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Where Are the Bromeliads? A Study on Different Trails in the Ecological Reserve of Guapiaçu, RJ

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Abstract

Bromeliaceae are important in ecological restoration, showing easy adaptation to different environments, and constantly interacting with each other through ecological relationships, whose effects may or may not benefit the species involved. The hypothesis tested whether the population density of *Hohenbergia augusta* is higher in areas at a more advanced successional stage (brown trail), since the species is typical of more structured forest environments, occurring especially in the lower strata of the forest. Six plots of 10 meters (6 × 10 m) were installed, parallel to the brown and yellow trails, and with a distance of 5 m from the edge. Plots were allocated alternately between the two sides of the trail, 10 meters apart from each other when on the same side. In each plot, all *H. augusta* (Vell.) E. Morren bromeliads were sampled, without a minimum inclusion criterion, provided they were epiphytic phorophytes. The logarithm of the value was used for data normalization and later, the data were tested in a student's t-test. The study pointed out that the highest population density of *H. augusta* occurred in the brown trail because the area is in a more advanced successional stage.

Keywords

Bromeliads, Atlantic Forest, Ecological Restoration

1. Introduction

Floristic inventories in several stretches of the Atlantic domain have pointed to Bromeliaceae among the families with the greatest richness and diversity, both generic and specific [1]. They belong to the herbaceous monocotyledons, currently having 56 genera and 3680 species [2] [3]. In the Brazilian Atlantic Forest, a total of 31 genera, 803 species, and 150 infraspecific taxa were recorded [1].

Bromeliads are herbaceous plants, with strong rosette leaves that have a stem that tends to be strongly reduced, where spirally arranged leaves are attached [4], have small stems, with beautiful inflorescences, and are potentially visited by bees and various invertebrates [5] [6] [7]. Generally, the leaf base is enlarged, giving some species greater or lesser capacity to store water and organic debris, with smooth margins or those covered by thorns [5] [8].

Water retention in bromeliads is of great ecological importance, so its release is gradual for the ecosystem to guarantee a constant supply for other species, thus, the presence of bromeliads in forests benefits the diversification of interactions with vegetative and animal species [9] [10].

The use of bromeliads in ecological restoration is highly versatile due to its high degree of adaptation to rocky environments, poor soils, and different situations of direct solar radiation intensity, as well as forest interiors [11].

Species in a community constantly interact with each other through ecological relationships, the effects of which may or may not benefit the species involved [12]. Engwald *et al.* [13] state that bromeliads are bioindicators of forest conservation since the increase in the complexity of the environment favors the abundance of these plants and species diversification, as well as the biomonitoring of air quality [14].

Thus, the present work aimed to evaluate the population density of the bromeliad *Hohenbergia augusta* (Vell.) E. Morren differed between the brown and yellow trails. The study hypothesizes that the population density of *H. augusta* is higher in areas at a more advanced successional stage (brown trail), since the species is typical of more structured forest environments, occurring especially in the lower strata of the forest.

2. Material and Methods

Study Area: The study was carried out in the Reserva Particular do Patrimônio Natural Reserva Ecológica do Guapiaçu (RPPN REGUA), a conservation unit which has 7200 ha and is located in the municipality of Cachoeira de Macacu, approximately 120 km away from the city of Rio de Janeiro, covering the upper basin of the Guapiaçu River.

REGUA is a Brazilian non-profit organization that aims to protect and conserve the Atlantic Forest, promoting the ecological restoration of the area, community interaction and visitation, and scientific research. Within the area are found six trails, which are distributed between the upper and lower parts of

REGUA.

Among the REGUA visitation and research trails, two were used in this study: the brown trail, whose vegetation structure is characterized as a secondary forest in an advanced stage of regeneration, with denser vegetation, structured canopy, and less dense understory; and the yellow trail, with a more open forest and trees with a smaller diameter than the brown trail.

Six plots of 10 meters (6 × 10 m) were established, parallel to the trails, and with a distance of 5 m from the edge. Plots were allocated alternately between the two sides of the trail, 10 meters apart from each other when on the same side. In each plot, all *H. augusta* (Vell.) E. Morren bromeliads were sampled, without a minimum inclusion criterion, provided they were epiphytic phorophytes.

Data normality was tested and when data did not show normal distribution, they were transformed to the logarithm of the value.

Subsequently, to compare the population density of the means in the two trials, the data were tested using student's t-test.

3. Results and Discussion

Seventy-five bromeliads of the *H. augusta* species distributed in the twelve plots studied were registered. In the plots close to the yellow trail, eight bromeliads were found, while in the plots close to the brown trail, sixty-seven individuals were observed epiphytic the phorophytes.

In the statistical test to evaluate the abundance of *H. augusta* among the trials, the data were analyzed in a t-test and transformed into a log demonstrating a significant difference between both with a p-value of 0.012, with the degree of freedom (df) of 9.5. Having a greater abundance of bromeliads in the brown trail, about the yellow trail (Figure 1).

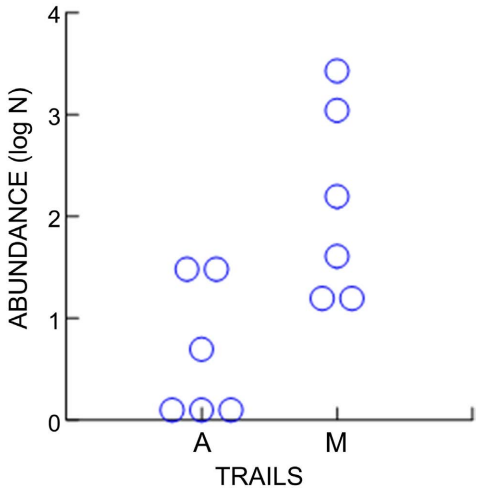

Figure 1. The abundance of *H. augusta* bromeliad on trails in different successional stages in the Ecological Reserve of Guapiaçu, Cachoeiras de Macacu, RJ. Y axis: Number of bromeliad individuals. X-axis: Yellow and brown tracks.

The environments studied have, in themselves, particularities that in turn define a greater abundance of epiphytic *H. augusta* bromeliads in plots close to the brown trail, where it has a more humid, closed environment with a greater diversity of phorophytes. The studied environments of the brown trail can be considered more structured, than the environments close to the yellow trail. The yellow trail has a high spacing between the phorophytes, with high light intensity, which may hinder the translocation of bromeliads in different trees for the occurrence of epiphytic. Considering that vascular epiphytic plants attach to other plants as support during their life cycle or for part of it, not being a parasite. They provide food and shelter for the fauna, as they simulate a micro-habitat, and are considered to enhance biological diversity.

And due to its epiphytic abundance in the two sample areas, we can highlight the high occurrence of *H. augusta* bromeliads in the brown trail, due to its habitat requirement and because it is an area that has been in the recovery process for a longer time [15].

Sugden and Robins [16], states that environmental factors such as temperature and humidity are responsible for the distribution of bromeliads in an ecosystem. Zotz and Hietz [17], state that in drier places there may be a reduction of individuals, the same may occur in lower temperatures accompanied by a defined dry season. This statement corroborates the results obtained in this study, where the yellow trail is in a short restoration period, with a more open environment and little tree diversity, with drier soil and greater light intensity, and with a high spacing between phorophytes (personal observation). Crayn *et al.* [18], report that the epiphytic habit is characteristic of the Bromeliaceae, as they develop anatomical, physiological, and morphological adaptations, thus being able to withstand intrinsic conditions concerning epiphytic, as they have absorptive trichomes that are of paramount importance for epiphytic evolution.

Being of great importance in forest ecosystems, as they play a great role in the hydrological and mineral cycles, says De Corrêa [19], these structures aim at greater absorption of water and nutrients, thus having greater permeability in the leaves. This corroborates with the results found in the high epiphytic of the brown trail, since the bromeliads tend to have survival strategies, they have a reduction of the roots as cited by Pittendrigh [20]. In the brown trail, there is a high variation of luminosity and humidity, having in its area places of large clearings, Zoltz and Tomas [21]. Highlight as a characteristic of this high capacity of epiphytes to survive in environmental variations.

Another adaptation present in epiphytic plants is Crassulacean Acid Metabolism (CAM) [18]. The CAM is a photosynthetic adaptation that arose independently several times in the evolution of vascular plants, possibly through the reorganization of already existing metabolic pathways in C3 plants [22].

Our results corroborate with Duarte and Gandolfi [23] who state that factors related to the soil, climate, and incidence of light in the restoration area are significant for the reproduction of the species and the success of the restoration

process, which proves this statement by observing the low abundance in the yellow trail. Bonnet *et al.* [24] state that the dimensions of the phorophytes are directly related to the bromeliads, which justify the greater abundance in the brown trail (**Figure 1**); since the trees are more mature because they are in a longer period. Restoration, thus having a better epiphytic composition of *H. augusta*. Thus, bromeliads can indicate the degree of conservation of the forest, since its climax phase presents a great abundance of individuals [13].

4. Conclusion

The highest population density of epiphytic bromeliads of the *H. augusta* species is found in areas at a more advanced successional stage. Thus, the role of this and other epiphyte species as bioindicators of the conservation status of forests.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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