

BUTTERFLY DIVERSITY IN THE ALAS RIVER OF SORAYA RESEARCH STATION, LEUSER ECOSYSTEM, ACEH PROVINCE

Fitria Nelda Fautama*, Alia Rizki*, Zuriana Siregar*, Suwarno*

*Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh, Indonesia, neldafautama@gmail.com, alia_rizki@unsyiah.ac.id, zuriana_siregar, suwarno@unsyiah.ac.id

Email Correspondence : suwarno@unsyiah.ac.id

Received : December 11, 2021

Accepted : April 1, 2022

Published : June 30, 2022

Abstract: Butterflies are insects that live along riverbanks and belong to the Lepidoptera order. The Alas River is one of the longest rivers in Sumatra which passes through four districts in Aceh Province. Along the river banks, there are varied vegetation conditions such as secondary forests, shrubs, and sandy banks. This study aims to determine the diversity and composition of butterfly species in the Alas River, which is included in the Soraya Research Station area of the Leuser Ecosystem. The transect method was used to conduct butterfly diversity research from August to December 2020. A total of 75 species of butterflies were found in this study belonging to five families: Hesperidae, Lycaenidae, Pieridae, Papilionidae, and Nymphalidae. The butterfly compositions obtained were Nymphalidae (32 species and 134 individuals), Papilionidae (16 and 137), Pieridae (16 and 121), Lycaenidae (9 and 52), and Hesperidae (2 and 2). The butterfly species diversity index was categorized as high ($H' = 3.763$).

Keywords: Diversity; composition; butterfly; Alas River; Soraya Research Station

Abstrak: Kupu-kupu merupakan serangga yang tergolong ke dalam ordo Lepidoptera yang banyak hidup di aliran sungai. Penelitian tentang keanekaragaman kupu-kupu dilakukan pada bulan Agustus - Desember 2020, sampel dikoleksi dengan menggunakan metode transek. Sungai Alas merupakan salah satu sungai terpanjang di Sumatera yang melewati empat kabupaten di Provinsi Aceh. Sepanjang tepian sungai ditumbuhi oleh berbagai jenis vegetasi membentuk hutan dan semak serta daerah yang berpasir. Studi ini bertujuan untuk mengetahui keragaman dan komposisi jenis kupu-kupu di aliran Sungai Alas yang masuk dalam wilayah Stasiun Penelitian Soraya Kawasan Ekosistem Leuser. Hasil penelitian ditemukan 75 jenis kupu-kupu yang tergolong dalam lima family yaitu Hesperidae, Lycaenidae, Pieridae, Papilionidae dan Nymphalidae. Komposisi kupu-kupu yang didapatkan berturut-turut adalah Nymphalidae (32 spesies and 134 individu), Papilionidae (16 dan 137), Pieride (16 dan 121), Lycaenidae (9 dan 52), dan Hesperidae (2 dan 2). Indeks keanekaragaman jenis kupu-kupu dikategorikan tinggi ($H' = 3.8$).

Kata Kunci: Keanekaragaman; Komposisi; Kupu-kupu; Stasiun Penelitian Soraya.

Recommended APA Citation :

Fautama, F. N., Rizki, A., Siregar, Z., & Suwarno. (2022). Butterfly Diversity in The Alas River of Soraya Research Station, Leuser Ecosystem, Aceh Province. *Elkawnie*, 8(1), 137-148. <https://doi.org/10.22373/ekw.v8i1.11646>

Introduction

Butterflies are one of the insect faunas with the greatest diversity in the world. There are around 4,000-5,000 species in Indonesia. Butterflies are daytime flying insects (diurnal). Butterfly existence is influenced by various biotic and abiotic factors. Butterflies prefer humid habitats. The butterflies exist in a variety of environments (Corbert & Pendlebury, 2020), including forests (Suwarno & Rasnovi, 2019; Salmah, Abbas, & Dahelmi, 2002), gardens (Suwarno, S., Hanum, I., Yasmin, Y., Rasnovi, S. and Dahelmi (2018), fields, shrubs, grasslands, residential areas (Ramesh, Hussain, Selvanayagam, Satpathy, & Prasad, 2012) and rivers (Herlina, 2017).

Butterflies prefer fresh, cool environments with plenty of light for their activities. The area around the river is one of the most popular butterfly habitats. Butterflies feed on the river's high humidity and many sorts of plants (Salmah, Abbas & Dahelmi, 2002). Male butterflies could obtain minerals from watersheds, particularly sandy, rocky, and wet riverbanks, which will be transmitted to females during copulation (Salmah, Abbas & Dahelmi, 2002). Male butterflies could obtain minerals from watersheds, particularly sandy, rocky, and wet riverbanks, which will be transmitted to females during copulation (Suwarno, Rasnovi, Utami, Rizki, & Dahelmi, 2019; Sharma & Sharma, 2017).

An important habitat element for butterfly life is the availability of vegetation as a source of food, reproduction, and protection. If the habitat supports this, butterflies can survive to the next generation (Herlina, 2017). In addition, environmental factors such as temperature and humidity also affect butterfly reproduction (Dewi, Hamidah & Siburian, 2016). The diversity of vegetation along the river basin plays an important role as a food source for larvae and a source of nectar for adult butterflies (Suwarno & Rasnovi, 2019; Lodh & Agarwaa, 2016; Kitahara, Yumoto, & Kobayashi, 2008).

In Deudap Pulo Nasi Village, Pulo Aceh District (Darnilawati, Nurul, Hafiz & Samsul, 2018), 22 species belonging to six families were identified. In Pulau Raya, Aceh Jaya District (Darnilawati, Nurul, Hafiz & Samsul, 2018), 22 species belonging to six families were identified (Yusuf, Rasnovi, Fithri, Rizki, & Suwarno, 2018) In Banda Aceh's City Garden, 17 species from three families were discovered (Suwarno, Hanum, Yasmin, Rasnovi, & Dahelmi, 2018). found that 30 species from seven families in the Brayeun River in Aceh Besar District ('Akla, Rasnovi, Fithri, & Suwarno, 2018), 51 species from four families in the forest of Soraya Research Station (Suwarno & Rasnovi, 2019), and 25 species from four families in the forest of Soraya Research Station (Suwarno & Rasnovi,

2019). According to all the studies, butterflies were diverse in terms of species, composition, and population. There seem to be no reports of butterflies along the Alas River, meanwhile.

The Alas River is one of the longest rivers in Sumatra, which is located in Aceh Province. This river originates in Gayo Lues Regency and continues to flow to the Indian Ocean bypassing through four regencies/cities namely Gayo Lues Regency, Southeast Aceh, Aceh Singkil, and Subulussalam City. This river also crosses the Gunung Leuser National Park (TNGL) area and the Soraya Research Station (Hanafiah, 2021). The banks of the Alas River, which runs through the Soraya Research Station region, are in a variety of different places, including secondary forests, shrubs, and sand. In general, butterflies prefer high-humidity environments, such as riverbanks (Handayani, et al, 2012). As butterfly host plants and food sources, a variety of vegetation thrives. As a result, it is assumed that the diversity of butterfly species along this river is fairly great.

Methods

Study Site

The research was carried out in the Soraya Research Station's Alas River (Lae Soraya). The Leuser Ecosystem encompasses the area. The Soraya Research Station is located at 2°55'25" South Latitude (South Latitude) and 97°55'43" East Longitude (East Longitude), with a topography of 75-350 meters above sea level (Figure 1). The pedestal river is 366 kilometers long and has a river area of 13,466.41 km². The Alas River is about 579 kilometers southeast of Banda Aceh, the provincial capital of Aceh.

Data Collection

This study was carried out utilizing a transect survey method at six different locations (Figure 1). Butterfly habitat is suitable in the Alas River (Lae Soraya) area, and collection is carried out at various sites to fulfill their distribution. From each location point, a 500 m long and 10 m wide transect line was drawn (Pollard & Yates, 1995). From August to December 2020, butterflies were collected from 8 a.m. to 4 p.m. The thorax is squeezed, stored on papilot paper, labeled, and noted on the worksheet for the butterflies that have been caught. The butterflies were temporarily maintained at the camp by injecting 4 percent formalin into the mesothorax. Air temperature, humidity, and light intensity are used to measure environmental physical parameters. The appropriate environmental conditions for butterfly development are described by each measurement data obtained (Salmah, Abbas & Dahelmi 2002)

Butterfly Preservation and Identification

Preservation and identification of butterfly samples were carried out at the Ecology Laboratory, Department of Biology, Faculty of Mathematics and Natural

Sciences, Syiah Kuala University (USK). The preservation of butterfly specimens refers to Salmah, Abbas & Dahelmi (2002).

The butterfly specimens were then identified based on the main characteristics as shown in Figure 2 (Salmah, Abbas & Dahelmi, 2002). The references used for identification were Corbet & Pendlebury (2020) and Otsuka (2001) as well as butterfly specimens in the Ecology Laboratory of Biology Department.

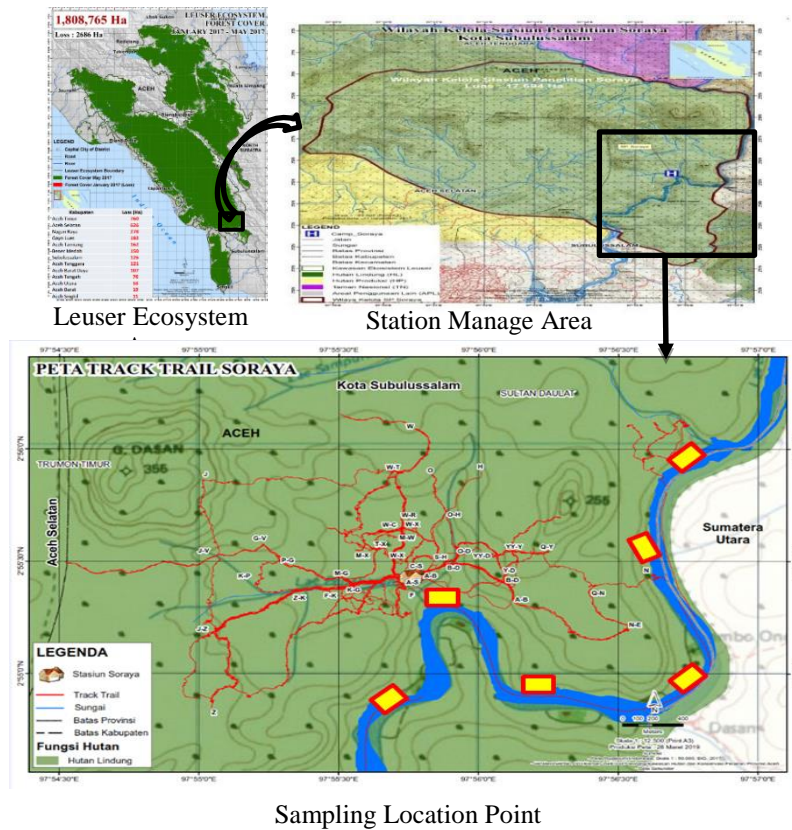


Figure 1. The point where the butterfly sample is taken

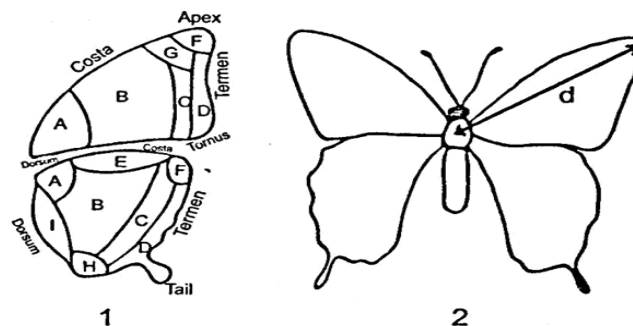


Figure 2. The wing parts that are considered in identification, A. Basal; B. Discal; C. Sub Marginal; D. Marginal; E. Costal; F. Apical; G. Sub Apical.; H. Tornus; I. Dorsal; J. Wing Length (Salmah, Abbas & Dahelmi, 2002).

Data Analysis

Data analysis was carried out on species composition in the community, Relative Density (RD), Relative Frequency (RF) and Diversity Index (H').

$$RD = \frac{\text{Number of individuals of a species}}{\text{Number of individuals of all species}} \times 100\%$$

$$RF = \frac{\text{Number of transects occupied by a species}}{\text{Total number of transects}} \times 100\%$$

The value of the Butterfly Diversity Index is calculated using the *Shannon-Wiener* formula (Odum, 1993), namely:

$$H' = -\sum P_i \ln P_i$$

Description :

H : Species diversity index

P_i : n_i/ N

n_i : Number of individual butterfly species

N : Total number of individuals of all species

To determine the existence of diversity values, the Shannon-Wiener diversity index is categorized into three criteria as follows:

H' < 1 = Diversity index is categorized as low.

H' 1-3 = Diversity index is categorized as medium.

H' > 3 = Diversity index is categorized as high.

Results and Discussion

Butterfly Type Composition

Butterflies were found in the Alas River, Soraya Research Station as many as 447 individuals, belonging to 75 species and 5 families, namely Hesperidae, Pieridae, Lycaenidae, Papilionidae, and Nymphalidae. The composition of the number of species and the number of individuals for each family is shown in Figure 3.

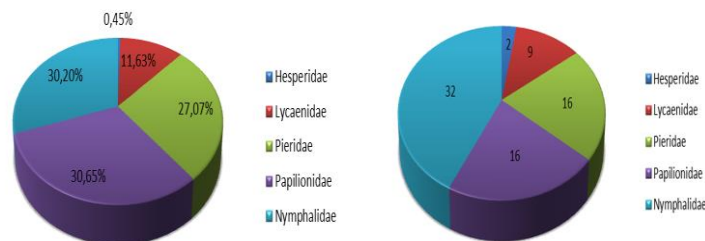


Figure 3. The composition of butterfly species and the number of individuals for each family, at Soraya Research Station, Leuser Ecosystem

The highest number of species was found in Nymphalidae, with as many as 32 species, followed by Papilionidae and Pieridae each with 16 species, while the Hesperidae only had 2 species (Figure 3). Furthermore, Figure 4 shows the highest number of individuals in the Papilionidae and Nymphalidae, respectively, as much as 30,65% and 30,20%, while the lowest was in the Hesperidae, which was 0,45%. Nymphalidae butterflies had a higher number of species and individuals than the others due to the number of food plants and host plants along the river that were suitable for the butterfly's survival, both as a source of food and as a place to reside and shelter (Tatang, et al., 2018). The Nymphalid butterfly is a polyphagous insect and some of its host plant species were found in the location such as *Graptopilum pictum*, *Asystasia gangetica*, *Garcinia* sp. and *Ficus* sp. The host plants of Nymphalidae butterflies include Annonaceae, Asteraceae, Verbenaceae, Moraceae, Rubiaceae and Anacardiaceae (Lamatoa, Koneri, Siahaan, & Maabuat, 2013).

Nymphalid butterflies are also the most numerous in the Lepidoptera, with members distributed across a wide range of habitats and a high tolerance for environmental influences. Physical environmental factors such as temperature, humidity, and light intensity influence butterfly diversity. Butterflies are poikilothermic insects, which means their body temperature is highly influenced by their surroundings. As a result, butterflies' activities have a limited temperature tolerance range. However, the high number of Papilionidae species was due to this butterfly family's wide distribution and preference for riverbank environments, as water is one of the major aspects for butterflies to engage in puddling activities (Murwitaningsih, 2019).

Previous research observing the puddling behavior of butterflies in the Alas River by Suwarno *et al.* (2019), found as many as 25 species belonging to four families, namely Papilionidae, Nymphalidae, Lycaenidae, and Pieridae. The Nymphalid and Papilionid butterflies were most found. In addition, 'Akla *et al.* (2018), reported that as many as 51 species of butterflies belonging to four families namely Lycaenidae, Pieridae, Papilionidae and Nymphalidae were found in the Brayeun River. The most common butterflies found were the Nymphalidae 23 species (45.10%), followed by Papilionidae (12 species; 23.53%), Pieridae (14 species; 27.45%) and Lycaenidae only (2 species; 3.92%).

Diversity of Butterfly Species

All butterfly species found along the Alas River in the Soraya Research Station area are shown in Table 1. Three species of Lycaenidae butterflies that have the highest relative density and frequency were *Caleta roxus*, *Jamides zebra* and *Caleta elna*. These three butterfly species were very often found puddling on wet riverbanks and sucking the liquid nectar from flowers. The abundance of host plants and food plants of Lycaenid butterflies, such as *Asystacia gangetica* (Acanthaceae), *Eupatorium odoratum* (Asteraceae) and some species of

Leguminoceae, was one of the main factors for these three species of butterflies found in river flows. The Lycaenidae butterflies that often puddle in the Alas River were *Caleta elna*, *Caleta roxus*, *Jamides zebra* and *Jamides parasaturatus* (Suwarno *et al.*, 2019).

Appias lybythea, *Appias lyncida* and *Eurema hecabe* are the dominant species in the family Pieridae (Table 1). The Pieridae butterfly above is a common species found in many locations. According to Suwarno *et al.* (2019), on the banks of the Alas River there are many Leguminoceae plants which are the host plants of Pieridae, and these three species also often puddle in the Alas River.

Furthermore, the Papilionidae butterflies were dominated by *Graphium* and *Papilio*. These two genera were always found at every sampling location because there are many plants in the Annonaceae, Lauraceae and Rutaceae families which are the host plants of the two genera. *Graphium agamemnon*, *G. antiphates* and *G. doson* were also found puddling on sandy riverbanks. Suwarno *et al.* (2019) reported that most of the Papilionidae that do puddle in the Alas River are *Graphium* and *Papilio*.

Two species of Papilionidae butterflies, *Trogoptera brookiana* and *Troides helena* which are protected species were also found with a high frequency of presence. The abundance of food impacts the existence of species which are restricted to habitats (Panjaitan *et al.*, 2020). The results of the research by Suwarno and Rasnovi (2019) also found the dominance of the two genera (*Graphium* and *Papilio*) and three protected species, namely *T. brookiana*, *T. helena* and *T. amphrysus* in the forest habitat at Soraya Research Station

The Nymphalidae family is dominated by *Cupha erymanthis* and *Doleschallia bisaltidae* which are species that are commonly found in bush areas and along streams (Table 1). Both species were preferring the open areas. The host plants and food plants of *D. bisaltidae* were found along the banks of rivers such as *Asystacia longifolia*. The Nymphalidae family has a wide host range, allowing it to exist in a variety of different habitats. (Nuraini *et al.*, 2020). This family is polyphagous. This means that this butterfly has more than one type of food. This is also supported by the number of plants that can be used as food sources so this family is often found in every research location (Hapsari *et al.*, 2022)

Table 1. Species Composition, Relative Density, Relative Frequency and Butterfly Diversity Index in the Alas River in Soraya Research Station.

Species	Number of individuals	H'	RD	RF
Hesperiidae				
<i>Astictopterus jama</i>	1	0,014	0,224	0,613
<i>Lotongus calathus</i>	1	0,014	0,224	0,613

Species	Number of individuals	H'	RD	RF
Lycaenidae				
<i>Caleta elna</i>	10	0,085	2,237	0,613
<i>Caleta roxus</i>	19	0,134	4,251	2,454
<i>Cheritra freja</i>	1	0,014	0,224	0,613
<i>Curetis regula</i>	1	0,014	0,224	0,613
<i>Curetis santana</i>	1	0,014	0,224	0,613
<i>Druphadia teda</i>	1	0,014	0,224	0,613
<i>Jamides celeno</i>	2	0,024	0,447	0,613
<i>Jamides philatus</i>	1	0,014	0,224	0,613
<i>Jamides zebra</i>	16	0,119	3,579	1,840
Pieridae				
<i>Appias albina</i>	3	0,034	0,671	0,613
<i>Appias libythea</i>	18	0,129	4,027	2,454
<i>Appias lyncida</i>	25	0,161	5,593	3,067
<i>Appias nero</i>	3	0,034	0,671	1,227
<i>Catopsilia pomona</i>	3	0,034	0,671	1,227
<i>Catopsilia pyranthe</i>	2	0,024	0,447	0,613
<i>Eurema ada</i>	1	0,014	0,224	0,613
<i>Eurema andersonii</i>	3	0,034	0,671	0,613
<i>Eurema blanda</i>	1	0,014	0,224	0,613
<i>Eurema hecabe</i>	28	0,174	6,264	3,681
<i>Eurema lacteola</i>	1	0,014	0,224	0,613
<i>Eurema sari</i>	15	0,114	3,356	2,454
<i>Eurema simulatrix</i>	7	0,065	1,566	1,840
<i>Eurema sp.</i>	8	0,072	1,790	0,613
<i>Eurema tilaha</i>	2	0,024	0,447	1,227
<i>Gandaca harina</i>	1	0,014	0,224	0,613
Papilionidae				
<i>Graphium agamemnon</i>	18	0,129	4,027	2,454
<i>Graphium antiphates</i>	10	0,085	2,237	3,067
<i>Graphium doson</i>	24	0,157	5,369	3,681
<i>Graphium evemon</i>	6	0,058	1,342	1,227
<i>Graphium sarpedon</i>	8	0,072	1,790	1,840
<i>Lamproptera curius</i>	9	0,079	2,013	2,454
<i>Lamproptera meges</i>	4	0,042	0,895	1,840
<i>Papilio domeleon</i>	4	0,042	0,895	1,840
<i>Papilio domeleus</i>	1	0,014	0,224	0,613
<i>Papilio helenus</i>	6	0,058	1,342	1,227
<i>Papilio iswara</i>	3	0,034	0,671	1,227
<i>Papilio memnon</i>	17	0,124	3,803	2,454
<i>Papilio nephelus</i>	1	0,014	0,224	0,613
<i>Papilio polytes</i>	3	0,034	0,671	1,227
<i>Trogonoptera brookiana</i>	19	0,134	4,251	3,067
<i>Troides helena</i>	4	0,042	0,895	2,454
Nymphalidae				
<i>Cethochia hypsea</i>	22	0,148	4,922	3,067
<i>Charaxes bernardus</i>	3	0,034	0,671	1,227
<i>Chirrochroa malaya</i>	1	0,014	0,224	0,613

Species	Number of individuals	H'	RD	RF
<i>Chirrochroa orissa</i>	3	0,034	0,671	1,227
<i>Chressonesia rahria</i>	1	0,014	0,224	0,613
<i>Captcha erymanthis</i>	14	0,108	3,132	3,067
<i>Cyretis themire</i>	2	0,024	0,447	1,227
<i>Danaus melanipus</i>	1	0,014	0,224	0,613
<i>Doleschallia bisaltide</i>	14	0,108	3,132	2,454
<i>Elymnias hypermnestra</i>	1	0,014	0,224	0,613
<i>Euploea camaralzaman</i>	5	0,050	1,119	1,840
<i>Euploea diocletianus</i>	3	0,034	0,671	0,613
<i>Euploea mulciber</i>	6	0,058	1,342	1,840
<i>Euploea radamanthus</i>	4	0,042	0,895	1,227
<i>Faunis canens</i>	1	0,014	0,224	0,613
<i>Hypolimnas bolina</i>	10	0,085	2,237	1,227
<i>Ideopsis vulgaris</i>	1	0,014	0,224	0,613
<i>Junonia atlites</i>	1	0,014	0,224	0,613
<i>Kalima limborgii</i>	1	0,014	0,224	0,613
<i>Moduza procris</i>	4	0,042	0,895	1,840
<i>Neptis hylas</i>	6	0,058	1,342	1,227
<i>Neptis clinioides</i>	5	0,050	1,119	1,227
<i>Phaedyma cf columella</i>	1	0,014	0,224	0,613
<i>Polyura athamas</i>	1	0,014	0,224	0,613
<i>Polyura delphis</i>	1	0,014	0,224	0,613
<i>Polyura hebe</i>	1	0,014	0,224	0,613
<i>Tanaesia palguna</i>	5	0,050	1,119	0,613
<i>Terinos clarissa</i>	1	0,014	0,224	0,613
<i>Thaumanthis noureddin</i>	2	0,024	0,447	1,227
<i>Vindula dejone</i>	7	0,065	1,566	1,840
<i>Vindula erota</i>	3	0,034	0,671	1,227
<i>Ypthima baldus</i>	4	0,042	0,895	0,613
Total	447	3,763	100	100

RD = Relative Density; RF = Relative Freuency;
Source: Research Result Data 2021

The diversity index of butterflies in the Alas River was high category ($H' = 3,763$). This is due to the abundance of host plants and food plants of butterflies along the Alas River. The presence and number of butterflies in an area is closely related to the presence of forage plants, and hosts, in the form of flowering plants that provide a source of nectar for imago and feed for their larvae (Setiawan *et al.* 2020). The existence of factors that encourage butterfly reproduction and development had an impact on the diversity of butterfly species. These include a variety of host plants that are beneficial to butterflies as well as outside conditions like humidity and temperature. These elements are more pronounced in daylight since they are diurnal organisms that are active during the day, and as a result, they have a big impact on butterfly survival (Bibas *et al.*, 2021). In addition,

abiotic factors such as temperature, air humidity, and light intensity are suitable for the butterfly's life. Based on this diversity index value, it can be stated that the habitat conditions along the pedestal river are still very suitable for the life of butterflies.

Conclusion

Based on the research data, found 75 species from 5 families (Hesperiidae, Lycaenidae, Pieridae, Papilionidae, and Nymphalidae) with a total of 477 individuals. The index value of butterfly diversity found in river habitats at the location of the Soraya Research Station is categorized as high $H'=3.763$. From the total diversity index value, it can be concluded that the river habitat in the Soraya Research Site is still in nature.

Acknowledgement

We would like to thank the Department of Biology, Faculty of Mathematics and Natural Sciences, Syiah Kuala University for allowing this research to be carried out and all parties who have contributed to the success of this research. As well as the Institute for Research and Community Service at Syiah Kuala University, through the Lektor Kepala Research Scheme with contract number: 170/UN11/SPK/PNBP/2021, dated February 19, 2021. We also thank the Leuser Conservation Forum and the Aceh Environment and Forestry Service for granting permission to enter the Soraya Research Station area.

References

- 'Akla, N., Rasnovi, S., Fithri, A., & Suwarno. (2018). The Diversity of Butterflies in the Brayeun River, Aceh Besar District. *Jurnal Bioleuser*, 2 (3), 69-71.
- Bibas, E., Herwina, H., Janra, M. N., & Amanda, A. K. (2021). Diversity of Butterfly species (*Lepidoptera: Rhopalocera*) attracted to Carrion Trap at Harau Valley Nature Reserve. In *IOP Conference Series: Earth and Environmental Science*, 757(1), p.012082. IOP Publishing. <https://iopscience.iop.org/article/10.1088/1755-1315/757/1/012082/meta>
- Braby, M. F. (2004). *The Complete Field Guide to Butterflies of Australia*. CSIRO Publishing. Australia.
- Corbet, A. S., Pendlebury, H. M., Van, P. G. M., Van, . P. N. E., & Malayan Nature Society, (2020). *The Butterflies of the Malay Peninsula*. Kuala Lumpur : Malaysian Nature Society.
- Darnilawati., Nurul, A., Hafiz, A., & Samsul, K. (2018). Pola Distribusi Kupu-kupu (*Lepidoptera*) di Desa Deudap Pulo Nasi Kecamatan Pulo Aceh Kabupaten Aceh Besar. Seminar Biotik. ISBN: 978-602-60401-9-0.
- Dewi, B., Hamidah, A., & Siburian, J. (2016). Keanekaragaman dan Kelimpahan Jenis Kupu-kupu (*Lepidoptera*) di Sekitar Kampus Pinang Masak Universitas Jambi. *Biospecies*, 9 (2), 34.

- Hanafiah, J. (2021). Indahnya Hutan Leuser dari Sungai Alas-Singkil. [Online]. [http://www.mongabay.co.id/2012/04/17/beautifulphotoof Leuser Forest from Alassinhkil River /](http://www.mongabay.co.id/2012/04/17/beautifulphotoof%20Leuser%20Forest%20from%20Alassinhkil%20River/). [Accessed: 18-Mei-2021].
- Hapsari, R. A., Idrus, A. A., & Ilhamdi, M. L. (2022). Diversity of Butterfly (Rhopalocera) in The River Flow Area at Taman Hutan Raya Sesaot as an Enrichment of Animal Ecology Practicum Materials. *Jurnal Biologi Tropis*, 22(1), 179–185. <https://doi.org/10.29303/jbt.v22i1.2610>
- Herlina, H. (2017). Kelimpahan Kupu-kupu Nymphalidae di Kawasan Air Terjun Parangloe Kabupaten Gowa. [Online]. <http://repository.uin-alaudin.ac.id/>. [Accessed: 20-Mei-2021].
- Kitahara, M., Yumoto, M., & Kobayashi, T. (2008). Relationship of butterfly diversity with nectar plant species richness in and around the Aokigahara primary woodland of Mount Fuji, Central Japan. *Biodivers Conserv*, 17, 2713-2734.
- Lamatoa, D. C., Koneri, R., Siahaan, R., & Maabuat, P. C. (2013): Population of butterflies (Lepidoptera) in Mantheage Island, Orth Sulawesi. – *Jurnal Ilmiah Sains*, 13 (1), 52-56.
- Lodh, R., & Agarwala, B. K. (2016). Rapid Assessment of Diversity and Conservation of Butterflies in Rowa Wildlife Sanctuary: An Indo-Bumesse hotspot-Tripura, N.E. India. *Tropical Biology*, 57 (2), 231-242.
- Murwitaningsih, S., Dharma, A. P., Depta, Dm., & Nurlaeni, Y. (2019). Keanekaragaman spesies kupu-kupu di Taman Cibodas, Cianjur, Jawa Barat sebagai sumber pembelajaran Biologi. *Science Education Journal (SEJ)*, 3 (1).
- Nuraini, U., Widhiono, I., & Riwidiharso, E. (2020). Keanekaragaman dan Kelimpahan Kupu-kupu (Lepidoptera : Rhopalocera) di Cagar Alam Bantarbolang, Jawa Tengah. *Bioeksakta : Journal Ilmiah Biologi Unsoed*, 2 (2), 157-164.
- Otsuka, K. (2001). *A Field Guide to the Butterflies of Borneo and South East Asia*. Hornbill Books- Adivision of Iwase Bookshop Sdn. Bhd, Malaysia.
- Panjaitan, R., Drescher, J., Buchori, D., Peggie, D., Harahap, I. S., Scheu, S., & Hidayat, P. (2020). Diversity of butterflies (Lepidoptera) across rainforest transformation systems in Jambi, Sumatra, Indonesia. *Biodiversitas Journal of Biological Diversity*, 21(11).
- Pollard, E., Hall, D., & Yates, T. J. (1995) Population trends of common British butterflies at monitored sites. *Journal of Applied Ecology*, 32, 9-16.
- Ramesh, T., Hussain, K. J., Selvanayagam, M., Satpathy, K. K., & Prasad, M. V. R. (2012). Patterns of diversity, abundance and habitat associations of butterfly communities in heterogeneous landscapes of the department of atomic energy (dae) campus at Kalpakkam, South India. *International Journal of Biodiversity and Conservation*. 2, 75-85.

- Salmah, S., Abbas, I., & Dahelmi. (2002). *Papilionidae Butterflies in Kerinci Seblat National Park*. Ministry of Forestry of the Republic of Indonesia, Jakarta.
- Setiawan, R., Sulistyowati., & Wulandari, F. (2020). Composition and Diversity of Butterfly (*Lepidoptera : Rhopalocera*) in University of Jember. Short Communication, *09(03)*, 77-80.
- Sharma M, Sharma N. (2017). Suitability of Butterflies Indicators of Ecosystem Condition: A Comparison of Butterfly Diversity across four habitats in Gir Wildlife Sanctuary. *International Journal of Advanced Research in Biological Sciences*, *4 (3)*, 43-53.
- Suwarno, S. & Rasnovi, S. (2019). Diversity and Distribution of Butterfly at Soraya Research Station Leuser Ecosystem Area and Its Conservation Effort. *Research Report*. University of Syiah Kuala. Banda Aceh.
- Suwarno, S., Hanum, I., Yasmin, Y., Rasnovi, S., & Dahelmi (2018). Diversity and Abundance of Butterfly (Lepidoptera: Rhopalocera) in the City Garden of Banda Aceh, Indonesia. *Ecology, Environment and Conservation*, *24 (3)*, 1009-1017.
- Suwarno, S., Rasnovi, S., Utami, S. D., Rizki, A., & Dahelmi, D. (2019). Mud-Puddling behavior of Butterflies in the Soraya Research Station, District of Subulussalam, Aceh, Indonesia. In *IOP Conference Series: Earth and Environmental Science*, *364(1)*, (p. 012027). IOP Publishing. <https://iopscience.iop.org/article/10.1088/1755-1315/364/1/012027>
- Tatang, V.C.L., Melanie, E., Kasmara, H., & Wawan. (2018). Keanekaragaman Kupu-kupu Famili Nymphalidae dan Pieridae di Kawasan Cirengganis dan Rumpuk Cikamal Cagar Alam Penanjung Pangandaran. *Jurnal Agrikultura*, *29 (1)*, 3.
- Yusuf, M., Rasnovi, S., Fithri, A., Rizki, A., & Suwarno, S. (2018). Keanekaragaman dan Distribusi Kupu-Kupu di Pulau Raya, Kabupaten Aceh Jaya, Provinsi Aceh. *Jurnal Bioleuser*, *2 (2)*, 69-71.