BEETLES DIVERSITY (ORDER: COLEOPTERA) OF R.E.A.C.H BIODIVERSITY CENTRE, CAMERON HIGHLANDS, PAHANG, MALAYSIA

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ABSTRACT

R.E.A.C.H Biodiversity Centre, Cameron Highlands is surrounded by 16 years old rehabilitated forest. This forest is currently managed by an NGO, Regional Environmental Awareness Cameron Highlands (R.E.A.C.H). A study on the diversity of Coleoptera was conducted at the area from July to August 2016. The beetles were sampled using four methods, namely the light trap, yellow pan trap, pitfall trap and manual collection on two trails. A total of 16 species comprise of 34 individuals from eight families was recorded. The Shannon-Wiener Diversity Index is high with H'=2.51 recorded. The most dominant beetles collected was the Scarabaeidae followed by Carabidae. Other beetles that were obtained are Cerambycidae, Colydiidae, Curculionidae, Lucanidae and Cetoniidae. They are all nocturnal beetles except one species, *Thaumastopeus pugnator* (Cetoniidae) which is diurnal. Coleopterans presence in this rehabilitated forest showed that the rehabilitation effort was successful as the replanted plants managed to attract the coleopterans. Further study at R.E.A.C.H Biodiversity Centre should be conducted in future to identify the changes in the beetle species composition over time.

Keywords: Beetles, diversity, richness, abundance, light trap, R.E.A.C.H

ABSTRAK

Pusat Biodiversiti *Regional Environmental Awareness Cameron Highlands* (R.E.A.C.H) yang terletak di Tanah Tinggi Cameron, Pahang di kelilingi oleh hutan yang telah dipulihara sejak 16 tahun yang lepas. Pusat ini diuruskan oleh satu badan bukan kerajaan yang dikenali sebagai R.E.A.C.H. Satu kajian mengenai kepelbagaian Coleoptera telah dijalankan di pusat ini dari Julai hingga Ogos 2016. Kumbang telah disampel dengan menggunakan empat kaedah iaitu perangkap cahaya, perangkap kuali kuning, perangkap lubang dan kutipan secara manual di dua denai semula jadi. Sejumlah 16 spesies merangkumi 34 individu daripada lapan famili telah direkodkan. Indeks Kepelbagaian Shannon-Wiener yang direkodkan adalah tinggi iaitu H'=2.51. Kumbang yang paling dominan adalah Scarabaeidae, diikuti dengan Carabidae. Kumbang lain yang didapati adalah Cerambycidae, Colydiidae, Curculionidae, Lucanidae dan Cetoniidae. Kesemua serangga merupakan spesies kumbang nokturnal kecuali satu spesies, *Thaumastopeus pugnator* (Cetoniidae) yang diurnal. Kehadiran kumbang dalam hutan yang dipulihara ini menunjukkan usaha pemuliharaan hutan tersebut telah berjaya

menarik spesies kumbang untuk hidup di kawasan sekitar. Kajian lanjutan harus dijalankan di R.E.A.C.H pada masa akan datang untuk mengenal pasti perubahan pada komposisi spesies kumbang mengikut peredaran masa.

Kata kunci: Kumbang, kepelbagaian, kekayaan, kelimpahan, perangkap cahaya, R.E.A.C.H

INTRODUCTION

Beetles represent about 40% of all known insects and consist about 450,000 species (Bouchard et al. 2011). They comprise of small to large insects with variable colour and shape, and they are compact, mostly strongly sclerotized and more or less flattened (Arnett 1973). The beetles can be found in all natural habitats, including aquatic habitats, trees from their bark to leaves, flowers, in all plant tissue, including decaying plants (Foottit & Adler 2009). As recorded in other insects, mechanical and chemical strategies are often used by beetles to protect themselves from their enemies (Dettner 1987; Chaboo 2011; Alia Diyana et al. 2019). Beetles are often used as biological indicator species to evaluate forest management, different elevation, the segmentation of mountain forest, deforestation, and forest fire (Werner & Raffa 2000; Muneeb et al. 2015). Human activities such as insecticide use at the plantation may affect abundance and diversity of beetles, especially the leaf beetles (Abdullah et al. 2011; Luqman et al. 2018).

There are about 166 families of species worldwide, and more than half have been recorded in Malaysia where the common families found were Scarabaeidae and Cerambycidae (Chung 2005). However, there is a great void of information on beetles in Malaysia. Although some families have been relatively well-studied, for example Chrysomelidae, there is very little documentation of many other families of beetles, especially in Peninsular Malaysia (Cheng & Laurence 2007; Muhaimin et al. 2017). The diversity of beetles may vary due to the differences in the ecosystem. In comparison between deciduous forest and reforested forest, ground beetles were found most abundantly in the deciduous forest (Magura et al. 2002).

Regional Environmental Awareness of Cameron Highlands (R.E.A.C.H) is a community founded organization formed in 2001 by a group of Cameron Highlands' residents. The Biodiversity Centre was established in 2012 to maintain the reforested forest around the centre with flora and fauna. The R.E.A.C.H Biodiversity Centre is located at the edge of Gunung Brinchang at an elevation of 1781 m above sea level (N 04º31'12.1", E 101º23'40.1"). Local farmers previously cleared the forest land for agricultural activities before R.E.A.C.H reforested the land (Regional Environmental Awareness Cameron Highlands 2016). Few scientific studies such as diversity of Lepidoptera (Aris et al. 2017) and lichens (Appalasamy 2016) have been conducted at the centre.

Considered to the rapidly declining environment especially the declining forests and water quality, R.E.A.C.H with the help of volunteers managed to cover about 80% of the site by planting some local plants. Since then, more than 9,200 trees were planted, and they are all from species such as *geruk*, *Syzygium*, rhododendrons and *Nepenthes*. The forest is one of the first reforestation sites at such a high elevation (Regional Environmental Awareness Cameron Highlands 2016).

MATERIALS AND METHOD

Study Site

R.E.A.C.H Biodiversity Centre was established in 2012 by residents under an organization of Regional Environmental Awareness Cameron Highlands (R.E.A.C.H). The center is surrounded by 50 ha of rehabilitated forest with an elevation of 1781 m above sea level. The forest consists of two trails, Trail 1 and Trail 2 with 380 m and 350 m in length, respectively (Regional Environmental Awareness Cameron Highlands 2016; Aris et al. 2017).

Sampling Method

All samples of beetles were collected using four methods, namely the light trap, pitfall trap, yellow pan trap and manual collection using a hand at Trail 1 and Trail 2 from July 2016 to August 2016. Data collection was conducted for 24 days using all four methods each day. Light traps were installed at both trails in the evening from 1830 hr to 0100 hr. A total of 15 pitfall traps and yellow pan traps were installed on each trail and the time inspection was twice in the morning (0700 to 0800 hr) and evening (1800 to 1900 hr). All the collected samples were kept in killing jars. The collected samples were brought back to the Faculty of Earth Science (FSB), Universiti Malaysia Kelantan, Jeli Campus for preservation and further identification. Identified specimens were deposited in the Natural Resources Museum of the university.

Preservation and Identification

The beetle samples were dried using oven at the 40^0C. After the drying process, the samples were identified to species level using identification guides (Triplehorn & Johnson 2004; Bosuang et al. 2017). The identified samples were labeled and deposited at Natural Resources Museum of Universiti Malaysia Kelantan, Jeli Campus.

Data Analysis

The collected data were analyzed using the Shannon-Wiener Diversity Index (H') and Margalef Index (D_{Mg}) to determine the diversity of the coleopterans (Magurran 2004). The evenness of a community was calculated using Pielou's evenness index (Mulder et al. 2004). The species accumulation curve was used to ensure sufficient data collected in the sampling site (Choate et al. 2009).

RESULTS AND DISCUSSION

A total of 16 species of Coleopterans with 34 individuals were collected at the Centre (Table 1). Eight families were recorded in this study, namely Carabidae, Cerambycidae, Cetoniidae, Colydiidae, Curculionidae, Lucanidae, Scarabaeidae and Silphidae. The species accumulation curve (Figure 1) indicated that the 24 days of data collection was sufficient. In this study, two species of Coleopterans were identified to species levels which are *Thaumastopeus pugnator* Heller (Cetoniidae) and *Nicrophorus nepalensis* Hope (Silphidae) while 14 morphospecies were identified to genus level only. There was only one diurnal beetle species collected in this study, which is *T. pugnator*, the green flower beetle.

Table 1. List of beetle species in R.E.A.C.H. Biodiversity Centre, Cameron Highlands.

No.	Family	Species	Common name
1	Carabidae	*Amara* sp.	Ground beetle
2		*Pterostichus* sp.	
3	Cerambycidae	*Sciades* sp.	Longhorn beetle
4	Cetoniidae	*Thaumastopeus pugnator*	Green flower beetle
5	Colydiidae	*Ascetoderes* sp.	Bark beetle
6	Curculionidae	*Telephae* sp.	Weevil beetle
7	Lucanidae	*Macrodorcas* sp.	Stag beetle
8	Scarabaeidae	*Adorefus* sp. 1	Dung beetle
9		*Anomala* sp. 1	
10		*Anomala* sp. 2	
11		*Phyllopertha* sp.	
12		*Blitopertha* sp.	
13		*Apogonia* sp. 1	
14		*Apogonia* sp. 2	
15		*Ectinohoplia* sp.	
16	Silphidae	*Nicrophorus nepalansis*	Burying beetle
TOTAL	8	16	

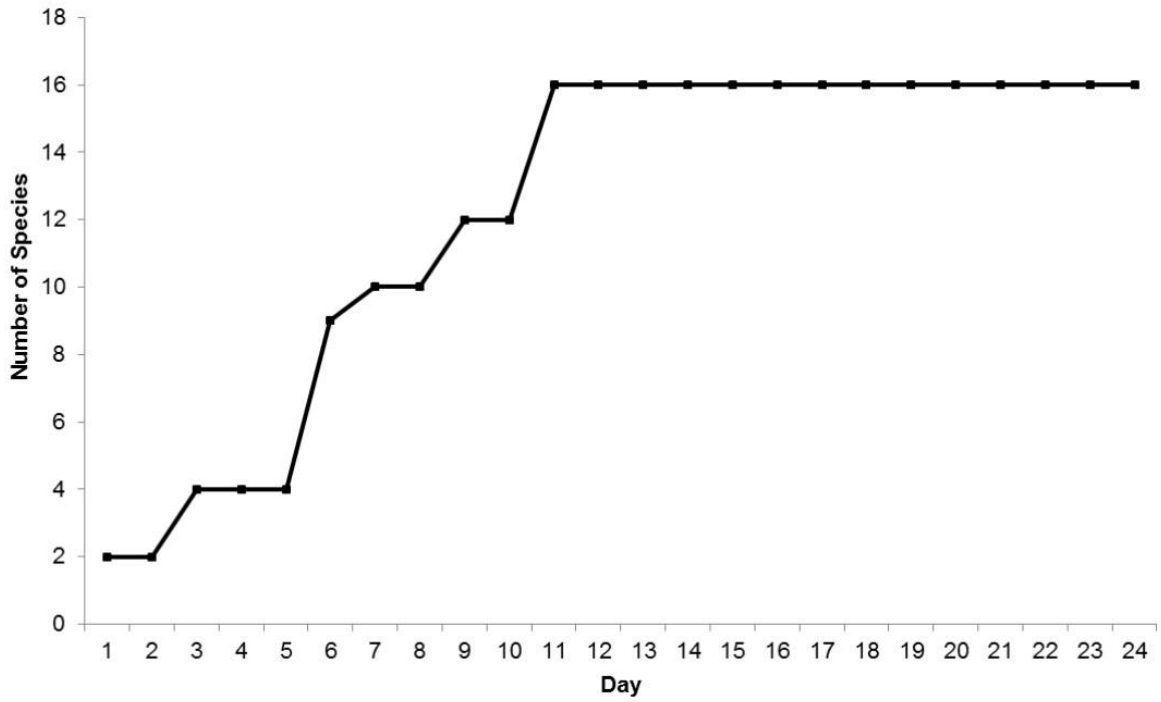

Figure 1. Graph of species accumulation curve of collected beetle species.

According to Abdullah et al. (2011, 2012), Scarabaeidae, Carabidae, Cetoniidae, Curculionidae, Cerambycidae and Silphidae are commonly found in Malaysia. The distribution of these beetle families are mostly in Southeast Asia (Malaysia, Indochinese Peninsula, Philippines and Thailand) (Kojima & Morimoto 2011). They also can be found in Australia, Japan and China (Maeto et al. 2002; Dalgleish & Elgar 2005).

The diversity of beetles recorded at the R.E.A.C.H Biodiversity Centre is better presented using ecological indices. The Shannon-Wiener Diversity Index (H') value is 2.51 while the value of H'_{max} is 3.53. The calculated value of Margalef's Diversity Index, D_{Mg} is 4.25. These indices show that the diversity of Coleopterans at the Centre is high. The calculated value of the Pielou's Evenness Index (J') of Coleopterans at the Centre is 0.71. This shows that the beetle assemblage in the Centre is evenly distributed as it may be caused by the type of plants that have been planted in the forest to attract other species of beetles from the neighboring forest areas.

The most abundant species collected was Scarabaeidae (eight species) followed by Carabidae (two species). The least number of species was collected from Cetoniidae, Curculionidae, Colydiidae, Cerambycidae, Silphidae and Lucanidae with only one species respectively. The Shannon-Wiener Diversity Index (H') also showed that the Scarabaeidae (H'=0.35) and Carabidae (H'=0.26) had higher diversity compared to other recorded family (Table 2) in this study.

Table 2. Shannon-Wiener index of beetle families collected at the Centre, Cameron Highlands.

Family	Shannon-Wiener Index
Scarabaeidae	0.35
Cetoniidae	0.17
Curculionidae	0.17
Carabidae	0.26
Colydiidae	0.17
Cerambycidae	0.17
Silphidae	0.17
Lucanidae	0.17

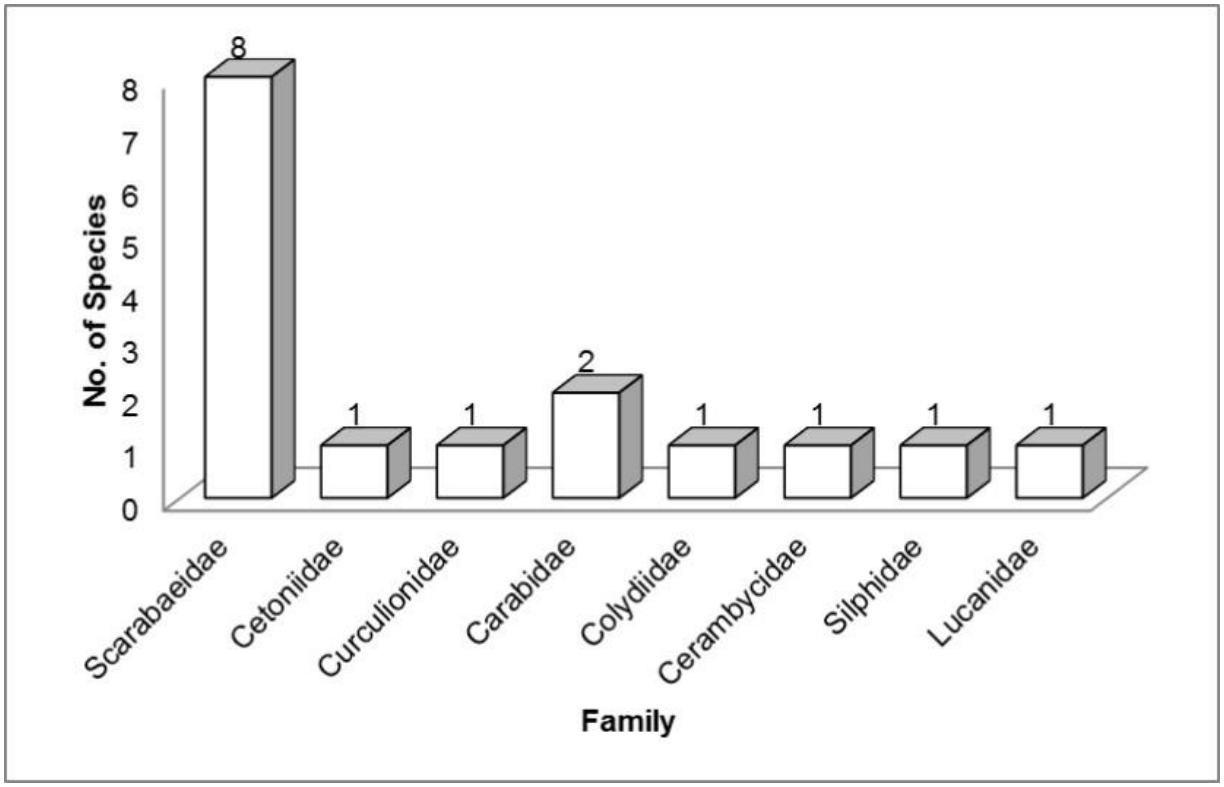

Figure 2. Number of species sampled according to the family of beetles at R.E.A.C.H Biodiversity Centre, Cameron Highlands.

Figure 3 shows that the highest number of Coleopterans collected belong to Scarabaeidae (n=17), followed by Cetoniidae (n=8), Carabidae (n=3) and Cerambycidae (n=2). The least number of Coleopteran specimens collected belong to Colydiidae, Curculionidae, Lucanidae and Silphidae with each of the family consist of only one specimen. The beetle assemblage at the forest is dominated by *T. pugnator* where a total of eight individuals was collected. The Scarabaeidae is the most commonly found family in the forest of Malaysia (Chung 2005). This is also proven in this study where the family recorded higher number of species and individuals at the Centre.

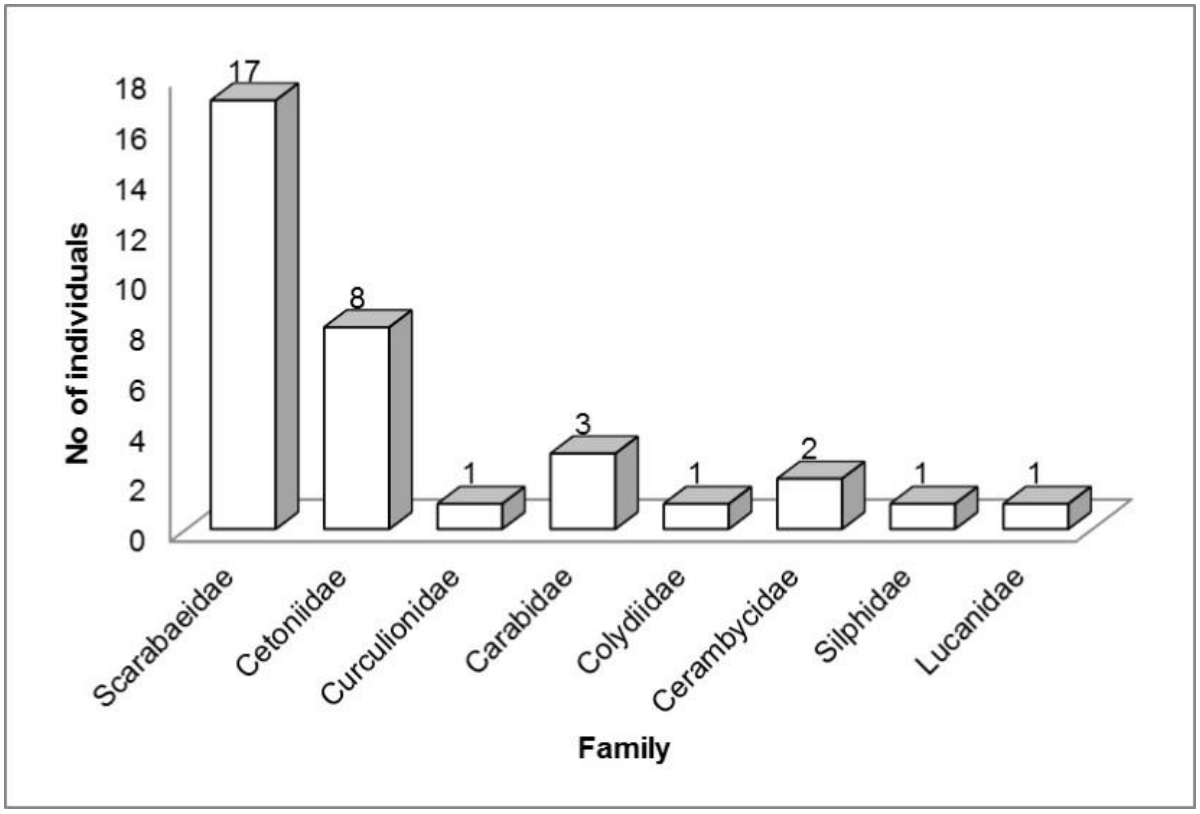

Figure 3. Number of individuals according to the family of beetles sampled at R.E.A.C.H Biodiversity Centre, Cameron Highlands.

Since the study site is a 16 years old rehabilitated forest, the number of beetles found is less than the number found in primary forest. This is because beetles are influenced by habitat changes, the synergistic effect of forest modification and fragmentation (Coleman & Hendrix 2000). For example, Gunung Brinchang forest located nearest to the Centre. This forest showed higher abundance and species richness of coleopterans compared to the Centre. A total of 73 beetle specimens that comprised of 54 species from 15 families were recorded in Gunung Brinchang (Abdullah et al. 2011).

Another factor that may influence the number of beetles at the study site is the interference of drizzle during data collection that can limit the number of beetles foraging in the night. William and Liebhold (2002) reported that warmer temperature increases the period of flight activity. However, drizzling is the common phenomena observed at the Centre during night time.

The alteration of the natural landscape by humans is the main cause of global biodiversity loss through all major taxonomic groups (Coleman & Hendrix 2000). The diversity and abundance of fauna are correlated to the habitat diversity, where abundant ecological functions will support more insect development and their trophic desires (Jeanner et al. 2003; Arumugam et al. 2019). Environmental changes cause varying effects on the beetle species richness and abundance, such as the number of leaf litter, plant species, ground cover, and soil pH (Chung et al. 2000).

CONCLUSION

A total of 34 individuals of Coleopterans comprising of 16 species from eight families were recorded in this study. The rehabilitated forest surrounding R.E.A.C.H BioD Centre, Cameron Highlands managed to attract Coleopterans diversity to the forest. The success rate of rehabilitation is unable to be measured due to the unavailability of data before the rehabilitation process of the forest. Some common Coleopterans from the neighbouring area, Gunung Brinchang were collected at the Centre. This shows that the effort to rehabilitate the forest by R.E.A.C.H is successful.

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