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Insects Diversity and Abundance in Coastal and Inland Forest of Perhentian Island, Terengganu, Peninsular Malaysia

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Perhentian Island is one of the most famous tourism sites in Terengganu, Peninsular Malaysia. The impact of tourism activities as well as high construction of infrastructure and facilities can pose a threat to flora and fauna, particularly on insects. Therefore, this study aimed to determine the insects' diversity and abundance in the coastal and inland forest of Perhentian Islands using three insect's traps which were; Malaise traps, yellow pan traps, and pitfall traps. The traps (i.e. three points per plots) were left for seven days before the insects were collected. A total of 1382 individuals of insects consisting of 11 orders were successfully collected with order of Diptera and Hymenoptera dominate the number of individuals collected. The insect's individuals were slightly higher in the coastal forest with 699 individuals (11 orders) than in the inland forest with 683 individuals (9 orders).However, there was no significant difference (P>0.05) of insect's abundance recorded between the coastal and inland forest of Perhentian Island. The Shannon-Weiner Diversity Index (H') showed that the diversity of insects in the coastal forest was higher with H'=1.51 than inland forest with H'=1.35 respectively. We conclude that the insects' diversity and abundance in Perhentian Island is relatively high in coastal forest but low in inland forest. This research provides a basic information and dataset of insects' diversity and abundance which may useful for further ecological research at Perhentian Island in the future.

Keywords: Insects, diversity, population, forest, island

INTRODUCTION

Insect is an important component of the most natural and transformed landscape. They play an important role in ensuring the delivery of various ecosystem services that are important to some aspects of human life such as agriculture, tourism, and natural resource (Kehinde et al., 2014). Insects are the world's most diverse group of animals and covered more than 58% of the global biodiversity (Adler and Foottit, 2009). Therefore insects can be found unbelievably great from the tropical rainforest canopy including in the island forest. Ecologically, insects are functionally important for forest ecosystems as pollinator, herbivore, decomposer, predator or parasitoid (Idris and Hasmawati, 2002). The islands located in the east coast of Peninsular Malaysia is very heavily forested and may provide a very important ecological role (Cronk, 2001). The islands offer a place for endemic, endangered and migratory species as previously evident in the same forested islands in Southeast Asia (Turner et al.,

2002).

The tourism industry is one of the largest services industries in Malaysia and Perhentian Island is one of the most popular tourist sites of Terengganu in Peninsular Malaysia. The forest of Perhentian Island is endowed with high biodiversity of flora and fauna (Pesiu et al., 2017). However, the impact of tourism activities on the environment has spread in various components which directly affected ecological and natural resources (Ramdas and Mohamed, 2014). The high construction of infrastructure and other facilities that aiming for increasing number of tourists threatens the habitat surrounded by flora and fauna. Constant destruction of the forest in Perhentian Island will have an impact on insects' abundance that eventually lead to the extinction of certain species. Thus, the destruction of forest greatly influenced the insect's abundance to inhabit in the forest island due to the decrease in the plant diversity that acts as the food sources and shelter to them. To date, there is no details study was conducted in assessing the insect diversity and abundance of coastal and inland forest at Perhentian Island. We suspect the diversity and abundance of the coastal forest and inland forest at that area may different. Therefore, this study was conducted to determine the diversity and abundance of insects between the coastal and inland forest of Perhentian Island. The data observed can be used for further ecological research at Perhentian Island in future.

MATERIALS AND METHODS

Sampling Site

This research was conducted at Big Perhentian Island, Besut, Terengganu, Peninsular Malaysia. It is located 20 km (10 nautical miles) from the north-eastern coast of Peninsular Malaysia with the maximum elevation is 70 m above sea level (asl). The samplings were carried out at two different forest types namely the coastal forest viz. 1 to 30 m asl (Plot A) and the inland forest viz. 50 to 70 m asl (Plot B). Each plot consists of three sampling points and the selection of trapping points in each sampling point is done randomly.

Insects sampling were carried out with three distinct types of trapping techniques such as Malaise trap, yellow pan trap and pitfall trap. In each sampling points, one Malaise trap and three yellow pan traps and three pitfall traps were set up. The traps were left in the forest for seven days (from 5 August 2018 – 12 August 2018). The insects collected were preserved in the collecting bottles containing 70% ethanol before brought back to the laboratory for sorting and identification process.

Insects Identification

The samples were brought to the Laboratory of Entomology, Faculty of Bioresources and Food Industry, Universiti Sultan Zainal Abidin (UniSZA) for the identification process. All insects collected were sorted out according to their order by using forceps. The insects were pinned to preserve the structure of the sample. The identification of orders was based on their morphological and physical characteristic under stereoscopy microscope (Olympus SZ51, Japan). All the specimens were identified based on Triplehorn and Johnson (2005).

Data Analysis

T-test analysis was conducted in comparing the insect abundance between the coastal and inland forest. One-way ANOVA was used for comparing the abundance of insects between orders. Both T-test and One-way ANOVA were analyzed using Minitab software version 2018. Analysis of the insect's diversity, richness and evenness were done by the Shannon-Weiner Diversity Index, and Margalef's Richness Index using Bio-Dap software. Shannon-Weiner Diversity Index of species diversity is commonly used to ascertain the species diversity (Izsák and Papp, 2000).

RESULTS

The abundance of Insects in the Coastal and Inland Forest of Perhentian Island

A total of 1382 individuals of insects were successfully collected from Perhentian Island forest which comprised of 11 insect orders (Table 1). The orders were identified as Diptera, Hymenoptera, Lepidoptera, Coleoptera, Collembola, Homoptera, Orthoptera, Hemiptera, Dermaptera, Isoptera and Blattodea. From the total sample collected, 699 individuals were collected from the coastal forest comprised of 11 orders (Table 2) and 683 individuals were collected from the inland forest comprised of nine orders (Table 3). Nonetheless, there was no significant difference ($P>0.05$) occurred of the insect abundance between the coastal and inland forest of Perhentian Island (Figure 1).

Table 1 showed that the Diptera and Hymenoptera recorded significantly the highest

individual number of insects in Perhentian Island compared to other orders with 543 (39.3%) and 537 (39.9%) individuals, respectively and followed by Lepidoptera (82 individuals, 5.9%). Whilst the lowest number of individuals collected was Blattodea with only 2 individuals (0.1%). The remaining 15.8% of the number of individuals collected were Coleoptera, Collembola, Homoptera, Orthoptera, Hemiptera, Dermaptera, and Isoptera. Overall, the insect abundance according to the order in Perhentian Island had shown a significant difference ($P<0.05$).

Similarly, for both forests, Diptera and Hymenoptera order recorded the highest number of individuals with represented 75.6% from the total individuals collected at the coastal forest (Table 2) and 81% in the inland forest (Table 3). However, there was no significance differences observed for insect's abundance between inland and coastal forest of Perhentian Island ($P>0.05$) (Figure 1).

Table 1; Total composition of Insect abundance of different orders in Perhentian Island.

Order	Average Insect (± SE)	Total Insect	%
Diptera	4.33 ± 0.26^{a}	543	39.3
Hymenoptera	4.39 ± 0.21^{a}	537	38.9
Lepidoptera	2.50 ± 0.21^{b}	82	5.9
Coleoptera	2.52 ± 0.17^{b}	80	5.8
Collembola	2.12 ± 0.37^{bc}	67	4.9
Homoptera	1.50 ± 0.26^{bcd}	32	2.3
Orthoptera	0.98 ± 0.15^{cd}	17	1.2
Hemiptera	0.73 ± 0.73^{cd}	11	0.8
Dermaptera	0.69 ± 0.40^{cd}	7	0.5
Isoptera	0.55 ± 0.55^{cd}	4	0.3
Blattodea	0.33 ± 0.21^{d}	2	0.1
	Total insects	1382	100

Mean with the same letters was not significantly different at $P<0.05$

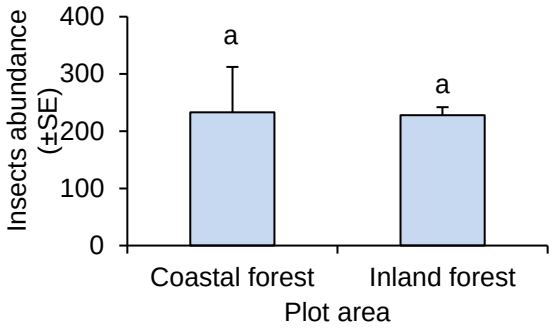

Figure 1; Insect abundance between the coastal and inland forest of Perhentian Island.

Table 2: The composition of insect abundance of different orders in the coastal forest of Perhentian Island.

Order	Average Insect (± SE)	Total Insect	%
Diptera	4.41 ± 0.40^{a}	294	42.1
Hymenoptera	4.23 ± 0.36^{ab}	234	33.5
Lepidoptera	2.63 ± 0.39^{abc}	48	6.9
Coleoptera	2.51 ± 0.06^{abc}	37	5.3
Collembola	2.52 ± 0.47^{abc}	45	6.4
Homoptera	1.33 ± 0.23^{bcd}	12	1.7
Orthoptera	0.99 ± 0.31^{cd}	9	1.3
Hemiptera	1.10 ± 0.9^{cd}	10	1.4
Dermaptera	1.39 ± 0.00^{cd}	4	0.6
Isoptera	0.55 ± 0.55^{cd}	4	0.6
Blattodea	0.00 ± 0.00^{d}	2	0.3
	Total insects	699	100

Mean with the same letters was not significantly different at $P<0.05$

Table 3; the composition of insect abundance of different orders in the inland forest of Perhentian Island.

Order	Average Insect (± SE)	Total Insect	%
Diptera	4.25 ± 0.40^{ab}	249	36.5
Hymenoptera	4.56 ± 0.26^{a}	303	44.5
Lepidoptera	2.37 ± 0.24^{bcd}	34	5.0
Coleoptera	2.73 ± 0.39^{bc}	43	6.3
Collembola	1.71 ± 0.53^{cd}	22	3.2
Homoptera	1.68 ± 0.51^{cd}	20	3.0
Orthoptera	0.96 ± 0.14^{cd}	8	1.2
Hemiptera	0.00 ± 0.00^{cd}	1	0.1
Dermaptera	0.35 ± 0.35^{d}	3	0.4
	Total insects	683	100

Mean with the same letters was not significantly different at $P<0.05$

Insects Diversity, Richness, and Evenness

Table 5 showed a summary of Shannon-Weiner Diversity Index, Evenness Index and Margalef's Richness Index in the coastal and inland forest of Perhentian Island The insect's diversity in the coastal forest is H'=1.51 and was higher than the inland forest with H'=1.35. But no significance different ($P>0.05$) of diversity was recorded between those forest. The result of species evenness showed similar value among coastal forest (E'=0.63) and inland forest (E'=0.62). Species richness (R') of coastal forest showed

higher value at 0.42, compared to the inland forest with lower value at 0.34.

Table 5; Shannon-Weiner Diversity Index, Evenness Index and Margalef's Richness Index of insects at Perhentian Island forest.

Index	Coastal Forest	Inland Forest
Diversity (H')	1.51	1.35
Evenness (E')	0.63	0.62
Richness (R')	0.42	0.34

DISCUSSION

The abundance of insects between the coastal and inland forest of Perhentian Island is non-significant ($p>0.05$). This might be due to the highest altitudes of the sampling site was only 70 m above sea level (a.s.l). According to McCoy (1990), the distribution of insects varies with every 100 m increase in elevation. His statement supported that the height of the sampling site in Perhentian Island was not high enough to meet a variety of insects. Besides that, Purcell (2010) reported that insects usually attribute at a lower elevation than higher elevation. For example, Khairul Husna et al. (2018) reported that the abundance of Diptera in Gunung Datuk, Negeri Sembilan had the highest number of individuals at low elevation (200 m asl) compared to high elevation (700 m asl). In addition, McCoy (1990) reported that the number of insects tends to decrease with elevation increase.

Results also showed that Diptera and Hymenoptera were the dominant insect orders in both types of Perhentian Island forest while Leidoptera was the third abundance order in both forests. The findings are similar to Koike et al. (1998) and Siti Aishah et al. (2017) which they reported that Diptera and Hymenoptera dominate the inside canopy structure in the tropical rainforest of West Kalimantan and Gunung Datuk, Negeri Sembilan, respectively. The reason for the highest number of Diptera recorded in Perhentian Island due to the Diptera as one of the largest groups of insects and make up the largest gathering of insects in the world (Brown, 2005). Diptera is important in balancing the ecosystem as it plays an important role as a pollinator, scavenger, predators and vector (Khairul Husna et al., 2018). Thus, hymenopteran species such as bees and ants as well as lepidopteran (butterflies) are also known as good pollinators for various vegetation. Previous studies conducted in Perhentian Island showed that about five species of bees were recorded (Adanan et al., 2016) while 32 species of butterflies were identified (Turner et al., 2003) and another 26 species of butterflies also were recorded at both Perhentian Island and Bidong Island (Rosmidi et al., 2017).

Meanwhile, the insect in the inland forest was less diverse might be due to a smaller number of trees to provide shelter or host for insects (Fara Nazuha, 2019). According to Abdul Hafiz et al. (2015), the diversity of insects in the coastal forest was higher due to the variation of plant species on the coastal island. Sanchez-Rodriguez and Baz (1995) stated that several factors contribute for the declines of insect richness at high elevation (i.e. inland forest) such as reduced habitat area, reduced resource diversity, reduced primary productivity and increasingly un-favourable environment at high elevations. According to Magurran (2004), the typical values of diversity are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4. However, referring to the diversity index value (H') for Perhentian Island which was between 1.5 (coastal forest) and 1.35 (inland forest), it can be considered that the diversity of insects was relatively high in coastal forest but low in inland forest. Furthermore, insect diversity and abundance are also influenced by biotic and abiotic factors and their interactions (Matilda, 2012). Some of the environmental factors that influence the abundance of insects were the temperature and humidity. Therefore, for the future, vegetation species, distribution and abiotic factor (i.e temperature (°C), relative humidity (%) and rainfall (mm) can be taken into consideration in determining the abundance and diversity of insects in Perhentian Island.

CONCLUSION

As the conclusion, the overall result showed that abundance of insects was not significantly different between the coastal and inland forest of Perhentian Island due to a small range of the elevation of the forest. Nonetheless, the insect's diversity of coastal forest was relatively higher than inland forest of Perhentian Island. Diptera and Hymenoptera were the most common order found in Perhentian Island forest followed by Lepidoptera order. They are functionally important for the well-being of the ecosystem. This study

provides basic information on the insects' abundance and diversity of insects at Perhentian Island. Further ecological research is required to investigate this pattern and the association with the distribution of vegetation at Perhentian Island in future.

CONFLICT OF INTEREST

The authors declared that the present study was performed in the absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

SM designed and performleed the experiments and also wrote the manuscript. KMZ and AZ performed data collection and data analysis. MR help with experimental design and data analysis. KM and MHS reviewed the manuscript. KM is the project leader for this research. All authors read and approved the final version.

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