

## Conference Paper

# Effect of Temperature on Butterfly Community (*Lepidoptera*) at Gunung Meja Recreational Forest Area, Manokwari, Papua Barat

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## Abstract

Gunung Meja is one of the forest areas in Manokwari, West Papua province. It has been designated as a recreational forest since 1980. Gunung Meja covers 460.25 ha and is located at 75–175 m a.s.l. Gunung Meja is directly adjacent to residential areas, therefore the community activities, such as felling trees and gardening, was conducted in the area frequently. These can interfere the existence of flora and fauna in the area, included butterflies. To reveal the impact of intrusive human activities on the forest area, it was necessary to obtain basic information about what flora and fauna are present there. This study was aimed to record the butterfly community in the area. Observations of butterflies were done by scan sampling on primary forest, secondary forest, gardens and settlements. Sampling and measurement of environmental parameters were performed in the morning and afternoon for seven weeks. This study recorded 113 species and 4,049 individuals of butterflies. There were 75 species in primary forest, 77 species in secondary forest, and 63 species in gardens and settlements. The number of species found was still increasing until the last day of the observation. Shannon-Wiener index ( $H'$ ) calculation showed that diversity in primary and secondary forests were 3.48 and 3.50, respectively, thus classified as high ( $H' > 3$ ). Sorensen index calculation ( $C_N$ ) showed high value reaching 0.5 quantitatively. The numbers of butterflies both species number and individual number, observed in the morning were higher than those in the afternoon. There was significant effect ( $P < 0.05$ ) of temperature on the number of individual butterflies. The result of PCA analysis showed that the environmental parameters in primary forest, secondary forest, gardens and settlements influenced the number of species and number of individuals.

**Keywords:** Butterflies, Community, Gunung Meja, Manokwari

## 1. Introduction

Papilionidae butterflies are members of the Lepidoptera order, which has a unique and beautiful color pattern wings characteristic. One group of butterflies, which have a high

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economic value in Papua, was a bird wings butterfly (*Ornithoptera* spp.) Some of which are endemic status. Papua has a high diversity of insects, about 300.000 species have been identified and 960 species are the Lepidoptera group. Papilionoidea butterflies that have been recorded in Papua New Guinea were 568 species, 60% of which are endemic in Papua islands. There are not many research that studies of species diversity and distribution of butterflies in Papua. Moreover, Gunung Meja, one of the forests in Manokwari West Papua Province, have no record on its butterfly species diversity.

## 2. Methods

Observations butterfly surveys conducted using a scan sampling method (Krebs 1999). Scan sampling conducted along lines that already exist in three types of habitat, primary forest, secondary forest, gardens and settlements. The study was begun by measuring of coordinates using GPS in every type of habitat. At the time of observation of butterflies, measurement environmental parameters, such as temperature, humidity, light intensity, wind speed, canopy cover, and rainfall were also performed every hour in every type of habitat observed. Along the transect line were counted and identified species of butterflies were found. Butterflies that cannot be identified immediately at the time of observation were sampled using insect nets/ sweep nets and insect pin set, kept in an envelope to be identified in a laboratory. Butterfly identification was referring to Parsons (1999), D'Abrera (1990), Mastrigt & Rosariyanto (2005), Brower (2008), and Kristensen et al. (2007). Observations diversity of butterflies were done as many as 11 repetitions on each type of habitat in two periods, morning time (08:00 to 12:00 pm) and afternoon time (12:00 to 16:00 pm). The diversity of butterflies was calculated by the Shannon-Wiener diversity index and evenness values. Butterfly species similarity among the research sites, analyzed by quantitative Sorensen similarity index (CN) (Magurran 1988). The number of species and number of individuals in the morning and afternoon time were displayed with bar graphs with error bars using the program Sigmaplot 2001. The relationship between environmental parameters with a number of individual butterflies was displayed in a scatter plot. Analysis PCA (Principle Component Analysis) was used to determine the influence of environmental parameters on the diversity of species and number of individual butterflies on each type of habitat, with a program of R 2.10.0 (Everitt and Hothorn 2006).

## 3. Results

In the period of this study were founded 113 species and 4,049 individual butterflies in Gunung Meja forest. Butterflies were found among five families, which are Papilionidae (14 species), Pieridae (13 species), Riodinidae (1 species), Lycaenidae (29 species), and Nymphalidae (55 species). The diversity species of butterfly in the Gunung Meja was high ( $H' = 4.08$ ). Species diversity in primary forests was higher, ( $H' = 3.50$ ) than in the garden and settlements ( $H' = 2.83$ ). This is due to the heterogeneous of Gunung Meja forests, and there also a garden and a settlement that allows a community habitat

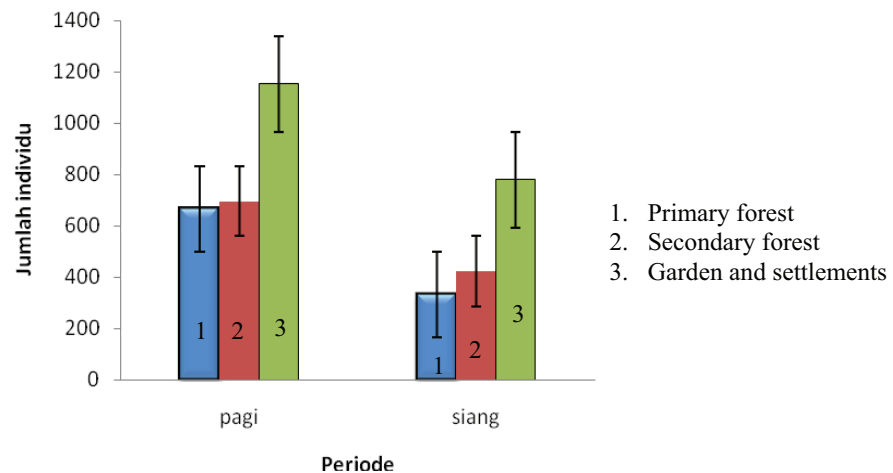
Takson/ Diversity	Type of Habitat			Total
	Primary forest	Secondary Forest	gardens and settlements	
∑ Family	5	4	4	5
∑ Subfamily	12	10	10	14
∑ Genus	45	47	34	60
∑ Species	75	77	63	113
∑ Individual	999	1119	1931	4049
Index H'	3.48	3.5	2.83	4.08
Value E	0.81	0.81	0.68	0.86

Note: H'=Index Shanon Wiener, E= evenness Value

TABLE 1: Number of family, subfamily, genus, species, individual, Diversity index, and evenness Value of Butterflies at Gunung Meja.

for butterflies. Evenness value at Gunung Meja was also found high (E = 0.86). In primary and secondary forests, both evenness value were given by the same value of E = 0.81, while in the garden and the settlement was given by the value of E = 0.68 (Table 1).

In the Gunung Meja area was found five families and 14 subfamilies of butterfly. Subfamily most commonly found in the family of Nymphalidae and 9 subfamilies. The highest number of species was given by the subfamily Polyommatainae, with 19 species. Butterflies are most commonly found in the family of Nymphalidae. It's due to the number of family, members Nymphalidae more than any other family. The lowest number of species was given by Apaturinae subfamily (one species with one individual) and subfamily Riodininae (one species with 2 people). The number of species of butterflies in primary forests and secondary forests (75 and 77 species) was higher than in the garden and settlements (63 species). The number of individual butterflies most commonly found in gardens and settlements (1931 people). It was considered due to the butterflies that were found was a common species, which have a high abundance. Butterflies which most common found in gardens and settlements were *Junonia hedonia* (264 individuals), *Mycalesis terminus* (231 individual), *M. phidon* (204 individuals), *Eurema hecabe* (157 individuals), and *Catopsilia pomona* (102 individuals). In secondary forests, 1119 individuals were found and in primary forest 999 individuals were found. In primary forests, access path was difficult due to dense vegetation, thus reducing the visibility at the time of observation than in secondary forests, gardens and settlements. Species found in primary forests (18/16% of species) butterfly found only in the forests and rarely found in secondary forest or in the garden and settlements. Based on the results quantitative Sorensen similarity index calculation (CN), butterfly similarity between primary forest with tall secondary forest (CN = 0.50), between primary forest with gardens settlements and low (CN = 0:22). The number of species and individuals made the community butterflies in primary forests to secondary forests



**Figure 1:** Number of individual butterflies at primary forest, secondary forest, garden and settlements inobservatin in the morning and afternoon. *Standard-errors* shown in lines.

was high. Vegetation and environmental conditions between primary forests and secondary forests were not different significantly, thus allow the species can live at both locations. In primary forest, secondary forest, garden and settlements were found 37 of the same species. *Ornithoptera priamus* butterfly was found in all three types of habitat. *O. priamus* larval host plantsis *Aristolochia tagala* (*Aristolochiaceae*) were found in three types of habitat. The species that are only found in primary forests were 18 species, in secondary forest were 10 species, and in the garden and settlements were 11 species. Butterfly were found in the morning time (08:00 to 12:00 pm) were more frequently than during the afternoon time (12:00 to 16:00 pm). The high number of species and number of individuals were found in the morning, influenced by the availability of feed.

In addition, it is likely caused at the time of observation in the afternoon time (starting at 15:00 pm) often dry to a downpour, so the butterfly becomes less active (Figure 2). Environmental conditions at the time of observation in primary forest, secondary forest, garden and settlements. The average temperature on primary forests and secondary forests not showed significant difference. The average temperature when the study ranged from 24 - 26°C. Humidity, temperature, light intensity, and a canopy cover a significant influence on the number of individual butterflies (value  $r^2$  and  $p$  respectively:  $r^2 = 0:18$ ,  $p = 0:02$ ;  $r^2 = 0:51$ ,  $p = 0.00004$ ;  $r^2 = 0:31$ ,  $p = 0:04$ , and  $r^2 = 0:33$ ,  $p = 0.0005$ ). Wind speed and precipitation did not have a significant effect ( $p = 0.78$  and  $p = 0:41$ ) to the butterfly community (Table 2). PCA analysis results show the number of individual butterflies is influenced by wind speed, light intensity, temperature and rainfall in habitat gardens and settlements. While the number of species affected by humidity and canopy cover in secondary forest (Figure 1).

Parameters	Number of butterflies individual			
	r <sup>2</sup>	R	p value	regresi analysis
Temperature	0,18	0,15	0,02	y = -317,12+17,28x
Humidity	0,51	0,48	0,00004	y = 440,08-3,74x
Light Intesity	0,31	0,11	0,04	y = 86,75+0,03x
Wind speeds	0,009	0,68	0,78	y = 103,96+22,5x
Canopi	0,33	0,31	0,0005	y = 191,24-1,08x
Rainfall	0,02	0,009	0,41	y = 130,92-4,95x

Note : r = Korelasi Pearson, p value = significant value

TABLE 2: Correlation Pearson, Value p, andregresi analysisbetween number of individual of butterflies with environmental parameters at Gunung Meja.

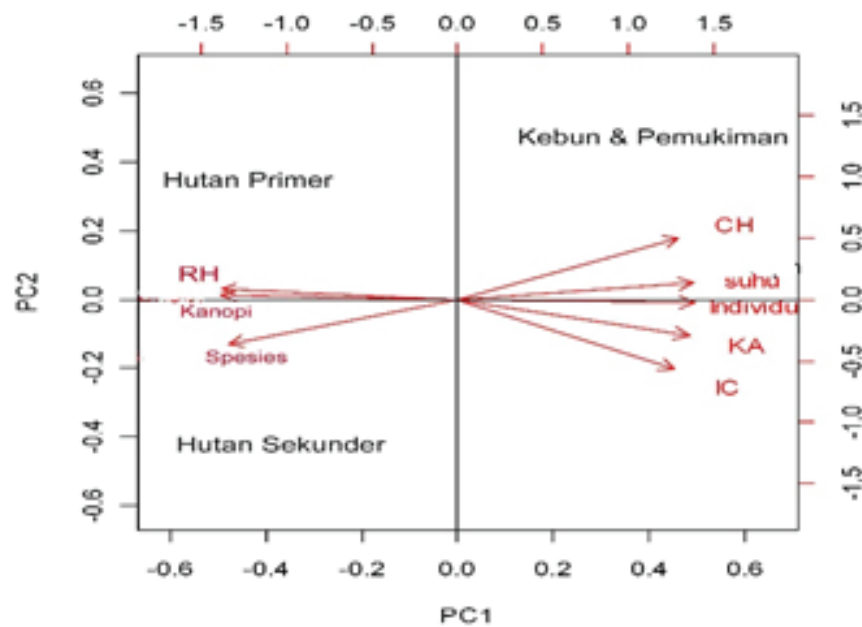


Figure 2: Analysis of PCA between number of individual and species number with environmental parameters at primary forest, secondary forest, garden and settlements.

### 4. Discussion

In the nature forest area of Gunung Meja 113 species of butterflies were found with a total of 4049 individuals. Index Shannon - Wiener and evenness values diversity of butterflies in Gunung Meja, show a very high value ( $H' = 4.08$ ,  $E = 0.86$ ). Butterfly diversity was high, due to the possibility was available for larval host plants and nectar-producing plants to imago. In addition, Gunung Meja was included as heterogeneous forests suitable as a habitat for butterflies. Javier et al. (2005) reported in heterogeneous forests, butterfly diversity is higher than in wetlands and grasslands.

Habitat	Temp (C)	RH (%)	IC (Lux)	KA (knot)	Kanopi (%)	CH (mm)
Primary forest	24.85	93.03	625.89	0.25	96.04	2.15
Secondary forest	24.95	88.39	1000.8	0.76	69.15	1.65
Garden & Settlements	26.91	73.29	1513.3	5.95	14.95	5.1

Note RH: Humidity; IC: Intensity of light ; KA: wind speeds; CH: Rainfall; Value= data CH from BMG Rendani Manokwari Juli – Agustus 2010.

TABLE 3: Average Value of environmental parameters at primary forest, Secondary forest with garden and settlements in Gunung Meja.

Butterflies which most commonly found were members of the family Nymphalidae (Table 1).

Butterflies of this family have a number of members of the most numerous and widely spread as compared to the other family. In addition, it is also influenced by food availability and suitability of environmental conditions that allow the presence of species of the family in all types of habitat (Panjaitan 2008). Zobar & Genc (2008) reported very high development of Nymphalidae family and can be found on a variety of environmental conditions. In addition, Rodrigues and Moreira (2002) reported, Nymphalidae family larvae can live in several types of plants, so that they can live in different habitat types. Number of lowest family members butterfly was Riodinidae family (1 species). In Papua, Riodinidae members were consists of 2 genera and 6 species only (Mastriq & Rosariyanto 2005). Humidity, temperature, light intensity, rainfall, and canopy have a significant influence on the number of individual butterflies. Wind speed did not provide significant effect ( $p = 0.78$ ) on butterfly communities (Table 2 and Figure 2). The research of average temperature ranges between 24-26 ° C. Freitas et al. (1997), reported the optimum temperature for the butterfly to actively search for food is between 23-30°C. PCA analysis results (Figure 2) shows the environmental parameters in primary forest, secondary forest, gardens and settlement shows the influence of the number of species and number of individuals in different habitat types.

The size of the variable influence on the number of species and number of individuals, demonstrated a great angle and length of the arrows (Figure 2). If the angle formed closer to 90°, the variable of the observation does not have a significant influence. The number of individual butterflies was influenced by wind speed, light intensity, temperature and rainfall on habitat gardens and settlements (Roland 2006). Severns (2008) reported that the butterfly population in a community was affected by the intensity of the light. High value of rainfall was reduced activity of the butterflies. The observation situation was raining during the afternoon until evening. The number of species were affected by humidity and canopy cover in secondary forests. Bergstrom et al. (2006) reported, a high canopy cover (80-100%) affected the existence of the butterfly to be reduced to a habitat. Gaston (2000) reported, the most influential in the high species diversity was the variety of vegetation making up a community and altitude.

## 5. Conclusions

Gunung Meja was found in 113 of 4,049 individual species of butterflies. In primary forest, secondary forest, gardens and settlements, each found 75 species, 77 species, 63 species of butterflies. Diversity of butterflies in primary forests and secondary forests is higher than in the garden and settlements. In primary forests and secondary forests evenness index higher (respectively  $E = 0.81$ ) than in the garden and settlements ( $E = 0.68$ ). Species similarity between primary forest with tall secondary forest (50%). Butterflies were more common in the morning compare the afternoon time. The environmental parameters that measured, temperature, humidity, light intensity, and canopy have also effected on the butterfly communities.

## References

- [1] A. Bergstrom, N. Janz, and S. Nylin, Putting more eggs in the best basket: clutch-size regulation in the comma butterfly, *Ecol Entomol*, **31**, 255–260, (2006).
- [2] Brower AVZ, 2008, True Butterflies, <http://www.tolweb.org/lepidoptera/papilionoidea/12027.html>, [19 Mei 2011].
- [3] D’Abrera, *Butterflies of the Australian Region*, Hill House, London, 1990.
- [4] B. S. Everitt and T. Hothorn, *A Handbook of Statistical Analyses Using R*. Francis, Chapman and Hall/CRC, 2006.
- [5] A. V. L. Freitas, W. W. Benson, O. J. M. Filho, and R. M. de Carvalho, Territoriality by the dawn’s early light: the Neotropical owl butterfly *Caligo idomenaeus* (Nymphalidae: Brassolinae), *J Res Lepid*, **34**, 14–20, (1997).
- [6] K. J. Gaston, Global patterns in biodiversity, *Nature*, **405**, 220–227, (2000).
- [7] D. M. Javier, Distribution patterns and indicator species of butterfly assemblages of wet meadows in southern Belgium, *Belg J Zool*, **135**, 43–52, (2005).
- [8] C. J. Krebs, *Ecological Methodology*, Addison-Welsey Educational Publishers, California, 2nd ed edition, 1999.
- [9] N. P. Kristensen, M. J. Scoble, and O. Karsholt, Lepidoptera phylogeny and Systematics: the state of inventorying moth and butterfly diversity, *Zootaxa*, **1668**, 699–747, (2007).
- [10] A. E. Magurran, *Ecological Diversity and its Measurement*, Princeton University Press, New Jersey, 1988.
- [11] H. van Mastrigt and E. Rosariyanto, *Buku Panduan Lapangan Kupu-kupu untuk Wilayah Manberamo sampai Pegunungan Cyclops*, Conservation International-Indonesia Program, Jakarta, 2005.
- [12] R. Panjaitan, Distribusi kupu-kupu (Superfamili Papilionoidea: Lepidoptera) di Minyambou Cagar Alam Pegunungan Arfak Manokwari Papua Barat, *Berk Ilm Bio*, **7**, 11–16, (2008).
- [13] M. Parsons, *The Butterflies of Papua New Guinea (Their Systematics dan Biology)*, Academic Press, London, 1999.

- [14] D. Rodrigues and G. RP. Moreira, Geographical variation in larval host-plant use by *Heliconius erato* (Lepidoptera: Nymphalidae) and consequences for adult life history, *Braz J Biol*, **62**, 321–332, (2002).
- [15] J. Roland, Effect of melanism of alpine *Colias nastes* butterflies (Lepidoptera: Pieridae) on activity and predation, *Can Entomol*, **138**, 52–58, (2006).
- [16] P. M. Severns, Seeding population size and microhabitat association in *Lupinus oreganus* a threatened plant of western oregon grasslands, *Nativeplants*, **3**, 358–364, (2008).
- [17] D. Zobar and H. Genc, Biology of the queen of spain fritillary, *Issoria lathonia* (Lepidoptera: nymphalidae), *Flor Entomol*, **91**, 237–240, (2008).