*SHILAP Revista de lepidopterología,* 53 (212) 30 diciembre 2025: 707-715 eISSN: 2340-4078 ISSN: 0300-5267
https://doi.org/10.57065/shilap.1103 https://shilap.org
https://zoobank.org/C3C43C22-36DE-4056-93DE-F38C514211A5

# Assessment of Papilionoidea Diversity and Host Plant Correlations amid Anthropogenic Impacts in District Barabanki, Uttar Pradesh (India) (Insecta: Lepidoptera)

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**Abstract**

This study evaluates the impact of anthropogenic activities on Papilionoidea diversity in Barabanki district, Uttar Pradesh (India), by analyzing the relationship between Papilionoidea and their host plants across urban, rural, and forest gradients. Field surveys documented 76 Papilionoidea species across five families, with Nymphalidae being the most prevalent (36.84%). Species richness was highest in forests (66 species), followed by rural (53) and urban areas (39). Among 156 plant species recorded, 89 were identified as host plants. Statistical analysis highlighted significant correlation between Papilionoidea and plant diversity, emphasizing the importance of host plant availability. Forest habitats showed the highest Shannon and Simpson indices (3.92 and 0.97 for Lepidoptera; 3.41 and 0.95 for plants), indicating rich biodiversity, while urban areas showed the lowest, illustrating adverse effect of Urbanization. Despite reduced species' richness, plant evenness was higher in urban areas, potentially due to fewer dominant species. These results emphasize that human-driven habitat loss reduces biodiversity, advocating for conservation strategies, such as afforestation and habitat protection, to sustain Lepidoptera populations and ecological stability. This study provides baseline data crucial for future research and conservation planning in Barabanki and similar regions.
**Keywords:** Insecta, Lepidoptera, Papilionoidea, anthropogenic activities, diversity, host plants availability, urban-rural-forest gradient, conservation, correlation, species richness, evenness, Uttar Pradesh, India.

**Evaluación de la diversidad de Papilionoidea y correlaciones con plantas huésped en medio de impactos antropogénicos en el distrito de Barabanki, Uttar Pradesh (India) (Insecta: Lepidoptera)**

**Resumen**

Este estudio evalúa el impacto de las actividades antropogénicas en la diversidad de Papilionoidea en el distrito de Barabanki, Uttar Pradesh (India), analizando la relación entre Papilionoidea y sus plantas hospedadoras en gradientes urbanos, rurales y forestales. Los estudios de campo documentaron 76 especies de Papilionoidea de cinco familias, siendo Nymphalidae la más prevalente (36,84%). La mayor riqueza de especies se registró en los bosques (66 especies), seguidos de las zonas rurales (53) y urbanas (39). De las 156 especies vegetales registradas, 89 fueron identificadas como plantas hospedadoras. El análisis estadístico puso de manifiesto una correlación significativa entre Papilionoidea y la diversidad de plantas, lo que subraya la importancia de la disponibilidad de plantas hospedadoras. Los hábitats forestales mostraron los índices de Shannon y Simpson más altos (3,92 y 0,97 para los Lepidoptera; 3,41 y 0,95 para las plantas), indicando una rica biodiversidad, mientras que las zonas urbanas mostraron los más bajos, ilustrando los efectos adversos de la urbanización. A pesar de la menor riqueza de especies, la uniformidad de las plantas fue mayor en las zonas urbanas, lo que podría deberse a un menor número de especies dominantes. Estos resultados ponen de relieve que la pérdida de hábitat provocada por el hombre reduce la biodiversidad, lo que aboga por estrategias de

conservación, como la repoblación forestal y la protección del hábitat, para mantener las poblaciones de Lepidoptera y la estabilidad ecológica. Este estudio proporciona datos de referencia cruciales para futuras investigaciones y planes de conservación en Barabanki y regiones similares.
**Palabras clave:** Insecta, Lepidoptera, Papilionoidea, actividades antropogénicas, diversidad, disponibilidad de plantas hospedadoras, gradiente urbano-rural-forestal, conservación, correlación, riqueza de especies, uniformidad, Uttar Pradesh, India.

## Introduction

Papilionoidea are phytophagous, relying on green plants for sustenance in various life stages (larvae/caterpillar or adult). They form close relationships with their host plants, which provide food, mating, and oviposition sites, and act as a habitat for a significant part of their life cycle (Forister et al., 2015). These adaptations require Papilionoidea to cope with plant phenology and chemical defenses, often limiting them to specific host plant species (Futyma & Agrawal, 2009; Futyma & Moreno, 1998). The availability of these plant resources significantly impacts butterfly diversity within a habitat (Shihan & Kabir, 2015), with Lepidoptera being opportunistic foragers of nectar, puddles, carrion, and excreta, influenced by factors like color and odor (Porter et al. 1992).

Plant diversity generally correlates with butterfly diversity as most Lepidoptera are dependent on specific plant species throughout their life cycles (Croxton et al. 2005; Kitahara et al. 2008; Simonson et al. 2001). However, some studies report a weaker relationship between plant species richness and Papilionoidea diversity, suggesting that while both may respond similarly to environmental conditions, plant diversity does not always directly impact diversity (Hawkins & Porter, 2003). Human activities, including habitat loss and landscape transformation, have increasingly affected ecosystems and species diversity, contributing to global declines and extinction rates that are 100 to 1000 times higher than natural rates (Dennis et al. 2013; Wagner et al. 2021; Kumar, 2017).

This study evaluates Papilionoidea and plant species richness and abundance across urban, rural, and forest landscapes to contribute data critical for conservation strategies in Barabanki, Uttar Pradesh, India. The findings aim to predict distribution patterns based on plant diversity and identify key food sources. The study underlines the importance of protecting remaining forested areas and promoting afforestation to bolster green cover and maintain biodiversity.

## Study Area

The present study was conducted in the district of Barabanki, Uttar Pradesh (India), and categorized into three distinct habitat types. The forest gradient was represented by the reserve forest of Ram Sanehi Ghat (N 26º 47’ 14.0” E 081º 32’ 05.1”), while the rural gradient included the agricultural lands of Village Malinpur (N 26º 51’ 20.2” E 081º 31’ 43.8”) and for the urban gradient, the urban park in Safedabad was selected (N 26º 54’ 58” E 081º 06’ 57”).

## Materials and Methods

The study was conducted in Barabanki district, Uttar Pradesh, from August 2023 to July 2024. Observations were carried out in two shifts: from 08:00 am to 12:00 pm and from 03:00 pm to 06:00 pm, encompassing all three major seasons-winter, summer, and monsoon. The surveyed habitats included a forest gradient, agricultural fields, and an urban gradient. Three sampling sites were selected, and at each site, three 1 km line transects were established. Each transect was surveyed for two hours per session.

Papilionoidea observed during the study were identified directly in the field using photography and identification manuals (Evans, 1932; Smetacek, 2017; Kehimkar, 2016; Bhakare and Ogale, 2018). No specimens were collected; instead, photographs were taken to ensure accurate species identification. Larval host plants were also identified and recorded in the field, along with observations of larvae and adults. For plant identification, reference books and articles such as (Robinson et al. 2010; Nitin et al. 2018; Smetacek and Smetacek, 2011; Kishor et al. 2011) were utilized.

## Results and Discussion

During study, 76 species of Papilionoidea belonging to five families were recorded in district Barabanki. Out of 76 species 28 belong to the family Nymphalidae, 25 to Lycaenidae, 12 to Pieridae, 4 to Papilionidae and 7 to Hesperiidae. Species belonging to the family Nymphalidae were most dominant (36.84%) followed by Lycaenidae (32.89%), Pieridae (15.78%), Hesperiidae (9.21%) and Papilionidae (5.26%). Out of 76 species, 66 species were recorded from forest, 53 from rural and 39 from urban biotopes.

There is a total of 156 species of plants present in the study areas out of which 89 host plants of Papilionoidea were identified in the study area (Table 1). The family wise categorization of the host plants indicated that 37.07 % of the plant family reported in present study was used by family Nymphalidae, followed by Lycaenidae 23.59%, 21.34% by family Hesperiidae, 8.98% by family Pieridae and 6.74% by family Papilionidae.

**Table 1.** Checklists of Papilionoidea and their host plants are available at the study site. Abbreviation used: F- Forest; U- Urban and R- Rural, habitat.

| Species Name | Biotope | Host Plants |
|---|---|---|
| *Telicota bambusae* (Moore, 1878) | FR | *Oryza sativa*, *Saccharum officinarum*, *Imperata cylindrica*, *Bambusa vulgaris* |
| *Matapa aria* (Moore, 1865) | F | *Bambusa vulgaris*, *Bambusa arundinacea*, *Dendrocalamus strictus* |
| *Borbo cinnara* (Wallace, 1866) | FUR | *Oryza sativa*, *Axonopus compressus* |
| *Borbo bevani* (Moore, 1878) | FR | *Saccharum officinarum*, *Imperata cylindrica* |
| *Pelopidas mathias* (Fabricius, 1798) | FR | *Axonopus compressus*, *Imperata cylindrica*, *Oryza sativa*, *Saccharum officinarum* |
| *Pelopidas conjuncta* (Herrich-Schäffer, 1869) | F | *Oryza sativa*, *Saccharum officinarum*, *Zea mays*, *Bambusa spp*., *Sorghum bicolor* |
| *Spialia galba* (Fabricius, 1793) | R | *Hibiscus rosa sinensis*, *Tridex procumbens*, *Sida rhombifolia* |
| *Curetis thetis* (Drury, 1773) | FR | *Butea monosperma*, *Pongamia pinnata* |
| *Arhopala atrax* (Hewitson, 1862) | FR | *Shorea robusta* |
| *Rapala iarbus* (Fabricius, 1787) | FU | *Ougeinia dalbergioides* |
| *Rapala manea* (Hewitson, 1863) | F | *Acacia pennata, Saraca asoca, Lantana camara, Mangifera indica* |
| *Anthene emolus* (Godart, 1824) | FR | *Mangifera indica*, *Combretum latifolium*, *Cassia fistula*, *Saraca asoca, Terminalia arjuna* |
| *Tarucus indica* (Evans, 1932) | FU | *Ziziphus jujube* |
| *Tarucus callinara* (Butler, 1886) | FR | *Ziziphus jujube* |
| *Tarucus nara* (Kollar, 1848) | FUR | *Ziziphus jujube* |
| *Castalius rosimon* (Fabricius, 1775) | FUR | *Ziziphus jujuba*, *Ziziphus rugosa* |
| *Tarucus balkanicus* (Freyer, 1844) | FR | *Ziziphus jujube* |
| *Prosotas dubiosa* (Semper, 1879) | FR | *Acacia nilotica*, *Mimosa pudica* |
| *Jamides celeno* (Cramer, 1782) | F | *Butea monosperma*, *Crotolaria retusa*, *Pongamia pinnata, Cajanus cajan* |
| *Catochrysops strabo* (Fabricius, 1793) | FUR | *Ougeinia dalbergioides*, *Butea monosperma, Pongamia pinnata* |
| *Lampides boeticus* (Linnaeus, 1767) | FR | *Pisum sativum*, *Pongamia pinnata*, *Cajanus cajan*, *Butea monosperma*, *Crotolaria retusa* |
| *Pseudozizeeria maha* (Kollar, 1844) | FUR | *Oxalis corniculata* |

| | | |
|---|---|---|
| *Zizeeria karsandra* (Moore, 1865) | FUR | *Amaranthus spinosus*, *Oxalis corniculata* |
| *Azanus jesous* (Guérin-Méneville, 1847) | F | *Acacia catechu*, *Mimosa pudica* |
| *Chilades pandava* (Horsfield, 1829) | FUR | *Acacia nilotica*, *Cycas revolute, Cajanus cajan, Phaseolus vulgaris, Bauhinia variegate, Butea monosperma, Saraca asoca* |
| *Euchrysops cnejus* (Fabricius, 1798) | F | *Butea monosperma*, *Ougeinia dalbergioides*, *Pisum sativum, Acacia nilotica*, *Cajanus cajan* |
| *Chilades lajus* (Stoll, 1780) | FUR | *Murraya paniculata*, *Citrus aurantifolia*, *Citrus maxima, Murraya koenigii, Mangifera indica* |
| *Spindasis vulcanus* (Fabricius, 1775) | UR | *Cadaba fruticosa, Ziziphus jujube, Dioscorea wallichii, Carissa carandas, Cassia fistula* |
| *Talicada nyseus* (Guérin-Méneville, 1843) | UR | *Bryophyllum pinnatum* |
| *Leptotes plinius* (Fabricius, 1793) | R | *Albizia lebbeck*, *Indigofera spp.*, *Sesbania bispinosa*, *Mimosa pudica* |
| *Prosotas nora* (C. Felder, 1860) | FR | *Acacia catechu*, *Mimosa pudica* |
| *Freyeria putli* (Kollar, 1844) | R | *Pisum sativum*, *Oxalis corniculata*, *Indigofera spp.,* |
| *Danaus genutia* (Cramer, 1779) | FUR | *Tylophora indica, Calotropis spp.* |
| *Danaus chrysippus* (Linnaeus, 1758) | FUR | *Calotropis procera*, *Tylophora indica* |
| *Tirumala limniace* (Cramer, 1775) | FU | *Calotropis procera*, *Tylophora indica*, *Ageratum conyzoides*, *Crotolaria retusa* |
| *Parantica aglea* (Stoll, 1782) | F | *Tylophora indica*, *Calotropis procera* |
| *Euploea core* (Cramer, 1780) | FU | *Tylophora indica, Ficus racemosa Ficus benghalensis, Ficus religiosa, Nerium spp., Ageratum conyzoides* |
| *Polyura athamas* (Drury, 1770) | F | *Acacia pennata*, *Albizia lebbeck*, *Acacia catechu*, *Caesalpinia pulcherrima*, *Delonix regia* |
| *Melanitis leda* (Linnaeus, 1758) | FUR | *Oryza sativa*, *Sorghum bicolor*, *Zea mays*, *Saccharum officinarum* |
| *Lethe europa* (Fabricius, 1775) | F | *Bambusa vulgaris*, *Dendrocalamus strictus* |
| *Mycalesis perseus* (Fabricius, 1775) | FR | *Oryza sativa*, *Axonopus compressus* |
| *Ypthima asterope* (Klug, 1832) | FUR | *Axonopus compressus* |
| *Ypthima huebneri* (Kirby, 1871) | FR | *Axonopus compressus, Musa paradisiacal* |
| *Phalanta phalantha* (Drury, 1773) | FR | *Gymnosporia senegalensis*, *Xylosma longifolia* |
| *Moduza procris* (Cramer, 1777) | FUR | *Cadaba fruticosa*, *Neolamarckia cadamba* |
| *Euthalia aconthea* (Cramer, 1777) | FUR | *Mangifera indica* |
| *Euthalia lubentina* (Cramer, 1777) | F | *Loranthus longiflorus* |
| *Ariadne merione* (Cramer, 1777) | FUR | *Ricinus communis* |
| *Ariadne ariadne* (Linnaeus, 1763) | FUR | *Ricinus communis* |
| *Junonia orithya* (Linnaeus, 1758) | FR | *Sida rhombifolia*, *Mimosa pudica, Asystasia gangetica* |
| *Junonia iphita* (Cramer, 1779) | FR | *Asystasia gangetica* |
| *Junonia atlites* (Linnaeus, 1763) | F | *Nelsonia canescens, Limnophila indica* |
| *Junonia almana* (Linnaeus, 1758) | FU | *Mimosa pudica* |
| *Junonia lemonias* (Linnaeus, 1758) | FU | *Cannabis sativa*, *Sida rhombifolia* |
| *Junonia hierta* (Fabricius, 1798) | R | *Asystasia gangetica* |

| | | |
|---|---|---|
| *Hypolimnas bolina* (Linnaeus, 1758) | FUR | *Sida rhombifolia, Hibiscus rosa sinensis, Asystasia gangetica* |
| *Hypolimnas misippus* (Linnaeus, 1764) | FUR | *Sida rhombifolia, Hibiscus rosa sinensis, Asystasia gangetica* |
| *Charaxes solon* (Fabricius, 1793) | UR | *Bauhinia racemosa*, *Tamarindus indica, Dalbergia sissoo* |
| *Vanessa cardui* (Linnaeus, 1758) | UR | *Hibiscus rosa sinensis, Pisum sativum, Cullen corylifolium* |
| *Acraea violae* (Fabricius, 1758) | UR | *Ipomoea carnea, Passiflora spp., Hybanthus emneaspermus* |
| *Eurema hecabe* (Linnaeus, 1758) | FUR | *Albizia lebbeck*, *Cassia fistula*, *Acacia nilotica*, *Sesbania bispinosa*, *Mimosa pudica* |
| *Eurema andersonii* (Moore, 1886) | F | *Ventilago maderaspatana* |
| *Eurema brigitta* (Stoll, 1780) | FUR | *Chamaecrista kleinii* |
| *Ixias pyrene* (Linnaeus, 1764) | FR | *Capparis zeylanica, Capparis sepiaria* |
| *Leptosia nina* (Fabricius, 1793) | FR | *Cleome rutidosperma, Crateva religiosa, Crateva adansonii, Capparis zeylanica* |
| *Pareronia hippia* (Fabricius, 1787) | FUR | *Capparis zeylanica* |
| *Cepora nerissa* (Fabricius, 1775) | FUR | *Capparis zeylanica*, *Capparis sepiaria* |
| *Belenois aurota* (Fabricius, 1793) | FUR | *Capparis zeylanica*, *Cadaba fruticosa* |
| *Delias eucharis* (Drury, 1773) | FUR | *Butea monosperma*, *Loranthus longiflorus* |
| *Ixias marianne* (Cramer, 1779) | R | *Capparis sepiaria, Cadaba fruticosa* |
| *Catopsilia pomona* (Fabricius, 1775) | FUR | *Butea monosperma, Bauhinia raecemosa, Cassia fistula* |
| *Catopsilia pyranthe* (Linnaeus, 1758) | FUR | *Sesbania bispinosa*, *Cassia fistula* |
| *Graphium doson* (C. & R. Felder, 1864) | FU | *Polyalthia longifolia* |
| *Papilio polytes* Linnaeus, 1758 | FUR | *Citrus maxima*, *Aegle marmelos*, *Murraya koenigii* |
| *Pachliopta aristolochiae* (Fabricius, 1775) | FUR | *Aristolochia spp., Thottea siliquosa* |
| *Papilio demoleus* Linnaeus, 1758 | FUR | *Murraya koenigii*, *Ziziphus jujuba, Todalia asiatica, Citrus spp.* |

The statistical analysis revealed a decline in species richness and individual counts for both Papilionoidea and plants, progressing from forest to rural to urban areas, indicative of the detrimental impacts of human activity and habitat degradation. Despite this, Simpson's Index remained relatively high across all area types, suggesting that moderate diversity was preserved even as overall numbers and richness decreased. The Shannon Index further underscored that forest areas harbored the greatest diversity, while urban zones consistently displayed the lowest diversity levels. Interestingly, plant evenness was higher in urban areas (0.64) compared to forest and rural zones, potentially highlighting a reduced presence of dominant plant species in urban environments (Figure 1).

The correlation analysis of diversity indices across forest, rural, and urban habitats demonstrates significant relationships between Papilionoidea and plant diversity. A near-perfect positive correlation ($r = 0.999$) was observed between Papilionoidea and plant species richness, indicating that plant-rich habitats also support diverse populations, highlighting their dependence on host plant availability. Similarly, the correlation between total individual counts of Papilionoidea and plants was exceptionally strong ($r = 0.998$), emphasizing the crucial role of plant abundance in sustaining higher populations across habitats. The Shannon diversity index correlation ($r = 0.857$) suggests that higher plant diversity generally supports greater Papilionoidea

diversity, though not in a strictly linear manner, while the correlation for Simpson's index (r = 0.693) was weaker, indicating variable distribution patterns in areas of higher plant diversity (Figure 2).

**Figure 1.** Diversity Indices comparison of Papilionoidea and plants across different habitats.

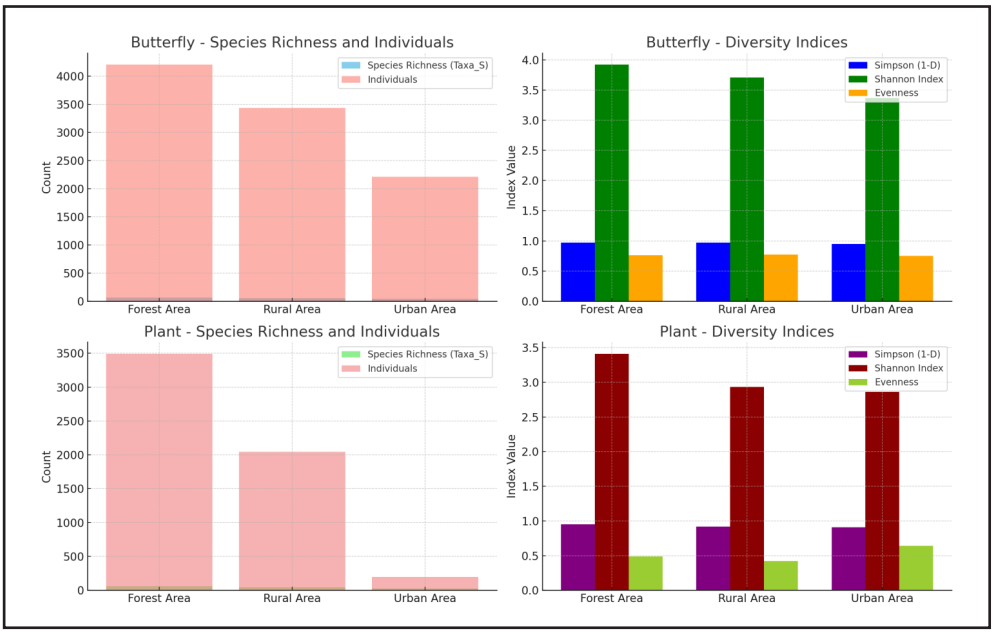
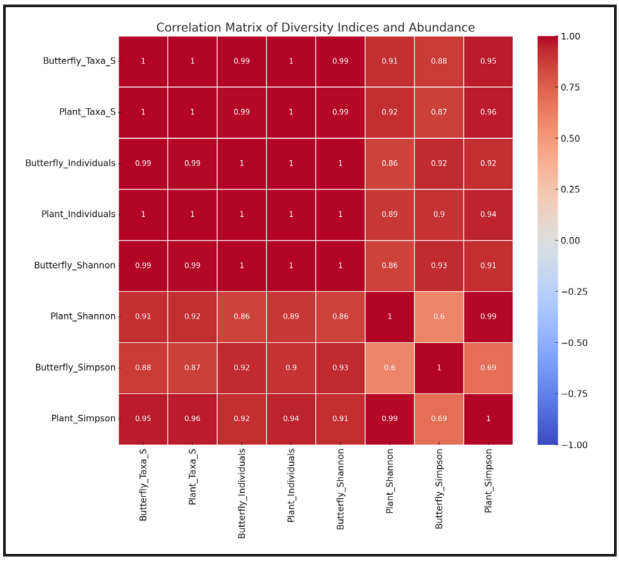



**Figure 2.** The heatmap showing correlation matrix between host plant and Papilionoidea diversity indices and abundance data of Papilionoidea and plants across different habitats.




Habitat-specific analysis of abundance revealed that forests support the highest numbers of both Papilionoidea (4,204) and plants (3,492), with elevated Shannon (3.92 for Papilionoidea; 3.41 for plants) and

Simpson indices (0.97 for Papilionoidea; 0.95 for plants), underlining the importance of dense vegetation in promoting biodiversity. Rural areas showed reduced counts (3,434 Papilionoidea s; 2,044 plants) but still maintained notable diversity (Shannon indices of 3.71 for Papilionoidea and 2.93 for plants), suggesting a moderate capacity for supporting species diversity. Urban habitats presented the lowest abundance (2,209 Papilionoidea; 199 plants) and the lowest Shannon indices (3.37 for Papilionoidea; 2.86 for plants), indicating significant reductions in host plant availability and subsequent impacts on Papilionoidea populations (Table 2-3).

**Table 2.** Diversity indices of Papilionoidea species across three different habitat types.

| Diversity Indices | Forest Area Papilionoidea | Rural Area Papilionoidea | Urban Area Papilionoidea |
|---|---|---|---|
| **Taxa_S** | 66 | 53 | 39 |
| **Individuals** | 4204 | 3434 | 2209 |
| **1-D (Simpson)** | 0.97 | 0.97 | 0.95 |
| **Shannon** | 3.92 | 3.71 | 3.37 |
| **Evenness** | 0.76 | 0.77 | 0.75 |

**Table 3.** Diversity indices of plant species across three different habitat types.

| Diversity Indices | Forest Area Plants | Rural Area Plants | Urban Area Plants |
|---|---|---|---|
| **Taxa_S** | 61 | 44 | 27 |
| **Individuals** | 3492 | 2044 | 199 |
| **1-D (Simpson)** | 0.95 | 0.92 | 0.91 |
| **Shannon** | 3.41 | 2.93 | 2.86 |
| **Evenness** | 0.49 | 0.42 | 0.64 |

The findings emphasize that host plant diversity and abundance are key drivers of Papilionoidea population health, with urbanization posing a major threat to biodiversity due to habitat loss and associated pressures. These results advocate for the conservation of plant diversity and abundance to support robust Papilionoidea populations, highlighting forests as ideal environments for sustaining biodiversity, while suggesting that targeted conservation measures are necessary to counteract biodiversity decline in urban areas. These findings collectively emphasize that forests support more resilient and varied populations of both Papilionoidea and plants, whereas urbanization imposes a significant reduction in both species' richness and diversity.

**Conflict of Interests**

The authors declare that there is no known financial interests or personal relationships that could have influenced the work presented in this article.

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(Recibido para publicación / *Received for publication* 12-XI-2024)
(Revisado y aceptado / *Revised and accepted* 10-III-2025)
(Publicado / *Published* 30-XII-2025)

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