RAPID ASSESSMENT ON MACRO-MOTH FAUNA AT NUSA BARONG NATURE RESERVE: A LOW DIVERSITY

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ABSTRACT

Rapid assessment on moth faunas with focus on macro-moths was conducted at Nusa Barong Nature Reserve. The aims of the study were to acquire information of macro-moth diversity and to access the composition of the species at this area by comparing data from Meru Betiri National Park, Sebangau National Park and Busang forest. The results showed that the number of species at Nusa Barong, Meru Betiri, Sebangau and Busang were 47, 75, 97 and 297, respectively. The diversity of macro-moth fauna based on William's α index at Nusa Barong was the lowest as compared to Meru Betiri National Park, Sebangau National Park and Busang forest, which were 34.58, 65.01, 50.91 and 102.08, respectively. The results also show that the similarity based on Jaccard's index of the binary comparison varies from 0.029 to 0.089. The highest value was the comparison between Nusa Barong and Meru Betiri while the lowest was the comparison between Nusa Barong and Sebangau. In addition, Pyralidae, Geometridae and Noctuidae were dominant across all sites. At Nusa Barong, only 10 species that have been known their host plants; three of them caused damage to some crops, namely, Conogethes punctiferalis, Cydalima laticostalis and Achaea janata. There might be more species that have not been found during this study as indicated by the species numbers across all sites have not reach a plateau. This study clearly showed us that floral diversity and size of area determined the diversity of macro-moths at Nusa Barong Nature Reserve.

Key words: *diversity, hostplant, macro-moths, Nusa Barong, similarity*

INTRODUCTION

In recent years several investigations have been conducted to access the diversity of Lepidoptera in Indonesia. The investigation concentrated on Borneo (Holloway, 1984; Robinson and Tuck, 1993), Seram (Holloway, 1993) and Sulawesi (Heppner, 1989; Holloway *et al*., 1990). Further data to improve our knowledge on Lepidoptera diversity with focus on macro-moths (> 20 mm in wingspan) in the region is presented in this paper. They were gathered at the Nusa Barong, East Java. Data from Meru Betiri National Park, East Java, Sebangau National Park, and Busang forest Central Kalimantan (Sutrisno 2005) were used for comparison.

The objective of this kind of biodiversity research was to obtain the number of species, their abundance and frequencies, occurring in a certain locality or region. Usually, a large fraction of the order is covered. The numbers were used to calculate various indices, which describe and elucidate features of the local or regional Lepidoptera community. By comparing these numbers and indices, it should be possible to recognize areas of being high or low diversity. Furthermore, quantitative measures of species and individual abundance provide comparative values for the evaluation of different habitats, biomes or ecosystem. These comparisons can be used in making conservation and management decision. Since the field work on all sites was performed with the same methods and sampling protocol, we were able to compare the results in order to see whether the diversity data can contribute to quantification and better understanding of the faunal differences among Nusa Barong, Meru Betiri, Sebangau, and Busang forest.

MATERIALS AND METHODS

Localities and dates

Nusa Barong Nature Reserve. This nature reserve is located southern of Jember District, 10 km from Java Island. This limestone nature reserve covers about 6000 Ha secondary rain forest (0–50 m above sea level). This island is characterized by stiff slopes of the limestone hills. There are about 278 species of plants, consist of 274 Angiospermae and four Pteridophyta species. Among them, Euphorbiaceae is the most dominant, where 28 species of Euphorbiaceae have been recorded to inhabit this island. The study was conducted from 23 to 28 April 2005.

Meru Betiri National Park. Named after the highest mountain in the area, Gunung Betiri, the park consists of one of the last large areas of lowland rainforest in Java, and covers about 50,000 Ha. Amongst these are mangroves, lowland swamp forest and beach. As of other forest in Java

and Sumatra, Euphorbiaceae is the most dominant in this National Park where more than 300 medical plants inhabit this area. The research was conducted twice, from 30 April to 3 May 2005 and 23–25 June 2006.

Busang Forest. Secondary rain forest at Busang River, Jujang Parit Village, Sumber Barito, Murung Raya District (230 m above sea level) is characterized by mix vegetation between Dipterocarpaceae forest and some agricultural plants such as coconut palm, mango, and rambutan. This forest is part of Muller Montane which cover more than 800,000 Ha in total. This research was conducted from 28 September to 8 October 2004.

Sebangau National Park. Sebangau National Park is one of timber logging company areas where operation was commenced in 1995. Currently, the area has been decided as a national park by government after almost 10 years had been used as a peat swamp forest research station under the management of Palangka Raya University. This National Park is located about 20 Km west of Palangka Raya city (10 m above sea level) and covers nearly 15,000 Ha. The most dominant vegetation at this forest is *Combretocarpus rotundus* (Tumih) (Sutrisno 2005). This research was conducted from 25 July to 5 August 2004.

Field work was performed by using night collecting lights. All groups of macro-moths (> 20 mm in wingspan), which are attracted by light, were sampled. Thus, day flying moths were not captured by this method. They were excluded from the sampling program and from the analysis.

Collecting began at dusk and was completed after 4 hours. The moths were picked from a white sheet that hung vertically and was illuminated by a 160 W mercury light lamp. The lamp was operated by a portable generator. Moths were killed on site using conventional killing jars. Shortly before the end of collecting in the night all remaining specimens on the sheet were counted. This counting ensured that all attracted species were indeed registered. The counts are summarized with the number of collected specimens to give the total number of specimens N, which is used in the statistical analysis. In the laboratory the paper stored material and the pinned moths were relaxed and set. After labeling all specimens were sorted to family and to species. Species identification was based on the morpho-species concept which proved to yield quite reasonable result if done by a lepidopterist. Key identification of Heppner (1998) and Holloway *et al*. (2001) were used to identify at specific or generic level. All the material specimens were deposited at Museum Zoologicum Bogoriense.

We have used William's α as a measure for alpha diversity (Krebs, 1998). In addition, we have chosen an extrapolation method which give estimate of the total number of species from empirical samples. The fauna of the localities were compared using Jaccard and Sorensen's indices of similarity. This was a robust measure of beta diversity and widely used in biodiversity research.

The value of light collecting

A correct statistical analysis first requires a certain number of replicate samples, which, secondly, have to be drawn randomly. Both conditions were not met in the present study. They were hardly achieved in these kinds of studies, because the use of light or light trap is a selective method and the number of replicate usually remains low. Nonetheless, the use of light in collecting Lepidoptera yields the highest proportion of the total species spectrum at a given locality. It is nearly impossible to get similar part of taxocenosis by applying other methods.

RESULTS

The record of the species collected in this study was presented in Appendix 1 and all the specimens were deposited at Museum Zoologicum Bogoriense. These results show that the short collecting time spent across all sites makes the results only a fragment of the actual existing Lepidoptera fauna. Figure 1 shows that the number of species still increases across all sites according to the number of collecting days. We do not know after what time the diversity value stabilizes. In any case, the collecting period of our study was too short to make a species accumulation curve approaching an asymptote. However, there are some statistical procedures which estimate the actual number of a community from empirical samples as has been implemented in Software of Ecological methodology (Krebs, 1998).

Table 1 shows the species number of each family, their abundant and the estimated the highest number of species in each community across all sites. Compare to other sites, Nusa Barong has the lowest numbers, only 47 species were recorded from four families: Pyralidae, Geometridae, Nuctuidae and Arctiidae. The remarkable differences between observed and estimated values demonstrate that a considerable part of the local fauna remained uncollected. In Nusa Barong, Meru Betiri and Busang, fauna which has been recorded varies from 88 to 90% but from Sebangau only about 60% of estimated value.

Table 1. Species richness of Lepidoptera collected at Nusa Barong, Meru Betiri, Sebangau, and Busang (S = Species number of taxa, St = number of all species)

Locality	Taxon	S	%	St	Species with 1 individual		Species with >2 individual		Estimation of Species Number
Nusa Barong	Pyralidae	28	59.7		16		12		
	Geometridae	9	19.1		6		3		
	Noctuidae	7	14.9	47	6	29	1	18	53
	Arctiidae	3	6.3		1		2		
Meru Betiri	Pyralidae	39	52.0		23		16		
	Geometridae	11	14.7		11		0		
	Noctuidae	17	22.7	75	12	50	5	15	84
	Arctiidae	8	10.7		4		4		
Sebangau	Pyralidae	17	17.5		9		8		
	Geometridae	36	37.1		26		10		
	Noctuidae	16	16.5		11		5		
	Thyrididae	6	6.2		5		1		
	Sphingidae	6	6.2		4		2		
	Arctiidae	5	5.2	97	3	64	2	33	160
	Lasiocampidae	3	3.0		2		1		
	Uraniidae	1	1.0		1		0		
	Lymacodidae	3	3.0		1		2		
	Lymantridae	1	1.0		0		1		
	Drepanidae	1	1.0		0		1		
	Notodontidae	2	2.1		2		0		
Busang	Pyralidae	66	23.6		15		51		
	Geometridae	64	22.9		21		41		
	Noctuidae	31	11.1		16		15		
	Thyrididae	4	1.4		1		3		
	Sphingidae	11	3.9		5		6		
	Arctiidae	22	7.9		6		16		
	Lasiocampidae	10	3.6		3		7		
	Uraniidae	1	0.4		1		0		
	Lymacodidae	8	2.9	297	6	97	2	200	326
	Lymantridae	24	8.6		11		13		
	Drepanidae	3	1.1		3		0		
	Notodontidae	7	2.5		4		3		
	Cossidae	11	3.9		7		4		
	Brahmaeidae	1	0.4		1		0		
	Eupteroptidae	1	0.4		1		0		
	Nolidae	10	3.6		5		5		
	Bombycoidae	2	0.7		1		1		
	Yponomeutidae	1	0.4		1		0		
	Psychidae	2	0.7		0		2		

Table 2 shows the similarity index of macro-moths fauna based on Jaccard's and Sorensen's indices for a binary comparison. The values of similarity indices based on both Jaccard's and Sorensen's indices for all pairwise comparisons were very low. The highest value is obtained by comparison between Nusa Barong and Meru Betiri and the lowest is comparison between Meru Betiri and Sebangau.

The values in the table 3 give a first clue about the diversity of macro-moths at Nusa Barong. The number of collected and recognized species is very low and it is the lowest compared to other sites. The diversity of this area based on William's α index is only 34.58. This index was used to measure diversity in this study because of its independence from sample size, at least in relatively small samples (Rosenzweig, 1995; Hubbell, 2001).

It is very important to know the status of fauna diversity and composition in a certain region for making priority on management conservation but the most important is to know the roles of each species in the ecosystem. In general, the adults of moths have important roles in the forest ecosystem as pollinators. But the larvae are mainly plant

Table 2. Species level of faunal similarity shared between different pairs of localities based on Jaccard's index at above and Sorensen's index at below (High value in bold face, number of shared species in parentheses)

	Nusa Barong	Meru Betiri	Sebangau	Busang
Nusa Barong	-			
Meru Betiri	**0.089** (10)	-		
	0.164			
Sebangau	0.029 (4)	0.03 (5)	-	
	0.056	0.058		
Busang	0.035 (11)	0.047 (16)	0.074 (26)	-
	0.067	0.09	0.138	

Table 3. Diversity of the moths at Nusa Barong, Meru Betiri, Sebangau, and Busang expressed by William's α (N = number specimens, S = number species, F = Family).

Locality	N	S (F)	Alpha
Nusa Barong	100	47 (4)	34.58
Meru Betiri	141	75 (4)	65.01
Sebangau	291	97 (12)	50.91
Busang	1466	297 (18)	102.08

defoliators that frequently cause damages to agricultural plant. Therefore, it is very important to asses each species whether they have a potential to damage agricultural crop or not by evaluating their host plants. Table 4 shows the species list and their hostplants. There were 10 species moths from Nusa Barong that have been known their host plants but only three species reported as really pests, they were *Conogethes punctiferalis*, *Cydalima laticostalis* and *Achaea janata*. The two first species belong to Pyralidae while the latter belong to Noctuidae. The first species was a medium moth about 28 mm in wing -expand and characterized by a yellow wing color with dark and large brown sports. The larvae have been reported boring fruits of *Durio zibethinus* (Bombaceae), pods of *Theobroma cacao* (Sterculiaceae), capsules of *Ricinus communis* (Euphorbiaceae) and also feeding on needles of *Pinus* (Pinaceae). The second species was also medium size moth about 34 mm. Wing colour is plain white with a purple, bluish green and brassy lustre along the forewing costa. The larvae have been reported feeding on leave *Flacourtia* (Flacourtiaceae) and *Aglaia domestica*. The third species was also a medium size (about 38 mm). Beside *Democarpus longan*, there are many alternative hostplants as have been reported by Common (1990) and Robinson *et al*. (2001) (See Table 4).

DISCUSSION

Table 1 shows that among other families, Pyralidae is the most highest in term of number of species across all sites except for Sebangau, in which Geometridae is the highest. This is because in these three sites there were a lot of disturbed areas as results of land clearing or illegal logging by local peoples. These areas are more suitable

Table 4. The host plant relationships and the pest status of macro-moths from Nusa Barong

No.	Species	Host plant	Status pest	References
1	*Botyodes asialis*	*Ficus* spp.	No report	Robinson *et al*. (1994)
2	*Conogethes punctiferalis*	*Nephelium lappaceum, Durio zibethinus, Theobroma cacao, Ricinus communis*	Important pest in South East Asia	Kuroko & Lewvanich (1993); Robinson *et al*. (1994); Kalshoven, (1982).
3	*Cydalima laticostalis*	*Aglaia domestica*, *Flacourtia*	Important pest in South East Asia	Kuroko & Lewvanich (1993); Robinson *et al*. (1994)
4	*Glyphodes bicolor*	*Ficus* spp	No report	Sutrisno, 2002
5	*Glyphodes bivitralis*	*Ficus elastica*	No report	Robinson *et al*. (1994)
6	*Glyphodes canthusalis*	*Ficus* spp	No report	Sutrisno, 2002
7	*Glyphodes conjunctalis*	*Ficus* spp	No report	Sutrisno, 2002
8	*Glyphodes cosmarcha*	*Ficus* spp	No report	Sutrisno, 2002
9	*Glyphodes stolalis*	*Ficus* spp	No report	Sutrisno, 2002
10	*Achaea janata*	*Dimocarpus longan*, *Litchi*, *Nephelium lapaceum, Brassica, Cucurbita*, etc.	Important pest in South East Asia	Kuroko & Lewvanich (1993); Common (1990); Robinson *et al*. (2001)

for pyralid and noctuid moths. On the other hand, a high proportion of green foliage biomass covered Sebangau area which is more suitable for Geometridae than Pyralidae and Noctuidae (Sutrisno, 2005). The results also show that Pyralidae, Geometridae and Noctuidae always dominate at across al sites. It is not surprising because this phenomenon has been repeatedly reported by numerous researchers (Mey *et al*., 2003).

The results in Table 2, show that the similarity index among all pairwise comparison is very low. There are many possibilities to explain why the faunal similarities between all pairwise comparisons were very low. In theory, they should have a similar fauna since Sumatra, Java and Borneo (Kalimantan) have a similar geological history, these islands just separated recently.

The first, macro-moth fauna is only a small portion of Lepidoptera. More than 60 families of Lepidoptera in South East Asia, only ¼ of them are macro-moths (Holloway *et al*. 2001). It indicates that macro-moths alone are not able to represent the diversity of the whole moths at a certain regions. Thus, all pairwise comparisons give very low similarity indices.

The second, some species apparently restricted by geographical boundaries and some others may be restricted to particular forest types associated with a particular climatic regime and may well reflect distribution of their hostplants. In addition, there is distinct altitudinal zonation in the Lepidoptera of SE Asia i.e. the fauna of lowland and hill dipterocarp forest of Borneo has few species in common with that the montane forest 1000 metres or more above sea level (Holloway, 1976); Holloway *et al*. (1990); Robinson and Tuck (1993). Moreover, groups of distinctive species are also associated with other specialized habitats such as kerangas, swamp forest, limestone forest, and mangrove (Murphy, 1990).

Based on the results in table 3, the diversity of moths across all sites varies in which Nusa Barong was the lowest. There are many factors that determined the diversity of macro-moths in a certain region, such as a floral diversity, altitudes, and seasons. But in this case, the most dominant is a floral diversity since the altitude of all of these sites is similar at the low land area (< 300 m above sea level) and these studies conducted at the same season, during rainy season. The floral diversity will determine the composition and diversity of macro-moths because their larvae of moths indeed often show great specificity to hostplants even though their adults can use any kinds of flowers as sources of their nutrition. The larvae are mainly defoliator, but there are also leaf miners (several micro-moth families such as Nepticulidae and Gracillaridae), stem borers (for instances in Noctuidae and Pyralidae), flower feeders (Noctuidae and Geometridae), and timber borers (Cossidae and Hepialidae) (Robinson, 1975; Holloway, 1976; Hebert, 1980; Inoue *et al*., 1982; Common, 1990; Robinson *et al*., 1994).

This island has been reported has a low floral diversity, there were about 278 species of plants in this island. Euphorbiaceae and Fabaceae are the most divers compared to other families. A limestone with a very thin top soil layer, a low nutrition, a lot of stiff slopes or hills and there is no fresh water is causing only certain plant species that can survive in this island. *Aglaia lawii* (Meliaceae) is the most abundant but not equally distributed over all areas. Moreover, this island is very small as compared to other sites and covered only few types of vegetations: mangroves, sandy coastal areas, a small valley and limestone hills. Thus, the number of plant species is very low. Compared to Nusa Kambangan, Nusa Barong is ¼ of its size but the number of floral species only 1/6 of those found at Nusa Kambangan (Partomihardja and Ismail, 2005).

This phenomenon is comparable with Sebangau's fauna which also has a low diversity of macro-moths, which was 50.91. The floral diversity of this area is slightly higher than Nusa Barong, about 300 species inhabit this area (Simbolon and Mirmanto, 2000). Only certain species that can well adapt and dominate to the peat environment which characterized by a low nutrition and acidity such as *Combretocarpus rotundus*, *Platea excelsa*, *Blumeodendron elateriospermum*, *Palaquium leiocarpum*, *Ploiarium alternifolium*, *Eugenia densinervium*, *E. castaneum* and *Xylopia fusca* (Sutrisno, 2005).

There is no doubt that more varies vegetations resulted more divers in number of plant species. Busang forest, part of Muller montane which covered more than 80,0000 Ha with more than 650 plant species, gives a highest rank in term of macro-moths diversity. These results clearly show us that the diversity of macro-moths at Nusa Barong was determined by a floral diversity and size of the area that associated with varies of vegetations.

Among the 47 macro-moth species that inhabit Nusa Barong, only three species have been reported harmful for Agriculture: *Conogethes punctiferalis*, *Cydalima laticostalis* and *Achaea janata* (Table 4). These three species occured in this island because as had reported by Paromihardjo and Ismail (2005), one of their alternative host plants found inhabit this island. These three species occurred in this island because one of their alternative host plants–as had reported by Partomihardjo and Ismail (2005)–found inhabit this island.

It is not surprising that there are some species of *Glyphodes* inhabit at Nusa Barong since this genus is a large group that distributed from subtropical to tropical areas (Table 4). More than 14 species of *Glyphodes* have been reported to occur in Indonesia (Sutrisno, 2002; Sutrisno *et al*., 2006). This group is specific to latex-containing plants (Moraceae) such as *Ficus* spp. and *Artocarpus* spp in which these plants inhabit varies type of vegetations in Indonesia. Thus, that is why this genus almost occurs across all sites.

Due to time constraints, the results of this study should not be taken as a final conclusion. Further studies are still needed to be conducted not only by increasing number of sampling points and duration of sampling time but also including micro-moths to get the actual number of species to represent the diversity of moths at this forest. In addition, observation on hostplant relationships will give some benefits to know more detail on ecological aspects of each species.

ACKNOWLEDGMENTS

Grateful thanks are due to Mr. Budiyanto (a ranger of Nusa Barong Nature Reserve) for his permission to access this nature reserve. Thanks also go to Mr. Cholik and Darmawan for helping me in collecting of the materials studies at Busang forest, Meru Betiri National Park and Nusa Barong Nature Reserve.

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