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Butterfly Species Diversity (Lepidoptera: Papilionoidea) in Surodadu Waterfall Tourism Area, Mojokerto, East Java

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Abstract

Surodadu Waterfall is a tourist area with a variety of vegetation that has the potential to provide butterfly host plants. However, at several points in the location, changes occurred due to landslides, potentially threatening the diversity and causing damage to the natural habitat of butterflies. This study aims to assess the diversity and abundance of butterflies in the Surodadu Waterfall tourist area. This study used the sweep net sampling method and photography by dividing the location into four stations. 33 species were found among a total of 151 individuals in the Surodadu Waterfall tourist area, with a high diversity index value of H' = 3.20. The tourist track station has the highest diversity value with H = 3.184, while the river bank station has the lowest diversity value with H = 2.091. The species with the species with the highest relative abundance value is Lethe confusa, with a value of RA = 13.25%. Meanwhile, the species with the species with the lowest relative abundance value is Potanthus omaha, Pseudocoladenia dan, Junonia hedonia, and Melanitis leda, with a value of RA = 0.66%.

Keywords: *Butterfly; Insect; Tourism site; Vegetation*

Abstrak

Air Terjun Surodadu merupakan kawasan wisata dengan berbagai vegetasi yang berpotensi menyediakan tanaman inang kupu-kupu. Namun, pada beberapa titik lokasi terjadi perubahan diakibatkan tanah longsor sehingga berpotensi mengancam keanekaragaman dan kerusakan habitat alami kupu-kupu. Penelitian ini bertujuan untuk mengkaji keanekaragaman dan kelimpahan kupu-kupu di Kawasan wisata Air Terjun Surodadu. Penelitian ini menggunakan metode sampling sweep net dan fotografi dengan membagi lokasi menjadi empat stasiun. Ditemukan 33 spesies dengan total 151 individu pada kawasan wisata Air Terjun Surodadu dengan nilai indeks keanekaragaman tinggi H' = 3.20. Stasiun *tourist track* memiliki nilai keanekaragaman tertinggi dengan nilai H = 3.184, sedangkan stasiun *river bank* memiliki nilai keanekaragaman terendah dengan nilai H = 2,091. Nilai kelimpahan relatif tertinggi adalah spesies *Lethe confusa* dengan nilai RA = 13.25%. Sedangkan, nilai kelimpahan relatih terendah adalah spesies Spesies *Potanthus omaha, Pseudocoladenia dan, Junonia hedonia*, dan *Melanitis leda* dengan nilai RA = 0.66%.

Kata Kunci: Kupu; Objek wisata; Serangga; Vegetasi

1. INTRODUCTION

Butterflies are flying insects with scales that belong to the order Lepidoptera (Gardiner and Williams 2023). The scales on butterfly wings are shaped like a precarious arrangement with different patterns in each species (Sari and Harmoko 2019). The body part of the butterfly is divided into three parts, including the head, thorax, and abdomen (Sianturi and Simanjuntak 2023). Butterflies have a life cycle with a perfect metamorphosis process (Cinici 2013), which starts from the egg, larva, pre-pupa, pupa, and imago phases (Van Huis 2019).

Butterflies can be found in open habitats, including agricultural land, plantations, river banks, primary forests, secondary forests, and residential areas (Rahman et al. 2018). Factors that influence the presence of butterflies in a habitat include the availability of host plants for larvae, nectar sources for adult butterflies, and suitable abiotic conditions (Nurjanah et al. 2022) Host plants function as a food source for the adult and larval phases (Aprillia et al. 2024) and a place to lay their eggs (Ramadani and Akmal 2023).

Ecologically, butterflies play a role in maintaining habitat balance and increasing biodiversity by pollinating flowers so that they can naturally reproduce plants in a habitat (Priyono and Abdullah 2013). The presence of butterflies can be an indicator of environmental health because they are sensitive to environmental changes, so research on butterfly diversity at a location can be an early indication of environmental change or damage (Anggrela et al. 2023). Butterfly species diversity can decline due to the impact of habitat destruction from deforestation, urbanization, and climate change (Bonebrake et al. 2016). One area that is threatened with habitat destruction is an area used as a tourist spot, one of which is the Surodadu Waterfall tourist area.

Surodadu Waterfall is an area with a waterfall and camp grounds used for tourism activities. This area is located in Pacet District, Mojokerto Regency, which is not far from residential areas. In the Surodadu Waterfall area, there is a riverside ecosystem composed of various vegetation that has the potential to provide butterfly host plants. In addition, there are pine and bamboo areas that have a variety of canopies so that they can affect the abiotic factors used by butterflies for activities. However, at some points in the location, changes occurred due to landslides, potentially threatening the diversity and causing damage to the natural habitat of butterflies. Therefore, this study aims to assess the diversity and abundance of butterflies in the Surodadu Waterfall tourist area.

2. METHOD

2.1. Time and Location Research

This research was conducted in the Surodadu Waterfall tourist area, Mligi Hamlet, Claket Village, Pacet District, Mojokerto Regency, East Java, in May 2024. Field research was conducted in the Surodadu Waterfall tourist area, divided into four stations, namely the Tourist Track, River Bank, Pine Area, and Bamboo Area (Table 1). The four research stations were selected based on the similarity of habitat types, namely the presence of butterfly host plants. Butterfly data collection was conducted using the transect line method combined with the VES (Visual Encounter Survey) method. The transect line method involved following the path of the road at the observation site. The VES method, meanwhile, involved observing the butterfly species present at the site, then recording and counting the total number of individuals of each butterfly species observed at the site. The research began at 07.00–12.00 WIB, which are the active hours of butterflies at the location of the observation station. This is supported by Miftakhul et al. (2023), who stated that the active hours of butterflies are at 07.00–12.00 WIB.

Table 1. Description of research station

Station	Description
Tourist track	Tourist Track station is an open habitat with little canopy cover. This station is dominated by grasses and shrubs with a slow river flow.
Riverbank	The Riverbank station is an open habitat where there is a river flow with various vegetation around the river. The vegetation that makes up this station includes shrubs, grasses, herbs, and shrubs.
Pine Area	The pine area station is a habitat dominated by pine trees. The light intensity at this station is low because it is blocked by a closed canopy
Bamboo Area	The bamboo area station is an enclosed habitat dominated by bamboo vegetation. Other vegetation that makes up this station includes shrubs, lower grasses, and ferns.

Figure 1. Observation Location (A) Tourist Track; (B) River Bank; (C) Pine Area; and (D) Bamboo Area

2.2. Identification

Identification is carried out by observing each thoracic shape, wing pattern, and flight method. The results that have been obtained are recorded and then observed using an identification book (Baskoro et al. 2018) and validated with the Kupunesia application.

2.3. Data Analysis

Species that have been found are then calculated data analysis using the Shannon-Wiener diversity index and relative abundance to determine the level of species diversity;

Shannon-Wiener Diversity Index

Diversity is determined by the number of species and the evenness of the population conserved by each species. The higher the diversity value, the more species are obtained; the value of the diversity index depends on the overall value of the species (Febrian et al. 2022). The data obtained is then analyzed using a diversity index by following Di Bitetti's (2000) formula, namely:

$$\mathbf{H'} = -\sum \boldsymbol{pi}\ \mathbf{ln}\ \boldsymbol{pi}$$

Description:
H′ = Shannon-Wiener Diversity Index
Pi = The result of division ni/N
n*i* = Number of individuals of the i-th species
N = Number of individuals of all types

Relative abundance

Relative abundance shows the percentage of a species compared to the total number of individuals found in an area or habitat observed (Planillo et al. 2021). The data obtained were then analyzed using relative abundance by following Zuhdi et al. (2019) using the formula, namely:

$$RA=ni/N \times 100\%$$

Description:
RA = Relative abundance
ni = Number of individuals of the i- species
N = Total number of all individuals

3. RESULT AND DISCUSSION

The results of research in the Surodadu Waterfall area found five families totaling 33 species with a total of 151 individuals (Table 2). The families found were Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, and Pieridae. The most common family found in the study was the Nymphalidae family, with as many as 19 species and a total of 105 individuals (Table 2). The Nymphalidae family was found in various open and closed habitats, and many were found actively flying to suck nectar. According to Handayani and Rahayuningsih (2022), the Nymphalidae family is polyphagous, so it is easier to adapt and can live in various types of habitats. In addition, the Nymphalidae family has a strong ability to fly to find food sources (Munisi et al. 2024). While the least number of families found in the study was the family Hesperiidae, there were as many as three species, for a total of five individuals. The Hesperiidae family is found in closed areas and perches under leaves. The Hesperiidae family likes to perch on shrubs and grasses so that they are not observed and only a few species are found (Nikmah et al. 2021).

Table 2. List of species and relative abundance of butterflies in Surodadu Waterfall tourism area

	Relative Abundance (%)				
Family and Spesies	**Tourist Track**	**River bank**	**Pine Area**	**Bamboo area**	**Total**
Hesperiidae					
Potanthus omaha (Edwards, 1863)	1.64	0.00	0.00	0.00	0.66
Pseudocoladenia dan (Fabricius, 1787)	1.64	0.00	0.00	0.00	0.66
Notocrypta curvifascia (Nicéville, 1889)	0.00	0.00	6.82	0.00	1.99
Lycaenidae					
Zizina otis (Fibricius, 1787)	1.64	0.00	4.55	0.00	1.99
Zizula hylax (Fibricius, 1775)	4.92	3.85	2.27	0.00	3.31
Chersonesia rahria (Westwood, 1857)	0.00	11.54	0.00	0.00	1.99
Euploea mulciber (Cramer, 1777)	3.28	0.00	0.00	0.00	1.32
Junonia hedonia (Linnaeus, 1764)	1.64	0.00	0.00	0.00	0.66
Junonia iphita (Cramer, 1782)	3.28	0.00	0.00	0.00	1.32
Lethe confusa (Aurivillius, 1897)	11.48	19.23	11.36	15.00	13.25
Lethe manthara (Felder, 1867)	4.92	0.00	0.00	10.00	3.31
Lethe minerva (Fibricius, 1775)	3.28	0.00	0.00	0.00	1.32
Melanitis leda (Linnaeus, 1758)	0.00	0.00	0.00	5.00	0.66
Melanitis zitenius (Herbst, 1796)	0.00	0.00	0.00	10.00	1.32
Nymphalidae					
Mycalesis horsfieldi (Moore, 1892)	0.00	7.69	11.36	15.00	6.62
Mycalesis moorei (Moore, 1857)	3.28	0.00	0.00	15.00	3.31

Neptis hylas (Horsfield, 1829)	4.92	0.00	0.00	0.00	1.99
Symbrenthia hypselis (Godart, 1823)	3.28	11.54	0.00	5.00	3.97
Symbrenthia lilaea (Hewitson, 1864)	3.28	0.00	4.55	5.00	3.31
Tanaecia trigerta (Moore, 1857)	3.28	0.00	2.27	0.00	1.99
Tirumala hamata (MacLeay, 1826)	1.64	0.00	0.00	5.00	1.32
Ypthima nigricans (Snellen, 1892)	6.56	15.38	4.55	10.00	7.95
Ypthima pandocus (Moore, 1858)	8.20	7.69	9.09	0.00	7.28
Ypthima iarba (Nicéville, 1895)	3.28	3.85	15.91	0.00	6.62
Papilionidae					
Graphium agamemnon (Linnaeus, 1758)	3.28	0.00	0.00	0.00	1.32
Graphium sarpedon (Linnaeus, 1758)	1.64	3.85	2.27	0.00	1.99
Papilio memnon (Linnaeus, 1758)	3.28	7.69	2.27	5.00	3.97
Papilio polytes (Linnaeus, 1758)	3.28	0.00	0.00	0.00	1.32
Troides helena (Linnaeus, 1758)	3.28	0.00	2.27	0.00	1.99
Pieridae					
Catopsilia pomona (Fibricius, 1775)	1.64	7.69	4.55	0.00	3.31
Eurema blanda (Biosduval, 1836)	1.64	0.00	6.82	0.00	2.65
Hebomoia glaucippe (Linnaeus, 1758)	3.28	0.00	0.00	0.00	1.32
Leptosia nina (Fibricius, 1793)	3.28	0.00	9.09	0.00	3.97

The highest relative abundance in the Surodadu Waterfall tourist area was *Lethe confusa* (Figure 2A), with a value of RA = 13.25% (Table 2). In contrast, the species with the lowest relative abundance were *Potanthus omaha* (Figure 2B), *Pseudocoladenia dan* (Figure 2C), *Junonia hedonia* (Figure 2D), and *Melanitis leda* (Figure 2E), with an RA value of 0.66% (Table 2).

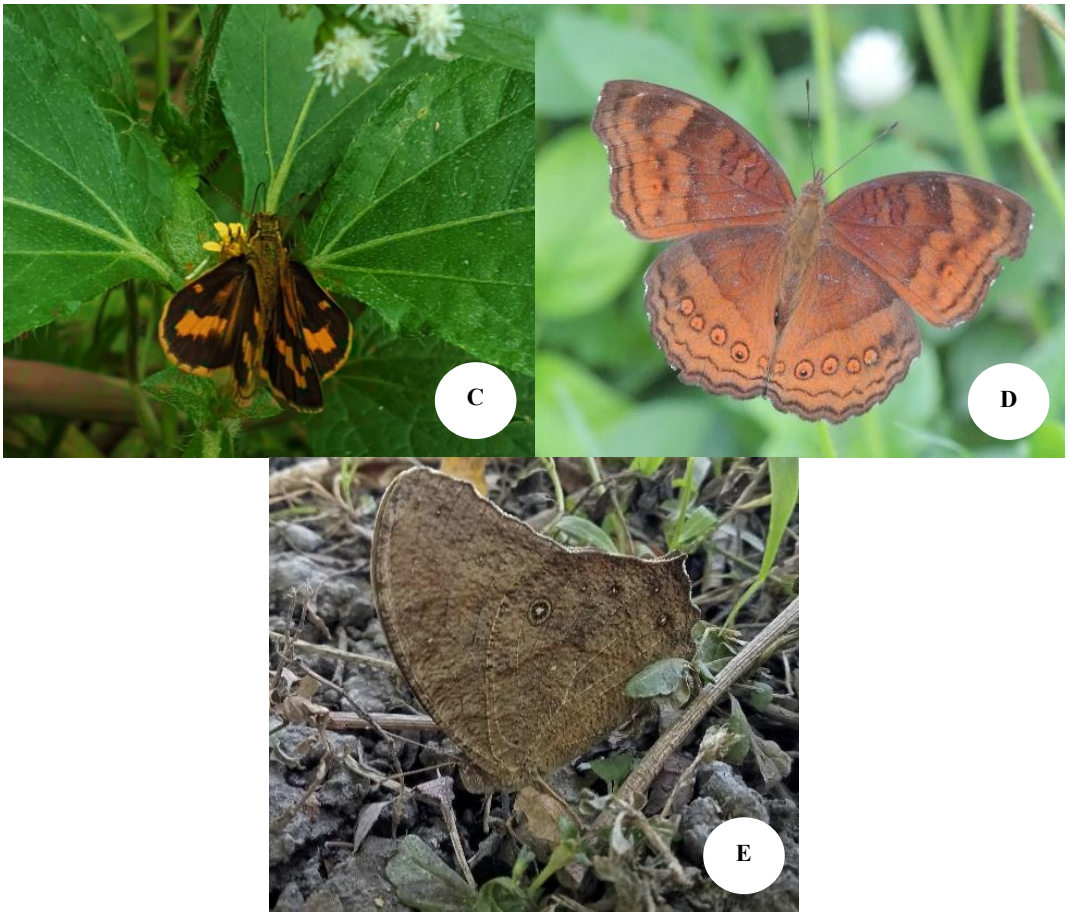

Figure 2. Photos of butterfly species A) *Lethe confusa* (Photo: ZF Arifin 2024): B) *Pseudocoladenia dan* (Photo: EP Agustin 2024): C) *Potanthus omaha* (Photo: EP Agustin 2024): D) *Junonia hedonia* (Photo: DM Zahro' 2024): E) *Melanitis leda* (Photo: EP Agustin 2024).

In this study, *Lethe confusa* species were found in four stations that were found perching on grass, shrubs, and leaves in open habitats with high light intensity to carry out sunbathing and nectar-sucking activities. The Lethe *confusa* species has the highest relative abundance because the habitat and abiotic factors in the Surodadu Waterfall tourist area are suitable for its survival. According to the results of Nuraini (2018), *Lethe confusa* is a butterfly species that tends to choose habitats with the influence of light intensity and high air temperature. This is supported by the results of research by Karyaningsih et al. (2024), which reported that *Lethe confusa* species were found in shrub, calliandra, and mixed forest habitats. Irsa et al. (2022) also reported in their research that *Lethe confusa* species were found in waterfall habitats, tea gardens, mixed gardens, and secondary forests.

Potanthus omaha, *Pseudocoladenia dan*, and *Junonia hedonia* species were only found at the tourist track station. *Potanthus omaha and Pseudocoladenia dan* were found perching on flowering herbaceous plants, while *Junonia hedonia* was found perching on leaves to sunbathe. In this study, *Potanthus omaha*, *Pseudocoladenia dan*, and *Junonia hedonia* had the lowest relative abundance values due to the lack of host plants. According to Nacua et al. (2019), *Potanthus omaha* and *Pseudocoladenia dan,* including the Hesperiidae family, can be found in habitats with vegetation composed of Poacea and Fabaceae plant species. *Junonia hedonia* can be found in vegetation composed of Acanthaceae and Malvaceae plants (Rohman et al. 2019). *Melanitis leda* species are rarely found at research stations because their distribution is limited to primary forests (Noerdjito and Erniwati 2017) and they are commonly found in urban areas (Gandhi and Kumar 2015).

The Shannon-Wiener diversity index in the Surodadu Waterfall tourist area has a value of H' = 3.20 (Figure 4) with a high category. This is in accordance with Wahyuningsih et al. (2019) report that if the butterfly diversity index value is greater than H' > 3, then it is categorized as high. The high diversity value indicates that the habitat in the Surodadu Waterfall tourist area is suitable for butterfly survival. The diversity index value is higher at the tourist path station H = 3.184 than at the Pine area station H = 2.581, Bamboo area H = 2.293, and the lowest diversity index at the riverside station H = 2.091. According to Ardianto et al. (2023), the difference in diversity index values is related to the number of species, the size of individual species, and vegetation structure factors that become habitat and host butterflies. In addition, butterfly diversity in an area can be influenced by abiotic factors, including temperature, humidity, and light intensity (Ruslan et al. 2019).

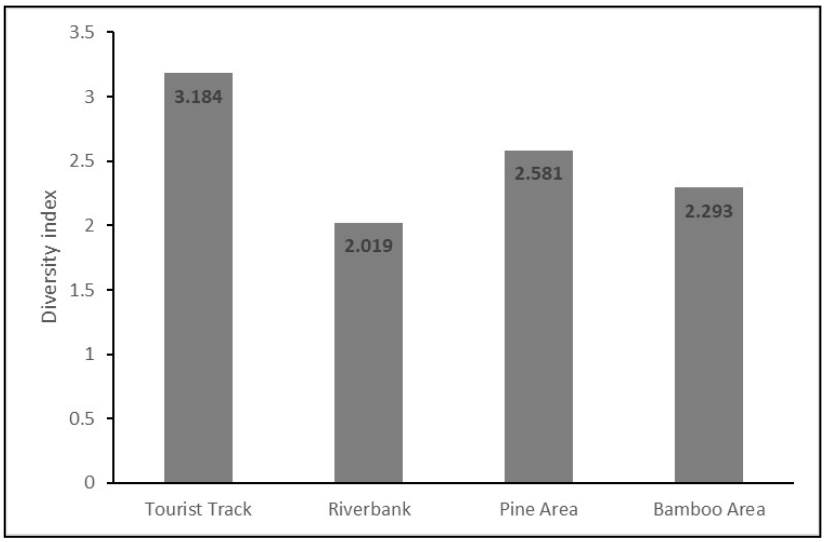

Figure 3. The results of the analysis of butterfly diversity index at each station in Surodadu Waterfall tourism area.

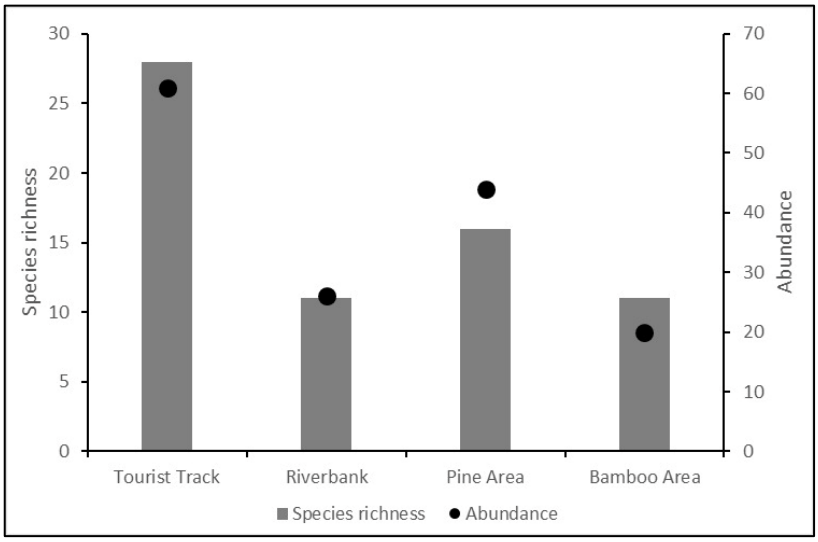

Figure 4. The results of the analysis of species richness and relative abundance of butterflies at each station in the Surodadu Waterfall tourism area.

The station with the highest diversity value in the Surodadu Waterfall tourist area is the tourist track station; besides that, this station also has the highest number of species, namely 28 species (Figure 4). Some butterfly species that are only found at the tourist track station include *Potanthus omaha*, *Pseudocoladenia dan*, *Euploea mulciber*, *Junonia hedonia*, *Junonia iphita*, *Lethe minerva*, *Neptis hylas*, *Graphium agamemnon*, *Papilio polytes*, and *Hebomoia glaucippe*. The tourist track

station that has the highest number of species in this study is because it has a variety of vegetation and abiotic factors such as light intensity, humidity, and temperature that are favorable for butterfly survival. Vegetation and abiotic factors are factors that can affect the existence of butterflies (Najah 2023). The vegetation at the tourist track station is composed of understory vegetation, flowering vegetation, and tree vegetation.

Lower vegetation is one of the factors that make up the butterfly habitat at the tourist track station. Lower vegetation, including grasses, herbs, and shrubs, is utilized by butterflies as a food source (food plant) and as a host (host plant) to lay eggs to develop into cocoons. This is in accordance with Mas' ud et al. (2019) which states that the presence of butterflies is related to the host plant component, which is the food for larvae and the beginning of butterflies laying their eggs, and food plants are a source of food for adult butterflies.

Flowering vegetation is a constituent component of butterfly habitat at tourist track stations. Flowering vegetation has the potential to be a source of nectar producers as butterfly food, so butterflies can utilize flowering vegetation to obtain food. This is in accordance with Wix et al. (2019), who reported that the number of flowering plants is a major factor in the diversity and presence of butterflies. Butterflies are phytophages that feed on nectar and sometimes pollen (Subedi et al. 2021). Flower nectar is utilized by female butterflies to increase their life span and egg-laying ability (Ngatimin 2019).

The vegetation of trees with open canopies at the tourist track station affects microclimate factors including temperature, light intensity, humidity, and wind speed. The measurement results at the tourist track station showed a temperature of 27.5 °C, a light intensity of 8.664 lx, and a wind speed of 0.2 m/s (Table 3). Light intensity and high temperature are inversely proportional to the low humidity value of 50% (Table 3). Abiotic factors can affect the presence of butterflies in an area. Temperature and humidity affect the availability of food and butterfly host plants (Zulaikha and Susanto 2023). Light intensity affects butterfly activity by basking to increase body temperature (Hariyatmi and Susetya 2013). Wind speed affects butterfly flight activity (Fitriani 2017).

Table 3. Microclimate measurement results in Surodadu Waterfall tourist area

Station	Temperature (°C)	Humidity (%)	Light intensity (lx)	Wind velocity (m/s)
Tourist track	27.5	50	8,640	0.2
River bank	27.3	52	5,300	0.3
Pine area	27.4	55	5,010	0.1
Bamboo area	27	60	1,060	0.1

The station with the lowest diversity value in the Surodadu Waterfall tourist area is the river bank station. Besides that, this station also has the lowest number of species, namely 11 species. River Bank Station has the lowest number of species in this study, which can be due to the impact of environmental degradation caused by landslides at the station. Landslides cause butterfly vegetation to be covered by landslides, which can affect butterfly activities such as nectaring or laying eggs. According to Koneri (2016), vegetation is closely related to diversity because butterflies utilize vegetation as a host for several larval species and as a source of food. In addition, according to Azahra et al. (2016), environmental disturbances can affect the presence of butterflies because the higher the level of environmental disturbance, the lower the level of butterfly diversity. As supported by Sinaga et al. (2019), the existence of butterflies is very sensitive to degradation and climate change in an area (Mahata et al. 2023).

4. CONCLUSION

The results showed that in the Surodadu Waterfall tourist area, 33 species with a total of 151 individuals were found. This study showed that the Surodadu Waterfall area has a high diversity

index value of H' = 3.20. The highest relative abundance value was for the species Lethe confusa with a value of RA = 13.25%.

5. ACKNOWLEDGMENT

The author suggests further research on butterfly diversity in an ecosystem, with additional research on the composition and diversity of host plants and butterfly food sources.

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