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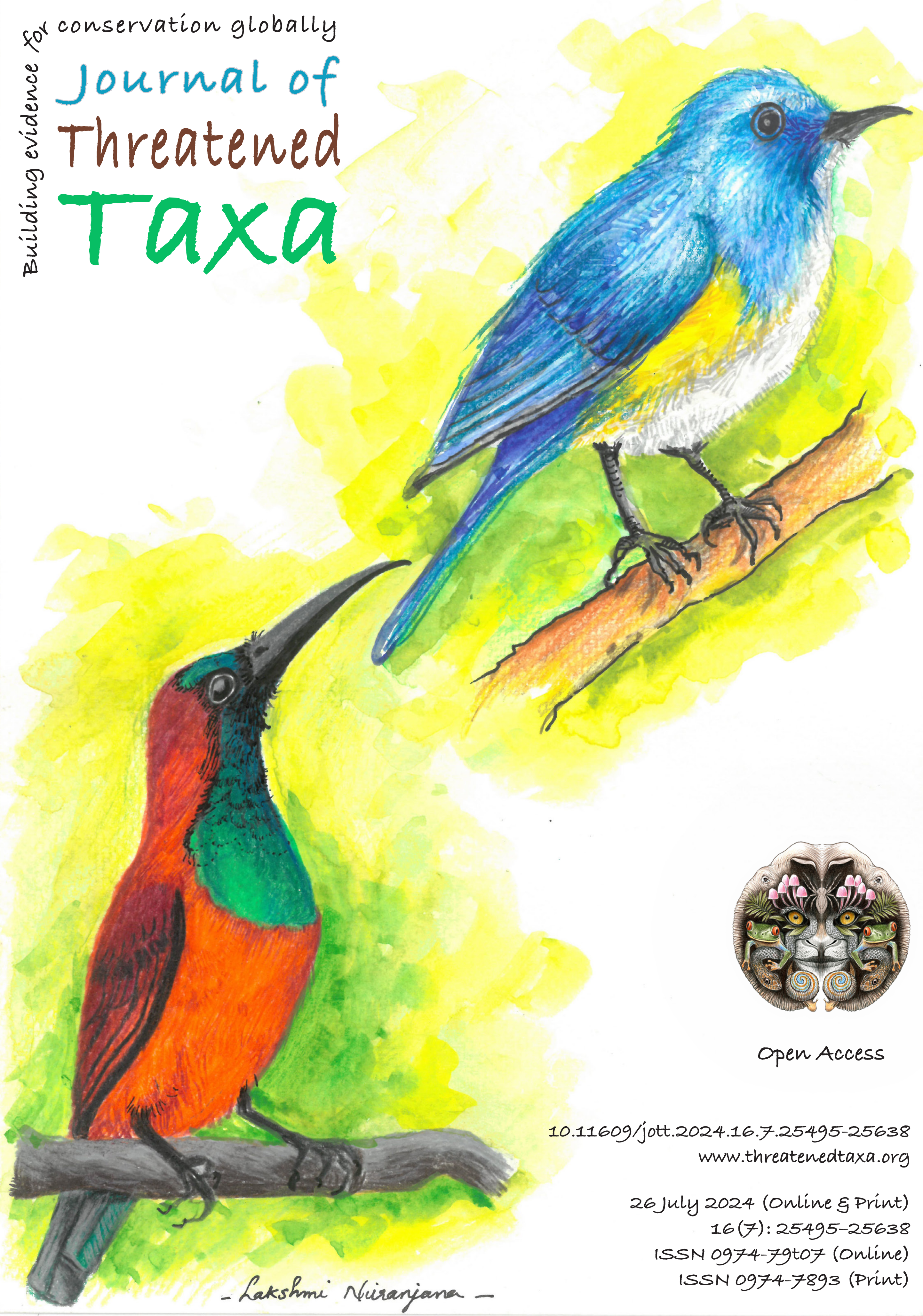

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ARTICLE

Assemblages of frugivorous butterflies in two urban parks in Quezon City, Philippines

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Abstract: Urban parks play a crucial role in supporting biodiversity, yet limited research on urban insect diversity poses challenges for conservation. Comprehensive biodiversity records are essential for monitoring insect population trends. Despite their significance as bioindicators, many urban parks lack baseline data on butterfly populations. This study utilized bait traps to assess butterfly diversity in two Quezon City parks: La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC). Bait trapping facilitates species identification and population trend monitoring without harming local butterfly populations. From April to August 2023, two bait traps equipped with fermented bananas and rum as lures were deployed in each park. A total of 145 individuals representing nine morphospecies of the Nymphalidae family were recorded. Differences in butterfly diversity were noted between LME and NAPWC, with LME showing greater diversity. However, sampling efforts at NAPWC may need expansion to ensure exhaustiveness, potentially affecting comparison accuracy. Notably, four species observed in both parks are endemic to the Philippines, while data on the IUCN Red lIst status of the remaining species are unavailable.

Keywords: Bait trap, biodiversity, bioindicators, La Mesa Ecopark, Lepidoptera, Ninoy Aquino Parks and Wildlife Center, Nymphalidae.

Filipino: Ang mga parke sa lungsod ay mayroong mahalagang papel sa pagsuporta sa iba't ibang uri ng buhay, ngunit ang limitadong pananaliksik sa dami ng mga insekto sa lungsod ay nagsisilbing hamon sa pangangalaga ng kapaligiran. Ang kumpletong tala ng iba't ibang uri ng buhay ay mahalaga para sa pagsubaybay sa mga pagbabago ng populasyon ng mga insekto. Sa kabila ng kanilang kahalagahan bilang mga *bioindicator*, maraming parke sa lungsod ang kulang sa pangunahing datos tungkol sa populasyon ng mga paru-paro. Gumamit ang pag-aaral na ito ng mga bitag na may pain upang masuri ang dami ng mga paru-paro sa dalawang parke sa Lungsod ng Quezon: *La Mesa Ecopark* (LME) at *Ninoy Aquino Parks and Wildlife Center* (NAPWC). Ang paggamit ng pain ay tumutulong sa pagkilala ng mga sarihay at pagsubaybay sa pagbabago ng populasyon nang hindi nakapipinsala sa mga lokal na populasyon ng paru-paro. Mula Abril hanggang Agosto 2023, dalawang bitag na may pain na naglalaman ng binurong saging at rum bilang pang-halina ang inilatag sa bawat parke. Nakapagtala ng 145 na indibidwal na kumakatawan sa siyam na sarihay na kabilang sa pamilyang Nymphalidae. Kapansin-pansin ang pagkakaiba sa uri ng mga paru-paro sa pagitan ng LME at NAPWC, kung saan mas mataas ang baryedad ng paru-paro sa LME. Gayunpaman, maaaring kailanganing palawakin pa ang pagsisiyasat sa NAPWC upang matiyak ang kasakupan nito, na maaaring makaapekto sa kawastuhan ng paghahambing. Kapansin-pansin, apat na sarihay ng paru-paro na nakita sa parehong parke ay endemiko sa Pilipinas, habang wala namang datos sa katayuan ng mga natitirang sarihay ang naitala sa IUCN Red List.

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INTRODUCTION

Importance of studying butterfly species in urban parks

Urban parks play a crucial role in cities by providing a range of ecosystem services, such as biodiversity preservation and urban climate regulation (Sadeghian & Vardanyan 2013; Mexia et al. 2018; Taylor et al. 2020; Sarı & Bayraktar 2023). Traditional efforts to combat global biodiversity decline have focused mainly on conserving natural environments, yet various flora and fauna persist in urban refuges (Gentili et al. 2023). Promoting biodiversity in urban ecosystems enhances the well-being of urban residents (Carrus et al. 2015; Cameron et al. 2020; Marselle et al. 2021) and contributes to conserving biodiversity in natural ecosystems (Savard et al. 2000).

While the literature extensively covers the impact of urbanization on prominent animal like birds and mammals (Seress & Liker 2015; Isaksson 2018; Schmidt et al. 2020), research focusing on invertebrates remains notably scarce, creating a concerning knowledge deficit in biodiversity conservation. Despite evidence of insect sensitivity to environmental change (Kellermann & van Heerwaarden 2019; Harvey et al. 2023), comprehensive data is still lacking. Butterflies are an exception, with extensive research covering many species (Essens et al. 2017). The conservation status of butterfly species is primarily assessed by analyzing population trends and changes in range, relying on extensive and systematic monitoring efforts spanning several decades.

Role of urban parks as crucial habitats for butterflies

Concomitant with economic growth engendered by urban development are significant alterations to human-environmental interactions (Haase 2021). Urban expansion, a hallmark of this expansion, demonstrably deteriorates biodiversity, disrupts vital ecosystem functions, and alters microclimates (Frank et al. 2017). However, recent research suggests that even seemingly inconsequential urban greenspaces, such as parks, can possess significant ecological value (Loures et al. 2007). Despite their relatively small size and artificial composition, these urban parks play a crucial role within the intricate network of the urban ecosystem, providing essential ecosystem services (Davies et al. 2011).

Butterflies face a multitude of challenges, such as habitat degradation (Geyle et al. 2021; Warren et al. 2021), climate change (Davies 2019; Crossley et al. 2021) and pollution (Shephard et al. 2020; Liu et al. 2021; Parlin et al. 2022), resulting in a worldwide decrease in butterfly populations. Assessing changes in butterfly populations is challenging because natural fluctuations (e.g., short-term weather changes (Oliver et al. 2015)) make it difficult to confirm actual decline (Van Strien et al. 1997). This raises serious concerns about ecosystem function as well as human food security, since some species are pollinators or otherwise agriculturally important (van der Sluijs 2020). Studies of butterfly populations underscore the need to assess trends in insect populations, identify vulnerable species and potential pest species (Badon et al. 2023; Eastwood et al. 2006), and determine the underlying causes of their decline. The majority of data so far has come from Europe (Warren et al. 2021), United States (Wepprich et al. 2019; Crossley et al. 2021; Grant et al. 2021), and Australia (Geyle et al. 2021; Sanderson et al. 2021).

The Philippines features a remarkable diversity of butterflies, with a documented total of 927 species, of which >300 are endemic (Treadaway 2012). The archipelagic nature of the Philippines significantly contributes to shaping its biological diversity (Brown et al. 2013). While it poses challenges for conservation, it also provides opportunities for understanding unique ecosystems. While species isolation can lead to speciation, some species are at risk of extinction if their habitat becomes too fragmented. Moreover, anthropogenic environmental changes provide novel ecological niches, which modify selection in many ways to stimulate diversification-however, these changes also frequently eliminate niches and result in extirpations (Ålund et al. 2023).

Understanding how increasing urban sprawl affects biodiversity is imperative in conserving biodiversity in urban green areas (Kuussaari et al. 2021). Among the numerous threats to butterflies in the Philippines is habitat fragmentation brought about by anthropogenic activities (Posa & Sodhi 2006). However, despite the extensive effects of urbanization on natural ecosystems, butterflies remain resilient components within the urban landscape (Pignataro et al. 2023). Moreover, there is a noticeable scarcity of data that looks into the butterfly diversity in urban parks; thus, this research sought to compile a list of butterflies found in two major urban parks in Quezon City. This study primarily focuses on the efficacy of bait traps for capturing frugivorous butterflies, aiming to gather data representative of the broader butterfly population in urban areas.

METHODS

Study Sites

La Mesa Ecopark

The La Mesa Ecopark, established in 1929, is an essential ecological reserve that serves as the primary water source for Metro Manila. This 700-hectare reserve in Quezon City includes a dam and an ecological reserve spanning 2,000 ha of contiguous forest (Image 1). The La Mesa Ecopark is characterized by its dense tree canopies, which provide ample shade, and the paved main trails, which accommodate bicycles. Visitors can access the park via public transportation, and sufficient parking is available (Masangkay et al. 2016; Estoque et al. 2018).

The La Mesa Dam Reservoir, the only major watershed in the metropolitan area, is protected and located adjacent to the park. The park's biodiversity surveys have revealed a diverse range of species, including ants (Pag-Ong et al. 2022), slime molds (Macabago et al. 2010), trees (Malabrigo et al. 2016), and vertebrates (Estoque et al. 2018). The park used to have a butterfly sanctuary, but it was closed during the 2020 pandemic. The sanctuary, managed by a concessionaire, was intended to house butterflies bred in captivity. There has yet to be a study on butterfly diversity within the park, making it an appropriate study site to evaluate butterfly diversity in urban areas.

Ninoy Aquino Parks and Wildlife Center

The Ninoy Aquino Parks and Wildlife Center (NAPWC) was established in 1954 as part of the Quezon Memorial Park. It spans over an area of 197.28 ha and is located at 14.6522°, 121.0453° (Image 2). Despite being located beside a busy highway the park has a tranquil atmosphere. It features an artificial lagoon that is surrounded by lush, cultivated plants. Visitors can access the park through paved pathways and can find shaded areas to relax and have picnics.

The NAPWC is a protected area that is home to diverse tree species. It also has a rescue center that houses various animals, including tigers, monkeys, birds, and snakes. Research conducted within the park has primarily focused on animal diseases (Maluping et al. 2007; Lumabas et al. 2018; Sioson et al. 2018; Gamalo et al. 2019), bird surveys (Vallejo et al. 2009), and freshwater invertebrates (de Leon et al. 2023) in the Philippines. However, there has been no study on butterfly diversity in this park to date.

Sampling

Duration of the Study, Trap Placement, and Monitoring Scheme

The investigation, conducted over five months of April–August 2023, comprised systematic weekly observations throughout both dry (April–May) and wet seasons (June–August). La Mesa Ecopark (LME) facilitated 13 bait trapping sessions, while Ninoy Aquino Parks and Wildlife Center (NAPWC) hosted ten sessions. Bait trapping sessions were subject to postponement during inclement weather, and the frequency of sessions was overseen by the regulatory constraints imposed by the respective management authorities of the urban parks.

Traps were set up between 0800 h and 1000 h in sunny conditions, equipped with rainproof plastic coverings to keep captured butterflies dry in case of sudden rain. After a minimum of 24 h placement, traps were retrieved, and captured butterflies and bycatches were released before deploying fresh traps for subsequent sessions. Each urban park had two traps, at least 200 m away from each other and positioned on sunlit trees less frequented by park visitors' areas to prevent disturbance and theft, in strict adherence to the regulations stipulated in permits issued by the respected administrative bodies responsible for park management.

Bait trapping facilitated the evaluation of specimens caught and subsequent bait replacement. After identifying and recording, butterflies and other insect bycatches were released. The identification of butterflies at the species level and endemicity in the Philippines was accomplished by consulting a wide range of relevant taxonomic literature, including comprehensive publications by Page & Treadaway (2004), Schroeder & Treadaway (2005), Treadaway & Schroeder (2012), Hardy & Lawrence (2017), and Badon (2023). Additionally, the website authored by Badon et al. (2013) entitled "Philippine Lepidoptera" was employed as a resource for conducting image comparisons and species identification, ensuring the research's thoroughness and reliability.

Bait trap Specifications and Observation Method

This study employed modified Van Someren-Rydon traps (see Image 2), initially proposed by DeVries et al. (1997). These traps, constructed from white nylon netting, are cylindrical with dimensions measuring 38 cm in diameter and 100 cm in height. The choice of these traps was based on their proven effectiveness in capturing butterflies, as demonstrated in previous studies. To protect captured specimens from dew and

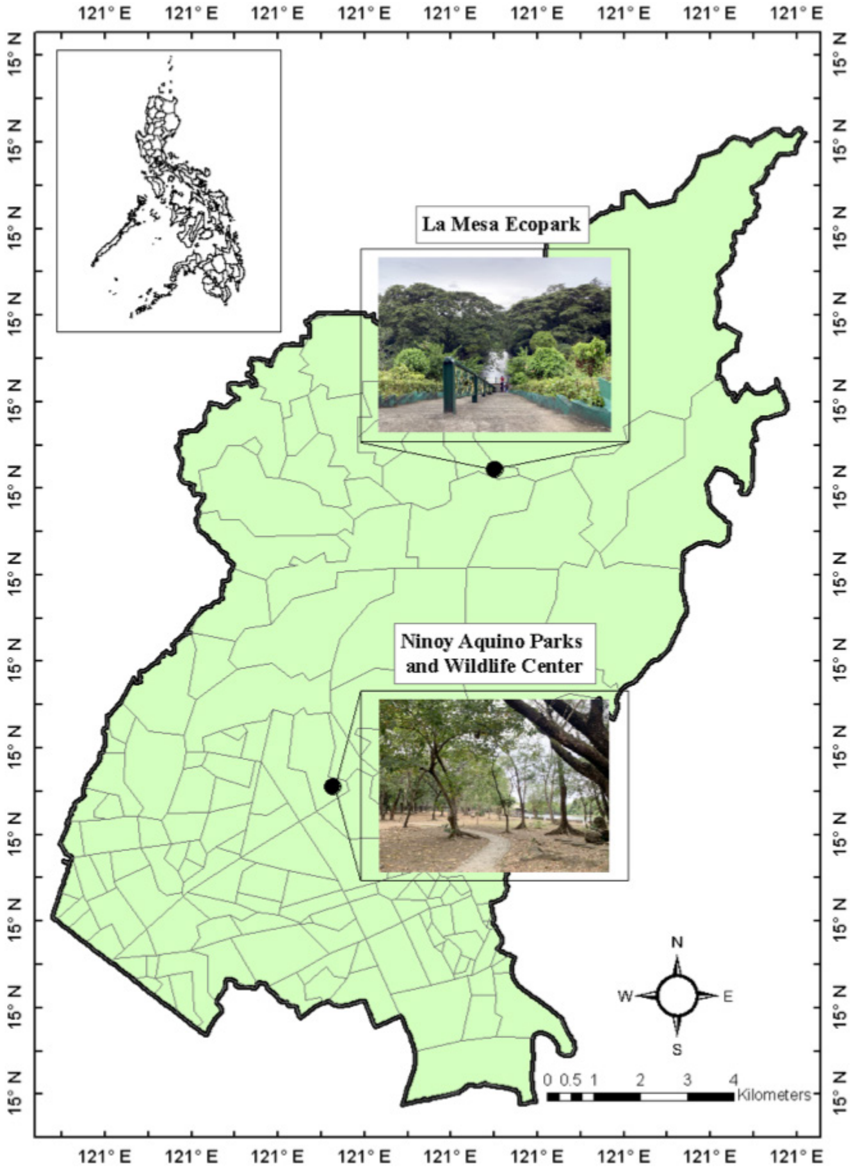

Image 1. This study was conducted in the confines of two urban parks: the Ninoy Aquino Parks and Wildlife Center (NAPWC), located in Diliman, Quezon City, and La Mesa Ecopark (LME), located in Greater Lagro, Quezon City.

rain, two wire hoops, enclosed within plastic casings, are affixed to the top end of each trap. A zippered aperture on the side was employed for ease of insect removal, replacing the use of Velcro. Additionally, a 25 cm diameter plywood sheet was affixed to the lower portion of the netting to serve as an entrance for insects. Beneath this entrance, another plywood sheet of identical dimensions was suspended using hooks, allowing for a five-inch clearance for butterflies. Positioned centrally on the suspended plywood sheet was a reusable plastic plate, 15 cm in diameter, intended for precise bait placement.

The bait selection process relied on prior research from the Philippines, selecting fermented banana as the bait—a mixture of Tanduay Rhum, with a 40% alcohol content by volume, and mature, fermented bananas. The preparation of this bait mixture occurred two days before its use to ensure thorough fermentation. The researchers deposit generous quantity of the bait mixture at each trap's base and left it undisturbed for a minimum of 24 hours to effectively monitor captures.

Permits issued for both parks stipulated minimal to no direct contact with wildlife, including butterflies. Accordingly, captured butterflies were visually observed, photographed using a smartphone camera, and documented. All butterflies and incidental catches were released from the traps by gently tapping the exterior of the bait trap to encourage flight. This tapping was done with hand to minimize any potential harm to the butterflies. The zippered access was used to facilitate this process. Additionally, bait replenishment occurred at the commencement of each baiting session.

Diversity analyses

All ecological data analyses were conducted using R version 3.6.0 (Team 2013) through RStudio version 1.1.453 (Team 2016). Firstly, species accumulation curves (SAC) to assess the adequacy of the sampling effort in this study and estimate species diversity. SAC is a useful tool for evaluating the effectiveness of a fauna survey in accurately representing the fauna population within a geographic area (Thompson & Withers 2003; Ugland et al. 2003; Colwell et al. 2004). The curve shows the cumulative species count in relation to sampling effort and indicates the rate of new species discovery. A steep initial slope suggests rich species diversity or limited sampling, while a flattening curve indicates diminishing returns in species identification. This study calculated SAC using R packages ggplot2 (Wickham & Wickham 2016) and iNEXT (Hsieh et al. 2016). Next, species diversity was calculated using the Hill series of diversity indices (Hill 1973; Jost 2007). This approach considers species richness and evenness based on the occurrence of butterfly species gathered during the rapid assessment. The researchers used the R package iNEXT (Hsieh et al. 2016) for these calculations as well.

RESULTS

Species richness

One-hundred-and-forty-five individuals representing nine species of butterflies were recorded in La Mesa Ecopark and Ninoy Aquino Parks and Wildlife Center. All were fruit-feeding nymphalids of the subfamilies Charaxinae, Nymphalinae, and Satyrinae. The subfamily Satyrinae presented the highest abundance and number of species, followed by Nymphalinae in terms of abundance. The most dominant species were *Amathusia phidippus pollicaris* Butler, 1870 (N = 38, 26%), *Hypolimnas bolina philippensis* Butler, 1874 (N = 30, 22%) and *Melanitis leda leda* (Linnaeus, 1758) (N = 26, 17%).

Species diversity

The quantified alpha diversity, which measures species richness and diversity within local habitats, is essential for understanding the ecological dynamics of

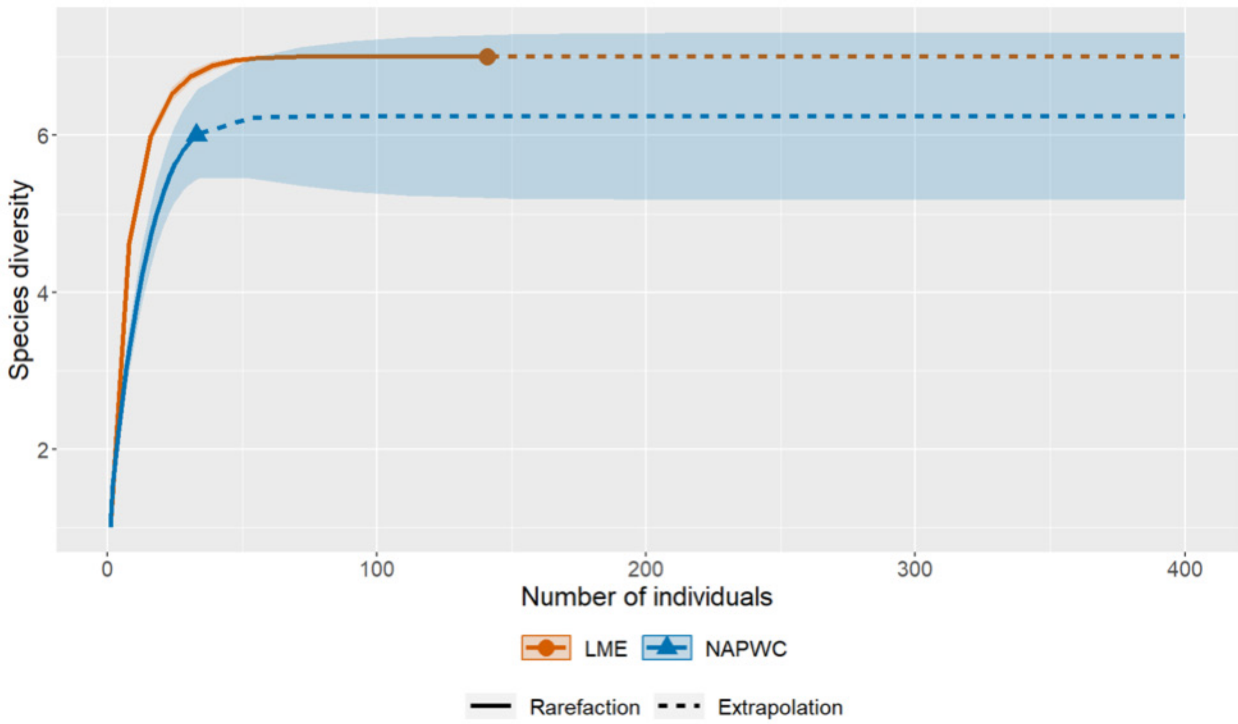

Figure 1. Species accumulation curves for La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC). (NOTE: data: solid lines; extrapolation: dashed line). Shaded areas indicate 95% confidence intervals.

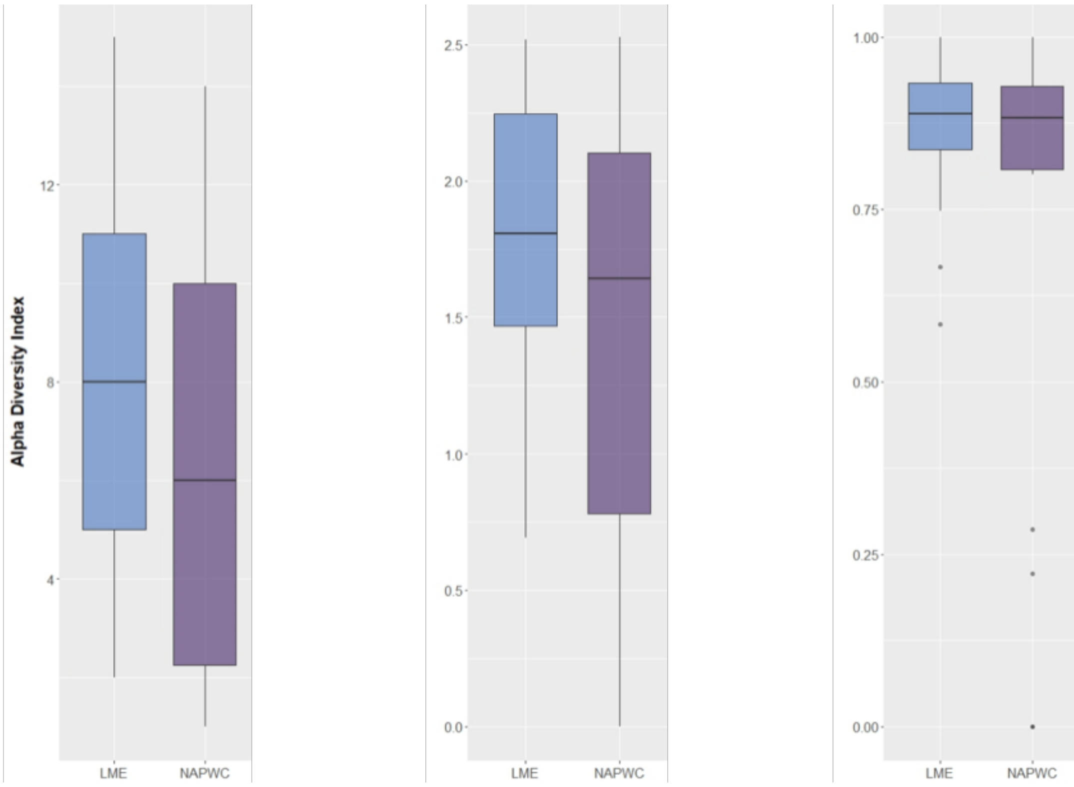

Figure 2. Boxplots illustrating alpha diversity in the two urban parks, highlighting variations in species richness, Shannon diversity, and Simpson diversity in La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC).

Table 1. Geographical coordinates for bait traps at La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC).

Study Site	Bait Trap One			Bait Trap Two		
	Latitude	Longitude	Elevation	Latitude	Longitude	Elevation
LME	14.711944	121.072778	60 m	14.711389	121.077222	70 m
NAPWC	14.649167	121.043889	40 m	14.6525	121.043333	50 m

Image 2. Details of the bait trap: A—Researcher descending down the bait trap, documenting the captured butterflies and bycatches | B—Details of the top portion of the trap with *Amathusia phidippus* and *Hulodes caranea* on resting positions | C—Detail of the narrowed portion of the trap base where the mixture of fermented banana is placed with *Discophora ogina* feeding. © © Micael Gabriel A. Itliong.

Table 2. List of nymphalids recorded in La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC). The species' endemicity is based on whether they have only been recorded in the Philippines, as indicated in the relevant taxonomic literature.

Subfamily	Scientific name	Common name	Endemicity in the Philippines	IUCN Status
Charaxinae	*Charaxes solon* (Fabricius, 1793)	Black Rajah	Native	Not Available
Nymphalinae	*Hypolimnas bolina philippensis* Butler, 1874	Great Egg-fly	Non-endemic	Not Available
Nymphalinae	*Junonia hedonia ida* (Cramer, [1775])	Brown Pansy	Non-endemic	Not Available
Nymphalinae	*Athyma gutama gutama* (Moore, 1858)	Sergeant	Endemic	Not Available
Satyrinae	*Amathusia phidippus pollicaris* Butler, 1870	Palm King	Non-endemic	Not Available
Satyrinae	*Discophora ogina ogina* (Godart, [1824])	Duffer	Endemic	Not Available
Satyrinae	*Melanitis atrax atrax* (C. & R. Felder, 1863)	Evening Brown	Endemic	Not Available
Satyrinae	*Melanitis leda leda* (Linnaeus, 1758)	Common Evening Brown	Non-endemic	Least Concern
Satyrinae	*Mycalesis igoleta* C. & R. Felder, 1863	Igoleta Bush Brown	Endemic	Not Available

Table 3. Occurrence and number of individual butterflies recorded in LME (La Mesa Ecopark) and NAPWC (Ninoy Aquino Parks and Wildlife Center), recorded from April to August 2023.

	Species	LME	NAPWC
1	*Charaxes solon* (Fabricius, 1793)	0	3
2	*Hypolimnas bolina philippensis* Butler, 1874	9	23
3	*Junonia hedonia ida* (Cramer, [1775])	0	3
4	*Athyma gutama gutama* (Moore, 1858)	0	1
5	*Amathusia phidippus pollicaris* Butler, 1870	38	0
6	*Discophora ogina ogina* (Godart, [1824])	9	0
7	*Melanitis atrax atrax* (C. & R. Felder, 1863)	13	2
8	*Melanitis leda leda* (Linnaeus, 1758)	24	2
9	*Mycalesis igoleta* C. & R. Felder, 1863	18	0

Table 4. Number of species recorded in each Nymphalidae subfamily in the two urban parks: LME (La Mesa Ecopark) and NAPWC (Ninoy Aquino Parks and Wildlife Center). Dry season—April–May | rainy season—June–August.

Nymphalidae Subfamily	LME		NAPWC	
	Dry	Wet	Dry	Wet
Charaxinae	0	0	0	1
Danainae	1	1	0	1
Morphinae	2	2	0	0
Nymphalinae	3	4	1	7
Satyrinae	3	4	1	3
Number of species	9	11	2	12

Table 5. Comparison of Shannon diversity index between LME (La Mesa Ecopark) and NAPWC (Ninoy Aquino Parks and Wildlife Center) using Hutcheson t-Test.

	LME	NAPWC
Abundance	111	34
Species Richness	6	6
Shannon Diversity	0.002647	0.036779
t value	2.627909081	
Degree of freedom	39	

butterfly populations in urban parks. Figure 2 presents box plots illustrating alpha diversity metrics between two urban parks: La Mesa Ecopark (LME) and Ninoy Aquino Parks and Wildlife Center (NAPWC). LME emerges to be more diverse in terms of species richness and Shannon diversity.

DISCUSSION

Before this study, there was no available data on what butterfly species occur in both parks; therefore, inferring diversity and population changes over time is impossible. All of the butterfly species recorded in both of the parks belong to the Nymphalidae family, which consists of around 7,200 species that are distributed throughout all continents except Antarctica (Zhang et al. 2008; Yan et al. 2023) and are mostly known to be frugivorous. Although alternative bait lures could have been employed, potentially leading to different results, the choice was guided by previous butterfly trapping research conducted in the Philippines (Toledo & Mohagan 2011; Gestiada et al. 2014; Mohagan et al. 2018; Reeves & Daniels 2020). Nevertheless, the species accumulation curve (see Figure 1) indicates adequate sampling was conducted in LME. Conversely, the curve has yet to reach its asymptote in NAPWC, implying that further sampling efforts could reveal additional

Image 3. Butterfly species caught in bait traps. A—*Charaxes solon* (Fabricius, 1793) ♂ | B—*Hypolimnas bolina philippensis* Butler, 1874 ♂ | C—*Junonia hedonia ida* (Cramer, [1775]) | D—*Athyma gutama gutama* (Moore, 1858) | E—*Amathusia phidippus pollicaris* Butler, 1870 ♂ | F—*Discophora ogina ogina* (Godart, [1824]) | G—*Melanitis atrax atrax* (C. & R. Felder, 1863) | H—*Melanitis leda leda* (Linnaeus, 1758) dry season form | I—*Mycalesis igoleta* C. & R. Felder, 1863. © © Micael Gabriel A. Itliong.

species. Various factors could contribute to the species accumulation curve failing to reach the asymptote. The most evident explanation is the possibility that the sampling effort has yet to achieve full exhaustiveness. Another plausible scenario is that the baits used might not be effective in attracting butterflies. However, it is more probable that the constraints of time imposed by park authorities impeded the optimal number of bait trapping, and increasing the sampling effort beyond the confines stipulated by the park might have facilitated the capture of additional butterfly species.

Among the butterfly species, only three occur in both parks (see Table 3), namely, *Hypolimnas bolina philippensis* Butler, 1874, *Melanitis atrax atrax* (C. & R. Felder, 1863), and *Melanitis leda leda* (Linnaeus, 1758). Both parks have recorded three unique butterfly species (see Table 2). NAPWC exclusively recorded *Charaxes solon* (Fabricius, 1793), *Junonia hedonia ida* (Cramer, 1775), and an individual *Athyma gutama gutama* (Moore, 1858). La Mesa Ecopark, on the other hand, recorded three satyrine species: *Amathusia phidippus pollicaris* Butler, 1870, *Discophora ogina ogina* (Godart, 1824), and *Mycalesis igoleta* C. & R. Felder, 1863.

As indicated by the abundance data presented in Table 4, it is anticipated that a greater number of species would be observed during the wet season. This trend is commonly associated with the wet season's propensity to foster lush vegetation and abundant flowering plants, consequently offering substantial food sources for both butterfly larvae and adults.

It is worth discussing the presence of *D. ogina* in LME. According to Schroeder & Treadaway (2005), species under this genus can be found in forests. They may be attracted to lights and ripened fruits such as pineapple, sometimes flying towards lowland areas. This occurrence and behavior were observed in the Balinsasayao Twin Lakes Natural Park (a Montane Forest). The species were attracted to the bait trap (bananas with Tanduay rhum). It was also observed near the Sierra Madre in Baler, Aurora, where it got attracted to household lights. The presence of *D. ogina* in LME may indicate isolation caused by urbanization, or there may be habitat corridors that connect LME to the mountains of Sierra Madre on the east.

The findings depicted in Figure 2 highlight a contrast between the LME and NAPWC in terms of species richness and diversity. Notably, the LME site demonstrates a considerably higher level of Shannon and Simpson diversity than NAPWC. However, it is crucial to reiterate the caution when interpreting this discrepancy, given the ongoing nature of sampling efforts at NAPWC, as indicated by the species accumulation curve depicted in Figure 1. This curve underscores that the sampling conducted at NAPWC may still need to be exhaustive, potentially impacting the accuracy of the comparison. Therefore, it's essential to approach these findings with caution. Nevertheless, the T-test results presented in Table 5 underscore a statistically significant difference in the number or diversity of observed butterflies between the two urban parks.

It is worth noting that LME is situated adjacent to a semi-natural landscape, suggesting that preserving natural habitats surrounding the city will be crucial for successfully preserving urban butterfly species (Koh et al. 2004). This result is consistent with previous studies conducted in Singapore (Koh & Sodhi 2004), southern China (Sing et al. 2016), and Brazil (Brown & Freitas 2002), which found that urban parks connected to forests had a greater diversity of butterfly species than standalone parks with limited space or lacking diverse flora. It is also expected that LME would have the most butterfly species, as Mohagan et al. (2011) have emphasized that butterflies prefer forested habitats over disturbed areas.

Challenges and opportunities in conservation

Utilizing bait traps for butterfly diversity assessment presents several advantages over the conventional insect net sampling technique. This approach allows researchers to target a more specific subset of local butterfly populations. The presence or absence of butterfly species in both study sites may offer insights into the type of habitat these species inhabit. Notably, the occurrence of endemic species in urban parks carries significant implications for public awareness and biodiversity conservation (Padrón et al. 2020; Koethe et al. 2023) The presence of endemic butterfly species in these urban parks, as evidenced in Table 2, serves as an indicator of the overall ecological health and habitat integrity (Pe'er & Settele 2008; Miller III et al. 2011) —a trend observed among invertebrates in general (Paoletti 1999; Gerlach et al. 2013). Thus, the presence of these species within urban parks underscores the critical importance of preserving natural habitats within urban environments. Habitat alterations, as noted by de Carvalho (Santos et al. 2020) and Uehara-Prado et al. (2007), can influence the diversity of frugivorous butterflies, potentially explaining the disparities in abundances and species presence or absence between LME and NAPWC. Consequently, long-term monitoring of butterflies in these parks is essential to establish baseline data regarding their occurrence and abundance.

CONCLUSION

The findings of this study emphasize the importance of urban parks in sustaining butterfly diversity, including the presence of endemic species. To ensure the survival of butterfly populations, it is important to focus on preserving and restoring interconnected natural forests and facilitating gene flow among butterfly populations. Monitoring schemes should be implemented to track butterfly populations in these parks as they are sensitive to environmental changes. Bait trapping is an effective method for monitoring butterfly populations in urban parks. However, due to urban management protocols, the use of fermented bananas as bait is limited. Therefore, future research should explore the efficacy of alternative lure bait traps in urban park settings. Butterflies are considered umbrella species and can serve as vital conservation indicators for these remaining refuges. Protecting these species is vital in the face of increasing urbanization risks. Urgent measures must be taken to safeguard these unique habitats and ensure the preservation of butterfly populations within urban parks. Integrating scientific data into urban planning and management processes is essential to understand the ecological significance of these habitats and devise effective conservation strategies.

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