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THE INFLUENCE OF OIL PALM PLANTATION TOWARD THE INSECT ECOLOGY ON CHILLI PLANT IN DESA BANGUN REJO, LABUHANBATU UTARA, INDONESIA

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ABSTRACT: *Chili has some compounds that are useful for human health. Chili also contains antioxidants that function to keep the body from free radical attack. The need for red chili (Capsicum annum L.) keeps on escalating along with the increasing number of population and the development of food industry that requires chilly as raw material. Based on the Tukey Test results showed that the observation time significantly affects the number of species (F = 3.049; P = 0.0006) and the abundance of pollinator insect (F = 5,739; P = 0,0000). The pollinator insects begin to activate at 07.00 am and increase at 10.00.*

KEYWORDS: *oil palm plantation. red chili, insect, ecology*

INTRODUCTION

Chili (*Capsicum annum L.*) is one of the important vegetable crops in Indonesia; because it is able to meet the specific needs of Indonesian community for the spicy taste of a food. Red chili can also provide color and flavors that can arouse appetite. It contains lots of vitamins and can also be used as medicines (Marliah, 2011). Chili has some compounds that are useful for human health. Chili also contains antioxidants that function to keep the body from free radical attack. The need for red chili (*Capsicum annum L.*) keeps on escalating along with the increasing number of population and the development of food industry that requires chilly as raw material. But this huge demand cannot be fulfilled, because the productivity of red chili plants per unit area is still low.
According to the Central Bureau of Statistics (2015) of North Sumatra states that from the data in 2012, the production of chili is already 197.409 ton. Meanwhile, in 2013, the production reached 161,933 tons and again decreased 14.123 tons (8.72%) in 2014 to 147.810 Ton. One effort that can be done to increase the production of red chilli is to activate the resource in the agricultural environment such as the role of pollinator insect. This insect is one part that cannot be separated from the plant. The interaction between the pollinator insects and the plants has a mutually beneficial relationship. In such interaction, the plant provides a source of feed, i.e. pollen and nectar, a shelter and a reproduction site. While the plant gets its advantage from the pollination which is the encounter of pollen with the pistil's head. The availability of feed on flowers is also associated with the insect diversity (Weni, et al., 2013).

The possibility is that the insect will do cross-pollinate on the flower depends on (a) the intermediate distance on a single plant, (b) the distance ability to reach the food, (c) the amount of flower in one plant, (d) the amount of food available in each flower and (e) the amount of food collected by animals (Raw, 2000). A potential insect as a pollinator is an insect which can help to

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move the pollen to the stigma. Emiwati (2010) found that there were 36 species of insects from *Apidae* family, *Megachilidae, Scoliidae*, and *Vespidae* that can do the pollination.
While Widhiono and Eming (2015) says that the pollinator insect which visited the chilly plant are 105 individuals consisting of 10 species of *Chrysosomaleucopogon* as many as 38 individuals, *Apis cerana* 14 individuals, *Amegillacingulata* 10 individuals, *Nomia sp.* 4 individuals, *Philanthuspolitus* 4 individuals, *Ropalidia romandi* 2 individuals and *Ropalidia fasciata* 4 individuals *Hylaeus modestus* 3 individuals, *Lasioglossum malachurum* 20 individuals, and *leucozonium Lasioglossum* as many as 6 individuals.

The forest in Indonesia is rich for high biological. It is indicated by the species diversity of flora and fauna. The natural richness of these living things is now declining as a result of the use of less sensible resources such as the changes in the allocation of forest areas (legal and illegal) to the plantation areas, including oil palm plantations. The expansion of palm oil plantations has increased from year to year. In 2010 the palm oil plantations were recorded at 8,385,394 hectares, while in 2012 it increased by 6.45% to 9,572,715 ha and in 2014 the area of palm oil plantation increased again to 10,956,231 Ha (4.69%). The width of the area is owned by the people (community plantation) is 4.55 million Ha or 41.55% of the total land area, state-owned plantation (PTPN) is 0.75 million Ha or 6.83% of the total area, 5.66 million hectares or 51.62%, of the private sector is divided into 2 (two) namely foreign private sector of 0.17 million Ha or 1.54% and the rest is the local plantation (Directorate General of Plantation, 2014). The use of this land causes the changes in the structure and composition of vegetation on the land and will ultimately affect the stability of new ecosystems. The change of ecosystem into the new ecosystem involves not only vegetation, but also in fauna both above the ground and on the ground.

Picture 1. Red Chilly plant

II. Methodology

The study was conducted from January to February 2017. This study was conducted in two plots of red chili of the people's garden in Desa Bangun Rejo, Labuhanbatu Utara to see the number of species of pollinator insects. The first red chilly garden is at the point of coordinates 03 n2 6'01.90"N and 098n 55'31.86"E while the second people's chilly garden is at the coordinate point 03°26'16.14"N and 098°55'14.59"E. Furthermore, the observation of the pollinator insect types was conducted at the laboratory of University of Medan Area, Medan, Indonesia. The width of the chilly cultivation on both locations is 1200 m divided into 24 plots. Each plot is 1 x 24 m2. The

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distance between plots is 1 m. The sampling of the pollinator insect was performed on six different plots. The determination of the six plots is conducted based on the random sampling by giving numbers to the plots from 1 to 24 on a piece of paper which was then put into a container to be sampled six times.

The environmental parameters are measured during the observations that consist of temperature Air (°) and air the humidity (%) with thermohigrometer. The wind speed data were taken from BMKG (Meteorology Climatology and Geophysics Agency). The measurement of air temperature was measured between 07.00 WIB until 17.00 WIB with the measurement interval every hour was one hour. The observations of pollinator insects were carried out at two plant sites of the 50 days old chilly after planting. At this age the plant has already entered the generative phase reproductively. The observation of pollinator insect on both WISPloRka' is conducted alternately, one day at the chili plantation which is near the oil palm plantation (LI) and one day later in the chili plantation which is far from the palm oil plantation (L2). The determination of the location for the first observation was done randomly by "toss coin". The observations were made for six days at each location. The observations were conducted on a sunny day starting at 07.00 pm-17 pm. The observation time on each plot is conducted for 10 minutes. The observation on the first day started at 07.00 WIB-16.00 WIB with 60 minute interval of each observation period. The observation on the second day began at 08.00 WIB-17.00 WIB with 60 minutes intervals of each observation period. And so on until the observation is completed. For the purposes of identification, some pollinator insects are captured by using insect webs. The caught insects are then inserted into a murderous bottle containing *ethyl acetate*. The dead insects are then stored into papilot paper and taken to the laboratory for identification.

Table.1 The period of Observation toward the Pollinator Insects

Observation	Time of Odd Survey	Time of Even Survey
1	07.00-08.00	08.00-09.00
2	09.00 - 10.00	10.0 0 – 11.00
3	11.0 0 - 12.00	12.00-13.00
4	13.00 -14.00	14.00-15.00
5	15.00-16.00	16.00-17.00

The results of the observation data obtained then were used for analysis.

1. The number of individuals is presented in tables.
2. Comparison of insect composition between the two sites was performed by using the similarity index of "Sorensen" with the formula:

$$S = \frac{2a}{2a + b + c}$$

Note:

a = number of species present in the communities a and b
b = number of species in the community b but not in the community a
c = number of species in the community a but not in the community b

5. The comparison of abundance for each taxon for both locations is performed by using the Mann-Whitney Test if the data is not normally distributed.

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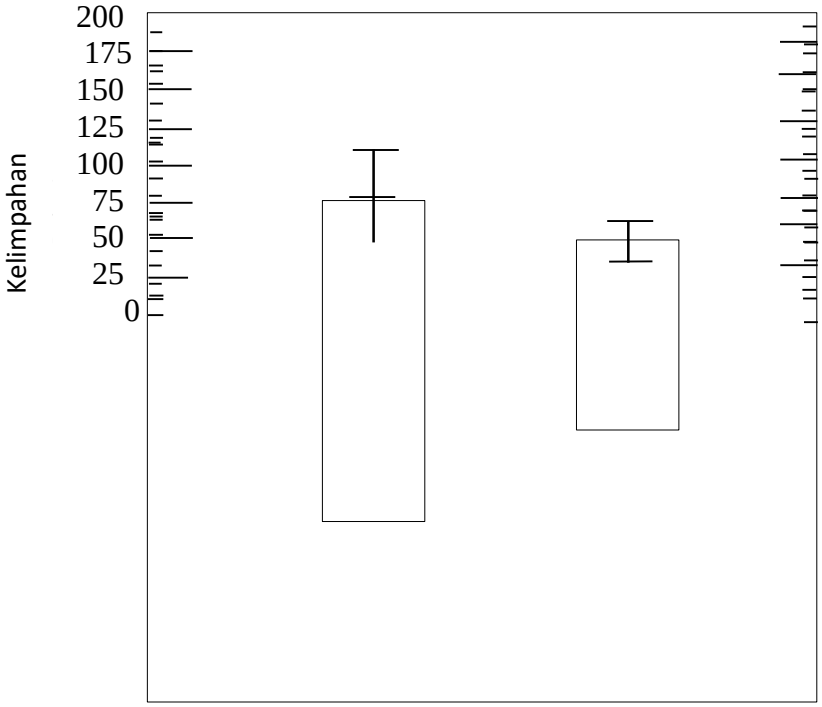
DISCUSSION

The ratio of abundance for each pollinator taxon was analyzed by using a non-parametric test of Mann-Whitney Test (U), this is conducted because of the amount of data that is "missing" due to the least amount of insects that are tested on many taxons. The abundance of the pollinator butterflies was not different significantly between the two microhabitats. The chilly plantations which are near the palm oil plantations and those far from the palm oil plantations, did not differ significantly (U = 1.493; P = 0.222).The *borbo cinnara* pollinator butterflies observed in the chilly pepper plantation which is near the palm oil plantations 5.5 ± 11.58 are significantly higher than the abundance of these insects found in chilly plantations which are far from the oil palm plantations of 1, 33 ± 2 , 89 (U = 5,968; P = 0,015).



The effect of oil palm plantations on the abundance of *Borbo Cinnara* Butterflies on the red chilli plants (L1 = near the palm oil, L2 = far from the palm oil)

The abundance of the pollinator butterflies was not different significantly between the two microhabitats. The chili plantations which are located near the palm oil plantations and those far from the palm oil plantation, did not differ significantly (U = 1.622; P = 0.203). The abundance of *Campsomeris collaris* pollinator wasp observed in the chilli plantations which are far from the palm oil plantations of 1.67 ± 7.33 is significantly higher than the abundance of these insects found in chilly plantation near the palm oil plantations (U = 7,763 ; P = 0.005;)

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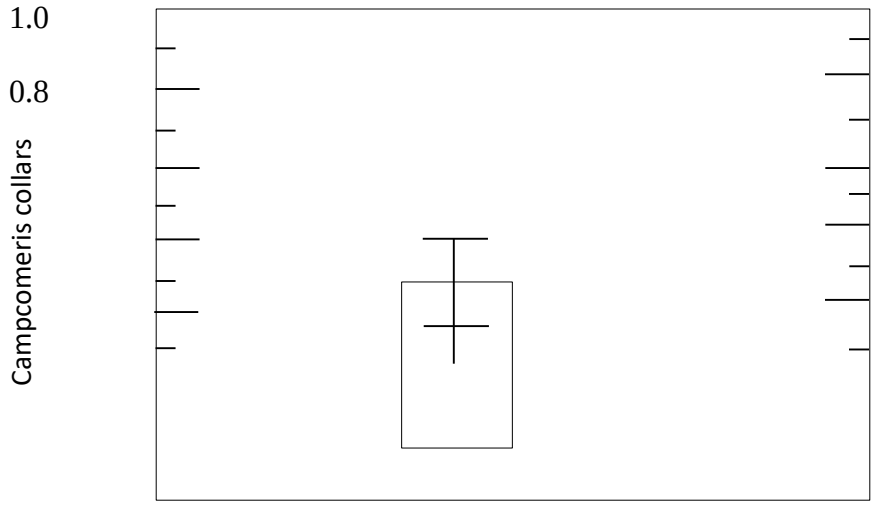


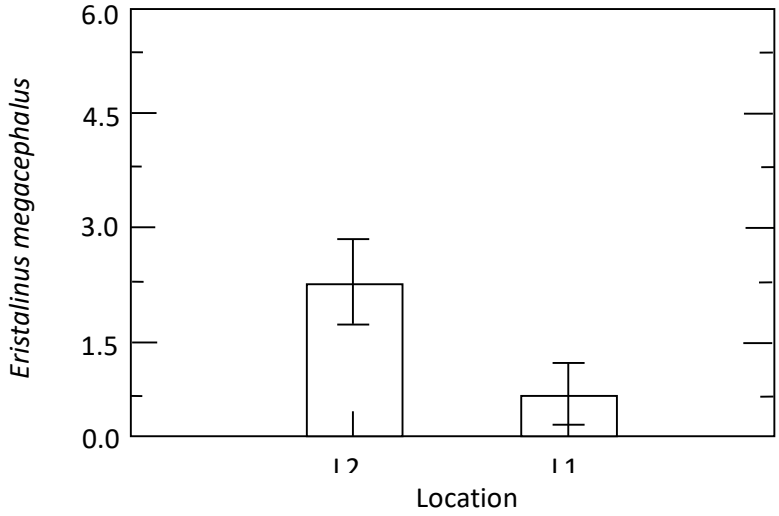
The effect of oil palm plantations on the abundance of *Campsomeris collaris* wasps on the red chilly plants (L1 = near the palm oil, L2 = far from the palm oil)

e. The Abundance of *Delias hyparate* butterflies

The abundance of the *Delias hyparate* pollinator butterfly was not different significantly between the two microhabitats which are near the chilly plantations. The far palm oil plantations, did not differ significantly (U = 1.556; P = 0.212)

f. Abundance of *Eristalynus megacephalus* flies

The abundance of *Eristalynus megacephalus* pollinator flies observed in the chilly plantations which are far from palm oil plantations of 3.67 ± 60.23 was significantly higher than the abundance of these insects found in the chilly gardens which are far from the palm oil plantation 10.67 ± 40,22 (U = 6,457; O = 0,011; Picture 4.6).



The effect of oil palm plantations on the abundance of *Eristalinus megacephalus* flies on the red chilly plants (L1 = near the palm oil, L2 = far from the palm oil)

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g. The abundance of *Junonia almana* butterflies

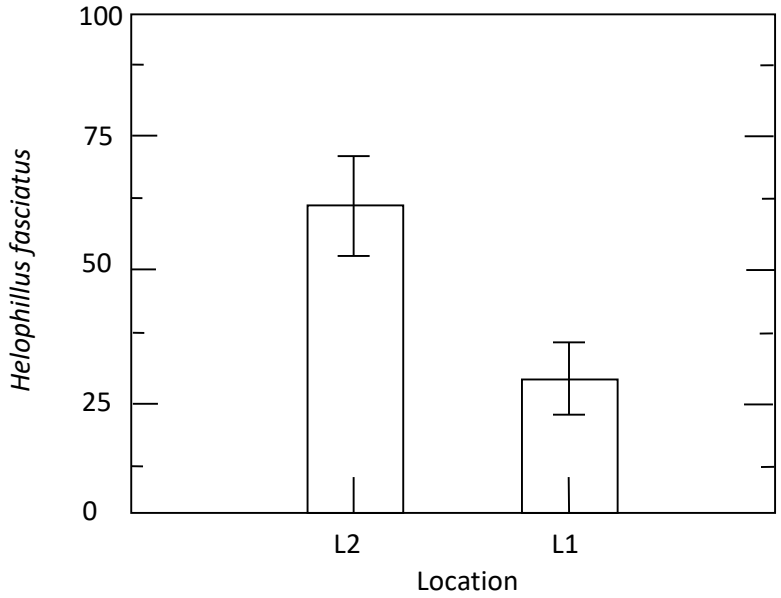
The abundance of these pollinator butterflies was not different significantly between the two microhabitats, the chilly plantations which are near the palm oil plantations and those far from palm oil plantations did not differ significantly (U = 3.372; P = 0.066).

h. Abundance of *Junonia atlites* butterflies

The abundance of these pollinator butterflies was not different significantly in the microhabitat cages, the chilly plantations which are near the palm oil plantations and those far from palm oil plantations, did not differ significantly (U = 0.468; P = 0.494).

i. The abundance of *Helophillus fasciatus* flies

The abundance of *Helophillus fasciatus* flies observed in the chili garden l which is far from the palm oil plantations 308,83 ± 23753,47 significantly higher than the abundance of these insects found in the chilly plantations which are near the palm oil plantations 145 ± 4173,33 (U = 9,739; P = 0.002;).



The effect of oil palm plantations on the abundance of *Helophillus fasciatus* flies on the red chilly plants (L1 = near the palm oil, L2 = far from the palm oil)

j. The abundance of *Meliscaeva cinstella* flies

The abundance of these pollinator flies was not different significantly in the microhabitat cages, the chilly gardens which are near the palm oil plantations and those far from palm oil plantations, did not differ significantly (U=0,633 ; P=0,426).

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k. The abundance of *Nomia strigata* wasps

The abundance of these pollinator wasps was not different significantly in the microhabitat, the chilly gardens which are near the palm oil plantations and those far from palm oil plantations, did not differ significantly (U=0,518 ; P = 0,472).

l. The abundance of *Polistes fuscata* wasps

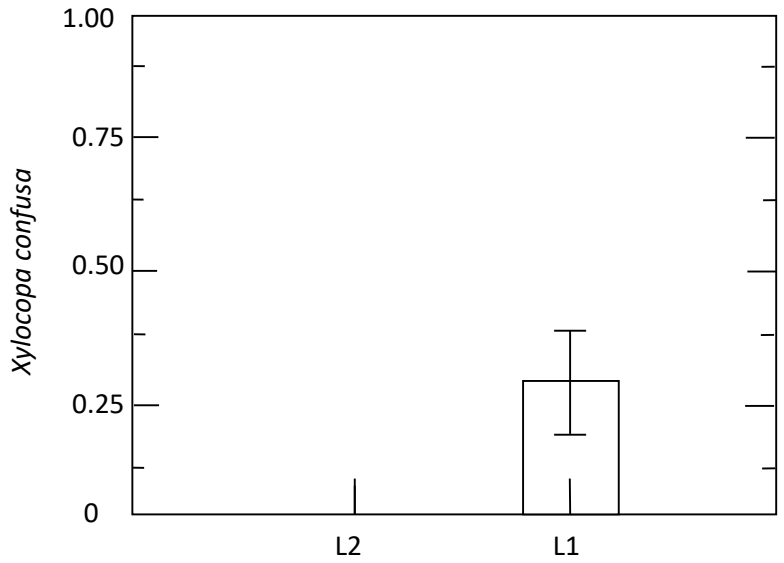
The abundance of these pollinator wasps was not different significantly in the microhabitat, the chilly gardens which are near the palm oil plantations and those far from palm oil plantations, did not differ significantly (U = 0,942 ; P=0,332).

m. The abundance of *Syrphus vitripennis* flies

The abundance of these pollinator flies was not different significantly in the microhabitat cages, the chilly gardens which are near the palm oil plantations and those far from palm oil plantations, did not differ significantly (U=3,124 ; P = 0,077).

n. The abundance of *Xylocopa confusa* wasps

The abundance of *Xylocopa confusa* wasps observed in the chilly garden which is far from the palm oil plantations 1,33 ± 0,222 significantly higher than the abundance of these insects found in the chilly plantations which are near the palm oil plantations (U=6,539 ; P = 0,011).



The effect of oil palm plantations on the abundance of *Xylocopa confusa* flies on the red chilly plants (L1 = near the palm oil, L2 = far from the palm oil)

1. The Influence of Observation Time toward the Number of Pollinator insects Taxon of Red Chili

The observation time significantly influenced the number of the pollinator red chili species (F = 3.049; P = 0.006). Furthermore, based on Tukey test, the results obtained the number of pollinator insect taxon at 10.00 WIB which was significantly higher when compared with the observations

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at 13.00 pm (0.4792 ± 5.4792), at 15.00 WIB (0.1459 ± 5.8126), at 16.00 WIB (0.1459 ± 5.8126), at 14.00 WIB (0.6459 ± 5.3126), and at 08.00 WIB (0.9792 ± 4.9792), but did not differ significantly when compared to at 07.00 WIB (1,9792 ± 3,9792), at 09.00 am (2.8126 ± 3.1459), at 11.00 am (2.6459 ± 3.3126), and at 12.00 WIB (1.4792 ± 4.4792)

2. The Influence of Observation Time on the Abundance of Pollinator Insects

The observation time significantly influenced the abundance of insect pollinator (F = 5,730; P = 0,000). Furthermore, based on Tukey test the results obtained the abundance of pollinator insect at 11.00 WIB is significantly higher when compared with the observation at 08.00 WIB (50,9637 ± 238,3697), at 07.00 WIB (31.7970 ± 219.2030) at 15.00 WIB (32,9637 ± 220,3697), and at 16.00 WIB (26,7970 ± 214,2030), but did not significantly differ when compared to the observation at 13.00 WIB (71.8697 ± 115.5363) at 09.00 WIB (34, 3697 ± 153,0363), at 10.00 WIB (7,3697 ± 180,0363) at 12.00 WIB (33,5363 ± 153,0363), and at 14.00 WIB (6,5363 ± 180,8697)

3. Chemical and Physical Factors of the Chilly Garden Environment

The environmental factors that influence the visit of pollinator insects include the temperature, the air humidity, and the wind speed.

a. Temperature

In the figure shows that the air temperature at the time of observation obtained ranged 26-32^{0}C. the air temperature measured between 07.00 WIB to 17.00 WIB with interval measurement time every one hour of observation shows that overall average air temperature is 28,82 ± 2.15 ^{0} C. This temperature obtained is good to increase the insect visits to the plants. The insects visit are generally on more flowers during the day with a temperature range of 24-350C (Khairiah, et al. 2012).

The environment temperature determines the body temperature for the animals of *poikilotermi*. Even the temperature becomes the limiting factor for the animals. Body temperature determines the work of enzymes that help the metabolism in the body. Therefore, from an ecological point of view, the importance of the environmental temperature for the *ectoterm* animals is not only related to their activities but also the effect on the rate of their development. For *ectoterm* animals, the prolongation of development will be different at different environment temperatures and the time is a function of environment temperature (Dharmawan et al., 2004). Insects have a certain temperature range where they can live. Outside that range the insects will die for being cold or overheated. Air temperature is very influential on pollinator insects, because the amount of energy needed is very dependent on environmental temperature (Widhiono, 2015b). Temperature fluctuations of 10-20^{0}C with an average temperature of 15^{0}C, the effect on animals is not the same as the constant temperature of 15^{0}C,. On the types of grasshoppers and butterflies observed, the various temperatures resulted the faster growth rates .

b. Humidity

The picture shows that the air humidity at the time of observation obtained ranged from 40-79%. The air humidity measured is between 07.00 WIB to 17.00 WIB with interval measurement time that every one hour observation, it shows that overall average air humidity is 60 ± 13.56%. The range of insects tolerance generally toward the air humidity located near the maximum point is

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between 73-100%. Humidity meant here is the air humidity and the insect place of life where it is an important factor that affects the distribution, activity, and development of the insects.

c. Wind velocity

The picture shows that the wind speed at the time of observation obtained ranged from 5-25 km/h. the wind speed is measured between 07.00 WIB to 17.00 WIB with the interval measurement time that every one hour observation it shows that the overall average wind speed is 13 ± 7,620 km / j. The data obtained showed that the wind speed is considered moderate. This affects the speed of the pollinator insects to move around. Wind affects the food search activity of the pollinator insect. The wind speeds is between 24-34 km/h and has effect on bee activity in searching the feed (Widhiono, 2015b).

d. Insect Pollinator Composition

The picture shows the difference composition of red chilly pollinator insects at both locations. The species of pollinator insects found in red chilly plants which fall from the palm oil are dominated by family of *Diptera* of *Helophilus fasciatus* species, followed by species of *Syrphus vitripennis, Erystalinus megacephalus, Nomia strigata* from family of Hymenoptera, *Meliscaeva cinctella, Polistes fustaca, Compsomeris collaris, Catopsilia piranthe, Junonia almana, Barbo cinnara, Delias hyparate, Appias olferna* dan *junonia atlites*. Mdeanwhile on the red chilly plants which are near the palm oil plantation it was dominated by pollinator insects of *Syrphus vitripennis, Helophillus fasciatus, Borbo cinnara, Nomia strigata, Polistes fuscata, Erystalinus megacephalus, Meliscaeva cinctella, junonia atlites, Xyloco[a confusa, Appias olferna, Catopsilia piranthe, Delias hyparate, Junonia almana.*

In the red chilly plant which are near the palm oil the species of *Compsomeris collaris* wasp was not found whereas in the locations around the people's fields did not find the *Xylocopa confusa* bee. The differences in the composition of pollinator insects that visit the flowers of red chilly plant is caused by the difference of flowering sugar vegetation around the plant as a feed provider and a nest for insects around the observation field. The more various flowering plants will be able to provide a source of feed at a time and throughout the year due to the different of flowering phenology among the plants.

Wild flowering plants or under plants are the plant communities that make up stratification near ground. This plant is generally in the form of grass, herbs, shrubs or low shrubs. In taxonomy, the lower vegetation is generally a a tribe member of *Poaceae, Cyperaceae, Araceae, Asteraceae,* ferns and others. This vegetation is widely found in open places, roadsides, river cliffs, forest floors, farmlands and plantations. The important value of the wild plants or can be said as agricultural weeds as a food source of pollinating powders insects, because they have a flower shape, the number of flowers and flowering time is various (Kearns & Inouye, 1997). Thus the variety of wild plants in natural or semi-natural lands around thev farmland will increase the diversity and the populations of pollinating insects are needed on the farmland (Carvell et al., 2007).

e. The abundance of Pollinator Insects

The result of t-test on the two variables shows that there are significant differences of the abundance of red chilly pollinator insects at the location around the fields of the people and those

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near the oil palm plantations (t = 1,834; P = 0.004) where the abundance of red chilly pollinator insects at the location surrounding the people's field (72.906 ± 115.267) was higher when compared with the abundance of pollinator insects found in red chilly plants near the palm oil (44.123 ± 67.967).

f. The influence of observation time

Based on the Tukey Test results showed that the observation time significantly affects the number of species (F = 3.049; P = 0.0006) and the abundance of pollinator insect (F = 5,739; P = 0,0000). The pollinator insects begin to activate at 07.00 am and increase at 10.00. This result was also demonstrated by a research of Purwantiningsih (2012) that overall pollinator insects visited more on the chili plants whose visit frequency peaked at 09-10.15 and began to decline at 15:00 to 16:15. The highest abundance found at 11 o'clock on the red chilly plant which is near the palm oil which is dominated by *Shirphus vitripennis* flies, while in the locations near the people's fields they are dominated by the insects from the same order *Dipetra* with different species of *Helophilus fasciatus* flies.

The highest presence of pollinator insects found at 10 to 12 o'clock occurs due to the factors that affect the pollinator insects to blow flowering plants such as atheist flower, and physical factor such as air temperature and sunlight. The splitting of chilly flowers begins in the morning between 04.00-05.00. At 07.30-08.30 the flowers have bloomed but not perfect yet (not in blooming fully). And in that period of time the pollen is already fractured through the hole at the head of the pollen. The white pollen is visible out of the sari's hole. Along with the fracture of the pollen head, the pistil head is also receptive, which is marked by the change in the color of the pistil head from green to green whitish due to the presence of clear liquid. The flower blooms perfectly after 10:00 am and the pollen head looks more that secrete the pollen (Erniwati, 2010). The outbreak of pollen and the discharge of nectar from the flower will create a scent that will invite more insects to visit the flower.

Another factor that causes an increase in pollinator insect visit is air temperature. Insects require optimum thoracic temperature (30-34°) to initiate the visit activity and the environment temperature of 24-35°C (Khairiah, Dkk.2012). When the thoracic temperature has not reached its optimum to begin the search for feed, the insects will warm up by moving the wing muscles. The lower the environment temperature, the longer the time it takes to warm up, and the longer it will take to start the feed search activity. This was shown in this study, at 07.00 with an average temperature of 26 ±0.83°C, the insects had started the activity, but at 11.00 with an average of 30±0.33°C the peak of the visit occurred. The same result also reported by Hasan (2015) at 07.00 with an average temperature of 23.6°C, insects have started foraging, but at 09:00 to 12:00 with an average temperature of 29.69-30.69 C the peak of the visit occurred.

CONCLUSION

From the results of the above research, some conclusions are obtained as follows:

1. There are two main types of pollinator insects in red chilly plants either found in the chilly garden or near the palm oil plantations and those far from the oil palm plantations are *Helophilus fasciatus* and *Syrphus vitripennis*. However, in chilly plants near the palm oil plantations, there

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was no *caminomeric collaris* found and vice versa in chilly which is far from the palm oil plantations there was no *Xylocopa confuse*.
2. The abundance of pollinator insects of chilly plants which are far from the palm oil plantations was 70% higher than the abundance of pollinator insects which are near the palm oil plantations. This indicates that the lower levels of vegetation diversity near the palm oil plantations have led to a decrease in the abundance of pollinating insects.
3. Number of pollinator insect taxon at the observation at 10.00 WIB was higher than other observation time. This means that the observation time significantly influences the number of red chilly pollinator taxon (F = 3.049; P = 0.006).
4. The abundance of insect pollinator at the observation at 11.00 WIB was higher when compared to other observation time. This means that the observation time significantly influences the number of red chilly pollinator taxon (F = 5,730; P = 0,000).

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