STUDY OF DURATION LARVAE STAGE BAGWORM (LEPIDOPTERA: PSYCHIDAE) ON MICHELIA CHAMPACA TREES IN EX-SITU AND IN-SITU REARING AND ITS SPECIES IDENTIFICATION

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Bachelor of Science with Honours
(Plant Resource Science and Management)

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I declare that this thesis entitled Study of Duration Larvae Stage Bagworm (Lepidoptera: Psychidae) on *Michelia champaca* Trees In Ex-situ and In-Situ Rearing and Its Species Identification is the result of my own research expect as cited in the references. This thesis has not been accepted for any degrees and is not currently submitted in candidature of any other degree.

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Plant Resource Science and Management Programme

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**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE PAGE</td>
<td>i</td>
</tr>
<tr>
<td>APPROVAL SHEET</td>
<td>ii</td>
</tr>
<tr>
<td>DECLARATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>viii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>ix</td>
</tr>
<tr>
<td>1.0 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2.0 LITERATURE REVIEW</td>
<td>4</td>
</tr>
<tr>
<td>2.1 Life Cycle of Insects</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Life Cycle of Bagworms</td>
<td>5</td>
</tr>
<tr>
<td>2.3 Bagworms as Pest</td>
<td>7</td>
</tr>
<tr>
<td>2.4 <em>Michelia champaca</em> Trees</td>
<td>8</td>
</tr>
<tr>
<td>3.0 MATERIALS AND METHODS</td>
<td>10</td>
</tr>
<tr>
<td>3.1 Ex-situ Rearing</td>
<td>10</td>
</tr>
<tr>
<td>3.1.1 Samples Collection</td>
<td>10</td>
</tr>
<tr>
<td>3.1.2 Rearing Larvae of Bagworms</td>
<td>10</td>
</tr>
<tr>
<td>3.2 In-situ Rearing</td>
<td>11</td>
</tr>
<tr>
<td>3.3 Species Identification</td>
<td>13</td>
</tr>
</tbody>
</table>
3.3.1 Adult Identification                          ..............................................13
  3.3.1.1 Adult Sampling by Insect Net   ..............................................13
  3.3.1.2 Adult Sampling by Light Trap                ..............................................13
3.3.2 Pupae Identification                          ..............................................14

4.0 RESULTS AND DISCUSSION                          ..............................................15
  4.1 Ex-situ Rearing                                    ..............................................15
  4.2 In-situ Rearing                                     ..............................................20
  4.3 Species Identification                           ..............................................25
      4.3.1 Adult Identification                          ..............................................25
          4.3.1.1 Adult Sampling by Insect Net  ..............................................25
          4.3.1.2 Adult Sampling by Light Trap                ..............................................25
      4.3.2 Pupae Identification                          ..............................................26

5.0 CONCLUSION                                      ..............................................30

6.0 REFERENCES                                      ..............................................32

APPENDICES                                         ..............................................34
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Tables</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1: Duration of larvae for replicate 1</td>
<td>15</td>
</tr>
<tr>
<td>Table 2: Duration of larvae for replicate 2</td>
<td>16</td>
</tr>
<tr>
<td>Table 3: Duration of larvae for replicate 3</td>
<td>17</td>
</tr>
<tr>
<td>Table 4: Larvae development for Tree 1</td>
<td>20</td>
</tr>
<tr>
<td>Table 5: Larvae development for Tree 2</td>
<td>21</td>
</tr>
<tr>
<td>Table 6: Larvae development for Tree 3</td>
<td>22</td>
</tr>
<tr>
<td>Table 7: Larvae development for Tree 4</td>
<td>23</td>
</tr>
<tr>
<td>Table 8: Larvae development for Tree 5</td>
<td>24</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figures</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1: Wrapped larvae</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2: Tagged samples</td>
<td>12</td>
</tr>
<tr>
<td>Figure 3: Insect net</td>
<td>13</td>
</tr>
<tr>
<td>Figure 4: Light trap</td>
<td>14</td>
</tr>
<tr>
<td>Figure 5: Bagworms attack <em>Morinda citrifolia</em> at FRST</td>
<td>18</td>
</tr>
<tr>
<td>Figure 6: Bagworms attack <em>Bougainvillea</em> sp. at FRST</td>
<td>19</td>
</tr>
<tr>
<td>Figure 7: Pupae of <em>Metisa plana</em> (Norman <em>et al.</em>, 1994)</td>
<td>26</td>
</tr>
<tr>
<td>Figure 8: Pupae of <em>Mahasena corbetti</em> species (Norman <em>et al.</em>, 1994)</td>
<td>27</td>
</tr>
<tr>
<td>Figure 9: Pupae of <em>Pteroma pendula</em> species (Norman <em>et al.</em>, 1994)</td>
<td>27</td>
</tr>
<tr>
<td>Figure 10: Pupae of bagworm that attacked <em>M. champaca</em> trees at FRST</td>
<td>28</td>
</tr>
<tr>
<td>Figure 11: Comparison of pupae from study site with the <em>Metisa plana</em> species pupa that was described by Norman <em>et al.</em> (1994)</td>
<td>29</td>
</tr>
</tbody>
</table>
Study of Duration Larvae Stage Bagworm (Lepidoptera: Psychidae on Michelia champaca Trees In Ex-situ and In-Situ Rearing and Its Species Identification

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ABSTRACT

Michelia champaca trees are dominant landscape trees that were planted in FRST, UNIMAS. However, bagworms attack create unhealthy landscape environment especially to the tree that were planted as ornamental plants. The most damaging stages of bagworms life stages were identified to be the larvae stage. In-situ rearing and ex-situ rearing were conducted to study the duration of the larvae bagworms. Ex-situ rearing showed larvae of bagworm only can survive for four weeks. While, in-situ rearing showed duration of bagworms of larvae depend on the tree condition. If the tree was not in the good condition the bagworms survival will slowly vanished after three weeks. Vice versa, if the tree was in good condition bagworms larvae could survived until three months. For species identification, pupae were used in species identifications. Based on the key of pupae identifications, bagworms that attack Michelia champaca trees at FRST, UNIMAS were identified to be Metisa plana species.

Key words: Michelia champaca trees, bagworm’s life cycle, species identification

ABSTRAK

Pokok Michelia champaca merupakan pokok landskap yang banyak ditanam di FSTS, UNIMAS. Walaubagaimanapun, serangan ulat bungkus telah mewujudkan persekitaran landskap yang tidak sihat terutama kepada pokok yang ditanam sebagai tanaman hiasan. Peringkat larva merupakan peringkat yang memberikan kerosakan yang paling kritikal dalam kitaran hidup ulat bungkus. Penternakan ulat bungkus telah dilakukan secara in-situ dan ex-situ untuk mengkaji tempoh kitaran hidup larva untuk ulat bungkus. Ternakan ex-situ menunjukkan larva ulat bungkus hanya dapat bertahan sehingga lima minggu sahaja. Manakala, ternakan in-situ menunjukkan bahawa kitar hidup ulat bungkus bergantung kepada keadaan pokok. Jika keadaan pokok berada dalam keadaan kurang memuaskan, ulat bungkus hanya akan bertahan dalam tempoh empat minggu. Sebaliknya, jika keadaan pokok berada di dalam keadaan yang baik, ulat bungkus dapat bertahan sehingga tiga bulan. Untuk pengenalpastian spesies, pupa digunakan dalam pengenalpastian spesies Berdasarkan kunci pengenalan pupa, ulat bungkus yang menyerang pokok Michelia champaca di FSTS, UNIMAS telah dikenal sebagai Metisa plana spesies.

Kata kunci: Pokok Michelia champaca, kitar hidup ulat bungkus, pengenalan spesies
1.0 INTRODUCTION

Bagworm is a general pest of trees and shrubs. They are leaf eating caterpillars characterized by the possession of bag, which they built out of tough silk embedded with materials from dried plants such as leaves and small twigs (Barlow, 1982). Bagworms feed on many kinds of plants such as arborvitae, southern white cedar, red cedar, juniper, spruce and pine and they are vulnerable to be attack (Caron, 2004). Bagworms live in the bag like cocoon that enlarges as they feed. Bagworms life cycle undergoes complete metamorphosis with four stages; egg, larvae, pupae and adult stages like other moths (Hadley, 2011). The eggs are round, yellowish and about $\frac{1}{34}$ inch in diameter and are found inside the bag that the old female bagworm still in there (Caron, 2004). After they hatch from egg, they become young bagworm in form of larvae. Young larvae of bagworms are tiny, glossy black on the back and a dull-amber underneath. A full grown bagworm is dull, dirty gray and splotched with darker markings toward the head. In mid to late summer, the bagworm changes to a dark red-brown resting stage called pupae and complete its life cycle (Caron, 2004). Female bagworm has no wings and remains in the same bag while male bagworm develops into small, black, hairy-bodied moths that emerge from the bags.

In Malaysia, bagworms are common on many orchard, landscape and ornamental trees (Ahmad and Ho, 1980). In Peninsular Malaysia, *Metisa plana* is the most serious and dominant pest of oil palm (Norman et al., 1994) while *Pteroma pendula* is the second most dangerous bagworm (Basri et al., 1988). According to Caron (2004), bagworms attack may not be noticed at the beginning because they are inconspicuous when young but the results from their attacks can be seen clearly. Newly hatch bagworms will make pupae on tree using
silk that their produce and twigs or dead leaf and at the same time feed on leaves. This time their ability to feed is at high rate because they need to prepare to enter pupae stage. Leaves that bagworms eat will turn to yellow and after that dead before falling down. Serious attack of bagworms can cause the dead of tree because all their leaves will fall down.

The example of serious attack of bagworms can be seen at the surroundings of Faculty of Resource Science and Technology, Universiti Malaysia Sarawak. Plants that are dominant at the surroundings of this faculty are *Michelia champaca* trees and were planted as ornamental plants. These trees undergo a serious attack of bagworms in March to May every year since 2009 and its appearance as bad as a dead tree. Their leaves are falling down and most of their branch full of bagworms pupae. However, the trees survive by producing new buds and new leaves. This situation becomes worse from time to time because no preventive measures are taken to control them. As observed the larva bagworms start infesting again in most individual and bagworms nests were hanging over the branches and the leaves of the plants were being forage.

The problem statement of this study is to study duration of life cycle and to identify the species and which attack *M. champaca* trees in Faculty of Resource Science and Technology, Universiti Malaysia Sarawak. Although this pest did not cause the tree to die but it create unhealthy landscape environment especially to the tree that were planted as ornamental plants. This study will provide enough information to control the bagworms population effectively not only to the *M. champaca* trees but also to the other planted forest species within Sarawak where infestation of bagworms may happen later.
The objective of this study is to study the duration of larval stage of bagworm that attack *M. champaca* trees at Faculty of Resource Science and Technology (FRST), Universiti Malaysia Sarawak. Second objective of this study is to identify the bagworm species that attack *M. champaca* trees at FRST Universiti Malaysia Sarawak.
2.0 LITERATURE REVIEW

2.1 Life Cycle of Insects

In order for insects to grow, they must undergo metamorphosis process. Metamorphosis is the biological process that enhanced grows of insects and they are two types of metamorphosis, which are incomplete metamorphosis and complete metamorphosis (Gullan and Cranston, 2005).

In incomplete metamorphosis, insects must undergo three life stages, which is egg, larvae and adult stage. Its life cycle start with an egg stages and when hatched larvae will come out. Larvae will undergo instars stage where they will shed their skin several times before they become adult. Examples of insect that undergo this process are cockroach, dragonflies and grasshoppers (Gullan and Cranston, 2005).

In complete metamorphosis, insect must undergo four stages, which are egg, larvae, pupae and adult stage. Larvae will be hatch from the eggs and look like worm in form. There are several types of larvae which are eruciform (caterpillar like), scarabaeiform (grub like), campodeiform (elongated, flattened and active), elateriform (wireworm like) and vermiform (maggot like). Larvae will eat a lot and grows up until they form pupae. This stage will reduce the movement of insect and regularly sealed within a cocoon. They are three types of pupae, which are obtect, exarate and coarctate. At pupae stage, they will undergo several changes and become adult at the end of this stage. Examples of insects that undergo complete metamorphosis are butterfly, moth, flies and beetles (Ruppert et al., 2004).
2.2 Life Cycle of Bagworms

Bagworm is belonging to Psychidae family. Bagworm undergoes complete metamorphosis and become moth when adult. Female adult is worm like with wings, functional legs and mouthparts but lacks in eyes. They will never leave the pupae. Male adult is sooty black and moth like and they have transparent wings (Hoover, 2002). Male adult will search for pupae that contain immoveable female for mating (Townsend and Potter, 1998). When mating, the male will tears the lower ends of the female’s bag and penetrates the genital opening after extending its abdomen up to 70 mm into the bag (Campos et al., 1987).

After mating, female adult will lays hundreds of eggs and after that leaves the bag and dies. They eggs will remain in the bag until they hatch (Townsend and Potter, 1998). These eggs are cylindrical with rounded edges. Initially, they are cream coloured, then orange and finally dark. After hatching, newborn larvae will abandon the maternal bag and produce a silken thread to be wind dispersed. Larvae that hatch from eggs are 2 mm long, glossy and have black colour on their back. Larvae length can achieve up to 25 mm long and have spotted with darker markings toward the head (Hoover, 2002). The larvae will start feeding immediately after being laid on the leaf surface. As the larvae developed, it will used lichen to build case as it fed and grew. They will start build their protective bags until they complete the larvae stages (Campos et al., 1987).

The larvae stage will undergo six larval instars. The first instar will took 9-16 days before change into second instar. The development of second instar to third instar will took 14-17 days. The third instar will took the longest period, 16-18 days to develop into fourth instar.
The development of the rest of the instar which are fourth to fifth instar will take between 10-15 days and fifth to sixth instar will take 12-16 days respectively (Chua et al., 2011).

Bagworm also can be detecting easily from their bag that made of silk and twigs that intertwined together to strengthen the bag. The bag can reach up to 30 to 50 mm long when larvae become matured (Hoover, 2002). Male bag are light brown or grey with 40-65 mm in size while female bag are darker with 58-85 mm in size (Campos et al., 1987).

In Malaysia there are three common species of bagworm that attack oil palm showed different duration life stage are Metisa plana, Mahasena corbetti and Pteroma pendula. For Metisa plana, the incubation period for eggs is 14-15 days while the larval period for males is 80 days, whereas for females, it lasts for 113 days. Males will pupate and the cocoons are characterized by a crook-shaped attachment to the leaf. Pupae period lasts for about 27 days. The males then emerge from the cocoon as adult male moths with wings, whereas females remain in the bags. Total life cycle of this species is about 4 to 5 months. While for Mahasena corbetti the eggs hatch after about 16 days and the larval stage lasts for 75 days for male and 82 days for female. Female larvae can reach up to 5 cm in length, whereas the males are about 3 cm. Larvae will construct cases made of large pieces of leaflet that give them their characteristics ‘shaggy appearance’. For Pteroma pendula, the total larvae period is 145 days while pupation takes 17-18 days to complete. Cocoon size is about 6 mm for males and 8 mm for females. The cocoons are suspended from leaves by a fine thread of about 10 mm in length (Chong et al., 1991).
2.3 Bagworms as Pest

Bagworms are one of the main leaf-eating pests of oil palm in Malaysia and Indonesia. Serious bagworm attack can cause to crop losses due to the extent of defoliation. A moderate defoliation about 10% to 30% may cause a crop loss of about 33% to 40% (Basri, 1993).

In February 1989, bagworm cause caused a defoliation of mangrove forests of Ecuador. By the end of June, the outbreak spread north and northeast in the direction of prevailing winds and included an area of 1000 ha. August and September trips to the infected zone showed that areas affected earlier were now completely defoliated and residual larvae were trying to survive by gnawing the bark of trees (Gara et al., 1990).

In Peruvian, the bagworm *Oiketicus kirbyi* recently become a pest of increasing importance in Peruvian avocado orchards. A study conducted in six commercial orchards evaluated the ecology and feeding damage caused by bagworms on avocado on the southern coast of Peru. In March 2009, the population of live individuals at different locations consisted of second to sixth larval instars. The damage caused by bagworm larvae usually results from defoliation, but in the case of *O. kirbyi* on avocado, the presence of larvae on the fruits was associated with blemishes that limit the marketability of fruits; thus bagworms cause direct economic losses for avocado growers (Marc et al., 2010).

Young larvae eat upper epidermis of attack trees and leaving small holes in that tree while matured larvae will eat needles like leaves and cause damage to trees. After several serious attacks of bagworms without any control, those trees that were attacked will dead (Hoover,
2002). However, the harshness of injury caused by bagworm depends on type of tree. For example, an evergreen will automatically dead from one serious attack but healthy deciduous trees, usually can produce new foliage and survive (Lacy, 1999).

At early infection, control cannot be made because bagworms attacks usually go undetected until damage is complete and very obvious. Early detection need to control this attack but need careful examination of host trees to detect the occurrence of small bagworm larvae that attach to leaves or needles (Hoover, 2002).

2.4 Michelia champaca Trees

*M. champaca* is belonging to the Magnoliaceae family. It is a small tree with glossy leaves and yellow or orange flowers with nice fragrant. It is a tall evergreen tree with a close and tapering crown and bole up to 18 to 21 m height. This tree cannot tolerate waterlogging and prefers well drained soil. Its fruit is aggregate of follicles and consists of long cluster of dark brown follicle while its seed are brown, angular and covered with pink fleshy arillus (Troup, 1921).

It also has commercial value from almost every parts of the plant especially the flower. The flower has a number of cosmetic, medicinal and economic uses. Flowers of *M. champaca* have been shown to contain quercetin, an unidentified flavonoid glycoside, β-sitosterol, unsaturated aliphatic ketones and hydrocarbons (Kapoor and Jaggi, 2004). Fresh flowers can be taken as natural fragrant and also can be extracted into perfumes and medicinal products
such as medicine for coughs and rheumatism. Some cosmetic products such as Joy, J’adore and Dior contain *M. champaca* fragrant extracts in their ingredient composition (Warren, 1998). This tree also is used in traditional medicine because almost every parts of the plant can be used as herbal. For examples, its flower can be used to treat bad urination, its roots can be used to cure flu fever and its flower can be used in bronchitis treatment.

These trees were plant mostly as ornamental plants because of its flowers. Their flowers smell nice with bright colour when bloom and can attract people attention at their beauty. These trees are evergreen with rounded to conical crown and may reach a height up to 15 m. They popular as landscape tree not only because of their flower but they also can produced a width shade and does not need a long time to produce flowers after they being planted (Kapoor and Jaggi, 2004).
3.0 MATERIALS AND METHODS

3.1 Ex-Situ Rearing

3.1.1 Samples Collection

Bagworms larvae were collected from infested *Michelia champaca* trees within the Faculty of Resource Science and Technology of Universiti Malaysia Sarawak starting from early of October 2011 until end of January 2012. Then, bagworm larvae were taken to the Ecological Laboratory, FRST for larvae rearing. Bagworms samples were collected by hand for every two weeks. Each collection samples, there were three replications with ten larvae samples per each replicate.

3.1.2 Rearing Larvae of Bagworms

The larvae were placed in an aquarium tank (11.5 cm height and 19 cm width) under standard laboratory condition (1 atm in pressure and 25°C). Fresh *M. champaca* leaves were placed daily into an aquarium tank after were rinsed with sodium hypochlorite 1% for 30 seconds and three times with water. The leaves were then cut into 1 cm width and 5 cm length sections. The leaves were placed in aquarium tank with its upper surface curve up to prevent it from reaching the upper part of the aquarium tank (Cheong *et al.*, 2010). The larvae were observed for their development for four months.
3.2 In-situ Rearing

Bagworms larvae were reared on *M. champaca* trees starting from February 2012 until April 2012. Five of *M. champaca* trees were used with ten replication for each tree. Cases of bagworm larvae were wrapped with net and were tagged (Figure 1 and 2). The larvae were observed for its development for three consecutive months with every week observations.

**Figure 1:** Wrapped larvae
Figure 2: Tagged samples
3.3 Species Identification

3.3.1 Adult Identification

Adult of bagworm were caught by using nets and light trap for adult identification.

3.3.1.1 Adult Sampling by Insect Net

Adult of bagworm were caught at night by using nets for three consecutive weeks. The dimension for the insect net is a 37 cm diameter frame and 60 cm extension handle (Figure 3).

![Insect Net](image)

**Figure 3:** Insect net

3.3.1.2 Adult Sampling by Light Trap

Light traps were located at selective *M. champaca* trees for one week. Light traps were built with a white bed sheet, hung in between the *M. champaca* trees with a light source
which is fluorescent tubes. The sheets were pinned to a rope tied between two trees with a bottom edge spread out on the ground beneath the light (Figure 4). Insects that were attracted to the trap were collected.

Figure 4: Light trap

3.3.2 Pupae Identification

Pupae of bagworm were collected by hand, and then pupae taken were compared with Key to common species of Psychidae infesting oil palm (pupation bag) by Norman et al. (1994) (Appendix 1).