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Diversity and abundance of aerial insects at PT Tri Bahtera Srikandi's oil palm plantation in Singkuang village, North Sumatera, Indonesia

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Abstract
This study aims to determine the diversity and abundance of aerial insects at oil palm plantations. Sampling was done by purposive sampling method by using yellow sticky traps and pheromone trap. Insect catching was carried out in December 2021 until February 2022 at PT Tri Bahtera Srikandi's oil palm plantation in Singkuang Village. The insect collection in oil palm plantation was done in three stations namely at core, plasma and hosmon gardens. Insect identification was carried out in the biology laboratory of Universitas Negeri Medan (Medan State University). The research results showed that there was 24 spesies of aerial insect that be found at oil palm plantation. The aerial insect obtained in core garden consisted of 21 species, 16 families and 6 orders with a diversity index value (H') of 2.47 (medium), a dominance index value (C) of 0.11 (low) and the evenness index value (E) is 0.81 (high). In plasma garden, aerial insect was found 21 species, 15 families and 6 orders with a diversity index value (H') of 2.66 (medium), a dominance index value (C) of 0.09 (low) and an evenness index value (E) was 0.87 (high). Meanwhile, in the hosmon garden, aerial insect was found 21 species, 16 families and 6 orders with a diversity index (H') of 2.55 (medium), a dominance index value (C) of 0.10 (low) and an evenness index value. (E) was 0.84 (high). Hutcheson's t test results showed that the diversity and abundance of aerial insects between core garden and plasma garden was significantly different, but between core garden and hosmon garden and also between plasma garden and hosmon garden were not significantly different.

Keywords: Aerial insects, oil palm plantation, diversity and abundance

Introduction
Biodiversity can be defined as the diversity of living things in various places that are riches in the world. Cholid (2017)[1] states that Indonesia is a rich country in biodiversity and has been recognized by the world as one of the mega biodiversity countries, one of which is aerial insects. Aerial insects are insects that live on land and have wings to fly. Insect populations are threatened mainly by land conversion. The rate of decline in insect populations will have a tremendous impact on every level on ecosystems and other life on earth, including humans. Oil palm (*Elaeis* sp) is an important plantation crop producing edible oil, industrial oil, and biofuel (biodiesel). Oil palm plantation is one of the plantation models that can be used to understand organisms biodiversity with different vegetation conditions and cultivation practices. Conversion of forest areas into oil palm plantations is often used as one of the main factors causing the loss of biodiversity in various tropical countries (Kartono, 2015) [2]. However, many people do not realize that oil palm plantations can accommodate a very large and diverse population of insects, especially if the management is carried out with attention to biodiversity. Based on the research results of Armando (2016) [3], different oil palm plantation habitat conditions affect the diversity and abundance of insects. One form of conversion of forest areas into oil palm plantations can be found at the PT Tri Bahtera Srikandi (TBS) Oil Palm Plantation in Singkuang Village, Mandailing Natal Regency, North Sumatera. This research aim is to know the diversity of aerial insect at this oil palm plantation at different conditions.

Methods
Research location and time
The location of the research was in the oil palm plantation area of PT Tri Bahtera Srikandi in Singkuang Village at three stations, namely at core garden, plasma garden and hosmon garden. The sampling of insect take place from December 2021 until February 2022.
Core garden consisted of mature oil palm plantations, which are about ten years old. The vegetation around the plantation is that there are many flower plants at eight o'clock or *Turnera sp*., ferns and citronella plants as a place to live for natural enemies and pests of oil palm. The core garden is relatively clean so that there are not many weeds or other wild plants that be found. However, there is a small amount of ex-harvested palm oil waste that has not been cleaned, such as empty fruit bunches and oil palm fronds.
Plasma garden has immature oil palm plantations that are about three years old. The vegetation around this garden was sweet potato plantations at the west and at the north there are houses and roads. At this plasma garden can also be found several flower plants as eight o'clock and citronella and also quite a lot of weed vegetation such as nut grass, ferns and others.
Hosmon garden has mature oil palm plants, which are about eight years old and located in a hilly area. Similar to the Plasma Garden, at hosmon garden also can be found several *Turnera sp*. and many weeds or grasses and fern. Its environment was relatively unclean.

Tools and materials
The tools that has been used in this research were roll meter, tweezers, magnifying glass, sample bottles, jars, insect

needles, scissors, digital camera, label paper, stationery, microscope, yellow sticky trap and pheromones. While the materials were 70% alcohol, "*Ronggit glue*" adhesive glue and ferromonas.

Data collection technique

The sampling technique of aerial insects in the field uses the *purposive sampling* method. Sampling was carried out using a yellow sticky trap and pheromones. Sampling with the yellow sticky trap was carried out using a 100-meter line transect with three replications at each station. Every 50 meters a yellow sticky trap is placed. The sampling replication was done on a different day, with an interval of three days from the first observation. Meanwhile, sampling using pheromones was carried out by placing one pheromones trap at each station. The trapped insect was taken after five days and furthermore be identified based on Sulthoni *et al*. (1991)[5] and also be referred to *https://bugguide.net.*

Data analysis

The insect data obtained was analyzed by using diversity index (H′), dominance index (C) and evenness index (E). The differences of insect diversity and abundance among three gardens was tested by using Hutcheson t test (Manurung, 2012)[6].

Results and Discussion

Diversity and Abundance of Aerial Insects

The research result showed, there was 24 spesies of aerial insect that be found at oil palm plantation of PT Tri Bahtera Srikandi in Singkuang Village. These species were *Cosmolestes* sp., *Chrysocoris* sp1., *Chrysocoris* sp2., *Scotinophara* sp., *Murgantia* sp., *Belostoma* sp., *Xylocopa* sp., *Apis dorsata*, *Spinaria* sp., *Vespa* sp., *Oulema* sp., *Epilachna* sp., *Cheilomenes* sp., *Anomala* sp., *Onthophagus* sp., *Oryctes rhinoceros*, *Tipula* sp., *Rhagoletis* sp., *Helophilus* sp., *Sarcophaga* sp., *Ryothemis* sp., *Acisoma* sp., *Parcoblatta* sp. and *Tettigonia* sp. (Fig.1). The species that be collected belong to 17 families and 6 orders. The insect order was Hemiptera, Hymenoptera, Coleoptera, Diptera, Odonata and Orthoptera, meanwhile the families were Reduviidae, Scutelleridae, Pentatomidae, Belostomatidae, Apidae, Ichneumonidae, Vespidae, Chrysomelidae, Coccinelidae, Scarabaeidae, Tipulidae, Tephritidae, Syrphidae, Sarcophagidae, Libellulidae, Blattidae and Tettigonidae.

At the core and hosmon oil plantation gardens there were 21 species that belongs to 6 orders and 16 families. In plasma garden there was also 21 species and belong to 6 orders but just only into 15 families.

The most aerial insects caught at the three oil palm gardens were *Cosmolestes* sp. species from the family Reduviidae and the order Hemiptera, totaling 141 individuals. The existence of *Cosmolestes* sp. at gardens may be determined by the presence of prey in the field, especially the presence of caterpillars which are one of the important pests of oil palm plants as well as prey for *Cosmolestes* sp. Diratika *et al*. (2020)[7] stated that the management of caterpillar pests in oil palm plantation ecosystems can be done by optimizing the function of natural enemies and one of the this natural enemies and act as predatory was *Cosmolestes* sp. The eating process of this insect be done by piercing the prey's body tissue and sucking out the body fluids (Kumar and Sahayaraj, 2012) [8]. In addition, the oil palm plantations are a suitable habitat for *Cosmolestes* sp. by the presence of a lot of wild vegetation such as ferns and *Turnera* sp. plants or eight o'clock flower that act as natural habitat (Alfitra *et al*., 2018) [9].

The least aerial insects that could be catched was *Belostoma* sp., family Belostomatidae, order Hempitera,. This is insect basically belongs to aquatic insect but it is also attracted toward the light. This finding was in accordance with Harahap *et al*. (2020) [10] that stated some adult *Belostoma* sp. species will fly towards the lights during the breeding season.

The graph of the abundance of aerial insect species that be collected in PT TBS is presented in Figure 1. The number of aerial insects caught in the "*Yellow Sticky Trap*" was 699 individuals, namely 273, 161 and 265 individuals in core, plasma and hormon gardens, respectively. The aerial insects caught by using pheromonas trap was only one species, namely *Oryctes rhinoceros* with a total of 4 individuals. According to Hosang and Salim (2014) [11], besides attracting the beetle *Oryctes rhinoceros*, pheromonas can also attract the other species of the beetle such as *Rhyncophorus ferrugineus* and *Xilotrupus gideon*. However, in this study, only the beetle *Oryctes rhinoceros* that could be trapped.

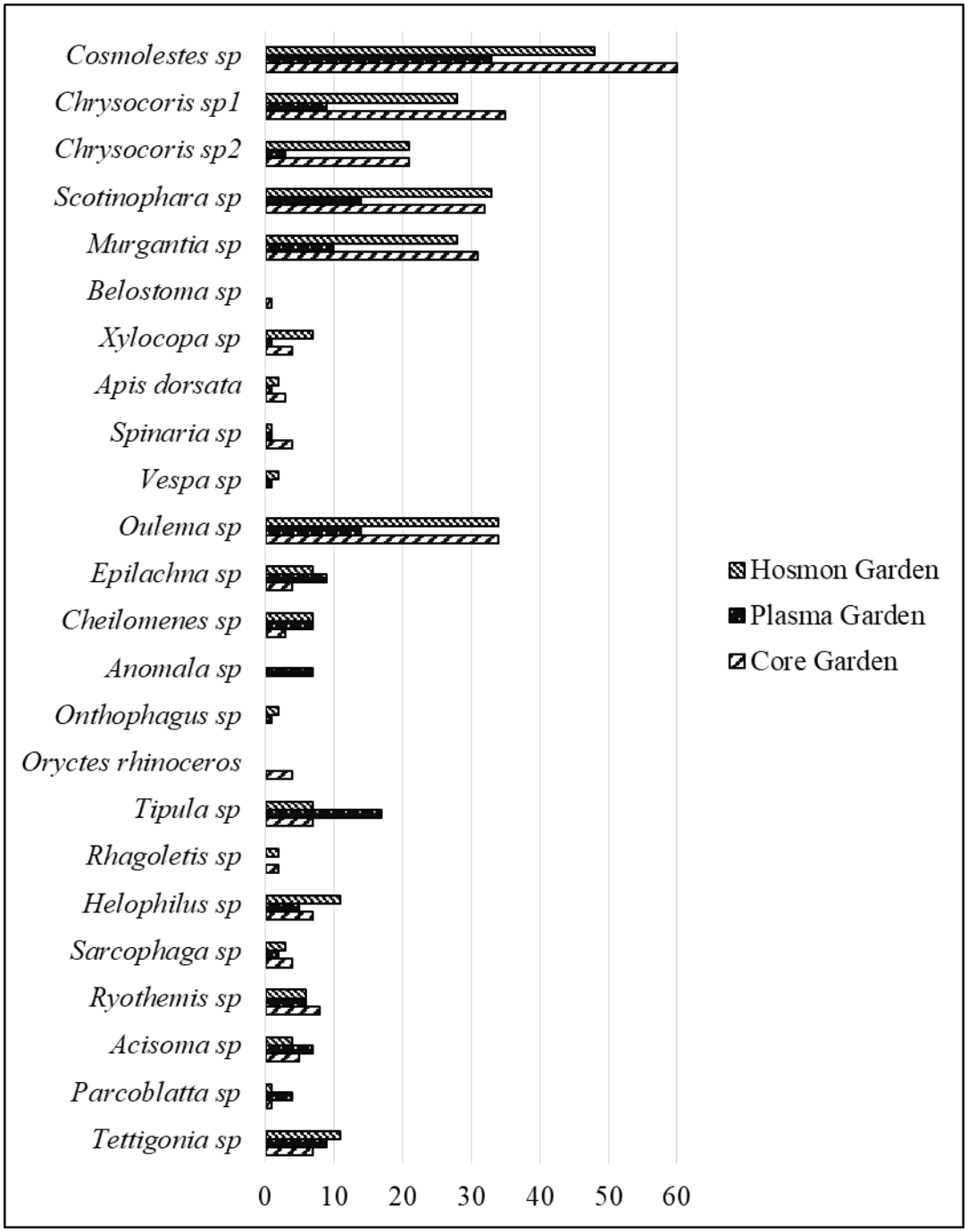

Fig 1: Diversity and abundance of aerial insects at three gardens of oil palm plantation of PT Tri Bahtera Srikandi

The research finding showed also that there was several insect species that be found only in one garden. Species *Anomala* sp. for example only be found in plasma gardens, meanwhile *Belostoma* sp. and *Oryctes rhinoceros* were found only in the core gardens. This finding differences maybe caused by the differences of vegetation that growth at the three gardens. As emphasized by Pratiwi and Widyastuti (2013) [12], the habitat selection could causes certain species be found in one habitat or location while other species are in other habitat.

Anomala sp. is one of the insects that light likes at night. This beetle is a nocturnal insect that feeds on the leaves of various ornamental plants (Depari *et al*., 2021) [13]. The environment around the plasma gardens is relatively unclean with many weeds. It is possible or coincidental that when these weeds rot, these insects lay their eggs in the organic waste (Harianto, 2009) [14].

Belostoma sp. are common predators in ponds and wetlands. This type of insect food is dragonfly nymphs, snails, small fish, shrimps that be found in the waters. Basically, these insects are often found in wetlands, swamps and ponds (Tobler *et al*., 2013)[15]. At the time of Yellow Sticky Trap laying in the core garden, there was one trap that be placed at the edge of the ditch. This is probably the reason why these insects be found and was only in the core gardens. According to Harahap *et al*., (2020) [10], the activity of *Belastoma* is more in the waters and its food source also comes from the waters and only during the breeding season this insect will fly into the light of the lamp. In addition, the number of *Belostoma* sp that be found during investigation was just only one individual, therefore the catching of this insect at the research, especially in core garden was only by chance.

Oryctes rhinoceros can live optimally with the support of suitable ecological factors. Nuriyanti *et al.* (2016)[16], suggested that the factors that influence the growth, development, and population density of *Oryctes rhinoceros* are the availability of resources such as food and living space as well as resource accessibility and the ability of individual populations to reach and obtain resources. The results showed that *Oryctes rhinoceros* was only found in the core gardens. The ecological condition of the core plantations showed there was no so many weeds or other wild plants that arise but palm oil wastes such as empty fruit bunches and midribs were be found. According to Yustina *et al.* (2012)[17] the present of rotting waste, rotting leaves and empty palm oil bunches after harvesting were condition and ideal places for rhinoceros beetles to thrive. The female *Oryctes rhinoceros* will lay eggs on the remains of decayed organic matter and then hatching to larve and furthermore develop into the pupa and imago stages.

Diversity Index, Dominance Index, and Aerial Insect Evenness Index

From the data analysis that has been carried out using the Shannon-Weinner diversity index, the Simpson dominance index, and the Pilou evenness index, the index values are obtained as displayed in Table 1.

Table 1: Diversity, dominance and evenness index of insect communities on oil palm plantations of PT Tri Bahtera Srikandi

Variable	Core garden	Plasma garden	Hosmon garden
Diversity Index (H')	2.47	2.66	2.55
Dominance Index (C)	0.11	0.09	0.10
Evenness Index (E)	0.81	0.87	0.84

The value of the diversity index in the core garden was 2.47, the plasma garden 2.66 and the hosmon garden 2.55. This value indicates that the diversity of aerial insects at the three oil palm plantations was in the moderate category. Research that be conducted by Dasuha (2020)[4] at other two oil palm plantation also obtained a moderate diversity index value (2.10-2.33). Lubis (2010)[18] also reported that the insect diversity index at immature and mature oil palm plantations was 2.22 and 2.79. The research result in this investigation was in accordance with the statement of Redjeki *et al.* (2017)[19], that stated, if H' = 1-3, it means, the diversity of insects is moderate. This category is almost good where the presence of pests and natural enemies are almost balanced.

The value of the dominance index in the core garden was 0.11, in plasma garden 0.09 and at the hosmon garden was 0.10. Based on this value, the dominance index of aerial insects at the three oil palm plantations was at the low category. This result indicated there was no aerial insect species dominates. Mujalipah *et al.* (2019) [20] stated that the dominance index ranges from 0-1. The smaller value of the dominance index, means there is no species dominates, on the contrary, the larger dominance index value, means there is the certain species dominate. In a community with high diversity index, there is no species that will be dominant and vice versa in a community with the low diversity index, there is one or two species that be dominant. Research that be carried out by Dasuha (2020)[4] also showed the similar result, namely the value of the insect dominance index at other oil palm plantations was relative low, namely 0.16.

The evenness index of insect at the three gardens of oil palm plantations were high. The evenness index value in core garden was 0.81, in plasma garden 0.87 and in hosmon garden 0.84. Based on these results could be concluded that the distribution of aerial insect species that be found at the three gardens were evenly distributed and indicated its ecosystem was in good condition. Dasuha (2020)[4] also found the similar result that the value of the insect evenness index at oil palm plantations was high. The high evenness of aerial insect species at these three gardens was due to the fact that there was no dominant species. Oka (2005)[21] stated that the evenness value will tend to be high if the individual number in one species does not dominate, on the contrary, evenness tends to be low if the individual number of one species at community was high or dominates the number of other populations. Diversity and dominance are negatively correlated.

Differences in Diversity and Abundance of Aerial Insects

The differences of vegetation at the three oil palm plantations will also cause differences in the diversity and abundance of aerial insects. Therefore, it is necessary to test this differences by using Hutcheson's t test. The testing results of these insect diversity and abundance at the three oil palm plantations during the study be presented in Table 2.

Table 2: The significant differences of diversity and abundance of aerial insect at three gardens at PT Tri Bahtera Srikandi oil palm plantation

Station	df	t-count	t-table at 0.05	Differences
Core vs Plasma gardens	379	2.16	1.96	significant
Core vs Hosmon gardens	430	0.90	1.96	not significant
Plasma vs Hosmon gardens	311	1.39	1.96	not significant

The results of Hutcheson's t-test showed that there was a significant difference in diversity between core garden and plasma garden. Meanwhile, there were no significant differences between core garden and hosmon garden and plasma garden with hosmon garden. The difference in diversity values between stations is thought to be due to differences in environmental factors and differences in vegetation that affect the presence of aerial insects. The core garden has mature oil palm plantations, while the plasma gardes have immature oil palm plantations, so it is suspected that this will affect the diversity of aerial insects in the two plantations. The differences in insect diversity between immature and mature palms have also been confirmed by Farinsza et al. (2021) [22] which stated that in oil palm areas that have not yet produced, there were many types of insects that be found. The vegetation of oil palm plantation at the core garden and the hosmon garden were relatively similar. In this case, the land of the two gardens were relatively unclean, be found many weeds such as grass, and other wild plants. So it is assumed that the diversity and abundance of aerial insects at the two gardens were not significantly different. Research result that be conducted by Dasuha (2020)[4] also stated that insects were more commonly found on natural vegetation than on clean oil palm land.

Conclusion

The research results showed that the aerial insects found in the oil palm plantation of PT Tri Bahtera Srikandi consisted

of 24 species that belongs into 17 families and 6 orders. The most abundant species found was *Cosmolestes* sp., *Oulema* sp. and *Chrysocoris* sp. Aerial insect diversity index obtained at the three oil palm plantations or gardens were moderate category, namely 2.47 in core garden, 2.66 in plasma gardens and 2.55 in hosmon garden. The dominance index obtained at the three gardens were in the low category indicating that there was no dominant insect species, namely 0.11 in core garden, 0.09 in plasma garden and 0.10 in hosmon garden. The evenness index obtained at the three oil palm plantations was in the high category, indicating that the distribution of aerial insect species that be found was evenly distributed, namely 0.81 in core garden, 0.87 in plasma garden, and 0.84 in hosmon garden. Diversity and abundance of aerial insects between core and plasma gardens was significantly different, meanwhile between core and hosmon gardens and between plasma and hosmon gardens were not significantly different.

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