

Analysis of Diversity and Relationships of Grasshoppers Based on Morphological Characters in Palangkaraya City, Central Kalimantan.

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Abstract: Grasshoppers are one of the most common herbivorous insects found in tropical areas, including the city of Palangka Raya, Central Kalimantan. This study analyzed the diversity and relationship of grasshoppers in Palangka Raya City based on morphological characters. Diversity analysis was determined by the Shannon Wiener diversity index formula (H'). Determination of relationship was calculated by scoring the morphological characters. The scoring results were then analyzed using MVSP software to construct the dendrogram. The results of morphological identification showed that there were six species of grasshoppers, namely *Oxya serville*, *Valanga nigricornis*, *Dissosteira carolina*, *Atractomorpha crenulata*, *Phlaeoba infumata* and *Hierodula vitrea*. The diversity index of the six species is $H'=1.5$ which is in the medium category. The results of the dendrogram construction show that there are two main clades consisting of clade I containing grasshoppers of the Order Orthoptera, namely *Oxya serville*, *Valanga nigricornis*, *Atractomorpha crenulata*, *Dissosteira carolina*, *Phlaeoba infumata* and clade II containing *Hierodula vitrea* of the order Mantodea. Clade I is divided into two subclades consisting of subclade I containing *Oxya serville* and *Atractomorpha crenulata* and subclade II containing *Valanga nigricornis*, *Dissosteira carolina*, and *Phlaeoba infumata*. Based on the comparative morphological analysis, the distinguishing characters are the shape of the head, wings, thorax and leg. According to these results, it can be concluded that Palangka Raya City has a medium category grasshopper diversity index and the results of the relationship analysis show that the praying mantis (*Hierodula vitrea*) has the most distant relationship compared to the five other grasshopper species

Keywords: Grasshoppers; diversity; relationship

1. Introduction

Palangka Raya City, Central Kalimantan Province is one of the tropical rain forest areas in the equator which has a biome characteristic in the form of a forest that is always wet or humid. There are various types of plants that can live in this area because tropical rain forests always get enough sunlight and also high rainfall even more than 2,000 mm / year. Meanwhile, the average monthly temperature is above 18°C (64°F) throughout the year. Moist tropical forests are ideal homes for some flora and fauna. In a humid tropical forest environment will be found high biodiversity and diverse fauna. The animals that inhabit this forest include mammals, reptiles, birds, amphibians, and insects [1].

Insects are one of the classes in the Phylum Arthropoda which have a segmented body characteristic and have 6 legs or called hexapods. The class Insecta is divided into 17 orders based on its morphological structure, including the wing structure [2]. One member of the class Insecta that has a wide geographical distribution in Indonesia is the grasshopper. The order Orthoptera can be found in almost all terrestrial ecosystems and in Indonesia. Grasshoppers are distributed in almost all parts of Indonesia such as Java, Sumatra, Kalimantan,

Sulawesi, and other islands that have environmental or ecosystem types including forests, shrubs / shrubs, residential areas, agricultural land, etc [3,4].

Despite having a wide geographical distribution, the analysis of the diversity and kinship of grasshoppers in Palangka Raya City has never been analyzed. Therefore, research on the analysis of the diversity and kinship of grasshoppers in Palangka Raya City needs to be carried out considering the significant role of grasshoppers for the environment. In nature, grasshoppers act as predators, scavengers, decomposers of plant and animal organic matter, feed on living and dead plant parts, and natural enemies of various other types of insects [5,6]. Grasshoppers and their relatives live in various types of environments or ecosystems, including rice fields, agriculture grass, shrubs, grass, and shrubs [7]. According to Leksono [8] the grasshoppers species commonly found in Indonesia are twig grasshoppers (*Phobaeticus chani*), wood grasshoppers (*Valanga nigricornis*), praying mantis (*Hierodula vitrea*), leaf grasshoppers (*Phyllium fulchrifolium*), ground-hoppers (*Criotettix robustus*), and The tobacco grasshopper (*Atractomorpha crenulata*).

Most species of grasshoppers are in forest ecosystems. Orthoptera has an ecological distribution

pattern. The order Orthoptera has several families including the Acrididae and Mantodea. According to Prakoso grasshoppers from the Acrididae family have short antennae and act as herbivores in the ecosystem. The praying mantis (*Hierodula vitrea*) has greater abundance and diversity in the tropics and macronesia. The number of praying mantis species is estimated to be more than 2,300 species [7,9].

Based on this background, it is necessary to conduct research on the Analysis of Diversity and Relationships of Grasshoppers Based on Morphological Characters in Palangkaraya City, Central Kalimantan. This research is important to do in order to determine the types of grasshoppers in the urban forest of Palangka Raya and their diversity index, then to analyze the relationship between grasshoppers which has not been studied before..

2. Research Method

Exploration of grasshoppers species was carried out in Palangka Raya City in two sub-districts, there were Jekan Raya and Pahandut in March – April 2021. The grasshoppers samples found were then morphologically identified to determine the species name. The morphological characters identified included wing color, abdomen color, head shape, antenna length, eye shape, eye color, chest shape, grasshopper size, leg spine length, and wing shape. Morphometry was performed on head length, thorax length, abdomen length, wing length, wingspan, and leg length.

Character scoring is done by giving a score of 1 for each appropriate character and a score of 0 for the unsuitable character. The scoring results are accumulated for the dendrogram construction using the MVSP3.1 software. Generating similarity between species was estimated by Simple Matching Coefficient (SSM) and cluster building was carried out using Euclidian method [9].

The grasshopper diversity index was calculated using the Shannon Wiener (H') diversity index equation as follows:

$$\text{Shannon Wiener : } H' = \sum P_i \ln P_i$$

H' : species diversity index

N_i : the number of the 1st species

P_i : n_i/N

N : the number of species

3. Results and Discussions

3.1. Diversity Index

The results of the exploration of grasshoppers species in Palangkaraya City and their diversity index are shown in the following Tabel 1. The results of morphological identification showed that there were six species of grasshoppers, there are five species of Ordo Orthoptera namely *Oxya serville*, *Valanga*

nigricornis, *Dissosteira carolina*, *Atractomorpha crenulata*, *Phlaeoba infumata* and a species of Ordo Mantodea, namely *Hierodula vitrea*.

Table 1. List of grasshoppers species found in Palangkaraya city

No	Species	Habitat	Amount
1	<i>Oxya Servoile</i>	Meadow	12
2	<i>Valanga nigricornis</i>	bush	3
3	<i>Dissosteira Carolina</i>	bush	4
4	<i>Phalaeoba sp.</i>	weeds	11
5	<i>Atractomorpha crenulata</i>	bush	1
6	<i>Hierodula vitrea</i>	weeds	15
Total			46
H'			1,5

The results showed that the diversity of grasshopper species in the city of Palangka Raya was classified as moderate. This is indicated by the value of the species diversity index (H') of grasshoppers of 1.5. The medium category was calculated by the number of grasshoppers species found, there are 46 individuals. The medium category was also influenced by the season, because the study was conducted during dry season conditions. According to the value of the species diversity index can be used to determine the effect of disturbance on the environment or to determine the stages and stability of the grasshopper community at a location [10]. According to, the diversity of grasshoppers affects the diversity of existing parasitoids and predators. Grasshoppers can be hosts for parasitoids and prey for predators. The higher the diversity of grasshoppers in a habitat, the higher the diversity of parasitoids and predators found in that habita [12]. This is related to the fulfillment and adequate food for these parasitoids and predators. The grasshopper community is greatly influenced by human activities, both in grassland and forest [8]. The diversity of grasshoppers in the ecosystem is also influenced by plants. The high diversity of plant species in an ecosystem will support a high diversity of grasshoppers as well [2, 13].

3.2. Analysis of Relationship

The results of the dendrogram construction show that there are two main clades consisting of clade I containing grasshoppers of the Order Orthoptera, namely *Oxya serville*, *Valanga nigricornis*, *Atractomorpha crenulata*, *Dissosteira carolina*, *Phlaeoba infumata* and clade II containing *Hierodula vitrea* from the order Mantodea. Clade I is divided into two subclades consisting of subclade I containing *Oxya serville* and *Atractomorpha crenulata* and subclade II containing *Valanga nigricornis*, *Dissosteira carolina*, and *Phlaeoba infumata*. Based on the comparative morphological analysis, the distinguishing characters are the shape of the wings, thorax and head.

Grasshoppers are generally insects in the order Orthoptera while members of the Order Mantodea are better known as Mantis. This morphological difference between the Orthoptera and the Mantodea causes the *Hierodula vitrea* species to be in a separate clade. The morphological differences between the two orders are indeed quite significant so that even though they have the same local name, the two orders are still far apart based on the analysis of kinship relationships. *Hsiao et al.* [13] said that the mantis has a small triangular head with two large compound eyes on the sides and three small eyes in between. The mouth protrudes like a beak and has a lower jaw. On the head there is also a pair of antennae. The mantis has an elongated neck and chest that appear fused. This neck is able to rotate up to 180 degrees so that these insects are difficult to fool. The body of the mantis is thin and can be brown, green, black, or even pink.

Grasshoppers have large eyes with a variety of colors, namely green, black, or brown. They have chewing mouthparts on the hard capsule head. Unlike the Mantis, the grasshopper's body is not thin but stocky with slight differences between the head, thorax and abdomen even though the insect has these three parts. However, the thorax is the most muscular part. Grasshoppers have filiform antennae that are shaped like threads but some are ensiform. Both mantis and grasshoppers have body sizes that range between two and five inches [14-16].

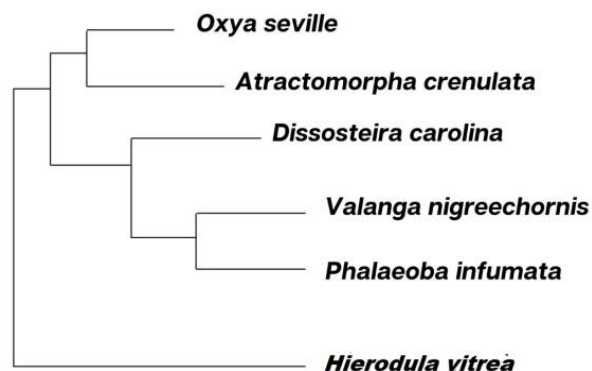


Fig. 1. Dendrogram of grasshoppers species based on morphological characters

In addition to morphological characters, the difference between mantis and grasshoppers is in the type of food. Mantis are carnivorous insects that feed on live insects and other prey. Their nymphs feed on insects such as thrips and aphids. Adult mantis eat crickets, spiders, butterflies, bees, and yes, grasshoppers. Grasshoppers are herbivorous insects and their mouthparts are designed for cutting and chewing plants. Their heads are generally tilted downwards so that their mouths are also facing downwards for easy access to the leaves, flowers and stems of the plants they feed on [17-19].

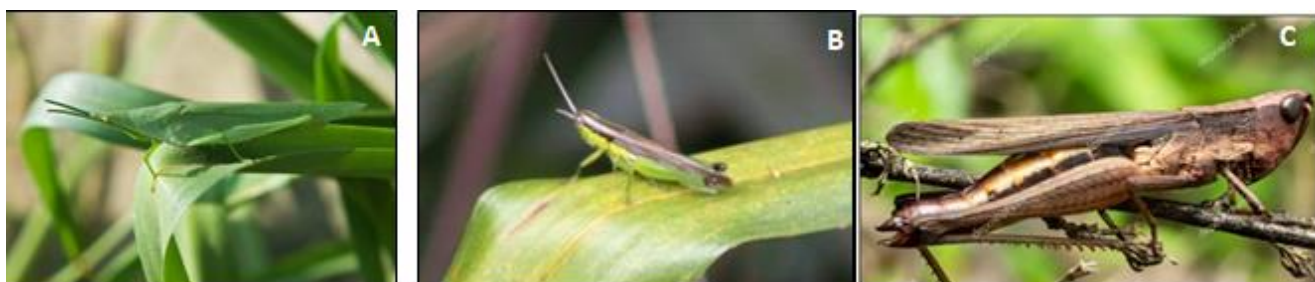


Fig. 2. Grasshoppers species found in Palangka Raya: A) *Atractomorpha crenulata*, B) *Oxya servile*, C) *Dissosteira carolinai*. Source: Research documentation.

4. Conclusions

According to these results, it can be concluded that Palangka Raya City has a medium category grasshopper diversity index and the results of the relationship analysis show that the praying mantis (*Hierodula vitrea*) has the most distant relationship compared to the five other grasshopper species.

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Conflict of interest

Authors have no conflict of interest regarding this study

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