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# Host species of the hemiparasitic shrub *Phoradendron nervosum* Oliv. in densely urban areas of Quito, Ecuador

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# Especies hospederas del arbusto hemiparasítico *Phoradendron nervosum* Oliv. en zonas urbanas de Quito, Ecuador

## Abstract

*Phoradendron nervosum* is a hemiparasitic shrub with a wide distribution. Despite this, the ecology and natural history of this species is not well studied. Host species of *P. nervosum* are reported from Mexico and Costa Rica, with recent reports from Ecuador. Inside the urban settings of the metropolitan area of the city of Quito, we found during our sampling that *P. nervosum* infects 21 species of plants. The most common infected species were introduced and cultivated species, which appear to be more prone to infection than native species, native and cultivated species, and introduced species. Through this study, the number of host species of *P. nervosum* reported in Ecuador increases from 11 species, reported in previous studies, to 27 species. More sampling is needed in other areas in the wide distribution of *P. nervosum* to test if introduced and cultivated species are more prone to infection than the other infected species categories, and to expand the list of the host species of this common species.

**Keywords:** Parasitic plants, natural history, Viscaceae, urban ecology

## Resumen

*Phoradendron nervosum* es un arbusto hemiparásito con una amplia área de distribución. A pesar de ello, la ecología y la historia natural de esta especie no está bien estudiada. Se reportan especies hospedantes de *P. nervosum* en México y Costa Rica, principalmente con informes recientes de Ecuador. En nuestro muestreo dentro de las áreas urbanas del área metropolitana de la ciudad de Quito, encontramos que *P. nervosum* infecta 21 especies de plantas. Las especies infectadas más comunes eran especies introducidas y cultivadas las cuales son más propensas a la infección en comparación con especies nativas, especies nativas cultivadas y especies introducidas. Este estudio eleva las especies hospederas reportadas en estudios previos de *P. nervosum* en Ecuador de 11 especies a 27 especies incluidas las especies reportadas en nuestro estudio. Se



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necesitan más muestreos en otras áreas de la amplia distribución de *P. nervosum* para probar si las especies introducidas y cultivadas son más propensas a la infección que las otras categorías de especies infectadas y también para aumentar la lista de especies hospederas de esta especie común.

**Palabras clave:** Plantas parásitas, historia natural, Viscaceae, ecología urbana

*Phoradendron nervosum*, colloquially referred to as "Matapalo," "Muérdago," or "Injerto" in South and Central America [1], is a hemiparasitic shrub that infects stems, a typical characteristic of the *Phoradendron* genus [2]. Despite the extensive native distribution of *P. nervosum*, which extends from Mexico to Bolivia, research about its natural history and ecology is limited. Particularly, studies related to host specificity have been performed mainly in Mexico and Costa Rica, with recent observations from Ecuador (Table 1) [1-12].

**Table 1.** ***Phoradendron nervosum*** **host species reported in the literature. Most records come from Mexico and Costa Rica.**

| Country | Species | Family | Reference |
|---|---|---|---|
| Ecuador | *Prunus serotina* | Rosaceae | [11] |
| | *Populus deltoides* | Salicaceae | |
| | *Acacia melanoxylon* | Fabaceae | |
| | *Acacia dealbata* | Fabaceae | |
| | *Salix humboldtiana* | Salicaceae | |
| | *Hibiscus rosa-sinensis* | Malvaceae | |
| | *Mimosa quitensis* | Fabaceae | [12] |
| | *Populus dealbata* | Salicaceae | |
| | *Callistemon citrinus* | Rutaceae | |
| | *Nerium oleander* | Apocynaceae | |
| | *Iochroma cyaneum* | Solanaceae | |
| Mexico (Querétaro) | *Bumelia* spp | Sapotaceae | [1] |
| | *Heliocarpus* spp | Tiliaceae | |
| Mexico (Veracruz) | *Croton xalapensis* | Euphorbiaceae | [8] |
| | *Heliocarpus* sp | Tiliaceae | |
| | *Ageratina ligustrina* | Asteraceae | |
| | *Lippia myriocephala* | Verbenaceae | |
| Mexico (Chapulhuacán) | *Melia* sp | Meliaceae | [9] |
| Mexico (Bajío) | *Bumelia* spp | Sapotaceae | [10] |
| | *Heliocarpus* spp | Tiliaceae | |
| | *Melia* sp | Meliaceae | |
| Costa Rica (Puerto Jimenez) | *Synclairia polyantha* | Asteraceae | [2] |
| | *Souroubea* sp | Marcgraviaceae | |


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The objective of this study is to expand the list of reported host species of *P. nervosum* within urban environments in Quito, the capital of Ecuador. Existing literature and preliminary field observations demonstrate that *P. nervosum* is parasitizing a wide range of plants including native, introduced, and cultivated species within Quito [11,12]. Due to its wide distribution, we assume that *P. nervosum* infects native, introduced, and cultivated species in similar frequencies. This information holds the potential to enhance our understanding of the ecological dynamics and natural history of this widely distributed species within urban settings across the Americas.

The city of Quito is located in the central-northern part of the Inter Andean region of Ecuador, at an average of 2850 m.a.s.l. Its valleys sit on the hillside of numerous volcanos, creating a variety of climatic floors and plant formations, including piedmont rainforest, high Andean scrub forest, dry forest, and others [13]. This study was performed across urban and densely populated areas in north and southern Quito, including the adjacent valleys of Los Chillos, Tumbaco, and Pomasqui, which are now part of the urban area of Quito [14]. The sampling limit to the north was San Antonio de Pichincha, and to the south was Chillogallo neighborhood. The eastern limits were Tumbaco and Los Chillos valleys, and the western limits were the Guagua Pichincha and Atacazo volcanoes. For the most part, these urbanized localities harbor small green areas that consist of gardens, parks, and abandoned land, which have some native vegetation, but most of the coverage consists of ornamental species and invasive vegetation.

Sampling was performed by three researchers between May and December of 2019, traveling by car in equidistant transects along and around eight principal roads inside our study area. We sampled a total distance of 120 km. The sampled roads were Antonio José de Sucre Avenue, Simon Bolivar Highway, Rumiñahui Highway, Manuel Cordova Galarza Avenue, Antonio José de Sucre Avenue, Ruta Viva Highway, 6 de Diciembre Avenue, and 10 de Agosto Avenue.

*P. nervosum* is easy to recognize due to its oblong or lanceolate leaves that contrast with those of the host tree, often presenting a conspicuous yellowish color in the stems. *P. parietarioides* also occurs in our study area and is similar in morphology when compared to *P. nervosum* but easily distinguished by a greyish coloration [11,12]. Each time we recognized an infested tree, we approached it to identify the host species and took a photograph. We registered the frequency of infected individuals of each species, and to avoid pseudo replication we marked each host individual. Additionally, removing parasitic plants may disrupt the co-evolutionary dynamics between the parasites and their host species, also removing the transmission of adaptive information for successful infection in their seeds [15]. In this context, no collections were made during this study; all records and species identification were photographic [16]. For some species, photographs were not possible to take because the infected trees were growing on private land and access was not granted.

We identified each host species using samples from the "Herbario de Botánica Económica de la Universidad San Francisco de Quito (QUSF)" and classified them into four categories: native, introduced, introduced and cultivated, and native and cultivated. These categories are based on the growing status of this species in Ecuador, which is compiled in the Catalog of the Vascular Plants of Ecuador [17]. To test if one of these categories was more prone


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to infection by *P. nervosum,* we performed a chi-square goodness-of-fit test including the standardized residuals as post-hoc analysis using R statistical analysis software version 4.1.1 [18]. The relative frequency of each species was calculated.


**FIGURE 1-a:** Photos of *P. nervosum* host species. **A.** *Phoradendron nervosum*. **B.** *Acacia baileyana*. **C.** *Acacia macracantha*. **D.** *Acacia mearnsii*. **E.** *Annona cherimola*. **F.** *Callistemon subulatus*. **G.** *Croton wagneri*. **H.** *Ficus carica*. **I.** *Hibiscus rosa-sinensis*. **J.** *Nerium oleander*. **K.** *Nicotiana glauca*. **L.** *Prunus persica*. Photos by Martín Carrera, Lía Altamirano, and Karla Barragán.


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*P. nervosum* appears to be a generalist hemiparasite plant, infecting 21 species from 14 families from the Eudicotyledonae class. The family with more frequently infected species is Fabaceae (4 species), followed by Malvaceae (3 species) and Solanaceae and Rosaceae (each with 2 species). In families like Apocynaceae, Asteraceae, Bignoniaceae, Lythraceae, Myrtaceae, Salicaceae, and Verbenaceae, we only found one infected species (Fig 1 a-b). From the 140 infected individuals reported, the four species with highest relative frequency are *Acacia mearnsii* with 22.30 %, followed by *Callistemon subulatus* with 14.29 %, *Salix humboldtiana* with 13.57 %, and *Nicotiana glauca* with 10.00 %. We registered 3 infected species with only one individual (*Tecoma stans, Acacia baileyana,* and *Annona cherimola,* each with 0.71 %) (Table 2).


**FIGURE 1-b:** Photos of *P. nervosum* host species. **A.** *Prunus serotina.* **B.** *Punica granatum.* **C.** *Salix humboldtiana.* **D.** *Solanum brevifolium.* Photos by Martín Carrera, Lía Altamirano, and Karla Barragán.


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**Table 2.** Host species of *Phoradendron nervosum*. Status is derived from Tropicos (introduced and cultivated, native, native and cultivated, and introduced). Common names are from Ecuador. Common use from Tropicos and geographic reference is given from one host species locality for each species. Bolded relative frequencies show a species with a high relative frequency of infection.

| Status | Family | Host species | Common name | Use | Geographic reference | Frequency | Relative frequency (%) |
|---|---|---|---|---|---|---|---|
| Introduced and Cultivated | Apocynaceae | *Nerium oleander* | Laurel | Ornamental | Lat: -0.143794º, Long: -78.397820º | 5 | 3.60 |
| | Fabaceae | *Acacia baileyana* | Acacia morada | Ornamental | Lat: -0.009691º, Long: -78.423091º | 1 | 0.72 |
| | | *Acacia mearnsii* | Acacia blanca | Ornamental | Lat: -0.008081º, Long: -78418731º | 31 | **22.30** |
| | | *Acacia melanoxylon* | Acacia negra | Ornamental | Lat: -0.029180º, Long: -78.443077º | 3 | 2.16 |
| | Lythraceae | *Punica granatum* | Pomarosa | Ornamental and frutal | Lat: -0.124205ºLong: -78.374257º | 3 | 2.14 |
| | Malvaceae | *Hibiscus rosa-sinensis* | Cucarda | Ornamental | Lat: -0.128298º, Long: -78.400651º | 4 | 2.86 |
| | Moraceae | *Ficus carica* | Higo | Ornamental and frutal | Lat: 0.070601º, Long: -78.407502º | 1 | 0.71 |
| | Myrtaceae | *Callistemon subulatus* | Cepillo blanco | Ornamental | Lat: -0.216698º, Long: -78.433207º | 20 | **14.29** |
| | Rosaceae | *Prunus persica* | Durazno | Ornamental and frutal | Lat: 0.070601º, L ong: -78.407502º | 3 | 2.14 |
| | Verbenaceae | *Lantana camara* | Supirosa | Ornamental (invasive) | Lat: -0.129505º, Long: -78.366327º | 3 | 2.14 |
| Native | Asteraceae | *Baccharis latifolia* | Chilca | Local uses | Lat: -0.030899º, Long: -78.422420º | 4 | 2.86 |
| | Euphorbiaceae | *Croton wagneri* | Croton | Local uses | Lat: -0.194791º, Long: -78.47811º | 2 | 2.86 |
| | Fabaceae | *Acacia macracantha* | Acacia amarilla | Local uses | Lat: -0.115721º, Long: -78.371988º | 4 | 3.57 |
| | Malvaceae | *Pavonia sepium* | Escobillo | Local uses | Lat: -0.072289º, Long: -78.382526º | 5 | 1.43 |
| | | *Byttneria ovata* | China cacha | Local uses | Lat: -0.137261º, Long: -78.408376º | 2 | 5.00 |
| | Rosaceae | *Prunus serotina* | Capulí | Ornamental and frutal | Lat: 0.012740º, L ong: -78445786º | 7 | 5.00 |
| | Solanaceae | *Solanum brevifolium* | Tomatillo | Local uses | Lat: -0.113606º, Long: -78.397245º | 7 | 1.43 |
| Native and Cultivated | Annonaceae | *Annona cherimola* | Chirimoya | Ornamental and Frutal | Lat: -0.126458º, Long: -78.360367º | 1 | 0.71 |
| | Bignoniaceae | *Tecoma stans* | Cholán | Ornamental | Lat: 0.099932º, Long: -78.425889º | 1 | **13.57** |
| | Salicaceae | *Salix humboldtiana* | Sauce | Ornamental | Lat: -0.238782º, Long: -78.448283º | 19 | 0.71 |
| Introduced | Solanaceae | *Nicotiana glauca* | Tabaco | Local uses | Lat: -0.154464º, Long: -78.419402º | 14 | **10.00** |
| | | | | | | Total= 140 | 100% |


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The chi-square goodness-of-fit test suggests that not all the categories have the same probability of infection ($X2 = 9.2857$, df = 3, $P = <0.05$). The category with higher standardized residuals is introduced and cultivated (2.0730), suggesting that this category is more prone to infection by *P. nervosum*. From the four categories in Figure 2, 53.06% of the identified infected individuals correspond to the introduced and cultivated category (10 species), 22.15% to native species (7 species), 14.99% to native and cultivated species (3 species), and 10% to introduced species (1 species) (Fig. 2).

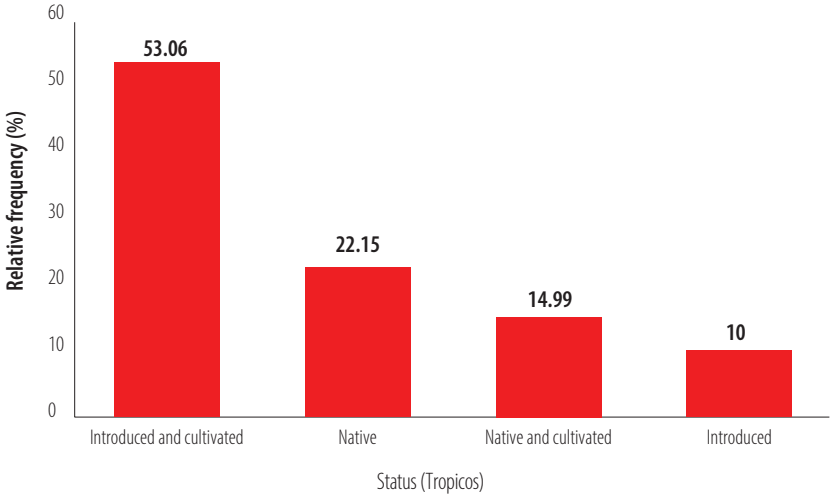


**Figure 2.** Relative frequency of the individuals infected by *Phoradendron nervosum* represented by their respective status according to Tropicos (Introduced and Cultivated, Native, Native and Cultivated, and Introduced).

Our results increase the host species list of *P. nervosum* in Ecuador from 11 species reported in the literature to 27 species, contributing to the knowledge of the natural history and ecology of this species [11-12]. Despite being a relatively abundant species in Quito, studies of *P. nervosum* in Ecuador are scarce. Further sampling in areas within its natural distribution could give us a better understanding on the abundance and preferences of parasitizing of these species.

This research suggests that most of the infected individuals are introduced and cultivated species, mainly ornamental plants from gardens. The most logical explanation is that introduced and cultivated individuals are more prone to infection just because they are more abundant in urban areas such as Quito. Complementary to this explanation, ornamental plants often receive abundant water and nutrient provisioning, from which parasitic plants could also benefit and spread onto surrounding individuals. Another possible explanation is that introduced species have not co-evolved with *P. nervosus*, and therefore, they lack defense mechanisms against this parasitic species' infection strategies [15]. These hypotheses open new doors for research on the ecology and infection mechanism of *P. nervosum* in urban areas.


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Personal observations suggest that *P. nervosum* prefers dryer areas (e.g., dry forest) within Quito, especially around the north of Quito and Tumbaco Valley [19]. In the south of Quito and Los Chillos Valley, which are more humid areas, individuals were harder to find. These observations create new research questions about *P. nervosum* environmental preferences and biogeography.

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## AUTHOR CONTRIBUTIONS

Martín Carrera conceived this research. Martín Carrera, Lía Altamirano, and Karla Barragán contributed to the experimental design. Martín Carrera identified the host species of *P. nervosum* and performed the statistical analysis. Martín Carrera, Lia Altamirano, and Karla Barragán contributed with the manuscript preparation. Tables and figures were prepared by Martín Carrera. Photographic material was provided by Martín Carrera, Lía Altamirano, and Karla Barragán. Martín Carrera, Lía Altamirano, and Karla Barragán funded this research.


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