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Changes in Weather Pattern Affect Insect Composition in Madai, Sabah

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Abstract

Biodiversity can be studied at a species level such as insect group. Insects play important roles in the ecosystem which is affected by the climate factors such as rainfall pattern, humidity and temperature. Changes on this climate pattern might give direct and indirect impacts on the insect activities as the global trend of climate showed a warmer effect which has caused the glacier to melt faster with less ice coverage, the rise at the sea level and the global temperature continues to rise in the future. Glacier has lost ice coverage tremendously. The sea level also reported rise up and the temperature predicted continuously increased. This study was carried out at Cocoa Research and Development Centre (CRDC) Madai, Sabah, Malaysia. The objective of this study was to examine the impacts of weather pattern changes on the insect composition in the last 11 years. This study was carried out at three different areas using four different insect trapping methods such as pitfall trap, winkler trap, line transet trap and light trap. Result from this study showed that the insect composition has changed drastically in the last 11 years. Reduction in number of insect catched using 4 different methods has suggested that the changes in weather pattern over period of time have some effects on insect composition.

Keywords: Effect, weather pattern, biodiversity, insect, Sabah

INTRODUCTION

Malaysia is considered as one of the twelve mega-diverse biodiversity countries in the world by having 15,000 species of vascular plants, 306 species of wild mammals, more than 742 species of birds, 567 species of reptiles, 242 species of amphibians, approximately 1,619 species of marine fish, more than 449 species of freshwater fish, 612 species of coral and over 150,000 species of invertebrates (Abul, 2011; MNREM, 2015). The species richness and the ecosystem diversities are recognised worldwide (Anonim, 2003).

Nowadays, biodiversity is facing a bigger threat as some of them are going to extinct at a critical rate due to human activities. Moreover, factor such as the changes in climate pattern has indirectly caused some impacts on biodiversity (IUCN, 2013; Martin *et al.*, 1999). Biodiversity can be studied at ecosystem level and also at species level. At the ecosystem level, regions located nearer to Earth pole will have larger impacts on the temperature and rainfall factors (Thuiller, 2007). At the species level, insect is the largest group of biodiversity (NWF, 2017).

Insect was a main focus to look out the changes on their composition because of many reasons. Insect also can be considered as a common animal in our planet. Insect can be seen everywhere and found in different habitats. There are more than 1.5 to 1.7 million species of insects that have been named and the number of insects is three times larger than other animals. Many insects are omnivorous. They can eat nearly anything they found in their environment including plants, fungi, dead animals and decaying organic matters (CAPU, 2014).

In an ecosystem, insect can play roles as predator, parasite, source of food, pollinators, herbivores, primary and secondary decomposer. During the decomposition process, insect contributes in the carbon cycle where insects act as decomposers at dead plants and animals or waste products. During process of decomposition, carbon dioxide is released the atmosphere and completes the carbon cycle (Martin *et al.*, 1999).

An insect can be affected by three important abiotic factors during its lifetime including temperature as insect are poikilothermic, photoperiod and humidity. The climate change subject considered as a new science. This subject involved various interactions between environment, natural resources and people. Today climate change is one of the greatest challenges that the world is facing (Johan & Frauke, 2011). It is increasing confidence that our climate is changing as a result of human activities (Johnson, 2012). This man-created calamity need more than immediate action and response to solved this problem (Devendra, 2012).

In various regions across the world, some high-altitude and high latitude ecosystems have already been affected by changes in climate. Climate changes give negative impacts on the biodiversity. The Intergovernmental Panel on Climate Change concluded that 20 percent to 30 percent of species assessed may be at risk of extinction from climate change impacts within this century if global mean temperatures exceed 2-3^{O}C relative to pre-industrial levels (IPCC 2007). Leadley (2010) in one study, has predicted that in next decade, climate change becomes a more important threat to biodiversity compared to habitat loss.

In Malaysia, positive trends in temperature have been observed for over past 43 years in Peninsular Malaysia, Sabah and Sarawak. The surface means temperature increase about 0.14-0.25^{O}C per decade (MNREM, 2015). Tan *et al.* (2009) indicated that the past record of Malaysia showed that the country temperature increased by 0.18^{O}C per decade over last 40 years since 1951. Meanwhile, since year 1986, the sea level reported to rise up at about 1.25 mm at a southern coastal site in the Peninsular Malaysia. The climate in Malaysia predicted to continue on an increasing trend.

Since the climate change is considered to be one of the biggest threats facing nature and humanity today (Haliza, 2009), National Policy on Climate Change in Malaysia has been approved in year 2009. Since then, several researches have been done by several researchers on the climate change such as by Haliza (2009), Tan *et al.* (2009), Devendra (2012), and Luan (2014); but, no one has studied on the climate changes impact on the composition of the insect especially in plantation area. Data and information on the impacts of climate change on the insect composition is still lacking. Therefore, this study was carried out to examine the insect composition at three different study areas at Cocoa Research and Development Centre (CDRC) Madai, Sabah, Malaysia.

MATERIALS AND METHODS

The study was conducted at three different areas at Cocoa Research and Development Centre Madai, Sabah, Malaysia (4.783414^{O} N, 117.967598^{O} E). The areas of study site were: in the cocoa field area Field 16, in the oil palm field and in the jungle area. In year 2005, first set of experiment was carried out using four different methods of trapping the insect. The same method of study was repeated in year 2016 at the same study area and study period as in year 2005, to examine the differences in insect composition related to climate change.

Insect Collecting

Four methods were used for collecting the insects in this study. (1) Pitfall Trap: This trap is useful to catch the insect which is active on the ground surface. This method considered as a passive sampling technique to assess biodiversity in an area. This trap consists of plastic cup that is submerged or buried in soil. The lip of the plastic cup is level with the ground surface. The plastic cup partially filled with an ethanol 70% as a preservative. Baited was placed in the middle of the plastic cup by hanging with a wire mesh to capture more specific types of insects. The traps left for 24 hours for insect to be trapped inside the plastic cup. After 24 hours, the traps then inspect for the catch and collected. The trap will be set up for the second and third catches. Collected specimens stored in 70% ethyl alcohol or pinned for dry storage and identification. 25 pitfall traps was set up with the distance 1 m x 1 m. This experiment was carried out with three replicates for each study site. (2) Winkler Trap: One square meter leaf litter samples were taken 3 replicates in every study sites. The entire leaf litter of the study sites, including little twigs and partly decomposed organic materials, was sifted in several portions through a ten mm mesh by intensively shaking a bag-sieve for approximately one minute for each portion. After sifting, samples were transferred into a bag and hang up or suspended for 3 days for insect collection. Samples were extracted using Winkler technique. The collected specimens were stored in 70% ethyl alcohol or pinned for dry storage and identification. (3) Line Transect Trap: A transect line is any line, marked at regular intervals, that is easy to use in the field. In this study, a permanent transect line of 100 m length build up from plastic string. At both left and right side of the permanent line, a quadrat size of 1 m x 1 m build up using a plastic string. A quadrat build up in every 5 m distance made the total number of the quadrat were 40 at both side of the permanent transect line. In 5 minute time, the entire fauna specimen in every quadrat were collected and kept temporary in a vial with 70% ethyl alcohol. The entire samples were brought back to the laboratory for identification. (4) Light Trap. A white sheet as a backdrop for the light so the insects come to the light can easily be spot. The sheet was draped over a clothes line, stretch between poles or hang it on a fence or wall. The insects were collect as soon as they land on the sheet because some kinds of insects will soon run away and hide. A light trap can attract certain insects especially to survey nocturnal insects and it is widely used. A rope is tied between the two stands or pillars which can be made from lightweight metal piping or PVC water piping. The white sheet was hung up to the rope with strong safety pins. A light source for this study was from fluorescent lamps light hung up on the other side of the white sheet and facing the direction which the insect were collected using soft brush or soft forceps. All the insects collected were placed in a killing jar and brought back to the laboratory for identification and setting up as dry specimen.

Weather Data

Data time series of annual temperatures for West and East Peninsular, time series of annual mean rainfall for West and East Peninsular and time series of annual mean rainfall for Sabah and Sarawak were obtained from WHO-WP (2016). Data mean annual precipitation and annual mean temperature in Tawau, Sandakan and Kota Kinabalu in year 2005 and 2016 were obtained from https:// weatherspark.com/history.

RESULTS AND DISCUSSION

Ministry of Science, Technology and Innovation in year 2009 in Malaysian Meteorological Department Scientific Report observed that increasing in the surface temperature within 0.6^{O}C to 1.2^{O}C by year 1969-2009. This report also indicated that the increasing in rainfall intensity >1-hour by 17% within year 2000-2007. Sea level was reported rise 4.6 cm to 11.9 cm by year 1993-2010. Figure 1A showed that the temperature in West and East Peninsular increased by 0.17^{O}C and 0.16^{O}C, respectively, per decade. Figure 1B showed that decreasing in the rainfall pattern of West and East Peninsular by -4.71 mm/year and -4.28 mm/year, respectively. Figure 1C showed that the decreasing pattern in rainfall for Sabah and Sarawak by 13 mm/ year.

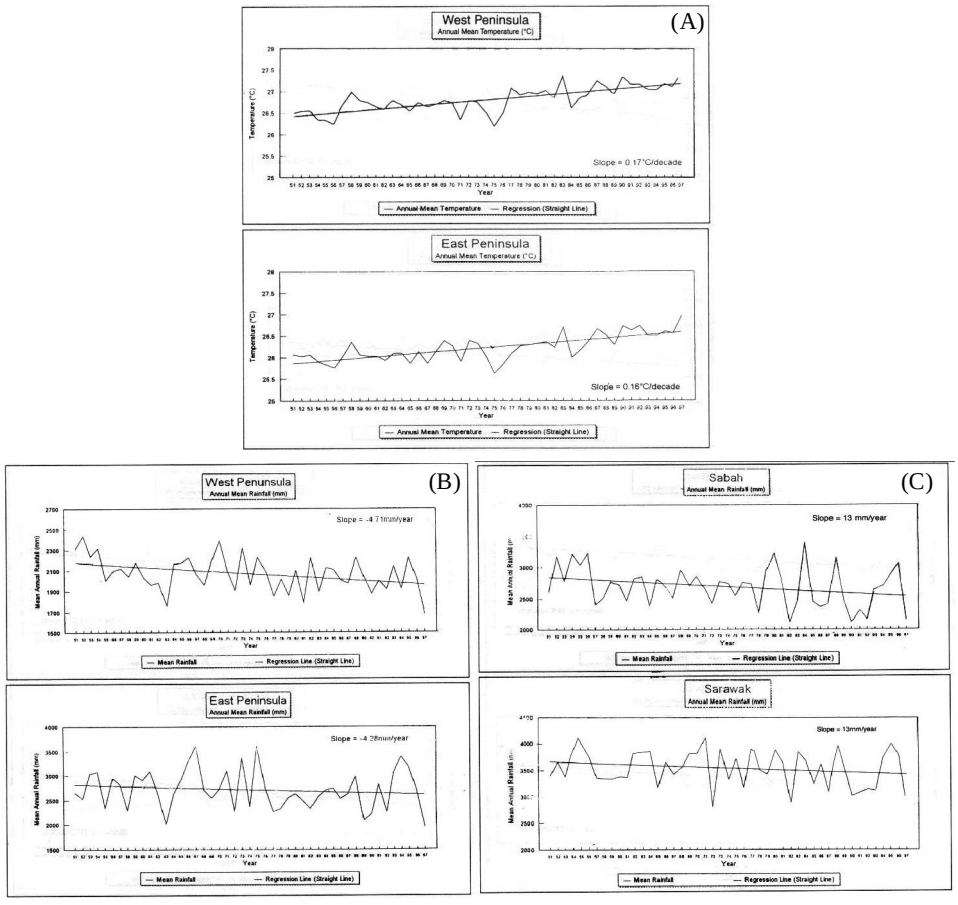

Figure 1. Time series of annual mean temperatures for West and East Peninsular (A); time series of annual mean rainfall for East and West Peninsular (B) and Sabah and Sarawak (C)

Figure 2A and 2B showed that the minimum temperature increased in Tawau by 2^{O}C within 11 years time. Minimum temperature in this area increased from 20^{O}C to 22^{O}C within 11 years time. Figure 2C and 2D showed that the minimum temperature for Sandakan is increasing by 1^{O}C from 21^{O}C to 22^{O}C within 11 years time. This figure also showed that the maximum temperature for this also increased by 1^{O}C within 11 years time from 35^{O}C to 36^{O}C. The maximum temperature also showed the same trend of increasing within 11 year time in Kota Kinabalu area. The temperature increased from 35^{O}C to 36^{O}C. It is indicated in Figure 2E and 2F. This figure also showed the increasing pattern of lower temperature for this area. The lowest temperature increases 2^{O}C from 20^{O}C to 22^{O}C within the same period of time. All the result from Figure 4 to Figure 9 showed the same pattern of warming trend in Tawau, Sandakan and Kota Kinabalu in Sabah state.

Figure 3A showed that the longest dry spell in Tawau area in year 2005 was from January 15 to January 31, constituting 17 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was January, with 84% of days reporting no observed precipitation at all. Figure 3B showed that the longest dry spell for Tawau area in year 2016 was from March 11 to March 25, constituting 15 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was March, with 77% of days reporting no observed precipitation at all.

Figure 3C showed the longest dry spell for Sandakan area for year 2005 was from March 10 to March 22, constituting 13 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was April, with 77% of days reporting no observed precipitation at all. Figure 3D showed that the longest dry spell was from for Sandakan area for year 2005 was in March 15 to March 31, constituting 17 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was April, with 77% of days reporting no observed precipitation at all.

Figure 3E showed that the longest dry spell for Kota Kinabalu area was from February 7 to February 19, constituting 13 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was February, with 71% of days reporting no observed precipitation at all. Figure 3F showed that the longest dry spell for Kota Kinabalu area in year 2016 was from February 18 to March 11, constituting 23 consecutive days with no observed precipitation. The month with the largest fraction of days without observed precipitation was March, with 94% of days reporting no observed precipitation at all.

This result showed that the longest dry spell period for Sandakan and Kota Kinabalu increased within 11 years time. It increased from 13 to 17 days for Sandakan area and increased from 13 to 23 days for Kota Kinabalu area. For days without precipitation for Kota Kinabalu area it increased from 71 % to 94 %. For Sandakan area the days without precipitation was about 77 % and it still remained the same value within 11 years time. For Tawau area, this result showed that the dry spell period and days without precipitation was lower in year 2016 compared to the value in year 2005. From this result it showed that the climate in Sabah state was changed within 11 years time and the temperature increased and the precipitation decreased within this period. This climate change might give an impact on the composition of insects within this period of time.

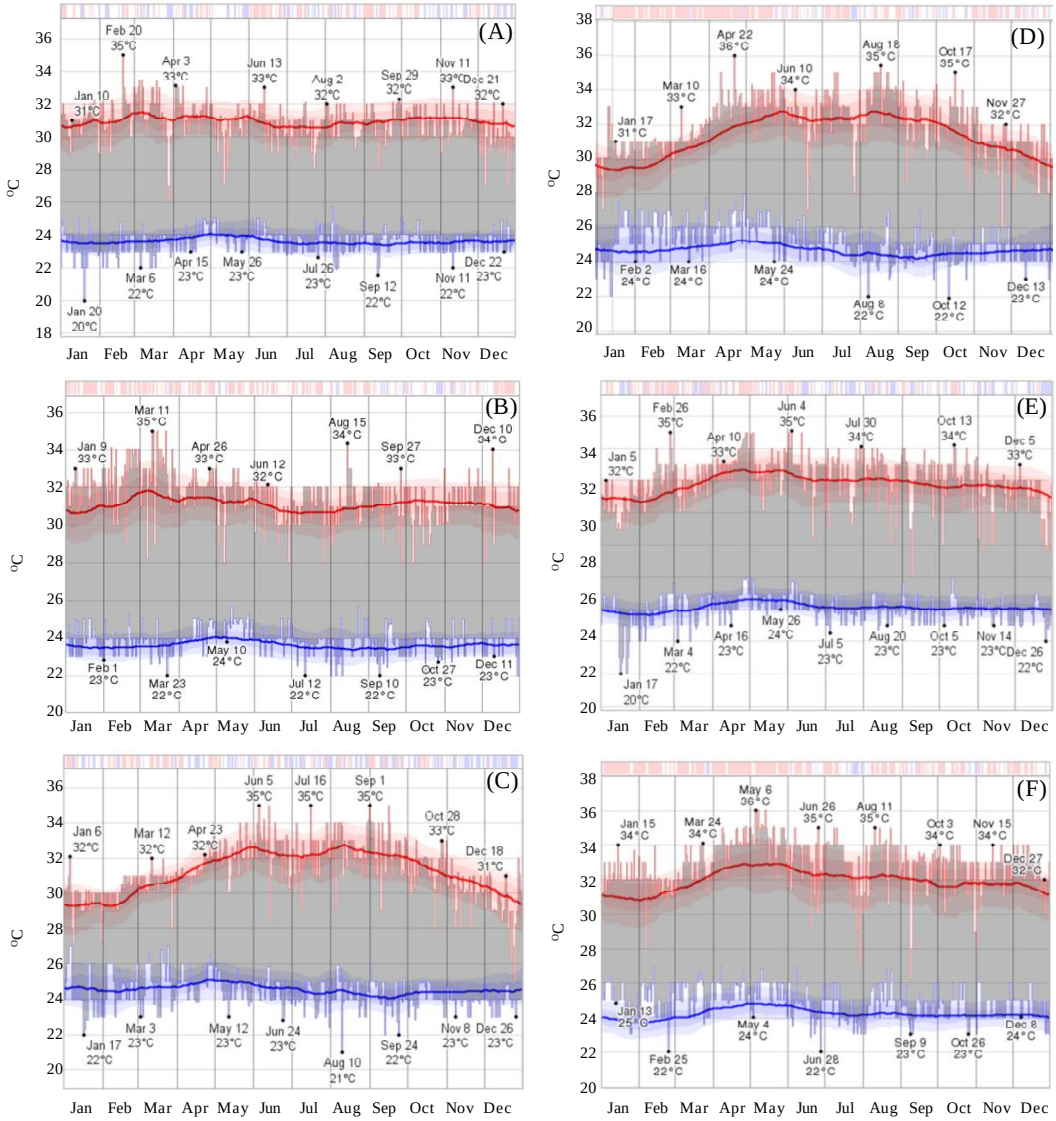

Figure 2. Annual mean temperature for Tawau in 2005 (A), Tawau in 2016 (B), Sandakan in 2005 (C), Sandakan in 2016 (D), Kota Kinabalu in 2005 (E), Kota Kinabalu in 2016 (F) (*https://weatherspark.com/history*)

Result from Figure 4 showed that the number of family and the abundance of the fauna catched using winkler bag method were reduced tremendously in year 2016 in three different areas. Only in palm oil field, the number of Family Hymenoptera increased in year 2016 compared to year 2005. Generally, the abundance of Family Hymenoptera was relatively higher in cocoa field for year 2005 compared to the catched in year 2016.

Result from Figure 5 showed that most of the fauna catched in year 2016 had been reduced compared to the fauna catched in year 2005 in jungle area, cocoa field and oil palm field. The group of Hymenoptera dominated during 2005 to 2016 at three different areas of catched.

Result from Figure 6 showed that only Hymenoptera group catched in this method. The number of Hymenoptera group has been

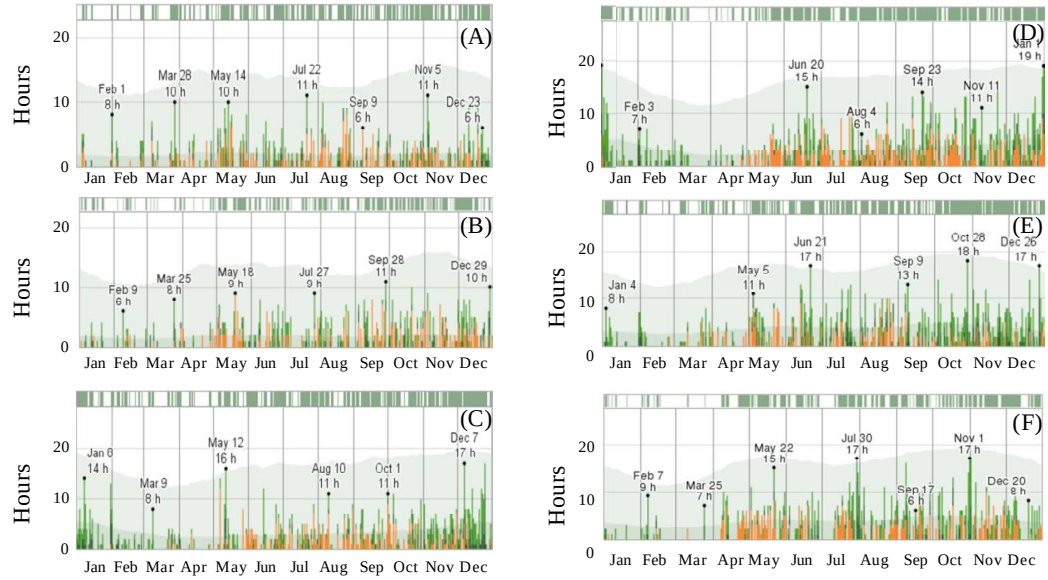

Figure 3. Mean annual precipitation at Tawau in 2005 (A), Tawau in 2016 (B), Sandakan 2005 (C), Sandakan in 2016 (D), Kota Kinabalu in 2005 (E), Kota Kinabalu in 2016 (F); *https:// weatherspark.com/history*

Notes: The daily number of hourly observed precipitation reports during 2005 and 2016, color coded according to precipitation type, and stacked in order of severity. From the bottom up, the categories are thunderstorms (orange); heavy, moderate, and light snow (dark to light blue); heavy, moderate, and light rain (dark to light green); and drizzle (lightest green). Not all categories are necessarily present in this particular graph. The faint shaded areas indicate climate normal. The bar at the top of the graph is green if any precipitation was observed that day and white otherwise.

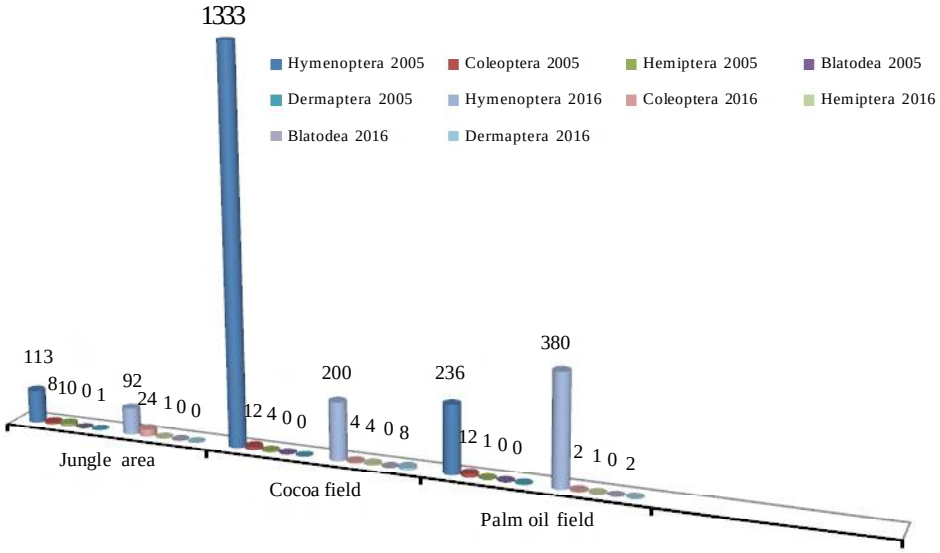

Figure 4. Number of fauna collected using winkler bag method in jungle area, cocoa field and oil palm field at CRDC Madai

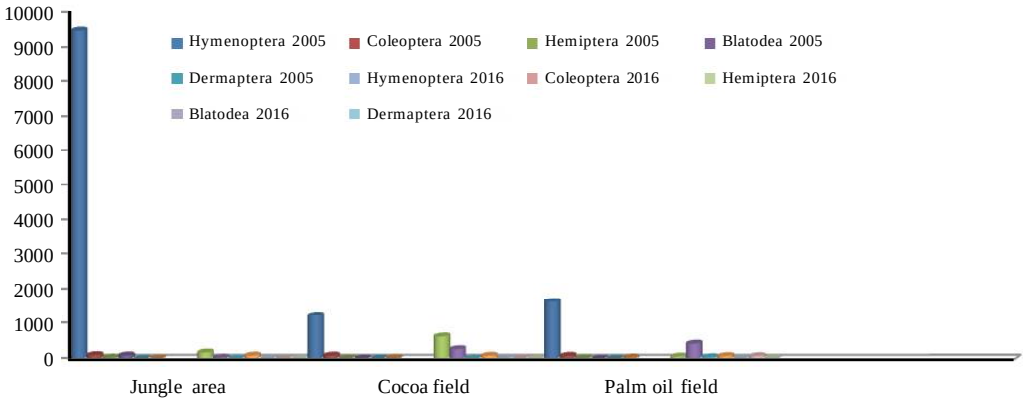

Figure 5. Number of fauna collected using pit fall method in jungle area, cocoa field and palm oil field at CRDC Madai

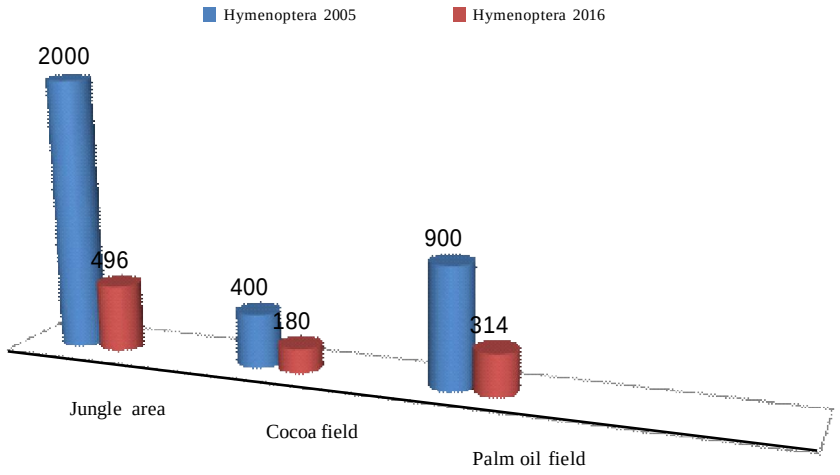

Figure 6. Number of Hymenoptera group catched using transect method at jungle area, cocoa field area and palm oil palm area at CRDC Madai

reduced tremendously in year 2016 compared to the number of catched in year 2005 in jungle area, cocoa field area and in palm oil field area.

Figure 7 showed the result using the light trap method catched the Family of Blatodea and Mantodea in year 2016 beside 5 others family of fauna. The number of other group of insect catched in year 2016 was reduced compared to the number of insect catched using this method in year 2005 except for the Family of Hymenoptera and Orthoptera.

Results from Figures 7 showed that number of catched insect has been reduced tremendously in year 2016 compared to the number of insect catched in year 2005. The same study on composition of ants in cocoa germplasm area at Cocoa Research and Development Centre Tawau, Sabah showed the same result of reduction in the number of ants catched and the composition of the ants families using the same method of trapping (Meriam, 2017).

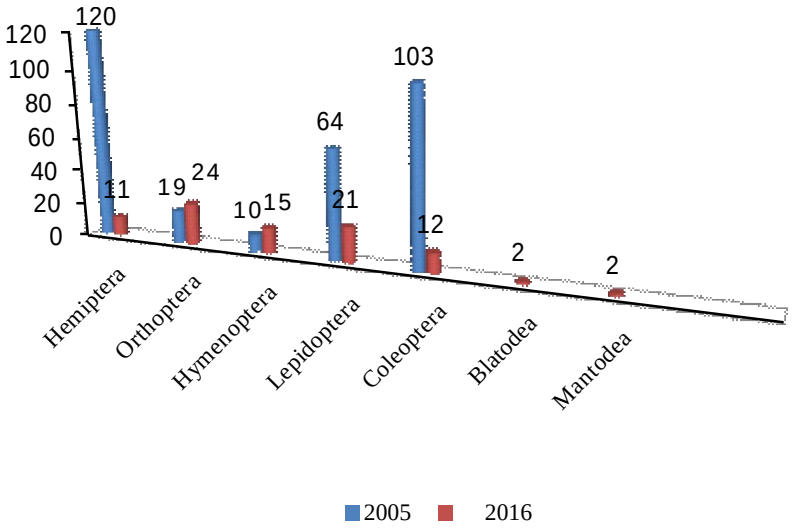

Figure 7. Number of fauna catched using light trap method at CRDC Madai in year 2005 and in year 2016

CONCLUSIONS

The reduction in the number of insect catched using 4 different methods has suggested that the changes in weather pattern over period of time have some effects on insect composition because individual insect is affected by the abiotic factors during its lifetime. Changes in climatic factors could affect directly on the ecosystem and individual performance on all of the activities and the physiology of the insect. These factors also can affect individual insect indirectly via the quality of its food and changes in genetic structure of the insect populations.

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