

Diversity, Dominance, And Conservation Status Of Butterflies (Lepidoptera: Papilionoidea) In The Gunung Puntang Protected Forest, West Java, Indonesia

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Abstract: Butterflies (Lepidoptera: Papilionoidea) are vital bioindicators for evaluating the ecological integrity of tropical forest ecosystems. This study assessed butterfly diversity, community structure, and conservation status within the Wana Wisata Gunung Puntang area, West Java, Indonesia. Data were collected across four habitat types—secondary forest, riparian zones, coffee-based agroforestry, and open areas—using the time-search sampling method over three consecutive days in July 2025. Diversity indices including Shannon–Wiener (H'), Margalef (D_{mg}), and Evenness (E) were calculated to determine community stability. Thirty-seven butterfly species belonging to five families and totaling 155 individuals were identified, with Pieridae and Papilionidae as the dominant families. The highest diversity occurred in secondary forest and agroforestry habitats, while open areas exhibited the lowest. Two species—*Troides helena* and *Troides cuneifera*—were identified as nationally and internationally protected species under CITES Appendix II and Indonesian Regulation No. P.106/2018. The results highlight the crucial roles of habitat heterogeneity, microclimatic variation, and floral resource availability in maintaining butterfly diversity. Gunung Puntang serves as an important ecological refuge for tropical forest butterflies and demonstrates strong potential as a model for community-based biodiversity conservation and ecotourism development.

Keywords: butterfly diversity; bioindicator; community structure; papilionoidea; West Java

1. INTRODUCTION

Butterflies (*Lepidoptera: Papilionoidea*) are among the most widely used insect groups for assessing biodiversity and ecosystem health. Their ecological role extends beyond pollination; they also serve as sensitive bioindicators of environmental change, reflecting processes such as forest fragmentation, vegetation degradation, and microclimatic fluctuation [1], [2]. The physiological sensitivity of butterflies to temperature, humidity, and light intensity makes them a central focus of tropical ecological and conservation research [3].

Indonesia, recognized as one of the world's megadiverse nations, harbors more than 1,500 recorded butterfly species [4]. Nevertheless, most ecological and distributional data remain concentrated in major conservation areas such as Mount Gede Pangrango National Park [5]. Meanwhile, numerous secondary forest landscapes and nature-based tourism sites in West Java possess high yet poorly documented biodiversity potential. One such area is the Gunung Puntang region in Bandung Regency, which ecologically represents a transitional habitat between lower montane forests and coffee-based agroforestry systems.

Increasing tourism intensity and vegetation modification in Gunung Puntang pose potential risks to butterfly populations. Despite its ecological and recreational importance, no quantitative studies have evaluated the impacts of these pressures on community composition or species conservation status.

Previous research has shown that butterfly diversity is strongly influenced by vegetation heterogeneity, host plant availability, and microclimatic conditions. Conversely, landscape transformation and increasing tourism pressure can reduce nectar resources and lead to the homogenization of butterfly communities [3]. Therefore, studying butterfly ecology in Gunung Puntang is crucial not only to understand the ecological dynamics of tropical forests in West Java but also to provide an evidence base for developing community-based conservation and sustainable ecotourism management strategies.

Based on this context, the present study was designed to:

1. Identify butterfly diversity and abundance across various habitat types in the Gunung Puntang area;
2. Analyze variations in community structure and diversity indices (H' , E , D_{mg}) among habitats and their relationships with environmental factors (light intensity, humidity, and temperature); and
3. Assess the conservation status of butterfly species based on national and international references (Permen LHK No. P.106/2018; CITES Appendix II; IUCN Red List, 2023).

This research contributes to strengthening the biodiversity database for insect fauna in West Java. Beyond providing a taxonomic inventory, the study also examines the ecological relationships between butterfly diversity and environmental variables, offering practical recommendations for biodiversity conservation and science-based ecotourism development in the Gunung Puntang landscape.

2. RESEARCH METHODS

2.1. Study area and period

The study was conducted in the Wana Wisata Gunung Puntang recreational forest, located in Bandung Regency, West Java Province, Indonesia ($7^{\circ}06' - 7^{\circ}10' S$ and $107^{\circ}36' - 107^{\circ}40' E$). The area is part of a protected montane forest ecosystem situated at elevations between 1,100 and 1,300 meters above sea level, covering approximately 400 hectares. According to the Schmidt and Ferguson classification, the regional climate is categorized as type C, with an average daily temperature of $24 - 26^{\circ}C$ and relative humidity ranging from 70 to 85%. The vegetation is dominated by stands of *Pinus merkusii*, *Schima wallichii*, and *Altingia excelsa*, with understory layers rich in flowering shrubs such as *Lantana camara*, *Clerodendrum japonicum*, and *Melastoma malabathricum*, which provide important nectar sources for butterflies.

Fieldwork was conducted from 28 to 30 July 2025, during the dry season when weather conditions were relatively stable and favorable for insect activity. Four main habitat types were identified within the study area: (1) secondary forest with dense canopy cover ($>80\%$), (2) riparian zones characterized by mixed vegetation and high humidity, (3) open areas consisting of grasslands and tourist zones with low vegetation cover ($<30\%$), and (4) coffee agroforestry sites where coffee is cultivated beneath pine stands. A map of the Wana Wisata Gunung Puntang area was prepared to illustrate the distribution of sampling locations and habitat types on Figure 1.

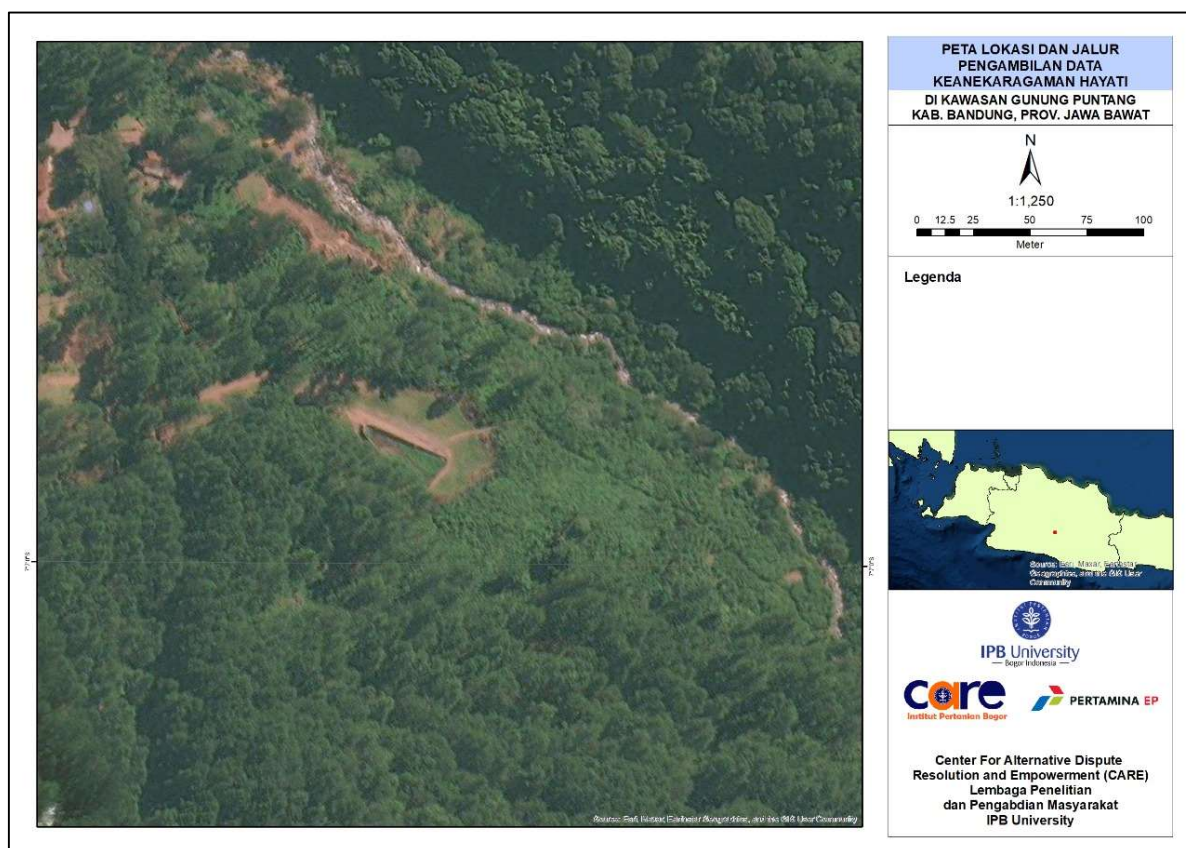


Figure 1. Map of the research location in the Wana Wisata Gunung Puntang area

2.2. Sampling design and data collection

Butterfly sampling employed the time-search method modified from [6], a widely used technique for tropical butterfly surveys. A stratified random sampling design was applied across the four habitat types. In each habitat, five observation plots measuring 50×50 meters (0.25 ha) were randomly selected, with a minimum distance of 100 meters between plots to prevent double-counting of individuals.

Each plot was observed for 15 minutes and replicated three times per session. Observations were conducted twice daily, in the morning (09:00–12:00) and afternoon (16:00–18:00), coinciding with the peak flight activity of butterflies [1]. The total observation effort amounted to $4 \text{ habitats} \times 5 \text{ plots} \times 3 \text{ replications} \times 2 \text{ sessions} \times 15 \text{ minutes} = 30$ observation hours, equivalent to 120 standardized time units. Butterfly abundance was expressed as catch per unit effort (CPUE), defined as the number of individuals observed per 15 minutes per plot, allowing for standardized comparisons across habitats.

2.3. Equipment, materials, and species identification

The field equipment used included insect nets, a digital camera (Canon EOS M50), a lux meter (LX-1330B) to measure light intensity (lux), a thermo-hygrometer (HTC-2) to measure temperature and humidity, and a GPS unit (Garmin eTrex 30x) to record the coordinates of each sampling plot. Captured butterflies were identified visually in the field based on wing morphology and coloration, then released back into their natural habitat following a catch-and-release protocol [3].

Species identification followed standard taxonomic guides:

- *Practical Guide to the Butterflies of Bogor Botanic Garden* [7]

- *Butterflies of West Java* [8]
- *The Illustrated Encyclopedia of the Butterfly World* [9]

Each identified specimen was documented through macro photography and assigned a habitat-specific code (e.g., H2-P3-R1). The field data recorded included: (1) species name, (2) number of individuals, (3) habitat type, (4) observation time, (5) GPS coordinates, and (6) micro-environmental variables.

2.4. Diversity data analysis

Data analysis was performed quantitatively using several standard ecological indices [6]:

Shannon–Wiener diversity index (H'):

$$H' = - \sum_{i=1}^S p_i \ln p_i$$

$p_i = \frac{n_i}{N}$, n_i is the number of individuals of species i , and N is the total number of

Evenness index (E):

$$E = \frac{H'}{\ln S}$$

Margalef species richness index (D_{mg}):

$$D_{mg} = \frac{S - 1}{\ln N}$$

The values of H' , E , and D_{mg} were calculated for each habitat type. The interpretation of values followed Magurran (2004):

- $H' > 3$ indicates high diversity,
- E approaching 1 indicates an even community structure, and
- $D_{mg} > 5$ indicates high species richness.

Sampling completeness was assessed using species accumulation curves and sample coverage-based rarefaction/extrapolation analysis (iNEXT). Good's coverage index was calculated to evaluate sampling adequacy, with values ≥ 0.9 considered representative of the actual community [10].

2.5. Conservation status assessment

Each recorded species was assessed for its conservation status using the following references:

- Regulation of the Minister of Environment and Forestry No. P.106/2018 on Protected Flora and Fauna Species,
- CITES Appendix II (2023), and
- The IUCN Red List (2023).

For protected species (*Troides helena* and *Troides cuneifera*), additional notes were made on their location, habitat characteristics, and behavioral observations to support conservation recommendations.

3. RESULTS

3.1. Butterfly Species Diversity

The 2025 biodiversity survey in the Gunung Puntang area recorded 37 butterfly species comprising 155 individuals from five families: Pieridae (15 species), Papilionidae (10), Lycaenidae (2), Erebididae (1), and Nymphalidae (9). The most frequently

encountered species was *Jamides elpis* (Lycaenidae), represented by 35 individuals. Notably, *Jamides elpis* and *Udara rona* (Lycaenidae) were absent from the 2024 survey, indicating possible temporal variation in occurrence. Four previously unrecorded Lepidoptera species were newly identified during the 2025 survey. A summary of species richness and individual counts for each butterfly species recorded in the Gunung Puntang area is presented in Table 1.

Field observations in 2025 revealed that the number of butterfly species recorded in the Gunung Puntang area was higher than in the previous year. However, the total number of individual butterflies observed declined. This reduction in individual abundance is presumed to have been influenced by unstable weather conditions during the observation period. The local climate of Gunung Puntang is highly unpredictable, often characterized by dense morning fog and heavy rainfall during the afternoon. Such conditions directly affect butterfly activity, as these insects require sunlight and warmth to perform basking—a thermoregulatory behavior that enables them to adjust body and wing temperatures before initiating flight and foraging activities. In addition, butterflies typically exhibit higher activity in humid areas such as riparian zones and shrublands, where they can access food sources, water, and appropriate basking sites.

Table 1. Butterfly Species Recorded in the Gunung Puntang Protected Forest

No	Species Name	Scientific Name	Number Individual	Dominance (%)
1	Ngengat putih marmer	<i>Nyctemera adversata</i>	2	1,290
2	Kapas rona	<i>Udara rona</i>	6	3,871
3	Azura kilau	<i>Jamides elpis</i>	35	22,581
4	Aristokrat malaya	<i>Tanaecia pelea</i>	6	3,871
5	Indomalayan nyphaline butterfly	<i>Symbrenthia anna</i>	3	1,935
6	Alan acak	<i>Symbrenthia hypatia</i>	3	1,935
7	Perumput jawa nigricans	<i>Ypthima nigricans</i>	2	1,290
8	Perumput mata tiga	<i>Ypthima pandocus</i>	2	1,290
9	Alan hippalus	<i>Symbrenthia hippoclus</i>	2	1,290
10	Pelaut biasa	<i>Neptis hylas</i>	3	1,935
11	Staf sersan jingga	<i>Athyma cama</i>	2	1,290
12	Horsfield's bushbrown	<i>Mycalesis horsfieldi</i>	5	3,226
13	Keluang kepala putih	<i>Atrophaneura priapus</i>	7	4,516
14	Sayap segitiga berekor	<i>Graphium agamemnon</i>	2	1,290
15	Sayap segitiga biru	<i>Graphium sarpedon sarpedon</i>	4	2,581
16	Ekor walet pita	<i>Papilio demolion</i>	1	0,645
17	Pastur besar	<i>Papilio memnon</i>	3	1,935
18	Helen hitam putih	<i>Papilio nephelus</i>	4	2,581
19	Paris	<i>Papilio paris gedeensis</i>	1	0,645
20	Pastur biasa	<i>Papilio polites</i>	2	1,290
21	Sayap burung cuneifera	<i>Troides cuneifera</i>	4	2,581
22	Sayap burung biasa	<i>Troides helena</i>	4	2,581
23	Albatros biasa	<i>Aphas libythea</i>	4	2,581
24	Albatros kecil	<i>Appias albina</i>	2	1,290
25	Albatros	<i>Appias Paulina</i>	3	1,935

No	Species Name	Scientific Name	Number Individual	Dominance (%)
26	Migran belang	<i>Catopsilia piyante</i>	1	0,645
27	Camar biasa	<i>Cepora nerissa corva</i>	5	3,226
28	Izebel sunda	<i>Delias belisama</i>	7	4,516
29	Izebel dorilaea	<i>Delias dorylaea</i>	5	3,226
30	Alang kuning biasa	<i>Eurema hecabe</i>	4	2,581
31	Polos-kuning	<i>Gandaca harina</i>	1	0,645
32	Putih bintik hitam	<i>Leptosia nina</i>	2	1,290
33	Biku tepi kunng	<i>Prioneris autothisbe</i>	4	2,581
34	Biku bintik merah	<i>Prioneris philonome</i>	4	2,581
35	Albatros coklat	<i>Appias lyncida</i>	3	1,935
36	Papuan jezebel	<i>Delias philonome</i>	2	1,290
37	Alang kuning bintik tiga	<i>Eurema blanda</i>	5	3,226



(a)



(b)



Figure 2. Dominant butterfly species in the Gunung Puntang area: (a) *Jamides elpis*, (b) *Eurema blanda*, (c) *Troides helena*, (d) *Symbrenthia hippoclus*.)

Butterflies play a crucial role in maintaining both ecosystem balance and human well-being. One of their primary ecological functions is pollination, facilitating the transfer of pollen from male to female flower structures and ultimately contributing to fruit and seed formation in angiosperms [1]. Diurnal butterflies frequently interact with brightly colored flowers, making them efficient pollinators across diverse vegetation types, including tropical forests and agricultural landscapes. This

pollination process not only enhances plant reproductive success but also enriches floral biodiversity and stabilizes trophic networks. At the same time, butterflies and their larvae constitute essential prey for a variety of predators.

Beyond their ecological value, butterflies hold significant cultural, economic, educational, and aesthetic importance for humans. Across many cultures, they are revered as symbols of beauty, transformation, and hope. Moreover, exotic butterfly species such as *Troides helena* are frequently utilized in ecotourism and butterfly breeding enterprises, providing sustainable economic benefits to local communities. Butterflies are also widely recognized as bioindicators in environmental research because their life cycles and dependence on specific habitats make them highly sensitive to ecological disturbances [1], [11]. Therefore, butterfly conservation yields dual benefits—preserving biodiversity while simultaneously enhancing community livelihoods through community-based conservation initiatives.

Butterflies are poikilothermic (cold-blooded) organisms incapable of generating sufficient metabolic heat to sustain independent flight (Utami, 2012). Consequently, they rely on solar radiation through basking as a thermoregulatory mechanism, particularly in the morning before becoming fully active. Two common basking postures are observed among butterflies. The first is dorsal basking, where butterflies fully open their wings in exposed areas to directly absorb sunlight—an effective way to raise thoracic temperature through solar radiation absorption. The second is lateral basking, in which butterflies close their wings and tilt their bodies at an angle toward the sun. In this position, the overlapping wings optimize heat absorption and body warming without causing overheating. Utami (2012) describes this technique as the most efficient method for acquiring thermal energy from sunlight. Through basking, butterflies can achieve their optimal body temperature—typically between 28°C and 40°C—necessary for activating flight muscles and engaging in foraging or mating behavior.

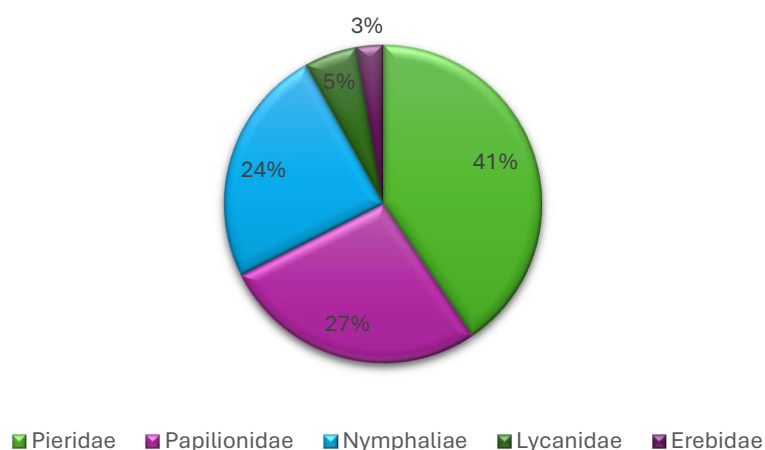


Figure 3. Dominance of butterfly families in the Gunung Puntang area.

Observations revealed that the most dominant families in Gunung Puntang were Papilionidae and Pieridae. Both families are commonly found across tropical ecosystems and were the two most species-rich and abundant groups recorded in the area. The Pieridae family, consisting of predominantly white to bright yellow butterflies such as *Catopsilia* and *Appias* spp., often dominates in terms of both species and individual numbers due to its high adaptability to open habitats such as forest edges, secondary growth, and anthropogenic clearings. Pierid butterflies are generally diurnal and strongly attracted to open, nectar-rich flowers, making them important pollinators within these habitats [1].

Based on diversity analysis, the Shannon–Wiener diversity index (H') in 2025 was 3.21, indicating a slight decrease from 2024 ($H' = 3.37$). Conversely, the Margalef species richness index (D_{mg}) increased markedly from 5.97 in 2024 to 7.13 in 2025. According to [6], higher species diversity values generally indicate better habitat quality. The decline in H' is presumed to result from both biotic and abiotic factors, consistent with [12], who reported that butterfly diversity and richness are strongly influenced

by host-plant and nectar availability. Meanwhile, the evenness index (E) in 2025 slightly declined to 0.89. An evenness value approaching 1.00 indicates that individuals are evenly distributed across species [6].

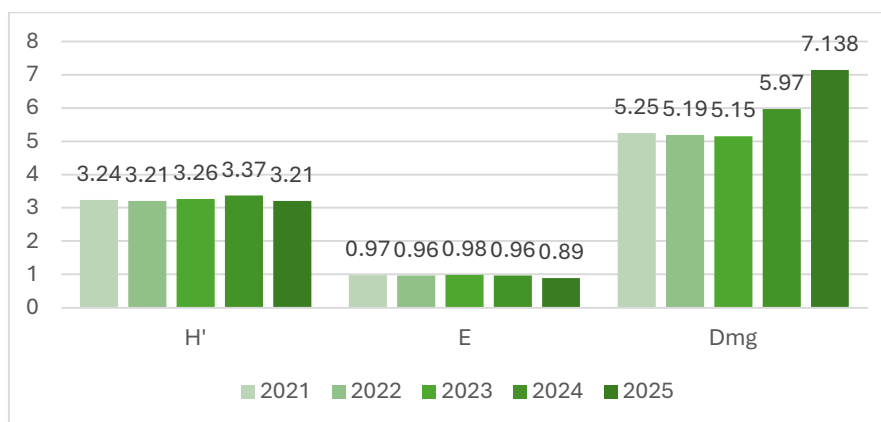


Figure 4. Comparison of annual butterfly diversity (H'), richness (Dmg), and evenness (E) indices in the Gunung Puntang area.

3.2. Conservation Status and Protection

Among the butterfly species recorded in the Gunung Puntang study area, the birdwing butterflies *Troides helena* and *Troides cuneifera* were classified as protected both nationally and internationally. These species are listed under Indonesia's Regulation of the Minister of Environment and Forestry No. P.106/MENLHK/SETJEN/KUM.1/12/2018 and included in Appendix II of CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora). Species listed in Appendix II are not necessarily threatened with extinction but may become so unless trade is strictly controlled.

Butterflies of the genus *Troides*, such as *Troides helena* and *Troides cuneifera*, belong to the family Papilionidae, renowned for their large body size and strikingly colored wings. Both species are endemic to Southeast Asia and play an essential ecological role as pollinators of tropical forest flora. Ecologically, *T. helena* and *T. cuneifera* typically inhabit lowland to montane forests where host plants from the family Aristolochiaceae—particularly *Aristolochia tagala*—are available to serve as oviposition sites and larval food sources [13].

Table 2. Conservation status of butterfly species in the Gunung Puntang area.

No	Species Name	Scientific Name	Protection Status		
			P.106	CITES	IUCN
Erebidae					
1	Ngengat putih marmer	<i>Nyctemera adversata</i>	TD	NA	-
Lycanidae					
2	Kapas rona	<i>Udara rona</i>	TD	NA	-
3	Azura kilau	<i>Jamides elpis</i>	TD	NA	-
Nymphalidae					
4	Aristokrat malaya	<i>Tanaecia pelea</i>	TD	NA	-
5	Indomalayan nyphaline butterfly	<i>Symbrenthia anna</i>	TD	NA	-
6	Alan acak	<i>Symbrenthia hypatia</i>	TD	NA	LC
7	Perumput jawa nigricans	<i>Ypthima nigricans</i>	TD	NA	-
8	Perumput mata tiga	<i>Ypthima pandocus</i>	TD	NA	-
9	Alan hippalus	<i>Symbrenthia hippoclus</i>	TD	NA	LC

No	Species Name	Scientific Name	Protection Status		
			P.106	CITES	IUCN
10	Pelaut biasa	<i>Neptis hylas</i>	TD	NA	-
11	Staf sersan jingga	<i>Athyma cama</i>	TD	NA	-
12	Horsfieldi's bushbrown	<i>Mycalesis horsfieldi</i>	TD	NA	-
Papilionidae					
13	Keluang kepala putih	<i>Atrophaneura priapus</i>	TD	NA	LC
14	Sayap segitiga berekor	<i>Graphium agamemnon</i>	TD	NA	-
15	Sayap segitiga biru	<i>Graphium sarpedon sarpedon</i>	TD	NA	LC
16	Ekor walet pita	<i>Papilio demolion</i>	TD	NA	LC
17	Pastur besar	<i>Papilio memnon</i>	TD	NA	-
18	Helen hitam putih	<i>Papilio nephelus</i>	TD	NA	LC
19	Paris	<i>Papilio paris gedeensis</i>	TD	NA	-
20	Pastur biasa	<i>Papilio polites</i>	TD	NA	-
21	Sayap burung cuneifera	<i>Troides cuneifera</i>	Dilindungi	App II	LC
22	Sayap burung biasa	<i>Troides helena</i>	Dilindungi	App II	LC
Pieridae					
23	Albatros biasa	<i>Aphas libythea</i>	TD	NA	-
24	Albatros kecil	<i>Appias albina</i>	TD	NA	-
25	Albatros	<i>Appias Paulina</i>	TD	NA	-
26	Migran belang	<i>Catopsilia piyanteh</i>	TD	NA	-
27	Camar biasa	<i>Cepora nerissa corva</i>	TD	NA	-
28	Izebel sunda	<i>Delias belisama</i>	TD	NA	-
29	Izebel dorilaea	<i>Delias dorylaea</i>	TD	NA	-
30	Alang kuning biasa	<i>Eurema hecabe</i>	TD	NA	LC
31	Polos-kuning	<i>Gandaca harina</i>	TD	NA	-
32	Putih bintik hitam	<i>Leptosia nina</i>	TD	NA	-
33	Biku tepi kunng	<i>Prioneris autothisbe</i>	TD	NA	-
34	Biku bintik merah	<i>Prioneris philonome</i>	TD	NA	-
35	Albatros coklat	<i>Appias lyncida</i>	TD	NA	-
36		<i>Delias philonome</i>	TD	NA	-
37	Alang kuning bintik tiga	<i>Eurema blanda</i>	TD	NA	-

Notes: NA = Non-Appendix (not listed in any CITES Appendix); TD = Not Protected; LC = Least Concern.

These butterflies also rely heavily on a diversity of flowering plants as nectar sources for adult sustenance, including *Lantana camara*, *Clerodendrum*, and *Ixora* species. However, the populations of *T. helena* and *T. cuneifera* are under increasing pressure due to habitat loss, forest fragmentation, and over-collection for trade and ornamental purposes. Consequently, both species are listed in Appendix II of CITES and categorized as protected wildlife in Indonesia under the Regulation of the Minister of Environment and Forestry No. P.106 of 2018.

4. DISCUSSION

4.1. Patterns of diversity and community structure

The findings of this study indicate that the Gunung Puntang landscape supports a high level of butterfly diversity ($H' = 3.21$; $E = 0.89$; $D_{mg} = 7.13$). Such elevated diversity reflects both ecosystem stability and habitat heterogeneity, even though the area experiences anthropogenic pressures from tourism and coffee agroforestry activities. The principal factor explaining this high diversity is the variation in vegetation structure and the abundance of local flowering plants such as *Clerodendrum japonicum*, *Lantana camara*, and *Ixora coccinea*, which provide continuous nectar sources. The presence of flowering shrubs and larval host plants also creates micro-niches that facilitate interspecific coexistence [3]. These results support the habitat-heterogeneity hypothesis, which posits that increased vegetation complexity enhances both the abundance and richness of pollinating insect species [14].

The evenness index ($E = 0.83$ – 0.92) suggests that the butterfly community in Gunung Puntang is relatively balanced across species, indicating that no single species dominates the assemblage. This equilibrium implies that ecological interactions among species remain stable. The findings reinforce the assumption that the forest–agroforestry mosaic in Gunung Puntang functions as an ecotonal landscape, a transitional zone integrating both forest-dependent and open-habitat species [1].

4.2. Influence of environmental factors on abundance

Gunung Puntang exhibits a natural microclimatic gradient from open areas to secondary forests. Differences in light intensity—ranging from 35% to 60% among habitats—strongly influence butterfly behavior and distribution. *Eurema blanda* and *Appias paulina* predominated in open areas, while *Troides helena* and *Delias belisama* were observed almost exclusively in secondary forests. This pattern reflects a functional relationship between canopy-light heterogeneity and butterfly daily activity. Micro-environmental variables such as canopy cover and air temperature also affect thermoregulatory behaviors like basking (sun exposure for body warming) and mud-puddling (mineral absorption from moist soil), both of which are essential for physiological regulation.

4.3. Community composition and indicator species

Four indicator species were identified—*Jamides elpis*, *Delias belisama*, *Troides helena*, and *Troides cuneifera*—reinforcing the concept of bioindicator species widely used in conservation ecology [11]. Indicator species reflect the degree of ecosystem disturbance, host-plant availability, and microclimatic stability. For instance, *Jamides elpis* exhibits intensive mud-puddling behavior in humid zones, making it a reliable indicator of riparian habitat stability. Meanwhile, *Troides helena* and *T. cuneifera* are highly dependent on the presence of *Aristolochia tagala* host plants, indicating the ecological integrity of secondary forest habitats. These findings align with [4], [15] who emphasized the value of indicator species for long-term monitoring of insect community responses to land-use and climate change across Southeast Asia.

4.4. Conservation value and ecological implications

Two species recorded in this study—*Troides helena* and *T. cuneifera*—are listed under CITES Appendix II and designated as nationally protected species (Permen LHK No. P.106/2018). Although both are categorized as Least Concern on the IUCN Red List (2025), their populations in the wild are becoming increasingly restricted due to host-plant loss and habitat degradation. The presence of these species in Gunung Puntang suggests that the area still functions as a natural refugium for large-bodied butterflies that have declined elsewhere in Java.

Ecologically, butterflies serve as secondary pollinators in tropical forest systems [1], contributing to natural vegetation regeneration and maintaining the foundational structure of food webs. Protecting butterfly communities, therefore, also safeguards pollination services and the diversity of native flowering plants.

Butterfly conservation in Gunung Puntang should prioritize a habitat-based conservation approach rather than a species-specific one. Recommended strategies include:

1. Replanting larval host plants such as *Aristolochia tagala* to support Papilionidae populations.
2. Developing flower gardens with species like *Lantana camara* and *Clerodendrum japonicum* to provide nectar sources and attract both butterflies and ecotourists.
3. Managing mass tourism activities, including implementing visitor quotas or restricting access to sensitive microhabitats such as natural riparian trails.

5. CONCLUSIONS

This study reveals that the Wana Wisata Gunung Puntang area constitutes one of the hotspots of butterfly diversity (Lepidoptera: Papilionoidea) in West Java, with a total of 37 species from 5 families and 155 individuals identified. The Pieridae and Papilionidae families were dominant, while Lycaenidae and Nymphalidae served as indicators of specific microhabitats such as riparian zones and secondary forests. The computed diversity indices—Shannon–Wiener ($H' = 3.21$), Margalef richness ($D_{mg} = 7.13$), and Evenness ($E = 0.89$)—indicate that the butterfly community in this area is stable and well-balanced. Four species were identified as significant habitat indicators, two of which—*Troides helena* and *Troides cuneifera*—are officially protected species under Ministerial Regulation No. P.106/2018, CITES Appendix II, and the IUCN Red List (2023). Overall, the findings emphasize that habitat heterogeneity, microclimatic conditions, and the availability of host and nectar plants are the key ecological factors maintaining the stability of butterfly communities in Gunung Puntang. The area holds high ecological and conservation value and has strong potential to be developed as a community-based model of tropical biodiversity conservation and ecotourism.

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