DIVERSITY OF NOCTURNAL COLEOPTERA IN UNIVERSITI MALAYSIA KELANTAN, JELI CAMPUS, KELANTAN

by

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DECLARATION

I declare that this thesis is entitled Diversity of Night-Flying Coleoptera in Universiti Malaysia Kelantan, Jeli Campus, Kelantan is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Date : 28 JULY 2024

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Diversity Of Night-Flying Coleoptera in Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

ABSTRACT

Universiti Malaysia Kelantan (UMK), Jeli campus located in the state of Kelantan, Malaysia, Jeli district. Jeli has beautiful georgical landscape that contribute and benefit to people and the state of Kelantan. UMK is surround by hills and a lot of nature attraction such as waterfall for recreation activities, which contribute to benefits to the public and the states of Kelantan. A study on diversity of beetle of Night-Flying Coleoptera has been conducted at Universiti Malaysia Kelantan, Jeli campus, Kelantan from 1st march to 7th March 2024. The objective of this study was to to collect the diversity index of Night-Flying Coleoptera at Universiti Malaysia Kelantan, Jeli campus, Kelantan. Light trap methods were used to sample the diversity of Night-Flying Coleoptera. A total of 79 individuals belonging to 7 species from 6 families were recorded in this study. Shannon-Wiener Diversity value is 1.645 and the Pielou evenness value is 0.845 this value shows low beetle diversity and also low species richness of beetle. The diversity of beetle in Jeli, Kelantan is considered low. As the outcome, the diversity of beetle species Universiti Malaysia Kelantan, Jeli campus, Kelantan is quite low because of the human disturbance of beetle's habitat at, Jeli, Kelantan. Future research on beetle diversity at Universiti Malaysia Kelantan, Jeli campus, Kelantan is recommended because there might be more species that would be collected and identified in the area and they are good pollinator. Therefor they are important for environment.

Kepelbagaian Coleoptera Terbang Malam di Universiti Malaysia Kelantan, Kampus Jeli, Kelantan.

ABSTRAK

Universiti Malaysia Kelantan (UMK), kampus Jeli terletak di negeri Kelantan, Malaysia, daerah Jeli. Jeli mempunyai landskap geografi yang indah yang menyumbang dan memberi manfaat kepada penduduk negeri Kelantan. UMK dikelilingi bukit bukau dan banyak tarikan alam semulajadi seperti air terjun untuk aktiviti riadah yang memberi manfaat kepada orang ramai dan negeri Kelantan. Kajian Kepelbagaian Coleoptera Terbang Malam di Universiti Malaysia Kelantan, Kampus Jeli, Kelantan dari 1 Mac hingga 7 Mac 2024. Objektif kajian ini adalah untuk mengumpul indeks kepelbagaian Coleoptera Terbang Malam di Universiti Malaysia Kelantan, Kampus Jeli, Kelantan. Kaedah perangkap cahaya digunakan untuk mencuba kepelbagaian Coleoptera Terbang Malam. Sebanyak 79 individu yang tergolong dalam 7 spesies daripada 6 keluarga telah direkodkan dalam kajian ini. Nilai Kepelbagaian Shannon-Wiener ialah 1.645 dan nilai indeks Pielou ialah 0.845 Nilai ini menunjukkan kepelbagaian kumbang yang rendah dan juga kekayaan spesies kumbang yang rendah di. Kepelbagaian kumbang di Jeli, Kelantan dianggap rendah. Hasilnya, kepelbagaian spesies kumbang Universiti Malaysia Kelantan, kampus Jeli, Kelantan agak rendah kerana gangguan manusia terhadap habitat kumbang di, Jeli, Kelantan. Kajian masa depan tentang kepelbagaian kumbang di Universiti Malaysia Kelantan, kampus Jeli, Kelantan adalah disyorkan kerana mungkin terdapat lebih banyak spesies yang akan dikumpul dan dikenal pasti di kawasan tersebut dan ia merupakan pendebunga yang baik kerana mereka penting untuk alam sekitar.

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INTRODUCTION

1.1 Background of study

The order Coleoptera is the most specious group (>300,000 described species) among insecta and its richness goes down towards increased latitudes. It is the largest order Coleoptera estimated that 400,000 species have been described in the world belonging to 170 families. What distinguishes beetles is their specially adapted forewings (elytra), which are hardened cases that protect the rear wings and that give this ancient beetle order its name. In beetles, which usually have two pairs of wings, the forewings are hardened. This feature is why beetles have the scientific name Coleeopteran, which translates to "sheat (sic) winged". This group also has a few other key aspects to its anatomy, including membranous hindwings and chewing mouthparts (the piels), as well as what is more easily remembered by most: two pairs of wings something that almost all insects have, but are only visible in the hysderans because they raised their fore-inguinal point on top of the perons. Nevertheless, with inadequate sampling in certain habitats and poorly studied families the biodiversity patterns of Coleopteran are somewhat unknown.

The diversity of Coleopteran fauna is in dynamic equilibrium in natural systems (Aquino, 2005), however linked with land use and its associated management that involves colonizing organisms related to agricultural production. Having said that, there are instances when environmental disturbance can increase the amount of pesticide used leading to higher infestation rates resulting in pest insects.

These are the fundamental roles in ecosystems - pollination, waste decomposition and recycling of nutrients. Coleopteran, or the beetles, which is an order of more types of collection

and some many. Evolution has led to divergent adaptations in these incredible animals, allowing them to inhabit numerous ecosystems and fill diverse ecological roles. A few beetles, herbivorous and carnivorous species may feed on other insect's while consume the dead and rotting flesh of an animal or decaying materials, serving a crucial role in natural waste management.

An extensive amount of research has been conducted to investigate insect diversity in the tropics. However, our current understanding of the diversity of many insect groups is still limited. The significance of good local species-richness data for a wide range of evolutionary biology and ecology questions is clear. Ecological and diversity inventories are an important tool for environmental management in determining the conservation value of habitats, and insects are a major component of every terrestrial habitat. Beetles are extremely diverse and abundant, and they engage in a wide range of interactions with other organisms. This makes them a significant group to study (Chung, 2007).

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1.1 Problem statement

It is crucial to investigate the beetle species present in Universiti Malaysia Kelantan, Jeli campus, Kelantan, and to determine their distribution and abundance in the study area. Currently, there is a limited understanding of the diversity of Coleoptera in this area, resulting in a knowledge gap regarding the importance of these insects in local ecosystems. Therefore, the need for a study to identify the quantity and range of Coleopteran species in the area is apparent in for data useful in future conservation efforts, it is required to assess the number and diversity of Coleopteran species in this area. Without enough related information, conservation plans would be poor.

1.2 Objective

i. To investigate the diversity and abundance of Coleoptera in Universiti Malaysia Kelantan, Jeli campus.

ii. To investigate factors influencing these species' distribution in Universiti Malaysia Kelantan, Jeli campus.

1.3 Scope of study

This study will determine the diversity and abundance of Coleopteran species present in a specific area of the Universiti of Malaysia Kelantan, Jeli campus, Kelantan. The collected data will be analyzed using the species accumulation curve to determine the diversity of the coleopterans in the present area. The evenness of a community was calculated using Pielou's evenness index. The species accumulation curve will be used to ensure sufficient data collected in the sampling site. To find the evenness the Shannon and Pielou indices will be used to ensure the sampling of Coleopteran species is adequate the species richness and evenness of Coleopteran species present in the area. Light trap will be used to capture Coleopteran species at designated locations within the study area. This study will identify the ecological factors such as habitat that might influence the distribution and abundance of Coleopteran species within the study area. Light traps will be installed simultaneously for a week at different sites in the Universiti Malaysia Kelantan, Jeli campus, Kelantan for a week between 1st to 7th march 2024.

1.4 Significance of Study

Coleoptera play an important role in ecosystems as they act as pollinators, decomposers, and predators. By understanding the diversity and abundance of these important insects, this will provide a better understanding of the current state of the coleopteran in University Malaysia Kelantan, Jeli Campus. Additionally, it will also provide information on the conservation status of the rare and endangered species of beetles in the area and suggest appropriate management strategies.

LITERATURE REVIEW

2.1 Morphology of Coleopteran

The order Coleoptera is the most diverse group in the Insect Class, with approximately 400,000 species described globally. It is the largest order of insects, with over 250,000 species. With so many species, this order exhibits a wide range of diversity in terms of size, morphological characteristics, biology, and behaviour. Ecosystem differences may have an impact on beetle biodiversity. The order is distinguished by its wings: elytra (hardened front wings) and membranous hind wings. They have chewing mouthparts that can be slightly modified to serve various functions and go through complete metamorphosis. Beetles live in almost every type of habitat, from deserts to aquatic systems, and they eat a variety of plant and animal materials.

2.2 Distribution of Coleopteran in Malaysia

The order Coleoptera includes beetles and weevils. It is the largest order of insects, accounting for approximately 40% of all known insect species. Among the over 360,000 Coleopteran species, many are among the largest and most visible insects, with brilliant metallic colours, showy patterns, or striking shapes. Beetles are distinguished by their two pairs of wings; the front pair has evolved into horny covers (elytra) that conceal the rear pair and much of the abdomen, usually meeting in a straight line along the back. Coleopterans are found in nearly every climate. They are divided into four groups: the first three, Archostemata, Adephaga, and Myxophaga, contain only a few families, whereas the fourth, Polyphaga, contains the vast majority of beetle species (Gressitt) .

The order Coleopteran, or beetles, is represented by some 350,000 known species (Lawrence et al., 1999), but recent estimates suggest there are hundreds of thousands or even millions of undescribed species (for a critical review see Ødegaard 2000). Beetles are not only rich in species, but also, or perhaps especially, extremely rich with respect to diversity in size, form, and ecological strategies. The largest beetles, Longhorn Beetles (Cerambycidae) from the Amazon, may be as long as 18 cm, while the smallest ones, Featherwing Beetles (Ptiliidae), measure less than half a millimetre (about 0.3 mm, acc. to Sörensson 1997). The oldest beetle fossils are known from the Lower Permian (about 280 million years) (Lawrence, 1999).

Dung beetles are a globally distributed insect group, with their highest diversity in tropical forests and savannas. Largely coprophagous, dung beetle species feed on the microorganism-rich liquid component of mammalian dung (and less commonly that of other vertebrates, as well as rotting fruit, fungus and carrion) and use the more fibrous material to brood their larvae (Nichols et al., 2008). The study of Coleoptera is an extensive and diverse field that covers a wide range of topics and aspects related to these insects. The order Coleoptera plays an important role in the development of organic matter, pollination of angiosperms, biotic interactions in communities (Mazurov, 2022). From their classification and taxonomy to their ecology and behavior, Coleoptera have been subject of extensive research by scientists and experts in the field. The following section provides an overview of the literature review's scope and the topics that will be covered

2.3 Methods in collecting Coleoptera

Malaise traps, light traps, and pitifull traps are commonly used in previous research to sample the diversity of Coleoptera. Malaise traps were made out of a nylon net that was fastened to a collection jar that was half filled with 70% ethanol and fastened to a tree branch at a height of around one metre. The light traps featured a mosquito net with a 160-watt mercury light attached, which was linked to a transportable Honda EU10i generator. Pitfall traps were made of transparent, colourless plastic cups that were partially filled with 70% ethanol and buried with the rim flush with the soil's surface (diameter: 65 mm, depth: 95 mm). To shield the pitfall traps from rain and litter, we positioned large, dry leaves above each one (Muneeb M. Musthafa, Fauziah Abdullah, Metho Matti J. Koivula, 2021).

Coleoptera diversity can be sample by utilizing several methods. In Thomas et al. (2013) , they use pitfall trap, coloured pan, and Malaise traps. Another study by Sh & Arumugam in 2016, all samples of beetles were collected using four methods, namely the light trap, pitfall trap, yellow pan trap and manual collection. Data collection was conducted at night using light trap methods each day.

In terms of cost, effort, and time, as well as the kinds of data they can yield, each of these methodologies has pros and cons. The study's objectives and available resources, as well as the traits and habits of the local Coleoptera species, will determine which technique is best. Light trapping will be used by me in my study.

2.4 Importance of Coleptera

2.4.1 As predators

As predators, the majority of coleopterans are carnivores, meaning they devour other animals; however, certain coleopterans, like Epilachna, also graze on plants. Through their consumption of caterpillars and other juvenile insects (larvae), many soft-bodied adult insects, and insect eggs, predators like the ground beetle family (Carabidae) and the rove beetle family (Staphylinidae) contribute to the management of insect populations. Aphids and scale insects are among the plant-sucking insects (Homoptera) that the majority of Coccinellidae, or ladybirds and ladybird beetles, feed on. These insects are very helpful to humans in their larval and adult stages. Very few only eat vegetation.

2.4.2 As plant feeder

Some Coleoptera are phytophagous which mean plant feeders. They are important, the leaf beetles (Chrysomelidae). Leaf-beetle larvae feed on leaves, stems, or roots of plants, and most adults chew leaves. Because some of the Coleoptera are plant feeders they can also be consider as pest, they eat crop plants, lawns and pastures. Metallic wood-boring beetle, (family Buprestidae), any of some 15,000 species of beetles (insect order Coleoptera), that can be found in tropical region have habits as destroying plant by destroying the inside plant call cambium. The Dynastinae (rhinoceros, Hercules, and elephant beetles) are often pests of palms, killing them by destroying the growing points. Lumber, furniture, and other items made from wood are sometimes severely damaged by several groups of beetles that bore in dry wood.

2.4.3 As scavenger

In Coleoptera, many scavenging groups exist. Organisms known as scavengers consume decaying materials like meat and plant matter, as well as decomposing plant and log debris, dead plant and animal remains, excrement, and other waste products. Scarabaeidae, Tenebrionidae (darkling beetles), Silphidae (carrion and burying beetles), and Dermestidae (dermestid or hide beetles) are among the coleopterans that serve as scavengers. Due to their consumption of dehydrated animals, several dermestid species seriously harm museums by consuming dehydrated animal materials. Several species of small dermestids cause damage to garments and carpets through their larvae. Nonetheless, certain species of dermestids are useful as scavengers; zoologists use species that consume carrion, such Dermestes caninus, to clean animal skeletons.

2.4.4 Pollination

The act of transferring pollen to an ovule, stigma, flower, or plant in order to facilitate fertilisation is known as pollination. It's common knowledge that flowers require bees to pollinate them, but few people are aware that coleopterans, in addition to bees, are also thought to be important pollinators for flowers. Phytophagous coleopterans are significant because they are still needed as pollinators in modern times, particularly for older species like spicebush and magnolias. Because they will eat their way through the petals and other floral parts, they are known as beetle flowers. According to fossil records, beetles were common 200 million years ago, during the Mesozoic era. The earliest angiosperms had beetles as guests at their flowers. Many beetle pollination associations in the modern era, such as the one of Magnolia, aprimitive woody angiosperm, have ancient evolutionary origins. Flower that usually beetles flower visit and eat is

bowl-shaped with sexual organs exposed, white to dull white or green, strongly fruity ,open during the day, moderate nectar producers may be large solitary flowers (i.e. magnolias, pond lilies) and may be clusters of small flowers (goldenrods, Spirea) .

2.4.5 Waste breakdown

In order to maintain nutrients in an ecosystem and support biodiversity, decomposition is an essential and delicately balanced process. Birds, insects, mollusks, millipedes, woodlice, fungi, moulds, parasites, and bacteria all aid in the decomposition process. When fungi and mould colonise a dead leaf, or when a carrion crow scavenges a rabbit carcass, allowing flies and beetles to feed on the inside nutrients, the first stage of decomposition may begin. The final stage of decomposition is the chemical breakdown of organic matter, leaving only the constituent molecules. These substances are then absorbed by plants and algae. Thus, the cycle never ends. Compost and decaying wood are broken down by the larvae of the Rose Chafer beetle (Cetonia aurata), which are found in organic matter.

2.4.6 Nutrient cycling

Some beetle species only feed on other organisms that require dead wood, such mosses and fungi, but a large number of them devour wood fibres or burrow in wood to form chambers in which to lay eggs. Rhagium mordax beetles are found on flowers, but the females need a spot to lay their eggs. This beetle will seek for a moist area close to plants, such as decaying wood, broadleaved trees, lumber and old stumps with cracks and crevices. Without human intervention, the larvae's development will take about three months.

Nutrient recycling involves both biotic and abiotic components. The main abiotic components are air, water, soil. recycling of carbon, hydrogen, nitrogen and oxygen occurs in water, air and soil, whereas calcium, phosphorus, potassium, etc. are recycled mainly in soil and are available locally.

The dung burial of some members of the Scarabaeidae family of beetles in the upper soil horizons greatly improves the cycling of nutrients. Many of these dung beetles cut round balls from large mammal faeces, which allow the dung balls to roll to a new location. The female dung beetle then lays her eggs inside the ball of dung and buries it in the ground. The distribution and burial of the dung not only gives the beetle larvae a food source, but it also shields the nutrients in the manure from volatilization and runoff, two processes that would easily deplete the nutrients if they were left on the soil's surface. For this reason, dung plays important roles in nutrient cycling and conservation in many grazed ecosystems.

There are thousands of species of dung beetles in the world, and many of them have evolved to become experts at burying the excrement of specific mammal species, such as cattle, buffalo, and elephants. Beetles burrow dung quickly, which also inhibits the reproduction of carnivorous flies and other pests of large dung-producing mammals. Scientists have discovered that the introduction of suitable species of dung beetles or earthworms can significantly increase the amount of vegetation produced and the number of grazing animals supported in grazed ecosystems (such as a savanna, prairie, or pasture) where native dung-burying 'engineer' species are lacking to another for use, such as air to soil or water, nutrient cycles help store and maintain the equilibrium of the ecosystem. Nutrient cycles help maintain ecosystem balance and store nutrients for later uptake by moving nutrients from one place to another for use, such as air to soil

or water. Living things engage in interactions with their abiotic surroundings through the cycling of nutrients.

evolved to specialize in the burial of dung from particular mammal species like cattle, buffalo, and elephant, among others. The reproduction of carnivorous flies and other pests of large dung-producing mammals is also prevented by the rapid burial of dung by beetles. Where native dung-burying 'engineer' species are lacking in a grazed ecosystem (such as a savanna, prairie, or pasture), it has been found by scientists that the introduction of appropriate species of dung beetles or earthworms can greatly increase the amount of vegetation produced and the number of grazing animals supported.

to another for utilisation, e.g., air to soil or water, nutrient cycles keep the ecosystem in equilibrium and help in storing nutrients for future uptake. Through nutrient cycling, living organisms interact with the abiotic components of them.

2.4.7 Coleopteran and transmitting diseases

With more than 360,000 species, or 40% of all known insect species worldwide, the order Coleopterans is the largest. Although they are not the first to be identified as disease vectors, some beetles carry plant pathogens that can inflict serious harm. Because they feed on plants and indirectly transfer plant pathogens to injured areas, where they then proliferate throughout the plant, insects are regarded as both pests and reservoirs, or even vectors, of plant diseases. A synopsis (Salaau Rojas, 2013; Pan et al., 2018).

2.4.8 Attraction to light

The cellular behaviour of coleopterans, known as phototaxis (phototactic response), involves the movement of cells either in the direction of the light source or away from it (positive or negative phototaxis, respectively). For navigation, nocturnal coleopterans rely on light sources like the moon. Although we are aware that insects fly at a certain level during the day, when artificial light is present at night, their flight route becomes totally unexpected. Although the process underlying insects' attraction to artificial light has long been recognised, it was not understood. The insects fly in a dispersed manner around the light because they confuse the light for being from the Moon or another celestial object, which confuses their sense of direction. Light sources that are artificially bright can function as an ecological trap.

MATERIAL AND METHOD

3.1 Study Area

The study area for the research is the University Malaysia Kelantan, Jeli campus an area that located in the state of Kelantan, Malaysia. The study area was selected based on its ecological diversity, high species richness, and conservation importance for the study of Coleopteran. This research was conducted at the Universiti Malaysia Kelantan, Jeli campus whose geographical coordinates are: 5.7443° N and 101.8635° E In Jeli the climate is hot tropical and humid. Jeli has a significant amount of rainfall during the year. This is true even for the driest month. According to the Köppen-Geiger classification, the prevailing climate in this region is categorized as tropical rainforest climate. The average annual temperature in Jeli is 24.3 °C and 2716 mm of precipitation annually. The climate of the region is hot tropical and humid with rains, the average annual temperature and average rainfall of 1,500 mm. The study will focus on the area of Universiti Malaysia Kelantan, Jeli campus, Kelantan which supports a diverse range of flora and fauna.

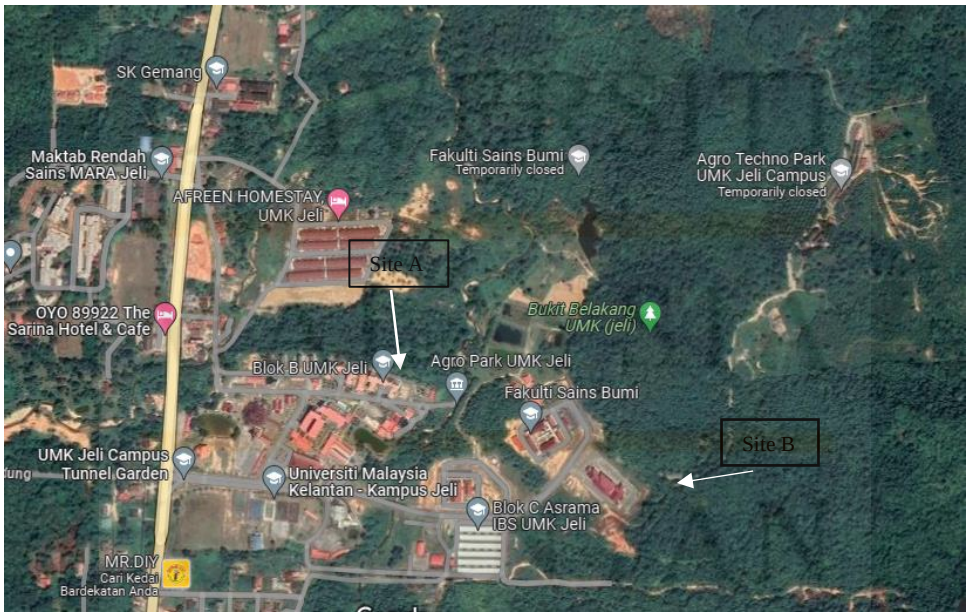

Figure 1: Maps of site A at Blok B UMK Jeli and Site B at Techno Park 2.

3.2 Material

Table 1 shows the list of materials and apparatus that will be used to capture species of Coleopteran species and preparation for mounting, preserving and identifying coleopteran.

Table 1: shows the material and apparatus

Material	Description
Combo 6W Rigid Portable light trap	To attract Coleopteran
Denatured ethanol 99%	To kill Coleopteran

3.3 Methods

Light traps will be installed simultaneously for a week at different sites in the Universiti Malaysia Kelantan, Jeli campus, Kelantan for a week between 1st to 7th March 2024. Data collection will be conducted for 7 days using light trap method. Light traps will be installed and run from 8.30 pm to 12:00 am and samples will be collected the next morning. Light trap that used in this specimen collection uses a 6w fluorescent tube light bulb powered by a battery. The design of the light trap is from a lightweight plastic bucket that is easy to open and clean and of course come with complete with a rain cover. Nocturnal coleopteran will be attracted to the light that light bulb produce and will fly towards the light then be trapped inside the bucket.

Figure: 6w Rigid portable light trap

3.4 Data analysis

To calculating the Shannon-Weiner index and Pielou index indices the member of species and individuals collected from site sampling will be recorded and checked.

3.4.1 Pielou's index (J)

The Pielou evenness Index or species evenness is to see the number of each species in the area. This index is important to measure of the distribution of individuals of species in the community.

$$J = \frac{H}{H_{max}}$$

3.4.2 Shannon Index (H)

In the Shannon Index, p is the proportion (n/N) of individuals of particular species found (n) divided by the total number of individuals found (N). The natural log Σ is the sum of the calculations, and s is the number of species.

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

3.4.3 Species Accumulation Curves

The data collected from the sampling will be analysed using the species accumulation curve. The species accumulation curve is a visual representation that illustrate the relationship between the number of species discovered and sampling effort. As sampling effort increases, more species are typically discovered. This curve is constructed by plotting the number of observed species against the cumulative sampling effort. The sampling effort could be represented by various metrics, such as the number of samples collected, the area surveyed or the time spent collecting data.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Overall species richness and abundance

In total, 79 individuals of beetles, belonging to six families and seven species were documented in this study (Table 4.1). The most abundant family was represented by Scarabaeidae (28 individuals) and Hybosoridae (28 individuals), meanwhile, the least abundant family was represented by Cerambycidae (2 individuals). *Phaeochrous emarginatus*, a species of scarab beetle, was the most abundant species observed in this study, accounting for 35.4% of the collected specimens. In contrast, *Pterolophia melanura* was the least common species, representing only 2.5% of the collected specimens.

In this study, *Phaeochrous emarginatus*, was the predominant species, likely due to the availability of suitable habitats. This species is detritivore and thrive in habitats that have abundant organic matter, such as decaying wood and leaf litter commonly seen in tropical rainforests. The abundance of this species could be further facilitated by the destruction of natural habitats and the expansion of agricultural areas, as they are able to adapt and thrive in these altered conditions. Modified natural environments, occasionally resulting in the formation of novel ecological niches for this beetle species. *Pterolophia melanura*, a species of longhorn beetle, is often found to be the least common species captured in light traps.

Table 4.1: A checklist of beetle species collected in Universiti Malaysia Kelantan, Jeli Campus.

Family	Species	Abundance
Calilirihipidae	*Elateriform* sp.	3
Cerambycidae	*Pterolophia melanura*	2
Curculionidae	*Phyllobiini* sp.	10
Hybosoridae	*Phaeochrous emarginatus*	28
Lampyride	*Photuris frontalis*	8
Scarabaeidae	*Anomala Salcatula*	21
	Adoretus sp.	7
Total		79

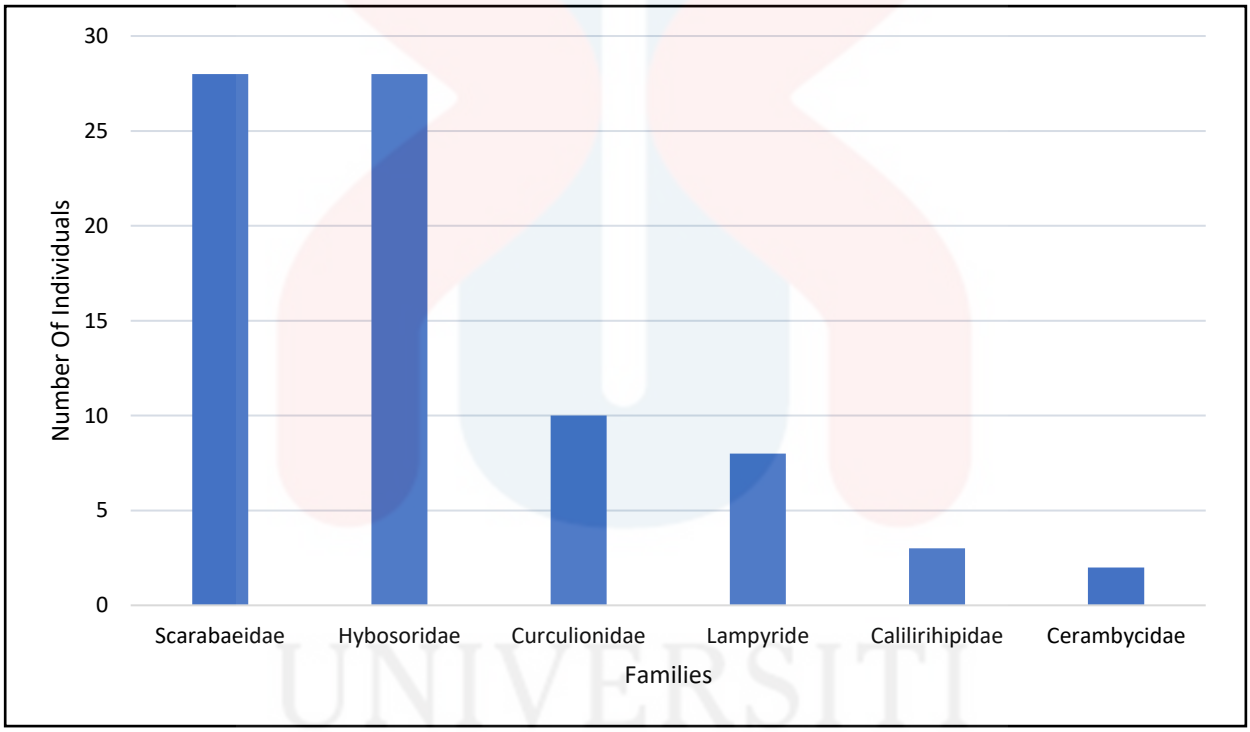

Figure 4.1: Rank abundance of night-flying Coleoptera in Universiti Malaysia Kelantan, Jeli Campus.

The data collected on beetle species was used to create a species accumulation curve (Figure 4.2). The species accumulation curve is used to create a sample curve, which indicates a point that means there has been significant sampling. When the curve reached asymptote. This type of curve helps in understanding the relationship between the sampling effort and the number of species observed. Based on Figure 4.2, there is a rapid increase in the cumulative number of species and then the curve shows a more gradual increase in species richness. The curve has not yet reached a plateau, suggesting that further sampling could potentially uncover more species. In order to achieve a complete understanding of the nocturnal Coleopteran diversity in Universiti Malaysia Kelantan, Jeli Campus, future studies should consider increasing the sampling effort. Further research with consideration of temporal variability is also recommended to achieve a more comprehensive understanding of species diversity.

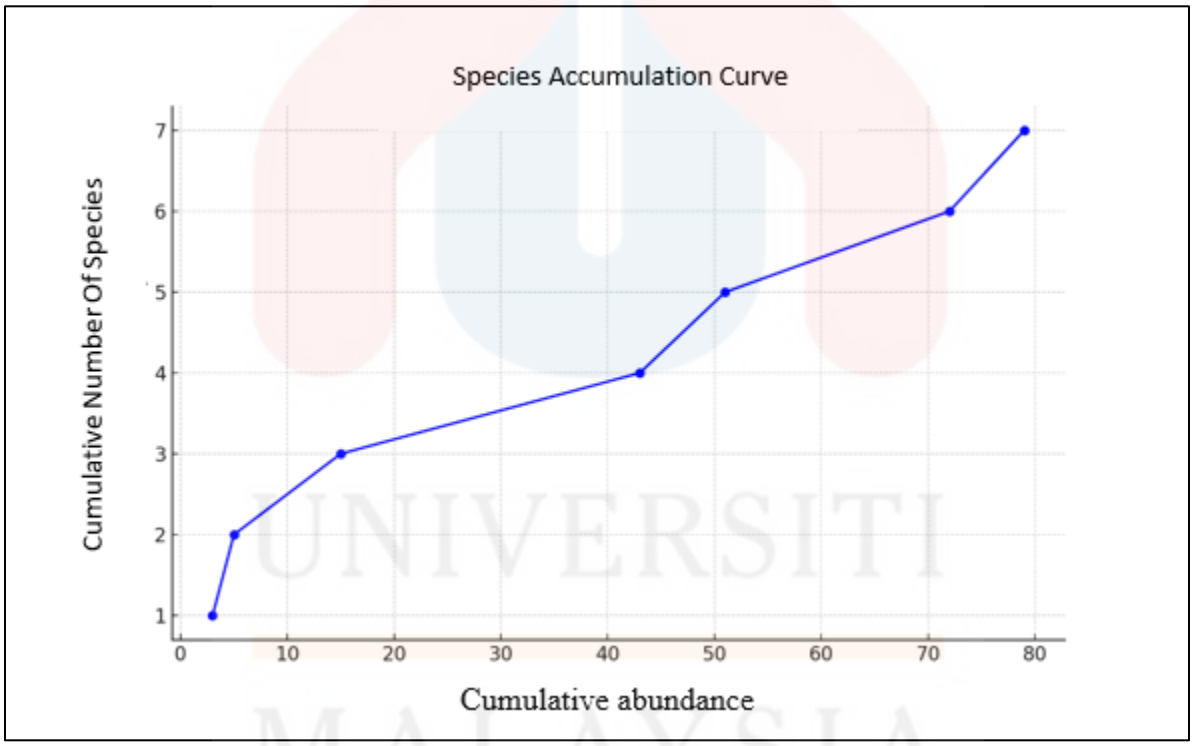

Figure 4.1.2: Species Accumulation Curve (SAC) of Diversity of Night Coleoptera in Universiti Malaysia Kelantan, Jeli Campus, Kelantan.

Photuris frontalis, the species of fireflies, has been identified with 8 abundances in the study area. Fireflies can be found all around the world, but this habitat is very sensitive to environmental change. This species may not be a rare species but it can be found only in small quantity in some areas that are not really suitable for their habitat due to deforestation and human activity, but in small quantities. Fireflies were found in the study area, but in low abundance. This species loves to live near standing water, especially during mating season; most live near forest meets water. An interesting fact about fireflies is that they also love long grass. They are nocturnal, and during the day they spend most of their time on the ground. At night, they crawl to the tops of blades of grass and fly into tree branches to signal for mates. Long grass conceals the fireflies better and allows them a better vantage point for signaling at night (Nick, 2018) and over-mowing your lawn may disturb your firefly population. This is why they can be seen on the grass near the Agropark Umk Jeli.

The Phyllobiini is widely distributed in Southeast Asia; this species is covered with green or yellow metallic scales, giving the beetle a dust-like appearance. It is commonly known as true weevil or snot weevil and is considered to be a plant disease on ornamental plants, trees in forest plantations, and agricultural crops. These species attack a wide range of host plants and eat different parts of the plant. Mature trees will not get a lot of damage that may lead to the death of the plant, but it may reduce the aesthetic value of the trees or stunt their growth. Cultural practices, such as tilling the soil, destroy the eggs and larvae of the beetle in the soil (Ong, 2017).

The abundance of Cerambycidae (*Pterolophia melanura*) in this research were low. This species dependence on food sources from various species of trees. In some natural ecosystems, longhorn beetles play an important role in nutrient cycling and pollination processes. Larvae of longhorn beetles are wood borers and tend to choose dead or decaying wood, and some species are considered pests. The structure of a community of longhorn beetles in a region is very closely related to the composition and development of trees. Different species of longhorn beetles will choose different species of tree or shrub. Some species of longhorn beetles live only on specific host plants, while others can inhabit a variety of plants (Sataral, 2015).

4.2 Species Diversity Index

Data on night-flying beetles sampled in this study were analyse using Shannon-Wiener Index (H'). Table 4.2 shows the diversity index of night-flying beetles in UMK, Jeli Campus, Kelantan. Shannon-Wiener Index value of H' = 1.645 is considered moderate, as typical values range from 1.5 to 3.5 for most ecological communities. This could mean a balance ecosystem where resources are well utilised by various beetle species, and no single species dominates the community.

Table: 4.2 Shannon-Wiener Index (H')

Site	DMg	H'	H'max
Universiti Malaysia Kelantan, Jeli Campus, Kelantan.	1.373	1.645	1.946

4.3 Species Evenness

Species evenness was calculated with Pielou's evenness index (J') to measure how evenly individuals are distributed across different species in their communities**.** A value close to 0 indicates that the community is dominated by one or a few species (low evenness), meanwhile, a value close to 1 indicates that all species are represented by a similar number of individuals (high evenness). Table 4.3 shows the Pielou's Evenness index (J') reported as 0.845. This high value suggests that the species within this community are evenly distributed. In other words, no single species dominates the community, and there is a relatively balanced representation of individuals across different species.

Table 4.3: Pielou's evenness index (J')

Site	J'
Universiti Malaysia Kelantan, Jeli Campus, Kelantan.	0.845

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study, Universiti Malaysia Kelantan, Jeli Campus, Kelantan documented a moderate level of Coleopteran species diversity. Six Coleopteran families had been recorded, namely, Calilirihipidae, Cerambycidae, Curculionidae, Hybosoridae, Lampyride and Scarabaeidae. The composition of Coleoptera showed that Scarabidae was the common family found with a total of 28 individuals, followed by Hybosoridae with same total which was 28 individuals, Curcolinidae (10 individuals), Lampyride (8 inviduals), Calilirihipidae (3 individuals) and lastly Cerambycidae with 2 individuals.

In addition, the value of Shannon-Wiener Index (H') was 1.645. The value of Shannon-Wiener Index shows that the diversity of beetle at Universiti Malaysia Kelantan, Jeli Campus is moderate. The Pielou evenness value (J') of 0.845 suggests that the species is fairly evenly distributed, with no single species dominating the community. The Shannon-Wiener Index (H') and evenness value (J') highlights the ecological richness of Universiti Malaysia Kelantan, Jeli Campus, and emphasise the significance of conserving such habitats to maintain biodiversity.

This study provides an insight into the beetle species present in Universiti Malaysia Kelantan, Jeli Campus. Additionally, baseline data from this study can be used for future comparative studies to monitor changes in beetle diversity over time. This study not only contributes to the scientific understanding of beetle diversity in Universiti Malaysia Kelantan, Jeli Campus, but also emphasises the wider significance of conserving biodiversity in tropical environments.

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