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ENTOMOFAUNAL DIVERSITY OF HYMENOPTERA AT HUTAN SIMPAN UiTM JENGKA, KEM SRI GADING

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ABSTRACT

A study on abundance and diversity of Hymenoptera was conducted in Hutan Simpan UiTM Jengka Kem Sri Gading to determine the relationship of diversity of Hymenoptera with the environmental gradient. The samplings were conducted from November 2013 to April 2014 using Malaise traps. Three malaise traps were installed at the forest fringe and another tree were placed at the inner forest. A total of 286 Hymenopteran comprising of 15 subfamilies and 63 species (morphospecies) were collected. The families identified were Icheneumonidae, Sphecidae, Braconidae, Formicidae, Vespidae, Pompilidae, Apidae, Tiphiidae, Bethylidae, Ampolicidae, Thynnidae, Evaniidae, Gasteruptiidae, Pelecinidae and Rhopalosomatidae. Overall result showed that Ichneumonidae was the most abundant family with 56 individuals while family Gasteruptiidae was the least abundant family with only one individual recorded. Inner forest had the most individual collected with 191 individuals that comprise of 12 families and 48 morphospecies. On the other hand, forest fringe recorded only 95 individuals (11 families and 28 morphospecies). Shannon Weiner Diversity Index (H') showed that each studied plots did not differs significantly ($P>0.05$) with inner forest having the highest diversity value for Hymenoptera with H'=2.13 while forest fringe recorded H'=2.09. Evenness index for both study sites recorded the same value of E'=0.88. For the Margalef index, inner forest recorded R'=2.09 slight lower than forest fringe with R'=2.19. As a conclusion, this study suggests that diversity and abundance of Hymenoptera was higher at inner forest compared to forest fringe. Overall study showed that the diversity and abundance of Hymenoptera in both study sites were low since the value of H' were less than 3.50.

Key words: Diversity, abundance,Hymenoptera, Hutan Simpan UiTM, reserve forest

INTRODUCTION

Insects are the richest species than other forms of life combined. They can be found in terrestrial habitat, fresh water and also can be found flying in the air (Campbell *et al.,* 2008). Insects fall into kingdom Animalia, phylum Athropoda and class Insecta. Alevi *et al.* (2013) claim that class Insecta comprises approximately 1,000,000 species distributed in 32 orders (Alevi *et al.,* 2013). Hymenoptera is the second largest insect orders after order Coleoptera. Order Hymenoptera include bees, ants and wasps are biologically and economically important members of natural and agro ecosystems (Ayasse *et al.,* 2001). This reflects their economic importance in agriculture and forestry, as pests or beneficial insects (Cheng, 2007). This order has the most highly developed insects' behaviour and social pattern. Hymenopterans undergo complete metamorphosis and have three divisions of body parts (Campbell *et al.,* 2008). Hence, the objective of this study was to determine the diversity of Hymenoptera in an inner forest and forest fringe.

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MATERIALS AND METHODS

Chemicals and raw materials

The chemical used was 70% alcohol and the raw materials used in this study were the insects collected from the sampling site at Kem Sri Gading, Hutan Simpan UiTM Jengka, Pahang, Malaysia.

Sampling Area

This study was conducted at Kem Sri Gading, Hutan Simpan UiTM Jengka located in Pahang. The sampling area was divided into two transect line; the forest fringe and inner forest. Study was conducted at this site starting from November 2013 until April 2014.

Sample Collection

Malaise trap with collecting jar was half-filled with 70% alcohol. Alcohol solution was used to kill the insects after they move up in the net and enter the alcohol solution. Mainly, the alcohol acts as a preservative in the collecting chamber so that sample will be preserved. Samples were collected from each trap every month for four month period. In every collection of samples, collecting jars were replaced with a new one.

Mounting and Preservation

All the samples in the collecting jar were sorted according to their families. The insects were preserved by using 70% alcohol before pinning. The right sizes of entomological pins were used to pin the specimens. The specimens were dried up and mounting process was done by mounting the insects with minute pin. The insects were mounted so that the ventral side of the body and legs are visible. The specimens were dried in an oven for a week at temperature between 38°C to 40°C.

Family Identification

After mounting and preserving the samples, the Hymenopterans were sorted according to their families. Sorting was based on their morphological and physical characteristics using microscopic observation technique. After that, the specimens were compared and identified at the Centre of Insects Systematic, Faculty of Science and Technology, Universiti Kebangsaan Malaysia (UKM).

Statistical Analysis

The Shannon's Weiner diversity index was used using log base e to analyse the data and also to measure the diversity in the study area. In order to show evenness and dominances among families of each habitat type the Evenness Index was used. Margalef Richness Index also was used to analyse the collected data. Meanwhile, independent t-test was used to compare abundance and species richness among different habitats in study area.

RESULTS AND DISCUSSION

Abundance of Hymenoptera in forest fringe and inner forest

Overall, 62 morphospecies were collected in this study. Forest fringe recorded 11 families with 28 morphospecies while inner forest recorded 12 families with 48 morphospecies (Table 1). Table 1 show the total sample collected at forest fringe were 95 specimens (33.3%) and at inner forest 191 specimens which contributed 66.7% from the overall result. Inner forest of Hutan Simpan Kem Sri Gading showed the highest number of samples collected during the study period. The result support qualitative analysis done by Jason *et al*. (2005) who

Table 1. Number of Hymenoptera at forest fringe and inner forest in Hutan Simpan Kem Sri Gading

Family	Morphospecies	Sites		Total
		Forest fringe	Inner forest	
Ichneumonidae	16	17(7)	39(11)	56
Apidae	3	3(2)	10(2)	13
Vespidae	8	8(5)	11(5)	19
Pombilidae	6	19(6)	2(2)	21
Sphecidae	5	5(2)	38(4)	43
Gasteruptiidae	1	1(1)	0	1
Formicidae	1	12(1)	13(1)	25
Tiphiidae	2	19(1)	8(2)	27
Pelicinidae	1	4(1)	0	4
Rhopalosomatidae	1	2(1)	0	2
Evaniidae	2	5(1)	1(1)	6
Bethylidae	1	0	22(1)	22
Ampolicidae	1	0	13(1)	13
Thynnidae	5	0	8(5)	8
Braconidae	6	0	26(6)	26
Total individual		95 33.3%	191 66.7%	286
Total family	15	11	12	
Total morphospecies	59	28	41	

* The value in the bracket is the total number of morphospecies among families of Hymenoptera at different sites

revealed that the relative habitat specificity of Hymenoptera decreased with habitat disturbance (Jason *et al.,* 2005).

The malaise traps set at the inner forest are less likely to be disturbed by any disturbances such as from human. The Inner site of the forest also has lower temperature compare to the forest fringe. The humidity was also quite high due to the placement of malaise trap near to the river. This statement differ from the claim made by Siti Khairiyah *et al.* (2011) that certain species of insects were abundantly found along the forest fringe where many species of flowering plants were found (Siti Khairiyah, 2011). Low numbers of Hymenoptera at forest fringe maybe due to the fact that the site is more open and exposed.

Insects need shelter from predator or human activities. Thus, at forest fringe where there are fewer trees, shrubs and grass, Hymenopetrans does not prefer to build their nest. Malaise trap set at the forest fringe was near to the camping site. Thus, more exploitation occurred compared to inner forest. The higher numbers of disturbance reduces the number of dispersal of insects (Keller *et al.,* 2001). Ichneumonidae was the most abundant at inner forest and the second largest individuals at forest fringe.

The number increased toward the interior forest. The number of individual of Ichneumonid wasps at forest fringe were 17 and at inner forest were 39. Ichenuemonidae was the most abundant family in Hymenoptera. This study was supported by Idris *et al.* (2002) which diversity of Ichneumonid species increases towards interior forest (Idris *et al.,* 2002). In tropical regions, Inchneumonidae is highly abundant in continuous region (Ruiz-Guerra *et al.,* 2013).

The second highest number of individuals in the inner forest was Sphecidae. Species in this family are predators include mud daubers and digger wasps. These wasps seem to locate their wasps based on chance while flying along the top of vegetations. They only differ in their hunting tactics (Blackledge and Pickett, 2000). Based on Starr (2004) most of the species build their nest on hanging roots (Starr, 2004). Thus, these support the findings that Sphecidae prefer to resides in the inner forest due to the abundance of trees.

On the other hand, resulst showed that at forest fringe, Pompilidae and Tiphiidae were the most abundant family collected. They shared the total of 19 individuals at the study site.

Pompilidae are also known as spider wasps. In research conducted by Szczepko *et al.* (2012), they found that the highest numbers and greatest species richness of Family Pompilidae at sites in open habitats, especially those located on dry soils. They preferred nesting sites of ground (Szczepko *et al.,* 2012). Thus, this can support the result from this study which Pompilidae were the most abundant in forest fringe with 19 individuals. The area of forest fringe covered with less shrubs and shorter trees by which the area is more exposed.

Diversity, Eveness and Richness of Hymenoptera

Abundance of the community were calculated by using Shannon-Weiner Index (H'), Margalef Index (R') and Evenness Index (E'). Basically, H' is used to measured diversity of the species represented in the sample while R' or species richness is to quantifies how many different types species in the sample. Evenness Index calculates how the individuals evenly distributed among different species (Table 2). The value of Shannon diversity is usually found to fall between 1.5 and 3.5; both sites have the valid value of diversity. The value of H' that less than 3.0 indicated that the study area has been disturbed and unstable.

Table 2. Community Indices of Forest Fringe and Inner Forest

Sites	H'	E'	R'
Forest Fringe	2.10	0.88	2.19
Inner Forest	2.19	0.88	2.09

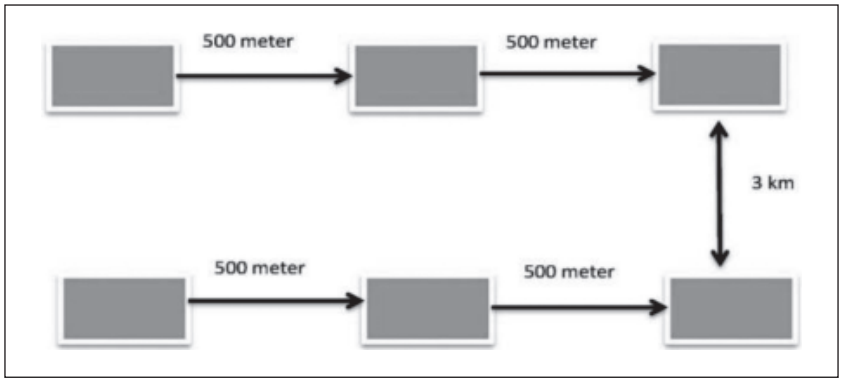

Fig. 1. Arrangement of Malaise traps.

Although both sites have H' less than 3.0, inner forest give the highest H' index due to the factor that location of inner forest is further into the forest and less disturbance. It has more plant and shrubs that can support the life of Hymenopterans. In contrast, lower H' value of forest fringe was due to the factors lack of vegetation. If insects do not find suitable nesting sites, they will move to somewhere where they can hide from predator and seek for shelter. Less flowering plant at the forest fringe also contribute to the least number of individuals. Evenness indices standardize abundance and range from near 0 when most individuals belong to a few species, to close to 1, when species are nearly equally abundant (Smith and Wilson 1996).

Same value of E' at both sites indicates that the species were evenly distributed throughout the forest. H' is also influenced by the value of E' and R'. Even though, both sites have the same Margalef's Index which is E' = 0.88 the sites are differentiated by the value of H' and R'. Species richness at forest fringe and inner forest did not show much difference. This may be because of the location that is only being separated by 500 meter. Insects' accumulations at the circumference are approximately same in number. At the study sites, the diversity values are low and these influence by many factors. One of the factors and most vulnerable are human impact such as climate changes (Bellwood and Hughes, 2001). Climate and weather also influenced the diversity of Hymenoptera in Hutan Simpan Kem Sri Gading.

Moreover, the sampling was conducted in November to April which rainy day is more frequent. Hymenopterans mostly do not reproduce during rainy seasons. In addition, the sampling sites are near to camping site. It is also one of the factors that reduce the diversity of the insects in the forest. Human activities reduce the number of species of insects in the forest. Body size and feeding habits were associated with habitat specialization at the family level. In particular, habitat generalists at the family level Hughes *et al.,* 2000). The pattern of distribution of the entire individual in Family Hymenoptera showed no significant difference with $P>0.05$. Statistical t-test comparing both forest fringe and inner forest show no significant different. The reason of this statistic value is that the length different of those two traps were only 500 meter.

CONCLUSIONS

As conclusion, there were 286 samples of Hymenoptera collected from the inner forest and forest fringe of Hutan Simpan Kem Sri Gading. The number of Hymenoptera was higher at inner forest compared to forest fringe. But overall diversity of Shannon-Weiner value of Hymenoptera in the forest was low. Species richness and abundance of individuals of this family is influenced by plant diversity, structural complexity and availability of food and nesting resources. Human disturbance also affect the number of samples.

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