Pattern of Lepidopteran pest community attacking oil palms and their associated hymenopteran parasitoid

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Abstract. Understanding the pattern of lepidopteran pest community attacking oil palms and associated parasitoid is very important to develop appropriate biological control strategies. Insects were surveyed by collecting larvae of lepidopteran pests attacking oil palm plantations. Samplings were conducted by diagonal transect walk crossing oil palm blocks. Insects collected from the field were brought into the laboratory and maintained with fresh leaves of oil palm until pupation. Parasitized larvae were intensively observed, and emerging parasitoids were collected for identification. In total, approximately 17 species were identified to attack oil palm by surveying 976 trees from three different age of palm oil plantations. Only 19.98% of which were infested by Lepidopteran pests. Limacodidae was found to be the most specious family inhabiting oil palm plantation of the study area, and Psychidae only represented by two species. Setora niten was recorded to be the most abundant species. Abundance structure of Lepidopteran pests seems to be different for different age of oil palm. S. niten was found to be dominant in younger oil palm but not in older oil palm. Only four species were found to be parasitized by parasitoid including Birthamula chara, Darna bradley, Darna deducta, Darna trima, and Limantriidae (ulat bulu-3). All parasitoid species attacked the larvae were gregarious belongs to Braconidae and Eulophidae. Euplectrus, gregarious endoparasitoid of Eulophid was found to parasitize D trima. Long term study is needed to understand the complete pattern of host-parasitoid interaction in oil palm plantations.

Keyword: lepidopteran pest, parasitoid, spatial pattern

1. Introduction
Oil palm plantation has been widely developed in Indonesia by occupying less than 5% of the total land of Indonesia or about 8.1 million hectares [1]. At the same time, this species is also a host for a wide range of herbivorous insects which can complete their life cycle in this palm, however only relatively few become serious pests [2]. All the insect pests of oil palm in the country are locally originated and they have adapted to the crop since its introduction a little over 100 years ago [3]. Lepidopteran pests such as bagworm, nettle caterpillars, slug caterpillars, and tussock or hairy caterpillars are important oil palm pests [4,2]. Nettle caterpillar and bagworm are the most important pests in Malaysia and Indonesia [5,6,7,8].

Caterpillar outbreaks of an extent and intensity not previously experienced began to occur from about 1956 [9]. In Malaysia, bagworm is the most important oil palm pest in the past and today [7,10]. The bagworms reaching outbreak proportions on occasions were Metisa plana, Cremastopsyche pendula, and Mahasena corbetti. These species are most commonly found in Malaysia [3]. For nettle caterpillars, Setora niten and Darna trima are considered prone to the outbreak [9]. Most studies on
the pest of oil palm are commonly dominated by reports on bagworm in Malaysia [4,7,8], but less for nettle caterpillar, especially for Indonesia [11].

Large scale plantations of oil palm are risky to pest attack and outbreak. Attack of nettle caterpillars can impact on yield losses until 70% in the first year after defoliation and become 90% if the attack continues in the following year [11]. In Malaysia, attacks of bagworm can cause high yield losses up to 43% after serious infestation [8]. This has been responded by applying pesticide which is now not relevant anymore for today due to its negative impact that is clearly understood [16] and the increasing global demand on sustainability (RSPO, ISPO). The environmentally sound approach has been developed by applying integrated pest management (IPM) concept and technologies. As part of IPM program, early warning system (EWS) has been run to identify the current status of pests in the field, but it does not stop the utilization of pesticide as a final strategy to combat pest outbreak. Although, natural enemies are believed to have a strong capability to suppress pest population, however, in facts, scattered outbreaks still happened.

Even though oil palm pests have been widely recognized and studied [4,6,2,8,7] however most studies only focus on identification of the occurrence of pests and their natural enemies, but fewer studies concentrated on the pattern of Lepidopteran pests community and their associated parasitoids. To develop an appropriate strategy to combat pests problem, we should understand how the pattern of three trophic interaction among crops, herbivorous insects and their natural enemies are affected by management in oil palm plantations. Since pest control is a function of natural enemy diversity [18], therefore decreasing diversity of natural enemies will strongly increase the release of pests from parasitism [19]. Successful biological of insect pests often depends on reliable baseline information on natural mortality imposed by natural enemies [15]. The main idea of the study is to understand the pattern of lepidopteran pests community, parasitism level, and parasitoid diversity under highly managed oil palm plantation. The objectives of the research are: (1) To study community structure of lepidopteran pests attacking oil palm plantation; (2) To evaluate the parasitization of hymenopteran parasitoids on lepidopteran pests in oil palm plantation.

2. Method

About two blocks of two years old oil palm plantation and two blocks of five to six years old oil palm plantation were selected to study the spatial pattern of lepidopteran pests and their associated hymenopteran parasitoids. The Hymenopteran parasitoid was surveyed by collecting lepidopteran pests attacking oil palm. Ecological samplings were conducted by diagonal transect walks crossing a single block of oil palm plantation. About four transects walks were conducted within a single block starting from the outer edge towards the inner part of the block. Design of sampling effort can be seen in Figure 1. Samplings were conducted between 07.00 and 11.00 am.

**Figure 1.** Sampling map for studying the spatial dynamic pattern.

Immature insects collected from the field were maintained in the laboratory by using fresh oil palm leaves under room temperature. A single species of larvae collected from a single oil palm tree was maintained in a single plastic container. To facilitate air circulation, a plastic container was
equipped with a mesh window (25 mesh). Larvae which are getting pupation were removed into a plastic container until adult emerged. Parasitized larvae were intensively observed, emerging parasitoids were then collected with alcohol 70% for identification.

All data was compiled into MS Excell. Data were not analyzed using specific statistical tools. Non-parametric Spearman rank correlation was applied to analyze the correlation between the number of trees attacked and the abundance. Limited data was statistically calculated, instead of ecologically analyzed.

3. Results

In total, approximately 17 species of Lepidopteran pests were identified to attack oil palm plantations in the study area (see Table 1). From about 976 sampled trees, only 19.98% of which were infested by Lepidopteran pests. The number of Lepidotrian pests species attacking oil palm trees varies between 7 and 14 species. The number of attacked trees were found to be correlated with the number of individuals (Fig. 2). Limacodidae was found to be the most specious family inhabiting oil palm plantation of the study area, and Psychidae only represented by two species. *Setora nitens*, followed by ulat bulu-3 (Limantriidae), and *Metisa Plana* and *Setora nitens* were recorded to be the most abundant lepidopteran pests attacking oil palm plantation (see Fig. 3). This can be seen from high number of trees attacked by those species. Block OA10 was infested higher species number of Lepidopteran pests than other sampled blocks (Fig.4). Abundance structure of Lepidopteran pests seems to be different for different age of oil palm. *S nitens* was found to be dominant in younger oil palm but not in older oil palm (Fig. 5 and 6).

| Families | Species            | Blocks |
|----------|--------------------|--------|
|          |                    | OA-10  | OA-15 | OB-1A | OB-3 | OB-6 |
| Nymphalidae | Amathusia phidippus | 1      |       |       |      |      |
| Notodontidae | Ambadra rafflesli | 1      | 1     | 2     |      |      |
| Limacodidae | Birthamula chara  |        |       |       |      |      |
| Limacodidae | Birthosea bisura  | 1      |       |       |      |      |
| Limacodidae | Darna bradleyi    | 6      |       |       |      |      |
| Limacodidae | Darna Catenatus   | 1      |       |       |      |      |
| Limacodidae | Darna Deducta     | 13     | 1     | 1     |      |      |
| Limacodidae | Darna Trima       |       | 2     | 2     |      |      |
| Lymantriidae | Dasychira inclusa| 4      | 10    | 2     |      |      |
| Limacodidae | Limacodidae-1    | 1      | 1     |       |      |      |
| Psychidae | Mahasena Corbetti | 6      | 3     | 8     | 3     | 3     |
| Psychidae | Metisa Plana      | 3      | 5     | 2     | 10    | 17    |
| Limacodidae | Setora Nitens     | 26     | 2     | 3     | 1     | 2     |
| Noctuidae | Spodoptera Litura |       |       |       |       | 1     |
| Lymantriidae | Ulat bulu-1     | 1      |       |       |      |      |
| Lymantriidae | Ulat bulu-2     | 2      | 11    |       |      |      |
| Lymantriidae | Ulat bulu-3     | 1      | 7     | 3     | 22    |      |

Table 1. List of species of Lepidopteran pests identified to attack oil palm plantation in PT Agro Menara Rahmat (N total: 976 trees) (OB=six years old oil palm plantation; OA= <3 years old oil palm plantation).
Fig. 2. Relationship between the number of attacked trees and the abundance of single species of Lepidopteran pests. Spearman rank correlation: \( r = 0.86, \ n = 17 \ p < 0.05 \).

Fig 3. Number of sampled trees attacked by oil palm pests (N of sampled trees= 976, N of attacked trees =195) and abundance structure of pest species

Fig.4. The number of Lepidotrian pests species attacking oil palm trees.
Fig 5. Abundance structure of Lepidopteran pests attacking young oil palm plantation.

Fig 6. The abundance of Lepidopteran pests attacking older oil palm plantation.

Fig 7. The abundance of Lepidopteran pests attacking oil palm. (a) First sampling, (b) second sampling.
The number of parasitized larvae were recorded to be very low. Only four species were found to be parasitized by parasitoid including *Birthamula chara*, *Darna bradley*, *Darna deducta*, *Darna trima*, and Limantriidae (ulat bulu-3). List of parasitoid species was shown in Table 2.

| Species       | Parasitoid               | Type       | Total parasite host/ the average individual parasitoid per host /total inang |
|---------------|--------------------------|------------|--------------------------------------------------------------------------------|
| *Darna bradley* | Braconidae-y, Tachinidae | gregarius, soliter | 4/31, 5/20                                                                 |
| *Darna deducta* | Braconidae-y             | gregarius  | 18/23, 22/70                                                                |
| *Darna trima*  | Braconidae-y, Eulophidae | gregarius, (Euplectrus sp) | 6/18, 67/11                                                                  |
| *Birthamula chara* | Braconidae-y          | gregarius  | 1/16/11                                                                      |

4. Discussion

Successful biological of insect pests often depends on reliable baseline information on natural mortality imposed by natural enemies [15]. This research recorded 17 species of Lepidopteran pests infested oil palm trees. All species recorded to be the main pests of oil palm are found in this research. However, the number of individuals was recorded to be very low and far from the outbreak. Usually, oil palm pests are generally kept in balance in low numbers by certain environmental factors [3]. Nevertheless, the balance sometimes breaks down and pest outbreaks ensue [3]. Decreasing population of natural enemies due to pesticide application may trigger the increasing pest outbreaks frequency [11].

Only two species of bagworm were found in this survey, *Metisa plana* and *Mahasena corbetti*. There are about 1700 species of Psychidae described worldwide [17] and only seven species are found in association with oil palm: *Metisa plana*, *Mahasena corbetti*, *Pteroma pendula*, *Brachycyttarus griseus*, *Manatha albipes*, *Amatissa*, and *Cryptothelea cardiophaga*. The most common species of bagworms are *M. plana*, *P. pendula*, and *M. corbetti* [3]. These species were reported to be the most important pests of oil palm in Sabah [4] by causing high yield losses up to 43% after serious infestation [8].

Limacondidae was the family with high number of species compared with other families consistently found to attack oil palm. However, only a low number of parasititized larvae was recorded in this study. The most important species, *S nitens* was released from parasitism. Only four species were found to be parasitized by parasitoid including *Birthamula chara*, *Darna bradley*, *Darna deducta*, *Darna trima*, and Limantriidae (ulat bulu-3). All parasitoid species attacked the larvae were gregarious (lot of individual emerge from only one host). Three species of Limacodidae: *D bradley*, *D deducta*, and *D trima* were parasitized by the same species, Braconidae. [5] reported that *Apanteles aluella* (Braconidae) was identified to parasitize *D. trima* and *D. Deducta*. *D. trima* was also found to be parasitized by *Euplectrus sp* (Eulophidae). This is uncommon finding since this gregarious endoparasitoid Eulophids are seldom to be reported to attack *D. trima* in oil palm plantation. Study of parasitoid complex conducted by [5] only recorded mostly ectoparasitoid Eulophid which was known to attack limacodids, and *D. trima* was identified to be attacked by *Platyplectrus orthocraspedae* (solitary eulophid). To generate information on natural mortality imposed by natural enemies requires painstaking longterm studies over a considerable geographical area [15].

5. Conclusions

This study successfully recorded a large number of species attacking oil palm plantation with low abundance. Based on this study a large number of selected oil palm trees were escaped from
herbivores attack. Low parasitization and a low number of parasitoid species were recorded in this study. Gregarious endoparasitoids of Braconidae showed to survive by parasitizing various species of hosts. Gregarious endoparasitoid of Eulophid found to attack *D. trima* was uncommon finding in oil palm plantation. Long term research is needed to get the complete pattern of host-parasitoid interaction in oil palm plantation.

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