Faculty of Resource Science and Technology

Occurrence of Bagworm and Nettle Caterpillar and Its Natural Enemies in Oil palm Plantation Planted with *Turnera ulmifolia* with Predatory Activities of *Oecophylla smaragdina* on the Bagworm

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Bachelor of Science with Honours

(Plant Resource Science and Management)

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This report is submitted in fulfillment of requirement for degree of

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Faculty of Resource Science and Technology

UNIVERSITI MALAYSIA SARAWAK

2022

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TABLE OF CONTENT

LIST OF TABLES

LIST OF ABBREVIATIONS

SAS	Statistical Analysis System
sp.	species
α	significance level
MPOB	Malaysian Palm Oil Board

LIST OF FIGURES

Occurrence of Bagworm and Nettle Caterpillar and Its Natural Enemies in Oil palm Plantation Planted with *Turnera Ulmifolia* with Predatory Activities of *Oecophylla Smaragdina* on the Bagworm

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ABSTRACT

Turnera ulmifolia belongs to Turneraceae family and a perennial flower. It native to Caribbean area and widely used as a beneficial plant and acted as a biological control to overcome infestation of bagworms as the colour of flower was bright and had nectar contents, it attracted the natural enemies came over to get nectaries and attacked the bagworms. This study was carried out at the Felcra Samarahan Jaya Oil Palm Plantation in Kota Samarahan, Sarawak, near Sungai Sui. The main objectives of this study were to assess the impact of *Turnera ulmifolia* on the populations of defoliate insects, bagworms as well as their natural enemies, in oil palm plantations. The sample results revealed a significant difference in the number of alive bagworms between plots T0 (without *Turnera ulmifolia*) and T1 (With *Turnera ulmifolia*). For the effect of planted *Turnera ulmifolia* on bagworm mortality over a four-week sampling period, the average number of dead bagworms in T0 was 64.75 and 83 in T1. This study also revealed the presence of natural enemies such as *Pedeobius foveolatus, Cosmolestes picticeps*, and *Brachymera carnata.* The most common bagworm species identified in this study were *Pteroma pendula* and *Metisa plana*. This study also discovered nettle caterpillars (*Susica sp*., unidentified species, and *Birthosea sp.)* in oil palm plantations. According to the findings of this study, planting a beneficial plant, *Turnera ulmifolia*, was effective in controlling defoliate insects, bagworm, and nettle caterpillars, as well as increasing the occurrence of its natural enemies.

Key words: *Turnera ulmifolia*, bagworm, natural enemies, nettle caterpillar

ABSTRAK

Turnera ulmifolia tergolong dalam keluarga Turneraceae. Ia berasal dari kawasan Caribbean dan digunakan secara meluas sebagai tumbuhan yang bermanfaat dan bertindak sebagai kawalan biologi untuk mengatasi serangan ulat bungkus kerana warna bunganya cerah dan mempunyai kandungan nektar, ia menarik musuh semulajadi datang untuk mendapatkan nektar dan menyerang ulat bungkus. Kajian ini telah dijalankan di Ladang Kelapa Sawit Felcra Samarahan Jaya di Kota Samarahan, Sarawak, berdekatan Sungai Sui. Objektif utama kajian ini adalah untuk menilai kesan Turnera ulmifolia ke atas populasi serangga defoliasi seperti ulat bungkus serta musuh semula jadi mereka, di ladang kelapa sawit. Keputusan sampel mendedahkan perbezaan yang ketara dalam bilangan ulat bungkus hidup antara plot T0 (tanpa Turnera ulmifolia) dan T1 (dengan Turnera ulmifolia). Bagi kesan Turnera ulmifolia yang ditanam ke atas kematian ulat bulu dalam tempoh persampelan empat minggu, purata bilangan ulat ulat mati dalam T0 ialah 64.75 dan 83 dalam T1. Kajian ini juga mendedahkan kehadiran musuh semulajadi seperti Pedeobius foveolatus, Cosmolestes picticeps, dan Brachymera carnata. Spesies ulat bungkus yang paling biasa dikenal pasti dalam kajian ini ialah Pteroma pendula dan Metisa plana. Kajian ini juga menemui ulat bulu (Susica sp., spesies tidak dikenal pasti, dan Birthosea sp.) di ladang kelapa sawit. Menurut penemuan kajian ini, penanaman tumbuhan berfaedah, Turnera ulmifolia, berkesan dalam mengawal serangga, ulat bungkus, dan ulat bulu, serta meningkatkan kejadian musuh semula jadinya.

Kata kunci: *Turnera ulmifolia, ulat bungkus, musuh semulajadi, ulat bulu*

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Malaysian Palm Oil Board (MPOB) issued a statement that oil palm (*Elaeis guineensis*) has become one of the most important plantation crops in Malaysia (Norman & Basri, 2007), as it has covered about five million hectares of land out of the total land available in Malaysia. Due to its high value and wider adaptability to different weathers, oil palm has a prominent position among plantation crops. Oil palm tree can take around 30 months to mature and produce and will continue to be productive for the next 20 to 30 years (Taylor, 2022). To ensure successful oil palm growth, care for pests is essential. Like other plantation crops, oil palm also does not escape exposure to pest attacks which results in less yields (Murphy et al., 2021). Various species that cause damage to this oil palm plantation have been studied. Of those, the main pest involved in oil palm damage is bagworm which is characterized by living in ‘bags’, which they carry on their bodies (Ho, 2002).

It has been proven that the species *Metisa plana* Walker, *Pteroma pendula* Joannis, and *Mahasena corbetti* Tams are the most dominant bagworm species found in Malaysia (Corley & Tinker, 2003). A systematic review has been conducted by Wood (2002) against these lepidopterans belonging to the Family Psychidae. His study provides an information about this pest based on its status on oil palm. Bagworms are also phytophagic, which are insects that like to eat plants that are very aggressive, causing damage to the leaf area, making it difficult for the tree to perform the process of photosynthesis of oil palm (Ahya Mahadi et al., 2012).

The management of bagworms in oil palm plantations have a negative impact on environment and human at present. They are more focused on how to manage these pesticides more quickly so that it cannot only satisfy the satisfaction of killing pests, but it can also do harm to non-target species. Many innovations have come up to address this issue. The term innovation refers to the newness of products, processes, or markets. In terms of integrated pest management (IPM) innovation, it refers to the use of new chemical, biological and cultural controls in an organized approach to maintaining ecological harmony. In this case, biological control approach is used. Biological control of pests is the management of a pest with their natural enemies called biological control agent. The most important with this technique, it can have an insignificant effect on non-target species such as using beneficial plant in conservation natural enemies. Therefore, the objective of this study is to evaluate the impact of *Turnera ulmifolia* on the abundance and population fluctuation of natural enemies of bagworm.

1.2 Problem Statement

There is limited information about the effect of biological control on bagworm population. These prompted the researchers to conduct this study. This study focuses on determining the effect of *Turnera umifolia* on the abundance and population fluctuation of natural enemies of bagworm. By conducting this study, it is also giving important information about how the fluctuation of natural enemies can affects bagworm in oil palm plantations.

1.3 Objective

- To evaluate the impact of *Turnera ulmifolia* on the abundance and population fluctuation of natural enemies of bagworm.
- To assess the occurrence of nettle caterpillar species.
- To study the predatory activities of *O. smaragdina.*

CHAPTER 2

LITERATURE REVIEW

2.1 Species of Bagworm in Oil Palm Plantation

There are some species of bagworms that show a very significant and dominant impact on oil palm plantations in Malaysia such as *Metisa plana*, *Pteroma pendula* and *Mahasena corbetti*. The occurrence of a bagworm varies by location. For example, *M. plana* and *P. pendula* are more dominant in Peninsular Malaysia while *M. corbetti* is more dominant in Sabah (Cheong et al., 2010). For Sarawak, the dominant bagworm species is *P. pendula* as well. Among the three species, there are some conflicts among researchers about which species are more damaging to oil palm plantations although these three species commonly achieve epidemic status (Hoong and Ho, 1992). Nevertheless, according to a recent study conducted by Cheong et al. (2010), showed that *P. pendula* is a more destructive and more dominant species. However, prior to obtaining such answers, a preliminary study conducted through Norman et al. (1994) and Norman & Basri (2007) showed different results where the results of the study showed that *M. plana* is the species responsible for destroying oil palm plantations and the most dominant. This contradiction was finally acknowledged through Wood (2002) where he noticed that before 1955, *P. pendula* was the most dominant pest but after that, he found that *M. plana* became more dominant. According to his study, the change is due to the widespread use of broad-spectrum long-distance exposure to pesticides and agrochemicals. Bagworm can cause losses of up to 44% to estate operators as bagworm causes moderate to severe defoliation of oil palm fronds resulting in significant loss of productivity (Thaer et al., 2021). According to MPOB data in 2005, the bagworm problem should not be underestimated in the oil palm industry, as 35 657 hectares have been attacked by this pest. MPOB also warns that it is becoming more prevalent if no proper controls are implemented.

2.1.1 General Characteristics and Life Cycle

2.1.1.1 *Metisa Plana* Walker

Metisa plana (Figure 2.1) is a species that is no stranger to the oil palm industry. There are many researchers who have studied its biology and life history well. Like common Psychidae, sexual dimorphism is present in the adult stage of *M. plana* where the male pupae will emerge as a winged moth. A unique feature is found in adult females where the adult females have reduced appendages and flightless. The larvae remain in their individual bags until the adult stage for females and pupal stage for males. The winged males will then search for females by pheromone attraction. A female can lay 99 to 200 eggs, with an average of about 130 eggs (Ho, 2002). The life cycle of *M. plana* is between 92 to 97 days. It underwent 7 larvae stage before pupation. Significant differences between *Metisa plana* and *Pteroma pendula* can be seen with a hook-shaped attachment on the leaf. The size of the female cases is usually larger than those of the males.

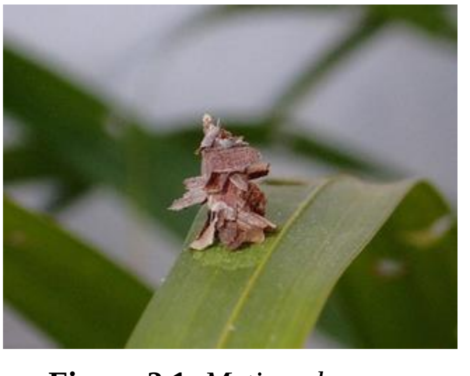

Figure 2.1: *Metisa plana*

2.1.1.2 *Pteroma Pendula* Joannis

Pteroma pendula (Figure 2.2) previously known as *Cremastopsyche pendula*. Sexual dimorphism also occurs in the adult stage of the insect where the male pupae will emerge as a moth with wings and a vestigial mouth. This moth is usually black. For adult females, it is just a simple sac without any appendages like adult males. It will only remain in the sac and will secretes pheromones to attract the male. According to Cheong et al. (2010), One female can lay 59 to 81 eggs, with average about 65 eggs. The life cycle of *P. pendula* is between 48 to 50 days. It underwent 4 larvae stage before pupation, and it has a smooth surface and there is a long attachment thread on the leaf. The size of the female case is also usually larger than the male case.

Figure 2.2: *Pteroma pendula*

2.1.1.3 *Mahasena Corbetti* Tams

There are differences in terms of biology and life history between the species *Mahasena Corbetti* (Figure 2.3) with *Metisa plana* and *Pteroma pendula*. This is because, the biology and life history of *Mahasena Corbetti* have not been studied and their life cycle is merely an estimation. Although there are differences, this species also experiences sexual dimorphism in the adult stage where the male pupae will emerge into a moth with wings. Just like other species, the adult females are just a simple sac without any appendages. It will only remain in the sac and will secretes pheromones to attract the male. *Mahasena corbetti* has the longest life cycle which is estimated to be between 110 to 140 days. To date, it has not been determined how many larve stage that needs to be through before pupation. The larval case of *M. corbetti* are very large compared to other species.

Figure 2.3: *Mahasena corbetti*

2.2 Control Measure of Bagworm

2.2.1 Chemical Control

Once the economic threshold is reached, chemical control is still the main method of pest control (Jamian, 2020). Pesticides are easy to use and can usually fast in reducing the number of pests. They are cheap, easy to handle, fast onset, and very reliable in most cases, especially for bagworm infestations. However, due to the large number of natural enemies in the field, wise pesticide treatment measures must be taken to prevent the death of the beneficial organisms, thereby avoiding secondary or continuous outbreaks of harmful organisms. Flubendiamide, chlorantraniliprole, cypermethrin and Bacillus thuringiensis are insecticides commonly used to control the spread of *M. plana* (Farrar et al., 2014). Several types of chemical application techniques have been used to control bagworm infestation, including ground spraying, aerial spraying, trunk injection, and root absorption techniques. Spraying technique is the most common method for applying biological pesticides in the field.

In a typical ecosystem, apart from relying on chemical control, there are ecological forces that are influenced by biotic and abiotic factors that can be used as weapons to control from denser bagworm breeding, and indirectly provide a natural protective wall to the environment and crop plants (Ahya Mahadi et al., 2012). Main factors in controlling bagworm populations are included physical and chemical conditions, food supply, predators, and competition. However, in a monoculture plantation such as an oil palm, this bagworm attack will be more severe than the others. The plants themselves can provide new food sources for the bagworm, which leads to higher population densities and affects farms, exacerbates the problem (Flint & Bosch, 1987). In addition, the use of broad -spectrum pesticides will eliminate the natural enemies responsible for the control of bagworm (Wood, 2002). In this case, farmers need to shift from chemical-based pest control to biological control which is more environmentally friendly.

2.2.2 Biological Control

The use of broad-spectrum pesticides in chemical control systems of pests is known as outbreak causal factors because it has a negative effect in promoting the resurgence of secondary pest's outbreak with more severe density in distribution. This is because, the pest can move to nearby untreated areas because it can survive on other host plants. Therefore, pesticide control using biological control became more sustainable method. Biological control is defined as the process by which a species population reduces the number of other species through mechanisms such as predation, parasitism, pathogenicity, or competition (Van Drische et al., 2010). According to Zhang & Swinton (2009), the ability of natural enemies to control pest populations effectively below economic thresholds has been extensively proven. The use of this control began in the 1800s when Asia's rice plantations were attacked by brown plant hoppers and since that event, many ecological studies have been conducted on the natural enemies of native pests for use as an environmentally friendly pest control management medium (Altieri et al., 2005; Bianchi et al., 2006). The parasitoid's parasitic behavior has made it an effective weapon in the fight against bagworm attacks found in palm plantation oil and it is also often used in biological control programs. The most common natural enemies associated with bagworms *M. plana* are *Dolichogenidea* *metesae*, *Cosmolestes picticeps* and *Sycanus dichotomus* (Salim, 2010). Parasitoids have been proven in reducing the number of bagworms. This can be manipulated by planting beneficial plant to increase the number of natural enemies which can enhance their numbers and consequently their impact on bagworms.

2.3 Biological Control by Using Beneficial Plant

Biological control of bagworm is emphasized with the cultivation of nectar-containing plants such as *Euphorbia heterophylla*, *Cassia cobanensis*, and *Turnera subulata* in and around the attacked oil palm plantations. This beneficial plant works in increasing the further development of the natural enemies population for bagworm as it has attractant which provides nectar and adult shelter for the natural enemies of bagworm. The purpose of this beneficial plant cultivation is more focused on long-term control as this method can succeed after many trials. According to Jamian (2020), these beneficial plants contain volatile components to attract insect predators and parasitoid. Nectar is a commercially necessary substance because it is that the sugar is point of supply for honey. It is conjointly helpful in agriculture and horticulture because of the adult stages of some predatory insects take advantage of the nectar. For example, variety of parasitoid wasps trust nectar as a primary food source and it gives them the energy to hunt their prey. Norman et al., (1996) stated that common natural enemies for the *M. plana* species is Hymenepteran from the families Braconidae, Eulophidae and Ichneumonidae. It has been shown that *Sycanus dichotomus* can be used to control bagworms. The data obtained from the research shows that, compared with other plants, a large number of adults of S. dichotomus are attracted by beneficial plants such as *C. cobanensis* and *T. subulate.*

2.4 Biological Agents

2.4.1 Parasitoid

It is common knowledge that parasitoids are very effective natural enemies for controlling pest populations on field (Hawkins et al., 1997). Parasitoids can be described as organisms that live inside or within a host organism and ultimately kill the host. In other words, a parasitoid is a parasitic insect that grows from larvae found on or in individual hosts that lay eggs in or near the host (Cheong and Tey, 2013). Since 1967, several parasitoid species have been identified namely those that oppose *M. plana* and *P. pendula* (Brian and Norman, 2019). There are two types of parasitoids, namely primary parasitoids and secondary parasitoids or another name called hyperparasitoids.

Dolichogenidea metasae is a major parasitoid in oil palm plantations in Peninsular Malaysia, found to attack the bagworm, Pteroma pendula. Previous research by Hanysyam et al. (2013) found that closely related parasitoids, *Goryphus bunoh* and *Brachymera carnata*, were also major parasitoids in bagworm infected oil palm plantations. Among the control impacts posed by major parasitoids, these species disrupt or slow down the formation of natural balance (Brian and Kamarudin, 2019). This indicates the importance of this species in controlling invasive populations.

2.4.2 Predators

Predatory insects are free-living species by catching and eating common bagworm, and the most common are bugs and beetles. Predatory species are an important group of predators found in oil palm fields, namely *Cosmolestes piciceps* and *Eucanthecona furcellata* which prey on bagworm. The study by De Chenon et al. (1989) also demonstrated the effectiveness of *Sycanus dichotomus* as a biological control agent for *M. plana*. However, previous studies by Azlina (2011) have shown that *C. piciceps* frequently exhibits cannibalism against its own population, which may hinder its role as an effective biological control agent for bagworms, making it a less specific prey.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area Description

This research was conducted at Felcra Samarahan Jaya Oil Palm Plantation located near Sungai Sui in Kota Samarahan, Sarawak. It is located approximately 8 km from Universiti Malaysia Sarawak (UNIMAS) (Figure 3.1).

Figure 3.1: Map of Kota Samarahan showing the location of the study area

3.2 Setting of Plots

For this study, two treatments were used that were seperated based on the presence of *Turnera ulmifolia* and without *Turnera ulmifolia*. Each treatments included three plots were chosen as replicates as follows: