivíduos de 10 espécies, tendo sido *Ameivula ocellifera* a espécie mais abundante e *Psychosaura macrorhyncha* a menos

abundante. Foi feita uma curva de rarefação e acumulação de espécies baseada em indivíduos, tendo a mesma atingido a assíntota por volta de 140 indivíduos coletados. Para examinar a relação existente entre as espécies de lagartos e as características do microhábitat, foi realizada uma Análise de Correspondência Canônica (CCA). A CCA mostrou uma ausência de relação entre a riqueza e abundância de espécies e a estrutura física do hábitat, isso indica que na área pode haver uma ausência ou redução de forças competitivas, fato que provavelmente pode estar ligado com a hipótese de liberação ecológica.

Palavras chave: Ecologia, comunidade de lagarto, estrutura do hábitat, microhábitat, riqueza.

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