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Species Diversity of Insect Pollinators in the Area of Plant Genetics Conservation Project under the Royal Initiation of Her Royal Highness Princess Maha Chakri Sirindhorn (RSPG) at the Rambhai Barni Rajabhat University, Chanthaburi Province, Thailand

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Insect pollinators are benevolent insects to human and environment. They are a main factor to bring stability to the world's food secutiy. Therefore, species of insect pollinators are of great interest and need to be studied. Species diversity of insect pollinators was conducted in the area of plant genetics conservation project under the Royal initiation of Her Royal Highness Princess Maha Chakri Sirindhorn (RSPG) at the Rambhai Barni Rajabhat University, Chanthaburi province, Thailand for a period of 12 moths from April 2016 to March 2017. The study involved using scan sampling method and collected by sweep netting. The results indicated that 955 samples were collected and belonged to 60 species of 15 families and 4 orders. The order of Lepidoptera were the highest to be found on flowers with 45 species, followed by Hymenoptera, Diptera and Coleoptera with 9, 3 and 3 species, respectively. All value indices, the species diversity index (H*) and evenness index were at their peaks in October at 2.61 and 0.64, respectively. Meanwile, the most abundant insect pollinators found is of the *Tetragonula laeviceps* (F.Apidae O.Hymenoptera) that shown as 32.04%.

Keywords: Insect pollinator, Species diversity, Plant genetics conservation

Introduction

Insect pollinators are benevolent insects as they help plants transfer pollen from one plant to another which begins the reproduction process that prevents plants from getting weak when have to self-reproduced on their owns. The process of cross pollination has many advantages such as yielding better plant species, creating new plant species, and bringing about the variation of genetic

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diversity (Malaipan, 2008). As studies have shown that the process of plant pollination is 60% dependent on insect pollinators (The Forest Entomology Research Center 2, 2011) which indicates that the insect pollinators are extremely important to the plant reproduction process (Tasen *et al*, 2009) and it agrees with the study conducted by IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service) which has found that 75% of human food-production sources are mainly dependent on the activities of bees, birds, and other pollinator (Khaikaew, 2016). In Thailand, there has been the uses of insect pollinators in the production of plants as it gives better qualities as well as higher quantities. Plants that have been used this method are Strawberry (Daily News, 2017), Longan (PPTV, 2017), Mangosteen, Durian, Rambutan, and Lychee (Panpum, 2014, 2017).

However, around 40% of the insect pollinators have globally been under threats and their populations are declining as there have been the uses of modern agricultures that allow the uses of pesticides, including the changes in global climate that consequently affects the food security of the world. Therefore, in order to increase the survival rate for the insect pollinators, there must be an increase in living space for those insect pollinators (Khaikaew, 2016).

Rambhai Barni Rajabhat University has been participating in the Royal Project of Plant Genetics Conservation under the initiation of HRH Princess Maha Chakri Sirindhorn which states that there must be a conservation area of 50 Rai from the total of 720 Rai of the campus which can be regarded as the Genetic Bank for any living organisms including the insect pollinators. Thus the objectives of this research are to study the types and numbers of the insect pollinatorswithin the plant genetics conservation area of Rambhai Barni Rajabhat University.

Materials and methods

Conducting the study in the area of Plant Genetics Conservation Project within Rambhai Barni Rajabhat University, Chanthaburi province, Thailand, once in every month for the total period of 12 months. Using the simple random sampling technique and collecting insect samples by using net, then study the samples at the Entomology Laboratory of the Faculty of Agriculture Technology, Rambhai Barni Rajabhat University in Chanthaburi province. The study has been conducted on the dead insect samples after using ethyl acetate, then forming and shaping the insect samples and taking the samples to be dried by using a hot air dryer machine set the temperature at 35 degree Celsius for 5 days. The next step is to study the characteristics of the samples based on Morphology, measuring the sizes, taking photographs of the samples under the

stereo microscopes, classifying the insects, conducting species analysis, the number of insect pollinators including Shanon- Wiener diversity index (H*) and Evenness Index by using the following formulas as shown below;

1) Shanon-Wiener diversity index: $H' = - [\Sigma \ Pi \ ln \ Pi]$

Where H* is a diversity index obtained from Shanon- Wiener diversity index, Pi is a ratio of insect(s) per total insects

2) Evenness index: $E = H^*/ In \ S$

Where E is an Evenness of Species,

H* is a diversity index obtained from Shanon- Wiener diversity index,

S is a number of species

When the result(s) approaches the value of 1 indicates that a complex community exists,

When the result(s) approaches the value of 0 indicates that a complex community does not exist.

Results

From the study of the diversity of the insect pollinators, found that there are 60 species, 15 families in 4 orders. The most commonly found insect pollinators is Lepidoptera which is accounted for 75 %, followed by Hymenoptera, Diptera, and Coleoptera which are accounted for 15, 5, and 5 % respectively. The order of Lepidoptera consists of 45 species and 7 families of the insect pollinators which are the Danaidae family which found 7 species, the Hesperiidae family which found 1 species, the Lycaenidae family that found 2 species, the Nymphalidae family found 15 species, the Papilionidae family which found 12 species, the Pieridae family that found 7 species, and the family of Satyridae which found only 1 species. As for the order of Hymenoptera which found the insect pollinators of 9 species of 4 families that are of the Anthophoridae family found 2 species, the Apidae family which found 5 species, the family of Scolidae found 1 species, The Formicidae family found 1 species. The order of Diptera, found the insect pollinators of 3 species from 2 families, which are 2 species from Syrphidae family and 1 species of the Tephritidae family. The order of Coleoptera, the study found the insect pollinators of 3 species of 2 families, which are Curculionidae family, found 1 species, and Scarabaeidae family, found 2 species (see Table 1, Figure 1-2).

From the samples of insect pollinators of 955, found that there is a large number of *Tetragonula laeviceps* which is accounted for 32.04%, followed by *Apis florea* which is accounted for 23.25%. Furthermore, the study of the diversity index of the insect pollinators for a period of 12 months using the formula of Shannon's Index (H*) found that the month of October yields the highest value of H* of 2.61 and the month of May yields the lowest value of H* of 1.48 (Table 2).

Table 1. List of insect pollinators

No.	Order	Family	Species	Total	%
1	Lepidoptera	Danaidae	*Danaus chrysippus chrysippus*	20	**2.09**
2			*Euploea core*	20	**2.09**
3			*Euploea sp.*	2	**0.21**
4			*Ideopsis vulgaris*	7	**0.73**
5			*Parantica aglea*	29	**3.04**
6			*Parantica agleoides*	9	**0.94**
7			*Tirumala septentrionis septentrionis*	9	**0.94**
8		Hesperiidae	*Notocrypta pria*	3	**0.31**
9		Lycaenidae	*Arhopala sp.*	1	**0.10**
10			*Everes lacturnus rileyi*	13	**1.36**
11		Nymphalidae	*Acraea violae*	12	**1.26**
12			*Cethosia bibles bibles*	2	**0.21**
13			*Cethosia cyane euanthes*	12	**1.26**
14			*Cyrestis thyodamas thyodamas*	2	**0.21**
15			*Hypolimnas bolina*	13	**1.36**
16			*Junonia atlites*	1	**0.10**
17			*Junonia iphita*	32	**3.35**
18			*Junonia lemonias*	9	**0.94**
19			*Junonia orithya*	3	**0.31**
20			*Kallima inachus siamensis*	1	**0.10**
21			*Lebadea martha malagana*	7	**0.73**
22			*Moduza procris procris*	3	**0.31**
23			*Neptis columella martabana*	3	**0.31**
24			*Parthenos sylvia gambrisius*	1	**0.10**
25			*Tanaecia sp.*	5	**0.52**
26		Papilionidae	*Graphium agamemnon agamemnon*	6	**0.63**
27			*Graphium doson*	3	**0.31**
28			*Pachliopta aristolochiae goniopeltis*	7	**0.73**
29			*Papilio demoleus malayanus*	5	**0.52**
30			*Papilio demolion demolion*	1	**0.10**
31			*Papilio mahadeva*	1	**0.10**
32			*Papilio memnon agenor*	1	**0.10**
33			*Papilio nephelus chaon*	3	**0.31**
34			*Papilio polytes romulus*	6	**0.63**
35			*Pathysa antiphates pompilius*	1	**0.10**
36			*Troides aeacus*	1	**0.10**
37			*Troides Helena*	1	**0.10**
38		Pieridae	*Appias olferna*	8	**0.84**
39			*Catopsilia pomona pomona*	14	**1.47**
40		Pieridae	*Catopsilia scylla*	4	**0.42**
41		Satyridae	*Delias hyparete*	4	**0.42**
42			*Eurema sp.*	40	**4.19**
43			*Hebomoia glaucippe*	2	**0.21**
44			*Leptosia nina*	13	**1.36**
45			*Elymnias hypermnestra*	3	**0.31**

Table 1. Continued

No.	Order	Family	Species	Total	%
46	Hymenoptera	Anthophoridae	*Ceratina* sp.	3	**0.31**
47			*Xylocopa latipes*	2	**0.21**
48			*Amegilla zonata*	1	**0.10**
49		Apidae	*Apis dorsata*	25	**2.62**
50			*Apis florea*	222	**23.25**
51			*Trigona melanoleuca*	9	**0.94**
52			*Tetragonula laeviceps*	306	**32.04**
53		Scolidae	Unknow1	1	**0.10**
54		Fomicidae	Unknow2	10	**1.05**
55	Diptera	Syrphidae	*Pseudodoros* sp.	12	**1.26**
56			Unknow3	1	**0.10**
57		Tephritidae	*Bactrocera diversa*	1	**0.10**
58	Coleoptera	Curculionidae	*Hypomeces squamosus*	9	**0.94**
59			*Ixorida* sp.	3	**0.31**
60		Scarabaeidae	Unknow4	7	**0.73**
		Total		**955**	**100**

Table 2. Diversity of insect pollinators in round years

Month	**Number of species of insect**	**Number of individual of Insect**	**Shannon Wiener's index (H)**	**Evenness indices**	**Dominant species**	
					1st	**2nd**
January 2017	18	95	2.30	0.56	*T. laeviceps* (33.68%)	***A. florea* (15.79%)**
February 2017	9	63	1.66	0.41	*T. laeviceps* (42.42%)	***A. florea* (27.27%)**
March 2017	13	73	2.04	0.50	*A. florea* (30.13%)	***T. laeviceps* (27.39%)**
April 2016	13	102	1.74	0.43	*T. laeviceps* (39.21%)	***A. florea* (31.37%)**
May 2016	12	78	1.48	0.36	*A. florea* (55.55%)	***T. laeviceps* (16.67%)**
June 2016	12	65	2.03	0.50	*A. florea* (30.76%)	***T. laeviceps* (23.07%)**
July 2016	10	29	1.85	0.45	*T. laeviceps* (37.93%)	***E. lacturnus rileyi* (20.28%)**
August 2016	8	35	1.94	0.47	*T. laeviceps* (28.57%)	***L. nina* (17.14%)**
September 2016	27	165	2.52	0.62	*T. laeviceps* (33.33%)	***A. florea* (16.96%)**
October 2016	23	109	2.61	0.64	*T. laeviceps* (25.68%)	***A. florea* (18.34%)**
November 2016	14	76	2.05	0.50	*T. laeviceps* (32.89%)	***A. florea* (23.68%)**
December 2016	13	65	1.88	0.46	*T. laeviceps* (46.15%)	***A. florea* (13.84%)**
12 months	**60**	**955**	**2.22**	**0.54**	***T. laeviceps* (32.04%)**	***A. florea* (23.25%)**

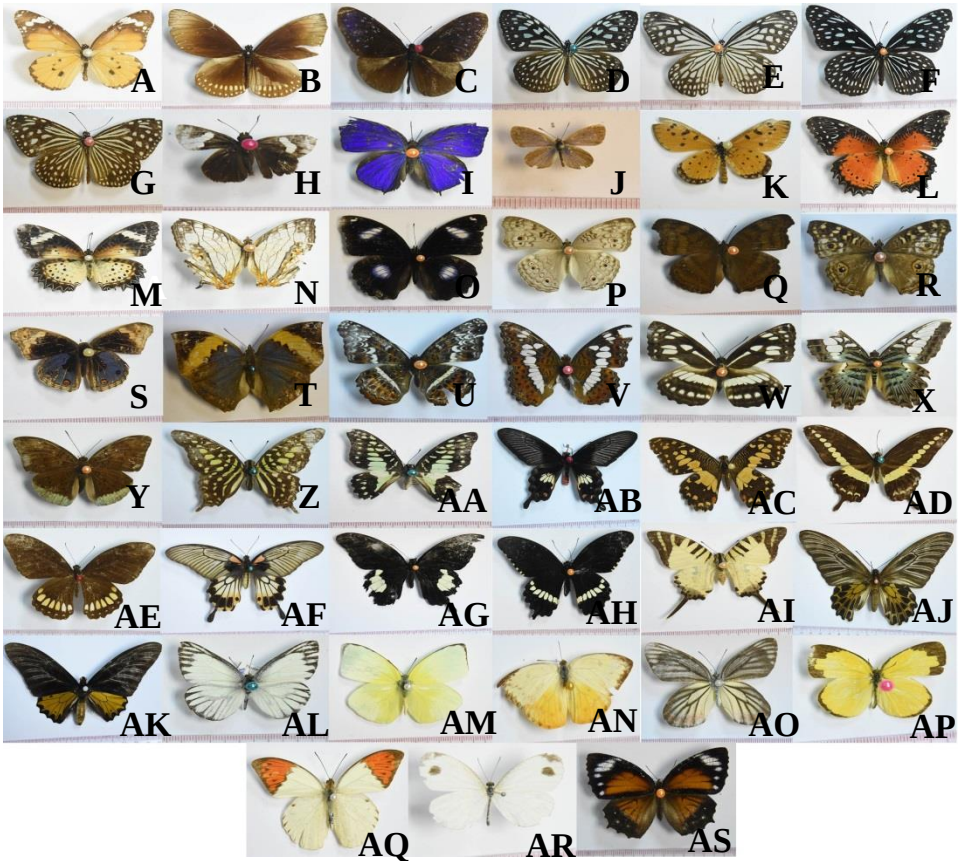

Figure 1. Lepidoptera species:

A) *Danaus chrysippus chrysippus* B) *Euploea core* C) *Euploea* sp. D) *Ideopsis vulgaris* E) *Parantica aglea* F) *Parantica agleoides* G) *Tirumala septentrionis septentrionis* H) *Notocrypta pria* I) *Arhopala* sp. J) *Everes lacturnus rileyi* K) *Acraea violae* L) *Cethosia bibles bibles* M) *Cethosia cyane euanthes* N) *Cyrestis thyodamas thyodamas* O) *Hypolimnas bolina* P) *Junonia atlites* Q) *Junonia iphita* R) *Junonia lemonias* S) *Junonia orithya* T) *Kallima inachus siamensis* U) *Lebadea martha malagana* V) *Moduza procris procris* W) *Neptis columella martabana* X) *Parthenos sylvia gambrisius* Y) *Tanaecia* sp. Z) *Graphium agamemnon agamemnon* AA) *Graphium doson* AB) *Pachliopta aristolochiae goniopeltis* AC) *Papilio demoleus malayanus* AD) *Papilio demolion demolion*
AE) *Papilio mahadeva* AF) *Papilio memnon agenor* AG) *Papilio nephelus chaon* AH) *Papilio polytes romulus* AI) *Pathysa antiphates pompilius* AJ) *Troides aeacus* AK) *Troides helena* AL) *Appias olferna* AM) *Catopsilia pomona pomona* AN) *Catopsilia scylla* AO) *Delias hyparete* AP) *Eurema* sp. AQ) *Hebomoia glaucippe* AR) *Leptosia nina* AS) *Elymnias hypermnestra*

Figure 2. Hymenoptera, Diptera and Coleoptera species:

A) *Ceratina* sp. B) *Xylocopa latipes* C) *Amegilla zonata* D) *Apis dorsata* E) *Apis florea* F) *Trigona melanoleuca* G) *Tetragonula laeviceps* H) Unknow1 I) Unknow2 J) *Pseudodoros* sp. K) Unknow3 L) *Bactrocera diversa* M) *Hypomeces squamosus* N) *Ixorida* sp. O) Unknow4

Discussion

After spending 12 months collecting data related to insect pollinators in the Genetics Plants Conservation area of 50 Rai, which is approximately 16.7 acres, found 955 insects categorized into 4 orders with the Hymenoptera as the most commonly-found order, 579 insects of this order (60.6%), followed by the Lepidoptera, Coleoptera, and Diptera orders which were found 343 (35.92%), 19 (1.99%), and 14 (1.47%) respectively. As for the number of insect species that have been found are 60 species with the insects of Lepidoptera order as the most commonly found insects of 45 species and followed by Hymenoptera, Coleoptera, and Diptera orders, which were 9, 3, and 3 species found for each order respectively. The findings agree with the study conducted by Tasen *et al* (2009) which surveyed the insect pollinators in Khao Yai National Park, Thailand, and indicated that the 46 species of Lepidoptera order were the most commonly found insects. This study may differ from other studies as they reported that the insect pollinators of 42 species of the Hymenoptera order were the most commonly found (Devi *et al*, 2017), 31 species (Siregar *et al*, 2016), and 8 species (Kamel *et al*, 2015). Other studies have also shown different results as they reported to have found insects that are not of Hymenoptera order as the most commonly found, but the insects of The Diptera order are as the most commonly found ones as they encountered 17 species of this order (Mattu and Nirala, 2013). The difference may cause by the differences of the surveyed areas as they tend to have difference factors, for instance, the sizes of surveyed area, the number of plants that can be sources of foods for insects. These factors

may have an impact on the results which could explain why there are differences in species of the insect pollinators found in different regions.

The most commonly found insects are of the *Tetragonula laeviceps* which are accounted for 32.04% and followed by the *Apis florea* with the percentage of 23.25 %. The insects of *Tetragonula laeviceps* can be found all year round with the exception of the month of March, May, and June as they belong to the family of Apidae and the order of Hymenoptera which agrees with the findings of other studies as they reported that the insect pollinators that are truly outstanding belong to the Apidae family and the Hymenoptera order, for instance, the study of water melon farms in Phichit province, Thailand, 48.13 % of the insects of this family and order were encountered (Jongitvimol *et al*, 2016) as well as the survey conducted in an apple orchard in Shimla Hills of Western Himalaya, India, reported 50.91 % that they encountered with the insects of this family and order. The insects of this family are social animal, and their nests are densely populated which explains why these insects have become the most commonly found species.

As for the diversity index of insect pollinators, during the period of 12 months of research, has found that the highest value of H* was obtained in October with the H* value of 2.61. The lowest H* value of 1.48 was obtained in May. However, when combining all of the diversity index values of the 12-month studying period, it was found that the value of H* was 2.22, and it indicated that there were 27 species of insects in September with the H* value of 2.52. Whereas, the 23 insect species were found in October with the H* value of 2.61. Although, the number of insect species was higher in September, the quantity of insects found and the consistency were too small, hence the decrease of diversity value. The insect pollinators that have beenfound in September were only 1 from 10 different species. But the insect pollinators that have been found in October was only 1 from 6 different species. Additionally, the H* value obtained from this study was 2.22 which is rather low compared to the results obtained in the study conducted by Tasen and Malaipan (2013), which involved the study of insect pollinators found in the low-level farmlands, the low-level Dipterocarp forests, and the low-level mixed forests in Chiang Mai province, yields the H* value of 4.24, 3.69, and 3.07 respectively. However, the H* value obtained from this study was greater than that obtained in the study of Jongitvimol *et al* (2016) that studied the insect pollinators in water melon farms in Phichit province which yielded the H* value of 0.35, which could be a result from the differences in the sizes of the areas and types of plants that may give different H* values.

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