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THE EFFECT OF ELEVATION ON DIVERSITY AND ABUNDANCE OF CLASS INSECTA AT GUNUNG DATUK, NEGERI SEMBILAN

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ABSTRACT

Insect are among the most diverse and ecologically important organisms on the earth, but their diversity and abundance are rarely quantified. The study was set out at Gunung Datuk, Negeri Sembilan with the objective to determine the diversity and abundance of insects and to identify the differences in their distribution of different elevations of Gunung Datuk forest by using the Malaise traps. Overall, a total of 15 orders of insects comprising 1678 individuals were successfully identified. Low and high elevations recorded with both 1027 and 651 individuals collected respectively which belong to 14 orders each. Even though both elevations recorded the same number of orders, but not all orders present at low elevation were present at high elevation. High existence of flowering trees and near to stream water at low elevation make them to have more abundant insect

rather than at high elevation. Diptera was found to be the most abundant order at Gunung Datuk forest with the total percentage of 51.97 followed by Hymenoptera (11.17%) and Lepidoptera (9.91%). The least number of individuals collected was Ephmeroptera with only one individual collected respectively. The Shannon Wiener Diversity Index (H') showed that low elevation had the highest diversity with the value of H'=1.29. Meanwhile, the T-test results showed that both elevations did not differ significantly with $P > 0.05$. Cluster analysis revealed there were no specific patterns of abundant for insects' order along the elavational and latitudinal gradient.

Keywords: diversity, abundance, elevation, order

ABSTRAK

Serangga merupakan organisma yang pelbagai di Bumi ini dan memainkan peranan yang penting dari aspek ekologi tetapi kepelbagaian dan kelimpahan mereka jarang dikaji. Kajian ini dijalankan di Gunung Datuk, Negeri Sembilan dengan matlamat mengkaji kepelbagaian dan kelimpahan serangga serta mengenal pasti perbezaan dari segi kelimpahan mereka pada aras ketinggian yang berbeza dengan menggunakan perangkap Malaise. Secara keseluruhan, sejumlah 15 order serangga yang terdiri daripada 1678 individu telah berjaya dikenal pasti. Kedua-dua aras ketinggian, rendah dan tinggi masing-masing telah merekodkan 1027 dan 651 individu yang terdiri daripada 14 order serangga. Walaubagaimanapun, tidak semua 14 order yang dikenal pasti di aras ketinggian yang tinggi direkodkan pada ketinggian yang rendah. Kekayaan pokok berbunga dan kedudukan yang berhampiran dengan sungai adalah faktor mengapa serangga lebih melimpah di ketinggian rendah berbanding pada aras ketinggian yang tinggi. Diptera merupakan order paling banyak di hutan Gunung Datuk dengan jumlah peratusan 51.97 diikuti oleh Hymenoptera (11.17 peratus) and Lepidoptera (9.91

peratus). Bilangan individu yang paling sikit dikutip adalah Ephmeroptera dengan hanya satu individu. Ujian kepelbagaian Shannon Wiener Diversity Index (H') menunjukkan bahawa kepelbagaian serangga adalah lebih tinggi di ketinggian rendah dengan H'=1.29. Manakala, keputusan ujian T menunjukkan bahawa purata kedua-dua ketinggian tidak berbeza secara signifikan dengan P>0.05. Analisis berkelompok menunjukkan tiada sebarang corak tertentu bagi kelimpahan serangga di sepanjang kecerunan ketinggian dan latitud.

Kata kunci: diversiti, kelimpahan, ketinggian, order

INTRODUCTION

Insects are the most enormously successful animal in terms of their number of species and abundance. According to Richards and Davies (1977), insects are tracheate arthropods in which the body is divided into head, thorax and abdomen. Insects is a remarkably organisms that attributed mainly to their small size, which allows them to occupy niches that are not available to larger organisms. They are adapted to highly differing environments from cold weather environment as well as warmer tropical rainforest. They are able to tolerate extremes of temperature and other environmental conditions (Elzinga 2004). The classification of animal is formulated by using the available evidence, structure, physiology and type of metamorphosis that have played a vital 6 roles in determining the relationships between species.

The hierachy of classification follows the pattern from kigdom, phylum, class, order, family, genus and species (Elzinga 2004. According to Triplehorn and Johnson (2005), insects are classified into 31 orders worldwide which are Microcorphia, Grylloblattodea, Phasmatodea, Orthoptera, Blattodea, Hemiptera, Strepsitera, Mecoptera, Coloptera, Lepidoptera, Phthiraptera, Isoptera, Mantophasmatodea, Thysanoptera, Plecoptera,

Embiidina, Zorapetra, Trichoptera, Siphonaptera, Dermaptera, Mantodea, Neuroptera, Mecoptera, Hymenoptera, Psocoptera, Odonata, Thysanura, Diplura, Protura, Ephemeroptera, Collembola and Diptera. Insects are essential in the ecosystem by helping in nutrient recycling through leaf litter and wood degradation, dung disposal, and soil turnover. They play a significant role in plant pollination and maintenance of plant community composition. Their demise result in the disruption of critical ecosystem services such as pollination and source of food (Campbell et al. 2011).

MATERIALS AND METHODS

The study site for this research is at Gunung Datuk. The forest of Gunung Datuk has dipterocarp forest which stand majestically at 880 metres (2,900 feet above sea level). Six Malaise traps were set up at two different elevations which are low elevation at 200 m and high elevation at 700 m of Gunung Datuk and the distance between each Malaise traps was 100 m. The traps were left unattended for three months but the collecting bottle consists with half-filled of 70% alcohol to kill and preserve the insects were replaced with a new bottle for every month. The insects in the collecting bottle were sorted out using forceps according to their order.

Pinning is a method that used to preserve the sample or insects especially for hard bodied insects. This method can retain accurate resemblance to the insect as it appeared when alive and make them easily to study and handle (Triplehorn and Johnson 2005). The samples collected were pinned vertically in the insect's box. Mounting procedure is a process that used for small insects in which the specimens were mounted with a minute pin on a card. Later, the samples were dried in the oven for a week at a temperature of 38° C to 40° C. The drying method is used to

prevent the sample from the fungal. After mounting and preserving, the order identification was conducted.

The identification process was based on observing the morphological and physical characteristics such as pattern of wing, type of antennae and pattern of leg. Later, the samples were classed into its order accordingly by comparing the result of identification with reference book and based on the insect collection at the Centre of Insects Systematic, Faculty of Science and Technology, University Kebangsaan Malaysia (UKM). The data was calculated using the Shanon-Weinner diversity index which formulates to determine diversity of insect at Gunung Datuk. Then, T-test was conducted to show the differentiation of abundance and diversity of insect at two difference elevations. Margalef's Index was used to measure the order diversity. Then, Evenness Index was used to determine common order in both study sites. Lastly, the statistical software program of Bio-dap was used to analyze all the data.

RESULTS AND DISCUSSION

During this study, a total of 1978 individuals of Class Insecta were collected at Gunung Datuk, Negeri Sembilan from both high and low elevation. The collected data represented 15 out of 27 orders which were Diptera, Hymenoptera, Lepidoptera, Coleoptera, Hemiptera, Blattodea, Isoptera, Thysanoptera, Embioptera, Mantodea, Archaeognatha, Odonata, Dermaptera, Plecoptera and Ephmeroptera.

The orders of insects were arranged in order from the highest number to the lowest numbers of individuals collected as shown in Table 4.1. In general, the total numbers of individual insects collected per insects' order at both elevations at Gunung Datuk were dominance ranked by order Diptera with 1028 individuals, followed by Hymenoptera with 221 individuals and Lepidoptera with 196 individuals. Ephemeroptera recorded the

least order collected with only 1 individual. According to Evans (2008), bettles (Coleoptera) is the largest order in Class Insecta followed by Lepidoptera, Hymenoptera, Diptera and Hemiptera.

Table 1. Percentage of total insects per insects' order of both high and low elevation at Gunung Datuk

Order	Percentage	Individual
Diptera	51.97%	1028
Hymenoptera	11.17%	221
Lepidoptera	9.91%	196
Coleoptera	5.11%	101
Hemiptera	4.60%	91
Blattodea	0.46%	9
Isoptera	0.35%	7
Thysanoptera	0.25%	5
Embioptera	0.25%	5
Mantodea	0.25%	5
Archaeognatha	0.15%	3
Odonata	0.10%	2
Dermaptera	0.10%	2
Plecoptera	0.10%	2
Ephmeroptera	0.05%	1
Total	100%	1678

According to Triplehorn and Johnson (2005), Diptera is one of the largest orders of insects. They are abundant both in individuals and species almost everywhere. Dipterous larvae live in many kinds of habitat but the largest proportion live in water and all sorts of aquatic habitats including streams, ponds, lakes and alkaline water. The predaceous larvae also live in soil, under stone or on vegetation. These significant findings can be said due to the Malaise traps that were set up near to source of water such as stream. In addition, the samples were collected on Malaysia's rain seasons which proved that Diptera was the most abundant insect at Gunung Datuk. 25

Further analysis of data revealed that Hymenoptera was the second most abundant of all insects in Gunung Datuk forest with 11.17%. This result supported previous study by Idris et al., (2002) that found Hymenoptera to be the most abundant order of all insects at Gunung Nuang forest which comprised 89.39 percent. According to Schoonhoven et al. (2005), Hymenoptera is the most beneficial in the entire insect class. They have a great many species pests and it have the most important pollinators of plants, the bees. It is obvious that the existence of tree with flowers explained the 11.17% of Hymenoptera collected in Gunung Datuk forest.

Lepidoptera are a common insect that are known as butterflies and moths (Elzinga 2004). This order contained 11 500 described species and have considerable importance. The larvae of Lepidoptera feed on plants. Generally, the larger larvae feed at the edge of the leaf and consume all the leaf. This statement parallel with the result showed that Lepidoptera was the third most abundance in Gunung Datuk forest with 9.91 percent.

Based on Table 1 the lowest percentage recorded was Ephemeroptera with only 0.05 percent or commonly known as mayflies. According to Collin et al. (2009), the mayfly nymphs are found invariety of aquatic habitats such as streamlined in form and very active. Adults and nymphs of Ephemeroptera are an important food of many freshwater fish. They also serve as food for other animal such as birds, spiders and many predaceous insects

Overall Diversity at Gunung Datuk

Species diversity is a concept that comprises both species richness and species evenness that defines as relative abundance of species in a particular area or community. Species richness is a number of different species that present in a sample and community (Collier and Schwertner 2012). However, species evenness is the abundance of species in a community (Newman, 2013).

There were three indices used to calculate the species richness of insects at Gunung Datuk forest which are Shannon-Wiener Diversity Index (H'), Shannon-Wiener Evenness Index (E') and Margalef Richness Index (R'). Table 2 shows the diversity index analysis of insect at Gunung Datuk forest.

Table 2. Quantifying diversity indices for overall result at Gunung Datuk

Elevation	Species richness
Shannon-Weiner Index, H'	1.29
Shannon-Weiner Evennes Index, E'	0.48
Margalef Richness Index, R'	1.84

According to Magurran (1998), a value of H' which falls within the range of 4.0 to 5.0 is considered highly diverse, H' value from 2.5 to 3.0 is considered as moderate species diversity while low species diversity has H' value within 1.0 to 2.4. The total individuals at low and high elevation result in a value of H' equal to 1.29 as showed in Table 2 which concluded that Gunung Datuk forest had low species diversity. This value was reflected by both values of E'= 0.48 and R'= 1.84 as the value E' and R' are positively correlated with the value of H', where if the value of both E' and R' are high so do the number of species presence.

The possible explanation for the lower species density (H'=1.29) at Gunung Datuk might due to the collected samples did not include the middle elevation as mid-elevation which is unimodal peak is reported to be a common pattern of species richness in most of the taxanomy of insects (McCain 2004). For example, as pointed out by Sanders et al. (2003), the ant species richness peaked at mid-elevation range as showed by a study on the patterns of ant species richness along elevational gradients in an arid ecosystem in Spring Mountains, Nevada, U.S.A.

Comparison in Abundance at Different Elevations

Abundance is defined as the number of individuals found per sample in each elevation (Triplehorn and Johnson 2005). As shown in Table 3, there was no specific pattern of abundance for insects' order along the elevational gradients.

Table 3**.** Cumulative number of insects' order at each Gunung Datuk's elevation

Order	No. of Individual	
	Low elevation	High elevation
Diptera	627	401
Hymenoptera	127	94
Lepidoptera	128	68
Coleoptera	63	38
Hemiptera	56	35
Blattodea	5	4
Isoptera	6	1
Thysanoptera	4	1
Embioptera	4	1
Mantodea	3	2
Archaeognatha	0	3
Odonata,	2	0
Dermaptera	1	1
Plecoptera	1	1
Ephmeroptera	0	1
Total Individual	1027	651

Overall results showed that low elevation has higher number of insects' collection with 1027 individuals compared to high elevation with only 651 individuals. A study conducted by Siti Khairiyah et al. (2013) also showed similar result where lower elevation cater more insect population than upper elevation. Diptera showed the most obvious differences in abundance of individuals between low and high elevation with 627 at low and 401 at high individual. This order mostly was collected at low elevation compared to high elevation. This result was due to the

study site at low elevation was near to the water streams. As stated before, larvae of Diptera generally live in still waters, ponds and backwater of streams. Even though at the high elevation was no waterfalls but there were many puddles.

Hymenoptera was the second highest order collected at low and high elevations with 127 and 94 individuals at Gunung Datuk. There were largely contributed by bees and wasps. Bees may influence by the many existence of flowering tree at Gunung Datuk at both elevations.

Ephemeroptera was the least individuals' for both high and low elevations. The reason for the finding was not clear but it might be related to their habitat preference and level of specific diversity. This result also influenced by the short sample collection period. Then, Malaise traps were damaged because of the rainy season which cause lower number of individuals collected.

Comparison in Diversity at Different Elevations

Diversity is the number and variety of species present in an area and their spatial distribution. The differences in diversity and abundance between low and high elevation is shown in Table 4.

Table 4. Quantifying diversity indices of high and low elevations

Elevation	Low elevation (200 m)	High elevation (700 m)
Shannon-Weiner Index, H'	1.29	1.27
Shannon-Weiner Evennes Index, E'	0.50	0.48
Margalef Richness Index, R'	2.2	2.0

Based on Table 4, H' shows that insect diversity is 0.02 higher at low elevation, 200 m (H'=1.29) compared to high elevation, 700 m (H'=1.27) though they do have similar value in their number of order (15 orders at each elevation). The high

species diversity at low elevation means that that low elevation at Gunung Datuk has complex environment in which a high degree of species interaction. However, both elevations still have low value which the value of H' at the range of 1.0 to 2.4 (Magurran 1998). According to Manuel (2008), communities with higher diversities typically have higher levels of competition and niche availability is limited and also high number of predation as limited source of food and larger size of animals.

As shown in Table 4, the E' value was high at low elevation which was 0.50 than what was obtained at high elevation which was 0.48. The high value at low elevation indicates that low elevation of Gunung Datuk was consisted high number of insects' order. The high elevation recorded higher R' values (2.2) compared to low elevation (2.0). These findings were supported by Evans (2008), pointed that if the value of both E' and R' are high so do the number of species presence. In general, the independent T-test results which assess whether the means of two groups are statistically different from each showed that both elevations did not differ significantly as $P > 0.05$.

CONCLUSIONS

In conclusion, a total of total 1978 individual of insects are successfully collected from both area of study which are at high elevation and low elevation at Gunung Datuk, Rembau. The study showed that the diversity and abundance of insects are highly abundant at low elevation compared to high elevation. A total of 1027 individuals are recorded at low elevation. While only 651 individuals found at high elevation for both 15 out of 27 orders. The diversity and abundance of insects at the study site are influenced by environmental condition such as availability of food resources, shelter requirement against predator, appropriate weather and climate influence the diversity of insects. As stated earlier, insects have many advantages such as act as a scavenger, vectors, predator, pollinators, bioindicator for water quality,

forensic and medical importance. Moreover, insects are important in stabilizing the nature and ecosystem. Thus, it is suggested to preserve the diversity and abundance of insects to prevent these orders against a threat of extinction from the ecosystem.

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