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ALTITUDINAL ACCUMULATION AND DIVERSITY OF LEAF BEETLE (COLEOPTERA: CHRYSOMELIDAE) AT FRASER'S HILL, PAHANG

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ABSTRACT

Most of the research on leaf beetles more focusing on their roles as a pest or biological control. On the ecological part is much understudied. So the objective of this study is to determine the accumulation and diversity of leaf beetles at different altitude on Fraser's Hill, Pahang. Sampling was done in Dec 2016 – Feb 2017 at lower (<500 m a.s.l), middle (500-900 m a.s.l) and higher (>900 m a.s.l) altitudes by using sweep net from 10.00 a.m. to 2.00 p.m. A total of 296 individuals, 28 species and five subfamilies successfully collected. Galerucinae has the highest number of species and individuals with 14 and 154 respectively. Lower altitude has the highest individuals with 116 but has the

lowest number of species with only 11. Meanwhile, sampling on Jan 2017 has the highest abundance of 108 individuals and 17 species. However, t-test indicates that there is no significant different between all Shannon index either by altitude-wise (H' Higher = 1.80; Middle = 2.07; Lower = 1.95) or month-wise (H' Dec '16 = 2.36; Jan '17 = 2.46; Feb '17 = 2.32). Nevertheless, there is evidence showing that existence of species specificity towards altitude especially on the higher altitude which only one species that shared with middle altitude (Galerucinae sp. 1), while middle and lower shared more overlapped species. More intensive study must be done to view the distribution pattern more clear and detailed.

Keywords: leaf beetle, altitude, distribution, specificity

ABSTRAK

Kebanyakan kajian kumbang daun lebih tertumpu kepada sifatnya sebagai serangga perosak atau kawalan biologi. Namun, kajian berkaitan ekologi masih kurang dijalankan. Objektif kajian ini adalah untuk mengenalpasti pengumpulan dan kepelbagaian kumbang daun di altitut berbeza di Bukit Fraser, Pahang. Persampelan dilakukan pada Dis 2016 – Feb 2017 di altitut bawah (<500 m d.a.l), tengah (500-900 m d.a.l) dan tinggi (>900 m d.a.l) dengan menggunakan perangkap jaring dari 10.00 pagi sehingga 2.00 petang. Sejumlah 296 individu, 28 spesies dan lima subfamili telah berjaya dikumpulkan. Galerucinae mencatatkan bilangan spesies dan individu tertinggi dengan 14 dan 154. Altitut bawah pula merekodkan angka individu tertinggi dengan 116 individu, tetapi jumlah spesies terendah dengan hanya 11 spesies. Semenatara itu, persampelan di bulan Jan 2017 pula merekodkan jumlah individu dan spesies tertinggi dengan masing-masing 108 dan 17. Walaubagaimana pun, ujian-t menunjukkan tiada perbezaan siknifikan diantara semua nilai indeks Shannon bagi perbandingan altitut (H' Tinggi = 1.80; Tengah = 2.07; Bawah =

1.95) atau mengikut bulan (H' Dec '16 = 2.36; Jan '17 = 2.46; Feb '17 = 2.32). Namun, terdapat bukti yang menunjukkan bahawa kewujudan spesies spesifik terhadap altitut terutamanya pada altitut tinggi yang terdapat hanya satu spesies yang berkongsi dengan altitut tengah (Galercinae sp. 1), sementara altitut tengah dan bawah lebih banyak berkongsi spesies. Kajian lebih mendalam perlu dilakukan bagi mendapatkan gambaran yang lebih jelas terhadap taburan kumbang daun di Bukit Fraser.

Kata kunci: kumbang daun, altitut, taburan, spesifik

INTRODUCTION

Being one of the largest Coleopterans group with around 40000 species (Jolivet et al. 2009; Biondi & D'Alessandro 2012) and 2000 genera (Jolivet et al. 1988), leaf beetles are more recognizable as a pest rather than their benefits. This is because leaf beetles are responsible for many crops and store product damage like cabbage, potato, tomato, and many more (Hill 1979; Annecke & Moran 1982). Nevertheless, there are also some benefits contributed by leaf beetles, especially in controlling invasive weed species (Wilf et al. 2000; Dolgovskaya et al. 2016).

Despite all studies done to leaf beetles, however, there is still lacking on their ecological aspects. Still, leaf beetles always being one of the attractions especially for nature photographers as it has bright, colourful and variety of patterns on their body (Arnett et al. 2002). One of the ecological factors that not has been entirely covered in the different species accumulation across altitudinal gradients. Mountains or hills have different groups of plant species at certain height depends on the adaptation. Due to leaf beetles are entirely phytophagous, some of it also possess host-plant specific characteristic. So, the objectives of this study

is to investigate the accumulation, distribution, and diversity of leaf beetle in Fraser's Hill.

MATERIALS AND METHOD

Study Site

Fraser's Hill was selected for this study as representative a hill ecosystem. Well-known for eco-tourism site, Fraser's Hill serves a vast forest landscape from lowland dipterocarp forest, hill dipterocarp forest at the middle part, and montane forest at the higher altitude (WWF 2001). Sampling sites also divided into three parts according to the different altitudes, which are higher (>900 m a.s.l), middle (500-900 m a.s.l), and low (<500 m a.s.l).

Sample Collection

Active sampling by using sweep net was used in this study and was done on December 2016 to February 2017. Sampling starts at 9.00 a.m. and ends at 2.00 p.m. because leaf beetles are more active in the morning compared to any other time. The beetles were found by observing any insects that can be found on or under the leaves in the reachable area by sweep net. The samples collected were then kept in 75% alcohol before taken to the lab to the identification of species.

Data Analysis

Species diversity index (H'), evenness (E), and richness (R) for each altitude were calculated by using PAST computer software, also t-test was obtained on the H' for each altitude to observe any significant difference at p=0.05. To spot the species distribution along the altitudes, two-way cluster analysis was done by using PCORD 6 computer software.

RESULTS

Sampling period successfully resulted in a total of 296 individuals with 28 species, under five subfamilies, namely Cassidinae, Criocinae, Eumolpinae, Galerucinae, and Hispinae. From that, Galerucinae is the most abundance subfamily with 154 individuals and 14 species which contribute 52% of total sample population (Figure 1). Species *Lema coromandeliana* is the most abundant species with 41 individuals and can be found in both middle and lower ground (Table 1). Based on the altitude, the lower ground has the most accumulation abundance with 116 individuals, followed by the higher (101) and the least in the middle (79). However, on species-wise, the lower ground has the least species number with 11 species, while higher altitude has 12 and the middle altitude has 13 species.

Table 1 Leaf beetles collected from Fraser's Hill according to the altitudes.

Subfamily	Species	Altitude			Total
		Higher	Middle	Lower	
Cassidinae	*Aspidomorpha miliaris*	1	0	0	1
	Cassidiane sp.1	0	0	11	11
	Cassidiane sp.2	0	1	2	3
	Chiridopsis punctata	0	24	33	57
Criocerinae	*Lema* (*Lema*) *rondoniana*	0	2	0	2
	Lema (*Lema*) *rufotestacea*	0	1	0	1
	Lema coromandeliana	0	16	25	41
Eumolpinae	*Aoria bowringii*	1	0	0	1
	Basilepta sp.	7	0	0	7
	Eumolpinae sp.1	3	0	0	3

	Eumolpinae sp.2	0	0	4	4
	Eumolpinae sp.3	0	0	7	7
Galerucinae	Alticinae sp.1	34	0	0	34
	Aulocophora diversa	0	2	0	2
	Galerucinae sp.1	34	6	0	40
	Galerucinae sp.2	5	0	0	5
	Hemipyxis bipustulata	2	0	0	2
	Mimastra sp.	5	0	0	5
	Monolepta bifasciata	0	6	2	8
	Monolepta laticornis	0	10	20	30
	Monolepta sp.1	4	0	0	4
	Monolepta sp.2	0	4	0	4
	Monolepta sp.3	0	5	2	7
	Paleosepharia truncata	3	0	0	3
	Paleosepharia zakrii	0	1	0	1
	Xenoda (*Xenoda*) *nigricollis*	0	0	9	9
Hispinae	*Dactylispa* sp.	2	0	0	2
	Gonophora haemorrhoidalis	0	1	1	2
	Total	101	79	116	296

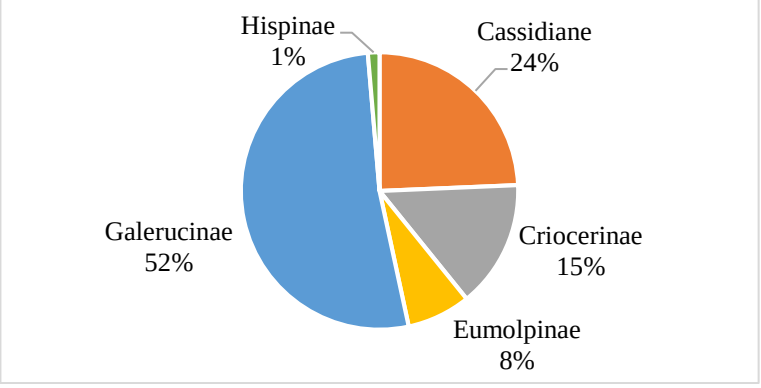

Figure 1 Total percentage contributed by subfamilies collected from Fraser's Hill.

Month-wise, sampling on January 2017 were the highest collection with 108 individuals and 17 species, compared to December 2016 (100 individuals, 18 species) and February 2017 (88 individuals, 16 species) (Table 2). In term of Shannon diversity index (H'), all altitude-wise and month-wise show no significant difference at p=0.05, although middle altitude gives the highest H' value for altitude-wise (2.07), and January 2017 also gives the highest value with 2.46 (Table 3 & 4).

Table 2. Accumulation of leaf beetles from Fraser's Hill according to the sampling period.

Subfamily	Species	Month			Total
		Dec '16	Jan '17	Feb '17	
Cassidinae	*Aspidomorpha miliaris*	0	1	0	1
	Cassidiane sp.1	0	9	2	11
	Cassidiane sp.2	0	2	1	3
	Chiridopsis punctata	15	21	21	57
Criocerinae	*Lema* (*Lema*) *rondoniana*	2	0	0	2

	Lema (*Lema*) *rufotestacea*	1	0	0	1
	Lema coromandeliana	9	15	17	41
Eumolpinae	*Aoria bowringii*	1	0	0	1
	Basilepta sp.	4	0	3	7
	Eumolpinae sp.1	1	2	0	3
	Eumolpinae sp.2	0	0	4	4
	Eumolpinae sp.3	0	0	7	7
Galerucinae	Alticinae sp.1	18	8	8	34
	Aulocophora diversa	2	0	0	2
	Galerucinae sp.1	21	11	8	40
	Galerucinae sp.2	0	3	2	5
	Hemipyxis bipustulata	1	0	1	2
	Mimastra sp.	1	4	0	5
	Monolepta bifasciata	8	0	0	8
	Monolepta laticornis	8	14	8	30
	Monolepta sp.1	0	2	2	4
	Monolepta sp.2	0	2	2	4
	Monolepta sp.3	0	6	1	7
	Paleosepharia truncata	3	0	0	3
	Paleosepharia zakrii	0	1	0	1
	Xenoda (*Xenoda*) *nigricollis*	3	6	0	9
Hispinae	*Dactylispa* sp.	1	0	1	2
	Gonophora haemorrhoidalis	1	1	0	2
	Total	100	108	88	296

Table 3. Number of species, individuals and diversity indexes for samples according to altitudes from Fraser's Hill.

Indexes	Altitude		
	Higher	Middle	Lower
No. of Species	12	13	11
No. of Individual	101	79	116
Shannon (H')	1.80[a]	2.07[a]	1.95[a]
Evenness (E)	0.50	0.61	0.64
Richness (R')	2.38	2.75	2.10

Table 4. Number of species, individuals and diversity indexes for samples according to months from Fraser's Hill.

Indexes	Month		
	Dec '16	Jan '17	Feb '17
No. of Species	18	17	16
No. of Individual	100	108	88
Shannon (H')	2.36[a]	2.46[a]	2.32[a]
Evenness (E)	0.59	0.69	0.63
Richness (R')	3.69	3.41	3.35

On the two-way cluster analysis (dendrogram), higher altitude shows extremely specificity by only shared one species with middle altitude, Galerucinae sp. 1. While the other 11 species are only found at higher altitude. Meanwhile middle and lower ground shared seven species together (Figure 2).

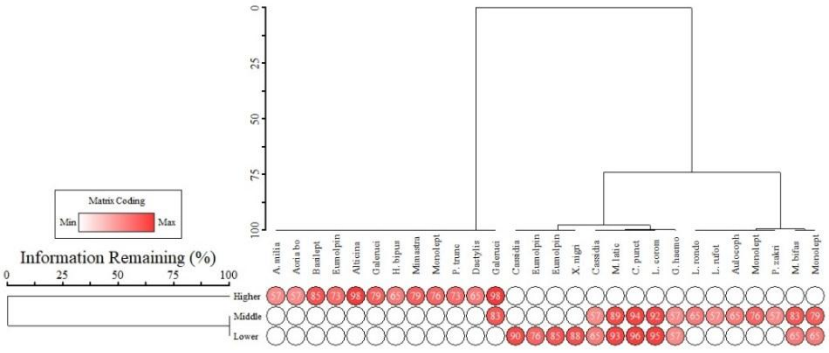

Figure 2. Sorensen two-way cluster analysis (dendrogram) indicating higher altitude made its own group, while middle and lower shared the same group based on the species accumulation.

DISCUSSION

Although there are 13 subfamilies that can be found in Malaysia (Mohamedsaid 2000), the five that found in this study are the common compared to the rest of the groups. Plus, sampling activity that limited only to the reachable area by the sweep net also contributing this finding. More methods such as fogging or even light traps during the night also can be practiced to increase the result.

Galerucinae gives the largest portion of this study with 52% (154 individuals and 14 species) from the total sample population. This subfamily is known to their diversity and abundance in various habitat type, including lowlands and highlands. Also, they distributed widely across different climate in different countries. Specifically, for Malaysia, the records of Galerucinae increased three-fold from the early record from Wilcox (1975). Because of the high diversity, Galerucinae also has a wide range of diet and can be categorized as a general eater.

Lema coromandeliana were found to be the most abundant species from Fraser's Hill. Also, it can be found in lower and middle elevation. There is not much work focusing on this particular species, and why this species cannot be found at higher altitude is also remain unknown. It could be due to its host plant that may be absent at higher altitude. Nevertheless, this species has been recorded all across Southeast Asia, but there is no altitudinal information included (Warchalowski 2011). Mohamedsaid (1989) also claimed that genus *Lema* widely distributed particularly in Peninsular Malaysia, Indochinese and also India.

Even though the Shannon diversity index has no significant different between the altitudes, but middle and lower ground has a slightly higher index. The main reason is that lower altitudes have more vegetation density and variety compared to a higher altitude (Adam et al. 2011). Due to leaf beetle exclusively eats on plants, a higher diversity of plants will directly increase the Chrysomelidae's diversity and abundance (Flinte et al. 2011; Linzmeier & Ribeiro-Costa 2013). This similar result where lower altitude has more diversity also obtained by the study of Barbieri Junior & Dias (2012) with Braconidae as their study species. Month-wise diversity also shows no significant between the sampling periods. This is due to there was similar weather pattern in the three month of sampling, which is in wet season that resulting similar diversity index. Extending the sampling period will give more solid view of the accumulation of leaf beetle especially in this study site.

Based on the clustering, higher altitude only shared one species with middle altitude (Galerucinae sp. 1) which resulting the higher altitude diverge from the other two altitudes. Although this study shows high specificity on the species accumulation at higher altitude, it is too early to make a solid assumption as this is only a three months of sampling effort. However, it can be

useful for a preliminary view of the distribution of leaf beetle species at different altitudes. There is some study showing that there are differences in the species accumulation of leaf beetle across an altitudinal gradient. Flinte et al. (2011) recorded Cassidinae species that two species found from an elevation of 1600 m and above, but six more species can only found in lower gradient. High specificity of distribution may closely have related to the host plant from the higher ground because there are different plant species can be found in different elevations (WWF 2001). Middle and lower altitudes shared more similar species are also due to the same reason. Plus, the climate also much more similar between these two elevations compared to the higher which colder.

CONCLUSION

This study shows that there is no significant difference in the diversity of leaf beetle in higher, middle and lower altitudes, and same goes for the month-wise diversity. *Lema coromandeliana* is the most abundant species that can be found in both middle and lower altitudes. However, a more detailed study has to be done to get a more solid view on the distribution and accumulation of leaf beetle in this study site. Still, this finding can be used as preliminary and latest checklist of Chrysomelidae species in Fraser's Hill, Pahang.

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