

INVENTORY AND DIVERSITY OF BUTTERFLIES (LEPIDOPTERA: PAPILIONOIDEA) IN PUTHUK PANGGANG WELUT TOURISM AREA, MOJOKERTO, EAST JAVA

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ABSTRACT

Tourism area is a tourism site that utilises the potential of natural resources, tourism areas support butterfly habitats, one of which is in Puthuk Panggang Welut Tourism, Mojokerto. The Puthuk Panggang Welut area has a natural ecosystem and there has been no previous research related to butterfly diversity. The purpose of this study was to determine the diversity of butterfly species (Lepidoptera: Papilionoidea) in the Puthuk Panggang Welut tourist area, Mojokerto. The capture of specimens was carried out by the transect method using an insect net (sweep net). Based on observations obtained, five families, namely Hesperidae, Lycaenidae, Nymphalidae, Papilionidae, and Pieridae, the number of species obtained, as many as 30 species from five families and 221 individuals, with a value of $H' = 3.07$ so that it can describe the quality of the environment at Puthuk Panggang Welut Tourism, is classified as a high level of diversity. In addition, on the tourist track, the species *Troides helena* was found, which is one of a protected species.

Keywords: Diversity, Lepidoptera, Tourism Area

INTRODUCTION

Puthuk Panggang Welut Tourism Area is a highland nature tour in the form of lush pine trees. In addition, there are ornamental plants, streams, and shrubs that have a lot of flower juice. These environmental conditions can support butterfly habitat. Puthuk Panggang Welut Tourism Area as a tourist attraction can be a threat to butterflies that will lose their vegetation. At this location, there is no data available on butterfly species diversity. Therefore, this study aims to analyze the diversity of butterflies found in the Puthuk Panggang Welut Tourism Area.

Indonesia is a country located along the equator and has a tropical climate. Indonesia is known for its Megabiodiversity (Sanka et al., 2023) because it has very high biodiversity, one of which is butterflies. The diversity of butterfly species in Indonesia is estimated to be more than 2,200 species (Peggie, 2014; Peggie et al., 2022). The distribution of the largest number of butterfly species in Indonesia is found on the islands of Sumatra (890), Kalimantan (790), Java (640), Sulawesi (557), Papua (466), Maluku (380), and the Nusa Tenggara region (350) (Widjaja et al., 2014).

Butterflies are flying insects that belong to the Order Lepidoptera (Suhaimi et al.,

2017). Lepidoptera comes from the Greek word *lepis*, which means scales, and *ptera*, which means wings (Mairawita & Herwina, 2023). Butterflies have three body parts, namely the head, thorax, and abdomen (Tsai et al., 2020). The head of the butterfly has an antenna for smell and touch, eyes, and a sucking mouth tool in the form of a proboscis. The butterfly thorax is divided into three parts, namely the pro-thorax, where the front legs are attached; the meso-thorax, where the middle legs are attached; and the meta-thorax, where the hind legs and hind wing pairs are attached. Female of butterfly legs consist of several parts, namely the coxa, trochanter, femur, tibia, and tarsus (Hassan & El-Aassar, 2022).

Butterflies undergo perfect metamorphosis, which consists of four phases: egg, larva, pupa, and adult butterfly, or imago (Wafa & Sari, 2017). Butterfly eggs are round (Kumar et al., 2018), and generally butterflies lay their eggs on the underside of plant leaves (Radchuk et al., 2013). The larval phase can be found on host plants, and the larvae have a cylindrical shape (Jahnavi et al., 2018). The pupal phase is found on twigs or plant stems in a hanging position (Patel et al., 2017) and has a round, oval shape. The imago phase is found in various types of habitats, such as gardens, agricultural areas, and primary and secondary forests (Basri & Zakaria, 2021).

Butterflies have an important role in the ecosystem, acting as pollinators in the process of pollinating flowers (Thangjam et al., 2018), this helping in natural reproduction in an ecosystem. Butterflies can be used as bioindicators of environmental quality (Koneri et al., 2019), because butterflies depend on host plants (Fahlefi et al., 2024), so there is a very close relationship between butterflies and their habitat. In addition, butterflies also act as the first consumers in the food chain and as food for predatory animals such as birds, katang, snakes, and spider (Koneri et al., 2019). Butterflies that have the potential to be bioindicators of environmental quality can be used as basic data in butterfly conservation monitoring efforts in the Puthuk Panggang Welut Tourism Area.

METHOD

Butterfly research was conducted in the Puthuk Panggang Welut area (Figure 1), Nogosari Village, Pacet District, Mojokerto Regency, East Java (Figure 1). Data collection was carried out on 17–18 June and 24–25 June 2023. The observation time of this study adjusts the active time of butterflies, namely at 08:00–13:00 WIB. This study was divided into three research locations based on habitat types, namely in Pine Forests, Tourist Track, and Riverbank (Table 1). In the Tourist Track is planted with many ornamental plants, Riverbank bordered by many trees and pine forests with lush pine trees (Figure 2). The selection of research locations is based on measurements of biotic and abiotic factors from each location.

Specimens were captured using the sweep net method. The cruising method is a technique of capturing several individuals of each species found in the research area randomly by exploring the vegetation around the research site. After sampling using insect nets placed on papilot paper, butterflies were observed, and the butterfly species found were documented using a camera to facilitate identification.

The identification process was carried out by observing the head, thorax, abdomen, legs, and wings of the butterflies, which were mainly seen from the shape, style, and color, using the identification Butterflies Protected Forest, Wildlife Sanctuary, Ecotourism, And Nature Park Angke Kapuk North Jakarta (Ruslan & Andayaningsih, 2021), Bioekologi kupu-kupu (Rohman et al., 2019), and Kupunesia application, recorded for each known species, counting the number of species, some butterflies were

preserved and some were released. In addition, abiotic factors such as temperature, humidity, and wind speed were measured using a thermohygrometer, and light intensity was measured using a luxmeter. After that, data was collected on the most dominant vegetation in the area.

Table 1. Description of Location

No	Station	Description
1.	Pine forest	Pine forest are the first station that has little light intensity because there are abundant pine trees
2.	Tourist track	The second station is the Puthuk Panggang Welut tourist track which has several herbal plants, has several trees, and a slightly closed canopy
3.	Riverbank	The third station is a riverbank which has an open canopy so that light intensity can enter, this station is the main flow of the waterfall and has several flowering plants

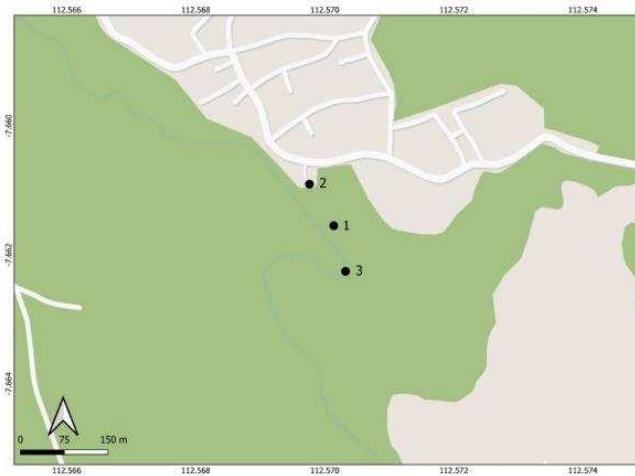


Figure 1. Map of the location. (1) Pine forest, (2) Tourist track, (3) Riverbank



Figure 2. Documentation of research location. (a) Pine forest, (b) Tourist track, (c) Riverbank

This study uses diversity index and evenness index analyses. Data on the types and number of individuals were then analyzed with the following diversity index, i.e. Shannon-Wiener Diversity Index, Evenness Index and Dominance index (Ashari et al., 2019).

RESULTS AND DISCUSSION

Based on observations made in the Puthuk Panggang Welut area, 30 species were found, with a total of 221 individuals. All species belong to five families, namely Hesperidae, Lycaenidae, Nymphalidae, Papilionidae, and Pieridae (Table 2). The largest family is Nymphalidae, with 19 species. Species of the Family Nymphalidae are polyphagous in nature (Bora et al., 2017). This can be the Nymphalidae family is easy to adapt to in all kinds of habitats (Koneri et al., 2017). The Nymphalidae family was found to favour open spaces, forests, and garden areas. The high proportion of Nymphalidae species indicates high host plant richness in the study area.

Table 2. List and relative abundance butterfly species

Species	Relative Abundance (%)				Conservation Status
	Pine Forest	Tourist Track	Riverbank	Total	
Hesperidae					
<i>Notocrypta paralysos</i> (Wood-Mason & de Niceville, 1881)	0,752	0,000	0,000	0,820	NE
Lycaenidae					
<i>Celastrina argiolus</i> (Linnaeus, 1758)	0,000	1,695	0,000	0,820	LC
<i>Acytolepis puspa</i> (Horsfield, 1828)	0,000	1,695	0,000	0,820	NE
<i>Discolampa ethion</i> (Westwood, 1851)	2,256	1,695	0,000	3,279	NE
<i>Jamides malaccanus</i> (Rober, 1886)	0,000	3,390	0,000	1,639	NE
<i>Zizina otis</i> (Fabricius, 1787)	0,752	0,000	0,000	0,820	LC
Nymphalidae					
<i>Cyrestis lutea</i> (Zinken, 1831)	0,000	0,000	3,448	0,820	NE
<i>Doleschallia bisaltide</i> (Cramer, 1777)	0,000	0,000	13,793	3,279	NE
<i>Euploea mulciber</i> (Cramer, 1777)	5,263	0,000	0,000	5,738	VU
<i>Hypolimnas bolina</i> (Linnaeus, 1758)	1,504	0,000	0,000	1,639	NE
<i>Ideopsis juvena</i> (Cramer, 1777)	3,759	0,000	6,897	5,738	NE
<i>Junonia iphita</i> (Cramer, 1779)	15,038	32,203	0,000	31,967	NE
<i>Lethe confusa</i> (Aurivillius, 1897)	9,774	0,000	0,000	10,656	NE
<i>Mycalesis janardana</i> (Moore, 1857)	4,511	0,000	0,000	4,918	NE
<i>Neptis hylas</i> (Linnaeus, 1758)	2,256	11,864	0,000	8,197	NE
<i>Neptis leucoporos</i> (Fruhstorfer, 1908)	8,271	0,000	17,241	13,115	NE
<i>Neptis vikasi</i> (Moore, 1899)	6,767	6,780	0,000	10,656	NE
<i>Orsotriaena medus</i> (Fabricius, 1775)	1,504	5,085	0,000	4,098	NE
<i>Parantica aspasia</i> (Fabricius, 1787)	0,752	0,000	0,000	0,820	NE
<i>Parthenos sylvia</i> (Cramer, 1776)	0,000	0,000	3,448	0,820	NE
<i>Symbrenthia hypselis</i> (Godart, 1824)	0,000	0,000	31,034	7,377	NE
<i>Tanaecia trigerta</i> (Moore, 1857)	3,008	0,000	0,000	3,279	NE
<i>Ypthima iarba</i> (Niceville, 1895)	11,278	0,000	0,000	12,295	NE
<i>Ypthima nigricans</i> (Snellen, 1892)	4,511	0,000	0,000	4,918	NE
<i>Ypthima pandocus</i> (Hubner, 1818)	5,263	5,085	0,000	8,197	NE
Papilionidae					
<i>Papilio memnon</i> (Linnaeus, 1758)	0,000	0,000	10,345	2,459	NE
<i>Troides helena</i> (Linnaeus, 1758)	0,000	8,475	13,793	7,377	LC
Pieridae					
<i>Catopsilia pomona</i> (Fabricius, 1775)	7,519	0,000	0,000	8,197	NE
<i>Eurema hecabe</i> (Linnaeus, 1758)	2,256	11,864	0,000	8,197	NE
<i>Eurema sari</i> (Horsfield, 1829)	3,008	10,169	0,000	8,197	NE

Meanwhile, the family with the least number of species is the Hesperidae family, which found only one species. This is because the Hesperidae family prefers to hide and be under the leaves, so it can go unnoticed. The characteristic of species in the Hesperidae family is to dart quickly in the air. So, only a few species were found during the observation. The most common species were *Junonia iphita* (Figure 3-G) with 31.967% relative abundance, *Neptis leucoporos* with 13.115% relative abundance and *Ypthima iarba* (Figure 3-K) with 12.295% relative abundance.

Junonia iphita belongs to the Family Nymphalidae. *Junonia iphita* is found perching on foliage to bask and has a low-flying characteristic in flowering shrub areas. This is because *Junonia iphita* absorbs nectar for nourishment. *Neptis leucoporos* belongs to the family Nymphalidae. This species was found basking on its host plant. It is a butterfly that has the habit of flying swiftly but at a low altitude. It is often found sucking nutrients and minerals from the soil. The existence of this species does not really depend on existing abiotic factors, because it can develop in all habitats. Species that can be found in Kalimantan, Sumatra and Java. *Ypthima iarba* has the ability to fly short distances and low over herbaceous plants, grasses, and shrubs. This species can often be seen perching and flying slowly in bushes. Species that can be found in open grassy areas. A slow-flying species, it is often seen visiting flowers to suck nectar and basking with its wings fully open in sunny conditions.

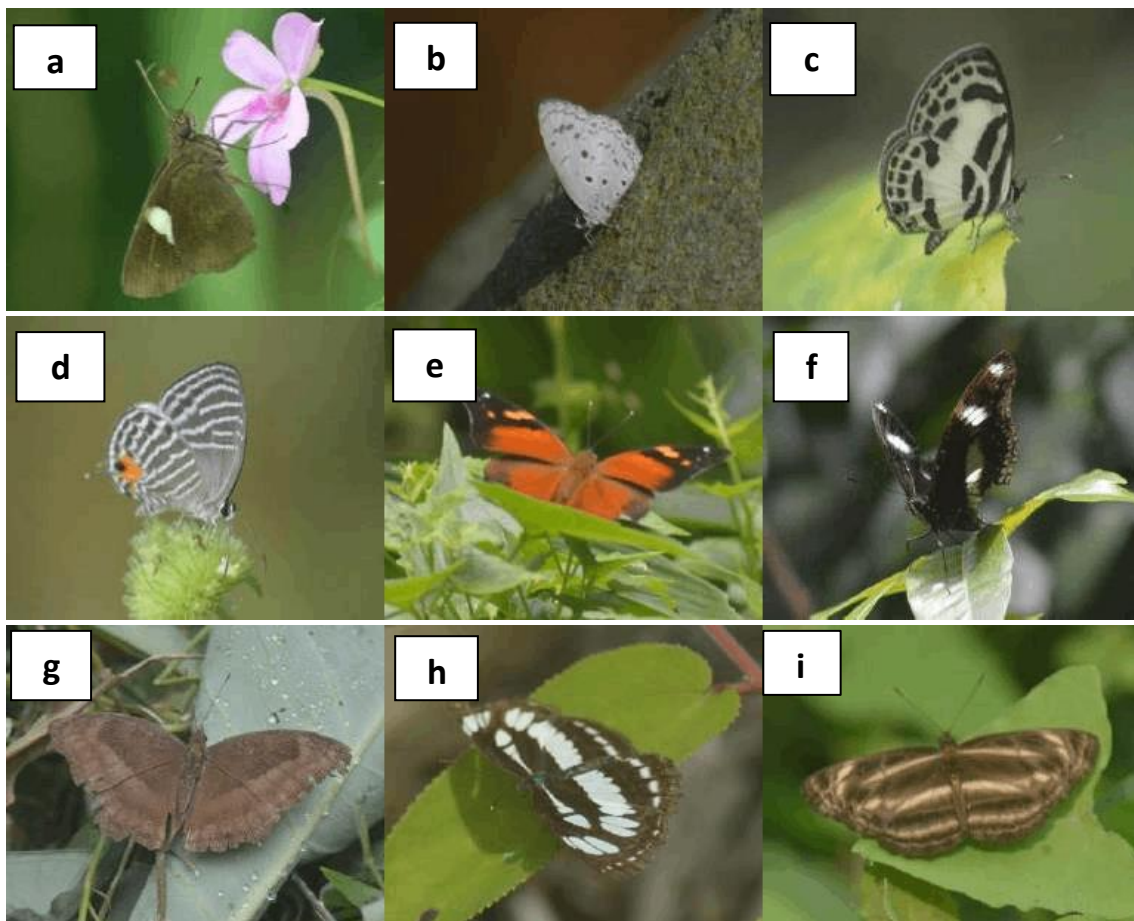


Figure 3. Documentation of Butterflies. (a) *Notocypta paralysos*, (b) *Acytolepis puspa*, (c) *Discolampa ethion*, (d) *Jamides malaccanus*, (e) *Doleschallia bisaltide*, (f) *Hypolimnas bolina*, (g) *Junonia iphita*, (h) *Neptis hylas*, (i) *Neptis vikasi*, (j) *Symbrenthia hypselis*, (k) *Ypthima iarba*, (l) *Troides helena*, (Photo: M. Azmi Dwi Susanto, 2023)

The index value of butterfly diversity in the Puthuk Panggang Welut Area is H' : 3.07. This shows that the diversity index value is high, this statement is supported by Aprilia et al., (2018). The diversity index of Puthuk Panggang Welut Tourism has diverse flora and fauna. At this location, abundant butterfly individuals can be found because the vegetation on this tour supports the existence of butterfly species. Butterfly diversity values are different because each location has different environmental conditions. Factors that can affect butterfly diversity are where butterflies need to eat. Other factors include temperature, humidity, light intensity, and habitat type at the study site (Millah et al., 2023).

Temperature and humidity are factors that not only affect butterfly activity but also host plants and food availability. According to Peggie (2014), the presence and diversity of butterflies in a location are directly proportional to temperature and humidity. Butterflies are cold-blooded animals that require optimal temperature and humidity for their internal metabolism to function properly (Haryadi et al., 2018). Conversely, when the temperature and humidity are less than optimal, the metabolic process in the body slows down, and the egg-laying process of female butterflies is also reduced. Light intensity is an important factor (Zulaikha and Susanto, 2022) for butterflies because they need good light intensity in order to dry their wings when they land on leaves. On the other hand, sunlight intensity can also affect the butterfly's life cycle, especially at the larval stage.

The distribution of host plants in a location will affect the distribution of butterflies. Butterfly habitats are characterized by the availability of host plants for larval (Burgio et al., 2015) feeding as well as nectar-producing plants for the imago. Plants are used as hosts and food sources by butterflies. Plants that are food sources for butterflies will be assisted in the pollination process, so they are known as insect pollinators. One of the animals that are pollinators is the butterfly. Therefore, it is also important for plants to have butterflies in their habitat to help with pollination. Butterflies use their long proboscis to suck nectar from flowers that have deep, nectar-rich corollas.

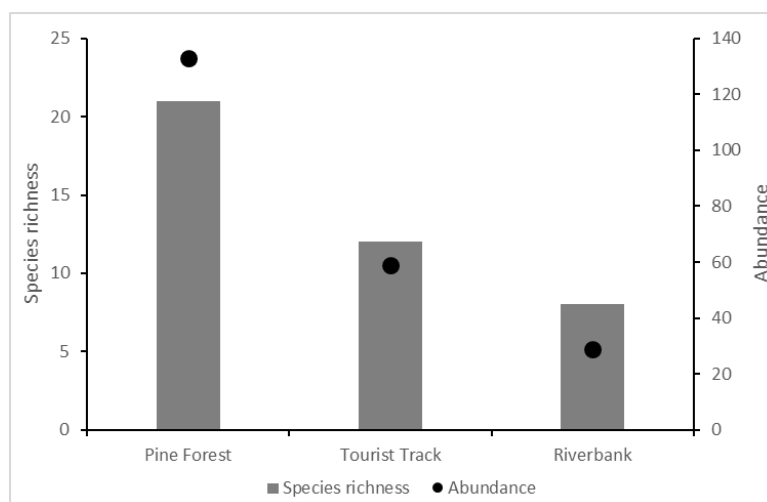


Figure 4. Species richness and Abundance

Pine Forest is a location that has the highest diversity value (Figure 5), namely H' : 2.83. Characterised by high abundance, species richness (Figure 4), and butterfly diversity index. This is because of the plants that spread in this location. Butterflies were found perched on the plant *Eupatorium perfoliatum* L. Plants on the pine forest site, such as *Pityrogramma calomelanos* and *Calyptocarpus viales*, become associated with

butterfly species. Species found only in pine forest sites are *Notocrypta paralysos*, *Zizina otis*, *Euploea mulciber*, *Hypolimnas bolina*, *Lethe confusa*, *Mycalesis janardana*, *Parantica aspasia*, *Tanaecia trigerta*, *Ypthima iarba*, *Ypthima nigricans*, and *Catopsilia pomona*. Habitats with environmental characteristics that have a variety of flowering plant vegetation make butterflies easy to find.

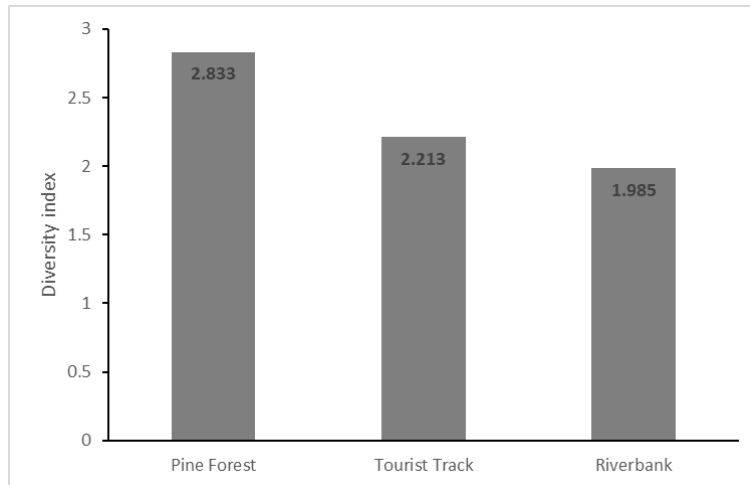


Figure 5. Results of Diversity index each location

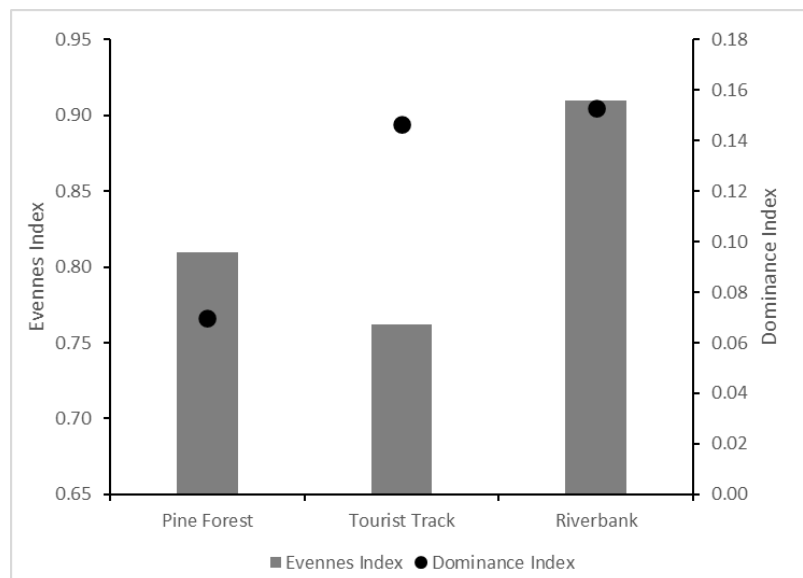


Figure 6. Results of Evenness and Dominance index each location

Table 3. Abiotic factors in Puthuk Panggang Welut Area

Location	Temperature (°C)	Humidity (%)	Light Intensity (lux)
Pine Forest	26	69	2593
Tourist Track	28	68	3306
Riverbank	22	73	1874

The location of the tourist path is in a habitat with open environmental conditions. There are many herbaceous plants, such as the following: *Curcuma longa* and *Tithonia diversivolia* have a canopy at some point. Less canopy cover causes light to enter the environment, resulting in warmer temperatures and lower humidity. On the tourist track, there are butterfly species that are only found in this location, including

Celastrina argiolus, *Acytolepis puspa*, and *Jamides malaccanus*. In addition, on the tourist track, the species *Troides helena* was found, which is one of the rare butterflies. This is due to the suitable habitat for development and the high flight rate of *Troides helena* species.

The Riverbank location has habitat conditions, a closed environment, riparian vegetation, and a high canopy density. It is located close to the Riverbank. The canopy cover that dominates this location causes light to not be able to enter the environment (Table 3), so that temperatures decrease and humidity becomes high. This can cause the location of the riverbank to have the lowest diversity. The evenness index of butterfly in the Riverbank is $E : 0.90$ (Figure 6). This shows Evenness index value is high then each location. There are rocks and *Mimosa pudica* plants that become perches for butterfly species. On the riverbank, several species were found, including *Cyrestis lutea*, *Doleschallia bisaltide*, *Parthenos sylvia*, *Symbrenthia hypselis*, and *Papilio memnon*.

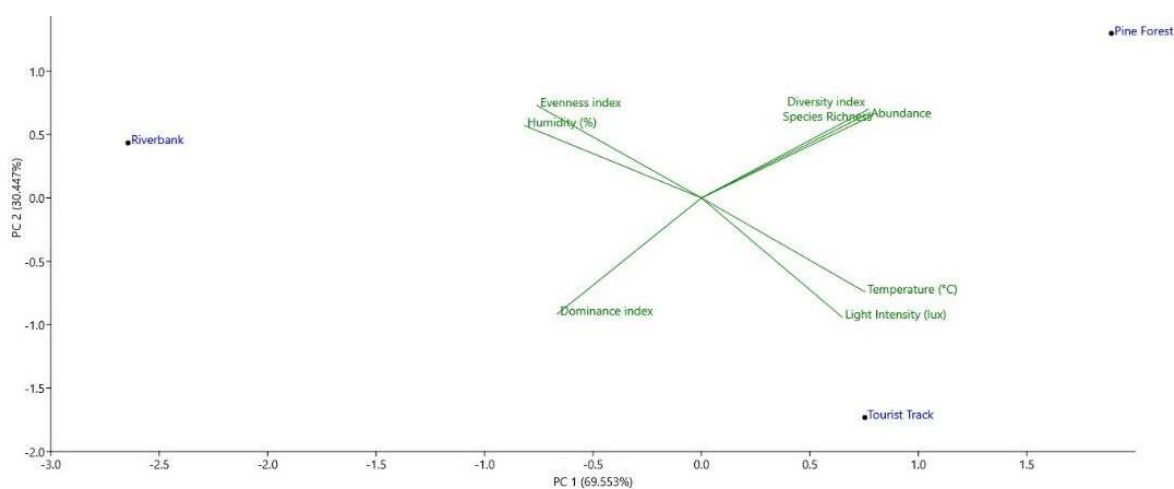


Figure 7. PCA Ordinations in Three Locations

The results of PCA analysis of the relationship between abiotic and biotic factors on butterfly diversity showed that both principal component axes contributed (Figure 7). The variables of light intensity and temperature (abiotic factors) have a negative correlation with the variable evenness index (Figure 7). This indicates that light intensity that is too high or too low can affect butterfly presence. This could be because in general, butterflies will choose to carry out activities such as sunbathing, flying, and foraging if the light intensity is sufficient. Meanwhile, a positive correlation occurred between the evenness index and humidity.

CONCLUSIONS

Based on the research that has been done, Puthuk Panggang Welut Tourism has a fairly diverse butterfly diversity. The most common family is the Nymphalidae family. The species with the most dominant individual is *Junonia iphita*. The species diversity index in Puthuk Panggang Welut Tourism has a high value.

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