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THE DIVERSITY OF MOTH FAUNA (LEPIDOPTERA: HETEROCERA) ACCORDING TO ALTITUDES OF TAMAN NEGARA JOHOR, GUNUNG LEDANG

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ABSTRACT

A total of 1113 individuals of moths representing 167 species in 118 genera under 17 families have been recorded for Johore National Park, Gunung Ledang, based on five sampling occasions conducted on 28 May – 2 June 2014 (P1), 25 – 30 June 2014 (P2), 20 – 25 July 2014 (P3), 17 – 22 August 2014 (P4) and 17 – 22 September 2014 (P5). Samplings had been done at three locations based on different altitudes i.e. location L1 (1100 m), L2 (700 m) and L3 (310 m). The main objective of this research is to provide a preliminary inventory and faunistic aspect of moth in Gunung Ledang. At every sampling location L1, L2 and L3, passive sampling was conducted using light traps of 160 watt mercury vapour light. Samplings were conducted at 1900 to 2300 hours during a dark moon phase. The Margalef's Species Richness Index (R') according to the sampling month shows the highest species richness was in P5 (R' = 12.55) and the lowest at P2 (R' = 8.28). The R' value based on altitude

shows that the highest was at L1 (R' = 15.67) and the lowest was at L2 (R' = 11.50). Analysis of the Shannon Diversity Index (H') and Evenness Index (E') based on sampling month shows that the highest H' was at P5 (H' = 3.73) and the lowest at P2 (H' = 3.02) The highest value of E' was recorded at P5 (E' = 0.67) and the lowest at P2 (E' = 0.41).The highest H' value following altitude was at L1 (H' = 3.67) and the lowest was at L2 (H' = 3.47), whereas the highest E' value was recorded at L3 (E' = 0.54) and the lowest at L1 (E' = 0.38). As a whole, the plotted species accumulation curve plotted shows that the curve does not reach the asymptote meaning that further sampling must be done to reach the asymptote. *Lyssa zampa* (Butler) appeared as the most common species spatially (found in every altitudes) and temporally (found in 12 out of 15 subsamplings). The most abundance species in Gunung Ledang was *Pogonopygia nigralbata* Warren with total of 131 individuals recorded, whereas the totals of 78 species have been identified as rare species. The highest percentage of overlapping species following sampling month is between P3 and P4 (75%), whereas following altitude is between L2 and L3 (100%).

Keywords: diversity, moth, Lepidoptera, Heterocera, altitudes, Gunung Ledang.

ABSTRAK

Sejumlah 1113 individu rama-rama yang mewakili 167 spesies dalam 118 genus di bawah 17 famili telah berjaya direkodkan bagi Taman Negara Johor, Gunung Ledang, berdasarkan lima kali pensampelan yang telah dijalankan iaitu pada 28 Mei – 2 Jun 2014 (P1), 25 – 30 Jun 2014 (P2), 20 – 25 Julai 2014 (P3), 17 – 22 Ogos 2014 (P4) dan 17 – 22 September 2014. Pensampelan telah dilakukan di tiga lokasi mengikut altitud yang berbeza iaitu lokasi L1 (1100 m), L2 (700 m) dan L3 (310 m). Objektif utama kajian ini adalah untuk menyediakan inventori awal dan meninjau aspek faunistik rama-rama di

Gunung Ledang. Pada setiap lokasi L1, L2 dan L3, pensampelan pasif telah dilakukan menggunakan perangkap cahaya daripada lampu wap raksa 160 watt. Pensampelan dilakukan antara jam 1900 dan tamat pada 2300 pada fasa bulan gelap. Indeks Kekayaan Spesies Margalef (R') mengikut bulan menunjukkan kekayaan spesies paling tinggi adalah pada P5 (R' = 12.55) dan paling rendah pada P2 (R' = 8.28). Nilai R' mengikut altitud adalah paling tinggi pada L1 (R' = 15.67) dan paling rendah pada L2 (R' = 11.50). Analisis Indeks Kepelbagaian Spesies Shannon (H') dan Kesamarataan Spesies (E') mengikut bulan pula menunjukkan nilai H' tertinggi pada P5 (H' = 3.73) dan P2 mencatatkan nilai H' paling rendah dengan nilai (H' = 3.02). Nilai E' tertinggi dicatatkan pada P5 (E' = 0.67) danterendahpada P2 (E' = 0.41). Nilai H' mengikut altitud pula adalah tertinggi pada L1 (H' = 3.67) dan terendah pada L2 (H' = 3.47), manakala nilai E' paling tinggi dicatatkan pada L3 (E' = 0.54) dan terendah pada L1 (E' = 0.38). Secara keseluruhannya, lengkung pengumpulan spesies yang telah diplotkan menunjukkan ianya masih belum mencapai asimptot yang menandakan pensampelan lanjutan perlu dijalankan untuk mencapai asimptot. *Lyssa zampa* (Butler) merupakan spesies umum secara ruang (ditemui pada setiap altitud) dan masa (ditemui dalam 12 daripada 15 subpensampelan). Spesies paling melimpah di Gunung Ledang adalah *Pogonopygia nigralbata* Warren dengan perolehan sebanyak 131 individu, manakala sejumlah 78 spesies telah dikenal pasti sebagai spesies langka. Peratus pertindihan spesies paling tinggi mengikut bulan pensampelan adalah antara P3 dan P4 (75%), manakala mengikut altitud adalah antara L2 dan L3 (100 %).

Kata kunci: kepelbagaian, moth, Lepidoptera, Heterocera, ketinggian, Gunung Ledang

INTRODUCTION

Johor National Park, Gunung Ledang formerly known as Gunung Ledang Forest Reserve has been recognized as one of the eco-tourism destination. This area covers of 8611 hectares has been commissioned in July 2003 and gazetted as a National Park in Johor on 3 October 2005. Gunung Ledang is known for its natural beauty and uniqueness has attracted the attention of thousands of visitors. It is a popular destination among local and foreign tourists especially on weekends and public holidays as the destination for recreation and hiking.

Gunung Ledang is located in the district of Muar, is the highest mountain in southern tip of the Peninsular Malaysia with a height of 1276 meters above sea level (Briggs 1985). Gunung Ledang is one of the montane rain forests that hold a vast richness of species and biodiversity. To date, there has been no previous publication of the aesthetic insects of the reserve, namely moth in Gunung Ledang. This statement was made as a rational study to produce preliminary data of the diversity and distribution of moth according to the altitudes in Gunung Ledang.

MATERIALS AND METHODS

Samplings are based on five sampling occasions conducted on 28 May – 2 June 2014 (P1), 25 – 30 June 2014 (P2), 20 – 25 July 2014 (P3), 17 – 22 August 2014 (P4) and 17 – 22 September 2014 (P5). Samplings had been done at three locations based on different altitudes i.e. location L1 (1100 m), L2 (700 m) and L3 (310 m). At every sampling location L1, L2 and L3, passive sampling was conducted using light traps. Each light trap was essentially a 160-watt mercury vapour light (powered by portable generator), hung in front of a white cloth screen, directed towards the surrounding forest, in each location.

For each night, each trap was set to operate from 1900 to 2300 hours during a dark moon phase. Moths that came to the screen were collected manually by hand. The collected specimens were killed in killing jars containing cotton wools soaked with ethyl acetate. The killed specimens were kept in dry plastic containers. The specimens were oven dried, pinned, labeled, identified and classified at the Centre for Insects Systematic, Universiti Kebangsaan Malaysia (CIS-UKM).

Identification, species naming and classification of the moth specimens were based on the standard taxonomic reference (e.g. Barlow (1982), Holloway et al. (1990) and Holloway (1983, 1985, 1986, 1987, 1988, 1989, 1993, 1996, 1997, 1998, 2001, 2003). The collection of moth specimens at the Centre for Insects Systematic has been made as a reference for identification process. Besides that, there are common features of moth that can facilitate the identification process which are the characteristics of wings and body color, wing shape and body shape antennae.

The number of specimens of each moth species accumulated from the three locations was accordingly tabulated to facilitate visualization of some interesting aspects of the moth fauna manifested. These include the assessment of the moth species being as rare, common or abundant and also the calculation and assessment of the moth species diversity and evenness in each location using software PAST.

RESULTS AND DISCUSSION

A total of 1113 individuals of moths representing 167 species in 118 genera belong to 17 families have been recorded for Johore National Park, Gunung Ledang, based on five sampling occasions conducted between May until September.

Species richness appeared highest for Noctuidae with 65 species under 10 subfamilies, followed by Geometridae (39 species, six subfamilies), Arctiidae (17 species, four subfamilies), Sphingidae (11 species, three subfamilies), Lymantriidae (nine species, one subfamily), Lasiocampidae (seven species, two subfamilies). For Notodontidae and Nolidae each represented by four species under two and three subfamilies, Bombycidae and Uraniidae (each represented with two species in one subfamily. Other families for example Agaristidae, Cossidae, Drepanidae, Eupterotidae, Limacodidae, Saturniidae and Zygaenidae recorded the same species that is each one species in one subfamily. To date, there has been no previous publication on moths for Gunung Ledang, including the three locations selected in this study. Thus, these form a preliminary moth records for the reserve.

Some interesting aspects of the fauna manifested include the following. Spatially and temporally, *Lyssa zampa* (Butler) appeared as the most common species (found in 12/15 subsampling). This species have been found almost at each altitudes and every time sampling conducted. This was followed by *Pogonopygia nigralbata* Warren and *Parallelia calefaciens* Walker who were present at each altitude and almost every subsamplings done (9 of 15 subsamplings). On the whole, the most abundant species during the sampling carried out is *Pogonopygia nigralbata* Warren. A total of 131 individuals recorded for this species and it encompasses 11.77% of the specimens obtained**.** Of the 167 species recorded, 79 appeared rare (each found with one individual only).

Spatially (over 3 altitudes which are L1 (1100 m), L2 (700 m) and L3 (310 m), L1 appeared as a relatively better altitudes in manifesting the moth species richness with 103 total species recorded compared to L2 and L3 with 64 species and 63 species recorded respectively. Temporally, the moth species richness appeared higher in July with 69 total species recorded.

Analysis of the Shannon species diversity index (H') in Table 1 shows L1 (1100 m) has the highest value of H'=3.67. This was followed by L3 (310 m) with H '= 3.52 and L2 (700 m, H' = 3.47). The H' values as such indicated that the moth species diversity of the reserve, L1 appeared to be a better altitude than L2 and L3. Analysis of species evenness index (E') shows L3 has the highest value of E'=0.54, followed by L2 (E'=0.50) and the lowest value of E' recorded at L1 (E' = 0.38).Index of Margalef Richness (R') shows the highest value at L1 (R'=15.67) with 102 total species recorded followed by L2 (R' = 11.50, 64 species) and the lowest in L3 (R' = 11.28, 63 species). T-test shows there is a significantly different at $p< 0.05$ between L1 and L2, L1 and L3, with $p = 0.011$ and 0.036 respectively. L2 and L3 shows no significant difference ($p > 0.05$) with value of $p = 0.639$.

Table 1. Shannon-Weiner species diversity index (H'), Evenness Species Index (E'), Margalef Richness (R') Index according to altitudes

Altitude	L1 (1100m)	L2 (700m)	L3 (310m)
H'	3.67	3.47	3.52
E'	0.38	0.50	0.54
R'	15.67	11.50	0.54

Table 2 List of species and individuals number of moth in Taman Negara Johor, Gunung Ledang according to the altitudes.

No	Taxon	Individuals Number			Total
		L1	L2	L3	
	AGARISTIDAE				
	Agaristinae				
1	*Mimeusemia vittata jordani* Pendlebury	1	-	1	**2**
	ARCTIIDAE				
	Aganainae				
2	*Asota caricae* (Fabricius)	-	-	5	**5**
3	*Asota egens* (Walker)	-	-	1	**1**
4	*Asota plana* Walker	1	2	1	**4**
5	*Asota product* (Butler)	1	2	-	**3**
6	*Neochera marmoreal* (Walker)	2	1	-	**3**
7	*Euplocia membliaria* (Cramer)	1	-	-	**1**
	Arctiinae				
8	*Nyctemera baulus* (Boisduval)	-	-	1	**1**
9	*Rhodogastria astreus* (Drury)	2	2	2	**6**
	Lithosiinae				
10	*Cyana malayensis* (Hampson)	4	1	1	**6**
11	*Cyana perornata* (Walker)	9	5	5	**19**
12	*Cyana pudens* (Walker)	8	1	-	**9**
13	*Cyana ridleyi* Hampson	-	-	4	**4**
14	*Miltochrista cornicornutata* Holloway	-	5	-	**5**

15	*Miltochrista syntypica* Swinhoe	-	-	3	**3**
	Syntominae				
16	*Ceryx transitiva* Walker	-	1	1	**2**
17	*Eressa annosa* Walker	-	1	1	**2**
18	*Syntomis euryptera* (Snellen)	2	19	6	**27**
	BOMBYCIDAE				
	Prismostictinae				
19	*Mustilia hepatica* Moore	10	11	-	**21**
20	Bombycidae Sp 1	2	-	-	**2**
	COSSIDAE				
	Zeuzerinae				
21	*Zeuzera indica* Herrich-Schaffer	1	-	-	**1**
	DREPANIDAE				
	Drepaninae				
22	*Albara reversaria* Walker	7	-	-	**7**
	EUPTEROTIDAE				
	Eupterotinae				
23	*Tagora pallid* Walker	1	-	-	**1**
	GEOMETRIDAE				
	Desmobathrinae				
24	*Alex palparia* Walker	-	1	-	**1**
	Ennominae				
25	*Abaciscus paucisignata*(Warren)	-	-	1	**1**
26	*Amblychia hymenaria* (Guenee)	-	1	-	**1**
27	*Arycanda maculosa* Walker	1	-	-	**1**
28	*Chorodna complicataria* Walker	3	1	3	**7**
29	*Chorodna pseudobolima* Holloway	1	-	-	**1**

30	*Cleora tenebrata* (Fletcher)	-	-	1	**1**
31	*Hypochrosis binexata* (Walker)	1	11	26	**38**
32	*Hypochrosis pyrrhophaeata* (Walker)	4	-	11	**15**
33	*Hypochrosis waterstradti* Holloway	-	-	8	**8**
34	*Hypomecis costaria* Guenee	3	18	-	**21**
35	*Hypomecis glochinophora* Prout	7	-	-	**7**
36	*Hyposidra aquilaria* (Walker)	-	1	-	**1**
37	*Medasina embolima* Prout	10	-	-	**10**
38	*Ophthal mitisrufilauta* (Prout)	18	3	-	**21**
39	*Ourapteryx claretta* Holloway	1	13	17	**31**
40	*Ourapteryx picticaudata* Walker	-	9	8	**17**
41	*Plutodes malaysiana* Holloway	9	4	1	**14**
42	*Pogonopygia nigralbata* Warren	109	15	7	**131**
43	*Racotisbo armiaria* (Guenee)	2	1	-	**3**
	Geometrinae				
44	*Agathia eromenoides* Holloway	-	1	1	**2**
45	*Dysphania malayanus* (Guerin-Meneville)	-	-	3	**3**
46	*Dysphania subrepleta* (Walker)	-	1	-	**1**
47	*Dysphania transducta* (Walker)	-	-	1	**1**
48	*Herochroma urapteraria* (Walker)	-	1	-	**1**
49	*Ornithospila avicularia* (Guenee)	1	-	-	**1**
50	*Ornithospila bipunctata* Prout	35	32	23	**90**
51	*Ornithospila succincta* Prout	1	-	-	**1**
52	*Sundadoxa multidentata* (Prout)	-	1	-	**1**
53	*Tanaorhinus rafflesii* (Moore)	3	1	-	**4**
54	*Tanaorhinus viridiluteata* (Walker)	6	-	-	**6**
55	*Thalassodes hypocrites* Prout	23	-	3	**26**

	Larentiinae				
56	*Celaenaclystis celaenacris* (Prout)	1	-	-	**1**
57	*Collix mesopora* Prout	10	-	-	**10**
	Oenochrominae				
58	*Milionia basalis*Walker	6	-	-	**6**
59	*Sarcinodes malakarius* Sommerer	2	-	-	**2**
60	*Sarcinodes sumatraria* Walker	-	1	-	**1**
	Sterrhinae				
61	*Zythos turbata* (Walker)	1	-	-	**1**
62	GeometridaeSp 1	2	-	-	**2**
	LASIOCAMPIDAE				
	Gastropachinae				
63	*Metanastria gemella* Lajonquiere	-	2	-	**2**
64	*Metanastria poeciloptera* Grunberg	1	-	-	**1**
	Lasiocampinae				
65	*Cyclophragma basidiscata* Holloway	-	5	-	**5**
66	*Gastropacha pardale* (Walker)	2	-	-	**2**
67	*Suanacon color* Walker	-	4	-	**5**
68	*Trabala ganesha* Roepke	2	-	1	**3**
69	*Trabala hantu* Roepke	4	-	-	**4**
	LIMACODIDAE				
	Limacodinae				
70	*Praesetora divergens* Moore	1	-	-	**1**
	LYMANTRIIDAE				
	Lymantriinae				
71	*Euproctis cosmia* Collenette	-	-	1	**1**
72	*Lymantria hollowayi* Schintlmeister	1	-	-	**1**

73	*Lymantria marginalis* Walker	7	-	-	**7**
74	*Lymantria narinda* Moore	3	-	-	**3**
75	*Lymantria panther* van Eecke	-	1	-	**1**
76	*Lymantria singapura* Swinhoe	2	2	2	**6**
77	*Nygmia solitaria* (van Eecke)	-	1	-	**1**
78	*Sitvia denudata*Walker	-	-	6	**6**
79	Lymantridae Sp 1	-	-	6	**6**
	NOCTUIDAE				
	Bagisarinae				
80	*Ecpatia alleni* Holloway	-	1	-	**1**
	Calpinae				
81	*Avitta quadrilinea*Walker	1	-	-	**1**
82	*Eudocima discrepans* (Walker)	1	-	-	**1**
83	*Eudocima phalonia* (Linnaeus)	13	1	-	**14**
84	*Eudocima strivijayana* Banziger	-	-	2	**2**
85	*Heterospila fulgurea* Guenee	1	-	-	**1**
86	*Masca abactalis* Walker	9	5	2	**16**
87	*Ommatophora luminosa* (Cramer)	2	-	-	**2**
88	*Othreis cajeta* Cramer	-	-	1	**1**
89	*Ramadasa fumipennis* Warren	5	-	-	**5**
90	*Ramadasa pavo* (Walker)	6	1	-	**7**
91	*Speiredonia mutabilis* (Fabricius)	1	-	-	**1**
92	*Sypna albilinea* Walker	-	1	-	**1**
93	*Sypna martina* Felder	1	-	-	**1**
	Catocalinae				
94	*Achaea serva*(Fabricius)	20	-	-	**20**
95	*Anisoneura aluco* Fabricius	-	-	1	**1**

96	*Artena convergens* (Gaede)	1	-	-	**1**
97	*Artena dotata*(Fabricius)	-	-	2	**2**
98	*Artena inversa*(Walker)	2	-	-	**2**
99	*Avatha bubo* (Geyer)	8	-	-	**8**
100	*Avatha simplex* (Roepke)	1	-	-	**1**
101	*Avatha pulchrior* Holloway	1	-	-	**1**
102	*Avatha pulcherrima* Butler	6	-	-	**6**
103	*Bastilla fulvotaenia* (Guenee)	-	-	1	**1**
104	*Chrysopera combinans* Walker	-	-	1	**1**
105	*Ercheia kebea* Bethune-Baker	-	-	1	**1**
106	*Ercheia multilinea* Swinhoe	1	-	-	**1**
107	*Erebus caprimulgus* (Fabricius)	3	-	-	**3**
108	*Erebus ephesperis* (Hubner)	-	-	1	**1**
109	*Hamodes lutea* (Walker)	-	-	1	**1**
110	*Hamodes propitia* Guerin-Meneville	-	2	-	**2**
111	*Ischyja ginnis* Prout	-	-	1	**1**
112	*Ischyja hemiphae* Hampson	1	-	2	**3**
113	*Ischyja inferna* Swinhoe	3	1	6	**10**
114	*Ischyja manlioides* Prout	-	-	1	**1**
115	*Ischyja marapok* Walker	7	1	9	**17**
116	*Ischyja paraplesius* Rothschild	-	-	1	**1**
117	*Lygniodes schoenbergi* Pagenstecher	-	-	1	**1**
118	*Oxyodes scrobiculata* (Fabricius)	13	8	-	**21**
119	*Parallelia calefaciens* Walker	7	6	19	**32**
120	*Pindara ilibata* (Fabricius)	-	-	2	**2**
121	*Platyja umbrina* (Doubleday)	-	-	2	**2**
122	*Pterocyclophora ridleyi* Hampson	-	1	-	**1**

123	*Rema costimacula* (Guenee)	-	-	1	**1**
124	*Sympis rufibasis* Guenee	1	-	-	**1**
125	*Thyas coronate* (Fabricius)	3	1	-	**4**
126	*Thyas honesta* Hubner	7	1	-	**8**
	Chloephorinae				
127	*Tochara creberrima* (Walker)	-	-	1	**1**
	Eublemminae				
128	*Eublemma versicolor* Walker	-	1	-	**1**
129	*Blasticorhinus decernens* (Walker)	-	-	1	**1**
	Herminiinae				
130	*Bocana manifestalis* Walker	3	-	-	**3**
131	*Mosopia megaspila* Walker	1	-	-	**1**
132	*Naarda nodariodes* Prout	1	-	-	**1**
133	*Nodaria externalis* Guenee	-	-	1	**1**
	Hypocalinae				
134	*Hypocala deflorata* (Fabricius)	1	-	-	**1**
135	*Hypocala violacea* Butler	40	-	-	**40**
	Ophiderinae				
136	*Aedia leucomelas* (Linnaeus)	3	-	-	**3**
137	*Anomis macronephra* Holloway	5	-	-	**5**
	Rivulinae				
138	*Oglasa costimacula* Wileman	-	-	1	**1**
	Stictopterinae				
139	*Aegilia sundascribens* Holloway	3	-	-	**3**
140	*Stictoptera describens paragiata* Walker	1	-	-	**1**
141	*Stictoptera macromma* Snellen	1	-	-	**1**
142	NoctuidaeSp 1	-	2	-	**2**

143	Noctuidae Sp 2	-	2	-	**2**
144	Noctuidae Sp 3	6	-	-	**6**
	NOLIDAE				
	Bleninae				
145	*Blenina donans* Walker	1	-	-	**1**
146	*Blenina lichenosa* Moore	3	-	-	**3**
	Chloephorinae				
147	*Carea biviata* Hampson	2	-	-	**2**
148	*Carea tumida* Hampson	-	1	-	**1**
	NOTODONTIDAE				
	Dudusinae				
149	*Dudusa nobilis* Walker	-	1	-	**1**
	Notodontinae				
150	*Cerura malaysiana* Holloway	8	-	-	**8**
	Stauropinae				
151	*Oxoias maragdiplena* Walker	-	1	-	**1**
152	*Somera viridifusca* Walker	-	1	-	**1**
	SATURNIIDAE				
	Saturniinae				
153	*Attacus atlas* (Linnaeus)	3	1	-	**4**
	SPHINGIDAE				
	Macroglossinae				
154	*Cechenena helops* Rothschild & Jordan	1	-	-	**1**
155	*Daphnis hypothous* (Cramer)	1	-	-	**1**
156	*Enpinanga assamensis vigens* (Walker)	-	-	1	**1**
157	*Macroglossum aquila* Boisduval	-	1	-	**1**
158	*Macroglossum corythus luteaum* Walker	-	1	-	**1**

159	*Panacra dohertyi* Rothschild	1	-	-	**1**
	Smerinthinae				
160	*Callambulyx rubricosa amanda* Rothschild	1	-	-	**1**
161	*Daphnusa ocellaris* Walker	-	1	-	**1**
	Sphinginae				
162	*Acherontia lachesis* (Fabricius)	1	-	-	**1**
163	*Ambulyx pryeri* Distant	1	-	-	**1**
164	*Ambulyx subocellata* Felder	5	2	2	**9**
	URANIIDAE				
	Uraniinae				
165	*Lyssa menoetius* (Hopffer)	7	1	2	**10**
166	*Lyssa zampa* (Butler)	68	12	14	**94**
	ZYGAENIDAE				
	Zygaeninae				
167	*Zeuxippa digitata* Walker	-	-	1	**1**
	Jumlah individu	**629**	**240**	**244**	**1113**
	Jumlahspesies	**102**	**64**	**63**	**167**
	Jumlah genus	**75**	**55**	**49**	**118**

CONCLUSION

In view of the above, it can be deduced that more regular surveys, each conducted over longer duration and covering more sectors would provide a better representation of the moth fauna of this reserve than thus far. It aims to achieve better results by obtaining additional specimens of species that have been identified as a new species and should be described.

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