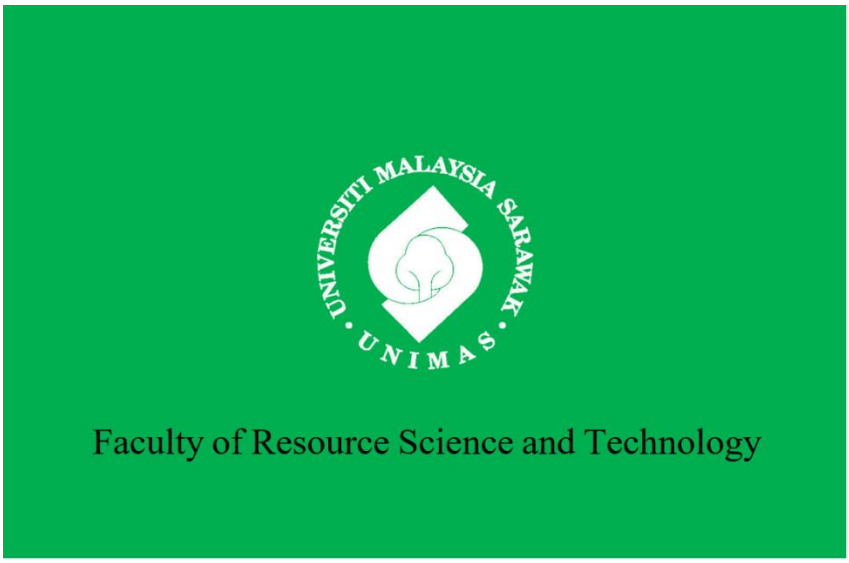

DEVELOPMENTAL STAGES OF PESTS ON HORTICULTURAL PLANTS IN HOME GARDEN AT KUCHING, SARAWAK.

FRANCIS SENEN BIN ALAU

(72241)

A final report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Science with Honours

(Animal Resource Science and Management)

Faculty of Resource Science and Technology

Universiti Malaysia Sarawak

2022

ACKNOWLEDGEMENT

First of all, I am very grateful to God for His blessings. I would also like to offer my heartfelt gratitude to a number of people and organization for their unwavering support throughout my undergraduate studies. First and foremost, I want to thank my supervisor, Mr. Muhamad Ikhwan bin Idris, for his excitement, patience, insightful remarks, valuable information, practical guidance, and never-ending ideas, which have greatly aided me during my study and writing of this thesis. This endeavor would not have been possible without his help and supervision. In my studies, I could not have asked for a better supervisor. I would also like to thank the University of Malaysia, Sarawak, for accepting me into their undergraduate programme giving me an opportunity to continue my studies. Finally, last but by no means least; I would like to thank both my parents, family for supporting me and always kept their faith believing in me, and friends; Loretta Nayan anak Duncan, Brainard Axton anak Brueen, Isaac Una anak Albert Nasat, Muhammad Ilyas bin Arsad, Joyce Cherish anak Jefree, Lydia Natasha Yeo, and Carollina Loudya anak Senda for providing assistance, giving me motivation and moral support throughout the hardship of this research project which led to its completion.

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This declaration is made on the 6th day of July 2022.

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I, Francis Senen bin Alau (72241), Faculty of Resource Science and Technology, hereby declare that the work entitled, Developmental stages of pests on horticultural plants in home garden at Kuching, Sarawak is my original work. I have not copied from any other students' work or from any other sources except where due reference or acknowledgement is made explicitly in the text, nor has any part been written for me by another person.

6th July 2022 — Date submitted

Francis Senen bin Alau (72241) — Name of the student (Matric No.)

Supervisor's Declaration:

I, Mr. Muhamad Ikhwan bin Idris, hereby certify that the work entitled, Developmental stages of pests on horticultural plants in home garden at Kuching, Sarawak prepared by the above-named student, and was submitted to the "FACULTY" as a * partial/full fulfillment for the conferment of Animal Resource Science and Management Programme (WS51), and the aforementioned work, to the best of my knowledge, is the said student's work.

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ABSTRACT

Insects-plants relationship exists all over the world, either directly or indirectly. Insects affect plants both beneficially and detrimentally. However, some insects become pest only in a certain stage in their life cycle. The purpose of this study is to investigate different pests and their preferred plants. In this study, insect pest development stages were observed on ornamental plants in a home garden at Kuching, Sarawak. The method used in this research is active sampling, which is handpicking. A total of six individuals comprising of three species (Lepidoptera; *Hippotion celerio*, *Clethrogyna turbata*, and sphingids) were caught and reared from three different species of host plants. In conclusion, this study provides a better understanding on different insect development stages and their preferred plants to aid future research and insects' management.

Keywords: insect developmental stages, pests, horticultural plants

ABSTRAK

Hubungan serangga-tumbuhan wujud di seluruh dunia, sama ada secara langsung atau tidak langsung. Serangga mempengaruhi tumbuhan secara berfaedah dan memudaratkan. Walau bagaimanapun, sesetengah serangga menjadi perosak hanya dalam peringkat tertentu dalam kitaran hidup mereka. Tujuan kajian ini adalah untuk menyiasat perosak yang berbeza dan tumbuhan pilihan mereka. Dalam kajian ini, peringkat perkembangan serangga perosak telah diperhatikan pada tanaman hiasan di taman rumah di Kuching, Sarawak. Kaedah yang digunakan dalam penyelidikan ini ialah persampelan aktif iaitu tangkapan tangan. Sebanyak enam individu terdiri daripada tiga spesies (Lepidoptera; Hippotion celerio, Clethrogyna turbata, dan famili Sphingidae) telah ditangkap dan dibesarkan daripada tiga spesies tumbuhan rumah yang berbeza. Kesimpulannya, kajian ini memberikan pemahaman yang lebih baik tentang peringkat pembangunan serangga yang berbeza dan tumbuhan pilihan mereka untuk membantu penyelidikan masa depan dan pengurusan serangga.

Kata kunci: peringkat perkembangan serangga, perosak, tanaman hortikultur

INTRODUCTION

Insects account for around two-thirds of all known animal species and can be found in a variety of environments. Insects have a variety of effects on humans. They feed on all kinds of plants. In their quest for sustenance, insects cause damage to plants, either directly or indirectly. Insects that do not cause more than 5% harm are not considered pests. Insects that cause harm of 5 to 10% are classified as minor pests, whereas those that cause damage of more than 10% are classified as severe pests (Beneficial Insects, 2016). In some cases, an insect will only become a pest in a certain stage of their life. For example, a caterpillar is considered as pest (juvenile stage) but not as a pest once it becomes a butterfly (adult stage).

Horticulture comes from the Latin words *hortus*, which means enclosure (garden), and *cultura*, which means cultivation. Horticulture, then, refers to the cultivation of a garden crop. Example of home horticultural plants are ornamental trees and lawns, as well as flowers, fruits and nuts, vegetables, and herbs. Horticultural plants are usually cultivated at home as a hobby or cultivated in plantation in the gardening industry.

With the rising amount of gardening hobby among people during this pandemic, horticultural plants that are cultivated at home increases. Due to this, pest on home horticultural plants also rises accordingly. This has intrigued an interest to study on this potential pest due to the lack of research on this topic. Common pests at home are caterpillars, aphids, and mealybugs (Serbajadi, 2022) whereas common houseplants are swiss cheese plant (*Monstera* sp.), elephant ears (*Xanthosoma* sp.), arrowhead plant (*Syngonium* sp.), prayer plants (*Calathea* sp.) and lacy tree (*Philodendron* sp.).

Insect development stages normally consist of four life stages, egg, larva, pupa, and adult for insects that carry out complete metamorphosis whereas for insects that undergo simple metamorphosis, consist of three stages, egg, nymph, and adult. The process through which insects evolve, grow, and change shape is known as metamorphosis. Metamorphosis is the process through which an insect develops from the egg stage to the juvenile stages (such as nymph, larva, or pupa) and finally to the adult form. "Instar" is another common phrase about insects. A juvenile larva or nymph expands by losing its exoskeleton, or outer skin, as it eats and develops. Each time it does so, it enters a new stage known as an instar. The first instar develops into the first

molt after emerging from the egg. In simple metamorphosis, the last instar grows into an adult, whereas in full metamorphosis, it develops into a pupa. Most insects have three to six instars.

This research proceeds as a rearing project. For a rearing project, it is essential to keep it at an early stage, preferably at the larvae stage. Insects and their food plants, as well as animals, may be reared in cages, which is a simple duplication of nature. During the 1950s, the science and practice of insect rearing acquired widespread recognition, and during the next two decades, it increased at an exponential rate. Insect rearing was necessary to develop and deploy new pest control methods, such as host plant resistance, chemical and microbial insecticides, sterile insect approaches, and biological control, which necessitated the expansion (Anderson & Leppla, 2013). As for this study, rearing the insect pests is essential to identify the species and to study the life cycle of the insects.

There are mainly three objectives for this research project, namely, to study the pest of home ornamental plants, to determine the pest species on specific ornamental plants and to investigate the life cycle of different pests on the ornamental plants in Kuching, Sarawak. This study focuses on the development stages of insect pests on home horticultural plants. Insects' development on different instars were observed, along with their damage levels according to target parts of the plants namely leaves, stems, and flowers throughout their life cycle.

LITERATURE REVIEW

Developmental stages

Metamorphosis

According to Chu (1949), metamorphosis is derived from the Greek terms *meta*, which means change, and *morphe*, which means shape. It is described as the process of transformations that an insect through over its life cycle, from egg to nymph to adult. In biology, metamorphosis is a dramatic change in an individual's form or structure following hatching or birth. The changes appear to be regulated by hormones known as moulting and juvenile hormones, which are not species specific. These morphological changes, as well as those affecting development and differentiation, are accompanied by physiology, biochemistry, and behaviour changes in the organism. The larvae, or young forms, are adapted to different surroundings and patterns of life than the adult forms. These distinctions might be important for ensuring that larvae and adults of the same species do not compete for food or living space.

Complete metamorphosis

The young are quite different compared to their adults in this form of metamorphosis. There are no visible signs of wings on the outside. Immatures are named larvae and pupae for insects that go through a complete metamorphosis. Adult is preceded by a pupal stage (Chu, 1949). Butterflies, moths, beetles, flies, ants, bees, wasps, and other insects undergo complete metamorphosis. During the immobile pupal stage, wings and other adult traits develop. Adults and immatures may or may not share the same environment. Adults are specialized for reproduction and dispersion, whereas immatures are designed for eating.

Insects

According to Anderson and Leppla (2013), if beekeeping and silk manufacturing are included, insect rearing has been a part of human history for almost 5000 years. Honeybees were widely cultivated in ancient Egypt for food and embalming materials. From 3000 B.C. until 1900 A.D., insect rearing was mainly a static craft. In their research Anderson and Leppla (2013) further stated, because of genetic investigations, papers on raising Drosophila sp. began to appear in the early 1900s. In the 1940s, nutritional and genetic studies on European corn borers and pink bollworms were conducted.

Pest

Pests are a plant or animal detrimental to humans or human concerns such as agriculture or livestock production (Merriam-Webster Dictionary, 2021). Insects that cause less than 5 % damage are not considered as pests. The insects which cause damage between 5 - 10% are called minor pests and those that cause damage above 10% are considered as major pests. Plant pests disrupt plant growth and inflict damage to both cultivated and wild plants. Plants are unable to reach their genetic potential because of the interference and harm. As a result, pre and postharvest pests and illnesses are projected to damage 30–40 percent of global agricultural production. Insect pest damage is one of the principal causes contributing to lower crop productivity. Considering the research done in Brazil, insect pests cause a 7.7% annual loss in production in Brazil, resulting in a loss of nearly 25 million tonnes of food, fibre, and biofuels. The overall annual economic losses are estimated to be around $17.7 billion. (Oliveira et al, 2014).

Horticulture

According to Swamy & Auxcilia (n.d), Horticulture comes from the Latin words "*hortus*" which means "garden" and "*cultura*" which means "cultivation". Protective enclosures with high walls or similar constructions surrounded the dwellings in ancient times where fruit, vegetables, flowers, and ornamental plants were grown in the enclosed spaces. Swamy & Auxcilia (n.d) further stated, "horticulture" in its original sense "refers to the growing of garden plants within enclosed enclosures." In present day, horticulture is the science and art of developing, producing, marketing, and using high-value, intensively farmed food, and ornamental plants in a sustainable manner ("What is Horticulture? A Modern Applied Plant Science!" 2021). Examples of horticultural plants are plants that are both annual and perennial, fruits, and vegetables, ornamental indoor plants, and landscape plants. The horticulture industry can be divided into 3 different areas, namely pomology (fruit and nut crops), olericulture (vegetable food crops) and ornamental horticulture (decorative plants). Among these horticultural plants, ornamental horticultural plants are the most common houseplants. Floriculture and landscape horticulture are two branches of ornamental horticulture that deal with the production and utilization of woody and herbaceous plants (Encyclopedia Britannica, 2017). According to Paiva (2018), floriculture is an industry that includes producers, wholesale markets, floral arrangement operations, and retail florists, as well as floral items in the florist's trade. A grower might be anything from a tiny family-run farm to a massive, technologically advanced operation. Although flower and pot plant production can take place outside, it is primarily done in greenhouses, hence it is closely linked to horticulture (Paiva, 2018). Paiva (2018) further stated that landscape horticulture is also covered by ornamental horticulture, which is separated into three categories: growth, design, and care. Environmental horticulture, often known as urban horticulture, is a relatively new term for landscaping, gardening, and arboriculture.

MATERIALS AND METHODS

Study site

The study site is located at 143, Lorong Resak 4E, Taman Sung Hong, 93300, Kuching, Sarawak (Figure 1). The satellite view can be seen on the figure below (Figure 4). The site has a large compound filled with horticultural plants such as bougainvillea, frangipani, and taro plants. Pests such as caterpillars and aphids are normally observed in the vicinity of the site infesting on the plants cultivated around the area.

Figure 1: Top view of the garden of the study site

Figure 2: Garden view of the study site

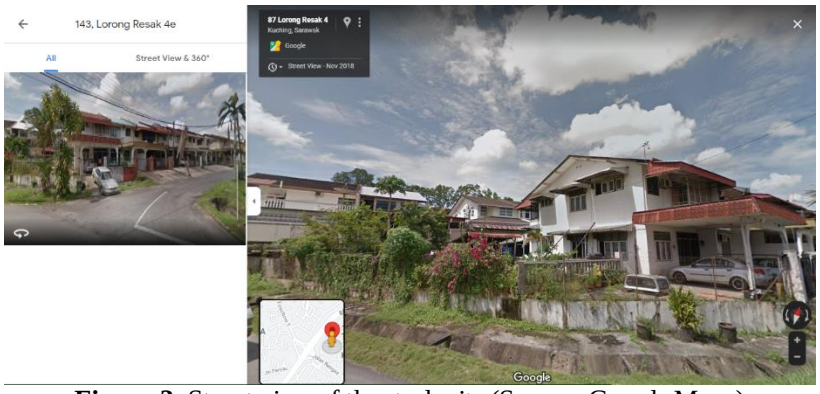


Figure 3: Street view of the study site (Source: Google Maps)

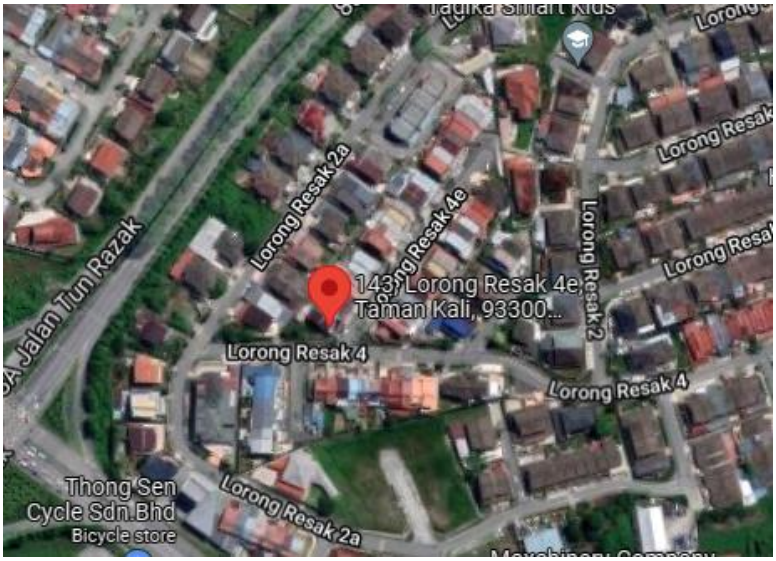


Figure 4: Map showing the location of study (Source: Google Map)

Sampling Method

The site was observed in the span of a month for the presence of pest infesting on the crops. When there are pests found (preferably in the juvenile stage/larvae), they were handpicked and placed in a proper temporary enclosure. The insects were provided with its essential needs until it reached the adult stage. The feeding of the insects on the plants were observed. Then, the insects were euthanized by using a killing jar for identification. Since this is a rearing project, one individual per species was kept (preferably in their larvae stage) to be rear to adult stage. Replicates of the insects were prepared for accuracy and in case some species of insects do not reach their adult stage. The sampling methods used are active methods which is handpicking. Specimens obtained in the field were sorted such as lepidopterans, being conserved as dry specimens, which were then pinned and oven-dried at 40-45°C in the lab (Sulaiman *et al.*, 2013).

Identification

The insects that were kept in the enclosure were identifed at the adult stage after pinning. The preservation, preparation and identification of the insect samples were done at FSTS Entomology laboratory at Universiti Malaysia Sarawak (UNIMAS) in Kota Samarahan, Sarawak. The identification process will be done by referring to the identification guidebook, which is "The Moths of Borneo" (Holloway, 1986).

RESULTS

There are a total of six samples caught and reared from three different host plant. Out of the six samples, three different species were assumed based on their morphology, with one species successfully reared into adulthood and identified. Sample 2 is a replicate of sample 1, whereas sample 4 and sample 5 are replicates of sample 3. Sample 6 has no replicate.

Host plant 1:

Caladium Thai Beauty

Figure 5: Host plant for sample 1 and 2

Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Alismatales
Family	Araceae
Genus	*Caladium*
Species	*C. bicolor*

Table 1: Taxonomy classification of host plant

Sample 1

Rearing Stage

(a) (b)

Figure 6: (a) Sample 1 after handpicked (Date: 20th April 2021), (b) Sample 1 during pupa stage (Date: 22nd April 2021)

Sample 2

Rearing Stage

a) b)

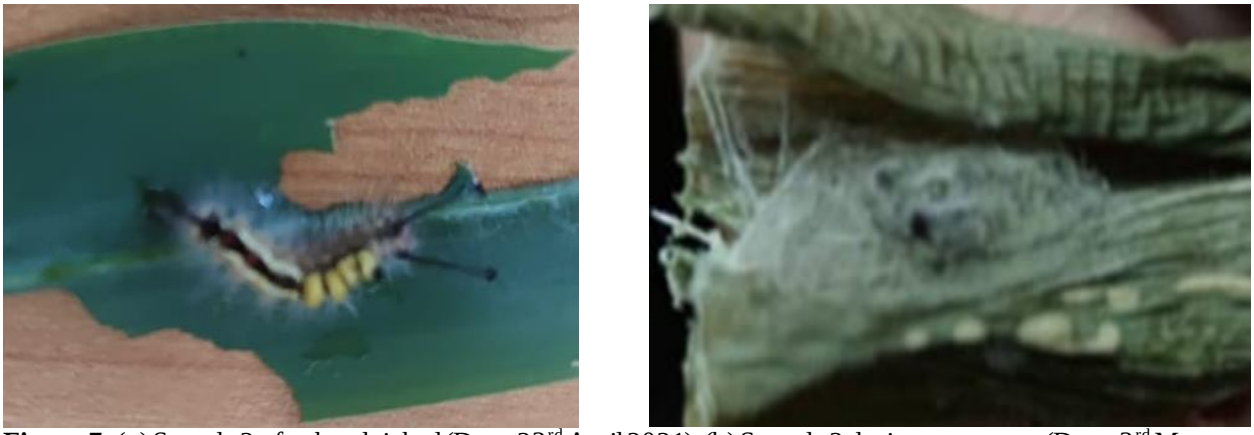


Figure 7: (a) Sample 2 after handpicked (Date: 23rd April 2021), (b) Sample 2 during pupa stage (Date: 3rd May 2021)

Identification based on sample 1 and sample 2 characteristics:

Kingdom	Animalia
Division	Arthropoda
Class	Insecta
Order	Lepidoptera
Family	Erebidae
Genus	*Clethrogyna*
Species	*C. turbata*

Table 2: Taxonomy classification of sample 2 (*C. turbata*)

Host plant 2:

Taro/Yam plant (*Colocasia esculenta*)

Figure 8: Host plant for sample 3,4 and 5

Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Alismatales
Family	Araceae
Genus	*Colocasia*
Species	*C. esculenta*

Table 3: Taxonomy classification of host plant(*C.esculenta)*

Sample 3

Rearing stage

(a)

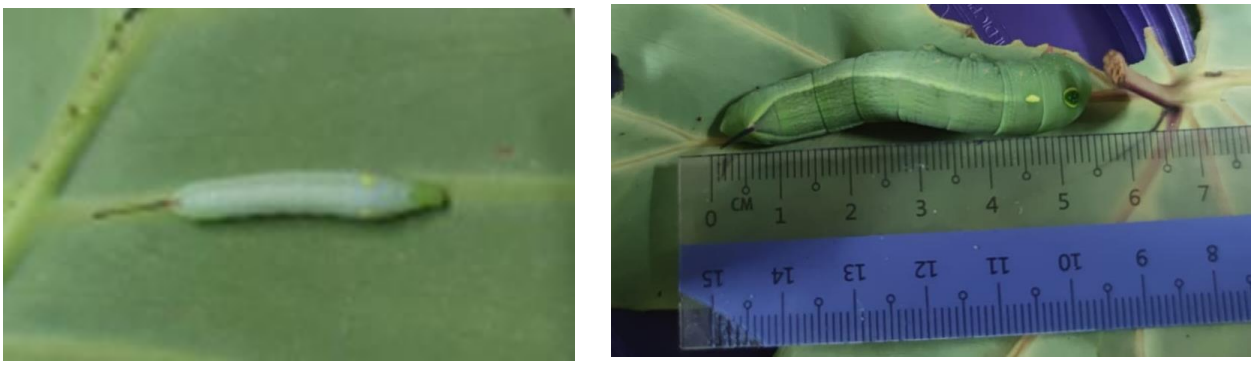
(b)

(c)

Figure 9: (a) Sample 3 after handpicked (Date: 24th May 2021), (b) Sample 3 post-feeding time (Date: 28th May 2021), (c) Sample 3 during pupa stage (Date: 5th June 2021)

Sample 4

Rearing Stage



(a) (b)

Figure 10: (a) Sample 5 after handpicked (Date: 3rd March 2022), (b) Sample 5 post-feeding, measured with a ruler (Date: 7th March 2022)

(a) (b)

Figure 11: (a) Sample 5 during pupa stage (Date: 8th March 2022), (b) Sample 5 after metamorphosis to adult form (Date: 12th March 2022)