

MACADAMIA SPP. AS AN EPIPHYTE HOST PLANT IN A CLOUD FOREST IN VERACRUZ, MEXICO

MACADAMIA SPP. COMO PLANTA-HOSPEDEIRA DE EPÍFITAS EM UMA FLORESTA NUBLADA EM VERACRUZ, MÉXICO

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Abstract

Epiphytes are representative groups of plants from the mountain cloud forest. This research was conducted in Tlalnehuayoan, Veracruz, Mexico, to identify epiphyte species richness in a macadamia nut crop. The area comprised 800 m², where cover, canopy richness, frequency, and epiphyte location were estimated. Results found 22 epiphyte species. The most represented genus was *Tillandsia*, with 10 species. The highest frequency was recorded in the middle area of the canopy. It is concluded that epiphytes can colonize macadamia trees mainly in the denser regions.

Keywords: Epiphytes. Macadamia. Cloud Forest.

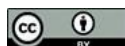
Resumo

*As epífitas são grupos representativos de plantas da floresta nublada de montanha. Esta pesquisa foi realizada em Tlalnehuayoan, Veracruz, México, com o objetivo de identificar a riqueza de espécies de epífitas em uma plantação de macadâmia. A área abrangia 800 m², onde foram estimadas a cobertura, a riqueza do dossel, a frequência e a localização das epífitas. Os resultados identificaram 22 espécies de epífitas. O gênero mais representado foi *Tillandsia*, com 10 espécies. A maior frequência foi registrada na área média da copa. Conclui-se que as epífitas podem colonizar árvores de macadâmia principalmente nas regiões mais densas.*

Palavras-chave: Epífitas. Macadâmia. Floresta Nublada.

1 INTRODUCTION

Epiphytes are vascular plants that spend part of their life cycle on other plants without harming them. They are generally found in tree canopies, where they can access the light and moisture conditions they require. Among the most representative families are Orchidaceae, Bromeliaceae, and Araceae. Epiphytes are an outstanding and essential component of tropical rainforests because of their contribution to species richness, biomass, and the interactions they generate with the ecosystem as a source of food and



habitat, as well as for their participation in the dynamics of the water and nutrient cycles of the forest (Kromer *et al.*, 2021). The mountain cloud forest (MCF) is the ecosystem that hosts the greatest diversity of epiphytic species. However, the MCF is currently highly fragmented and under anthropogenic pressure from land-use change, leading to a decline in species richness within this vital group of vascular plants (Kromer *et al.*, 2020). In Mexico, macadamia was introduced as part of the Coffee Crop Production Diversification Program promoted by INMECAFE in the late 1960s (Escamilla *et al.*, 2013). As a result, it has spread into mountain regions, mainly in mountain cloud forests. The municipality of Tlalnahuayocan is recognized in Mexico as one of the main areas of national macadamia production. There are more than 7 small orchards (with areas of 2 to 12 hectares) that are at least 30 years old. In these, the crop is managed as a single-crop system within the MCF, yielding 6-24 kg per tree, with an average of 11.4 kg per tree. Based on this production data, macadamia orchards in the municipality yield between 1,200 kg and 5,800 kg per ha, with an average of 3,500 kg per ha (Quintas *et al.*, 2017).

Among the studies conducted in the central region of Veracruz are those by Kromer *et al.* (2021), who compare epiphyte biodiversity among MCF, a secondary forest, and a shade coffee plantation. The same author *et al.* (2020) compile and synthesize information on the diversity and distribution of epiphytic angiosperms in the state of Veracruz, documenting 21 families, 142 genera, and 569 species. The families with the highest species richness were Orchidaceae, Bromeliaceae, and Piperaceae, while the genera with the most taxa were Tillandsia, Peperomia, and Epidendrum. Other research in the area is scarce and is more than 10 years old. Therefore, studies of epiphyte composition in macadamia nut plantations could be pioneering research in the field. Thus, this study aims to identify epiphyte species richness in a macadamia nut crop in Tlalnahuayocan, Veracruz, to determine if the macadamia tree can serve as a potential host for epiphytes.

2 METHODOLOGY

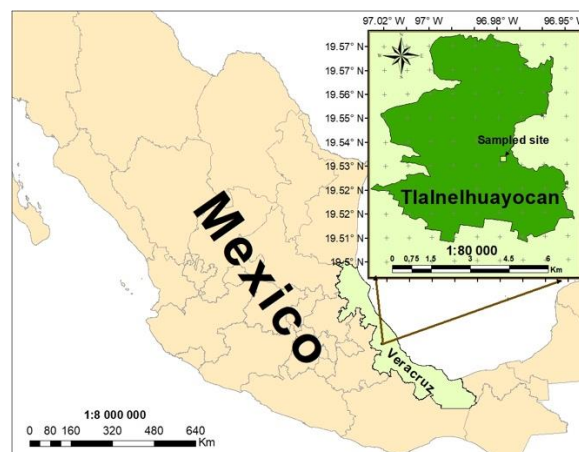
The municipality of Tlalnahuayocan has a humid-temperate climate with an annual rainfall of 1350 mm, an average yearly temperature of 14-16 °C, and an average altitude of 1619 masl (CEIEG, 2023). In this municipality, a macadamia orchard that had

previously been a pasture area for over 20 years was selected. The size of the study region comprises five hectares (geographical coordinates 19.533360 N 96.975298 W, 19.534261 N, 96.974766 W, 19.531303 N, 96.972647 W, 19.531957 N, 96.972151 W) (Fig. 1). The site has 25-year-old trees at a density of 200 trees per hectare, and with more than five established macadamia varieties, including Huatusco, Victoria, Alberca 527, Mauka and Gabor varieties. The sampled data was taken in the second week of June.

Five 20 x 10 m sampling units were randomly established in the orchard, where the number of macadamia trees at each site was counted. Data recorded for each tree per unit included the diameter at breast height (DBH, 1.3 m), the height measured with a bamboo stick marked at 0.5 m intervals, and the crown area measured with a tape measure to obtain the basal area of the tree at the height of the live crown. The presence or absence of epiphytic plants and in which zone they are found as described by Nardy *et al.* (2024), who divided the host tree into four strata: (A) base of the trunk, (B) lower trunk, (C) inner canopy and (D) outer canopy, to recognize which part of the canopy had the highest presence of epiphytes. The epiphyte species found were identified taxonomically using the local Handbook by Díaz-Toribio (2013).

Figure 1

Location of Tlalnahuayocan municipality in the State of Veracruz, Mexico.

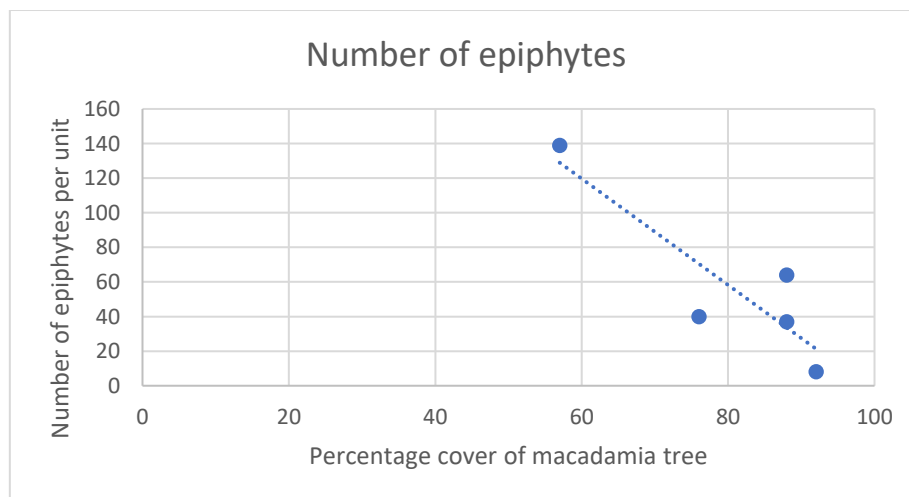


3 RESULTS

A total of 22 epiphyte plant species were recorded, six of which were determined at the genus level. The remaining species belong to the genera *Anthurium*, *Jacquinella*, *Pleopeltis*, *Phlebodium*, and *Tillandsia*. The best-represented genus among the epiphyte species recorded in the macadamia nut plantations is *Tillandsia*, with 10 species, followed by *Pleopeltis* and *Phlebodium*. The total number of trees per sampling area (200 m²) was very regular, between 4 and 5, 6 to 15 m in height, with the average first ramification at 1.4 m and 4 or 5 branches, as the plantation density was homogeneous. However, tree cover ranged from 57% to 92%, and the number of epiphytes recorded varied widely, from a minimum of 4 to a maximum of 187 per tree. The minimum canopy cover was 4 m², and the maximum was 10.7 m². The highest epiphyte species richness (Figure 2) was found in macadamia trees with a DBH of 10 to 16 cm; in terms of location, most of the epiphytes were found inside the main branches of the trees in zone C - inner canopy, being practically scarce in the peripheral areas (zone D).

Figure 2

Comparison of the decrease in epiphytic plants with the increase in tree cover in macadamia trees.



4 DISCUSSION

The distribution of epiphytes within the tree structure coincides with that observed in neotropical rainforests (Muramaki *et al.*, 2021). The number of epiphytes per unit of cover shows a clear decreasing trend (-4.75), indicating that there are almost 50 fewer plants for every 10% increase in tree cover. However, more variables would need to be analyzed to determine why there are no plants in unit 5. In this respect, Murakami *et al.* (2022) note that microclimatic gradients in a tree canopy are complex and can generate different patterns of epiphyte distribution. Although a well-defined tree layer exists in a macadamia nut plantation, some trees may not have the climatic and biological conditions to support the various epiphytic plants. This observation coincides with that of Gómez (2010), who reported the same situation in his comparative study of epiphytes in the preserved MCF versus an early successional forest in the Xalapa region. These results may be due to macadamia trees not providing adequate conditions for epiphytic plants that require high humidity and greater sunlight (Ferguson *et al.*, 2022). In addition to the juvenile state of the macadamia trees, the short colonization time and the narrow angle of the branches do not contribute to substrate accumulation (Murakami *et al.*, 2022).

The biodiversity richness of 22 species is below half of what Kromer (2021) recorded in the lowest ecosystem biodiversity he studied in a neighboring municipality of Tlalnelhuayocan, a secondary forest with 38 epiphyte species. However, in his study, the area was twice as large as in this study.

5 CONCLUSIONS

The macadamia nut plantation can support epiphyte species; however, it presents a low species richness, which may be due to the architecture of the macadamia trees, which are 6 to 15 m in height, with the average first ramification at 1.4 m and 4 or 5 branches. These trees are sparsely branched compared to typical mountain cloud forest trees and do not provide suitable conditions for epiphytes. The highest epiphyte density was recorded in macadamia trees near the mountain cloud forest boundary. Under this scenario, if the proliferation of epiphyte plant species within macadamia plantations is to be encouraged, fragments of mountain cloud forest adjacent to the orchard must be

conserved, pruning to increase branching must be implemented, and mature native cloud forest trees within the macadamia orchard should be left standing.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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