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Research note

Diversity of parasitic plants associated with the tree canopy on the *Universidad Intercultural del Estado de Guerrero* campus

Diversidad de plantas parásitas asociadas al dosel del arbolado del campus de la Universidad Intercultural del Estado de Guerrero

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Abstract

The diversity of parasitic species and their hosts was estimated on the campus of the *Universidad Intercultural del Estado de Guerrero* (Intercultural University of the State of *Guerrero*, UIEG). Through surveys of different vegetation fragments, parasitic plants were visually identified, and their abundance, height above ground (m), and diameter (cm) were recorded. The latter measurement was categorized into three groups: small (1 to 15 cm), medium (16 to 30 cm), and large (31 to 60 cm or more). The normal diameter (*Nd*), total height (*Th*), and crown diameter (*Cd*) of the hosts were recorded. Samples of the parasitic and host species were collected for taxonomic identification. Species accumulation curves were constructed to estimate sampling effort using the EstimateS v.9.1 software. Alpha diversity (Shannon-Wiener $-H'$, Simpson, and effective species number) was evaluated. In addition, the mensuration variables were correlated with the abundance of parasitic plant taxa. Seventy-nine hosts from eight taxa belonging to six families (Fagaceae, Clethraceae, Cupressaceae, Betulaceae, Solanaceae and Asteraceae) were recorded. Five parasitic species from four families (Santalaceae, Bromeliaceae, Loranthaceae, and Convolvulaceae) were identified. The diversity of parasite species found in this study is low ($H'=1.25$, five sp.) and represents 12.5 % of the richness cited for the state of *Guerrero*.

Keywords: Abundance, diversity, host, mistletoe, *Struthanthus interruptus* (Kunth) G. Don, mensuration variables.

Resumen

Se estimó la diversidad de especies parásitas y sus hospederos en el campus de la Universidad Intercultural del Estado de Guerrero (UIEG). A través de recorridos en diferentes fragmentos de vegetación, se reconocieron visualmente a las plantas parásitas y se registró su abundancia, altura sobre el suelo (m) y diámetro (cm). Este último fue categorizado en tres grupos: pequeño (de 1 a 15 cm), mediano (de 16 a 30 cm) y grande (de 31 a 60 cm o más). De los hospederos se registró el diámetro normal (*Dn*), la altura total (*At*) y el diámetro de copa (*Dc*). Se recolectaron muestras de las especies parásitas y hospederas para su identificación taxonómica. Se

construyeron curvas de acumulación de especies para estimar el esfuerzo de muestreo mediante el programa *EstimateS* v.9.1. Se evaluó la diversidad alfa (*Shannon-Wiener -H'*, *Simpson* y el número efectivo de especies). Además, se hizo la correlación de las variables dasométricas con la abundancia de los taxa de plantas parásitas. Se registraron 79 hospederos de ocho taxones, pertenecientes a seis familias (Fagaceae, Clethraceae, Cupressaceae, Betulaceae, Solanaceae y Asteraceae). Se identificaron cinco especies parásitas de cuatro familias (Santalaceae, Bromeliaceae, Loranthaceae y Convolvulaceae). La diversidad de especies parásitas registrada en este trabajo es baja ($H'=1.25$, cinco sp.) y representa 12.5 % de la riqueza citada para el estado de Guerrero.

Palabras clave: Abundancia, diversidad, hospedero, muérdago, *Struthanthus interruptus* (Kunth) G. Don, variables dasométricas.

Development of the topic

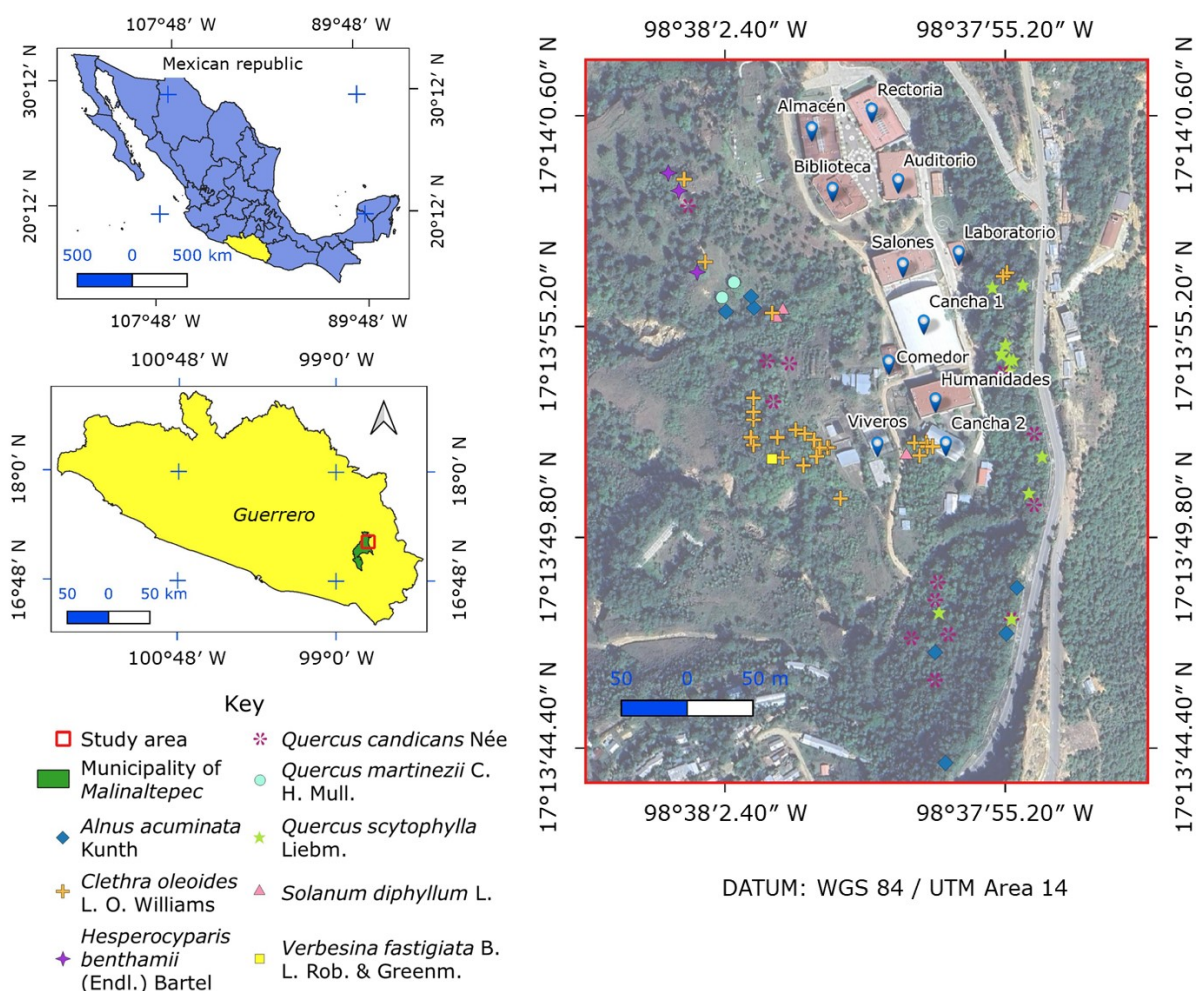
Forests are nature's most diverse ecosystems and provide a wide range of economic, social, environmental, and cultural goods and services to the human population (Armenteras & Rodríguez-Eraso, 2014). However, disturbances affect their structure and, consequently, their ecological functions. In addition, they are vulnerable to attack by certain pest plants such as mistletoe, which, despite possessing photosensitive pigments, have developed parasitic habits, making them partially or totally dependent on their host (Queijeiro-Bolaños & Cano-Santana, 2015). Some epiphytes, when they grow excessively, can limit sunlight penetration and create unfavorable conditions for host trees (Valenzuela-Núñez et al., 2021). Because of this, they have been called "structural parasites" (Benzing, 1979). These organisms have long been of public concern, as they cause damage to forest, fruit, and ornamental species, resulting in significant economic losses (Sánchez-Martínez & Reséndiz-Martínez, 2021). Furthermore, their distribution throughout all environments represents one of the main threats within forests, as they cause low productivity of wood and other products (Asiaín et al., 2008).

In the state of *Guerrero*, parasitic plants are widely distributed, and during the period 2012-2020 affected an area of 6 729 ha, where the main harmful species were

Phoradendron velutinum (DC.) Nutt., *Cladocolea* sp., *Psittacanthus calyculatus* G. Don, *P. schiedeanus* (Cham. & Schltdl.) G. Don, and *Tillandsia recurvata* (L.) L.; moreover, the entity is classified as high risk (Comisión Nacional Forestal [Conafor], 2021).

Insufficient information on parasitic plants in the *Montaña* Region limits the planning of strategies for their control. The objective of this study is to evaluate the diversity of aerial parasitic species (on stems, leaves, or flowers) (Nickrent, 2002) and their tree hosts in the campus of the Intercultural University of the State of *Guerrero* (UIEG), as well as to identify the relationship between the abundance of these pest plants and the mensuration variables of their hosts.

The UIEG campus is located in *La Ciénega*, in the municipality of *Malinaltepec*, *Guerrero*, at kilometer 54 on the *Tlapa-Marquelia* highway, at 2 061 masl (Figure 1). The climate is temperate subhumid A(C)m and the vegetation corresponds to an oak-pine forest (Instituto Nacional de Estadística y Geografía [Inegi], 2020).



Rectoría = Administrative offices; *Almacén* = Storeroom; *Auditorio* = Auditorium; *Biblioteca* = Library; *Laboratorio* = Laboratory; *Salones* = Classrooms; *Cancha 1* = Court 1; *Comedor* = Canteen; *Humanidades* = Humanities; *Viveros* = Nursery; *Cancha 2* = Court 2.

Figure 1. Geographical location of the community of *La Ciénega*, *Malinaltepec* municipality, and of the parasitized hosts within the UIEG campus.

The hosts were selected directly from fragments of original vegetation (oak-pine forest) located on the UIEG campus, through surveys and with the aid of binoculars (model BN131056 Bushnell®). Trees with deformities, yellowed or wilted leaves

caused by parasitic plants and structural parasites were visually identified. The latter belonged to the genus *Tillandsia* L. (Benzing, 1979), as the hosts had large quantities of them. Once identified, the infested individuals were georeferenced (model GRGPSMAP65S Garmin® GPS) (Figure 1).

The number of parasites per host was recorded, as well as the diameter in cm (using a model TP50ME Truper® tape measure), categorized as small (1-15 cm), medium (16-30 cm), and large (31-60 cm or more). In addition, the height (m) above ground level (AHAG), stem, or branch on which they were located was measured using a model 360PC Suunto® clinometer. The normal diameter (cm) of the hosts was measured with a model 283D Forestry Suppliers® diameter tape (Mostacedo & Fredericksen, 2000); the total height (m), with a model PM5/360PC Suunto® clinometer, and the crown diameter (m) with a model TP50ME Truper® measuring tape, from North to South and West to East, in order to average both measurements and avoid overestimating or underestimating them (Benavides-Meza & Fernández-Grandizo, 2012).

Specimens of the hosts and parasitic plants were collected for taxonomic identification following the method suggested by Lot and Chiang (1986). They were identified using specialized literature (Fonseca & Velázquez, 1998; Martínez-Ambriz, 2020; Pulido-Esparza *et al.*, 2004; Valencia-Ávalos, 2010; Valencia-Ávalos *et al.*, 2002) and the nomenclature was corroborated in the database at The World Flora Online (2025).

Accumulation curves for parasitic species were constructed using each host recorded per species as a sampling unit. To do this, the nonparametric Chao 2 estimator was used in the *EstimateS* v.9.1 software (Colwell & Elsensohn, 2014). Diversity was estimated using Shannon-Wiener indexes (H'), Simpson dominance (λ), and effective species numbers (0D , 1D , and 2D) (Moreno *et al.*, 2011) (Table 1).

Table 1. Indexes used to calculate diversity.

Index	Formula
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Shannon-Wiener	$H' = - \sum P_i \ln P_i$
Simpson's index	$\lambda = \sum P_i^2$
Effective number of species	${}^qD = (\sum_{i=1}^S P_i^q)^{\frac{1}{(1-q)}}$

P_i = Relative abundance of species i ; $\ln$ = Natural logarithm; qD = Diversity; q = Diversity order: Total number of species = 0D ; Number of abundant species = ${}^1D = e^{H'}$, Number of very abundant species = ${}^2D = \frac{1}{\lambda}$.

The correlation analysis between the mensuration variables (Th , Cd , and Nd) of the hosts and abundance was performed using the R 4.3.3 software (Barrios, 2024).

The observed species (*observed_S*) and those calculated with the Chao 2 estimator indicated 100 % of the recorded parasitic taxa; i. e., the sampling effort was representative.

Seventy-nine hosts belonging to six families were identified; of the latter, Fagaceae was the best represented, with three species; while Clethraceae, Cupressaceae, Betulaceae, Solanaceae and Asteraceae had only one species (Table 2).

Table 2. Number of individuals of the host species of parasitic plants recorded at the UIEG campus and their mensuration variables.

Family	Scientific name	Common name	Abundance	Cd	Th	Nd
Fagaceae	<i>Quercus candicans</i> Née	Oak	17	10.5	14.1	37.8
	<i>Quercus martinezii</i> C. H. Mull.	White oak	2	12.9	13.5	47.0
	<i>Quercus scytophylla</i> Liebm.	Red oak	13	9.4	12.5	26.3
Clethraceae	<i>Clethra oleoides</i> L. O. Williams	Aguacatillo	32	6.6	10.5	28.7
Cupressaceae	<i>Hesperocyparis benthamii</i> (Endl.) Bartel	Cypress or white cedar	3	8.5	14.8	35.8

Betulaceae	<i>Alnus acuminata</i> Kunth	Andean alder	8	7.3	13.1	23.2
Solanaceae	<i>Solanum diphyllum</i> L.	Twoleaf nightshade	3	3.0	7.0	10.1
Asteraceae	<i>Verbesina fastigiata</i> B. L. Rob. & Greenm.	Tacote	1	4.0	5.5	10.0

Cd = Crown diameter, *Th* = Total height, *Nd* = Normal diameter.

Of the 79 trees found at the UIEG campus, 32 belong to the species *Clethra oleoides* L. O. Williams, 17 to *Quercus candicans* Née, and 13 to *Q. scytophylla* Liebm. The rest of the taxa had fewer than 10 individuals each (Table 2). One hundred seventy-five parasitic plant individuals were recorded, *Struthanthus interruptus* (Kunth) G. Don being the most abundant, with 79 individuals (Table 3).

Table 3. Number of individuals per species and average height above ground (*AHAG*) of parasitic plants recorded on the UIEG campus.

Family	Species	Common name	<i>AHAG</i>	Number of individuals			
				Small	Medium	Large	Total
Loranthaceae	<i>Struthanthus interruptus</i> (Kunth) G. Don	True mistletoe	6.11	21	30	28	79
Bromeliaceae	<i>Tillandsia usneoides</i> (L.) L.	Spanish moss	5.98	6	12	34	52
Santalaceae	<i>Phoradendron velutinum</i> (DC.) Nutt.	Graft	11.4	5	8	15	28
Loranthaceae	<i>Psittacanthus schiedeana</i> (Cham. & Schltdl.) G. Don	Cloud forest mistletoe	8.2	3	3	9	15
Convolvulaceae	<i>Cuscuta</i> sp.	Dodder	4.5	-	-	1	1

AHAG = Average height above ground.

The normal diameter of the parasitized individuals ranged from 4.9 to 79.3 cm and an average of 26.89 ± 17.88 cm. The taxon with the highest average *Nd* was *Quercus*

martinezii C. H. Mull., with 47 cm, followed by *Q. candicans*, with 37.8 cm, and *Hesperocyparis benthamii* (Endl.) Bartel with 35.8 cm. The other taxa had diameters of less than 30 cm.

For the height (*Th*) of the parasitized individuals, there was a range of 4.3 m to 22.5 m, with an average of 11.4 ± 4.6 m. Cypress or white cedar (*Hesperocyparis benthamii*) had the highest average height (14.8 m), followed by oak (*Quercus candicans*), with 14.1 m; white oak (*Q. martinezii*), with 13.5 m, and alder (*Alnus acuminata* Kunth) at 13.1 m. The other species recorded average heights of less than 13.0 m.

Five species belonging to five genera and four families were identified among the parasitic plants; Loranthaceae was the best represented, with two species; for Bromeliaceae, Santalaceae, and Convolvulaceae, only one taxon was identified.

The average height above ground level (*AHAG*) at which the parasitic plants were located was 6.85 ± 4.20 m. *Phoradendron velutinum* was found at an average height of 11.4 m of its host, followed by *Psittacanthus schiedeianus* at 8.2 m, and *Struthantus interruptus*, at 6.11 m. In addition, 49.7 % of the parasitic plants were large, 30.3 % were medium-sized, and 20.0 % were small (Table 3).

The Shannon-Wiener (*H'*) value for the diversity of parasitic species on the UIEG campus was 1.2, the dominance (λ) was 0.32, with a richness of five species (0D), three abundant (1D), and three very abundant (2D). *Alnus acuminata* and *Clethra oleoides* showed greater diversity of parasitic species (Table 4).

Table 4. Number of species (NS) and individuals of parasitic plants (NIPP) per host recorded at the UIEG campus.

Hosts	Parasitical plants						NIPP
	CSP	PS	PC	SI	TU	NE	
<i>Alnus acuminata</i> Kunth	-	✓	✓	-	✓	3	18
<i>Clethra oleoides</i> L. O. Williams	-	✓	-	✓	✓	3	68
<i>Hesperocyparis benthamii</i> (Endl.) Bartel	-	-	-	-	✓	1	15

<i>Quercus candicans</i> Née	-	-	✓	✓	✓	3	32
<i>Quercus martinezii</i> C. H. Mull.	-	-	-	-	✓	1	21
<i>Quercus scytophylla</i> Liebm.	-	-	✓	✓	-	2	17
<i>Solanum diphyllum</i> L.	✓	-	-	✓	-	2	3
<i>Verbesina fastigiata</i> B. L. Rob. & Greenm.	-	-	-	✓	-	1	1
Total	1	1	3	5	5	5	175

CSP = *Cuscuta* sp.; PS = *Psittacanthus schiedeanus* (Cham. & Schltdl.) G. Don;
 PC = *Psittacanthus calyculatus* G. Don; SI = *Struthanthus interruptus* (Kunth) G.
 Don; TU = *Tillandsia usneoides* (L.) L.

The Coefficient of correlation between normal diameter, height, and crown diameter and the abundance of parasitic plants considering all the evaluated trees was significant for *Nd*, with $r=0.30$ ($p<0.01$), followed by *Cd*, with $r=0.29$ ($p<0.05$). At the species level, *Alnus acuminata* exhibited an $r=0.76$ ($p<0.05$) in relation to *Th*, and *Quercus* sp. had an $r=0.36$ with a *Cd* ($p<0.05$); the rest of the variables showed no correlation ($p>0.05$), with values of $r=0.3$, $r=0.2$, and $r=0.19$, respectively. This indicates that an increase in the normal diameter, crown, or height of the host does not translate into an increase in the abundance of parasitic plants.

In the correlation, the mensuration variables of the most abundant hosts, such as *Clethra oleoides*, and the number of individuals were not significant ($Nd=0.32$, $Th=0.19$, $Cd=0.25$); likewise, no significant relationships were observed for the species *Quercus candicans* and *Q. scytophylla*.

The families and species recorded in this work have been documented by other authors like Galván-González *et al.* (2022). Regarding species diversity, the recorded diversity is relatively low ($H'=1.25$, $S=5$), given that 40 species from different families (Balanophoraceae, Cytinaceae, Krameriaceae, Lennoaceae, and Olacaceae) are cited for the state of Guerrero (Galván-González *et al.*, 2022), and the species examined herein represent only 12.5 % of the wealth of this group in the state. *Struthanthus interruptus*, the most abundant pest plant in the campus trees, is considered a

generalist species, as it attacks timber, fruit, and ornamental trees, and even other mistletoes; it is also widely distributed in Mexico in general and in the state of *Guerrero* in particular (Conafor, 2021).

The mensuration variables of the trees (height, crown diameter, and normal diameter) do not show a significant relationship with the abundance of parasitic species, which suggests that these variables do not affect their presence. However, Arriola-Padilla et al. (2013) point out that mensuration variables can hurt parasitic species; when the host's branches are thin, these plants do not have time to complete their biological cycle and die, whereby the number of their individuals is reduced. In addition, they also tend to compete for nutrients from the host. Likewise, García-Cuevas et al. (2020) mention that parasitic plants cause minimal damage when hosts are abundant, as these species tend to persist for longer periods.

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Conflict of interest

The authors declare that they have no conflict of interest.

Contribution by author

Marisa Silva Aparicio: design, organization, data analysis and drafting of the manuscript; Jolissa Rosas Altamirano: design, organization, information analysis and drafting of the manuscript; Bernardo López López: data analysis and revision of the manuscript.

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