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Diversity and colonization of butterfly (*Lepidoptera*) on Pasoso Island, Central Sulawesi

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Abstract

Various biotic and abiotic environmental factors influence the preservation of butterfly species in an area. The pressure and threat of extinction for butterflies that occupy relatively narrow and isolated habitats such as small islands are pretty large. This study aims to estimate the diversity of butterfly species, predict colonization, predict local extinction of butterflies, and conservation implications to minimize local extinction of butterflies in the habitat type on Pasoso Island, Central Sulawesi Province. Data was collected using field observations in four land cover types (primary forest, coconut groves, "ecotone" between coconut groves-primary forests, and shrubs) on a 100 m line transect line. Each line transect is divided into point counts, with a distance between points of 100 m. The results of the identification of butterfly species in four habitat types on Pasoso Island found 16 species from 78 individual butterflies belonging to four families (*Nymphalidae, Papilionidae, Pieridae, and Lycaenidae*). Butterflies in all habitat types on Pasoso Island are in the moderate category. Species diversity in garden habitat types based on the analysis of the Shannon-Wiener index showed higher than other habitat types (H'=1.89), while the Ecotone habitat type has the lowest diversity value (H'=1.06). The results of the t-test showed that there was no significant difference in the diversity of butterfly species in the four habitats. The results showed that colonization and local extinction occurred in butterfly species on Pasoso Island. Four of the nine species are included in the local extinct category, namely *Apias albina, Tajuria sp., Ideopsis juventa, Phalanta alcippe celebensis*. Five other species were colonized, namely *Arhopala araxes, Catochrysops strabo, Catopsilia pomona, Hypolimnas anomala*, and *Idea blanchardii*.

Keyword: butterfly, colonization, diversity, local extinction, Pasoso island

1. Introduction

The butterfly species diversity in Indonesia is estimated at 2.000 number of species [1]. Sulawesi Island according to Koneri et al. [2] has 557 species of butterflies from the order Lepidoptera. Butterflies on Manado Tua Island, North Sulawesi with an area of 1028.27 ha found 29 species [3]. Butterflies on Mantehage Island, North Sulawesi with an area of 738.10 ha found 19 species [4], and on Talaud Island, North Sulawesi with an area of about 1.251 km² found 32 species [2]. Research on butterflies Central Sulawesi has been carried out on Grand Forest Park, by Sabran et al. [5] who found as many as 97 species.

The ecological and geological conditions of the island, including variations in the size and shape of the island and the level of isolation of the island, will affect the diversity of butterfly species that live on the island [6]. The process of exchanging biotic components on an island will also allow the process of colonization of an organism including butterflies on an island. The ability to spread an organism in a habitat in many cases becomes an important aspect in the colonization process as shown in the Krakatau Islands after a volcanic event, namely butterfly and bird species have a wide distribution area [6].

An important factor that supports the success of butterfly colonization in an ecosystem is the carrying capacity of the environment, in the form of food plants, host plants, resting places, and shelters. The availability of host plants is an important factor because it serves as a place to lay eggs for female butterflies [7]. Butterfly colonization is also related to the habitat's ability to food resource and host plants [2], [8]. The existence of butterflies is very dependent

on the food plants, both as a host for the larvae and as a source of nectar for the imago [8]. Availability of plants as a source of food and hosts are closely related to butterfly diversity [7], [9].

Pasoso Island is one of the islands in Central Sulawesi Province with the status as a wildlife reserve area. Even though it is located close to the mainland, namely Sulawesi Island, due to its small size, the existence of this island is small when compared with the area of the island of Sulawesi. Butterflies on Pasoso Island are strongly suspected to be vulnerable to local extinction processes. The level of local extinction threat, theoretically, will be slightly reduced if the butterfly colonization process occurs. Regarding the diversity of butterfly species, what and how the process of butterfly colonization on Pasoso Island and its controlling factors and its relation to the potential for local extinction, there is not enough data and information available so far regarding this question, therefore it is important to know this data and information so that it can be used as a reference in formulating appropriate steps for its preservation. There is no scientific research related to the diversity of butterfly species and aspects that support their existence and colonization process.

2. Research Methodology

The study was conducted from May to September 2019 at the Pasoso Island Wildlife Reserve (0°4'20”- 0°7'20” N and 119°36'20”- 119°39'00” E), Manimbaya Village, Balaesang Tanjung District, Donggala Regency, Central Sulawesi Province (Figure 1). The land area of Pasoso Island is about ± 45 ha with rock topography and sea corals that form steep cliffs. Habitat types used for data collection are primary forest habitat, ecotone habitat (between coconut groves and primary forest), shrubs, coconut groves habitats.

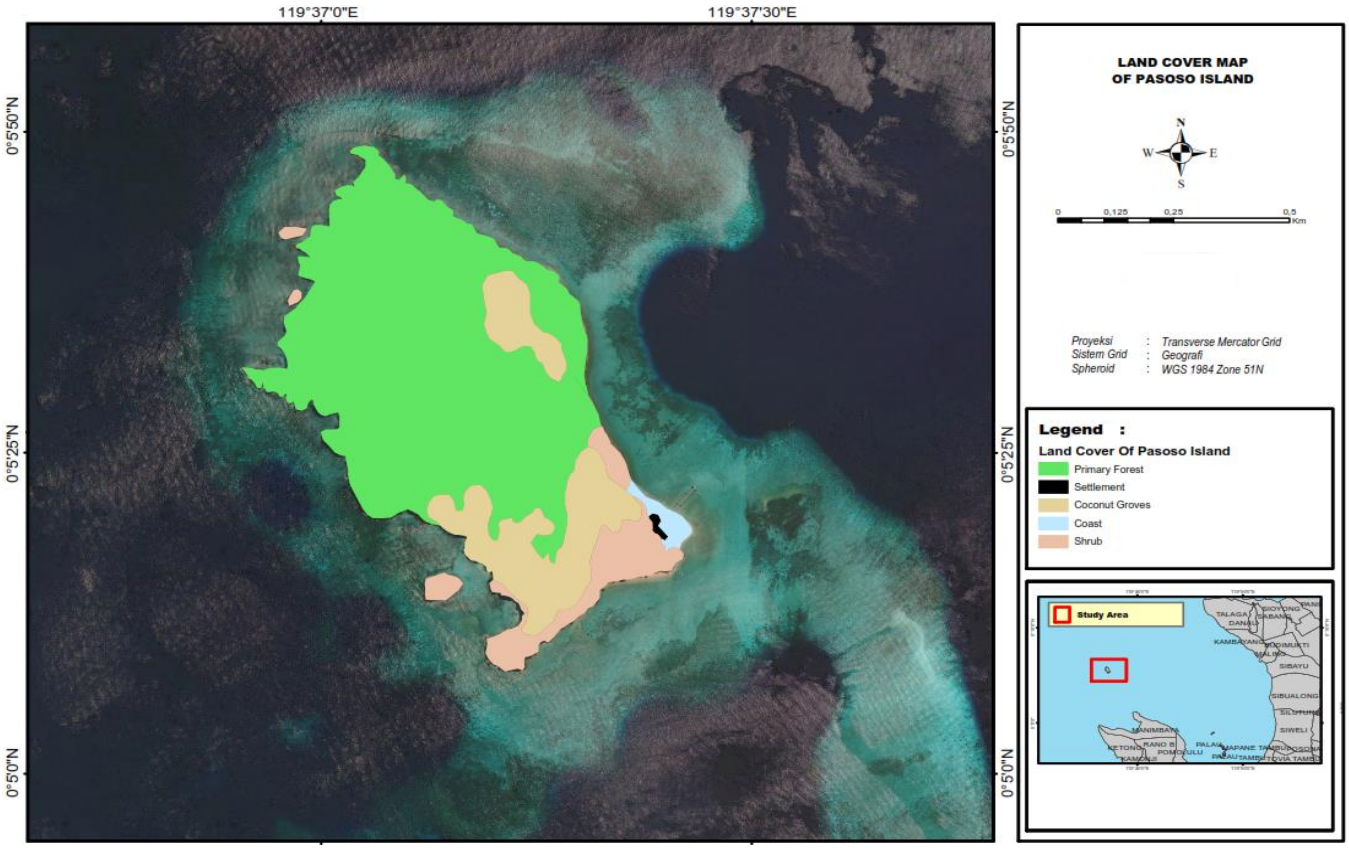

Figure 1. Land cover map of Pasoso Island

2.1. Data Collection

2.1.1. Butterfly Population

Observations were made from 07:00 to 11:00 AM considering the topographic conditions of the research location. Data was collected using field observations in four land cover types (primary forest, coconut groves, "ecotone" between coconut groves-primary forests, and shrubs). Butterfly population data was collected using the Variable Circular Plot (VCP) method [10] on a sample unit in the form of a 1000 m line transect. The point count is placed with each transect line, the distance between the points is ±100 m. Observation of butterfly species was carried out using the VCP method.

2.1.2. Butterfly Colonization and Local Extinction

Data were recorded using the presence/absence method using a binary technique, namely 0 if butterfly not found and 1 if butterfly species were found. The value of colonization and local extinction was carried out on the same plot or patch for 3 (three) series where series refer to the repetition period with a distance between series of 1 month and the plots were placed in each type of research habitat. The value of colonization and extinction according to Blomqvist et al. [11] based on presence/absence data with four transition states in each plot, namely the plot remains absent (0-0), persists (1–1), appears (0–1) and disappears (1–0).

Apart from that identification, the variables used to determine the effect of colonization on Pasoso Island, namely the area of the patch, the shape of the patch, the air temperature, the intensity of light, the number of types of predators, and humidity. These variables are then observed and measured according to time series data collection for one month.

2.2. Data Analysis

2.2.1. Species Diversity

Data analysis for the diversity of butterfly species on Pasoso Island used the equation of species diversity with the Shannon-Wiener Index [12]. The species diversity was then tested using the equation namely the t-test. Species richness using the Margalef Diversity index (Dmg) [12]. Species evenness was calculated using Shannon Equitability Index, and community similarity using the Jaccard Index [13].

a. Species diversity using the Shannon-Wiener Index were calculate using:

$$H' = -\sum p_i . \ln(p_i) = -\sum \left(\frac{n_i}{N}\right) . ln \left(\frac{n_i}{N}\right) \quad (1)$$

Description: H'= species diversity Shannon, p_i = the proportion of individuals found in the i-th species, n_i = number of individuals of the i-th species, *N* = the total number of individuals of all species found.

To test differences in H' values between sample units, you can use the Hutcheson method [14] for significance testing with the t-test.

b. Species richness using the Margalef Diversity Index were calculate using:

$$D_{Mg} = \frac{S-1}{\ln(N)} \quad (2)$$

Description: D_{Mg} = Margalef diversity index, *N* = the total number of individuals of all species found, S = number of recorded species.

c. Species evenness was calculated using Shannon Equitability Index were calculate using:

$$E_1 = \frac{H'}{\ln(S)} \quad (3)$$

Description: E_1 = Shannon Equitability Index i.e., evenness values range from 0 to 1. The value E=1 represents a situation that all species have the same abundance.

d. Community similarity using the Jaccard Index were calculate using:

$$JI = \frac{a}{(a+b+c)} \quad (4)$$

Description: JI = Jaccard index (community similarity), a = the number of species found in the first and second communities or habitat types, b = the number of species found only in the first community or habitat type, c = the number of species found only in the second community or habitat type.

2.2.2. Colonization and Local Extinction

There are two stages in processing colonization and local extinction data. In the first stage, the results of recording presence-absence data were processed using the colonization and local extinction equation [11] with four transition states in each plot, namely the number of plots expressed as (1) plots that remained unchanged -no species: n_{0-0}; (2) plots where species persist: n_{1-1}; (3) plots that were previously non-existent became species-free: n_{1-0}, and (4) plots that were previously absent became species-free: n_{0-1}. The results of this calculation illustrate the value of colonization and local extinction of butterflies that occurred on Pasoso Island. The occupancy value at t=0 is calculated as follows:

$$p = \frac{n_{1-1} + n_{1-0}}{n_{total}} \quad (5)$$

Occupancy at t=1 is as follows:

$$q = \frac{n_{1-1} + n_{1-0}}{n_{total}} \quad (6)$$

Colonization (C) of a patch is indicated n_{0-1} i.e., the previously empty plot becomes filled with species. Local extinction (E) is indicated by n_{1-0} i.e., from a plot that was originally filled or contains species to an empty patch. The value of colonization and local extinction is calculated based on the probability of hope, then the value of colonization and local extinction can be calculated using the Blomqvist et al. equation [11], as follows:

a. Colonization

$$C = \frac{n_{0-1}}{(1-p)qn_{total}} \quad (7)$$

Description: C = colonization value, n_{0-1} = plot that did not exist before becoming species, ρ (t=0), q (t=1)

b. Extinction

$$E = \frac{n_{1-0}}{p(1-q)n_{total}} \quad (8)$$

Description: E = extinction value, n_{1-0} = plot that originally existed to no species, ρ (t=0), q (t=1)

The second stage test was conducted using the multiple linear regression method to measure the number of butterfly species. Multivariate analysis using SPSS software through multiple linear regression method to determine the variables that affect the number of butterfly species in each plot. Analysis of the relationship between the dependent variable (Y = Number of butterfly species), and the independent variable (X). The variables that cause colonization in butterflies are patch area (ha) (X1), patch shape (X2), air temperature (3 times; in the morning, in the afternoon, and in the evening) (X3), light intensity (X4), number of predators (X5), and humidity (X6), with the shape multiple linear regression equation used, as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p \quad (9)$$

The test was carried out simultaneously (ANOVA) with the following hypotheses:

H_0: β_1 all = 0 (no X affects Y) and H_1: there is $\beta_1 \neq 0$ (no X has an effect on Y). After that, a partial test (t-test) was carried out with the hypothesis:

H_0: β_p = 0 (X has no effect on Y) and H_1 : $\beta_p \neq 0$ (X has no effect on Y).

2.3. Conservation Implications

The analysis used to formulate the implications of conservation is descriptive analysis. This analysis is based on theoretical studies, conservation status based on the IUCN Red List Vulnurable (VU), Endangered (EN), and Critically Endangered (CR), CITES trade status, species endemic status and protection status of butterfly species. In Indonesia, based on the Minister of Environment and Forestry Regulation Number 106 of 2018 concerning The List of Protected Plant and Animal Species, a general and comprehensive description of the actual situation, based on the results of this descriptive analysis, then formulated conservation implications to minimize the potential for local extinction and ensure the preservation of butterflies on the island Pasoso.

3. Results and Discussion

3.1. Size of Butterfly Species Diversity

The results of the identification of butterfly species in four habitat types on Pasoso Island found 16 species of 78 individual butterflies belonging to four families (*Nymphalidae, Papilionidae, Pieridae*, and *Lycaenidae*) (Table 1 & Appemdix 1). The results of the analysis showed that the diversity of butterfly species in the habitat of Pasoso Island was in the moderate category based on Magurran's [12] criteria. Species diversity in coconut groves habitat types showed that it was higher than other habitat types (H' = 1.89) (Table 1), while the ecotone habitat type had the lowest diversity value (H' = 1.06). This is in line with the research results of Hermawanto et al. [15], namely the diversity index value (H') of butterfly species in the garden is higher because the garden conditions are more open than another habitat. Butterflies prefer open places where soil or rock is accessible for them to land on and obtain mineral nutrients. This behavior is carried out by many tropical species, including a number of species with canopy (species that like closed places) [16], [17].

Butterflies are more often found in open areas than in closed areas because based on the activities of butterflies that need sunlight, find food, and mate. Variations in canopy cover provide a suitable place for butterfly activity so that butterfly species in the coconut groves habitat are more diverse.

Table 1. List of butterfly species found in the four habitat types on Pasoso Island

No	Family	Species	Habitat				Number of Individuals
			P	K	E	S	
1.	Nymphalidae	*Hypolimnas anomala*	0	1	0	0	1
2.	Nymphalidae	*Idea blanchardii*	18	3	4	0	25
3.	Nymphalidae	*Ideopsis juventa*	0	1	3	1	5
4.	Nymphalidae	*Phalanta alcippe celebensis**	5	0	0	0	5
5.	Nymphalidae	*Hypolimnas* sp.	1	0	0	0	1
6.	Nymphalidae	*Doleschallia polibete*	0	2	0	0	2
7.	Papilionidae	*Graphium agamemnon*	0	2	0	0	2
8.	Pieridae	*Apias albina*	8	7	0	0	15
9.	Pieridae	*Catopsilia pomona*	0	3	0	3	6
10.	Pieridae	*Leptosia nina*	0	0	0	1	1
11.	Pieridae	*Eurema* sp.	2	0	0	0	2
12.	Lycaenidae	*Arhopala araxes*	1	3	2	1	7
13.	Lycaenidae	*Catochrysops strabo*	0	0	0	1	1
14.	Lycaenidae	*Jamides* sp.	0	0	0	2	2

No	Family	Species	Habitat				Number of Individuals
			P	K	E	S	
15.	Lycaenidae	*Tajuria* sp.	2	0	0	0	2
16.	Lycaenidae	*Jamides aratus*	1	0	0	0	1
Number of individuals			38	22	9	9	78
Number of species			8	8	3	6	26
Species diversity (H')			1.54	1.89	1.06	1.67	
Species richness (R)			1.92	2.26	0.91	2.28	
Species Evenness (E)			0.74	0.91	0.96	0.94	

Description: P (Primary), K (Coconut groves), E (Ecotone), S (Shrubs), * (endemic)

The results of the t-test showed that there was no significant difference in the diversity of butterfly species in the four habitat types. Differences in the diversity of butterfly species found in the four habitat types on Pasoso Island are factual conditions, that indicate differences in carrying capacity of the environment. Differences in environmental factors and plant vegetation between one type of land cover and other types of land cover cause differences in diversity, distribution patterns, and abundance of butterflies found in the land cover [16], [17]. Butterflies according to Irni et al. [9] can adapt to their food plants when they become adult butterflies, but according to Koneri and Saroyo [3] the loss or threat of these host plants will also threaten the existence of butterflies to breed in a habitat. Environmental changes can cause butterflies to lose their host plants and food resources [20].

The results of the calculation of the species richness (R) (Table 1) show that the shrubs and coconut groves habitat types have high species richness values, factors that affect the species richness of butterflies in a habitat are temperature, humidity, rainfall, light, predators, and parasites [2].

The calculation of species evenness (E) (Table 1) shows that ecotone habitat has the highest species evenness index value (E= 0.96), while primary forest habitat has the lowest species evenness index (E= 0.74). Species evenness index in the coconut groves, ecotone, and shrub different, but the species evenness value in the three habitat type were included in the evenly distributed category, meaning that in the three habitat types, no butterfly species dominated.

The results of the analysis of species diversity, species richness and evenness of butterfly species in the four habitat types on Pasoso Island showed different results, meaning that there was no one habitat type that had species richness, species evenness, and species diversity simultaneously. The highest species diversity was in the coconut groves habitat, the highest species richness was in the shrub's habitat, then the highest species evenness was in the ecotone habitat. These results indicate that the highest butterfly species diversity index value is not directly proportional to species richness and high species evenness. The two indexes do not have to have the same pattern. According to Kurnia [21], this pattern does not have to have the same pattern. The difference is thought to be caused by differences in the availability of butterfly feed in each habitat type on Pasoso Island, the factor of feed availability where the amount of feed for butterflies is mostly found in coconut groves and shrubs habitat types, while in primary and ecotone habitat types it is less found. Host plants are more common in primary and ecotone forests. This shows that coconut groves and shrubs areas are butterfly foraging habitats, while primary forest and ecotone are breeding grounds, this is supported by the abundance of vegetation, especially trees in primary and ecotone forest types compared to coconut groves and shrub habitat types. Butterflies use trees as a place to lay their eggs as their host plants [9].

The results of the calculation of the similarity index of the butterfly community were found to be the highest between the coconut groves and ecotone habitat types, which was 0.37 while the lowest was between primary forest and shrub habitat types, which was 0.07 (Table 2). Ecotone and coconut groves habitat types have a similarity of 0.37 compared to primary forest and shrubs by only 0.07, so the habitat types that are close to similarity are ecotone and coconut groves habitat types, because the position of ecotone and coconut groves

habitats is directly adjacent, while access between habitats including primary forest and shrubs is far from each other.

Adult butterflies can adapt to a new or degraded habitat. This form of adaptation is only limited to forage plants. The female butterfly is very dependent on the host plant when the butterfly will lay eggs. This also applies to the larval and pupal stages. The probability of the occurrence of similarity of butterfly communities between different habitats is related to the presence of butterfly species in existing habitat types which are influenced by the distribution and adaptation capabilities of the butterfly species found [22]. The high and low level of similarity of the butterfly community on Pasoso Island is therefore influenced by certain habitat characteristics.

Table 2. Community similarity of butterfly species in the four habitat types on Pasoso Island

Habitat	Habitat Type		
	Coconut groves	Ecotone	Shrubs
Primary	0.23	0.22	0.07
Coconut groves		0.37	0.27
Ecotone			0.33
Shrubs			

3.2. Butterfly Colonization and Local Extinction

The results showed that colonization and local extinction occurred in butterfly species on Pasoso Island (Table 3). Four of the nine species are included in the local extinct category, namely *Apias albina*, *Tajuria* sp., *Ideopsis juventa*, *Phalanta alcippe celebensis*. Five other species were colonized, namely *Arhopala araxes*, *Catochrysops strabo*, *Catopsilia pomona*, *Hypolimnas anomala*, and *Idea blanchardii*. An illustration of the type of butterfly that colonizes is shown in Figure 2. The value of colonization and local extinction shows that the butterfly species *Arhopala araxes* have almost equal colonization and local extinction values, namely the colonization value of 0.95 and the local extinction value of 0.94. Balance in spatial scope according to Yukawa [23] will be achieved if the rate of immigration and extinction have the same value. The lowest colonization value is found in the butterfly species *Apias albina* with a value of 0.28 and this species has a smaller colonization value than the extinction value of 0.54 which indicates that this species is included in the local extinct category. The species *Phalanta alcippe celebensis* is also included in the local extinct category because the colonization value is smaller than the extinction value, which is 0.63 < 0.87.

Table 3. The value of colonization and local extinction of butterflies on Pasoso Island

No	Species	C	E	Note:
1	*Arhopala araxes*	0.95	0.94	Colonize
2	*Catochrysops strabo*	0.86	0	Colonize
3	*Catopsilia pomona*	0.30	0.18	Colonize
4	*Hypolimnas anomala*	0.69	0	Colonize
5	*Idea blanchardii*	0.73	0	Colonize
6	*Apias albina*	0.28	0.54	Local Extinct
7	*Tajuria* sp.	1.09	1.14	Local Extinct
8	*Ideopsis juventa*	0.4	0.57	Local Extinct
9	*Phalanta alcippe celebensis**	0.63	0.87	Local Extinct

Description: C (colonization value), E (local extinction value), *endemic

The results of multiple linear regression analysis show that there is a significant relationship between light intensity and the number of butterfly species, meaning that light intensity affects the number of butterfly species on Pasoso Island. An important component of the habitat for a butterfly's life is sufficient light. Clean or unpolluted air and water as materials needed for environmental humidity so that butterflies can live. The intensity of the light also

affects the mating of butterflies when flying. Some butterflies prefer light for activities such as flying/sunbathing, playing, looking for a mate, and eating. Several studies have shown that environmental factors suitable for active butterflies are at a minimum temperature of 15°C, an optimum temperature of 30°C and a maximum temperature of 45°C, air humidity ranging from 70-86%, and sunlight intensity ranging from 523-1159 x 10Lux. Butterflies need 84-92% humidity to breed based on Irni et al. [9], so when the environmental conditions change, their existence also changes. This is in line with the opinion of Koneri et al. [24] which states that light intensity affects butterfly diversity. If the light intensity is higher, the diversity of butterfly species will decrease. This is because the high light intensity causes the air temperature to rise and humidity to fall outside the range of air conditions required by the butterfly. An increase in air temperature will accelerate the evaporation of body fluids and endanger the life of the butterfly.

Unsuitable micro-habitat other than in the primary habitat which tends to be cool and has lots of shade. Types of butterflies according to Indriani et al. [25] some are only found in and/or dark and sheltered parts of the forest with relatively low temperature levels. The need for resources and microhabitats in the primary habitat supports the survival of *P. alcippe celebensis* but based on the results of research this species is classified as locally extinct, it can be indicated that the resources in the primary habitat are not sufficient for its survival.

Another habitat component that is important for butterfly life is the availability of vegetation as a source of food and protection. The presence of butterflies is also influenced by host and feed factors, it can be seen that the type of habitat that has food and hosts is found in many types of butterflies. The existence of butterflies is very dependent on food plants, both as hosts for larvae and as a source of nectar for imago [8]. In addition, the availability of plants as a source of food and host is closely related to butterfly diversity [7], [9].

3.3. Conservation Implications

The endemic butterfly species on Pasoso Island is *Phalanta alcippe celebensis* by Vane-Wright and de Jong [26]. The endemicity of butterflies on Sulawesi Island which reaches 40% by Koneri et al. [2] makes endemic butterflies have a very high conservation value compared to generalist butterflies. This is because endemic species are specialist species that prefer certain habitats. *P. alcippe celebensis* is a special type of butterfly because it only occupies primary forest habitats. The encounters were only found in primary forest habitats, both during and outside observations. Species that are only found in closed areas (shade) are one of the strategies of this species to avoid predators so that in the selection of habitat it is very important for this type of butterfly. The diversity of endemic butterfly species between habitats is different and there is a tendency to decrease diversity from forest habitat conditions to non-forest habitats in line with the results of Widhiono's research [27]. Butterflies are endemic to cases like this, requiring appropriate conservation strategies, especially for unsupported habitats.

The calculation results also show that the butterfly species *Phalanta alcippe celebensis* is classified as local extinct (Table 3). Habitat dependence for endemic species allows these species to become extinct locally, especially if these species have small populations. A habitat if there is increased extinction and decreased immigration on isolated islands, according to the hypothesis MacArthur and Wilson [27], then the species therein is included in the target of conservation because of the threat to the population of that species, in particular for species endemic to that habitat.

Conservation of butterfly species *P. alcippe celebensis* on Pasoso Island can be guaranteed, the following conservation efforts need to be done:

1. Intra-species diversity *P. alcippe celebensis* is a potential local genetic resource that needs to be studied further as a basis for the conservation of endemic species that have the potential to become extinct.
2. Type dependency *P. alcippe celebensis* to the primary habitat indicates that the environmental carrying capacity of the habitat can ensure the survival of the *P. alcippe celebensis* population on Pasoso Island which has ecological value. It is necessary to know more specifically the ecological data such as environmental and biotic factors.

3. Planting forage plants and host plants for species *P. alcippe celebensis* in the habitat on Pasoso Island which is thought to be the site of the butterfly colonization.

4. Conclusion

On Pasoso Island 16 species of butterflies have been found with moderate species diversity category. There are differences in diversity, similarity, and evenness of species in the four habitat types. The coconut groves habitat type had the highest species diversity (1.89) and the habitat had the lowest species diversity (1.06) compared to the primary forest and shrub habitat types. Based on the results of this study the value of colonization and local extinction of butterflies, the butterflies included in the colonization category were *Arhopala araxes*, *Catochrysops strabo*, *Catopsilia pomona*, *Hypolimnas anomala*, *Idea blanchardii*. Meanwhile, those included in the local extinct category are *Apias albina*, *Tajuria* sp., *Ideopsis juventa*, *Phalanta alcippe celebensis*. The butterfly species *Phalanta alcippe celebensis* is endemic to Pasoso Island.

Pasoso Island as a conservation area with the status of a wildlife reserve, serves as a habitat for a diversity of butterfly species including endemic and endangered species, as well as an opportunity as an alternative source of butterfly habitat, and has the potential for beautiful tourist attractions, carried out in a planned manner to ensure the preservation of the diversity of butterfly species.

Author Contributions

FR: Conceptualization, Analysis Data, Methodology, Investigation, Writing - Composing; **BM:** Writing - Review & Editing, Supervision; **DAR:** Writing - Review & Editing, Supervision**.**

Conflicts of interest

There are no conflicts to declare.

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Appendix 1.

Hypolimnas anomala

Idea blanchardii

Ideopsis juventa

Phalanta alcippe celebensis

Doleschallia polibete

Catopsilia pomona

Appias albina

Leptosia nina

Eurema sp.

Arhopala araxes

Tajuria sp.

Hypolimnas sp.

Jamides sp.

Jamides aratus

Notes:

Graphium agamemnon and *Catochrysops strabo* can only be observed directly, there are no photos and specimens because the topography is difficult.