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HOW DO RICHNESS AND DIVERSITY OF BIRDS FEEDING ON *BURSERA SIMARUBA* CHANGE IN MODIFIED LANDSCAPES OF TROPICAL DRY FOREST?

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Abstract · Land-use change and urbanization are the main threats to biodiversity in tropical dry forest, but few studies have evaluated the influence on bird-plant interactions across a gradient of land-use conditions. In this context, we aimed to evaluate changes in richness and diversity of birds feeding on *Bursera simaruba* fruits in different land-use conditions of tropical dry forest in the Central Depression of Chiapas, Mexico. From December 2022–April 2023, when *B. simaruba* had mature fruits, we performed focal observations of birds feeding on fruits at each of 27 *B. simaruba* trees (8 h observation/tree), dispersed among three land-use conditions: wildlands, non-urban production systems, and urban. We recorded a total of 34 bird species (22 residents, 11 winter migrants, and 1 unidentified *Empidonax* species). Richness (q^0) and diversity (q^1) of birds consuming *B. simaruba* fruits differed significantly among land-use conditions, being significantly higher for trees in the non-urban production systems. Avian consumers of *B. simaruba* fruits were predominantly insectivorous, possibly due to the influence of the agricultural landscape. However, the majority of species consumed fruits as legitimate dispersers. Our results support the intermediate disturbance hypothesis, where species diversity is highest in sites with an intermediate degree of modification, thereby possibly having higher landscape heterogeneity than both low- and high-disturbance conditions. We also suggest that *B. simaruba* fruits are a key resource for birds, particularly in modified landscapes of rural or urban areas.

Resumen · ¿Cómo cambia la riqueza y la diversidad de aves que se alimentan de *Bursera simaruba* en paisajes modificados del bosque tropical seco?
El cambio de uso de suelo y la urbanización representan las principales amenazas a la biodiversidad en el bosque tropical seco, pero pocos estudios han evaluado las interacciones ave-planta a lo largo de un gradiente de condiciones de uso de suelo. En este contexto, nuestro objetivo fue evaluar los cambios en la riqueza y diversidad de aves que se alimentan de los frutos de *Bursera simaruba* bajo diferentes condiciones de uso de suelo en el bosque tropical seco de la Depresión Central de Chiapas, México. Desde diciembre de 2022 a abril de 2023, cuando *B. simaruba* tenía frutos maduros, realizamos observaciones focales de las aves que se alimentaban de los frutos de *B. simaruba* en 27 árboles (8 h de observación/árbol), distribuidos en tres condiciones de uso de suelo: áreas silvestres, áreas de producción no urbanas y urbano. Registramos un total de 34 especies de aves (22 residentes, 11 migratorias de invierno y 1 especie de *Empidonax* no identificada). La riqueza de especies (q^0) y la diversidad (q^1) de aves difirieron significativamente entre condiciones de uso de suelo, siendo significativamente mayores para los árboles en los sistemas productivos no urbanos. Las aves consumidoras de frutos de *B. simaruba* fueron predominantemente insectívoras, posiblemente debido a la influencia del paisaje agrícola. Sin embargo, la mayoría de las especies consumieron los frutos como dispersores legítimos. Nuestros resultados respaldan la hipótesis del disturbio intermedio, donde la diversidad de especies es mayor en sitios con un grado intermedio de modificación, presentando así una posible mayor heterogeneidad del paisaje que las condiciones de bajo y alto disturbio. Asimismo, sugerimos que los frutos de *B. simaruba* son un recurso clave para las aves, particularmente en paisajes modificados de áreas rurales o urbanas.

Keywords: *Avian frugivory · Feeding guilds · Intermediate disturbance hypothesis · Neotropical birds · Urban Ecology*

INTRODUCTION

Anthropogenic activities abruptly modify the landscape, and urbanization is considered the most threatening anthropogenic factor for ecosystems since it drastically affects the diversity of plants, insects, and vertebrates (Newbold et al. 2015, Hautier et al. 2015, Zhao et al. 2016, Carrasco et al. 2018). Some aspects of biodiversity that are most strongly affected by urbanization are species richness, abundance, and presence of niche restricted species (Newbold et al. 2015). This is especially notable in high-biodiversity regions in the tropics, specifically in developing countries (Bohus et al. 2023), resulting in ecosystems with low species richness, dominated by a few

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species that are well-adapted to urban environments (Schneiberg et al. 2020).

In this context, it is expected that ecological properties of species interaction networks will be affected by urbanization-related processes in multiple ways, including the absence or weakening of interactions (Start et al. 2019). One of the ecosystems most strongly affected by anthropogenic activity in the Neotropics, particularly in Mexico, is the tropical and subtropical dry broadleaf forest biome (Olson et al. 2001), hereafter tropical dry forest, which in this region is predominantly characterized by tropical deciduous and semi-deciduous forests (Rzedowski 2006, Rocha-Loredo et al. 2010). This degradation is mostly because the expansion and intensification of agricultural areas have transformed the original landscape into fields for livestock and crop monocultures (Meave et al. 2012, CONABIO 2022).

The tropical dry forest has a highly diverse flora, containing at least 6000 species of phanerogamic plants, of which almost 40% are endemic to tropical dry forests (Rzedowski 1991). While endemism is exceptionally high at the community level, the functional structure of these forests often relies on widespread, dominant species (Grime 1998, Gaston 2010). In these forests, one of the most important tree genera is *Bursera* (Becerra 2005), which plays a central role in maintaining ecosystem interactions (Lanuza et al. 2023, Barrales-Alcalá and Bonfil 2024) and holds great sociocultural value, as its resins have been used in religious ceremonies since prehispanic times (Montúfar 2016, García-Flores et al. 2019, Díaz-López et al. 2026).

Of the 94 *Bursera* species found in Mexico, *B. simaruba* is the most widely distributed (Rzedowski 1991, Challenger and Soberón 2008, Villaseñor 2016, CONABIO 2021). In ecological terms, this species is particularly vital because its fruits provide food resources for many vertebrate species, including breeding birds (Ortiz-Pulido et al. 2000, Guerrero-Cárdenas et al. 2018, Rodríguez and Almazán 2019). Due to the plasticity of *B. simaruba*, it can be found in many environmental conditions in the tropical dry forest of the Central Depression of Chiapas, including in remnants of natural vegetation, in rural areas as living fences, and in urban areas as an ornamental tree (Vázquez-Yanes et al. 1999). These characteristics make *B. simaruba* an ideal study subject for the analysis of species interactions across an urbanization gradient, since regardless of the condition in which they are found, they offer resources for birds (Cano-Velázquez 2017).

Additionally, the Central Depression of Chiapas is a region of high avian diversity (305 bird species) and hosts the highest proportion of migratory birds in the state of Chiapas, México (Rangel-Salazar et al. 2013). At the same time, the central depression region of Chiapas contains a large conurbation conformed by the two largest and most populous cities in the region, Chiapa de Corzo and Tuxtla Gutiérrez, as well as the municipalities of Berriozábal and Suchiapa (INEGI 2021). Despite this, few ecological studies in Chiapas, and specifically in the central depression, explore the effect of urbanization on avian taxonomic richness and diversity (Sánchez-Alvarado et al. 2019, Siliceo Abarca 2021). Furthermore, no studies have evaluated bird-tree interactions under different land-use conditions in Chiapas. Therefore, our objective was to evaluate changes in richness and diversity of birds feeding on *B. simaruba* fruits under different land-use conditions.

METHODS

Study area. We conducted the study in urban areas and natural parks in and around the Chiapas state capital of Tuxtla Gutiérrez (16°44’00”N, 93°08’00”W) and adjoining historical city of Chiapa de Corzo (16°36’00”N, 92°58’00” W), which are the two most populous cities in the conurbation of the central depression of Chiapas, Mexico. These cities are distinctive in that they are bordered by natural protected areas that contain physical barriers, including the Cañón del Sumidero, El Zapotal, and Mactumatzá Mountain. The native vegetation is tropical deciduous forest, which is characterized by tree species of the genera *Ceiba*, *Leucaena*, *Annona,* and *Bursera*, including *B. simaruba* (Rzedowski 1991, Rocha-Loredo et al. 2010)*,* located mainly in the periphery and urban parks. Within the cities, the plant mosaic has been fragmented and supplanted by exotic vegetation like *Delonix regia*, *Ficus benjamina,* and *Ficus microcarpa.*

Site conditions. We carried out field work in a landscape with a gradient of three different land-use conditions of wildlands, non-urban production systems, and urban areas (MacGregor-Fors and Vázquez 2020). Wildlands comprised remnants of tropical deciduous forest (mainly ≥60 ha) characterized by a high number of trees of different species and relatively little landscape modification. These areas included two Wildlife Management Units (known as UMAs), and the lower part of the Cañón del Sumidero National Park (a federal protected area). Non-urban production systems were rural sites characterized by living fences, active rain-fed agricultural fields, and fallow fields. Finally, urban areas were dominated by extensive human infrastructure, such as paved roads, buildings, interspersed with patches of both exotic and native vegetation.

We located 27 *B. simaruba* trees (Figure 1) distributed across the three landscape conditions: urban (*n* = 9 trees), non-urban production systems (*n* = 11 trees), and wildlands (*n* = 7 trees). To characterize the environment surrounding each focal tree, we established a 100-m radius (3.1 ha) circular plot centered on each individual tree. To quantify landscape variables within these plots, we first performed an unsupervised classification of a 10-m resolution Sentinel-2 satellite image from 2 January 2023 (Correia et al. 2018), obtained from the European Space Agency via Copernicus SciHub. Through this classification, we identified five land-cover classes: urban (buildings), pavement, shrub, tropical dry forest, and herbaceous cover. We then used FRAGSTATS software (McGarigal and Marks 1995) to calculate five landscape metrics (Supplementary material S1) within each circular plot: Class Area (CA), Percentage of Landscape (PLAND), Number of Patches (NP), Interspersion and Juxtaposition Index (IJI), and the Shannon Landscape Heterogeneity Index (SHDI), following McGarigal and Marks (1995) and Bogaert et al. (2002).

In addition, during focal observations of fruiting trees we measured three urban activity variables at each site: the total number of 1) pedestrians and 2) vehicles, as well as 3) the mean ambient noise levels (dB). We measured noise levels with a sound-level meter for 15 mins each hour across the 8-h observation period at each tree. All landscape metrics and urban activity variables were scaled (McCune and Grace 2002, Legendre and Legendre 2012) and subjected to a Principal Component Analysis (PCA) and a Permutational Multivariate Analysis of Variance (PERMANOVA) to validate our assignment of *B. simaruba* trees to the three land-use conditions.

Focal tree observations. From December 2022–April 2023, during the fruiting season of *B. simaruba* (Hernández-Rodríguez et al. 2021)*,* we recorded foraging activity of birds at each of the 27 *B. simaruba* trees when they had ripe pseudoaril fruits (Figure 2). Each tree was sampled on two consecutive days (Mendonça and dos-Anjos 2006, Partida-Lara et al. 2018), although we did not conduct observations on rainy or windy days. We commenced observations at sunrise and continued for four hours at each tree on each day, for a total 8 hours observation per tree, and an overall total of 216 hours field observations.

We used Eagle optics 10x32 binoculars for focal observations, and photographed interactions with a Canon 80D camera with a 150–600mm Sigma lens. During observations at focal

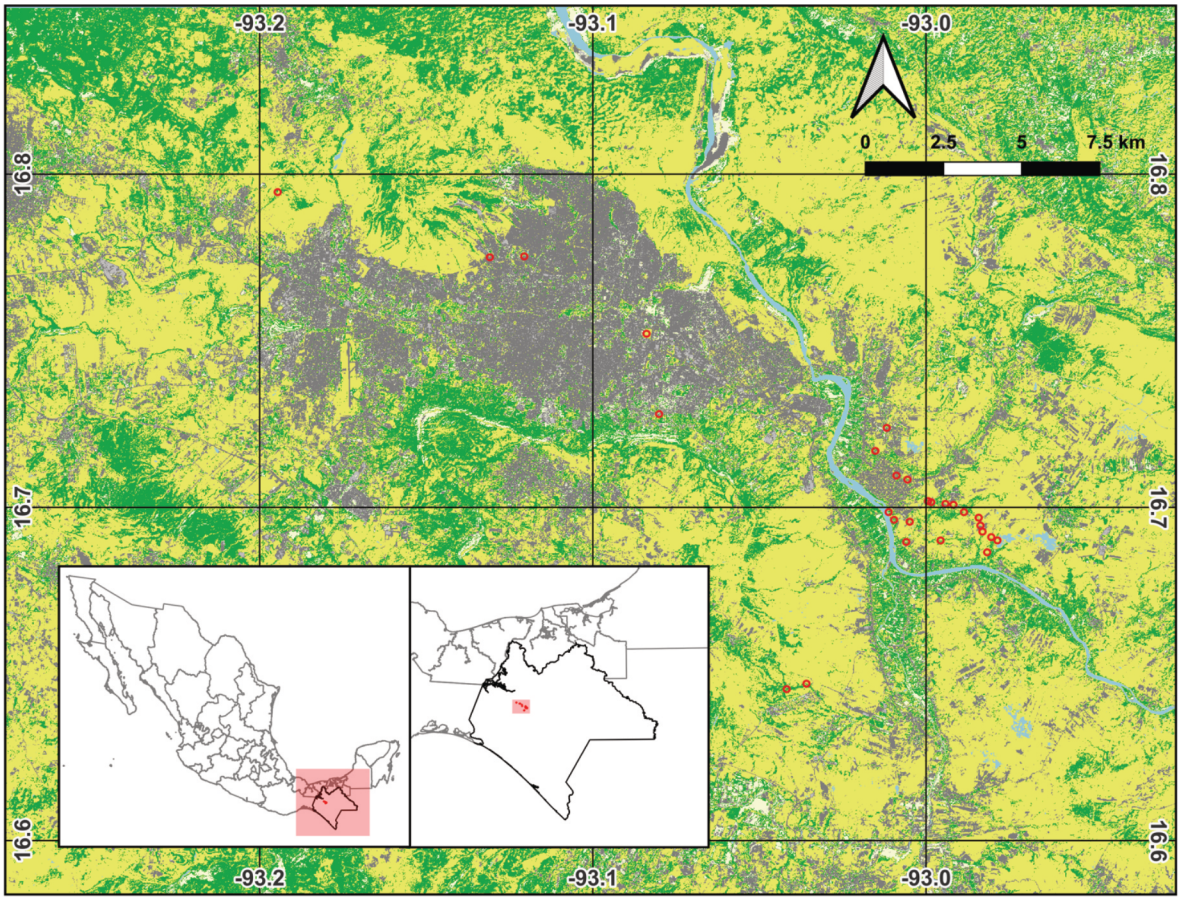

Figure 1. Location of 27 *Bursera simaruba* trees (red dots) sampled in the conurbation of Tuxtla Gutiérrez and Chiapa de Corzo, Chiapas, Mexico. Land covers shown in light gray (buildings), dark grey (pavement), light green (shrub cover), dark green (tropical dry forest), light yellow (herbaceous cover) and light blue (water).

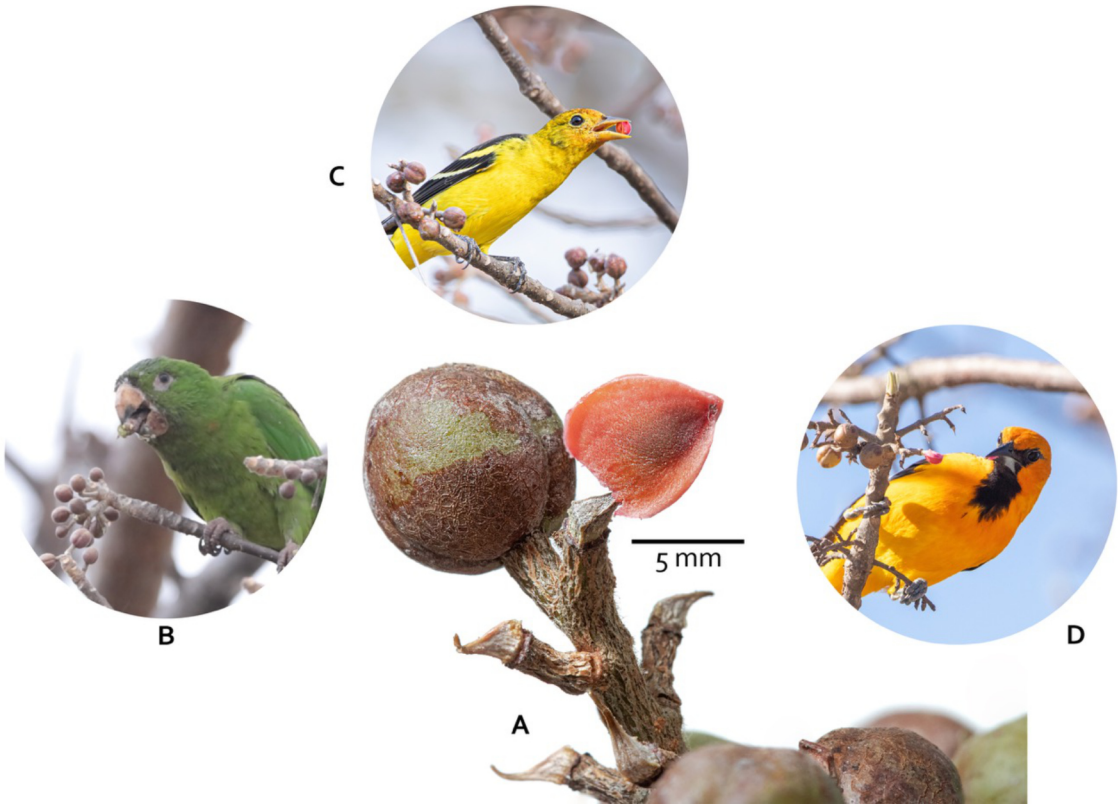

Figure 2. A) Fruit of *Bursera simaruba* and an exposed pseudoaril. B) Seed predator *Psittacara holochlorus* feeding by crushing the fruit and seed. C) Legitimate disperser *Piranga ludoviciana* consuming the pseudoaril and whole seed without crushing. D) Pseudoaril consumer *Icterus pustulatus* feeding by consuming only the pseudoaril. Photos: SJ Siliceo-Abarca.

Table 1. Richness and diversity of bird species consuming fruits in *Bursera simaruba* trees in three land-use conditions in Chiapas, Mexico.

Richness and diversity	Wildlands	Productivity systems	Urban
Families	6	12	9
Total bird species	15	30	24
Migratory species	5	11	7
Risk category	0	1	1
Quasi-endemic species	1	1	0
Exclusive species	1	7	3
Species Richness (q^0)	13	30	25
Shannon diversity (q^1)	9.49	15.16	9.75

trees, we continuously recorded all the bird-fruit interactions. We defined an interaction as an event in which an individual bird ingested the pseudoaril, or a part of it, from a single *B. simaruba* fruit (Valenzuela Ospina and Kattan 2022). Thus, every individual fruit consumed was quantified as a separate interaction, meaning a single avian visitor could account for multiple interactions during a single visit until it left the tree (Crestani et al. 2019). In cases where multiple birds visited the tree simultaneously, we recorded active consumers sequentially and pooled the interactions by bird species (Rumeu et al. 2020, Li et al. 2022, Cazelles 2024).

We identified the species of each avian visitor using field guides (Howell and Webb 1995, González-Salazar et al. 2014, Sibley 2014). Based on our direct field observations of bird-fruit interactions, we classified avian visitors into three types of consumer: seed predator, pseudoaril consumer, and legitimate disperser. Seed predators were defined as consumers that completely crushed both the fruit and the seed. Pseudoaril consumers were those that opened the exocarp to consume only the pseudoaril. Finally, legitimate dispersers were those consumers that opened the fruit and ingested the seed and pseudoaril whole without crushing them. We also determined the migratory status of each bird species according to the Checklist of Birds of Mexico (González-Salazar et al. 2014, Berlanga et al. 2015), assigned their main feeding guild using the AVONET database (Tobias et al. 2022), and classified their conservation status according to Mexican legislation (SEMARNAT 2010, 2025).

Data analysis. We compiled a matrix of data on number of interactions (number of pseudoarils consumed) by each bird species in each tree, where rows represented each of the 27 *B. simaruba* trees, and columns represented the bird species. We used the Chao 1 estimator based on the frequency of interactions to estimate the completeness of our sample, and compared species richness (q^0) and Shannon diversity (q^1) across land-use conditions. Both analyses were performed in the RStudio software (R Core Team 2021, Posit Team 2023) using the iNEXT package (Chao et al. 2014, Hsieh et al. 2016). For each species diversity index (q^0 and q^1) we calculated 84% confidence intervals, which enabled us to determine a non-overlap comparison with $p(a) \leq 0.05$ significance level (MacGregor-Fors and Payton 2013). Finally, to validate the environmental classification of our 27 study trees into the three land-use conditions, we conducted a cluster analysis with pairwise PERMANOVA (Martinez-Arbizu 2020) based on six landscape metrics and three urban activity variables.

RESULTS

Differentiation among *B. simaruba* sites. The principal component analysis of landscape metrics and urban activity variables showed differentiation among *B. simaruba* tree locations in the study area. The first two dimensions accounted for 57.5% of the total variance (PC1 = 39.3%, PC2 = 18.2%). PC1 was negatively driven by the percentage of shrub coverage (PC1 contribution = 9.9%), and positively associated with urban infrastructure (pavement = 8.2%, buildings = 7.4%), herbaceous cover (7.4%), and higher levels of environmental noise (5.3%). Meanwhile PC2 was predominantly driven by tropical dry forest coverage (PC2 contribution = 24%) and overall Shannon Landscape Heterogeneity Index (7.6%). Consistent with the PCA, the PERMANOVA showed differentiation among *B. simaruba* tree locations by land-use conditions ($F_{2,26} = 4.26$, $P = 0.001$), and post-hoc pairwise comparisons confirmed that all three conditions of wildlands, non-urban productive systems and urban, differed significantly from each other (Padj < 0.05 in all cases).

Richness and diversity of birds feeding on *B. simaruba* fruits. We recorded a total of 34 bird species, from 24 genera and 12 families, interacting with *B. simaruba* fruits (Supplementary Table S2). Eleven species were winter migrants and 22 were residents (excluding one unidentified species of the genus *Empidonax*). The most abundant families were Tyrannidae (nine species), Vireonidae (five species), Cardinalidae (five species) and Icteridae (four species). Two parakeet species (*Psittacara holochlorus* and *Eupsittula canicularis*) were classified as threatened or at risk in Mexico (SEMARNAT 2025), and one species (*Momotus mexicanus*) is considered quasi-endemic to Mexico (Berlanga et al. 2015, Supplementary material S2).

Total species richness was highest in the non-urban productivity systems land-use condition with 30 bird species, followed by the urban (24 species) land-use condition, while the lowest number (15 species) was recorded for *B. simaruba* trees in wildlands (Table 1). The quasi-endemic *M. mexicanus* was found in the wildlands and non-urban productivity systems conditions. No threatened species were recorded interacting with *B. simaruba* trees in the wildlands condition, whereas one threatened species was recorded in non-urban productivity systems and one in the urban condition (*E. canicularis* and *P. holochlorus*, respectively). The non-urban productivity systems harbored the highest number of exclusive species, as well as a higher number of migratory birds (Table 1). These exclusive species included the migratory birds *Leiothlypis peregrina*, *Passerina cyanea*, and *Icterus spurius*, alongside the resident *Turdus grayi*, *Saltator coerulescens,* and *E. canicularis* for productivity systems. In contrast, only one exclusive species (*Pheucticus chrysopeplus*) was recorded visiting *B. simaruba* trees in the wildlands condition, and three exclusive species (*Thraupis episcopus*, *P. holochlorus*, *Icterus wagleri*) were recorded visiting trees in the urban condition (Table 1).

According to the Chao 1 estimator, sampling effort reached ≥ 99% completeness for the estimators of both species richness (q^0) and Shannon diversity (q^1) in each land-use condition (Figure 3). Species richness differed among all three land-use conditions, as indicated by the non-overlapping confidence intervals (Figure 3A). Non-urban productivity systems showed markedly and significantly higher q^0 = ~29 species richness, followed by urban (q^0 = ~22 species), and wildlands (q^0 = 13 species). On the other hand, Shannon diversity in the non-urban production systems was significantly higher (q^1 = 15) compared to urban (q^1 = 10) and wildland (q^1 = 9) conditions (Figure 3B). Nevertheless, the diversity of avian consumers did not differ significantly for trees in urban and wildland conditions (Figure 3B).

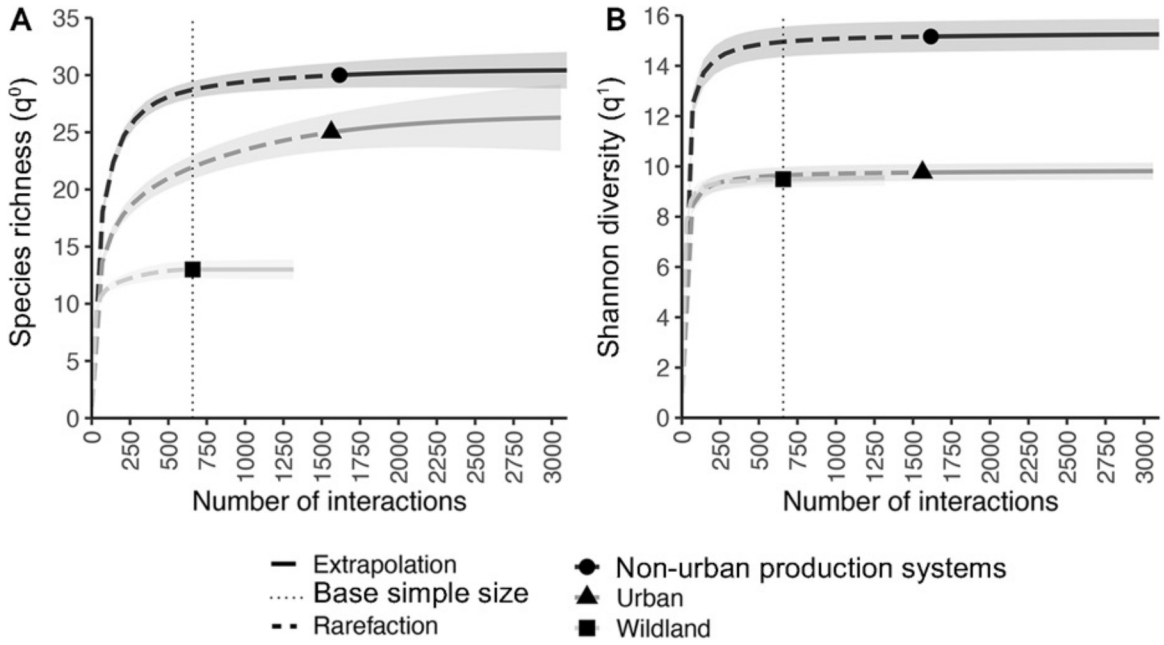

Figure 3. Rarefaction and extrapolation curves plotted as a function of the number of bird-fruit interactions for A) species richness (q^0), and B) Shannon diversity (q^1) of birds feeding on fruits of *Bursera simaruba* trees in three land-use conditions. Solid lines represent extrapolation, dashed lines represent rarefaction, dotted lines represent the lowest number of interactions for completeness in one of the land-use conditions, and shaded areas indicate 84% confidence intervals.

Type of avian consumers and feeding guilds. Regarding interaction types, the majority of the avian visitors were legitimate dispersers (28 species), followed by a few seed predators (two psittacine species) and pseudoaril consumers. The latter group included four species of the genus *Icterus* and the Peppershrike *Cyclarhis gujanensis*, which was the only bird species observed feeding in two ways, as both a legitimate disperser and pseudoaril consumer (Table S1). Almost 70% of the avian species recorded consuming fruits of *B. simaruba* trees belonged to the insectivore guild (27 species), with only a few frugivores (4 species), granivores (2 species), and one omnivore species. Frugivorous birds were absent in wildlands, and granivores were not recorded in the urban condition. Omnivores were recorded only once in each condition. Insectivores were recorded in all conditions, mostly in the productivity systems land-use condition (26 species), closely followed by urban sites (21 species).

DISCUSSION

Richness and diversity of birds feeding on *B. simaruba* in three land-use conditions. Avian species richness recorded feeding on *B. simaruba* in this study (34 species) was higher than the 27 species reported at a field station and private reserve in La Mancha, Veracruz (Ortiz-Pulido et al. 2000). Similarly, species richness in our study surpassed the 19 species recorded feeding on isolated trees within continuous forest patches in Morelia, Michoacán (Delgado Carrillo 2012). In addition, the composition of bird species varied across regions, meaning that many of the consumers recorded in our study differed from those found in previous studies (Ortiz-Pulido et al. 2000, Delgado Carrillo 2012). Despite these differences *B. simaruba* consistently emerges as a highly interactive plant species within frugivory networks (Ortiz-Pulido et al. 2000). While legitimate seed dispersers predominated across studies, the relative importance of pseudoaril consumers and seed predators varied, indicating context-dependent functional roles within these assemblages (Albrecht et al. 2012). These differences in species richness and composition are likely driven by latitudinal variation, sampling effort, vegetation type, and spatial scale of the study area (Durán-García and Garcia-Contreras 2010, Rangel-Salazar et al. 2013, Cancino-Oviedo et al. 2020). This suggests that landscape heterogeneity and regional species pools strongly influence interaction networks (Berón et al. 2025).

We found that patterns of richness and diversity of avian species that fed on *B. simaruba* fruits varied across land-use conditions. While species richness (q^0) was significantly higher in the urban condition compared to the wildlands, this difference vanished when considering Shannon diversity (q^1). This pattern suggests that urban areas harbor a high number of rare or occasional species that contribute to overall richness, but do not significantly alter the community's evenness or the dominance structure of the bird-plant interaction (Chao et al. 2014). Furthermore, the productivity systems land-use condition was the most diverse, differing from the urban and wildlands conditions. These results seem to support the intermediate disturbance hypothesis, which suggests that species richness is generally higher at moderate disturbance levels, in comparison to conserved areas (Connell 1978, Hobbs and Huenneke 1992). This is especially noticeable at a local scale, since disturbance increases environmental heterogeneity, which increases habitat diversity and promotes species richness (Limberger and Wickham 2012). An analysis of native and exotic birds recorded in the eBird dataset across the United States of America shows that urban green areas (with high heterogeneity) have higher values of richness, evenness, and Shannon diversity in contrast with natural green areas that have low heterogeneity (Callaghan et al. 2019).

The high frequency of interactions for *B. simaruba* trees in the productivity systems and urban land-use conditions compared to trees in wildlands may be driven by environmental characteristics. For instance, the reduction of native forest cover in human-modified landscapes often creates a bottleneck in food resource availability (Marzluff 2001, Velho et al. 2012, Gopal et al. 2020). This scarcity of alternative fruiting trees likely forces avian consumers to rely on widespread species like *B. simaruba*. Additionally, the canopy surrounding trees in modified areas might be more open, potentially making fruit crops more conspicuous to avian consumers, a factor known to promote increased plant-bird interactions (Ramos-Robles et al. 2016, Blendinger et al. 2012, Bomfin et al. 2021). It is also possible that differences in fruit crop abundance across land-uses influenced these interaction rates. Furthermore, a high number of fruits in *B. simaruba* trees is associated with temperature (Hernández-Rodríguez et al. 2021). Therefore, it is possible that the heat island created by urban areas accelerates fruit matura-

tion and increases removal rates in urban trees compared to wildland counterparts.

In our study, human-modified conditions did not cause a collapse in avian visitors, but instead maintained high richness and diversity compared to wildlands. Although bird community composition varied across land uses, human-modified habitats retained high conservation value. Non-urban production systems harbored the highest number of exclusive species, including several migrants and a parakeet species considered at risk, *Eupsittula canicularis*, while urban areas hosted unique taxa such as the threatened *Psittacara holochlorus*. In contrast, wildlands retained only one exclusive species (*Pheucticus chrysopeplus*). Furthermore, the presence of the quasi-endemic *Momotus mexicanus* in anthropized environments demonstrated that human-modified landscapes, from agricultural mosaics to urban areas, can serve as functional refuges for regional biodiversity when key structural resources like *B. simaruba* are present (Velho et al. 2012, Lin and Fuller 2013, Fischer et al. 2014, Gopal et al. 2020).

Type of consumer and feeding guilds of birds. There was a high dominance of birds considered as legitimate seed dispersers, which highlights the role of *B. simaruba* in the maintenance of ornithochory within anthropized landscapes. In contrast, the specialized feeding behavior of the genus *Icterus*, all four species of which consumed the pseudoaril, suggests a role as pseudoaril consumers that may not contribute to long-distance seed movement. Furthermore, the presence of psittacines as seed predators introduces an antagonistic component to the interaction network. Our observations of *C. gujanensis* performing dual feeding roles underscore the context-dependent nature of functional classifications, suggesting that some species may shift between mutualistic and non-mutualistic roles depending on resource availability or foraging strategy.

We found that insectivores dominated the bird assemblage visiting *B. simaruba* trees including in anthropized landscapes, a pattern that aligns with other studies of avian feeding guilds in tropical urban and fragmented landscapes (Pineda-Diez de Bonilla et al. 2012, Panda et al. 2021). Although anthropized environments with impervious surfaces generally exhibit negative trends in insectivorous bird abundance (Evans et al. 2018), the high dominance of this guild in our study could be a reflection of the high environmental seasonality of the region. This may potentially force insectivorous birds to exhibit high dietary plasticity and rely on other available resources in the environment, such as *B. simaruba*, which produces lipid-rich fruits during the dry season in our study area (Hernández-Rodríguez et al. 2021)**.** Furthermore, the dominance of insectivorous birds in our feeding guilds likely may be supported by the influence of the surrounding agricultural matrix and silvopastoral systems, which provide critical food and refuge resources within the urban-rural interface (Harvey et al. 2006, Perfecto and Vandermeer 2010). In this context, *B. simaruba* constitutes a critical resource in modified environments, such as cities and non-urban production systems, particularly for insectivorous birds with the plasticity to adapt to fluctuating resource availability.

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