



Diversity of fruit-feeding nymphalidae butterflies in baruzo forest and onolari forest on nias island, north Sumatra, Indonesia

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Abstract

A study about the diversity of fruit-feeding Nymphalidae butterflies had been carried out in Baruzo forest and Onolari forest on Nias Island. Sampling was conducted during three periods from August 2014 to April 2015, with a total of trapping as many as 340 trap days in the understorey and canopy within the forest using Cylindrical gauze traps. A total of 276 individual butterflies belonging to 18 species in four subfamilies and 12 genera was captured during the sampling periods in Baruzo forest and Onolari forest, with an Index of Diversity (H') = 1.92. Index of Evenness (E') of fruit-feeding Nymphalidae butterfly obtained from this study was 0.66. Meanwhile the butterflies in Baruzo forest and Onolari forest have a high similarity in species, with Sorensen Index of Similarity (QS) = 71%. Subfamily Satyrinae in the species *Melanitis leda* has the highest value of Abundance, Relative Abundance, and Frequency of Attendance.

Keywords: nymphalidae butterfly, diversity, forest, nias island

Introduction

Butterflies are part of the insects from the phylum of Arthropoda of the division of Endopterygota of the class of Insecta in the order Lepidoptera. They have the highest numbers among other orders, spread out from lowlands to highlands, at an altitude of 1500-1800 m above sea level (Kunte, 2006) [17]. Their ecological needs vary depending on the level of their life cycle. They are also very sensitive to environmental changes which can be seen from the changes in forest composition. The diversities of Nymphalidae butterflies are about 7200 species, found in all habitats and continents except Antarctica (DeVries, 1987) [8]. Across the world there is a burgeoning wealth of information on tropical forest butterfly assemblages and the effects of land disturbance on these communities (Haber, 2006) [16]. Butterflies in the family Nymphalidae are among the most charismatic insects in many habitats, and their beauty and diversity inspire a lifelong passion for the natural world among scientists and enthusiasts alike (Wahlberg *et al.*, 2009) [31]. In tropical forests, fruit-feeding butterflies are a convenient indicator group because they can be readily trapped and are comparatively easy to identify (Molleman *et al.*, 2006) [20]. Butterflies are classified into three guilds based on their foods (feeding-guild), i.e. nectar-feeder, fruit-feeder, and omni-feeder (Kunte, 2006) [18]. The second guild is composed of certain subfamilies of the Nymphalidae whose adults gain virtually all of their nutritional requirements by feeding on the juices of rotting fruits or plant sap (De Vries *et al.*, 1997) [9]. Several studies on diversities and community structures have been conducted

in Sumatera, such as in the Forest of Educational and Biology Research Andalas University Padang, in Aie Sirah Forest (Salmah and Abbas, 2006) [23], in the forest of Rimbo Panti Nature Reserve in Kabupaten Pasaman (Sitompul, 2008) [25], and in Siberut, Mentawai Islands (Luk *et al.*, 2011) [18]. Nias Island is one of the districts in North Sumatera that most of its land is hilly and steep, also has mountains with the altitude above sea level vary between 0-800 m. The island consists of lowland to bumpy ground as much as 28.8% and of bumpy ground to mountains as much as 51.2% of the total area of the land. The information about the diversity and movement as well as the vertical stratification of fruit-feeding Nymphalidae butterflies had not yet been found in Nias Island. Therefore, we need to conduct a research in this location.

Material and methods

Study site

This research was conducted in Baruzo forest and Onolari forest, Subdistrict Lolowau Regency South Nias, Nias Island (Fig. 1) on three periods (29 August– 2 September, 15 – 20 October 2014, and 4 – 9 April 2015). The coordinates of the sampling sites in each trap range between $N = 00,88919^{\circ} - 00,89526^{\circ}$, $E = 097,55582^{\circ} - 097,56795^{\circ}$, with the altitudes of 36 – 144 m above sea level. Temperatures during the sampling range between 27°C – 30°C with the humidities of 78% – 89%.

Sampling Methods

The butterflies were captured using Cylindrical Gauze traps with rotten pineapple bite (De Vries, 1987, 1988). We set up the traps vertically, i.e. ± 1 m in understorey trap and ± 20 m in

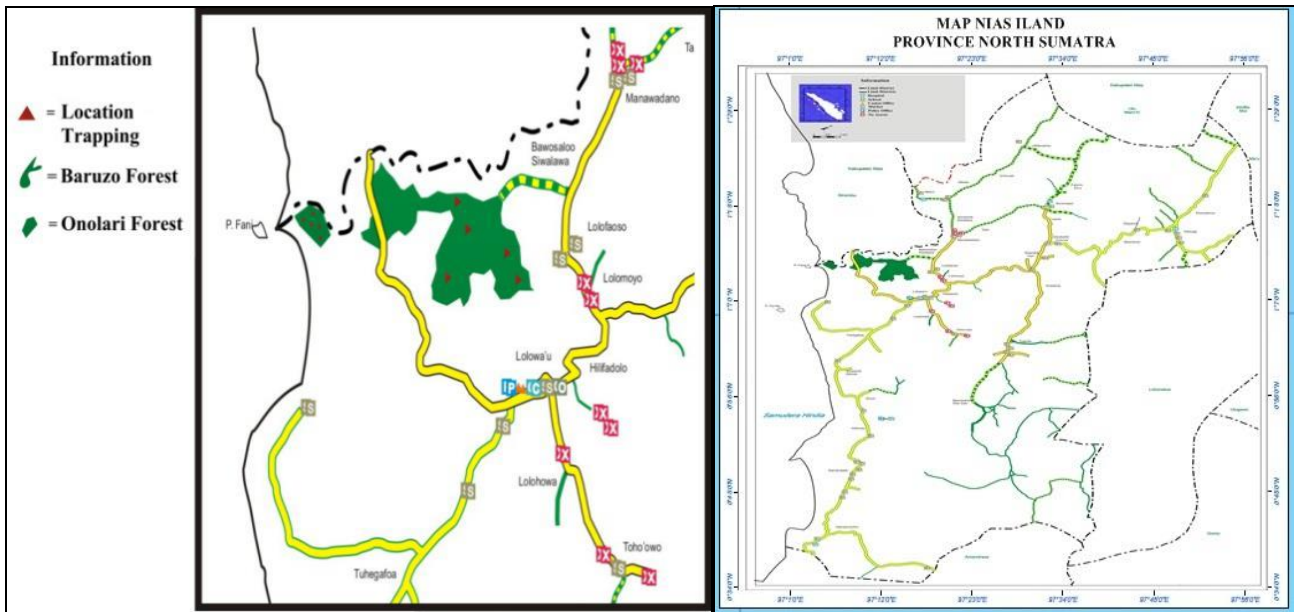


Fig 1: Study site and trapping location

Canopy trap (De Vries, Debra and Ressel, 1997; Fermon, Walter and Muhenberg, 2003; Tangah *et al.*, 2004) [9, 13, 26]. In all five plots each replicated with one understorey and one canopy traps.

During the first period, we installed 20 traps in Baruzo forest and Onolari forest for 5 days total (100 trap days). As for the second period, we set the traps for 6 days (120 trap days). And then in the three period, trapping was also carried out for 6 days (120 trap days). Thus, trapping was done during 340 trap days in total.

The traps were installed with a distance of ± 100 m between each trap (Barlow *et al.*, 2008; Fermon *et al.*, 2000) [1, 12]. We put some rotten pineapples in some plastic cups and fixed those baits at the base of each trap. Trap inspection and bait replacement were done every 24 hours. (Fermon *et al.*, 2000, 2005; De Vries, Debra and Russell, 1997) [12, 4, 9]. All trapped butterflies were collected and kept in spreading papers and needles. The butterflies were identified to species using references (Tsukada, 1982, 1991; Tsukada, Nishiyama and Kaneko, 1985) [29, 30, 28].

Data Analysis

The diversity of butterflies was determined using Shanon index (Magurran, 1988) [19], by the following formula:

$$H' = - \sum_{i=1}^s pi \ln pi$$

where, pi is the proportion within the Sample of the number of individuals of i th species and it is ni/N , where ni is number of individuals in i th species and N is the total number of individuals.

The following formula was used to calculate the index of Evenness at understorey and canopy strata:

$$E' = \frac{H'}{\ln S}$$

H' is index of species diversity and S = the number of species found. To calculate the index of similarity between

the species in Baruzo Forest and Onolari Forest, we used Sorensen Index (QS) by the following formula:

$$QS = \frac{2j}{a + b} \times 100\%$$

Where j = number of species in sample a and sample b (joint occurrences); a = number of species found in understorey trap; b = number of species found in canopy

Results and discussion

Diversity of Fruit-feeding Nymphalidae Butterflies

The diversity of the fruit-feeding Nymphalidae butterflies captured by using Cylindrical Gauze traps in Baruzo forest and Onolari forest, Nias Island consists of 276 individuals that belonging to 18 species in 4 subfamilies and 12 genera. There were 141 individuals captured in Baruzo forest, which are belonging to 16 species in 3 subfamilies and 11 genera, while 135 individuals belonging to 12 species in 3 subfamilies and 8 genera were found in Onolari forest (Table 1). Index of diversity (H') of fruit-feeding Nymphalidae butterflies captured in both study sites is 1.92, with $H' = 1.91$ in Baruzo forest and $H' = 1.78$ in Onolari forest (Table 2). These indices showed that both sites have a moderate level of species diversity. This is presumably because the forests are still in good condition. Magurran (1988) [19] stated that if $H' < 1$ then the diversity of the community is low, if $1 \leq H' < 3$ then the diversity is moderate, and if $H' \geq 3$ then the diversity is high. The result of this study can be used as an indicator that Baruzo forest and Onolari forest are in good shape, because those forests have not been disturbed by human activities and are supported by the closed canopy. Ghazoul (2002) stated these analyses suggest a more complex butterfly community at the undisturbed site. Thomas *et al.*, (2004) [27] stated that a great number of individual butterflies in a habitat shows the better quality of its environment.

Table 1: Subfamilies/species and number of individual fruit-feeding Nymphalidae butterflies in understory and canopy strata in Baruzo forest and Onolari forest.

No	Subfamily/Species	Baruzo forest			Onolari forest			Total
		U	C	U+C	U	C	U+C	
I Amathusinae								
1.	<i>Amathusia phidippus</i>	2	2	4	1	2	3	7
2.	<i>Discophora necho</i>	1	-	1	1	1	2	3
3.	<i>Xanthotaenia busiris</i>	-	1	1	-	-	-	1
4.	<i>Zeuxidia amethystus</i>	3	4	7	14	7	21	28
II Biblidinae								
5.	<i>Lexias dirtea</i>	1	-	1	-	-	-	1
6.	<i>Lexias elna</i>	1	-	1	-	-	-	1
III Charaxinae								
7.	<i>Protheo franck</i>	-	-	-	3	-	3	3
IV Satyrinae								
8.	<i>Elymnias nesaea</i>	4	6	10	4	2	6	16
9.	<i>Elymnias panthera</i>	-	2	2	-	3	3	5
10.	<i>Faunis canens</i>	1	1	2	-	-	-	2
11.	<i>Melanitis leda</i>	39	21	60	36	26	62	122
12.	<i>Melanitis phedima</i>	19	18	27	8	5	13	40
13.	<i>Melanitis zitenius</i>	-	-	-	1	1	2	2
14.	<i>Mycalesis fusca</i>	1	-	1	-	-	-	1
15.	<i>Mycalesis horsfieldi</i>	8	2	10	14	-	14	24
16.	<i>Mycalesis orseis</i>	9	1	10	1	-	1	11
17.	<i>Neorina lowii</i>	1	-	1	-	-	-	1
18.	<i>Orsotriaena medus</i>	3	-	3	3	2	5	8
Σ Individuals		93	48	141	86	49	135	276
Σ Species		14	10	16	11	9	12	18
Σ Genera		10	7	11	8	6	8	12
Σ Subfamilies		3	2	3	3	2	3	4

Table 2: Index of Diversity (H'), Index of Evenness (E'), and Index of Similarity (QS) of Fruit-feeding Nymphalidae Butterflies in Baruzo Forest and Onolari Forest in Nias Island

Parameter	Baruzo forest	Onolari forest	Both sites
H'	1.91	1.78	1.92
E'	0.69	0.72	0.66
QS	71%		

Index of diversity of fruit-feeding Nymphalidae butterflies found in Baruzo forest and Onolari forest belong to moderate criteria. It's presumably because of the similarity of tree vegetations on the trapping sites. Most of the trees were fruitful, such as plants from *Moraceae* family (*Ficus fulva*, *Ficus cf. obscura*, *Ficus* sp. 1 and *Artocarpus elasticus*) that dominates the forest vegetations. Butterfly can survive at a temperature of $18^{\circ}\text{C} - 38^{\circ}\text{C}$ (Simanjuntak, 2000) [24]. According to Checa *et al.*, (2009) [3] peak of the discovery and the highest abundance of species of Nymphalidae butterflies are at an average temperature of $25.8^{\circ}\text{C} - 26.7^{\circ}\text{C}$. The diversity Index of the butterflies in Baruzo forest and Onolari forest might indicate that those forests are still in good condition or still undisturbed. Species richness seemed highest at the disturbed site, but both abundance and diversity of endemic butterflies were significantly higher in the natural forest (Fermon *et al.*, 2005) [14]. Fruit-feeding Nymphalidae butterflies captured in Baruzo forest are slightly higher in number and diversity than the community in Onolari forest. Amathusinae subfamily (*Xanthotaenia busiris*), Biblidinae subfamily (*Lexias dirtea*, *Lexias elna*), and also Satyrinae subfamily (*Faunis canens*, *Mycalesis fusca* *Neorina lowii*) were captured only in Baruzo forest. *Lexias elna* are the endemic species which the distribution is found only in Nias Island

(Tsukada, 1991) [30]. But there are also species that are found only in Onolari forest, such as Charaxinae subfamily (*Protheo franck*) and Satyrinae subfamily (*Melanitis zitenius*). In Baruzo forest, that has more species, is presumed that there are more fruitful vegetations which many fruits are falling to the ground and become rotten than in Onolari, although their basic plant vegetations are similar. This is in accordance with their index of diversity that equally included in the moderate level.

In some earlier studies conducted in several places in Sumatra, index of diversity of fruit-feeding butterfly found in the Forest of Educational and Biology Research Andalas University, Padang is 1.57 (Salmah and Abbas, 2006) [23], in the forest of Rimbo Panti Nature Reserve is 2.98 (Sitompul, 2008) [25], in the forest of Siberut, Mentawai Islands is 2.02 (Luk *et al.*, 2011) [18]. While the index of diversity of the butterflies found in Baruzo forest and Onolari forest is 1.92 , with $H' = 1.91$ in Baruzo forest and $H' = 1.78$ in Onolari forest. In this case, we can conclude that the previous study sites in Sumatra and Baruzo forest and Onolari forest have similarity in forest quality and index of diversity level. Also in the previous researches, a total of 410 individuals belonging to 36 species in seven subfamilies and 16 genera had been found in the Forest of Educational and Biology Research Andalas University, Padang and 66 individuals belonging to 22 species in eight subfamilies and 15 genera had been found in Aie Sirah (Salmah dan Abbas, 2006) [23]. The next research conducted in Rimbo Panti Pasaman Barat showed that a total of 397 individuals belonging to 47 species in eight subfamilies and 25 genera were captured (Sitompul, 2008) [25]. In the Conservation Forest of Palm Oil Plantation of Tidar Kerinci Agung (TKA) Company, West Sumatra, 25 species of fruit feeding butterflies were captured, the diversity index for all samples collected were 2.72 (Muhelni *et al.*, 2016) [22]. The same research done in Siberut Mentawai Island gave a result that 244 individuals of 20 species in 4 subfamilies and 14 genera live there (Luk *et al.*, 2011) [18]. As for the next, the same research also conducted in Borneo. A total of 542 individual butterflies of 40 species in four subfamilies and 29 genera were captured (Tangah *et al.*, 2004) [26]. Meanwhile, the number of individuals captured in Baruzo forest and Onolari forest in Nias Island is 276 individual butterflies belonging to 18 species in four subfamilies and 12 genera. Thus, when we compared to the number of butterflies found in Siberut, the number of individuals found in Nias Island is a bit more. But when we see from the number of species and genera, Siberut has a little more than Baruzo forest and Onolari forest in Nias Island. Also the number of subfamilies found in Siberut and in Nias Island are the same.

Evenness of the Fruit-feeding Nymphalidae Butterflies

Index of Evenness (E') of the fruit-feeding Nymphalidae butterflies captured in the study in Baruzo forest and Onolari forest in Nias Island was 0.66 in total, while the index of evenness of each site is 0.69 for Baruzo forest and 0.72 in Onolari forest (Table 2). These show that the evenness between species in Baruzo forest and Onolari forest are quite evenly distributed. Previous study conducted by Christharina and Abang (2014) in National Park of Kubah Borneo got indices of evenness which are almost identical to those got in Baruzo forest and Onolari forest; $E' = 0.63$ in primary forest, $E' = 0.65$ in secondary forest,

and $E' = 0.62$ in the shrubs.

Index of Similarity of Fruit-feeding Nymphalidae Butterflies

The fruit-feeding Nymphalidae butterflies between the plots in Baruzo forest and Onolari forest have a high similarity in species, with the Sorensen index of similarity (QS) = 71% (Table 2). This means that a high value of the Sorensen index of similarity will lead to a high similarity of species between two sites, and *vice versa*. There are 10 species found in both sites, i.e. *Amathusia phidippus*, *Discophora necho*, *Zeuxidia amethystus*, *Elymnias nesaea*, *Elymnias panthera*, *Melanitis leda*, *Melanitis phedima*, *Mycalesis horsfieldi*, *Mycalesis orseis*, and *Orsotriaena medus*.

This similarity is estimated because there are some vegetations that are equally found in both trapping sites.

The vegetation that dominates the Baruzo forest and Onolari forest are the families Moraceae, Urophorbiaceae and Melastomataceae which are the host plants of fruit-eating butterflies. Corbet and Pendlebury (1956) stated that the host plants of fruit-eating butterflies include the Annonaceae, Malvaceae, Tiliaceae, Rutaceae, Sapindaceae, Anacardiaceae, Leguminosae, Melastomataceae, Passifloraceae, Rubiaceae, Acanthaceae, Loranthaceae, Euphorbiaceae, Moraceae, and several others. Pardonnet *et al.*, (2013) [22] stated that the vegetation structure and composition were important factors affecting the butterfly assemblages. Most of the butterfly species showed an avoidance of vines and a strong association with the presence of trees and shrubs in gaps.

Conclusion

In this study, a total of 18 species were captured in Baruzo Forest dan Onolari Forest, with an Index of Diversity (H') = 1.92 and classified in moderate level. Subfamily Satyrinae in the species *Melanitis leda* has the highest value of Abundance, Relative Abundance, and Frequency of Attendance.

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