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Variation of butterfly diversity in different ages palm oil plantationsin Kampar, Riau

Variasi keanekaragaman kupu-kupu di berbagai umur perkebunan kelapa sawit di Kampar, Riau

YANTO SANTOSA♥,[1], INTAN PURNAMASARI[1]
[1]Ecology and Wildlife Management Division, Department of Forest Resources Conservation and Ecotourism, Faculty of Forestry, Institut Pertanian Bogor. Dramaga, Bogor, Indonesia 16680. Tel.: +62-251-8621677. Fax.: +62-251-8621256. ♥email: yantohaurjaya@yahoo.co.id

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Abstrak. *Santosa Y, Purnamasari I. 2017. Variasi keanekaragaman kupu-kupu di berbagai umur perkebunan kelapa sawit di Kampar, Riau. Pros Sem Nas Masy Biodiv Indon 3: 278-285.* Perkembangan perkebunan kelapa sawit di Indonesia diduga telah menurunkan keanekaragaman hayati. Oleh karena itu perlu dilakukan kajian keragaman spesies kupu-kupu pada berbagai umur kelapa sawit. Kupu-kupu adalah salah satu hewan penyerbuk yang memiliki peran penting dalam ekosistem dimana perubahan keanekaragaman hayati dan kepadatan populasi dapat digunakan sebagai indikator kualitas lingkungan. Penelitian ini dilakukan pada bulan Maret-April 2016 di tujuh umur kebun kelapa sawit yang berbeda-beda di empat Perkebunan Kelapa Sawit di Kampar, Riau dengan menggunakan metode pencarian waktu selama 3 jam mulai pukul 8:00 pagi sampai 11:00 dengan repetisi 3. Hasil penelitian menunjukkan bahwa ada 42 spesies dari 181 individu yang terbagi dalam lima famili, yaitu Papilionidae (5 spesies), Nymphalidae (27 spesies), Pieridae (6 spesies), Lycaenidae (2 spesies), dan Hesperidae (1 spesies). Keluarga Nymphalidae ditemukan pada semua umur tegakan kelapa sawit sedangkan keluarga Hesperidae ditemukan pada satu umur kelapa sawit. Jumlah spesies tertinggi ditemukan pada kelapa sawit berusia 21 tahun (26 spesies), sedangkan jumlah spesies terendah ditemukan pada umur 2 tahun (7 spesies) dan kelapa sawit 19 tahun (7 spesies). Dengan demikian, perbedaan umur kelapa sawit tidak mempengaruhi variasi spesies dan jumlah individu kupu-kupu yang ditemukan.

Kata kunci: Kupu-kupu, keanekaragaman, Kampar, perkebunan kelapa sawit

Abstract. *Santosa Y, Purnamasari I. 2017. Variation of butterfly diversity in different ages palm oil plantationsin Kampar, Riau. Pros Sem Nas Masy Biodiv Indon 3: 278-285.* The development of palm oil plantations in Indonesia has been alleged of decreasing the biodiversity.Therefore it is necessary to study on variation in species diversity of butterflies at various ages palm oil. Butterfly is one of the pollinators animal that has an important role in the ecosystem in which changes in biodiversity and population density can be used as an indicator of environmental quality. This study was conducted in March-April 2016 at seven different age palm oil in four Palm oil Plantation Estates in Kampar, Riau by using time search method for 3 hours starting at 8: 00 a.m. to 11: 00 a.m. with 3 repetitions. The results showed that there were 42 species of 181 individuals divided into five families, namely Papilionidae (5 species), Nymphalidae (27 species), Pieridae (6 species), Lycaenidae (2 species), and Hesperidae (1 species). Family Nymphalidae was found at all palm oil stand age whereas Hesperidae family was found in one age of the palm oil. The highest number of species was found in 21-years-age palm oil (26 species), while the lowest number of species was found in 2-years-age (7 species) and 19-years-age palm oil (7 species). Thus, the age difference of the palm oil did not affect the species variation and the number of individual of the butterflies found.

Keywords: Butterfly, diversity, Kampar, palm oil plantation

INTRODUCTION

Palm oil plantations have a great contribution to national development. As one of the largest contributors of foreign exchange from non-oil and gas sector, palm oil plantation earned their income from CPO trade (total exports in 2012 reached 18.14 million tons equal with 20.78 billion US dollars) (Charles 2012). From the businessman/investor side, palm oil plantation is a promising business because the benefits are long-term and the market opportunities are wide open (the current CPO market 44% controlled by Indonesia, 39% by Malaysia and 17% by other palm oil producer countries) (Muin 2013).The development of palm oil plantation area in Indonesia has increased significantly. In 2005 the plantation area was increased from 5.45 million ha to 10.96 million ha with average growth rate of 11.71% per year (Charles 2012). This development in certain areas also provides substantial benefits to the surrounding community. Goenardi (2008) estimated works provided by palm oil plantation could lead 6 million people out from poverty. Currently, the community also has been heavily involved in the development of palm oil plantations, proved by 41% of all palm oil plantations owned by the public, while 49% of them belongs to private (World Growth 2011).

Palm oil plantation development also caused changes in land cover from a wide variety of plant species cover into monoculture cover. This system could also bring the environmental risk such as biodiversity loss (Rojidin et al. 2013). Scoble (1992) explained that the presence of plants affects the diversity of butterflies, who rely heavily on plants either for food as well as for the host of their larvae. Therefore, the monoculture system was presumed to affect the diversity of butterfly species. The butterfly is one of pollinators animal that has an important role in the ecosystem in which the changes in its biodiversity and population density can be used as an indicator of environment quality. In addition to that, the research related to the diversity of butterfly species in palm oil plantation is still rare. Thus, this research is important to determine variations of butterflies diversity in palm oil plantations at various ages and identifying butterfly species similarities in different ages palm oil plantation.

MATERIALS AND METHODS

Study area

The study was conducted on seven age of palm oil plantations.There were 25, 22, 21, 19, 18, 16 and 2 years from seven palm oil plantations are included into four companies located in Kampar, Riau (Figure 1). The study was held from March to April 2016.

Procedures

The observation was conducted by time search method combined by transect for three hours starting at 8: 00 a.m. to 11: 00 a.m. with 3 repetitions. Things that should be written were the species name, the time is found, the number of individuals, and activity.This research also observed the condition of the location. The conditions that were observed such as canopy cover, condition of the ground and undergrowth vegetation, availability of water source as well as temperature and humidity. Temperature and humidity were only observed in 25 and 21 years old palm oil.

Data analysis

Data analysis of this study for determining butterfly diversity are species richness index (Dmg) Margalef (Magurran 1998), Shannon-Wiener diversity index (H') (Krebs 1978), and Evenness index (Maguran 1998). For comparing the similarity of the age of palm oil plantations, It is used index of similarity of Sorensen (Magurran 1998)

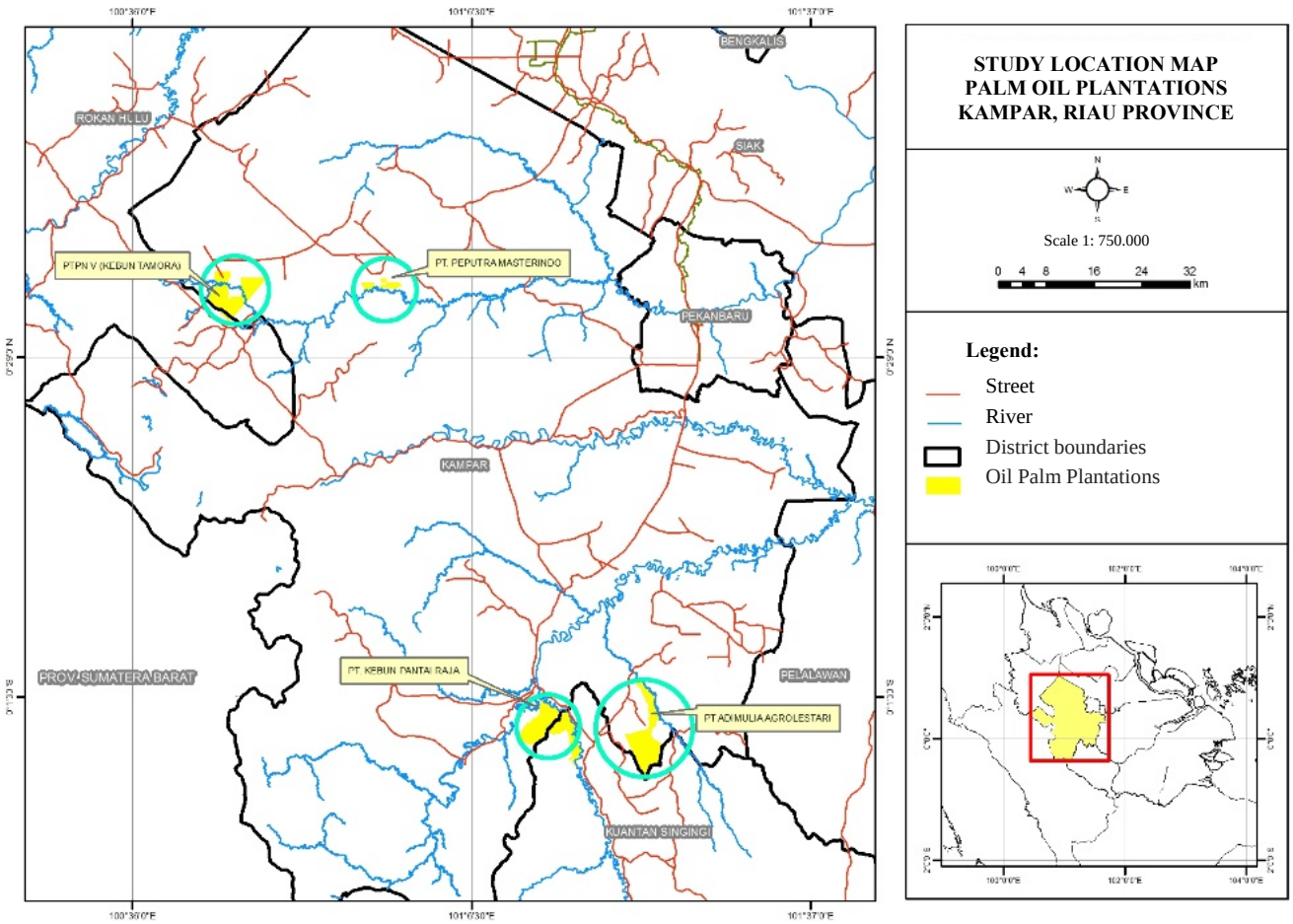

Figure 1. Location study in palm oil plantations in Kampar, Riau

RESULTS AND DISCUSSION

Variation condition of research location

The variation of palm oil plantation condition in detail can be seen in Table 1.The environmental factors such as canopy cover, condition of the ground and undergrowth vegetation, availability of water source as well as temperature and humidity are important in the existence and diversity of butterflies (Aidid 1991; Effendi 2009).

Variation of butterfly species diversity in different palm oil plantation

The observations on the seven palm oil plantations hadfound181 individuals from 42 species. All of those discovered butterfly species are not the protected ones based on Indonesian Policy No. 7/1999. They were belong to five families, Papilionidae (5 species from 13 individuals), Nymphalidae (27 species from 104 individuals), Pieridae (6 species from 55 individuals), Lycaenidae (2 species from 7 individuals), and Hesperidae (1 species from 2 individuals). The type and distribution of all discovered butterflies from observation sites can be seen in Table 2.

For the family level, family Nymphalidae was the most commonly found (Figure 2) and Table 2 shows that family Nymphalidae was discovered in all research location, opposite with family Hesperidae which was found only in one research location.

At the genus level, *Junonia* (Figure 3) is the genus that discovered in all age varieties of palm oil. *Junonia* genus belongs to family Nymphalidae, commonly found perched on the bottom of the plant/ground of the garden. Meanwhile, at the species level, *Leptosia nina* (Figure 4) of the family Pieridae is a species with individuals encountered the most during the study.

Most butterflies were discovered while flying or perching on plants under the palm trees. Only a few species were discovered while perching on the palm trees such as *Euploea* sp, *Amathusia*sp, and *Elymnias* sp (Figure 5). All of them belongs to family Nymphalidae.

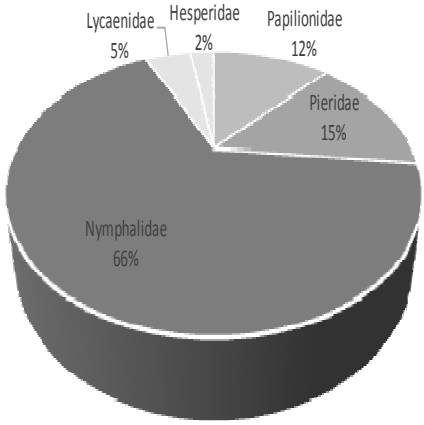

Figure 2.Percentage of total discovered family butterflies in palm oil plantations in Kampar, Riau

Figure 3. Genus *Junonia*

Figure 4. *Leptosia nina*

Figure 5. Species discovered perched in palm oil in palm oil plantations in Kampar, Riau

Table 1. The condition of research location in palm oil plantations in Kampar, Riau

Palm oil plantation	Description	Photo
2 years	Open canopy cover and the ground of palm oil plantation was covered by mukuna (bean). Water source in this location wasa small ditch every 200 meters distance. The border of this location was secondary forest and palm oil plantation small holder.	
16 years	Open canopy cover, no many found plant in the ground, ground cover was just sandy soil and dry palm oil buches. This location did not have water source, and the border of this location was19-years-age palm oil plantation and palm oil plantation office.	
18 years	Canopy cover not too closed where sunlight can reach the ground freely. Water source in this location is a small ditch. The ground was covered by undergrowth. The border of this location was secondary forest, palm oil plantation smallholder, and main road in palm oil plantation.	
19 years	Canopy cover rather closed, the open space was the only divider between palm oil plantation. Water source in this location wasa puddle. No many found plant in the ground, ground cover was just sandy soil and dry palm oil stem. his location did not have water source, and the border of this location was16-years-age palm oil plantation	
21 years	Canopy cover rather closed, water source in this location wasa small ditch with width 1 meter. The border of this location was secondary forest and Kampar river. The ground was covered by undergrowth and dry palm oil bunches.	
22 years	Canopy cover closed, the open space was only divider between palm oil plantation. This location di not have water source and no many found undergrowth in the ground. The border of this location was main road in palm oil plantation.	

25 years	Canopy cover closed, the open space was only divider between palm oil plantation, water source in this location wasa small ditch with width0.5 meter. The border of this area high conservation value (HCV) area like river border with kind of forest vegetation and palm oil. The ground was covered by undergrowth and dry palm oil bunches.	

Table 2. Type and distribution of the discovered butterflies in palm oil plantations in Kampar, Riau

Species	Family	Palm oil plantation age (years)						
		2	**16**	**18**	**19**	**21**	**22**	**25**
Papilio demoleus	Papilionidae	0	0	0	0	0	0	2
Papilio demolion	Papilionidae	0	0	1	0	0	0	1
Papilio memnon	Papilionidae	0	0	0	0	0	0	5
Graphium sarpedon	Papilionidae	0	0	0	0	2	0	0
Artophonura alcinous	Papilionidae	0	0	0	0	2	0	0
Acrea violae	Nymphalidae	0	0	0	0	2	0	0
Elymnias hypermnestra	Nymphalidae	0	1	5	0	0	0	2
Euploea eunice	Nymphalidae	0	1	0	1	4	0	1
Euploea mulciber	Nymphalidae	0	0	0	0	1	0	1
Euthalia monina	Nymphalidae	0	0	0	0	2	0	0
Hypolimnas bolina	Nymphalidae	1	5	0	3	0	0	8
Ideopsis vulgaris	Nymphalidae	0	0	0	0	0	0	1
Ideopsis juventa	Nymphalidae	0	0	0	0	1	0	0
Amathusia phidippus	Nymphalidae	0	1	0	1	4	0	0
Amathusia taenia taenia	Nymphalidae	0	2	1	0	0	1	0
Danaus melanippus	Nymphalidae	0	0	1	0	0	1	0
Doleschallia bisaltide	Nymphalidae	0	1	0	1	2	0	0
Cupha erymanthis	Nymphalidae	0	0	0	0	1	0	0
Junonia atlites	Nymphalidae	0	1	0	1	2	0	1
Junonia iphita	Nymphalidae	0	0	2	0	1	1	0
Junonia orithya	Nymphalidae	3	0	1	2	1	0	1
Mycalesis horsfieldii	Nymphalidae	2	2	2	0	2	1	0
Mycalesis janardana	Nymphalidae	0	0	0	0	0	0	1
Mycalesis sangaica mara	Nymphalidae	0	0	0	0	0	1	1
Mycalesis sirius canicula	Nymphalidae	1	0	0	0	0	0	0
Tanaecia iapis puseda	Nymphalidae	0	0	0	0	1	0	0
Tanaecia jahnu	Nymphalidae	0	0	0	0	1	0	0
Orsotriana medus	Nymphalidae	0	0	0	0	1	0	0
Neptis hylas	Nymphalidae	2	0	0	0	3	0	0
Ypthima horsfieldii	Nymphalidae	2	0	1	0	0	0	2
Ypthima gavalisi	Nymphalidae	0	0	0	0	0	0	1
Ypthima kalelonda	Nymphalidae	0	0	0	0	0	0	1
Catopsilia pomona	Pieridae	0	0	0	0	2	0	0
Catosilia scylla	Pieridae	0	0	0	0	1	0	0
Appias olferna	Pieridae	0	1	0	1	3	1	0
Eurema sari	Pieridae	0	0	0	0	1	0	0
Eurema hecabe	Pieridae	0	0	0	0	1	1	1
Leptosia nina	Pieridae	0	12	0	0	6	4	20
Jamides pura	Lycanidae	0	0	0	0	0	0	4
Zizina otis	Lycanidae	2	0	0	0	0	0	0
Calycopis atrius	Lycanidae	0	0	0	0	1	0	0
Ancistroides nigrita	Hesperidae	0	2	0	0	0	0	0
Individuals number		**13**	**29**	**14**	**10**	**48**	**11**	**54**

The amount of discovered family, species, and individuals on various palm oil plantation was diverse but did not show the tendency of correlation between butterflies diversity and the age difference of palm oil (Figure 6). The highest number of discovered species comes from palm oil plantations age 21 years (26 species out of 50 individuals from 4 families), while the lowest number found in palm oil plantations age 2 years (7 species

out of 13 individuals from 3 families) and palm oil plantation age 19 years (7 species out of 10 individuals from 2 families). This is not different with the results of Richness, Diversity, and Evenness index calculation that shows variation on each palm oil ages. The highest score of Richness index and Diversity index occurred on 21-year-old palm oil (Dmg = 6.39; H '= 3.09), the lowest score of richness index occurred on 2 years old palm oil (Dmg = 2.34) and the lowest score of diversity index occurred on 19 years old palm oil (H '= 1.83). Meanwhile, the score of evenness index in all locations varied between 0.78 to 0.97 indicating no dominant species on the entire palm oil plantations that were observed.

Similarity degree among palm oil plantation

The similarity degree of discovered species of butterflies based on Sorensen's species similarity index can be seen in Table 3. The value of similarity index at each location ranging from 0.133 to 0.667. The value indicates the degree of similarity among palm oil plantations that tend to different.

Table 3 shows that the highest similarity value comes from palm oil plantation aged 19 and 16 years in which there were six types of butterflies found in both locations such *Euloea eunice, Hypolimnas bolina, Amathuhsia phidippus, Doleschallia bisaltide, Junonia atlites*, and *Appias olferna*. Both of the plantations located next to each other. Meanwhile, the lowest similarity value came from observation site aged 2 and 22, aged 18 and 19, and aged 19 and 22.

Discussion

Family Nymphalidae was the most commonly found discovered in all research location, opposite with family Hesperidae which was found only in one research location. The high diversity of family Nymphalidae caused by its ability to easily adapt to the environment and was the family with the largest number out of Lepidoptera order (Gunadharma 2013). Primark in Tabadepu (2008) also stated that Nymphalidae is a family of butterflies that has the largest number of species and a cosmopolitan kind. Their distribution is spread in many regions of the world and is capable of surviving on various types of habitat (polifag). The species of this family generally have wide deployment, favoring bright spot, thus easily spotted in the gardens and forests. Some species of this family likes the foul-smelling place. Family Nymphalidae had certain characteristics such as wing span between 25-130 mm with varied colors, the eggs has several different forms but mostly the horizontal axis exceeds the vertical axis, and the larvae commonly have fur/thorn (Aidid 1991). Furthermore, Vane et al. 1984 on Syaputra 2011 explained that the caterpillars of this family ate plants from family Arecaceae, Gramineae, Verbenaceae, and Moraceae. Opposite to that, family Hesperidae has smaller body size and fly fast it was hard to catch (Gunadharma 2013). Aidid (1991) also mentioned that species of this family has a fat, short, and strong body. From the evolution side, this species could be considered as a primitive one and similar with moth; the wing size is small with a brown shade, dark and yellowish; fly fast; also the caterpillar commonly found inside rolled leaf.

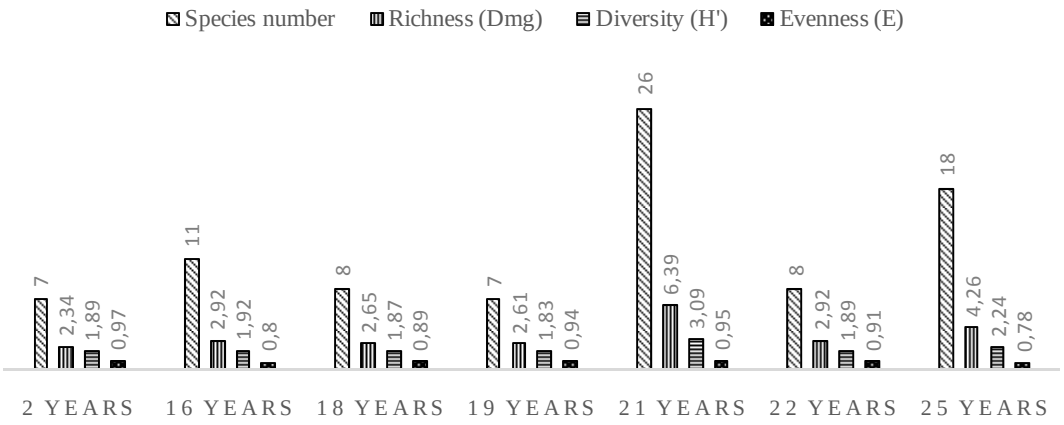

Figure 6. Comparison of species number, richness, diversity, and similarity value in palm oil plantations in Kampar, Riau

Table 3. The Value of Species Similarity among palm oil plantation in Kampar, Riau

Palm oil plantation age	2 years	16 years	18 years	19 years	21 years	22 years	25 years
2 years		0.222	0.400	0.286	0.182	0.133	0.240
16 years			0.316	0.667	0.378	0.421	0.345
18 years				0.133	0.176	0.500	0.308
19 years					0.364	0.133	0.320
21 years						0.294	0.231
22 years							0.318
25 years							

The highest number of discovered species came from palm oil plantations age 21 years (26 species out of 50 individuals from 4 families; Dmg = 6.39; H' = 3.09), while the lowest number found in palm oil plantations age 2 years (7 species out of 13 individuals from 3 families; Dmg = 2.61; H' = 1.83) and 19 years (7 species out of 10 individuals from 2 families; Dmg = 2.34; H' = 1.89). The differences between richness and diversity value were suspected got influenced by habitat condition of each palm oil plantation. Judging from the canopy cover condition on figure in Table 1, older palm oil plantations had a more dense canopy cover more than younger palm oil plantations. Dense canopy cover blocked the sunlight to reach the ground. Watanabe & Imoto (2003) states that butterflies will bask under the sun before flying to obtain optimal body temperature, therefore, butterfly easily found in open areas where the sunlight can reach the ground freely. This statement is opposite to the result of field observation. The obtained data shows that palm oil plantation aged 21 years with denser canopy cover has a higher value of richness and diversity than palm oil age of 19 and 2 years with lesser canopy cover. The results also contradict to the statements of Utami (2012) which states that species diversity of butterflies higher in open habitats than in a closed habitat.

Furthermore, the vegetation that cover the ground of palm oil age 21 was more varied, including ferns, grasses, and dry palm oil bunches, while in palm oil plantation age 2 the vegetation cover was more homogeneous only consist of leguminous plant, moreover ground cover of palm oilage 19 years was just sandy soil and dry palm bunches. The variations of ground cover were suspected to affect the species diversity of butterflies. The homogenous ground cover on palm oil plantation age 2 and 19 resulted in fewer varieties of butterflies. This state caused by the lack of plants which is the source of food as well as the host for butterflies. Scoble (1992) also stated that butterflies are highly dependent on the diversity of the host plant, thus caused a close relationship between the diversity of butterflies and their habitat conditions. On the other hand, although the location of palm oil plantation age 21 and 2placed on the border of secondary forests that still had various plant species, this condition still did not affect the abundance and diversity of butterflies.

Another condition that supposedly affected the difference of richness and diversity value is temperature and humidity. A substantial impact of temperature conditions and humidity environment is an abundance of a population, where the abundance of butterflies occurred fewer during the rainy season and high temperatures (Robinson et al. 2012).The temperature on palm oil plantation age 21 years was lower than on palm oil plantation age 2 years (data of temperature and humidity of palm oil plantation age 2 was taken by approached from the temperature at another location with similar age) but nevertheless, both were still included in the category of optimal temperature for butterflies activities based on research conducted by Mamahit (2003), Gusnenti (2010), and Guppy at all (2002) in Azahra (2012). Mamahit (2003) explains that butterflies will feed on warm temperatures (around 30^{o}C). The temperature of the butterfly as it flew was 5-10^{o}C above the environment temperature, therefore hunting for foods at low temperature will require a lot of energy. Mamahit (2003) also explained that butterflies and caterpillars avoid dry conditions and looking for a place with high humidity enough to rest. Based on the results of temperature measurements, palm oil plantation aged 25 years has temperature 29.1^{o}C, while palm oil plantation aged 21 years has temperature 28,3^{o}C. Watanabe & Imoto (2003) states that the average temperature of 29.1^{o}C to 32.00^{o}C is a suitable temperature for butterflies to move. The statement was reinforced by Gusnenti (2010) that the range of temperatures that could support the life of a butterfly is between 21-34^{o}C. Meanwhile, according to Azahra (2012) optimal temperature for butterflies are between 28-35^{o}C.

The humidity of palm oil plantation age 21 years was also lower than the younger one. However, it still included in the category of optimal humidity for butterflies based on research conducted by Kingsolver in Suwarno (2012) which is between 60-75% for activities, and 84-92% for breeding. In contrary, the humidity of younger palm oil plantation was higher makes it difficult to find species of butterflies in the area. The results of temperature measurements at other 2 years old plantation showed humidity over 90%, which according to Borror et al. (1992) butterflies cannot adapt in areas with too high humidity such as 92%, and according to Orr and Kitching (2010) butterfly is hard to find in the regions with humidity above 90%. Therefore the difference in the humidity of palm oil plantations affects the richness and diversity of butterflies.

Furthermore, similarity index showed value in each location start from 0.133 to 0.667 that indicates the degree of similarity among palm oil plantations that tend to different. The highest similarity value comes from palm oil plantation aged 19 and 16 years. The proximity of those locations supposedly triggers the kind of similarity which found in two locations. In addition to that, other factors such as undergrowth plants and ground condition were relatively similar. Keindeigh (1980) also stated that the other factors that allow similarity between 2 habitats are the proximity between the habitat, same vegetation composition as well as other environmental factors. Meanwhile, the lowest similarity value comes from observation site aged 2 and 22, aged 18 and 19, and aged 19 and 22. The distance between observation site, different ground condition, as well as the distinction of other environmental factors, are the reason of no similarity between those locations.

In conclusion, this study showed the number of butterfly species on various palm oil plantation was diverse but did not show the tendency of correlation between butterflies diversity with the age difference of palm oil plantation.Besides that, there are several factors suspected to affect the value of richness and diversity of the research sites especially condition of canopy cover, the condition of the ground and undergrowth vegetation, as well as air humidity.

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