# DIVERSITY AND ABUNDANCE OF DIPTERAN SPECIES AT TWO DIFFERENT ELEVATIONS IN GUNUNG DATUK, NEGERI SEMBILAN, MALAYSIA

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## ABSTRACT

A study on diversity and abundance of Diptera was conducted at two different elevations of Gunung Datuk viz. low (200 m) and high (700 m) from December 2014 to February 2015 using Malaise traps. Three malaise traps were set up in each elevation. A total of 1028 individuals of Diptera consisting of 31 families and 71 morphospecies were successfully collected. The abundance of Diptera at low elevation had the highest number of individuals collected with 627 (27 families, 62 morphospecies), while at high elevation only 401 individuals have been collected (23 families, 48 morphospecies). The most abundant family was Cecidomyiidae (322 individuals) while the least abundance was showed by the families Tipulidae, Rhagionidae and Agromyzidae with only one individual. The Shannon Weiner Diversity (H') showed that low elevation had the higher diversity value with H'= 3.71. Further analysis conducted by using T-test showed that there was no significant difference between both elevations ($P > 0.05$). Overall, this study showed that the diversity and abundance of Diptera were higher at low elevation compared to high elevation.

**Keywords**: Elevation, diversity, abundance, Diptera.

## ABSTRAK

Kajian ke atas kepelbagaian dan kelimpahan Diptera telah dijalankan di Gunung Datuk, Negeri Sembilan pada ketinggian rendah dan tinggi, iaitu 200 meter dan 700 meter dari bulan Disember 2014 sehingga Februari 2015 menggunakan perangkap Malaise. Tiga perangkap Malaise telah dipasang di setiap ketinggian. Sejumlah 1028 individu Diptera terdiri daripada 31 famili dan 71 morfospesies telah berjaya direkodkan. Kelimpahan Diptera pada ketinggian rendah merekodkan sebanyak 627 individu (27 famili, 62 morfospesies). Manakala, pada ketinggian 700 meter hanya 401 individu diperolehi (23 famili, 48 morfospesies). Cecidomyiidae adalah famili yang melimpah (322 individu). Selain itu, famili Tipulidae, Rhagionidae dan Agromyzidae menunjukkan kelimpahan rendah dengan satu individu. Indeks Kepelbagaian Shannon Weiner (H') menunjukkan ketinggian rendah mencatatkan nilai kepelbagaian tertinggi dengan H'=3.71. Ujian T menunjukkan tidak terdapat perbezaan yang signifikan antara dua ketinggian ($P > 0.05$). Hasil kajian mendapati bahawa

kepelbagaian Diptera adalah lebih tinggi di ketinggian rendah berbanding di ketinggian tinggi.

**Kata kunci**: Ketinggian, kepelbagaian, kelimpahan, Diptera

## INTRODUCTION

Insects are the world's most diverse group of animals (Adler & Foottit 2009). They have made up more than 58% of the global biodiversity. Order Diptera or true flies comprise of 10-15% animal diversity and are included among the four megadiverse insect order (Carvalho et al. 2018). Courtney et al. (2009) stated an estimation of 150 000 species of Diptera are known and many more undescribed species. This order was classified into about 10 000 genera, 150 families, 22 to 23 subfamilies, eight to nine infraorders and two suborder (Yeates et al. 2007). According to Scherber et al. (2014) insects from Order Diptera are among the most abundant animals in temperate habitats and fulfil the ecological functions, acting as predators, parasitoids, herbivores, detritivores and pollinators.

Most insect taxonomists divide the Order Diptera into two suborders namely Nematocera and Brachycera (Rohdendorf 1974). Nematocera are the flies with long antennae like mosquitoes. This suborder was distinguished by having a slender body with long legs and relatively long antennae with many segments of similar shape and size (Britton 2012). The mandibles of Nematochera are opposable and move horizontally (Cannings & Scoudder 2006). Whereas Brachycera are the flies with short antennae like house flies. Brachycera generally has a robust body with short antennae that are very variable in shape (Britton 2012). All Brachcyera have two or fewer segments in the maxillary palp (Cannings & Scudder 2006).

According to McCoy (1990), insect richness declines with elevation. There are some reasons for the declines of insect richness at high elevation such as reduced habitat area, reduced resource diversity, reduced primary productivity and increasingly unfavourable environment at high elevations (Sanchez-Rodriguez & Baz 1995). Previous study done by Hodkison (2005), Mcgsin and Grytnes (2010) claimed that the maximal diversity of insects is often recorded at low or mid elevation. However, research on the biodiversity of arthropods in tropical regions predominantly focused on lowland rainforest compared to montane rainforest (Brehm et al. 2003). Recent study done by Chatelain et al. (2018) was regarding Diptera, Empididae from Doi Inthanon, Thailand at gradient from 400-2556 metre. However, in this present study, the diversity and abundance of Diptera at two different elevations in Gunung Datuk was conducted at 200 and 700 metre. The result from this study can provide a baseline data for future research and monitoring of Diptera species with changes in this mountain habitat as Gunung Datuk is also known as recreational forest which has direct exposure with human activities.

## MATERIALS AND METHODS

This research was conducted at Gunung Datuk Negeri Sembilan. It is located in the Tampin Forest Reserve which is a hill dipterocarp forest (Forestry Department of Peninsular Malaysia 2013) with an elevation of 2900 feet. The samplings were carried out at two different elevations of Gunung Datuk Negeri Sembilan viz. low (200m) and high (700m) elevations. Six Malaise traps were used to collect the insects from both elevations. The traps were left

unattended for three months, but the collecting bottle filled with 70% alcohol were replaced every month.

All insects that were collected from collecting bottle were sorted out according to their order by using forceps. The insects were pinned to preserve the structure of the sample. After mounting and preservation process, the insects under Order Diptera were sorted out according to their families. The identification of families was based on their morphological and physical characteristic under stereoscopy microscope. The wings venation is always used in identifying Diptera species. Venation in Diptera is relatively simple and many families tend toward the reduction in number of veins. The wings are identified based on its color, shape, or character of the lobes at the wing base (Johnson & Triplehorn 2005).

The specimens were identified at Centre for Insect Systematic (CIS), Faculty of Science and Technology, Universiti Kebangsaan Malaysia (UKM). Data were analysed using Shannon-Weiner Diversity Index, Margalef's Richness Index and T-test. Statistical software Bio-dap was used for the all analyses.

## RESULTS AND DISCUSSION

According to Mohd Pudzi et al. (2016), general information on diversity and abundance of Insecta collected from Gunung Datuk have been obtained before. However, details on species level of the dipterans species never been conducted and carried out for the first time in this study. A total of 1028 individuals of Diptera was successfully collected from Gunung Datuk. From the sample collected, 627 individuals were collected from the low elevation and 401 individuals were collected from the high elevation. From that number, 31 families of Diptera were identified in which 17 families were found at both elevations, another nine families were found only at low elevation and the remaining five families were found only at high elevation. A total of 71 morphospecies were identified where 62 morphospecies were recorded at low elevation and 47 morphospecies were recorded at high elevation (Table 1).

Family Cecidomyiidae recorded the highest number of individuals collected at the low elevation of Gunung Datuk with 119 individuals followed by Thaumaleidae with 55 individuals represented and Phoridae with 51 individuals represented. The lowest number of individual collected were Tipulidae, Ulididae, Rhagionidae and Agromyzidae with only one individual.

Similarly, for high elevation, family Cecidomyiidae recorded the highest number of individuals with 203 individuals and this total number represented 50% from the total individuals collected at the low elevation. According to Skuhrava and Skuhravy (2010), Cecidomyiidae is one of the most diverse and economically important families of Diptera. This statement was supported by Gagne (2004) and Johnson and Triplehorn (2005). Johnson and Triplehorn (2005) proved that Cecidomyiidae is a large group with 1200 North American species, which about two thirds of it are the gall makers. Family Simulidae, Tachinidae, Phiophilidae and Chironomidae had the same number of individuals collected with nine individuals. The lowest number of individuals collected at the high elevation were from family Mycetophilidae and Muscidae with only three individuals each.

The highest numbers of individuals were at the low elevation with 627 individuals collected that represented 61% compared to the percentage of individual collected at the high

elevation with 401 individuals that represented only 39% from the overall results. Based on the results there were no significant difference in term of the abundance of Diptera between low and high elevation ($P < 0.05$)

A summary of Shannon-Wiener Diversity Index, Evenness Index and Margalef Richness Index is shown in Table 2. The results of the Shannon-Weiner Index, H' which mainly to measure the rarity and commonness of species in community revealed that, insect's diversity is 0.69 higher at low elevation, 200 m (H' = 3.71) than what was obtained at high elevation, 700 m (H' = 3.02). The data of E' value was high at low elevation (E' = 0.90) compared to the result obtained at high elevation (E' = 0.78). This result showed a regularity of distribution of individual species as E'> 0.7 that approached to E'=1. The low elevation recorded higher R' values (R' = 9.47) compared to low elevation (R' = 7.84).

According to Manuel (2008), if species diversity is high, then the study area has a complex environment in which have a high degree of species interaction. Both study site of Gunung Datuk at the low and high elevation have high value of species diversity. This supported by Sharkey (2007), stated that the higher H' value indicated the greater the diversity of species. For this reason, communities with higher diversities typically have higher levels of energy transfer, predation, competition and niche availability as pointed out by Manuel (2008) that if species diversity is higher, then that particular study area has a complex environment.

Even though there was no significant difference between both elevations, however there was slight difference as low elevation was found to be more abundant compared to the high elevations. This result was supported by the previous study by Khairiyah et al. (2013), stated that the low elevation has more abundant insects rather than at high elevation because there is high existence of vegetation like saplings, shrubs and spruces at low elevation. According to Dillon et al. (2006) insects experience constant low oxygen at high altitude, and this influence the low abundance of insect at the high elevation.

Furthermore, aaccording to Matilda (2012) insect abundance and diversity are influence by biotic and abiotic factors and their interactions. Some of the environmental factors that influence the abundance of insects were the temperature and the humidity. Temperature was the major abiotic factor that influence herbivorous insects because it affects development, survival, range and abundance (Bale et al. 2002). According to McReynolds (2003), the mosquitoes are very active in the period of dawn and dusk because these are cooler times of the day while the adult mosquitoes will also give feedback to small differences in temperature change. Elevation gradients create varied climates, along with resultant soil differentiation, promote the diversification of plant (Lomolino 2001).

## CONCLUSIONS

As a conclusion, overall result showed that diversity and abundance of Diptera were higher at low elevation compared to high elevations. From this study Cecidomyiidae were the most commonly family found in Gunung Datuk with 31.32%, followed by Phoridae (6.61%) and Thaumaleidae (6.42%). Dipteran diversity was higher at low elevation (H'= 3.71) than at high elevation (H'= 3.02) due to the higher E' and R' values. The T-test indicates that there was no significant difference between both elevations ($P > 0.05$). Diptera is important in balancing the ecosystem as it plays role as a pollinator, scavenger, predators and vector.

Since Diptera are important in nature and stabilize the ecosystem, Order Diptera should be conserved and protect to ensure their existence in the ecosystem.

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## APPENDICES

Table 1 The results of specimens collected based on families at Gunung Datuk, Negeri Sembilan.

| Families | Morphospecies | Site | | Total | Percentage (%) |
|---|---|---|---|---|---|
| | | Low | High | | |
| Tipulidae | 1 | 1(1) | 0 | 1 | 0.1 |
| Trichoceridae | 4 | 25(4) | 14(2) | 39 | 3.8 |
| Ptychopteridae | 2 | 19(2) | 4(1) | 23 | 2.2 |
| Cerotopogonidae | 3 | 26(3) | 6(2) | 32 | 3.1 |
| Culicidae | 2 | 26(2) | 11(2) | 37 | 3.6 |
| Dixidae | 2 | 29(2) | 8(2) | 37 | 3.6 |
| Simulidae | 2 | 8(2) | 9(2) | 17 | 1.7 |
| Thaumaleidae | 2 | 55(2) | 11(2) | 66 | 6.4 |
| Blephariceridae | 2 | 19(2) | 0 | 19 | 1.8 |
| Anisopodidae | 2 | 27(2) | 0 | 27 | 2.6 |
| Axymiidae | 2 | 39(2) | 0 | 39 | 3.8 |
| Cecidomyiidae | 3 | 119(3) | 203(3) | 322 | 31.3 |
| Mycetophilidae | 2 | 0 | 3(2) | 3 | 0.3 |
| Rhagionidae | 1 | 1(1) | 0 | 11 | 1.1 |
| Tabanidae | 2 | 11(2) | 8(2) | 19 | 1.8 |
| Acroceridae | 3 | 31(3) | 0 | 31 | 3.0 |
| Asilidae | 3 | 5(3) | 0 | 5 | 0.5 |
| Dolichopodidae | 3 | 4(3) | 6(2) | 10 | 1.0 |
| Phoridae | 3 | 51(2) | 17(3) | 68 | 6.6 |
| Syrphidae | 2 | 4(2) | 12(2) | 16 | 1.6 |
| Calliphoridae | 2 | 2(2) | 7(2) | 9 | 0.9 |
| Oestridae | 2 | 0 | 4(2) | 4 | 0.4 |
| Tachinidae | 2 | 0 | 9(2) | 9 | 0.9 |
| Phiophilidae | 2 | 12(2) | 9(2) | 21 | 2.0 |
| Tephritidae | 4 | 28(4) | 11(4) | 39 | 3.8 |
| Ulididae | 3 | 1(1) | 30(3) | 31 | 3.0 |
| Drosophilidae | 2 | 28(2) | 7(2) | 35 | 3.4 |
| Chironomidae | 2 | 5(2) | 9(2) | 14 | 1.4 |
| Ephydridae | 3 | 30(3) | 0 | 30 | 2.9 |
| Muscidae | 2 | 10(2) | 3(2) | 13 | 1.3 |
| Agromyzidae | 1 | 1(1) | 0 | 1 | 0.1 |
| Total individual | | 627 | 401 | 1028 | |
| Total Families | 31 | 27 | 23 | | |
| Total morphospecies | 71 | 62 | 48 | | |

(The value in the bracket is the total number of morphospecies among family Diptera at the study site)

Table 2 Diversity Index Analysis of Diptera at Gunung Datuk, Negeri Sembilan.

| | Low Elevation (200 m) | High Elevation (700 m) |
|---|---|---|
| H' | 3.71 | 3.02 |
| E' | 0.9 | 0.78 |
| R' | 9.47 | 7.84 |