



**Diversity and Distribution of Dragonflies (Odonata)  
in Universiti Malaysia Kelantan Jeli Campus,  
Kelantan**

by

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A report submitted in fulfillment of the requirements for the degree of  
Bachelor of Applied Science (Natural Resources Sciences) with  
Honours

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**FACULTY OF EARTH SCIENCE  
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2024

## DECLARATION

I declare that this Final Year Project (FYP) report entitled "Diversity and Distribution of Dragonflies (Odonata) in Universiti Malaysia Kelantan Jeli Campus Kelantan" is an original report of my research study. I am aware of and understand the university's policy on plagiarism and I certify that this report is my own work, except where indicated by reference, and the work presented in it has not been submitted in support of another degree or qualification from this or any other university or institute of learning. Except where stated otherwise by reference or acknowledgement, the work presented is entirely my own.

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**Diversity and Distribution of Dragonflies (Odonata) in Universiti Malaysia  
Kelantan, Jeli Campus, Kelantan.**

**ABSTRACT**

A study on the diversity and distribution of dragonflies was conducted in Universiti Malaysia Kelantan, Jeli Campus, Kelantan. The objectives were to determine diversity and distribution of dragonflies in Universiti Malaysia Kelantan Jeli Campus. Sampling was conducted from 22 February 2024 until 07 March 2024 in the three selected study sites with 10 sampling days. A total of 162 individuals from one family, 6 genera and 13 species were recorded using sweep net. *Acisoma* (2 species), *Brachydiplax* (1 species), *Neurothemis* (3 species), *Orthetrum* (4 species), *Rhytemis* (1 species) and *Trithemis* (2 species) were identified in this research. The most dominant genera that be recorded are *Brachydiplax*. The diversity indices that applied for the data analysis and value were obtained; Shannon-Wiener Index,  $H'$  site A= 0.368, site B = 1.106, site C=1.642. The values of these diversity indices of dragonfly's species were higher at site C. There were because of several factors that can affect the determination of dragonfly's diversity such as food sources and suitable habitat

**Kepelbagaian dan Taburan Papatung (Odonata) di Universiti Malaysia  
Kelantan, Kampus Jeli, Kelantan.**

**ABSTRAK**

Kajian tentang kepelbagaian dan taburan papatung telah dijalankan di Universiti Malaysia Kelantan, Kampus Jeli, Kelantan. Objektifnya adalah untuk menentukan kepelbagaian dan taburan papatung di Universiti Malaysia Kelantan Kampus Jeli. Persampelan dijalankan dari 22 Februari 2024 hingga 07 Mac 2024 di tiga tapak kajian terpilih dengan 10 hari persampelan. Sebanyak 162 individu daripada satu keluarga, 6 genera dan 13 spesies direkodkan menggunakan jaring sapu. *Acisoma* (2 spesies), *Brachydiplax* (1 spesies), *Neurothemis* (3 spesies), *Orthetrum* (4 spesies), *Rhytemis* (1 spesies) dan *Trithemis* (2 spesies) telah dikenal pasti dalam penyelidikan ini. Genera yang paling dominan yang direkodkan ialah *Brachydiplax*. Terdapat dua indeks yang digunakan untuk analisis data dan nilai diperoleh; Indeks Shannon-Wiener, tapak H' A= 0.368, tapak B = 1.106, tapak C=1.642. Nilai indeks kepelbagaian spesies papatung ini lebih tinggi di tapak C. Terdapat kerana beberapa faktor yang boleh mempengaruhi penentuan kepelbagaian papatung seperti sumber makanan dan habitat yang sesuai.

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**LIST OF SYMBOLS**

H'	Shannon-wiener diversity index
H <sub>a</sub>	Alternative hypothesis
H <sub>0</sub>	Null hypothesis
F	F-Statistic
df	The degree of freedom in the sources
P	Probability



## INTRODUCTION

### 1.1 Background of Study

Any of the nearly 3,000 species of flying predatory insects known as dragonflies (suborder Anisoptera), often known as darners, devil's arrows, or devil's darning needle, were most frequently found near freshwater ecosystems all over the world. The Anisoptera class of dragonfly species were distinguished by their long bodies and two narrow pairs of elaborately veined, membranous wings that, though often transparent, might have colourful patterning. The front and back wing pairs were formed differently than those of damselflies. Dragonflies also rest with their wings extended horizontally rather than vertically against each other, with the exception of one extremely small family, the Leptophlebiidae. Damselflies were weaker flyers than dragonflies, which were normally built more powerfully.

Additionally, some dragonflies have nearly 360-degree fields of vision because of their enormous, protruding eyes that take up most of their heads. The colours of the mature winged birds range from metallic to pastel, and they have a variety of patterns. They are big compared to other insects, with some of them having wingspans of up to 16 cm (about 6 inches). Even the tiniest species were 20 mm (0.8 inch) wide. They were some of the quickest insects and had incredibly nimble wings. If it was cool outside, dragonflies frequently whirl their wings and bask in the sun to warm up before taking flight since their wing muscles need to be warm to function properly (Britannica, 2023).

Since their larvae, or "nymphs," were aquatic, dragonflies were typically found near bodies of water like lakes, ponds, streams, and marshes. Dragonflies rarely sting or bite people, but if they were grabbed by the abdomen, they would bite to try to get away. They were prized as predators because they aid in reducing populations of

dangerous insects like mosquitoes (Animal Corner, 2022). Odonata were a diverse group of animals with a wide range of distribution. While the distribution of some genera and species was rather global, that of other species was largely limited. Families might be limited to ponds or calm, clear waterways, cool streams or rivers, or marshy areas. Indicators of a healthy ecosystem include the presence of damselflies and dragonflies. Although dragonflies tend to be far more vulnerable to pollution than damselflies, the highest species densities can be found at locations with a range of microhabitats (Berkeley, 2023).

According to Pupke (2018), dragonflies were a diverse collection of insects that live in a variety of settings around the world. They were known for their striking colours and captivating flight patterns. Studying the variety and distribution patterns of dragonflies can help us better understand the dynamics of ecosystems and the conservation of biodiversity by acting as significant environmental health indicators. With an emphasis on their ecological value and the necessity of thorough research in this area, this introduction strives to illustrate the importance of understanding dragonfly variety and distribution. In order for ecosystems to function and remain ecologically that dragonflies were bioindicators of the health of ecosystems. Their distribution and existence might be indicators of the health of the aquatic ecosystems in the area. The lack of thorough information regarding the diversity and distribution of dragonflies in this specific region necessitates research on the insects at UMK. The objectives of the study were to determine diversity of dragonflies and distribution of dragonflies (Odonata).

There were around 6,000 different Odonata species in existence. In Malaysia, about 400 species have been identified with over 160 of those species found in the state of Sabah. Nearly 400 species of Odonata from 17 families were discovered in

Malaysia (Choong et al, 2018). Dragonflies come in 180 species or more. Orr (2004) estimates that there were 342 species of Odonates Malaysia including 161 Zygopterans (ten families) and 181 Anisoptera (five families). About 239 species have been documented for Sabah, Sarawak and Brunei, whereas Peninsular Malaysia and Singapore have 226 species listed (Norma-Rashid et al, 2001).

## **1.2 Problem Statement**

There was a knowledge gap regarding the dragonfly populations and their ecological value in the Universiti Malaysia Kelantan, Jeli Campus because of the lack of in-depth research into the diversity and distribution of dragonflies in this area. Due to a lack of knowledge efforts to manage and conserve these significant insect species and their habitats have been hampered. Study on the variety and distribution of patterns of dragonflies in Universiti Malaysia Kelantan, Jeli Campus was essential to fill this information and direct future conservation efforts.

## **1.3 Objective**

This study aims to determine the diversity and distribution of dragonflies (Odonata) in Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

## **1.3 Scope of Study**

The study was conducted in random places where there are dragonfly species. Field sampling conducted for fourteen consecutive days from 20 February 2024 until 04 March 2024. Dragonflies were collected using sweep nets. The Shannon Wiener index was utilised to assess the degree of species or composition at each study site. Environmental variables such as habitat types, weather, and water quality that had an impact on the distribution of dragonflies recorded.

#### **1.4 Significant of Study**

This study will contribute to the broader understanding of dragonfly biodiversity in UMK Jeli Campus and provide valuable data for conservation efforts. By identifying key habitats and environmental factors that support dragonfly populations, the study will aid in the development of strategies to preserve these important bioindicators. Furthermore, the findings can serve as baseline data for future ecological studies



## LITERATURE REVIEW

### 2.1 Odonata

A complex collection of insects called dragonflies (order Odonata, suborder Anisoptera) serve as important predators and environment health monitors in the ecosystem. Colourful, large-eyed dragonfly species can exhibit sexual dimorphism, colour transition and colour polymorphism (Futahashi, 2016). Furthermore, they feature unique traits that set them apart from other insects such as a long, slender abdomen, two pairs of wings and enormous, globular eyes on their heads with short antennae (Neog and Rajkhowa, 2016). They have a broad, flexible neck, three ocelli and two short, bristle-like antennae on their head. Corbet (2013) claims that adults' dragonflies are simple to identify because they have two pairs of thin, translucent wings, a sloping thorax and a body that is longer than the wings.

### 2.2 Methods in dragonflies sampling

According to Hasyimah et al (2021) and Wahizatul et al (2006), the samples of dragonflies were taken using sweep nets. The insect nets are sturdy and lightweight with handles that measured 2 feet, 24 inches long and an open mesh net that had diameter of around 25 cm and no resistance (Orr & Hamalainen, 2003). In order to capture the dragonfly in flight, it is swiftly swung (Orr, 2013). After being taken out of the net, the Odonata were grabbed by the body and shocked by compressing the thorax. The lowest taxonomy possible were used to identify the collection and the sample identified by using the “Dragonflies of Peninsular Malaysia and Singapore” (Orr, 2005) and “ A Guide to the Dragonflies of Borneo” (Orr, 2003).

The Shannon Wiener Index was to measure the degree of species or composition at each study site and one way analysis of variance (ANOVA) used to assess how the distribution of odonata species and their population varied across to all study locations. Software from the Statistical package for Social Science (SPSS) used to conduct this analysis (Hasyimah et al, 2021).

### **2.3 Diversity of Dragonflies**

One of the largest insect orders, dragonflies have approximately 5,000 species that have been identified globally. They have a great range in terms of morphology and ecology. According to Choong et al (2020), there are around 6,000 different Odonata species in existence. In Malaysia, about 400 species have been identified with over 160 of those species found in the state of Sabah. Based on another journal from Hasyimah et al (2021) , nearly 400 species of Odonata from 17 families were discovered in Malaysia (Choong et al, 2018).

### **2.4 Habitat of dragonflies**

A variety of terrestrial and freshwater habitats, dragonflies can be found on all continents save Antarctica. Lakes, ponds, rivers, and marshes are just a few examples of the freshwater areas where they are frequently found. Dragonflies can, however, be found in a variety of terrestrial settings, including forests, grasslands, and even populated areas. Climate, habitat accessibility, and optimal breeding grounds all have an impact on distribution patterns. Their distribution patterns are also influenced by the water quality, which includes pollution and oxygen levels. A moderately high number of species (56 species) or 35% of the species known to Sabah were recorded by the Borneo Biogeographic Expedition. These include rivers, streams, streamlets,

marshes and waterfalls, all of which can be found at the Kangkawat Research Stations and in the area around them (Choong et al, 2020).

Compared to the Wahizatul et al (2006), the majority of Odonata chose to perch on foliage, including overhanging vegetation, forested and riparian vegetation areas of the stream. In comparison to studies conducted in other areas, the number of Zygoptera found in this study area was very high, particularly in collections from lakes, rivers, rice fields, freshwater swamps (Norma Rashid et al., 2001; Che Salmah, 1996; 2001). The majority of Odonata liked overhanging vegetation because it offered a variety of perching places, a large range of food sources and a cover for predators.

### **2.5 Ecological factors influencing dragonflies' diversity and abundance.**

Dragonfly distribution and diversity are influenced by a number of ecological factors. Their geographic range is greatly influenced by temperature and precipitation with greater diversity being found in warmer and more humid places. For their larval development as well as for adult foraging and mating dragonflies are very reliant on the availability of adequate water habitats and suitable vegetation cover. Their distribution patterns are also influenced by the water quality which includes pollution and oxygen levels. According to several authors' theories (Chovanec & Raab, 1997; Hofmann & Mason, 2005), specific characteristics of the vegetation may play a significant impact in the distribution and assembly of Odonata

Based on another journal, ecological factors also caused the domestic trash from there to be thrown into the river through drainage. Additionally, a road bridge and a water dam add to the area's exposure to vehicle noise pollution. A big, unmanned abandoned machine beside the riverbank that could affect water quality. The variety and distribution of dragonflies may be impacted by certain human activities (Hasyimah et

al, 2021). Pollutants including untreated sewage from people, runoff from agriculture, urbanization and industrial pollutants have an effect on them. Rivers that are still unpolluted or unaltered are extremely rare (Ameilia et al, 2006).

## **2.6 Dragonflies conservation implication**

Due to their sensitivity to environmental changes, dragonflies can be used to detect habitat deterioration and water pollution by their presence or absence. According to the Hasyimah et al (2021), if the environmental quality declines, dragonfly diversity also declines assert that Odonata exhibit their distinct environment requirements through their dispersion, which mostly involves microhabitats. The eggs of these insects are laid in or close to freshwater.

## MATERIAL AND METHOD

### 3.1 Study Area

This study was conducted in Universiti Malaysia Kelantan (UMK) Jeli Campus (5.7443° N, 101.8635° E), located in the north-eastern part of Peninsular Malaysia, near the Thailand border (Figure 3.1). Universiti Malaysia Kelantan (UMK) Jeli Campus is surrounded by lush greenery and is located in an area renowned for its abundant natural resources and diverse ecosystems. The climate in Jeli is characterised by a tropical rainforest climate with high humidity and significant rainfall throughout the year. This area experiences a monsoonal climate, with a distinct wet season from November to February, influenced by the Northeast Monsoon. Temperatures in Jeli are typically ranging between 24°C and 32°C. The high humidity levels, often around 80-90%, contribute to a warm and humid environment, ideal for a variety of flora and fauna. The area is rich in plant species, ranging from tall dipterocarp trees to a dense undergrowth of shrubs, ferns, and climbers, supporting a wide range of wildlife, including numerous insect species such as dragonflies. UMK Jeli Campus has a diverse landscape that includes lowland regions, undulating hills and is enriched with various water bodies (rivers and ponds), which serves as habitat for aquatic life. The campus is moderately populated, primarily by students and staff of Universiti Malaysia Kelantan. Social infrastructure includes academic buildings, research facilities, residential areas, recreational spaces, and basic amenities such as cafeterias and medical services. The surrounding community is involved in various agricultural and small-scale industries.

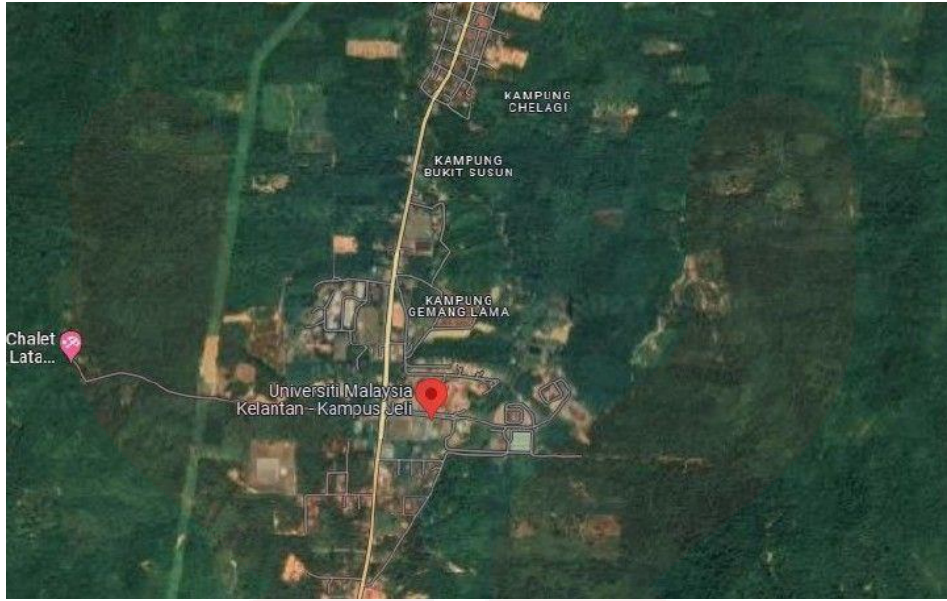


Figure 3.1: Map showing the locality of study sites in Universiti Malaysia Kelantan, Jeli Campus



Figure 3.2: Sampling sites on Universiti Malaysia Kelantan Jeli Campus



### 3.2 Material

Table 3.2.1 shows the important materials that were used during the sampling of dragonflies.

Table 3.2.1 : Materials and methods

Material	Functions
Field Equipment <ul style="list-style-type: none"> <li>● Sweet net.</li> <li>● Pins</li> <li>● Handheld GPS</li> </ul>	<ul style="list-style-type: none"> <li>● Sweet net used for catching adult dragonflies.</li> <li>● Pins for entomological specimen preservation</li> <li>● GPS gadget used to get plot coordinates.</li> </ul>
Identification Guides <ul style="list-style-type: none"> <li>● Taxonomic keys or field guide</li> </ul>	<ul style="list-style-type: none"> <li>● Field guides are useful for identifying different species.</li> </ul>
Data Recording <ul style="list-style-type: none"> <li>● Field notebooks</li> <li>● Tablet and laptop for digital data recording</li> </ul>	<ul style="list-style-type: none"> <li>● Field notes used for recording observations such as data, time and locations.</li> <li>● Tablets and laptops used for digital recording.</li> </ul>
Insect Collect Instruments <ul style="list-style-type: none"> <li>● Forceps</li> </ul>	<ul style="list-style-type: none"> <li>● Insect collects instruments used for handling and gathering.</li> </ul>
Preservation of Specimens <ul style="list-style-type: none"> <li>● 70% Ethanol</li> <li>● Containers</li> <li>● Markers</li> </ul>	<ul style="list-style-type: none"> <li>● 70% Ethanol is used to passed out the specimens.</li> <li>● Container used for holding and moving specimens.</li> <li>● Markers and labels used to identify the specimen.</li> </ul>

### 3.3 Fieldwork

Sampling was carried out for ten days from 22 February 2024 until 07 March 2024 in the three selected study sites (Site A, Site B and Site C). Sampling was carried out for two hours per day in three different areas. Sampling was conducted during peak Odonata activity periods that is between . Dragonflies were collected using sweep nets. Captured dragonflies were placed in transparent containers and brought back to laboratory for identification and preservation purposes. The dragonflies were pinned and preserved as dry specimens. Information on species name, locality, date and time, and collector name were labelled on each specimen.

### 3.4 Species Identification

Dragonflies are identified based on body pattern, wing pattern, body size and their colours. Species identifications were done following Dragonflies of Peninsular Malaysia and Singapore (Orr, 2005) and MyBis website.

### 3.5 Data Analyses

#### a) Species Accumulation Curve

Species accumulation curve was plotted to assess the species richness and determining the adequacy of the sampling effort. This graph represents the cumulative number of species recorded as a function of the cumulative effort expended or the number of sampling events. Species accumulative curve enable researchers to compare and appraise population diversity or determine the advantages of further sampling (Deng et al., 2015).

### b) The Shannon Wiener Index

The Shannon Wiener Index was to measure the level of species at each study site. The more species diversity there is in a given community, the higher the value of H. Diversity decreases with decreasing H value. H= 0 denotes the presence of a single species in the community (Bobbitt, 2021).

$$H = -\sum p_i * \ln(p_i)$$

$\Sigma$ : Greek symbol for "sum"

ln: Natural log

$p_i$ : Proportion of the total population made up of species, i

### c) One-way Anova

A statistical technique to test the alternative hypothesis ( $H_a$ ), which states that least one population mean differs against the null hypothesis ( $H_0$ ), which states that three or more population mean are equal (*One-Way ANOVA*, 2024).

$$H_0: \mu_1 = \mu_2 = \dots = \mu_k \quad H_a: \mu_1 = \mu_2 = \dots = \mu_k$$

$H_a$ : not all means are equal

where  $\mu_i$  is the mean of the  $i$ -th level of the factor.

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## CHAPTER 4

### RESULTS AND DISCUSSION

#### 4.1 Species Richness and Abundance

Overall, a total of 162 individuals representing 13 species of dragonflies were collected from site A, site B and site C. All collected specimens belonged to the Libellulidae family (Table 4.1). The most abundant species was *Brachydiplax chalybea* and the least abundant species that is recorded as singleton were represented by *Neurothemis ramburi*, *Orthetrum glaucum* and *Trithemis festiva*. Site C exhibited the highest dragonfly abundance with 101 individuals collected, meanwhile site A represents the least dragonfly abundance. The IUCN status for all collected dragonfly species were classified as least concern (LC), indicating that these species are not currently at risk of extinction and are widely distributed (Ritchie & Roser, 2024).

**Table 4.1 A checklist of dragonfly species encountered in Universiti Malaysia Kelantan Jeli Campus.**

Family	Species	Site A	Site B	Site C	Status IUCN
Libellulidae	<i>Acisoma panorpoides</i>	0	0	15	Least Concern
	<i>Acisoma variegatum</i>	0	0	3	Least Concern
	<i>Brachydiplax chalybea</i>	0	0	52	Least Concern
	<i>Neurothemis flunctuans</i>	0	2	8	Least Concern
	<i>Neurothemis ramburi</i>	0	0	1	Least Concern
	<i>Neurothemis terminata</i>	0	1	8	Least Concern
	<i>Orthetrum triangulare</i>	0	0	6	Least Concern
	<i>Orthetrum glaucum</i>	0	0	1	Least Concern
	<i>Orthetrum sabina</i>	1	1	2	Least Concern
	<i>Orthetrum testaceum</i>	19	24	0	Least Concern
	<i>Rhytemis phyllis</i>	1	0	1	Least Concern
	<i>Trithemis aurora</i>	0	11	4	Least Concern
	<i>Trithemis festiva</i>	0	1	0	Least Concern
	<b>TOTAL</b>	<b>21</b>	<b>40</b>	<b>101</b>	

According to figure 4.1, datasets were used to create SAC which was then examined using Microsoft Excel. Every piece of data displayed was intended for sweeper collecting. The sampling was conducted for ten days in three different sites. The sampling takes two hours and was carried out in the evening from 5pm to 7pm because dragonflies are less active and easier to catch with a sweep net.

The majority of the species present have been sufficiently sampled when a species accumulative curve approaches an asymptote and the asymptotic values serves as a measure of the entire species abundance. Figure 4.1 shows that the species accumulative curve (SAC) has asymptote from day 8 to day 10, encompassing 13 species. The sampling was stopped after no new species was found in three sites.

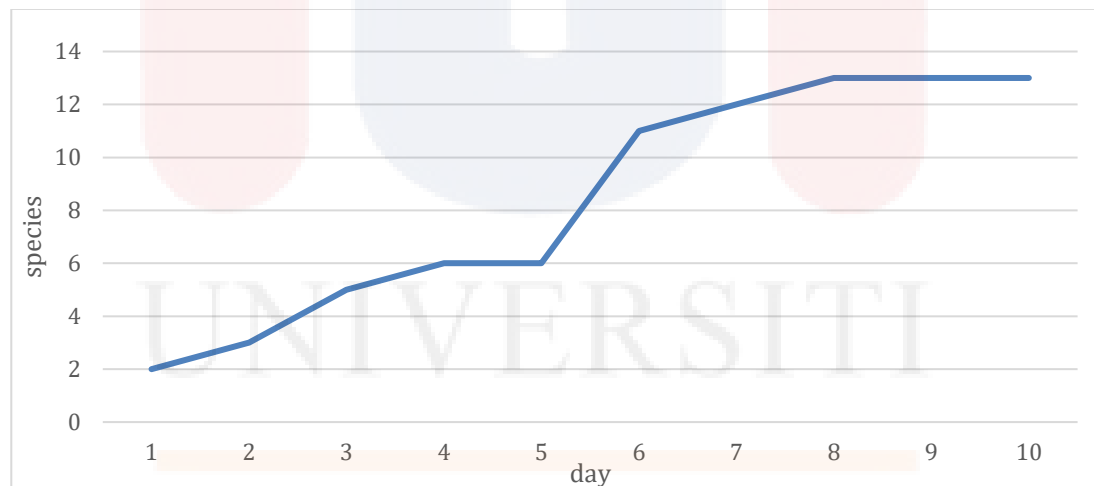


Figure 4.1: Species accumulative curve of dragonfly's species collection in Universiti Malaysia Kelantan.

## 4.2 Species Richness

The term “species richness” describes the variety of species found in a given region or environment. It gives an indication of biodiversity and can also show how complicated and healthy an ecosystem is. The diversity of life forms within an ecosystem increases with species richness (Karr et al., 2024). The result from the sampling conducted at Universiti Malaysia Kelantan revealed the outcome for a species richness or more specifically, the total number of species.

Figure 4.2 indicates that with three species documented, *Orthetrum* and *Neurothemis* are the predominant genera at site C in Universiti Malaysia Kelantan. However, in site B, only *Neurothemis* is dominant in that particular area.

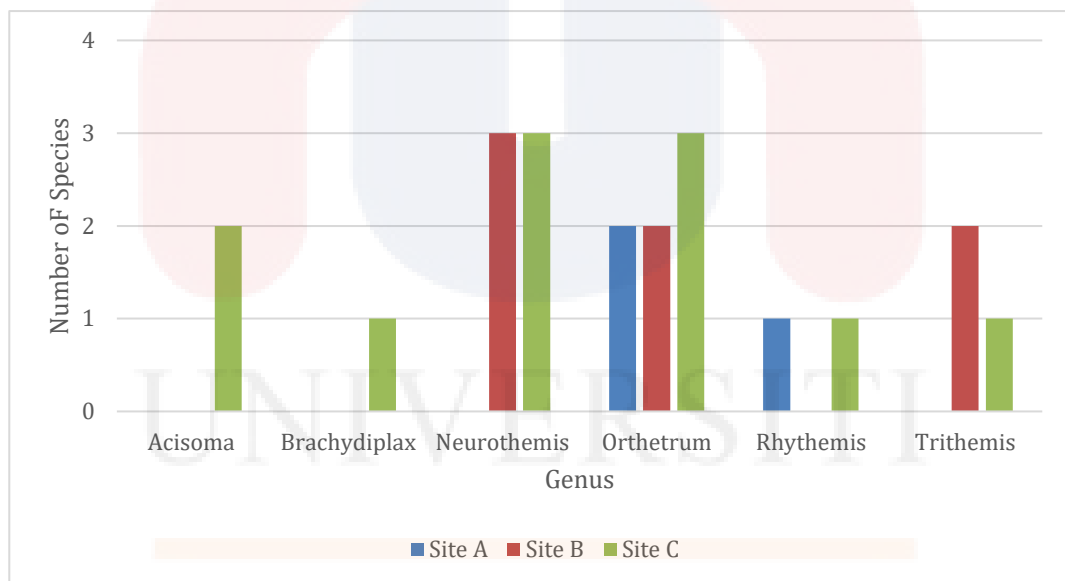


Figure 4.2 Number of species of each genus of the dragonflies collected in Universiti Malaysia Kelantan, Jeli Campus Kelantan.

### 4.3 Diversity Index

In this study, the Shannon-Wiener Index reveals varying levels of diversity across the three study sites. Site C exhibited the highest diversity with an  $H'$  value of 1.642, whereas Site B follows with an  $H'$  value of 1.109, and Site A exhibits the lowest diversity with an  $H'$  value of 0.368. Reduced species richness and evenness is indicated by low Shannon index value that have ecological relevance (Bacaro et al.,2013).

Table 4.2: Species Diversity Index

Diversity Indices	Value		
	Site A	Site B	Site C
Shannon-Wiener Index ( $H'$ )	0.368	1.106	1.642

#### 4.4 Species Abundance

The total number of members of a certain species in a given area is usually considered the species abundance. When a species' population is large in relation to the size of the area it occupies, it is deemed abundant (Dubey, 2023). Based on figure 4.3, the *Orthetrum testacaeum* species is the most dominant species at three sites (54 individuals) in Universiti Malaysia Kelantan Jeli Campus. The species *Orthetrum testacaeum* with 19 individuals at site A, 24 individuals at site B and 52 individuals at site C is the dominant species at three sites. Figure 4.3 also shows that there are different species in the three sites where the genus *Acisoma* and *Brachydiplax* are only found in site C.

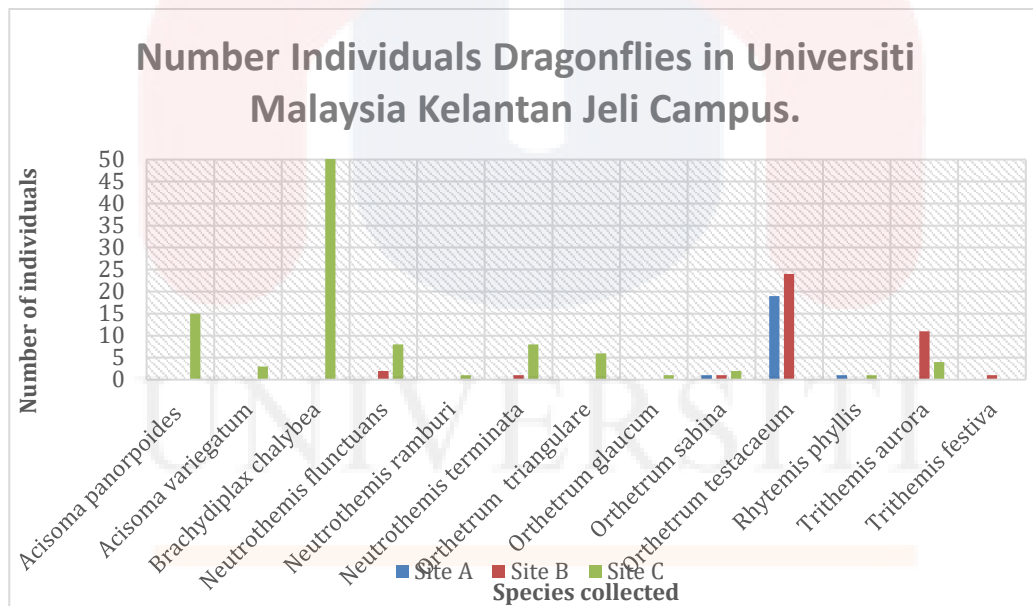


Figure 4.3: Number of individuals of each species of dragonflies collected in Universiti Malaysia Kelantan Jeli Campus.

*Brachydiplax chalybea* (Figure 4.4) is the highest number of individuals in this research that recorded 52 of individual but the genus *Orthetrum* is the most dominant species. Compared to previous study that *Brachylthemis* contaminate and *Trithemis aurora* recorded were dominants species.



Figure 4.4: *Brachydiplax Chalybea*

The second dominant species was *Orthetrum Testacaeum* resulted 54 individuals at site A, B and C. Then followed by *Acisoma panorpoides* that obtained 20 individuals. The least amount individual was *Rhythemis Phyllis* (Figure 4.5) species that obtained 2 individuals because of compete food source with other insects.



Figure 4.5 : *Rhythemis Phyllis*

The data recorded that the third sampling site (SC) recorded the highest number of individuals which was 101 individuals from 162 individuals then followed by the second sampling site (SB) that recorded 40 individuals and first sampling site

(SA) that collected 21 individuals (Table 4.4). It shows that more individuals collected at site C. This is because the habitat and food at site C are appropriate for adult dragonflies. Furthermore, the area has a high population of insects, which draws dragonflies because they are aggressive predators who eat flies, mosquitoes and other flying insects. Adult dragonflies find refuge and resting spots among aquatic vegetation (Aleš Dolný et al., 2014). They can relax by perching on stems or leaves, take shelter from sun or keep an eye out for potential prey. The site A was only managed get 21 individuals because of predator. Many birds were looking for dragonflies at site A on the second day of the sample since the dragonflies were their food sources. Numerous aquatic creatures including amphibians, birds and even mammals eat dragonflies. The dragonfly nymphs are eaten by fish, frogs, and other larger aquatic animals. Bats, spiders and birds eat adult dragonflies (kjdesign22, 2017). Thus, this show that dragonfly's predator also reasons why the less dragonflies at that area.

**Table 4.4:** List of dragonfly's genera collected from three sampling site: site A, site B and site C in Universiti Malaysia Kelantan.

No.	Taxon	Sampling Point			Total Individual
		SA	SB	SC	
1	<i>Acisoma</i>	0	0	18	18
2	<i>Brachydiplax</i>	0	0	52	52
3	<i>Neurothemis</i>	0	3	17	20
4	<i>Orthetrum</i>	20	25	9	54
5	<i>Rhythemis</i>	1	0	1	2
6	<i>Trithemis</i>	0	12	4	16
<b>TOTAL</b>		21	40	101	162

#### 4.5 Dragonflies Distributions

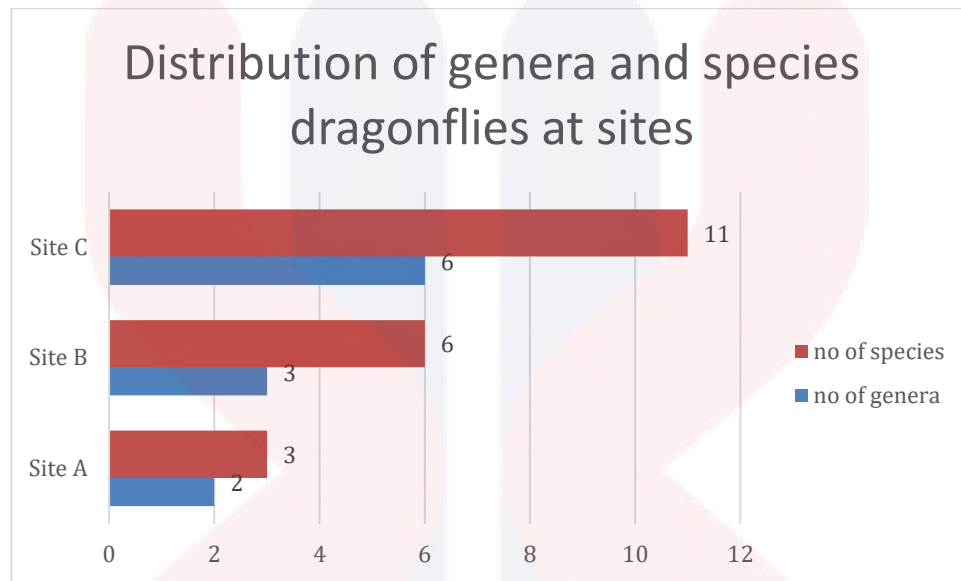


Figure 4.6: distributions of genera and species of dragonflies at sites.

The figure 4.6 show that distributions of genera and species of dragonflies at three sites which was site A, site B and site C in the Universiti Malaysia Kelantan Jeli Campus. Site C show that higher distributions than site A and site B with 6 genera and 11 species compared to site A had 2 genera and 3 species. Followed by site B had 3 genera and 6 species because compete of food sources with other insects.

It caused of the site C had many vegetation that areas and suitable area for dragonflies to live there. Ponds provide wide areas where dragonflies were free to fly around and look for insects. In addition to giving dragonflies perches from which to see and catch prey, flora around ponds serves this purpose. Compared to site A just only had 3 species because the areas not enough food to other dragonflies' species to live there and also caused by human activities because site A is close to human areas. Site A does not have many species of dragonflies because the site is smaller than site C. The site also not suitable for dragonfly habitat because the water there is from dirty water.

The environmental factor is that, whereas site A and B are a lentic ecosystem with regions where the water will flow to the river, site C is a pond of water with a lotic ecosystem, allowing dragonflies to travel farther and avoid congregating in one spot. There is more food available in static water areas, such as algae and other microscopic creatures that feed dragonfly larvae. Site C surroundings are typically quieter and offer a secure space for dragonflies to lay their eggs and raise their larvae. In addition to offering safety from predators, Site C deeper pond sections or intricate structures may offer stronger defence against predators, drawing more dragonflies to the location.

For dragonflies, an appropriate habitat is another environmental component. Compared to sites A and B, site C contains more water plants. Protective areas and perfect spawning grounds are found in places with a lot of water plants and a complex habitat structure. Because they provide habitat and protection, water plants are vital to dragonfly populations. For dragonfly larvae, water plants serve as both breeding grounds and a barrier against predators. Larvae use complex plant structures to conceal themselves and evade harm. By absorbing excess nutrients, aquatic plants also contribute to the stabilisation of water quality, improving the health of aquatic species like dragonflies. The area's biodiversity is supported by a diverse range of water plants, which gives dragonflies a richer and more favourable habitat (Jun-Yan et al, n.d).

A statistical technique to test the alternative hypothesis ( $H_a$ ), which states that least one population mean differs against the null hypothesis ( $H_0$ ), which states that three or more population mean are equal (One-Way ANOVA, 2024). One-way anova was used to measure the types of dragonflies found at site A, site B and site C. The number of samples taken was based on the amount obtained during sampling in all

three places. The Null Hypothesis (H0) has the same characteristics in the three locations and the alternative hypothesis (Ha) has different characteristics in the three locations. Based on figure 4.7 one-way anova analysis, the f value obtained from the analysis is 1.4888. The df for between groups is while the df for within groups is 36. The P value (same) in this analysis is 0.2393 in significance between groups.

One-way ANOVA	Residuals	Tukey's pairwise	Kruskal-Wallis	Mann-Whitney pairwise	Dunn's post hoc
<b>Test for equal means</b>					
	<b>Sum of sqrs</b>	<b>df</b>	<b>Mean square</b>	<b>F</b>	<b>p (same)</b>
<b>Between groups:</b>	268.769	2	134.385	1.488	0.2393
<b>Within groups:</b>	3250.31	36	90.2863		<b>Permutation p (n=99999)</b>
<b>Total:</b>	3519.08	38			0.224
<b>Components of variance (only for random effects):</b>					
<b>Var(group):</b>	3.39218	<b>Var(error):</b>	90.2863	<b>ICC:</b>	0.0362108
<b>omega<sup>2</sup>:</b>	0.02444				
<b>Levene's test for homogeneity of variance, from means</b>				<b>p (same):</b>	0.2054
<b>Levene's test, from medians</b>				<b>p (same):</b>	0.3377
<b>Welch F test in the case of unequal variances: F=1.117, df=21.92, p=0.3452</b>					

Figure 4.7: One-way Anova analysis for comparing three sites sampling.

## CHAPTER 5

### CONCLUSION AND RECOMMENDATION

#### 5.1 Conclusion

As conclusion, the result show analyzes of diversity and distribution of dragonflies in the Universiti Malaysia Kelantan Jeli Campus Kelantan. The finding revealed that most dominant is *Brachydiplax chalybea*. The diversity index calculated that site C had higher diversity index which is 1.642. The study also shows that environmental variable effects to dragonfly's was habitat types, food sources and predators of dragonflies. Strategies for dragonfly conservation that are effective emphasise the preservation and restoration of wetlands, upholding the quality of the water, guaranteeing habitat connectivity and raising public awareness.

#### 5.2 Recommendation

My first recommendation is maintaining a variety of native plant species around the water body at Universiti Malaysia Kelantan encourages a variety of dragonfly species and provides food for their prey. It also creates buffer zones with natural vegetation to filter pollutants, provides additional habitat and ensure that the species of dragonflies are guaranteed in the area. All of these benefits come from necessary plant management. Habitat characteristics also needed which is collect data on habitat variable such as water quality, vegetation composition and substrate type to assess their influence on odonatan distribution and abundance. Incorporating habitat data enables the identification of environmental factors driving species assemblages.

Next, public awareness and education also needed to conserve dragonfly's species. It is crucial to raise public awareness and educate the public, particularly through community involvement in educating the locals about the value of dragonflies and enlisting them in conservation efforts. Temporal variation also to conduct sampling effort across different seasons and times of days to account to temporal variation in odonatan activity and emergence patterns. This provides a more comprehensive understanding of species richness and abundance throughout the year.

Last but not least, research and monitoring are also essential to the protection of dragonflies. Regular monitoring surveys of dragonfly populations and their habitats are carried out to the success of conservation efforts. In order determine the unique ecological and behavioural requirements of various dragonfly species and to guide conservation, ecological and behavioural research are also required.

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**APPENDIX A**

Image of randomly sites sampling in Universiti Malaysia Kelantan Jeli Campus, Kelantan.



Image 1: Site A



Image 2: Site B



Image 3: Site C

## APPENDIX B

Image of collected of dragonfly's species at Universiti Malaysia Kelantan, jeli Campus, Kelantan.



Image 4: Collected dragonfly's species.



Image 5: *Orthetrum Glaucum*



Image 6: *Trithemis aurora* (female)



Image 7: *Trithemis aurora* (Male)

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Image 8: *Brachydiplax chalybea* (Male)



Image 9: *Acisoma panorpoides*



Image 10: *Acisoma Variegatum*



Image 11: *Neurothemis ramburi*



Image 12: *Neurothemis Terminata*



Image 13: *Neurothemis Flunctuan*



Image 14: *Rhythemis Phyllis*



Image 15: *Orthetrum Triangulare*



Image 16: *Orthetrum testaceum*



Image 17: *Orthetrum sabina*



Image 18: *Trithemis festiva*

### APPENDIX C

Number of species, individuals and Shannon-wiener Index of dragonflies Universiti Malaysia Kelantan Jeli Campus.

Species	Site A	Pi	In (Pi)	Pi* In (Pi)
Acisoma panorpoides	0	0	0	0
Acisoma variegatum	0	0	0	0
Brachydiplax chalybea	0	0	0	0
Neurothemis flunctuans	0	0	0	0
Neurothemis ramburi	0	0	0	0
Neurothemis terminata	0	0	0	0
Orthetrum triangulare	0	0	0	0
Orthetrum glaucum	0	0	0	0
Orthetrum sabina	1	0.047619048	-3.044522438	-0.144977259
Orthetrum testaceum	19	0.904761905	-0.100083459	-0.090551701
Rhytemis phyllis	1	0.047619048	-3.044522438	-0.144977259
Trithemis aurora	0	0	0	0
Trithemis festiva	0	0	0	0
TOTAL	21			-0.380506218
			H'	0.368

Species	Site B	Pi	In (Pi)	Pi* In (Pi)
Acisoma panorpoides	0	0	0	0
Acisoma variegatum	0	0	0	0
Brachydiplax chalybea	0	0	0	0
Neurothemis flunctuans	2	0.052631579	-2.94443898	-0.154970473
Neurothemis ramburi	0	0	0	0
Neurothemis terminata	1	0.026315789	-3.63758616	-0.095725952
Orthetrum triangulare	0	0	0	0
Orthetrum glaucum	0	0	0	0

<i>Orthetrum sabina</i>	1	0.026315789	-3.63758616	-0.095725952
<i>Orthetrum testaceum</i>	24	0.631578947	-0.45953233	-0.290230945
<i>Rhytemis phyllis</i>	0	0	0	0
<i>Trithemis aurora</i>	9	0.236842105	-1.44036158	-0.34113827
<i>Trithemis festiva</i>	1	0.026315789	-3.63758616	-0.095725952
TOTAL	38			-1.073517542
			H'	1.109

Species	Site C	Pi	In (Pi)	Pi* In (Pi)
<i>Acisoma panorpoides</i>	15	0.148514851	-1.907070316	-0.283228265
<i>Acisoma variegatum</i>	3	0.02970297	-3.516508228	-0.104450739
<i>Brachydiplax chalybea</i>	52	0.514851485	-0.663876798	-0.341797956
<i>Neurothemis flunctuans</i>	8	0.079207921	-2.535678975	-0.200845859
<i>Neurothemis ramburi</i>	1	0.00990099	-4.615120517	-0.045694263
<i>Neurothemis terminata</i>	8	0.079207921	-2.535678975	-0.200845859
<i>Orthetrum triangulare</i>	6	0.059405941	-2.823361048	-0.167724419
<i>Orthetrum glaucum</i>	1	0.00990099	-4.615120517	-0.045694263
<i>Orthetrum sabina</i>	2	0.01980198	-3.921973336	-0.077662838
<i>Orthetrum testaceum</i>	0	0	0	0
<i>Rhytemis phyllis</i>	1	0.00990099	-4.615120517	-0.045694263
<i>Trithemis aurora</i>	4	0.03960396	-3.228826156	-0.127874303
<i>Trithemis festiva</i>	0	0	0	0
TOTAL	101			-1.641513026
			H'	1.642

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