Faculty of Resource Science and Technology

THE BIOLOGY OF THE INVASIVE SPECIES ASPIDOMORPHA DUESTA (CHRYSOMELIDAE : CASSIDINAE) IN SARAWAK

Siti Norfatiha Binti Hasnul

Bachelor of Science with Honours
(Animal Resource Science and Management)
2006

Borang PTA4

Borang Pengesahan
Laporan Projek Tahun Akhir (STF3014)

Fakulti Sains dan Teknologi Sumber
Universiti Malaysia Sarawak

Saya SITI NORFATIHA BINTI HASNUL (nama) no. pelajar 11030 mengaku telah membuat perubahan yang perlu* / ~~tidak ada perubahan~~ terhadap Laporan Projek Tahun Akhir yang bertajuk:

THE BIOLOGY OF AN INVASIVE SPECIES ASPIDOMORPHA DUESTA (CHRYSOMELIDAE : CASSIDINAE) IN SARAWAK

Bersama ini saya kemukakan 3 salinan Laporan Projek Tahun Akhir dan 1 salinan 'softcopy' Laporan berkenaan.

Tandatangan Pelajar	Tandatangan Penyelia
(SITI NORFATIHA BTE. HASNUL)	(Nama & Cop rasmi)
	Assoc Prof Dr Fatimah Bt Abang Lecturer Faculty of Resource Science and Technology UNIVERSITI MALAYSIA SARAWAK

Pengesahan
Tandatangan Ketua Program

(Nama & Cop rasmi)
Assoc Prof Dr Mohd Tajuddin Abdullah
Head Animal Resource Science and Management
Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK

* - potong yang tidak berkaitan

THE BIOLOGY OF THE INVASIVE SPECIES *ASPIDOMORPHA DUESTA* (CHRYSOMELIDAE: CASSIDINAE) IN SARAWAK.

SITI NORFATIHA BINTI HASNUL

THIS PROJECT IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE WITH HONOURS (ANIMAL RESOURCE SCIENCE AND MANAGEMENT).

Faculty of Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2005/2006

Statement of Originality

The work described in this Final Year Project, entitled

The biology of the invasive species

***Aspidomorpha duesta* (Chtysomelidae: Cassidinae)**

in Sarawak.

is to the best of the author's knowledge that of the author except where reference is made.

11 MEI 2006
(Date submitted)

(Student's signature)

Siti Norfatiha Binti Hasnul
11030

Contents

6.0 Results and Discussions

List of Figure

List of table

List of Appendices

ACKNOWLEDGEMENT

Thank you to Allah for His blessing, I can finish my research. I express my gratitude to my family especially to my parents, Hasnul bin Jamil and Faridah Binti Tawil, who give both moral and financial support during my research. Deepest thanks to my supervisor Associate Professor Dr. Fatimah Abang for her advices and guidance in doing this research.

I would like dedicate special thanks to my friends, Audry Mengan, Pang Sing Tyan, Muhammad Ikhwan Idris and Nadirah Nazri for their patient in accompany me in collecting samples and data for this research.

Not forgotten to my coursemate, students and lecturers of Faculty of Resource Science and Management and all direct and indirect individuals who had contribute and give support for this research. Thank you very much.

The biology of an invasive species *Aspidomorpha duesta* (Chrysomelidae: Cassidinae) in Sarawak.

Siti Norfatiha Binti Hasnul

Animal Resource Science and Management
Faculty of Resource Science and Technology
University Malaysia Sarawak

ABSTRACT

The life cycle of the tortoise beetle, *Aspidomorpha duesta* (Fabricius) was studied and its feeding preferences among *Ipomoea pes-caprae*, *I. batatas* and *I. aquatica* were identified. This study was carried out at University Malaysia Sarawak (UNIMAS) from 19th September 2005 until 10th March 2006. The life stages include the egg, five larval instars, pupa and adult. This tortoise beetle takes an average of 84 days to complete its life cycle. Its life cycle was compared with the life cycle of *A. miliaris* and *Silana farinosa* (Boheman) based on previous studies. *A. duesta* shows the most feeding preference towards *I. pes-caprae*, the host plant for the beetle (Tukey's Studentized Range Test, q-value>0.05) while there were equal preferences between *I. batatas* and *I. aquatica* (Tukey's Studentized Range Test, q-value<0.05).

Key words: Life cycle, *Aspidomorpha duesta*, and feeding preferences

ABSTRAK

Kitar hidup kumbang kura-kura, A. duesta (Fabricius) telah dikaji dan pemilihan makanan antara I. pes-caprae, I. batatas dan I. aquatica telah dikenal pasti. Kajian telah dilakukan di Universiti Malaysia Sarawak (UNIMAS) dari 19 September 2005 hingga 10 Mac 2006. Peringkat kitar hidup merangkumi telur, lima peringkat larva, pupa dan dewasa. Kumbang kura-kura ini mengambil masa purata selama 84 hari untuk melengkapkan satu kitaran hidup. Kitaran hidup A. duesta dibandingkan dengan kitaran hidup A. miliaris dan Silana farinosa berdasarkan hasil kajian terdahulu. A. duesta menunjukkan pemilihan makanan terhadap I. pes-caprae, iaitu tumbuhan perumahnya. (Tukey's Studentized Range Test, q-value>0.05) sementara pemilihan makanan adalah sama bagi I. batatas dan I. aquatica (Tukey's Studentized Range Test, q-value<0.05).

Kata kunci: Kitar hidup, Aspidomorpha duesta dan pemilihan makanan

1.0 Introduction

Aspidomorpha duesta (Fabricius) or commonly known as the tortoise beetle is classified in the family Chrysomelidae, subfamily Cassidinae. This species is distributed in Australia and New Guinea (Noramly, 2000). The occurrence of this species in Malaysia was first reported by Noramly (2000). *A. duesta* is a recent introduction to Malaysia and thus could be considered as an invasive species.

Invasive species are species of animals and plants that have been transported with human aid, beyond the limits of their native geographic ranges and which continue to expand their distribution by displacing species indigenous to the invaded area (Calow *et al.*, 1998). This is also known as introduced species which may have been transported intentionally or inadvertently (Calow *et al.*, 1998). There are numerous effects of invasive species (Nieremberg, 1995) and this biological invasion is not a new phenomenon but in recent decades the issues have been accelerated by orders of magnitude (Calow *et al.*, 1998).

Invasive species can give effects on one another or on native species. The effects can be directly or indirectly. The direct effects such as habitat modification, competition, predation, parasitism and disease, and hybridization and introgression may occur (Levin, 2001) while the indirect effects are impacts on chain reactions (Nieremberg, 1995) and economic effects (Levin, 2001).

This study was conducted to observe and understand the biology of *A.duesta* including the life cycle and to determine the feeding preferences among three species of *Ipomoea*, including its host plant *I. pes-caprae*.

2.0 Literature Review

Chrysomelidae is a very large phytophagous family of the order Coleoptera and widely distributed worldwide, having approximately 50 000 species in over 2 000 genera (Aslan and Ozbek, 2000). Although Chrysomelidae is most nearly related to the Curculionoidea and less closely to the Cucujoidea (Lawrence and Britton, 1970), this family is different in several general appearances. The antennae are only of moderate length, and the eyes do not embrace of their points of insertion while the upper surface of the body is generally bare and shinning, frequently with metallic coloration (Richards and Davies, 1977).

The tortoise beetles, which are included in the subfamily Cassidinae have strongly esplanade margins and an almost circular outline (Lawrence and Britton, 1970). These characteristics give the beetles a flattened shield-like appearance (Richards and Davies, 1977). Many species are recognized by their brilliant coloration which fades very quickly after death (Richards and Davies, 1977).

Most of the species of Cassidinae are included in the genus *Aspidomorpha* (Lawrence and Britton, 1970), which is a common Australian genus (Naumann, 1991). They are mainly tropical (Lawrence and Britton, 1970). The larvae are leaf-feeders and carry their cast skins or feces over their backs with the aid of a long forked caudal process (Lawrence and Britton, 1970). The adults are poor flyers and have a tendency to adhere to plants on which they are feeding (Rice, 2003). Species within the genus *Aspidomorpha* have a strong preference for *Ipomoea* (Naumann, 1991). The host plant of *A. duesta*, is *I. pes-caprae* (L.)R.Br. which is a common beach creeper (Noramly, 2000).

According to Noramly (2000), *A. duesta* have never been record in Malaysia until it was found at Kapar, Selangor in 2000. It is distributed in Australia and New Guinea (Australopapuan Region) and is now common in Java (Noramly, 2000). The species has also never been recorded either from Sumatra or Borneo prior to the year 2000 (Noramly, 2000).

It was believed that *A. duesta* could have come from Australia via importation along with trade goods (Noramly, 2000). The available of its host plant, *I. pes-caprae*, on the beaches throughout Malaysia (Noramly, 2000) enhances a proliferation of this immigrant species to establish itself (Noramly, 2000).

Ipomoea pes-caprae commonly referred to as railroad vine (Devall, 1992) belongs to the genus *Ipomoea* (Convolvulaceae). This genus consists of more than 200 species that are widely distributed in tropical and subtropical countries (De Souza *et al.*, 2000). It grows just above the high tide line along coastal beaches and assists in stabilizing sands. The seeds are dispersed by ocean currents (Stone, 1974). The flower of this plant is a shade of pink and mostly of a slightly magenta hue (Stone, 1974).

Ipomoea batatas, commonly known as sweet potato originated from Central America. It is widely cultivated and consumed almost throughout the world (Zhoa *et al.*, 2005). *I. aquatica* Forsk is known as 'kangkung' and commonly consumed in Sri Lanka as a green leafy vegetable (Malalavidhane *et al.*, 2000). This plant grows abundantly in marshy area and also a delicacy in Chinese cuisine (Malalavidhane *et al.*, 2000).

The tortoise beetles species are often confused with the ladybird beetles (Coccinelidae). The adult are broadly oval or circular, with the wide elytra and the head largely or entirely covered by the pronotum (Borror *et al.*, 1991). They are normally small (5-6mm in length) and are brilliantly colored, often with golden color or markings (Borror *et al.*, 1991).

Growth in insect is discontinuous for the sclerotized cuticular parts of the body. This is because the rigid cuticle limits expansion. The size increases by moulting, where a periodical formation of new cuticle of greater surface area and shedding of the old cuticle occur (Gullan and Cranston, 1994). Generally, increase in size is measured as the increase in a single dimension. In a life cycle study, only the length or width of some sclerotized body parts will be measured, rather than a weight increment that may be misleading due to variability in food and water intake (Gullan and Cranston, 1994). An instar duration or known by stadium was defined as the time between two successive moults or between two successive ecdyses. The succession of moulting may be affected by food supply, temperature, larval density and physical damage such as loss of appendage and may differ between the sexes of a species (Gullan and Cranston, 1994).

Insect development pattern can be categorized into ametaboly and metamorphosis. Ametaboly is a primitive development pattern in which the insect hatches from the egg in the form essentially resembling a miniature adult but lacking genitalia. Metamorphosis can be subdivided into hemimetaboly and holometaboly. In the youngest immature instars of hemimetabolous insects, the developing wings are visible in external sheaths on the dorsal surface of the nymph or larvae. In contrast, the holometabolous insects share the unique evolutionary innovation of a resting stage or pupal instar. During this stage, the major structural differences between the larval and adult phases are bridged (Gullan and Cranston, 1994).

In certain species of Cassidinae, the eggs are enclosed in an ootheca often of complex structure while in others, the ootheca is very small and imperfect with a layer of excrement laid over it (Richards and Davies, 1977). The larvae of tortoise beetles are elongate-oval and flattened. They are known in having a specialized defense mechanism. The larvae will carry a mass of exuviae of earlier instars, mixed with faeces over their backs (Britton, 1974). The posterior end of the body is a forked process that is usually bent upward and forward over the body (Borror *et al.*, 1991). The larva will swing the faecal mass when disturbed by an insect predator to face the intruder (Borror *et al.*, 1991).

The larvae and adults feed principally on morning glories and related plants (Borror *et al.*, 1991). Phytophagous insect are very restricted when selecting their food and the Chrysomelidae are the most selective among the phytophagous beetles (Lawrence and Britton 1970). In all of the phytophagous insect orders, the ranges of plants eaten by individual species are much more limited and 70% or more of the species are oligophagous or monophagous (Bernays and Chapman, 1994). Oligophagous refers to the insect that feeds on a number of plants, usually in different genera within one plant family while monophagous feeds only one species of plants within a single genus (Bernays and Chapman, 1994).

The interaction between phytophagus insects and their food plants over evolutionary time had been described as co-evolution (Gullan and Cranston, 1994). Many ecologists believe that the current diversity of both plants and insects is a result of their co-evolution (Bernays and Chapman, 1994). In order to exploit the plants, the phytophagous insects had evolved infinite numbers of paths to overcome and deal with the plant protective devices including chemicals compounds (Bernays and Chapman, 1994).

Various factors that may contribute to the selection of host plant among phytophagous insects are the behavior and morphology of the insects, plants compounds and their defense mechanisms (Ananthakrishnan, 1992). A change in the insect's behavior was the first factor that would occur when the process of adaptation to a new plant begins before any physiological or morphological changes can occur (Bernays and Chapman, 1994).

Invasive species give numerous impacts to balance ecosystems. The most widespread impacts of invaders are usually due to modification of habitat (Levin, 2001). Almost all introduced species are believed to have had major impact on native communities by modifying the habitat (Nieremberg, 1995). According to Levin (2001), the introduced goats in St. Helena had built up enormous herds since their introduction in 1513. These are believed to have extinguished at least half of some 100 endemic plant species before botanists had even visited the island.

Competition by an introduced species against a native is often difficult to demonstrate but observational evidence is quite convincing (Levin, 2001). There is strong reason that the introduced species often use some resources so effectively and they deprive native species of it (Levin, 2001). This is because, native or endemic species often occupy narrow ranges, have small population sizes and lack defenses (Jermy *et al.*, 1995). There could be a competition for resources and interference competition (Levin, 2001). An introduced species can also depress a native one not by eliminating some resources but by direct interference (Levin, 2001). Sometimes the limiting resources do not even have to be used in the same way for an introduced species to harm a native one (Nieremberg, 1995).

An introduced species can also be a predator to a native species or be an herbivore of native plants. According to Nieremberg (1995), the most famous case is that of the lighthouse keeper's cat on Stephen Island in New Zealand. The cat arrived in 1894 and eliminated the entire population of Stephen Island wren (*Xenicus lyalli*) within a year.

Apart from being a predator, an introduced species can directly affect other species as a pathogen or parasite. The impact of a pathogen can range from minor to enormous, depending on the particular way in which it weakens infected individuals and the fraction of the population that is infected (Nieremberg, 1995). It also can be vectors or reservoirs of disease to which they are resistant but to which native species are susceptible (Nieremberg, 1995).

Introduced species can hybridize with native ones, potentially modifying the native species or even become a new species (Nieremberg, 1995). This hybridization also can produce a new pest (Nieremberg, 1995).

Introduced species can give indirect effect of invasion when one species alters interaction between two others (Levin, 2001). Modification of habitat will lead to a more homogenous global biota (Jermy *et al.*, 1995). Animals can disperse and function as pollinators of many species of plants. Some introduced animals disperse introduced plants that disrupt native plant communities (Levin, 2001).

3.0 Objectives

Very little research has been done in Malaysia on invasive species. Since the effects of invasive species are numerous and could affect the balance of the natural ecosystem invaded, this study was conducted in order to understand the biology of a new invasive species in Sarawak, *A. duesta*. The basic information that has to be understood is their life cycle. It has been reported that species of *Aspidomorpha* have strong preferences for *Ipomoea* (Naumann, 1991). The objectives of this study were two fold. Firstly, it aimed at studying the life cycle and secondly it also aimed at studying the feeding preference of *A. duesta*.

4.0 Materials and Methods

4.1 Sampling site.

Samples of *Aspidomorpha duesta* were collected from Kampung Pasir Pandak and Pantai Puteri, located along Santubong Peninsula (Figure1). Santubong Peninsula is an island separated from the mainland of Kuching by the Santubong and Sarawak River (Tuen *et al.*, 2000). It is dominated by an 810m Mount Santubong. The main activities of the villagers around Santubong are fishing. Some of the villagers were engaged in agriculture, hunting and gathering the forest resources on a part time basis (Tuen *et al.*, 2000).

Figure 1: Map of Borneo Island. The arrow shows the study site located in Santubong.

4.2 Methods

4.2.1 Life cycles

Thirty individuals of adult beetles were collected from Kampung Pasir Pandak and Pantai Puteri on 19^{th} September 2005. They were confined in aquarium for oviposition. These aquariums were kept in the netted house. Further observations in this study were conducted fully in this house.

The beetles were provided with fresh leaves of the host plant, *I. pes-caprae* at every alternate day. This host plant was also planted in the wire mesh house. The beetles were observed every 12 hour and all the newly laid eggs were collected because there were probabilities that not all the eggs would hatched due to various factors. The total length of the eggs was measured by using callipers and recorded. The eggs were then incubated individually in plastic containers until they hatched. The time interval (stadium) taken for the eggs to hatch was recorded. Photographs were taken to aid in the observation of the developmental changes from the egg stage to the newly emerged adult stage.

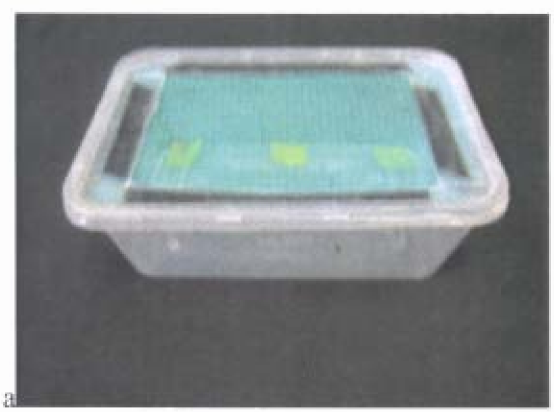
Upon hatching, each larva was transferred separately into a plastic container (17cm x 12cm x 6cm) and the plastic containers were labelled. The larvae were also provided with fresh leaves of *I. pes-caprae* at every alternate day. The body length and head capsule of the larvae were measured for every instar by using calipers and the data were recorded. Moulting was confirmed by examining the exuviae and head capsules in the excreta accumulated at the tip of the abdomen (Sajap and Mohamedsaid, 1997). Photos were taken after the measurement to examine the morphological changes.

During the pupal stage, fresh leaves of *I. pes-caprae* were not provided. The pupae were observed every 6 hours and the emergence of the pupae to adults were observed. Photographs were taken. Measurements of the newly emerged adults were recorded. The newly emerged adults were reared until they died. Specimens of the adults were preserved and deposited as voucher specimens in the Insect Collection of the Faculty of Resource Science and Technology, University Malaysia Sarawak.

4.2.2 Feeding preferences

Thirty individuals of adult *A. duesta* were starved for two days before they were tested for their feeding preferences. Three types of *Ipomoea* species were tested in this study, namely *I. aquatica* Forssk, *I. batatas* (L) and *I. pes-caprae* (L) R.Br.

In this experiment, the leaves of the plants were cut into 2 x 2 cm square. Thirty plastic containers (17cm x 12cm x 6cm) were used. Each plastic container contained a leaf (2 x 2 cm square) of each of the three *Ipomoea* species. One adult individual of *A. duesta* was placed in the plastic container (Figure 2). The adult was then exposed to the leaves in the container for twelve hours where feeding would take place.

a 

b 

Figure 2: Plastic containers used in the feeding preferences analysis.

a. The feeding preferences were conducted in plastic container (17cm x 12cm x 6cm).
b. A cut leaf of three *Ipomoea* species (2 x 2cm) were placed in the plastic container and one individual of an adult *A. duesta* was exposed to the leaves for 12 hours.