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RESEARCH ARTICLE

Species diversity of butterflies (Lepidoptera: Rhopalocera) in an urban ecosystem, *Hutan Bandar Jeli*, Kelantan

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ABSTRACT

Urban green spaces are vital refuges for biodiversity within expanding cityscapes, yet butterfly diversity in Malaysian urban forests remains poorly documented. This study provides the first comprehensive checklist and diversity assessment of butterflies (Lepidoptera: Rhopalocera) from Hutan Bandar Jeli, Kelantan. Field sampling was conducted over 15 consecutive days using fruit-baited traps and aerial nets allowing for the detection of both fruit-feeding and active flying species. A total of 244 individuals representing 38 species across 11 subfamilies were recorded. The most abundant species were *Mycalesis mineus* (n = 41), *Jamides celeno* (n = 32), *Tanaecia iapis* (n = 27), and *Mycalesis janardana* (n = 27), highlighting their adaptability to urban forest environments and potential role as indicators of habitat quality in disturbed landscapes. Conversely, 16 species were recorded as singletons, reflecting the presence of rare or less commonly encountered taxa. Diversity indices indicate a moderately high species richness and evenness (Shannon-Wiener Index (H') = 2.82; Margalef's Richness Index (D_mg) = 6.72; Pielou's Evenness Index (J') = 0.77). Rarefaction and extrapolation analyses (iNEXT) revealed that sampling captured over 93% of the expected species richness, suggesting effective sampling effort with potential for additional species to be detected through extended or seasonal surveys. This study demonstrates that even small urban forest parks can sustain a remarkably diverse butterfly assemblage, highlighting their ecological and conservation value as biodiversity reservoirs within human-dominated landscapes. The findings further emphasise the importance of incorporating biodiversity considerations into urban planning and habitat management to safeguard such green spaces for the benefit of both wildlife and people.

1. INTRODUCTION

Urbanisation is one of the most pervasive drivers of habitat transformation globally, resulting in significant alterations to biodiversity, ecosystem function, and species interactions (McKinney, 2008; Aronson et al., 2014; Sol et al., 2020; Mosman et al., 2024; Straka et al., 2025). Among terrestrial invertebrates, butterflies (Lepidoptera: Rhopalocera) serve as valuable bioindicators of environmental quality due to their sensitivity to habitat changes, short life cycles, and dependence on specific host plants (Thomas, 2005; Bonebrake et al., 2010; Pallottini et al., 2023; Kitahara & Yasuda, 2024; Wang & Xu, 2024). Butterflies are not only charismatic insects but also essential pollinators (Hassan et al., 2024) and components of the food web (Sinha & Dutta, 2024). Their presence and diversity are often reflective of habitat quality, vegetation structure, and microclimatic conditions. Monitoring butterfly communities in urban environments is therefore critical for assessing the ecological health of remnant green spaces and guiding urban conservation strategies.

In tropical regions such as Southeast Asia, where biodiversity is exceptionally rich yet increasingly threatened, urban expansion often leads to the fragmentation and degradation of natural habitats (Sodhi et al., 2004; Li et al., 2022; Zhang et al., 2025). Despite this, urban green spaces can provide important refugia for insect biodiversity if managed appropriately (Soga & Gaston, 2016; Mata et al., 2021; Gentili et al., 2024; Weber et al., 2024). Despite their small size and anthropogenic surroundings, urban green spaces can maintain surprisingly high levels of species richness (Brassard et al., 2021; Labadessa & Ancillotto, 2023; Stanford et al., 2025) and play a vital role in urban biodiversity networks (Chen & Cheng, 2022).

In Malaysia, butterflies constitute one of the most conspicuous and well-studied groups of insects. Butterflies represent a significant component of insect biodiversity, with over 1,044 species recorded in Peninsular Malaysia alone (Corbet & Pendlebury, 2020). However, much of the existing research has focused on protected forest reserves, national parks, or rural landscapes (e.g., Gintoron & Abang, 2014; Hasnizan et al., 2021; Wan Chik & Mustaffa, 2022) while data on their distribution and diversity in urban settings remain limited in many parts of the country particularly in the East Coast region of Peninsular Malaysia. This gap limits our understanding of how urbanisation affects insect diversity in this part of the country.

Kelantan, situated in northeastern Peninsular Malaysia, is facing increasing land-use pressures from agriculture and urban development. Despite this pressure, studies on insect diversity in this region remain limited. Recent studies have begun to establish baseline inventories in Jeli, Kelantan. For example, Christianus et al. (2024) documented 53 species of butterflies from Lata Hokkaido, a natural forest site in the Jeli district, highlighting the richness and ecological value of such habitats. However, comparable studies in urban forests are still scarce. Hutan Bandar Jeli, a small urban forest park within the same district, provides an opportunity to assess how butterfly communities persist in a more fragmented, human-dominated landscape. Establishing baseline data on species composition, richness, and diversity within such habitats is essential for biodiversity planning and conservation prioritization in the face of accelerating habitat loss.

This study aims to document the diversity and abundance of butterflies in Hutan Bandar Jeli and to evaluate the composition of its butterfly assemblage in an urban forest context. This study provides baseline data on butterfly diversity in Hutan Bandar Jeli, highlighting the ecological value of small urban forest parks in supporting insect biodiversity. The findings from this study are expected to inform conservation planning, species monitoring, and future efforts aimed at preserving biodiversity within fragmented urban landscapes.

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted in Hutan Bandar Jeli (5.6986° N, 101.8431° E), located in the Jeli District, Kelantan, Malaysia (Figure 1). The park covers an area of approximately 10 hectares and is characterized by a mix of natural and semi-natural habitats, including secondary forests. The vegetation includes native tree species, shrubs, and grasses. Additionally, the park features small water bodies and shaded areas, providing a range of microhabitats suitable for wildlife, including butterflies. This park is located near Jeli town and is easily accessible with man-made pathways. The average annual temperature is 24.3 °C, and the annual precipitation is approximately 2700mm. The driest months are from February to April, and the wettest months are from November to January during the Northeast Monsoon.

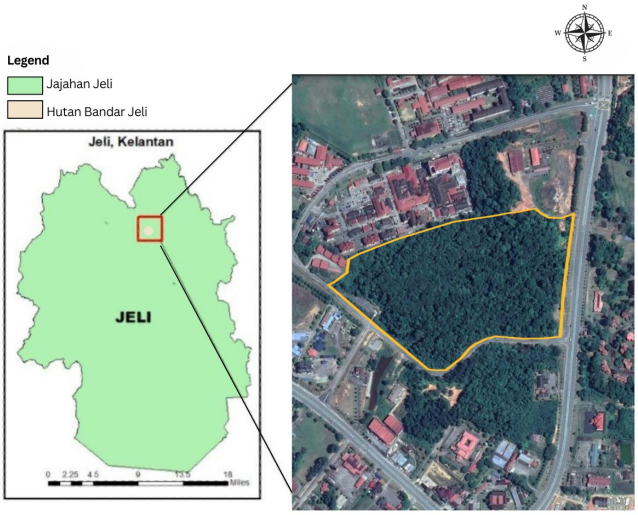

Figure 1: Map showing the location of Hutan Bandar Jeli, Kelantan

2.2. Sampling Methods

Butterflies were sampled for 15 consecutive days between 18 February 2025 and 4 March 2025. Two methods were used, i.e., bait traps and sweep nets. A total of ten baited traps were installed using fermented bananas as bait to attract fruit-feeding butterfly species. The traps were hung from tree branches and set up approximately one meter above ground level. Each trap was positioned at intervals of 20 meters from the other traps. The traps were checked daily at approximately 11:00 a.m. and 2:00 p.m. Baits were replenished daily to ensure continued attractiveness to butterflies. Additionally, butterflies were actively searched around the study area using a sweep net. Sweep netting was conducted along a fixed transect during peak butterfly activity (9:00 a.m. –12:00 p.m. and 2:00 p.m. – 4:00 p.m.) in clear weather. Following standard mark–recapture procedures (Haddad et al., 2008), captured butterflies were individually marked with a unique number on the underside of the hind wings using a waterproof permanent marker (STABILO OHPen universal F). The captured butterflies were identified to species level, following Corbet and Pendlebury (2020) and Kirton (2020). Immediately after data collection, the butterflies were released at their point of capture. Ethical approval for this study was obtained from the Ethics Committee, Faculty of Earth Science, Universiti Malaysia Kelantan (UMK).

2.4 . Data Analysis

All statistical analyses were performed in R version 4.5.0 (R Core Team, 2025) using R Studio version 2025.05.1+513 (Posit Team, 2025). The packages dplyr (Wickham et al., 2023), tidyr (Wickham et al., 2024), forcats (Wickham, 2023), and ggtext (Wilke & Wiernik, 2022) were used for data management, exploration, and visualisation. The diversity of butterfly species was assessed using Shannon-Wiener Index (H'), Margalef's Richness Index (M), and Pielou's Evenness Index (J') using the package vegan (Oksanen et al., 2019). Species richness estimation, including rarefaction and extrapolation, was performed using the iNEXT package (Hsieh et al., 2024) in R. This method provides a visual evaluation of sampling completeness and estimates species richness based on abundance data, generating an interpolated–extrapolated species accumulation curve. All figures were plotted using ggplot2 (Wickham, 2016).

3. RESULT AND DISCUSSION

3.1 Species Composition

A total of 244 individual butterflies, representing 38 species from six families, were recorded in Hutan Bandar Jeli, Kelantan (Table 1). The butterfly fauna recorded in this study represents approximately 3.6 % of the total butterfly species documented in Peninsular Malaysia (Table 2).

The Nymphalidae was the most dominant family, both in terms of species richness and abundance, accounting for 57.9 % of all recorded species and 63.7% of total individuals (Table 3, Figure 2). This is followed by Pieridae and Lycaenidae, contributing 10.5% and 5.3% of species, and 14.7% and 13.5% of individuals, respectively. Hesperiidae, despite representing 15.7% of the species, accounted for only 4.9% of the total individuals. Papilionidae and Riodinidae each comprised 5.3% of the species and 1.6% of individuals.

The dominance of Nymphalidae is consistent with previous tropical butterfly studies, which highlight that this family often exhibits prevalence due to its ecological adaptability, wide host plant range, and affinity for forested habitats (Bonebrake et al., 2010; Basset et al., 2015). Many Nymphalids, particularly subfamilies such as Satyrinae and Nymphalinae, are known to thrive in shaded, moist environments typical of secondary or semi-urban forests. Their larvae often feed on common grasses and herbaceous plants that regenerate quickly in disturbed or fragmented habitats, enabling them to persist under varying environmental conditions (Nylin et al., 2014). In contrast, Pieridae and Lycaenidae, though less dominant, exhibited moderate representation in both richness and abundance. These families are typically associated with open or edge habitats (Munisi et al., 2024; Kwon et al., 2025), which are well-represented in the mosaic structure of Hutan Bandar Jeli. Their host plants are mainly legumes and capparids, which are often abundant along forest edges and pathways, promoting their presence in disturbed or transitional zones. The relatively low abundance of Hesperiidae, despite moderate species richness, may reflect their cryptic behaviour, fast flight, and preference for dense understory vegetation (Pietrzak & Pabis, 2024), making them less likely to be captured through visual or baited methods. Similarly, the low representation of Papilionidae and Riodinidae likely reflects their specialized habitat and host plant requirements, which may be limited in urban forest patches, consistent with long-term observations reported by Carreira et al. (2025).

Table 1: A checklist of butterfly species recorded in Hutan Bandar Jeli, Kelantan

Family	Species	No. of individuals
Hesperiidae	*Atrytonopsis hianna* (Scudder, 1868)	1
	Idmon obliquans (Mabille, 1893)	4
	Notocrypta paralysos (Wood-Mason & de Nicéville, 1881)	2
	Oriens gola (Moore, 1877)	1
	Pirdana hyela (Hewitson, 1867)	1
	Tagiades gana (Moore, 1865)	3
Lycaenidae	*Jamides celeno* (Cramer, 1775)	32
	Prosotas dubiosa (Semper, 1879)	1
Nymphalidae	*Amathusia phidippus* (Linnaeus, 1763)	2
	Athyma perius (Linnaeus, 1758)	1
	Dophla evelina (Stoll, 1790)	1
	Elymnias hypermnestra (Linnaeus, 1763)	3
	Euploea eyndhovii (C. & R. Felder, 1865)	1
	Euploea mulciber (Cramer, 1777)	1
	Ideopsis vulgaris (Butler, 1874)	1
	Lasippa tiga (Moore, 1858)	1
	Lexias dirtea (Fabricius, 1793)	6
	Melanitis leda (Linnaeus, 1758)	3
	Melanitis phedima (Cramer, 1780)	7
	Mycalesis janardana (Moore, 1857)	27
	Mycalesis mineus (Linnaeus, 1758)	41
	Neptis hylas (Linnaeus, 1758)	2
	Neptis leucoporos (Fruhstorfer, 1908)	2
	Orsotriaena medus (Fibricius, 1775)	1
	Parantica aspasia (Fibricius, 1787)	1
	Tanaecia iapis (Godard, 1824)	27
	Tanaecia julii (Lesson, 1837)	5
	Tanaecia pelea (Fabricius, 1787)	3
	Ypthima baldus (Fabricius, 1775)	18
	Zeuxidia amethystus (Butler, 1865)	1
Papilionidae	*Papilio helenus* (Linnaeus, 1758)	2
	Papilio polytes (Linnaeus, 1758)	2
Pieridae	*Belenois aurota* (Fabricius, 1793)	1
	Catopsilia pomona (Fabricius, 1775)	1
	Eurema hecabe (Linnaeus, 1758)	22
	Leptosia nina (Fabricius, 1793)	12
Riodinidae	*Abisara geza* (Fruhstorfer, 1904)	1
	Zemeros emesoides (C. & R. Felder, 1860)	3
Total		244

Table 2: Comparison of butterfly species richness recorded in Hutan Bandar Jeli, Kelantan, with the total number of species documented across Peninsular Malaysia (Corbet & Pendlebury, 2020).

Family	No. of species recorded		Percentage of species recorded in this study
	Hutan Bandar Jeli	Peninsular Malaysia	
Papilionidae	2	45	4.4 %
Pieridae	4	46	8.7 %
Nymphalidae	22	278	7.9 %
Lycaenidae	2	399	0.5 %
Riodinidae	2	16	12.5 %
Hesperiidae	6	260	2.3 %
Total	38	1044	3.6%

Table 3: Total abundance and species richness of butterfly families recorded in Hutan Bandar Jeli, Kelantan. The table shows the number of species and individuals observed per family, along with their respective percentages of the total recorded.

Family	No. of individuals	Percentage (%)	No. of species	Percentage (%)
Nymphalidae	155	63.7	22	57.9
Pieridae	36	14.7	4	10.5
Lycaenidae	33	13.5	2	5.3
Hesperiidae	12	4.9	6	15.7
Hesperiidae	4	1.6	2	5.3
Riodinidae	4	1.6	2	5.3

Among the recorded species, *Mycalesis mineus* was the most abundant (n = 41), followed by *Jamides celeno* (n = 32), *Mycalesis janardana*, and *Tanaecia iapis* (each with n = 27) (Figure 3). The high abundance of these species can be attributed to several ecological and life-history traits, particularly their multivoltinism, habitat preference, and broad host plant associations.

The high abundance of Satyrinae subfamily members, particularly *Mycalesis* spp., may be a reflection of the understorey structure and microhabitat conditions within the park. These butterflies are known to be shade-adapted, low-flying forest specialists, traits that favour their dominance in understorey environments (Dutra & Freitas, 2024). Similar patterns have been described in tropical rainforests where Satyrinae species are disproportionately abundant at lower forest strata, highlighting their dependence on shaded microhabitats for survival and reproduction (Hill et al., 2001; DeVries & Walla, 2001; Checa et al., 2009; Bonebrake et al., 2010). Similarly, *Jamides celeno*, which is a widespread and adaptable species in Southeast Asia, is known to thrive in both disturbed and semi-natural habitats (Robinson et al., 2010; Ilhamdi et al., 2023). Its high abundance may reflect its ecological plasticity, rapid reproductive cycle, and association with a wide range of larval host plants, such as *Desmodium* and *Pueraria* species, which are widely available in secondary vegetation. The species' tendency to form small flocks and its nectar-feeding behaviour near open sunlit paths increased its detectability during daytime sampling.

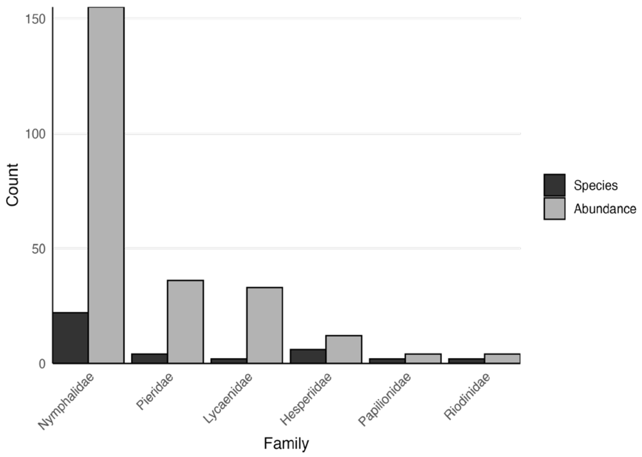

Figure 2: Comparison of species richness and total abundance across different butterfly families recorded in Hutan Bandar Jeli.

On the other hand, *Tanaecia iapis* is typically associated with well-vegetated lowland forest environments (Corbet & Pendlebury, 2020) and is known to respond positively to moderately disturbed habitats (Hill et al., 1995). In the present study, *T. iapis* exhibited relatively high abundance in areas with moderate canopy openings and dense vegetation cover, suggesting its preference for partially disturbed yet structurally complex habitats.

According to Reiss-Woolever et al. (2023), broader findings suggest that butterfly abundance tends to be higher in structurally complex understory habitats, supporting the notion that vegetation heterogeneity within the study site may favour forest-dependent species, such as *T. iapis*. Its attraction to fermenting fruit bait also increases its likelihood of capture in baited traps, which may have contributed to its relatively high count in this study. Moreover, all of these species are multivoltine, allowing multiple generations per year, which enhances their population persistence and contributes to their high abundance in the tropical habitats.

In contrast, a total of 16 species, represented by singletons (i.e., only one individual), were recorded in this study (Figure 3). The occurrence of singleton species is a typical pattern in tropical butterfly surveys, which can often be attributed to a combination of ecological, behavioural, and methodological factors (Basset et al., 2015; Pinkert et al., 2023).

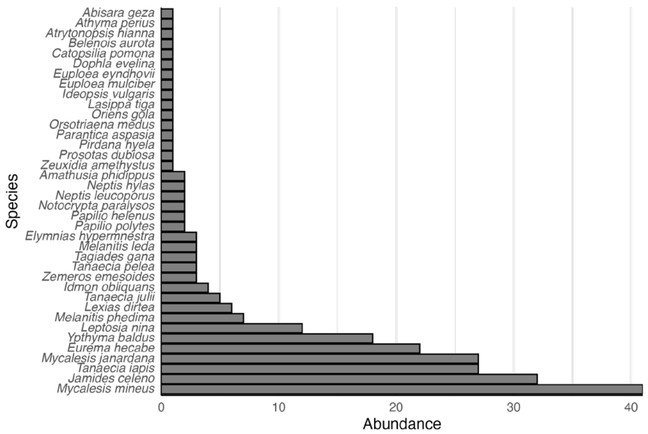

Figure 3: Rank abundance of butterfly species recorded in Hutan Bandar Jeli.

Many of these singletons, such as *Zeuxidia amethystus*, *Parantica aspasia*, and *Lasippa tiga*, are known to be habitat specialists typically associated with dense forest interiors, shaded understorey, or mid-canopy strata. Their low detectability during ground-level surveys or limited activity during the sampling period may contribute to their rare appearance in this study. Similarly, *Orsotriaena medus*, a crepuscular species known to be active under low light conditions, may have been undersampled due to its temporal activity pattern. Notably, *Abisara geza* (Riodinidae), a species typically found in shaded and undisturbed forest habitats, was recorded only once, supporting the idea that this butterfly favours microhabitats less represented in the study site or that it occurs naturally at low densities. In contrast, widespread species such as *Catopsilia pomona* and *Belenois aurota*, typically found in disturbed or open habitats, were also recorded as singletons, suggesting their possible seasonal movement patterns or incidental presence at the site during sampling.

The three singleton skippers, namely the *Atrytonopsis hianna*, *Oriens gola*, and *Pirdana hyela*, are generally elusive, fast-flying, and ground-dwelling species. Their low capture rates may reflect both their cryptic habits and the structural characteristics of the habitat that do not fully support their populations. For instance, the *Atrytonopsis hianna* typically inhabits open grassy areas, and its larvae feed on various Poaceae species. Its presence in this study is likely incidental, reflecting dispersal from nearby open or disturbed habitats not well represented within the study area.

Several singleton species, particularly within the Danainae subfamily (e.g., *Euploea eyndhovii*, *Euploea mulciber*, *Ideopsis vulgaris, Parantica aspasia*), are highly dependent on host plants in the families Asclepiadaceae and Apocynaceae, which were not widespread in the study area. For instance, *Parantica aspasia* primarily depends on *Tylophora* and *Hoya* plant species (Kitching et al., 1999; Robinson et al., 2010), which are more commonly found in undisturbed lowland rainforests than in fragmented or urban forest parks such as Hutan Bandar Jeli. Additionally, *Papilio helenus* depends on host plants from the Rutaceae family, such as *Citrus* and *Zanthoxylum*, which may be scarce in the study area, potentially limiting larval development and the establishment of local populations. Meanwhile, the *Zeuxidia amethystus* larvae feed on monocotyledonous plants such as *Bambusa* (bamboo), which were not commonly observed in the study area (personal observation). Therefore, the presence of these species in low numbers may reflect the scarcity or patchy distribution of their larval host plants.

3.2 Diversity Indices

Table 4 presents the diversity indices of butterflies recorded in Hutan Bandar Jeli, Kelantan. The Shannon Diversity Index (H') of 2.8179 indicates a moderately high level of species diversity within the study area. This value reflects a relatively diverse butterfly community with a fairly even distribution of individuals among species. Generally, a higher H' value signifies both substantial species richness and evenness. While a few species, such as *Mycalesis mineus* and *Jamides celeno*, were more dominant, the presence of numerous less abundant species contributed meaningfully to the overall diversity. The Margalef's Richness Index ($D_{m}g$) was 6.72, suggesting a relatively high species richness in relation to the number of individuals sampled. This highlights the presence of a wide variety of butterfly species in the area. The Pielou's Evenness Index (J') was 0.77, indicating a moderately high level of evenness. This means that individuals were relatively evenly distributed among the recorded species, with no significant skew toward a few dominant species. Additionally, the Simpson's Index of Diversity ($1 - D$) yielded a value of 0.9143, further supporting the interpretation of high species heterogeneity. Values closer to 1 for this index typically denote greater biodiversity, suggesting that the butterfly community in Hutan Bandar Jeli is both rich in species and ecologically balanced.

When compared with other urban and semi-urban forest studies, the diversity indices recorded in Hutan Bandar Jeli are within the upper range ($H' \approx 2.82$). For instance, Koh and Sodhi (2004) reported Shannon indices ranging from 2.2 to 2.8 in urban parks of Singapore. In Malaysia, urban and semi-urban studies exhibit similar trends. For instance, Sing et al. (2016) documented 60 butterfly species across urban parks in Kuala Lumpur, and Jasmani et al. (2020) highlighted the importance of small urban parks in Petaling Jaya for supporting butterfly species richness. Basri and Zakaria (2021) reported moderate butterfly diversity in recreational areas in Sungai Petani, Kedah, whereas Zohdi (2019) recorded lower H' values (0.41) in highly urbanised areas.

In contrast, studies in less disturbed or semi-natural sites, such as Hasnizan et al. (2019) in Gunung Ledang (H' = 3.388), recorded higher diversity. Similarly, Christianus et al. (2024) found an H' of 3.02 in the more natural forest environment of Lata Hokkaido, Jeli. However, it is worth noting that these studies differ in terms of sampling effort, duration, methods, and spatial coverage, which can impact diversity estimates. Therefore, while direct numerical comparisons should be interpreted cautiously, the data suggest that butterfly diversity in Hutan Bandar Jeli is relatively high for an urban or semi-urban forest and approaches the levels observed in less disturbed habitats, underscoring its ecological importance despite being located within a developed area.

The relatively high diversity values observed in this study may be attributed to the structural complexity and mixed vegetation of the Hutan Bandar Jeli, which provides multiple microhabitats and food sources for butterflies. The coexistence of shaded forest interiors, open clearings, and edge habitats allows both shade-tolerant and sun-adapted species to persist. Moreover, the proximity of the site to surrounding green areas may facilitate species dispersal and recolonization, enhancing local diversity through connectivity effects.

Table 4: Diversity indices of butterflies in Hutan Bandar Jeli, Kelantan

Diversity Indices	Value
Shannon-Wiener Index (H')	2.8179
Margalef's Richness Index (D_{mg})	6.72
Pielou's Evenness Index (J')	0.77
Simpson's Index of Diversity (1-D)	0.9143

3.3 Rarefaction and extrapolation curve

The rarefaction and extrapolation curve (Figure 4) generated using the iNEXT package illustrates the species richness pattern of butterflies recorded in Hutan Bandar Jeli. The analysis was conducted using individual-based abundance data. The rarefaction curve shows a steady increase in estimated richness with increasing individuals sampled, reaching approximately 38 species at 243 individuals, just before the observed point. This indicates that most of the species had been captured by the time the sample size approached 244 individuals. Extrapolation up to double the reference sample size (i.e., up to 488 individuals) projects an increase in species richness to approximately 49 species. Sample coverage at the reference point (244 individuals) was estimated at 93.46%, suggesting a high completeness of the sampling effort.

The rarefaction-extrapolation analysis provides important insights into butterfly diversity and sampling completeness in Hutan Bandar Jeli. With an observed richness of 38 species at 244 individuals and an estimated sample coverage of 93.46%, it can be concluded that the majority of common species in the assemblage have been captured; only a small percentage might have been missed (probably rare or hard-to-detect species). The extrapolated richness curve indicates that additional sampling could reveal more species, with the richness potentially increasing to around 49 species if sampling were doubled. This result suggests the presence of undetected rare or cryptic species in the area. The gradual rise in the extrapolated curve also indicates that the butterfly community is moderately diverse but has not yet reached an asymptote, implying that further survey efforts could still be productive.

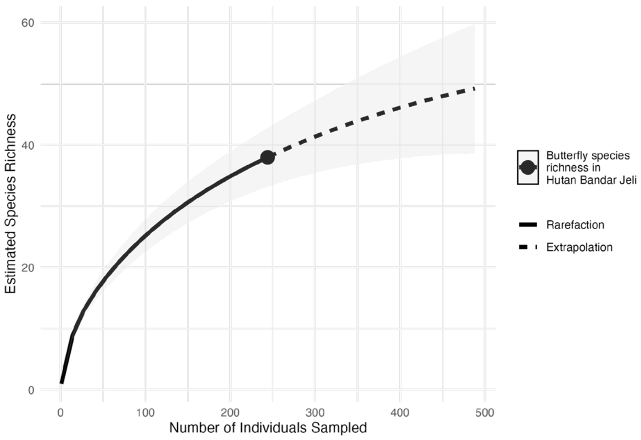

Figure 4: Rarefaction and extrapolation curve of butterfly species richness in Hutan Bandar Jeli based on individual abundance data. The solid line represents the rarefaction (interpolation) of observed species richness, while the dashed line indicates the extrapolated estimate of additional species expected with increased sampling effort. The shaded area denotes the 95% confidence intervals. The reference point (solid dot) marks the observed sample size and corresponding species richness.

While sampling was effective (with 93.46% coverage), the presence of 16 singleton species suggests that additional rare taxa may be present. Therefore, future research should expand sampling across different seasons, incorporate additional environmental variables, and investigate larval host plant associations to gain a deeper understanding of the dynamics of urban butterfly communities. For the long-term conservation of butterflies in Hutan Bandar Jeli, establishing long-term monitoring programs will be crucial in tracking changes in species composition, population abundance, and seasonal dynamics. This will also aid in assessing the impacts of urban development, climate change, and other environmental pressures on butterfly communities. Additionally, habitat management efforts should prioritise the conservation and restoration of native plant species that serve as larval host plants and nectar sources for butterflies. This includes minimising pesticide use, preserving understory vegetation, and rehabilitating degraded habitats with butterfly-attracting flora. Urban planning in and around Hutan Bandar Jeli should incorporate the creation of ecological corridors to facilitate the movement of butterflies and genetic exchange between populations.

4. CONCLUSION

This study provides the first baseline assessment of butterfly diversity in Hutan Bandar Jeli, Kelantan, documenting a total of 244 individuals representing 38 species from six families within a small urban forest park. Although this constitutes only 3.6% of the total butterfly fauna recorded in Peninsular Malaysia, it reveals a moderately diverse community within an urban forest setting. The Nymphalidae family emerged as the most dominant in both species richness and abundance, consistent with its ecological flexibility, wide host plant range, and affinity for forest habitats. Diversity Indices ($H' = 2.82$, $D_{m}g = 6.72$, $1 - D = 0.91$, $J' = 0.77$) indicated a well-balanced and heterogeneous community, while rarefaction analysis confirmed high sampling efficiency.

Overall, this study is significant as it contributes valuable baseline data on butterfly diversity within an understudied urban forest park in Kelantan. With the increasing urbanisation and habitat fragmentation in the future, such information is crucial for understanding how remnant green spaces can function as biodiversity reservoirs. The documentation of rare and specialist species highlights the potential of small forest fragments to support conservation efforts.

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