RAPID ASSESSMENT ON MACRO-MOTH DIVERSITY AT GUNUNG TAMBORA NATIONAL PARK, WEST NUSA TENGGARA

KAJIAN SINGKAT KERAGAMAN NGENGAT BESAR DI TAMAN NASIONAL GUNUNG TAMBORA, NUSA TENGGARA BARAT

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(diterima Desember 2015, direvisi Desember 2017, disetujui Februari 2018)

ABSTRAK

Kajian singkat keragaman ngengat besar telah dilakukan di Taman Nasional Gunung Tambora tanggal 16-26 April 2015. Tujuan kajian ini adalah untuk mengumpulkan informasi keragaman ngengat dan juga untuk mengkaji komposisi spesies di kawasan ini. Hasil kajian mencatat hanya sekitar 77.8 % dari perkiraan species yang ada ditemukan di kawasan ini (242 dari 311 species). Index keragaman Fisher's alfa dikawasn ini rendah (97.21). Jumlah famili yang ditemukan di kawasan ini juga rendah hanya 17 famili atau sekitar sepertiga dari jumlah famili yang ada di kawasan Indo-Malayan. Camp II memiliki indeks diversitas lebih tinggi jika dibandingkan dengan Camp Oi Marai. Indeks kesamaan Jaccard coefficient kedua lokasi juga rendah (13.8%). Noctuidae (26%), Pyralidae (20%) dan Geometridae (19%) adalah famili yang paling dominan pada kawasan ini. Noctuidae, Geometridae, dan Lymantridae di kawasan Camp II lebih tinggi bila dibandingkan di Oi Marai. Disisi lain, Pyrlaidae jumlahnya lebih banyak ditemukan di Oi Marai jika dibandingkan dengan Base Camp II.

Kata kunci: Fisher's α, indeks keragaman, kesamaan.

ABSTRACT

Rapid assessment on moth fauna with focus on macro-moths was conducted at Gunung Tambora National Park from 16 to 26 April 2015. The aims of the study were to acquire information on macro-moth diversity and to access the composition of the species at this area. The result showed that a short collecting time within two sampling sites recorded only about 77.8% of estimated value in this park (242 of 311 species). Index diversity based on Fisher's α is low (97.21). In addition, the number of families recorded from this park is also low, only 17 families, or about one third of the moth families that occur in Indo-Malayan region. Camp II site was higher than the base camp Oi Marai sites in term of the diversity index. These two sites have a few species in common as indicated by Jaccard coefficient that was low (13.8%). In general, Noctuidae (26%), Pyralidae (20%), and Geometridae (19%) dominate across all sites. Noctuidae, Geometridae, Lymantriidae were higher in Camp II than those found in Oi Marai. On the other hand,Pyralidae was higher in Oi Marai than those found in Base Camp II.

Keywords: Fisher's α, index diversity, similarity.

INTRODUCTION

Lepidoptera: moths and butterflies, is one of the most diverse group among insects in the world (Holloway *et al*. 2001). It has been estimated that the number of this order is more than 160,000 species and more than 90% of them is moths. The adults of Lepidoptera have an important role in the forest ecosystem as a pollinator and their larvae indeed often show a great specifity to host plants (Holloway 1976, 1979, 1984, 1987; Hebert 1980; Heppner 1989).

Our knowledge on Indonesian moths are still very limited and poorly documented especially on its diversity. Researches on moths have mostly focused on biological aspects of certain groups of economic value: i.e. agricultural pests, storage pests and silk production. Ecological studies conducted by Sutrisno (2005, 2007, 2014) in peat swamp forest of Sebangau National Park, Nusa Barong Nature Reserve (East Java) and Foja Mountain (Papua) showed only a small portion of moth diversity which might be far

from the actual number of species in those areas since this work was conducted during a short period. Other studies, mostly focused on certain groups of moths in Sumatra which have been carried out by Germany researchers and published in a series book of Heterocera Sumatrana. Holloway (1987) studied in Sulawesi and Seram Island with focused on macrolepidoptera. The most comprehensive ecological study on moths was conducted during three years in Gunung Halimun-Salak National Park, West Java. Two series of moths of Gunung Halimun-Salak National Park has been published recently but only cover Pyraloidea, Thyridoidea, Geometroidea and Drepanoidea (Sutrisno, 2008; Sutrisno *et al*. 2012; Sutrisno *et al*. 2015). Therefore, all these efforts are still needed to be continued to cover all Indonesian moth. In order to acquire information of Indonesian moth diversity, we conducted a study at Gunung Tambora National Park, West Nusa Tenggara.

There are many vertebrate which has been reported to inhabit this area such as birds, mammals, and reptiles but no information on the insect diversity especially moths in this area even though this park holds the largest remaining lowland and montane tropical rain forest in West Nusa Tenggara. I suspect that there are many un-described species of moths inhabit this area. Therefore study on moths in this national park is needed. The aims of the study were to acquire information of the moth diversity and to assess the composition of moth species at Gunung Tambora National Park.

MATERIALS AND METHODS

Sites of Study

Samplings were conducted during six nights. Two sites of sampling were chosen, namely base camp Oi Marai and camp II, all the sites were accessed from Kawinda Toi Village (Figure 1). Based on the report, this track is most divers in term of plant species numbers, about 90% of total plant species (277 species) of Gunung Tambora National Park were recorded from this Kawinda Toi track.

a. Base Camp Oi Marai

This site is the closest from villages Kawindai Toi and near to Water fall Oi Marai (S 08.11154 E. 118.00852), at altitude of approximately 100 m. As a secondary forest, the vegetation at this site is mixed between the monoculture of the timber

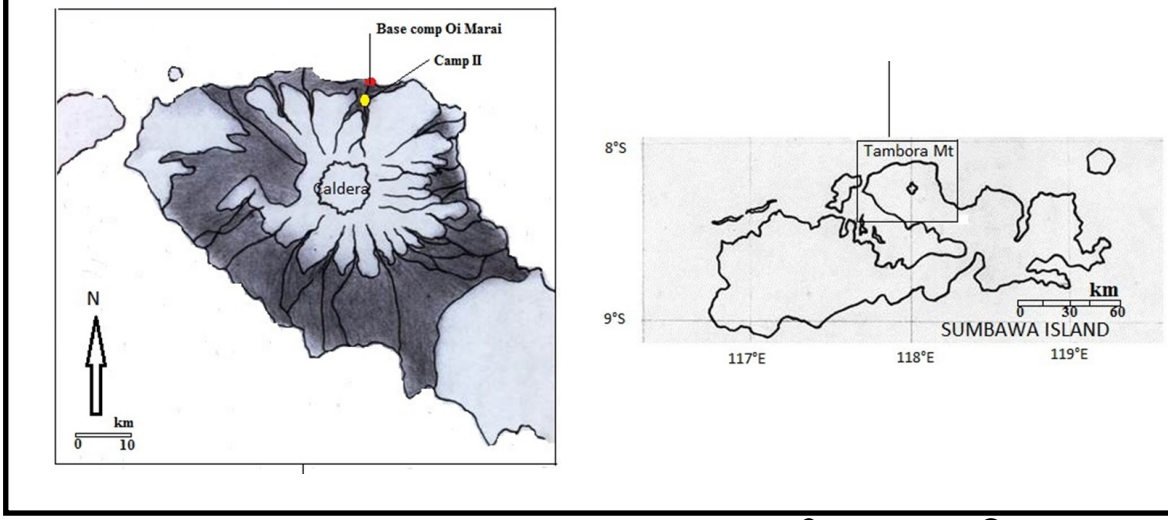

Figure 1. The two sampling sites: Base camp Oi Marai; Camp II

plantation and the traditional farming area. In this site, the researches of moth were conducted during three nights.

b. Camp II

This site is located within tropical rain forest (S 08.13967 E. 117.99985), at altitude 500 m. Vegetation of this site is dominated by *Buchacania sessifolia* and *Syzigium* spp. In this site, samplings were conducted during three nights.

Collecting of Adult Moths

Collecting sample was conducted using a light trap equipped with a 160 watt mercury vapor light and a 2 X 2.5 m white screen. The light trap was set up randomly at the open area within the National Park. Moths attracted to the light trap and lied at the white screen were collected into an ethyl acetate-killing bottle. All specimens collected at the night and then were pinned using insect pins no. 3 and 4 at the next morning, while the specimens are still in fresh condition.

Samplings were conducted six times from 16 to 26 April 2015 (each site 3 times). Due to time constraint only two sites (Base camp Oi Marai and camp II) within the national park were sampled.

Specimen Preservation

Preservation of the specimens was conducted at the laboratory of Entomology, Division of Zoology, Research Center for Biology, Cibinong. All moth specimens were labeled based on the field collection data. Their wings were spread and then dried up using oven at 45-50°C for 3-5 days, depends on the condition of specimens. All the materials were deposited at the Museum of Zoologicum Bogoriense, the Indonesian Institute of Sciences, Cibinong. Identification of moths was conducted by using Series of Moths of Gunung Halimun National Park Part I and II (Sutrisno & Darmawan 2009; Sutrisno *et al*. 2015).

Data Analysis

Fisher α index was used to measure the diversity for species-richness (Fisher *et al*. 1943). Fisher's alpha diversity index, defined implicitly by the formula: $S=a \ln(1+n/a)$ where S is the number of taxa, n is the number of individuals and a is the Fisher's alpha. Justification for this on grounds of the frequent approximation of light-trap moth samples to a log-series distribution of abundance among the species is given by Taylor, Kempton and Woiwod (1976) and, within a South East Asian context is given by Barlow and Woiwod (1989). Wolda (1983) demonstrated that this statistic was the most sample-size independent of a number of frequently used of diversity measure.

To estimate the total number species from empirical samples, an extrapolation method was used. N: the total number of individuals in the sample, s: the total number of species, and Ni: the number of individuals of species i. The expected number of species $E(S_n)$ in a sample of size n and the variance $V(S_n)$ are then given:

$$E(S_n) = \sum_{i=1}^{s}\left[1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}}\right]$$

$$V(S_n) = \sum_{i=1}^{s}\left[\frac{\binom{N-N_i}{n}}{\binom{N}{n}}\left(1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}}\right)\right] + 2\sum_{j=2}^{s}\sum_{i=1}^{j-1}\left[\frac{\binom{N-N_i-N_j}{n}}{\binom{N}{n}} - \frac{\binom{N-N_i}{n}\binom{N-N_j}{n}}{\binom{N}{n}\binom{N}{n}}\right]$$

All this methods were implemented in "methodological ecology" software (Krebs, 1998).

For comparison among two sites, Jaccard coefficient is used. This is a robust measure of beta diversity and widely used in a biodiversity research. The formula to find the Index is:

Jaccard Index =

$$\frac{\text{(the number in both sets)}}{\text{(the number in either set)}} * 100$$

The same formula in notation is:

$$J(X,Y) = |X \cap Y| / |X \cup Y|$$

In Steps, that's:

1. Count the number of members which are shared between both sets.
2. Count the total number of members in both sets (shared and un-shared).
3. Divide the number of shared members (1) by the total number of members (2).
4. Multiply the number you found in (3) by 100.

RESULTS AND DISCUSSION

All specimens were deposited at Museum of Zoologicum Bogoriense. The results in Table 1 showed that the short collecting time spent across all sites in this park makes the results only a fragment of the actual existing Lepidoptera fauna which is only 242 of 311 species or about 77%. In addition, the number of families recorded from this park was moderate, 17 families, less than one third of the families of moth that occur in Indo-Malayan region.

Table 1. Species richness of Lepidoptera collected at two sites within Gunung Tambora National Park from 16 to 26 April 2015.

Location	No	Taxa	S	N	Estimation of species number	Fisher α index	Jaccard coefficient
Base Camp Oi Marai	1	Aganaidae	1				
	2	Arctiidae	8				
	3	Bombycidae	2				
	4	Cossidae	3				
	5	Drepanidae	2				
	6	Geometridae	32				
	7	Limacodidae	3				
	8	Lymantriidae	8		159	61.2	
	9	Noctuidae	28				
	10	Notodontidae	1				
	11	Psychidae	1				
	12	Pyralidae	32				
	13	Sphingidae	3				
	14	Thyrididae	4				
	15	Tortricidae	2				
	16	Uraniidae	3				13.8
			134				
Camp II	1	Arctiidae	10				
	2	Bombycidae	1				
	3	Drepanidae	3				
	4	Geometridae	34				
	5	Limacodidae	3				
	6	Lymantriidae	15				
	7	Noctuidae	37		166	63.4	
	8	Notodontidae	4				
	9	Pyralidae	27				
	10	Sphingidae	1				
	11	Thyrididae	9				
	12	Tortricidae	2				
	13	Zygaenidae	1				
			148				

Table 2. List of species collected at two sites: Base Camp Oi Marai (1st, 2nd, and 3rd) and Camp II (4th, 5th, and 6th) within Gunung Tambora National Park.

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
	Aganidae							
1	Asota egens	0	0	3	2	0	0	5
	Arctiidae							
2	Aethalida sp.	1	3	3	0	0	1	8
3	Amerila sp.	7	10	20	0	0	2	39
4	Arctiinae sp1	1	0	0	0	0	0	1
5	Arctiinae sp2	2	0	0	0	0	0	2
6	Arctiinae sp3	0	1	2	0	0	0	3
7	Arctiinae sp4	0	0	1	0	0	0	1
8	Asura sp1	0	0	0	5	2	10	17
9	Asura sp2	0	0	0	5	0	0	5
10	Barsine sp1	0	0	0	2	2	2	6
11	Creatonotos transiens	0	0	0	5	0	1	6
12	Lyclene ashleigera	0	0	0	0	1	0	1
13	Nyctemera sp1	0	0	0	0	2	0	2
	Bombycidae							
14	Bombycinae sp.	1	1	1	1	0	0	4
15	Ocinara albicollis	2	2	2	0	0	0	6
16	Ocinara bifurcula	0	0	0	0	1	0	1
	Cossidae							
17	Cossinae sp1	2	0	0	0	0	0	2
18	Cossinae sp2	0	0	0	0	0	0	1
19	Cossinae sp3	0	0	0	0	0	0	1
20	Cossinae sp4	0	0	0	0	0	0	1
21	Cossinae sp5	0	0	0	0	0	0	1
22	Cossus sp.	0	0	1	0	0	0	1
23	Xyleutes sp1	0	0	1	0	0	0	1
	Drepanidae							
24	Drepaninae sp1	1	0	0	0	0	0	1
25	Drepaninae sp2	0	0	0	1	2	0	3
26	*Oreta* sp.	0	0	0	0	2	1	3
27	*Tridrepana* sp.	0	0	0	0	3	0	3
	Geometridae							
28	*Antitrygodes* sp.	5	1	0	0	0	3	9
29	*Borbacha bipardaria*	1	1	5	0	1	3	11
30	*Chorodna* sp.	1	1	0	0	0	3	5
31	*Chrysocraspeda* sp.	1	1	3	0	0	0	5
32	*Cleora determinata*	3	0	2	0	0	1	6
33	*Cleora inoffensa*	1	3	0	0	0	1	5

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
34	*Cleora* sp1	1	0	0	0	0	0	1
35	*Cleora* sp2	2	1	1	0	1	0	5
36	*Cleora* sp3	1	0	0	0	0	0	1
37	*Cleora* sp4	1	0	0	0	0	0	1
38	*Cleora* sp5	1	0	2	0	0	2	5
39	*Ecliptopera rectilinea*	1	0	0	1	2	2	6
40	*Eumelea* sp.	2	0	0	0	0	0	2
41	Geometrinae sp1	1	0	1	0	1	1	4
42	Geometrinae sp2	0	1	0	0	0	0	1
43	Geometrinae sp3	0	1	0	0	0	0	1
44	Geometrinae sp4	0	1	1	0	0	1	3
45	Geometrinae sp5	0	1	2	0	0	0	3
46	Geometrinae sp6	0	1	0	0	0	0	1
47	Geometrinae sp7	0	0	1	0	0	0	1
48	Geometrinae sp8	0	0	5	0	0	0	5
49	Geometrinae sp9	0	0	3	1	0	5	9
50	*Godonela dora*	0	0	4	0	0	0	4
51	*Godonela* sp.	0	0	1	0	0	0	1
52	*Heterostegane tritocampsis*	0	0	0	1	0	0	1
53	*Hypochrosis* sp1	0	0	0	1	1	5	7
54	*Hypochrosis* sp2	0	0	0	1	0	0	1
55	*Hyposidra talaca*	0	0	0	2	0	0	2
56	*Luxiaria subrasata*	0	0	0	2	0	1	3
57	*Nadagara* sp.	0	0	0	5	0	1	6
58	*Oxyodes scrobiculata*	0	0	0	2	0	0	2
59	*Oxyodes* sp.	0	0	0	10	0	0	10
60	*Pelagodes* sp1	0	0	0	0	1	0	1
61	*Pelagodes* sp2	0	0	0	0	1	0	1
62	*Petelia delostigma*	0	0	0	0	5	1	6
63	*Petelia tuhana*	0	0	0	0	1	0	1
64	*Pingasa rubimontana*	0	0	0	0	1	0	1
65	*Pingasa ruginaria*	0	0	0	0	1	5	6
66	*Pingasa* sp.	0	0	0	0	15	5	20
67	*Pingasa subpurpurea*	0	0	0	0	1	0	1
68	*Pingasa tapungkanana*	0	0	0	0	1	3	4
69	*Plutodes* sp1	0	0	0	0	1	0	1
70	*Protuliocnemis biplagiata*	0	0	0	0	1	0	1
71	*Tamba* sp1	0	0	0	0	1	0	1
72	*Tamba* sp2	0	0	0	0	1	0	1
73	*Thalasodes* sp.	0	0	0	0	1	0	1
74	*Traminda aventiaria*	0	0	0	0	2	0	2

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
	Limacodidae							
75	*Cania minuta*	1	0	0	3	0	0	4
76	*Cania* sp.	0	1	0	0	0	0	1
77	*Demonarosa mediodorsata*	0	0	0	1	0	0	1
78	Limacodinae sp.	0	0	0	0	6	0	6
	Lymantriidae							
79	*Arctornis* sp1	1	2	5	1	0	0	9
80	*Arctornis* sp2	1	0	0	0	0	0	1
81	*Arctornis* sp3	2	4	5	1	0	0	12
82	*Artaxa* sp1	0	2	5	0	0	0	7
83	*Artaxa* sp2	0	0	1	0	0	0	1
84	*Carriola ecnomoda*	0	0	1	0	0	0	1
85	*Euproctis* sp1	0	0	2	0	0	0	2
86	*Euproctis* sp2	0	0	10	5	3	0	18
87	*Euproctis* sp3	0	0	0	5	6	10	21
88	*Lyamntria singapura*	0	0	0	1	0	1	2
89	*Lymantria ganara*	0	0	0	1	0	0	1
90	*Lymantria* sp1	0	0	0	3	2	1	6
91	*Lymantria* sp2	0	0	0	0	1	0	1
92	*Lymantria* sp3	0	0	0	0	1	0	1
93	*Lymantria* sp4	0	0	0	0	1	0	1
94	*Lymantria* sp5	0	0	0	0	3	0	3
95	*Lymantria temburong*	0	0	0	0	1	0	1
96	Lymantriinae sp1	0	0	0	0	1	0	1
97	Lymnatriinae sp2	0	0	0	0	5	0	5
98	*Nygmia venata*	0	0	0	0	1	0	1
	Noctuidae							
99	*Ariola coelisigna*	1	0	0	0	2	1	4
100	*Avatha* sp1	1	0	0	0	0	0	1
101	*Avitta surrigens*	1	0	0	0	0	0	1
102	*Bastilla maturata*	2	5	5	0	0	0	12
103	*Bastilla* sp1	6	3	0	0	0	0	9
104	*Bastilla* sp2	3	2	5	0	0	0	10
105	*Blasticorhinus decernens*	0	1	0	0	0	0	1
106	*Bocula* sp.	0	1	0	0	0	0	1
107	*Bocula xanthostola*	0	1	1	0	0	0	2
108	*Borbotana nivifascia*	0	1	1	0	0	0	2
109	*Buzara forceps*	0	1	1	0	0	0	2
110	*Chalciope mygdon*	0	0	1	0	0	0	1
111	*Chalciope* sp.	0	0	1	0	0	0	1
112	*Chrysodeixis minutoides*	0	0	1	0	0	0	1
113	*Chrysodeixis* sp.	0	0	1	0	0	0	1

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
114	*Daddala lucilla*	0	0	1	0	0	0	1
115	*Earias flavida*	0	0	1	0	0	0	1
116	*Ercheia* sp.	0	0	1	0	0	0	1
117	*Ergia spissa*	0	0	1	0	0	0	1
118	*Eudocima phalonia*	0	0	1	0	10	0	11
119	*Hypocola deflorata*	0	0	2	0	0	0	2
120	*Ischyja manlia*	0	0	1	0	0	0	1
121	*Ischyja manlioides*	0	0	1	0	0	0	1
122	*Ischyja marapok*	0	0	1	0	0	0	1
123	*Lacera uniformis*	0	0	2	0	0	0	2
124	*Lasiolopha saturata*	0	0	2	0	0	0	2
125	*Lophoptera* sp.	0	0	1	0	0	0	1
126	*Mecodina bisignata*	0	0	0	2	0	0	2
127	*Mecodina praecipua*	0	0	0	2	0	0	2
128	*Mocis undata*	0	0	0	1	0	0	1
129	*Neochera dominia*	0	0	0	1	0	0	1
130	Noctuinae sp1	0	0	0	2	0	0	2
131	Noctuinae sp2	0	0	0	1	0	0	1
132	Noctuinae sp3	0	0	0	1	0	0	1
133	Noctuinae sp4	0	0	0	1	0	0	1
134	Noctuinae sp5	0	0	0	1	0	0	1
135	Noctuinae sp6	0	0	0	1	0	0	1
136	Noctuinae sp7	0	0	0	1	1	0	2
137	Noctuinae sp8	0	0	0	5	5	10	20
138	Noctuinae sp9	0	0	0	1	0	0	1
139	Noctuinae sp10	0	0	0	1	0	1	2
140	Noctuinae sp11	0	0	0	0	3	0	3
141	Noctuinae sp12	0	0	0	0	1	0	1
142	Noctuinae sp13	0	0	0	0	1	0	1
143	Noctuinae sp14	0	0	0	0	1	0	1
144	Noctuinae sp15	0	0	0	0	1	0	1
145	Noctuinae sp16	0	0	0	0	1	0	1
146	Noctuinae sp17	0	0	0	0	1	0	1
147	*Plecoptera* sp.	0	0	0	0	1	0	1
148	*Plusiodonta wahri*	0	0	0	0	1	0	1
149	*Psimada hybrida*	0	0	0	0	1	0	1
150	*Pyrrhia exprimens*	0	0	0	0	1	0	1
151	*Saroba antecedens*	0	0	0	0	1	0	1
152	*Sympis rufibasis*	0	0	0	0	1	0	1
153	*Sympis* sp1	0	0	0	0	1	0	1
154	*Sympis* sp2	0	0	0	0	1	0	1
155	*Targala scelerata*	0	0	0	0	1	0	1
156	*Targala* sp.	0	0	0	0	1	0	1

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
157	*Tiracola* sp.	0	0	0	0	1	0	1
158	*Tiruvaca hollowayi*	0	0	0	0	1	0	1
159	*Xenochroa* sp.	0	0	0	0	1	0	1
160	*Yepcalphis dilectissima*	0	0	0	0	1	0	1
	Notodontidae							
161	*Allata* sp.	1	0	0	0	0	0	1
162	Notodontinae sp1	0	0	0	1	0	0	1
163	Notodontinae sp2	0	0	0	0	1	0	1
164	*Parasinga* sp.	0	0	0	0	1	0	1
165	*Quadricalcarifera* sp.	0	0	0	0	1	0	1
	Physcidae							
166	*Eumeta variegata*	0	1	0	0	0	0	1
	Pyralidae							
167	Acentropinae sp1	3	10	10	0	0	0	23
168	Acentropinae sp2	1	2	2	0	0	2	7
169	Acentropinae sp3	2	12	3	0	0	0	17
170	*Aetholix flavibasalis*	2	1	5	2	5	2	17
171	*Aulacodes crassicornis*	1	0	0	0	0	0	1
172	*Aulacodes* sp.	1	1	2	0	0	0	4
173	*Botyodes asialis*	2	0	2	0	2	0	6
174	*Bradina diagonalis*	5	5	0	0	0	0	10
175	*Chrysothyridia triangulifera*	1	2	2	1	3	3	12
176	*Cirrhochrista brizoalis*	10	6	15	0	0	0	31
177	*Gadessa* sp.	1	1	0	0	0	0	2
178	*Glyphodes* sp1	1	1	0	0	0	0	2
179	*Glyphodes* sp2	1	0	5	0	0	0	6
180	*Glyphodes* sp3	10	3	15	5	2	1	36
181	*Glyphodes* sp4	10	12	10	0	0	0	32
182	*Glyphodes* sp5	1	1	5	0	0	0	7
183	*Hyalobathra* sp1	1	0	4	0	0	0	5
184	*Hymenia perspectalis*	1	0	1	0	0	0	2
185	*Maruca testulalis*	3	0	1	0	0	0	4
186	*Pachynoa purpuralis*	1	0	0	0	0	0	1
187	*Palpita* sp1	0	1	0	0	0	0	1
188	*Palpita* sp2	0	1	0	0	1	0	2
189	*Pygospila tyres*	0	1	1	0	0	0	2
190	Pyralinae sp1	0	1	0	0	0	0	1
191	Pyralinae sp2	0	1	1	0	0	0	2
192	Pyralinae sp3	0	1	1	0	2	0	4
193	Pyralinae sp4	0	1	1	0	1	0	3
194	Pyralinae sp5	0	0	1	0	0	0	1

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
195	Pyralinae sp6	0	0	5	0	0	0	5
196	Pyralinae sp7	0	0	1	0	0	0	1
197	Pyralinae sp8	0	0	3	0	0	0	3
198	Pyralinae sp9	0	0	1	0	0	0	1
199	Pyralinae sp10	0	0	1	0	0	0	1
200	Pyraustinae sp 1	0	0	1	0	0	0	1
201	Pyraustinae sp 2	0	0	1	0	0	0	1
202	Pyraustinae sp 3	0	0	1	0	2	0	3
203	Pyraustinae sp4	0	0	0	1	5	5	11
204	Pyraustinae sp5	0	0	0	1	0	0	1
205	Pyraustinae sp6	0	0	0	1	0	0	1
206	Pyraustinae sp7	0	0	0	1	1	0	2
207	Pyraustinae sp8	0	0	0	2	4	1	7
208	Pyraustinae sp9	0	0	0	2	0	1	3
209	Pyraustinae sp10	0	0	0	1	4	1	6
210	Pyraustinae sp11	0	0	0	1	0	1	2
211	Pyraustinae sp12	0	0	0	0	5	1	6
212	Pyraustinae sp13	0	0	0	0	5	1	6
213	Pyraustinae sp14	0	0	0	0	3	0	3
214	Pyraustinae sp15	0	0	0	0	165	0	165
215	Pyraustinae sp16	0	0	0	0	1	0	1
216	Spelomelinae sp1	0	0	0	0	1	0	1
217	Spelomelinae sp2	0	0	0	0	1	0	1
218	Spelomelinae sp3	0	0	0	0	2	0	2
219	Spelomelinae sp4	0	0	0	0	5	0	5
220	*Talanga* sp.	0	0	0	0	1	0	1
	Sphingidae							
221	*Cechenena aegtota*	3	2	0	0	0	0	5
222	*Elibia dolichus*	0	0	1	0	0	0	1
223	*Rhagastis* sp.	0	0	1	0	1	0	2
	Thyridadae							
224	*Banisia myrsusalis*	0	1	0	0	0	0	1
225	*Banisia* sp1	0	0	1	0	0	0	1
226	*Banisia* sp2	0	0	1	0	3	0	4
227	*Monodecus* sp.	0	0	2	0	3	0	5
228	*Opula* sp.	0	0	2	1	1	0	4
229	*Sonagara strigipennis*	0	0	0	2	0	0	2
230	*Striglina* sp.	0	0	0	2	0	0	2
231	Striglininae sp1	0	0	0	2	0	0	2
232	Striglininae sp2	0	0	0	3	0	0	3
233	Striglininae sp3	0	0	0	0	1	0	1
234	Striglininae sp4	0	0	0	0	1	0	1

No	Species	Individual number collected						∑
		1st	2nd	3rd	4th	5th	6th	
	Tortricidae							
235	Tortricinae sp1	1	0	0	0	0	0	1
236	Tortricinae sp2	1	0	1	0	0	0	2
237	Tortricinae sp3	0	0	0	1	0	0	1
238	*Isodemis* sp.	0	0	0	1	2	0	3
	Uraniidae							
239	Uraniinae sp1	2	0	0	0	0	0	2
240	Uraniinae sp2	0	1	0	0	0	0	1
241	Uraniinae sp3	0	0	2	0	0	0	2
	Zygaenidae							
242	Zygaeninae sp	0	0	0	2	0	1	3
		124	123	238	122	363	104	1078

Figure 2 shows that the number species has not reach saturation as indicated by increasing the number of species at the end of collecting time. Family Noctuidae, Pyralidae and Geometridae were dominant among other families in this park, they were 63 species (26 %), 50 species (%) and 46 species (11.7%), respectively. It was not surprising since the same phenomenon has been repeatedly reported by numerous researchers. The number of species with more than two individuals was slightly higher than the number of species with 1 individual, they were 125 (51.66%) and 117 (48.34%).

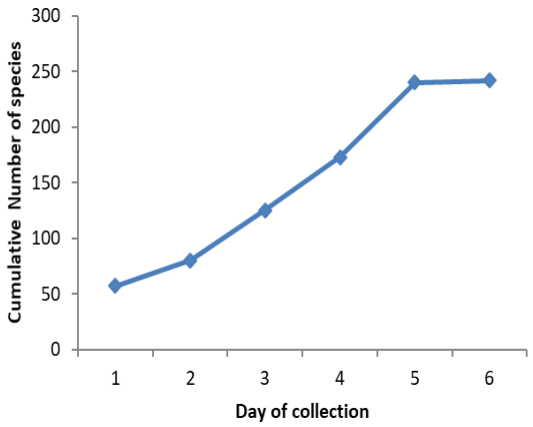

Figure 2. Day of collection versus cumulative number of species.

Table 1 also showed the species number of each family, their abundant and the estimated species on each site in this park. Base Come Oi Marai was lower than Camp II in term of species number. On the other hand, the record of the family number, Camp II was lower than those at Base camp Oi Marai. The remarkable differences between observed and estimated values demonstrate that a considerable part of the local fauna remained uncollected. In these two sites, fauna which has been recorded were 84.2 and 88.5 % of estimated value. In addition, family Noctuidae was the most dominant among other families in Base camp Oi Marai followed by family Pyralidae and Geometridae. On the other hand, family Noctuidae in Camp II site was the lowest compared with Pyralidae and Geometridae. The percentages of the two families, Geometridae and Pyralidae were similar (24%) (Figure 3).

The values of similarity index based on Jaccard coefficient for pairwise comparisons between two sites were very low (13.8%).

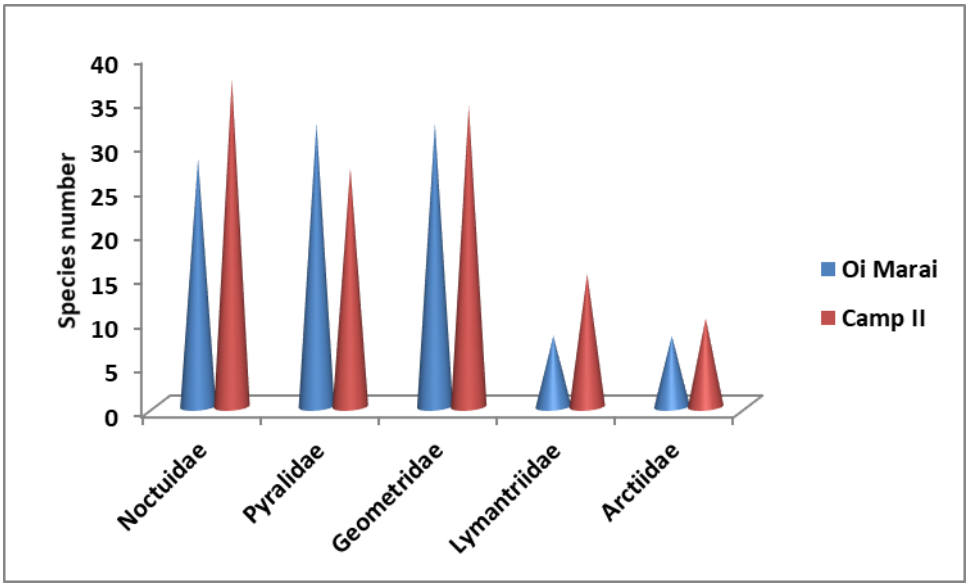

Figure 3. The most dominance families of moths in the two sites: Oi Marai and Camp II.

Possibly host plants of some species inhabit only a certain area. The values in the Table 2 showed a first clue about the diversity of macro-moths at Gunung Tambora National Park and its two sites. The number of collected and recognized species in Base Camp Oi Marai was lower than those in Camp II. The diversity of this area based on Fisher's α index was only 97.3. The number species in base camp Oi Marai was slightly lower than those in Camp II as well as the index diversity. In addition, the percentage of the number of the species with single individual at Camp II is also higher than those in Base Camp Oi Marai.

The value of diversity in Gunung Tambora National Park was slightly higher compared with other sites in Indonesia such as Nusa Barong Nature Reserve (East Java), Meru Betiri National Park (East Java) and Sebangau National Park (Central Kalimantan), Kwerba, Foja Mountain (Papua) that has been reported by Sutrisno (2005, 2007, 2012). However, this park was lower than the Gungung Halimun-Salak Nasional Park. Some factors have determined the diversity of macro-moths in this region, such as a floral diversity, altitudes, and seasons.

It is well known that a floral diversity will determine the composition and diversity of macro-moths because their larvae indeed often show great specificity to host plants even though their adults can use many 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). More varies vegetations resulted more divers on moth fauna as has been reported on the study of Pyraloid and Sphingid moth diversity (Beck *et al*. 2002; Fiedler & Schulze 2004).

In general, high land forest has a higher floral diversity compared to low land forest. This is because in the low land forest there were a lot of disturbed areas as results of land clearings or illegal loggings by local peoples. Gunung Tambora National Park is

one of the best conservation areas that occur in Nusa Tenggara. Its position which covers from low land to high altitude has made this huge area is less disturbed compare to other conservation area. The ecosystem of this park is also more complete than other conservation area because this park occupies various altitudes from 100 to 2400 m. More than 277 species of plants has been discovered at this park (about 234 are floral plants) while in Nusa BarongNature reserve, and Sebangau National Park, there were 278 and 300 species (Sutrisno 2007). However, the species diversity of moths in Gunung Tambora was lower compared than Gunung Halimun-Salak national park as has been reported by Sutrisno (2008). The floral diversity at Gunung Halimun-Salak National is almost double than those of Gunung Tambora National Park. More than 700 species of floral plants has been reported to occupy various altitudes from 500 to 200 m asl. (Sutrisno, 2008).

There is no doubt that a short collecting time gives more representative results to cover the diversity when conducted during both on rainy and dry seasons. Due to time constraint, the study was conducted only on April when the rain still falls every night in these sites. In general, number of collected specimens increased when sampling was conducted during a dark moon night with rain than without rain at all. This phenomenon is similar to the study on fluctuation in the abundance of insect community in this park that conducted by Kahono *et al.* (2002). They showed that during January and February 1999-2001 was the most abundance where the peak rainy season occurs at those two months.

There are many reasons to explain for why the similarities between all pairwise comparisons were very low. Macro-moth is only a small portion of Lepidoptera. More than 60 families of Lepidoptera in South East Asia, only 1/2 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 host plants (Beck & Kitching 2007). 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 meters asl or more (Holloway 1976; Holloway *et al*. 1990; Robinson & Tuck 1993). This result also showed that the base came Oi Marai and Camp II have a few species in common since these two sites have a significant difference on altitude. Only a certain group which is able to adapt at high altitudes, especially species which has very dense scales such as large Noctuids and Geometrids. They are able to survive at the high altitude (>500 m) with temperature vary from 20° to 25°C.

In addition, the increase of altitude up to a certain level brings a consequent in the increase of plant species, even though at the highest altitude the vegetation become homogeneous (> 2000 m). Thus, it causes many choices for moths that have a specific–host relationship to be able to survive at Camp II (>500 m) since the vegetation at this altitude

is more varied. So, it is for why, the index diversity at Camp II is slightly higher than Base camp Oi Marai. More over some typical species that inhabit canopy forest such as Noctuidae, Geometridae and Lymantriidae was higher found in the Camp II than those in Oi Marai. This finding was almost similar with those found in Gunung Salak in where Geometridae was dominant in primary forest while Pyralidae was dominant in the disturbed forest (Sutrisno, 2010).

CONCLUSION

A short collecting time within two sampling sites within Gunung Tambora National Park recorded only about 77.8% of estimated value in this park (242 of 311 species). Index diversity based on Fisher's α is low (97.21). In addition, the number of families recorded from this park is also low, only 17 families, or about one third of the moth families that occur in Indo-Malayan region. Camp II site was higher than the base camp Oi Marai sites in term of the diversity index. These two sites have a few species in common as indicated by Jaccard coefficient that was low (13.8%). In general, Noctuidae (26%), Pyralidae (20%), and Geometridae (19%) dominate across all sites Indonesian

ACKNOWLEDGEMENT

Grateful thanks are due to the head of Gunung Tambora National Park for his permission to access this park. Many thanks also go to Iwan for helping me in collecting of the materials and Darmawan for helping me in identification of specimens. This research is supported by DIPA-LIPI Project 2015, without this grant it is impossible to conduct this research successfully.

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