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COMPARISON OF INSECTS COMPOSITION AND DIVERSITY BETWEEN EDGE AND WITHIN REGENERATED SECONDARY TROPICAL FOREST, SARAWAK, MALAYSIA

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ABSTRACT

Insects are categorized in the biotic composition of the forest, and plays very important role in balancing the ecological system of the forest. Large parts of its tropical rainforest now are logged-over area and now some of it undergoes the regeneration phase. This condition may affect the species composition of insects in the forest as the forest ecosystem really depending on each other to survive. However, until today there are still limited scientific study has been conducted regarding the insects composition and biodiversity of between these forests area. The purpose of this study is to identify insect order under two different type of forest, to assess the efficiency of different types of trap and to determine the species composition and diversity between forest edge and regenerated secondary forest Bintulu, Sarawak. The research was conducted in Sarawak, which is located 3°12'20.1"N 113°05'34.1"E. This research was carried out for 10 weeks at four areas namely Riparian Forest, Rehabilitation Forest, Regenerated Secondary Forest and Forest Edge. Three stages involved are insect trap method, insect identification and data analysis. Assessment of the species diversity of the insects between the two forest area are based on Shannon-Wieneri index where it focused on insects species richness and evenness. The total number of insect order found from the 2 types of forest is 5 orders, Coleoptera, Blattodae, Hemiptera, Hymenoptera. It was found that the two forests had the same order of insects. The Shannon-Wieneri index of diversity (H') is to characterize species diversity in a community where it is another index that is commonly used. The Shannon-Wiener index diversity for Forest Edge (H') shows the value 1.10 and for Regenerated Secondary Forest, the value is 0.833. The H' for Forest Edge is more diversity compare than Regenerated Secondary Forest because the values for H' is higher compare the Regenerated Secondary Forest. The higher of Shannon-Wiener index diversity (H'), the more diversity of insect species. For Forest Edge, the species evenness is 1.00 where that mean that all insect order have the same frequency. Typically values are generally between 1.5 and 3.5 in most ecological studies and indicate for diversity, and the index is rarely greater than 4. For Regenerated Secondary Forest, the species evenness is 0.755. The species evenness for that forest a little bit low than Forest Edge.The normalizes Shannon-Wiener Index of Diversity a value between 0 and 1. The nearest the values into 0 indicate that the insect species dominant into 1 species. The value nearest to the 1, the insect species more evenness. From the result obtain, it can be conclude that Forest Edge has more insects diversity compare to Regenerated Secondary Forest.

Keywords : insect diversity RSF, Forest Edge, Sarawak

INTRODUCTION

Tropical rain forests are rich with species composition and diversity where this environment can be found in Borneo Island in South East Asia. The factors that affecting this biodiversity are the community structure, composition such as biotic, abiotic, edaphic and historical factors (Suratman et al. , 2015).

Insects categorized in the biotic composition of the forest, and plays very important role in balancing the ecological system of the forest. Insects are a very important due to its immense biodiversity and abundance. Insects serving as providers, eliminators and facilitators across multiple trophic levels in the forest influence the composition and dynamics of ecosystems. Statistically, about 75% of the animal species covered by insects, which highly diverse in tropical rainforest. The fact that these insects are dominance, they are ecologically significant in the rainforest ecosystem function, whether as decomposers, pollinators, defoliators, nutrient recyclers, food sources for birds also in other forest ecosystem chain. Ants from the hymenoptera order for example, form symbiotic associations with some species of tree where the ants provides nutrient for the tree and the tree provides shelter for the ants

However, in Borneo, big parts of its tropical rainforest now are logged-over area and some of it undergoes the regeneration phase. This condition may affect the species composition of insects in the forest as the forest ecosystem really depending on each other to complete their daily cycle. Furthermore, degraded forest undergoes the regeneration process to develop secondary forest. Regeneration process slowly will continue from time to time along with the composition of the insects. As the density of tree species increase in the forest, the composition and diversity of insect will increase.

This situation also includes the forest area in Universiti Putra Malaysia Bintulu Campus itself. The Forestry Park UPMKB once was a logged-over area during the construction of this campus for the past 20 years and some parts of the forest affected. The forest area is a Mixed Dipterocarp Forest. Since there is no scientific research record ever found regarding the insects composition and biodiversity of between these forests area, it is compulsory for this study to be conducted in order to determine the level of insects diversity. Our study sites are chosen based on the site condition and the purpose of this research. The purpose of this study is to identify insect order under two different type of forest, to assess the efficiency of different types of trap and to determine the species composition and diversity between edge forest and regenerated secondary forest of Universiti Putra Malaysia Bintulu Campus, Sarawak.

METHODOLOGY

Sampling sites

The research on the analysis of insect biodiversity in University Putra Malaysia Bintulu Campus, Sarawak, which is located 3°12'20.1"N 113°05'34.1"E. The Universiti Putra Malaysia Bintulu Campus is a branch campus of Universiti Putra Malaysia located in Bintulu, Sarawak. The campus was reopened in November 2001 based on the third objective of UPM's 2001-2010 planning strategy, which is to upgrade UPM's ability as an internationally acclaimed Centre of Study, Agricultural and Biosource Services. UPMKB is situated 13 kilometers from the town of Bintulu, and is surrounded by an environment rich in flora and fauna, and this natural abundance is fully utilized to affirm UPM's mission to further explore the fields in agriculture and biosource. This campus covers an area of 715.16 hectares.

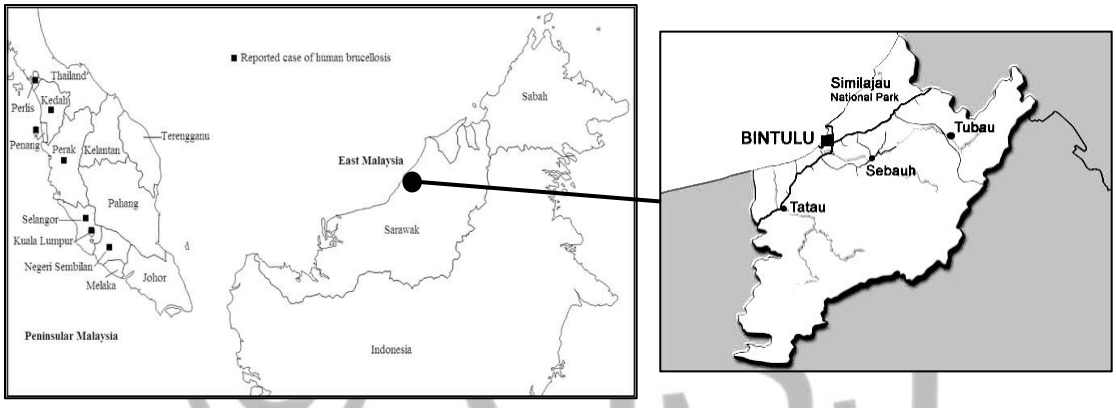

Figure 1 : Map of study site location at UPM Bintulu, Sarawak.

Insect Sampling

This research was carried out on February until April 2019 which is week 2 to week 10 during the period of study. This analysis was conducted at four areas which is Riparian Forest, Rehabilitation Forest (behind of Nursery UPM-Mitsubishi), Secondary Forest Regenerate (Forestry Park, UPMKB) and Edge Forest (Forestry Park, UPMKB). The method used in this analysis consist of three stages. The three stages are insect trap method, insect identification and data analysis.

Insect Trap Method

Insect trap method divided into two categories collecting method; 1) Active collecting method, 2) Passive collecting method. Active collecting method is involved the in an active search in finding out the insects by hand or by using apparatus such as net. In this research, the active collecting method using sweeping net. In the passive collecting method, on the other hand, is based on the movement of the insects towards a trapping device. This research using continuous trap; pitfall trap, yellow pan trap and light trap. The every area divided with quadrant technique, as many as four quadrants. In one quadrant there are sixteen pitfalls, one light trap and four yellow pan traps.

1) Sweeping net

One of the most valuable pieces of equipment for studying insects. The net is a very handly tool and considered a much valuable equipment. Made up of three parts which is bag made up of cloth, wire hoop and handle or pole made up of wood or metal. The cloth size 96cm. The length of wire is about 150-200cm. The hoop in a proper round shape, use wire wrapped around a cross of wood. The cloth able air to flow freely and easy to see through it. This trap use hand and sweeping.

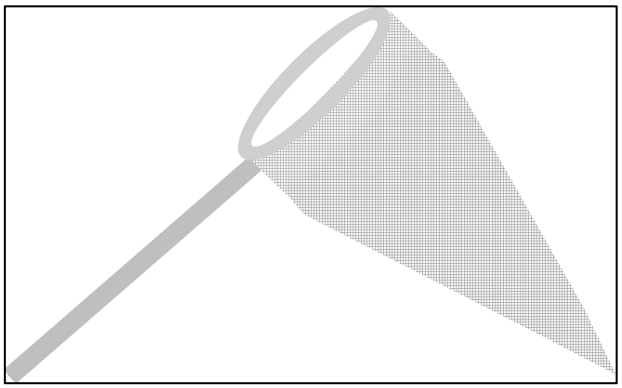

Figure 2 : Sweeping net

2) Pitfall trap

Pitfall traps are used to collect insects that crawl along the surface of the ground. Pitfall traps using plastic bowl and bury up to the rim, so that rim is level with the ground surface. Insects crawling over the surface of the ground will fall into the bowl and will be unable to climb out.

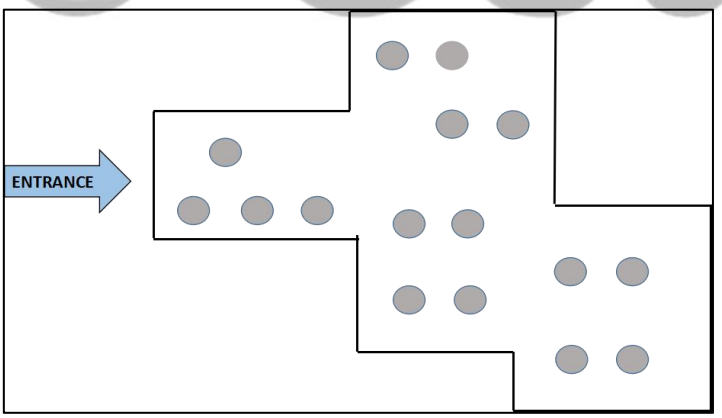

Figure 3 : Pitfall trap pattern

3) Yellow pan trap

In this trap, using shallow pans and colour in yellow. The pans might be replaced with bowls, plates, trays and food containers. The traps installed by simply placed on the ground. The yellow colour attracted the insects to came to the traps.

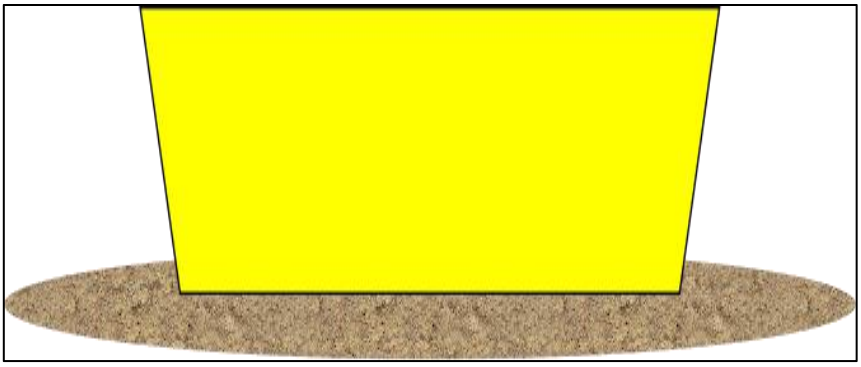

Figure 4 : Yellow pan trap

4) Light trap

The insects are attracted to the light. Since many insects navigate by the moon, they get confused by bright lights and are attracted to them instead. To make a light trap, hanging a white sheet or cloth near a porch light. The insects will be came to the traps because of the lights and land on the sheet. The insects will be collected off the sheet by hand.

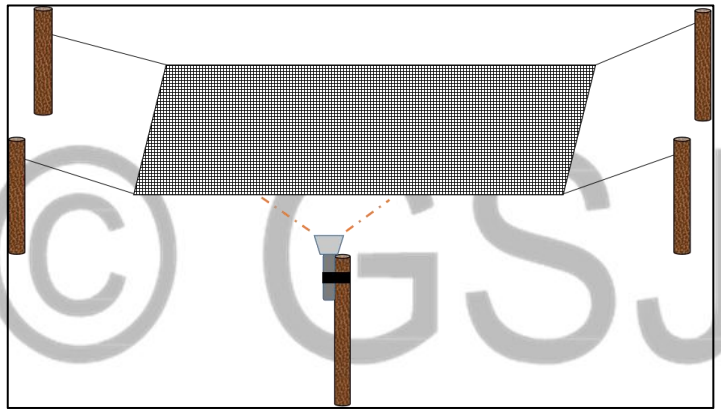

Figure 5 : Light trap

All of that traps setup up from week 2 until week 10. For light trap, setup on every evening until next morning where insects nocturnal species active at night and more attracted to the lights. All the insects that captured are put into plastic.

Analysis of Data

Insect identification

The insect identification is done by using morphological identification technique where determining its taxonomy such as Scientific Name, Order and Family with various references.

Shannon-Wiener Index of Diversity (H')

The Shannon-Wieneri index of diversity (H') is to characterize species diversity in a community where it is another index that is commonly used. It is a quantitative measure that reflects how many different types such as species there are on a

community. The Shannon-Wiener index assumes that all species are represented in a sample and that the sample was obtained randomly.

where:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

H = the Shannon-Wiener Index of Diversity
$\mathbf{P_i}$ = fraction of the entire population made up of species *i*
S = number of species
$\sum$ = sum from species 1 to species 5

RESULT AND DISCUSSION

Major Insect Orders Between Edge and Within Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak

There are 3 insect orders found at Edge Secondary Tropical Forest where the order are Coleoptera, Blattodae, and Hemiptera. The number of insects found is 6 individual insects which is Coleoptera (*Alaus lacteus, Lepidiota stigma*): 2, Blattodae (*Blatta orientalis, Pseudophoraspis sp.*): 2 and Hemiptera (*Tessaratoma sp., Megapomponia merula*): 2. The insect order on Edge Secondary Tropical Forest have the same number of individual insects in which each insect order has 2 individual insects.

While for Regenerated Secondary Tropical Forest there are 4 individual insects found. There are 3 insect orders identified where Hymenoptera (*Paratrechina longicornis*): 20, Orthoptera (*Laxta sp., Blatta orientalis*): 2, and Coleoptera: 10 (*Hydrochara spp.*). The highest individual order found is insect order Hymenoptera which is 20 individual insects and the lowest is Orthoptera which is 2 individual insects.

The total number of insect order found from the 2 types of forest is 5 orders, Coleoptera, Blattodae, Hemiptera, Hymenoptera. It was found that the two forests had the same order of insects, Coleoptera, insect order for tough-skinned insects like beetles. Figure 1 and Figure 2 below shows the number of insects recorded based on the type of insect order on both types of forest.

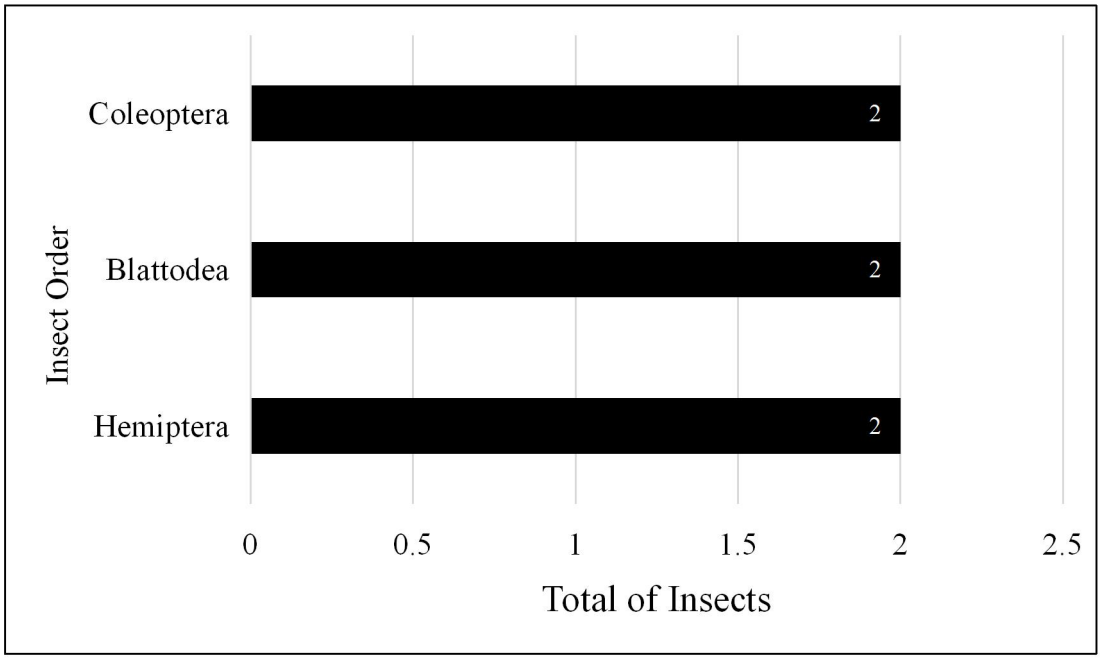

Figure 6 : The Total Number of Insects Trapped based on Insect Order at Edge Secondary Tropical Forest in UPM Bintulu, Sarawak

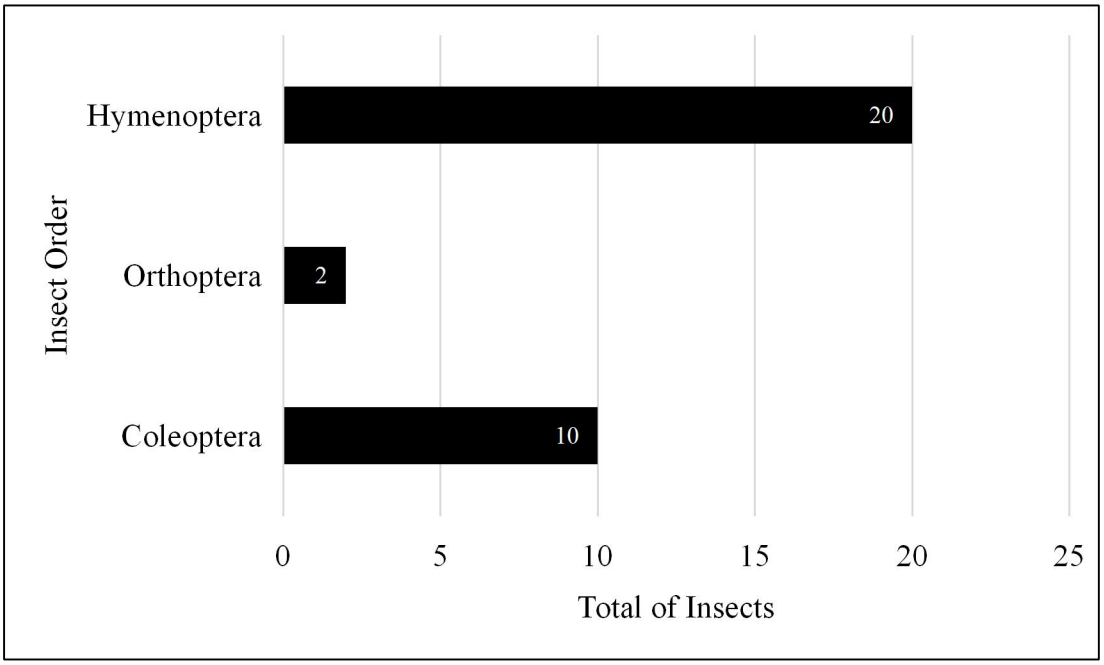

Figure 7 : The Total Number of Insects Trapped based on Insect Order at Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak.

Efficiency of Insect Traps Between Edge and Within Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak

The study was conducted using four types of insect trap installed in both forest types Edge Secondary Tropical Forest and Regenerated Secondary Tropical Forest. These traps are pitfall, light trap, yellow pan and sweeping net.

In figure 3, Edge Secondary Tropical Forest, the number of insects recorded is 6 individual insects on different trap traps. At pitfall traps there are 2 individual insects found. Whereas in light trap is 3 individual insects. At yellow pan trap, there no trapped insects and for sweeping net trap only 1 individual insect found. Light trap is a trap that has the highest individual number of insects trapped which is higher than other traps. While the trap with a lowest number of insects is yellow pan where there no insects trapped.

At figure 4, the Regenerated Secondary Tropical Forest, there are 4 individual insects trapped on traps that are used but only pitfall traps are recorded. While other traps which is light trap, yellow pan and sweeping net were not able to trap insects in the forest.

Figure 3 and figure 4 below shows the number of insects recorded based on type of traps at Edge Secondary Tropical Forest and Regenerated Secondary Tropical Forest.

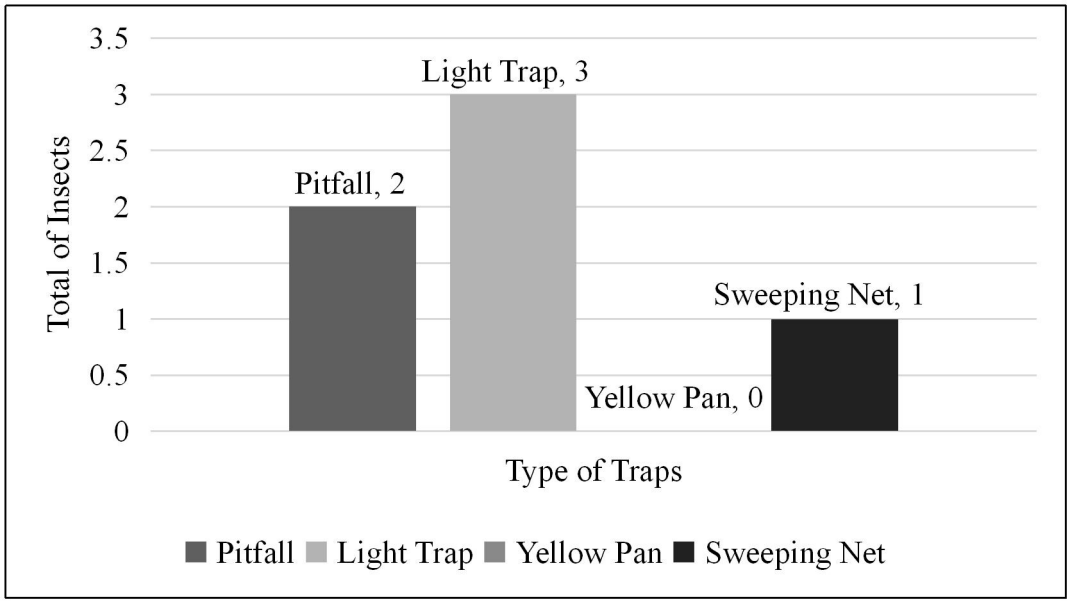

Figure 8 : The Total of Insect Trapped Based on Insect Order at Edge Tropical Forest in UPM Bintulu, Sarawak

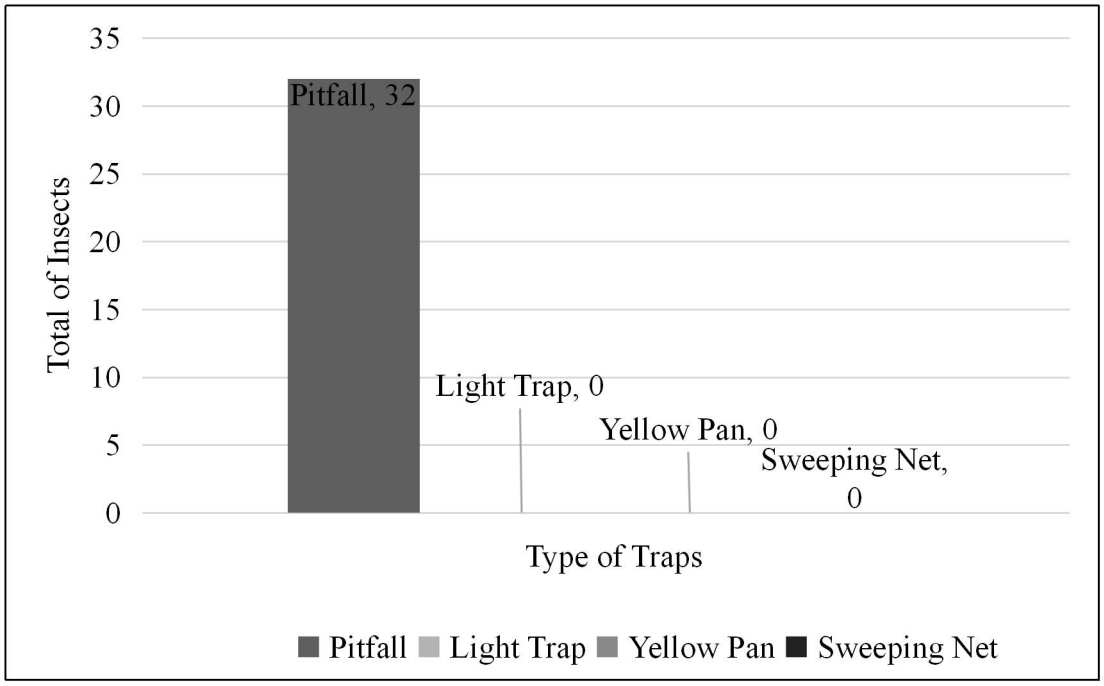

Figure 9 : The Total of Insect Trapped Based on Insect Order at Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak

Shannon-Wiener Index of Diversity (H') and Species Evenness Between Edge and Within Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak

Table 1 shows the Shannon-Wiener index diversity (H') responds to differences in both richness and evenness. The Shannon-Wiener index diversity for Edge Secondary Tropical Forest (H') shows the value 1.10 and for Regenerated Secondary Tropical Forest, the value is 0.833. The H' for Edge Secondary Tropical Forest is more diversity compare than Regenerated Secondary Tropical Forest because the values for H' is higher compare the Regenerated Secondary Tropical Forest. The higher of Shannon-Wiener index diversity (H'), the more diversity of insect species.

For Edge Tropical Forest, the species evenness is 1.00 where that mean that all insect order have the same frequency. Typically values are generally between 1.5 and 3.5 in most ecological studies and indicate for diversity, and the index is rarely greater than 4. For Regenerated Secondary Tropical Forest, the species evenness is 0.755. The species evenness for that forest a little bit low than Edge Tropical Forest.The normalizes Shannon-Wiener Index of Diversity a value between 0 and 1. The nearest the values into 0 indicate that the insect species dominant into 1 species. The value nearest to the 1, the insect species more evenness.

Table 1 : Shannon-Wiener Index of Diversity (H') and Species Evenness for Edge Secondary Tropical Forest in UPM Bintulu, Sarawak

No	Insect Order	(n)	(n/N) Relative Abundance	ln(n/N)	n/N*In(n/N)
1	**Hemiptera**	2	0.333	-1.099	-0.366
2	**Blattodea**	2	0.333	-1.099	-0.366
3	**Coleoptera**	2	0.333	-1.099	-0.366
	N	6			
	Species Richness (S)	3			
	Number of individuals	6			
	Shannon-Wiener Index of Diversity (H'):	1.10			
	Species Evenness (H'/ln(S)):	1.00			

Table 2 : Shannon-Wiener Index of Diversity (H') and Species Evenness for Regenerated Secondary Tropical Forest in UPM Bintulu, Sarawak.

No	Insect Order	(n)	(n/N) Relative Abundance	ln(n/N)	n/N*In(n/N)
1	**Blattodea**	2	0.063	-2.765	-0.173
2	**Coleoptera**	10	0.313	-1.1620	-0.363
3	**Hymenoptera**	20	0.625	-0.4700	-0.294

N	32
Species Richness (S)	3
Number of individuals	32
Shannon-Wiener Index of Diversity (H'):	0.83
Species Evenness (H'/ln(S)):	0.755

CONCLUSION

This study successfully recorded 5 orders of insect in two different type of forest which are Edge Secondary Tropical Forest and Regenerated Secondary Tropical Forest. It has been figured out that both forest type consist of same insects order. The orders are Coleoptera, Blattodae, Hemiptera, Hymenoptera, and Coleoptera. The Shannon-Wiener index diversity (H') responds to differences in both richness and evenness. The Shannon-Wiener index diversity for Edge Secondary Tropical Forest (H') shows the value 1.10 and for Regenerated Secondary Tropical Forest, the value is 0.833. The H' for Edge Secondary Tropical Forest is more diversity compare than Regenerated Secondary Tropical Forest because the values for H' is higher compare the Regenerated Secondary Tropical Forest. The higher of Shannon-Wiener index diversity (H'), the more diversity of insect species. For Edge Tropical Forest, the species evenness is 1.00 where that mean that all insect order have the same frequency. Typically values are generally between 1.5 and 3.5 in most ecological studies and indicate for diversity, and the index is rarely greater than 4. For Regenerated Secondary Tropical Forest, the species evenness is 0.755. The species evenness for that forest a little bit low than Edge Tropical Forest.The normalizes Shannon-Wiener Index of Diversity a value between 0 and 1. The nearest the values into 0 indicate that the insect species dominant into 1 species. The value nearest to the 1, the insect species more evenness. The presence of distinctive number of insects are influence by the biotic and abiotic factors of the surrounding area which it can provide shelter and food for the insects. Moreover, when it is a raining season, the number of individual insects decrease, so that the presence of other insects species also decrease. From the result obtained, it can be conclude that Edge Secondary Tropical Forest has the best ecosystem and provide a prominent level of insects diversity. With the limitation of expertise in taxonomist in this study and the time constraint especially in the species identification, further efforts will be needed to increase the sampling areas. It is hoped that, this study provided the data needed for the conservation and improvement of the environment in the future. For future studies, identification of overall species is important for conservation purposes to determine the endemic species and endangered species in the study area in line with the Malaysian Convention on Biological Diversity (CBD).

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