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Each Epiphyte on Its Branch: A Comparative Study between Different Phorophytes

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Abstract

Epiphytes are plants that use the mechanical support provided by a host tree, called phorophytes, without emitting haustorial structures. Constituting an important component of the flora, playing an important role in the maintenance of ecosystems, such as water and nutrient cycling, in addition to providing resources, sometimes unique, such as food and shelter, for the canopy fauna. However, the epiphytic flora may show high beta diversity, even when compared with different phorophytes, possibly as a response to the dendromorphological characteristics of the phorophyte. Thus, this work aims to: 1) compare whether the species richness of epiphytes differs in trees with different morphological characteristics, and 2) compare species composition among three tree species. For this, 10 individuals of three tree species were selected: *Guaria guidonia*, *Ficus* sp., and *Roystonea oleracea*. In each individual, the number of species (richness) of vascular epiphytes was recorded and obtained from the species composition. To test differences in richness values between the three trees, we used analysis of variance (ANOVA) followed by Tukey's test. To understand whether the epiphyte community formed separate groups according to the tree species used, we used the available non-metric multidimensional scaling method (NMDS). Thirty-four species of epiphytes were found in the 30 phorophytes surveyed. The three tree species showed significantly different richness, with the highest found in *Guarea guidonea* and the lowest in *Roystonea oleraceae*. The NMDS showed that epiphytes group the three tree species into distinct groups, although Ficus sp individuals present a transitional community between the two other species.

Thus, the results suggest that the differences in the richness and composition of the epiphytic flora of the different phorophytes are influenced by their distinct morphological characteristics.

Keywords

Atlantic Forest, Ecological Reserve, Tree Species

1. Introduction

Epiphytes are plants that depend on other species, usually trees and shrubs, as mechanical support during all or part of their life cycle [1]. These plants are highly specialized to water stress, as according to Reyes-García *et al.* [2], epiphytes have a type of metabolism called CAM, which is a modification of the common C3 photosynthesis. This type of photosynthesis allows plants to absorb the carbon needed for photosynthesis only at night, when relative humidity is high, reducing water loss. This means that with their stomata closed during the day, they release CO_2 stored in the vacuole to carry out photosynthesis in the presence of light. We know that epiphytes can form and divide into two functional groups: those that have "tanks", which are water reservoirs formed between the broad leaves in a rosette, and those that do not have "tanks", called atmospherics, these atmospherics are generally smaller and have features that help save water. In both cases, epiphytes have leaf trichomes that help them absorb water and nutrients [2].

In Brazil, the epiphytic vascular flora stands out in the Atlantic Forest, a biome under the influence of high atmospheric humidity, with a large share of biomass. An example is in the Atlantic Forest located in southern Bahia, where epiphytic was found in 80% of the trees, with orchids and bromeliads being the most abundant [3]. The presence of forest moisture and the incidence of light are essential for the occurrence of such vegetation, however, it is important to highlight the presence of vines and bryophytes, which causes dispersion and the chemical and morphological attributes of the hosts to shape the bonds and patterns of interaction between epiphytes and phorophytes, thus leading to the formation of their communities [4].

Vascular epiphytes represent 10% of vascular plant species, with 27,614 species and 73 families. It can reach 35% of plant species in tropical forests, with greater diversity in the neotropical region, being of paramount importance for the ecosystem, since they provide shelter and food for animals and with the potential to indicate the state of conservation of the environment [5]. The knowledge of these plants in the ecosystem is of paramount notability because, according to Gonzatti *et al.* [6], the families with the greatest diversity of epiphytic species were Bromeliaceae, Orchidaceae, and Piperaceae, which entails implications for responses to the environment in which they are grown. inhabit.

Tree crowns are another important factor influencing plant diversity and development. The vertical distribution of epiphytes is affected by microclimatic differences in the crown and trunk of the tree, with more sensitive species found at lower heights. In addition, competition for light can occur both in the horizontal dimension, related to the canopy width and in the vertical dimension, especially for diffuse and reduced light, which can result in greater plasticity in the canopy depth compared to the width [5].

Thus, the present work aimed to 1) test differences in the richness of the vascular epiphyte community occurring in three tree species with distinct dendromorphometric characteristics and 2) evaluate whether the communities occurring in the three tree species are separated by species composition. Thus, our hypothesis is that differences in the dendromorphometric structure of the studied trees create different conditions for structuring distinct epiphytic communities.

2. Material and Methods

The study was carried out in the Private Natural Heritage Guapiaçu Ecological Reserve (RPPN REGUA), located in the municipality of Cachoeira de Macacu, approximately 120 km away from the city of Rio de Janeiro, covering the basin of the upper Guapiaçu River, at geographic coordinates 22˚27'12"S and 42˚46'13"W (**Figure 1**). REGUA is a Brazilian non-profit organization that aims to protect and conserve the Atlantic Forest, promoting the area's ecological restoration, community interaction and visitation, and scientific research.

REGUA is located in a rural area, where there are also other private properties in the surroundings, with access to all of them, both in the Reserve and neighboring ones, through dirt roads. Data collection for the current work took place on the sides of the access roads to REGUA and some surrounding farms.

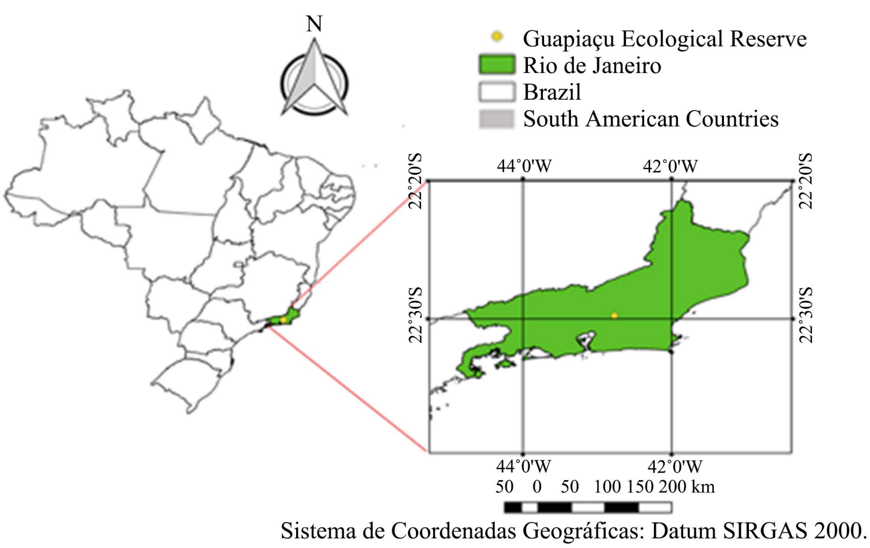

Figure 1. Geographical location of the Guapiaçu ecological reserve, located in the state of Rio de Janeiro, Brazil.

Methodology—For the present study, 10 individuals of three tree species were selected: *Guaria guidonia* (tick), *Ficus sp.* (fig tree), and *Roystonea oleracea* (imperial palm). Each individual was evaluated for the occurrence of epiphytes, which were mold-specified. The richness of vascular epiphytes was then recorded, and obtained from the species composition.

To test possible differences in epiphyte richness (S) between the three tree species studied, analysis of variance (ANOVA) was used, followed by the Tukey test (a posteriori test), in the Systat statistical package. To compare the composition of epiphytes in phorophytes, the ordering was performed using the non-metric multidimensional scaling method (NMDS) in the PAST program.

3. Results and Discussion

In all, 34 species of epiphytes were found in the 30 phorophytes surveyed. The highest species richness was recorded in Guarea guidonea (S = 24 sp.), while the lowest value was in Roystonea oleraceae (S = 12) (**Table 1**). Among the epiphytes, the species *Rhipsalis baccifera*, *Micrograma vaccinifolia*, *Rhipsalis oblonga*, *Pleopeltis pleopeltifolia*, *Tillandsia recurvata*, and *Tillandsia stricta* were found in the three species of phorophytes (**Figure 2**). *Rhipsalis baccifera*, *M. vaccinifolia*, *Aechmea nudicaulis*, and *R. oblongata* were the species with the highest frequencies, occurring in more than 50% of the individuals sampled (**Table 1**).

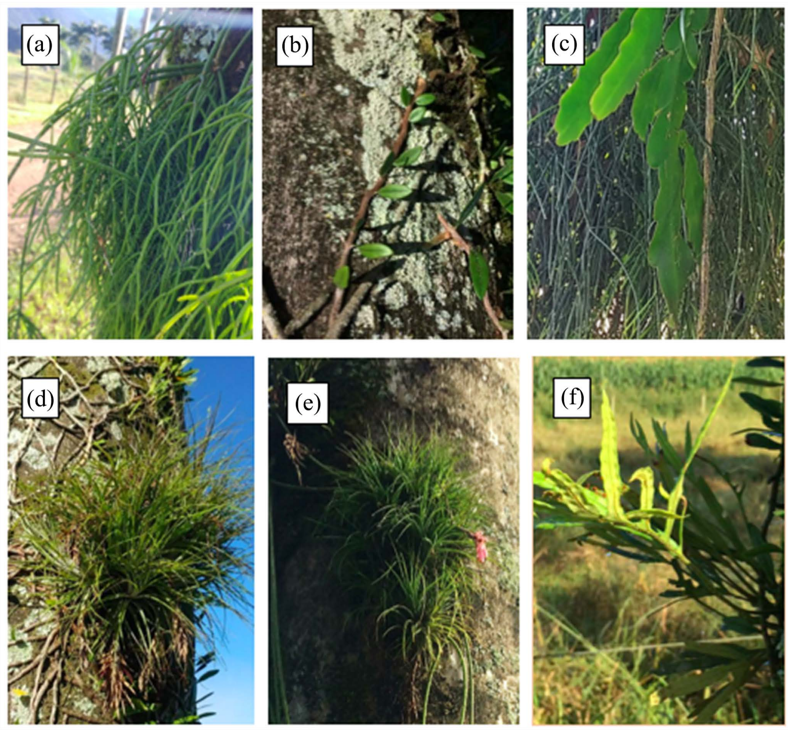

Figure 2. Photos of the species present in the three types of phorophyte (a) *Ripsalis baccifera*, (b) *Microgram vaccinifolia*, (c) *Rhipsalis oblonga*, (d) *Tillandsia stricta*, (e) *Tillandsia recurvata* and (f) *Pleopeltis pleopeltifolia*, in Guapiaçu Ecological Reserve.

Table 1. Species of epiphytes observed, with the number of phorophytes and in their respective groups that were found.

Spp.	Qnt. forófitos	Carrapeta	Figueira	Palmeira I.
Ripsalis baccifera	21			
Micrograma vaccinifolia	20			
Achmea nudcaulis	17			
Rhipsalis oblonga	16			
Hohenbergia augusta	14			
Quesnelia quesneliana	11			
Pleopeltis pleopeltifolia	10			
Tillandsia stricta	9			
Tillandsia stricta	9			
Araceae folha comprida	7			
Epífita filha dura	6			
Pteridofta 2	5			
Epífita fruto rosado	4			
Ficus sp.	4			
Monstera sp.	4			
Plecuma 1	4			
Vrisea sp.	4			
Asteraceae 2	2			
Epífita pilosa flor branca	2			
Erva de passarinho	2			
Pteridium sp.	2			
Seticrezia purpura	2			
Tillandsia tricholepsis	2			
Tillandsia usneoides	2			
Araceae 2	1			
Araceae 3	1			
Asteraceae 1	1			
Euphorbiaceae 1	1			
Filodendrum cordifolium	1			
Gesnericeae	1			
Jibóia	1			
Orquídea oncidium	1			
Plecuma 2	1			
Solanaceae 1	1			
Total	189	24	20	12

The three tree species differed in mean species richness (ANOVA: F = 23.4; gl = 2; p < 0.001) (**Figure 3**).

The NMDS result showed that the individuals of each phorophyte species formed homogeneous and separate groups (**Figure 4**), indicating that each tree species has a very characteristic epiphyte flora. The imperial palm and the tick formed separate groups. Fig trees, on the other hand, have a characteristic flora, but which are similar to the flora of the other two tree species.

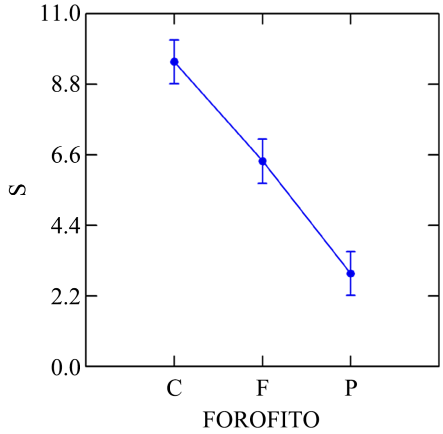

Figure 3. Average species richness (±dp) of epiphytes recorded in the three species of phorophytes studied in the urbanized area surrounding the Ecological Reserve of Guapiaçu, municipality of Cachoeiras de Macacu, RJ. C = *Guarea guidonea*; F = *Fucus* sp; P = *Roystonea oleracea*. Different letters indicate significant differences between the three species indicated by Tukey's test.

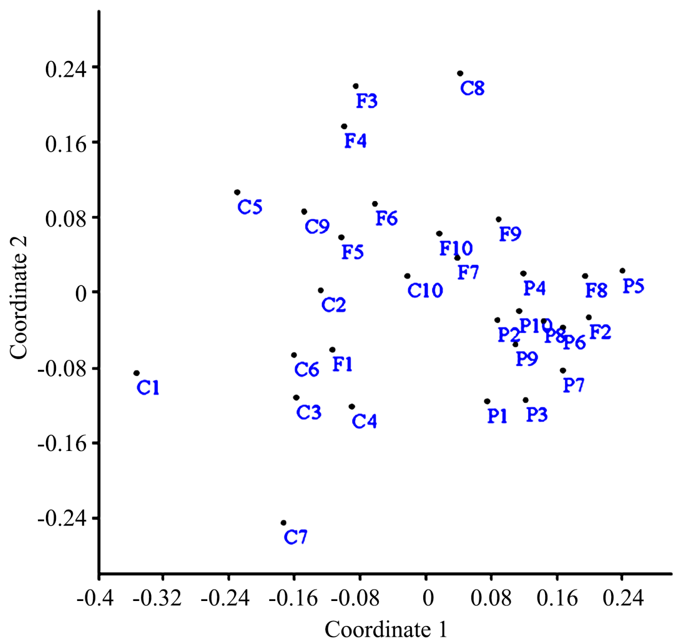

Figure 4. Graph with the result of the non-metric multidimensional scaling test. The tick and fig trees, on the other hand, have an architecture that allows for a greater number of niches and microhabitats, as their canopies help in the interception of rain.

The phorophytes studied represent three different levels of habitat complexity since they have morphological characteristics that create different niches among themselves and themselves. The imperial palm, due to the type of stem, without branches and cylindrical, and crown, with almost no cover, ends up not providing a diversity of environments for the occupation of several epiphytic species in its structure. The tick and fig trees, on the other hand, have an architecture that allows for a greater number of niches and microhabitats, as their canopies help in the interception of rain. According to the study carried out by Balieiro [7], the absence of indiscriminate land use in areas of agroforestry system can contribute significantly to the storage of carbon in the soil, as evidenced by the comparison with an area of native forest that sheltered the tick-true. In addition, the agroforestry environment is favorable for the germination and development of seedlings, thanks to the branched stems and rhytidomes that allow the fixation of the seeds and the availability of substrate for the soil. Although the fig tree and the tick have similar morphological characteristics about the presence of branches and branches that favor the fixation of seeds and availability of substrate for the soil [7], that make this variety of niches possible, we could assume that the difference in the richness between the epiphytic floras of the two have to do with factors such as the age of the studied trees, since all the ticks observed were mature individuals, which enables a greater fixation of epiphytes in themselves and the creation of new niches by the epiphytes themselves, while the fig tree individuals observed were in different stages of development, including young and smaller trees. The location where the trees are located can also interfere with the composition, since the luminosity and the weather and wind conditions directly influence the establishment and development of this flora. According to Marchiori *et al.* [8], this fact corroborates the discovery of a higher population density of bromeliad epiphytes in areas of more advanced successional stage, due to the presence of a more closed environment with higher humidity. In Brazil, the types of vegetation with the highest number of epiphyte and hemiepiphyte species were forests and campiness with fifty-four and six species, respectively [9].

Epiphytes prefer smooth and persistent trunk phorophytes, both in areas of primary forest and in areas of the urban forest. More than 50% of the forest tree species studied by Castro [10], form phorophytes, preferring those with smooth and fissured bark and persistent rhytidome. The ticks had seven species of bromeliads, while the imperial palms had only four.

Epiphytes are especially sensitive to microclimate variations because they obtain the water they need through the air and nutrients through rain, for this reason, they can survive environments with water and nutrient stress since the relative humidity of the air is more important. Then the volume of rain [3]. The epiphyte species that colonized the palm trees adapt to different conditions, including adverse conditions, different from some species found in ticks, such as the Oncidium Orchid, which is a more demanding species in choosing its phorophyte.

4. Conclusion

We conclude that habitat complexity directly contributes to species diversity, following the maxim that the greater the number of niches present in the phorophyte, the greater the number of epiphyte species colonizing it. The habitat not only influences the richness, but also the species composition of each phorophyte, which was different for each habitat.

Conflicts of Interest

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

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