



Faculty of Resource Science and Technology

**A GENERAL SURVEY ON THE PRESENCE OF DECAPITATING FLY (GENUS:
PSEUDACTEON) ATTACKING FIRE ANT (GENUS: *SOLENOPSIS*) IN
SAMARAHAN DIVISION, SARAWAK.**

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Bachelor of Science with Honours
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APPROVAL SHEET

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DECLARATION

I hereby declare that this Final Year Project report 2012 is based on my original work except for the quotations and citations which have been dully acknowledge also, declare that it has not been or concurrently submitted for any other degree at UNIMAS or other institutions of higher learning.

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LIST OF ABBREVIATIONS

Tmn. : Taman (residential housing area)

Kpg. : Kampung (village)

U.S. : United States

Sg. : Sungai (river)

P. wasmanni : *Pseudacteon wasmanni*

S. Invicta : *Solenopsis invicta*

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A GENERAL SURVEY ON THE PRESENCE OF DECAPITATING FLY (GENUS: PSEUDACTEON) ATTACKING FIRE ANT (GENUS: SOLENOPSIS) COMMUNITIES IN SAMARAHAN DIVISION, SARAWAK

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ABSTRACT

Decapitating fly is a scuttle fly which is also known as phorid fly and *Pseudacteon* fly. The fly is a member of the family Phoridae in section Aschiza and genus *Pseudacteon*. The *Pseudacteon* species is a parasitoid of fire ant which lay or injects its eggs into the ant's thorax. Larvae of the *Pseudacteon* fly lives and complete their metamorphosis inside the head of the ant, consuming the head contents and eventually kill the ant by decapitating the head with their enzyme. The *Pseudacteon* fly was studied by collecting the fire ants in Samarahan division. Fire ants belong to the order Hymenoptera. The genus of the fire ants studied is *Solenopsis*. *Solenopsis* was detected at Kpg. Sebayor, Kpg. Meranek and Tmn. Samarindah of Samarahan division. The *Pseudacteon* was not detected and may be concluded that it is also not in Samarahan division.

Keywords: Decapitating, parasitoid, *Pseudacteon*, *Solenopsis*

ABSTRAK

Lalat 'Decapitating' adalah lalat 'scuttle' dan juga dikenali sebagai lalat 'Phorid' dan lalat '*Pseudacteon*'. Lalat ini tergolong dalam famili Phoridae, 'section' Aschiza dan *Pseudacteon* genus. Species *Pseudacteon* ialah parasitoid kepada semut merah di mana lalat ini akan bertelur atau suntik telurnya ke dalam toraks semut itu. Larva *Pseudacteon* menghuni dan melengkapkan metamorfosis dalam kepala semut tersebut, mengambil kandungan kepala dan akhirnya membunuh semut tersebut dengan memenggal kepala menggunakan enzim. Kewujudan lalat *Pseudacteon* dikaji dengan mengumpul semut merah di sekitar bahagian bahagian Samarahan. Semut merah tergolong dalam order Hymenoptera. Semut merah yang dikaji adalah daripada genus *Solenopsis*. *Solenopsis* telah dikesan di Kpg Sebayor, Kpg. Meranek dan Tmn. Samarindah dari bahagian Samarahan. *Pseudacteon* tidak dapat dikesan dan boleh menyimpulkan bahawa ia mungkin tidak hadir dalam bahagian Samarahan.

Kata kunci: Decapitating (memenggal), parasitoid, *Pseudacteon*, *Solenopsis*

1.0 Introduction

Ants are categorized under Hymenoptera and they are the one of the social families (Hickman *et al.*, 2006) in this order. Based on Marshall (2006), almost 9,500 of the world's ant species comprise of most important predators, scavengers and soil turners globally as well as the most familiar household and backyard insect at home. Thereto, ant colonies have labour division where some individuals specialized for reproduction and others leaned with colony cares (Marshall, 2006).

There are 21 subfamilies in family Formicidae (Bolton, 2012). Some are Formicinae, Ponerinae, Ecitoninae, Pseudomyrmecinae and subfamily Myrmicinae. Subfamily Myrmicinae is infamous for its defensive ovipositor. The Myrmicinae ants have a wasp-waist which is a pedicel with two-segmented and appears to have two lobes (Marshall, 2006). Most Myrmicinae are less specialized. He added that the ants generally foraging on dead or alive insects or scavenging a variety of materials including the contents of kitchen. One of the genera that categorised in this Myrmicinae family is *Solenopsis*. The *Solenopsis* focused in this study.

The *Solenopsis* ants are commonly called as fire ant. The ants are aggressive stinging insects and are important predators, scavengers and soil turners globally (Marshall, 2006) that can be found worldwide which live in many major terrestrial habitats. Basically, the fire ant that categorized under *Solenopsis* has mesosoma attached to the gaster by 2 segments, the petiole and postpetiole, eyes generally small, antennae with 10 segments (including the scape) and distinct 2-segmented club, lacking groove and no spine on propodeum (Hashimoto & Rahman, 2003).

Table 1: The taxonomy of fire ant.

Taxonomy of Fire ant	
Kingdom	: Animalia
Phylum	: Arthropoda
Class	: Insecta
Order	: Hymenoptera
Family	: Formicidae
Subfamily	: Myrmicinae
Tribe	: Solenopsidini
Genus	: <i>Solenopsis</i>

Source from: Iowa State University, 2003-2011

Invasion factor cause discover of fire ants in 19th century. Tropical fire ant, *Solenopsis geminata* was the first discovered fire ant. This species is a well-known pest in many parts of the world for its potent sting. According to Wheeler (1910), the tropical fire ants attack and eat almost everything that comes their way while Smith (1965) said that the species is considered to be one of the most important predators of all the ants as cited in Wetterer (2010). The species is native to South and Central America and be exotic to the South-eastern U.S. and West Indies. The ant is spreading through many parts of Old World such as tropical Asia and Oceania.

However, the species' invades take over by another fire ant species ant that is *Solenopsis invicta*, or commonly called as imported fire ant. In the mid-20th century the species start to spread around the world. Few parts of US states where they were conquered by tropical fire ant were displaced by the *S. invicta*. These ants are able to dominate any habitats even areas that cleared or disturbed by humans. Its nesting tolerance, high reproductive rates and survivorship might lead them to make passage in ships and migrated to other countries.

Human faced serious medical problem from allergic and economic drops from damages of crops and also dead of livestock caused by the ants. They aggressively attack livestock as well as the pets and wildlife, particularly when the animals step into or lie down on the ant

mound. The fire ants even cause life threatening allergic (Mcintyre, 2009) reactions in human (Gaskill, 2011). Therefore, scientists took initiative to survey and study on the ants' live pattern, biology, distribution and spreads. While do researches, scientists found that the imported fire ants originated from Caceras region of South-western Brazil (Taber, 2000).

Research had been done in Caceras as well to further deep the research on the fire ants and accidentally, the scientists discovered a fly family which parasitize the fire ants. They named the fly as decapitating fly as it causes the head of the ant detached from the body or thorax in the process of parasitizing. The fly is parasitoid insect. It is the major enemy of the ants specially the one categorized in *Solenopsis* genus, fire ants.

Decapitating fly is known also as scuttle fly and phorid fly. This fly belongs to family Phoridae, classified under section Aschiza. The genus of the fly is *Pseudacteon*. It is odd little fly about 0.5-6.0 mm in length.

Table 2: The taxonomy of Decapitating fly based on Integrated Taxonomic Information.

Taxonomy of Decapitating Fly	
Kingdom	: Animalia
Phylum	: Arthropoda
Subphylum	: Hexapoda
Class	: Insecta
Order	: Diptera
Section	: Aschiza
Family	: Phoridae
Subfamily	: Metopininae
Genus	: <i>Pseudacteon</i>

Source: Integrated Taxonomic Information System on-line database, <http://www.itis.gov>

The researchers found the fly are widely distributed in the natural range of their hosts in western Brazil. Nevertheless, no native phorid fly attacks the fire ants in North America, United States (Marshall, 2006). Therefore, the scientists cultured the flies and released them in Florida for the first time in 1997 as biological control of fire ants.

The fire ants are spreading around the world (Wetterer, 2010) in all countries even in few states of Malaysia (Azan, 2006). There were three species of *Solenopsis* recorded under a research of household ants done in Pulau Pinang in 2002 (Lee, 2002). The presence of decapitating flies is discovered only in western country for this moment. Therefore, the study conducted in Sarawak to survey whether the fly is presence in Malaysia and is it the fly parasitizes the fire ants here. Even though, the flies attack other genera of ants, the study had done on *Solenopsis* ants only because they are the most serious pest and invaders in world (Azan, 2006). Therefore, the study was conducted in Samarahan division to find whether the decapitating fly present in old world. The survey believed will useful in future as biological control in Malaysia, if the number of fire ant pest is predicted to rise.

1.1 Objective

The objectives of this study are:

- a. To investigate the presence of the *Solenopsis* ant and *Pseudacteon* fly at Samarahan division.
- b. To identify the species of the *Solenopsis* ant and *Pseudacteon* fly in Samarahan division if present.

2.0 Literature Review

2.1 Fire Ant

Fire ants are small myrmicine ants distinctive for their 10-segmented antenna with a two-segmented club and also have two nodes on the petiole (Marshall, 2006). They are stinging insects where usually people are thought they bite. They actually use mandible to hold the prey before sting venom into prey.

According to Marshall (2006), the fire ant well known for its mucky habits for example the Minute thief ant (*S. molesta*) and the famous Red Imported fire ant (*S. invicta*) are the fire ants with such a habit. He added, this two species are pest of crops and households. Besides, this species produce toxic that can cause allergy to certain people once injected into body.

The fire ant species that have been recorded are *S. richteri* (black imported fire ant) (Summerlin & Green, 1977), *S. invicta* Buren (red imported fire ant), *S. geminata* (tropical fire ant), *S. xyloni* McCook (southern fire ant), *S. aurea* Wheeler and *S. amblychila* Wheeler (desert fire ant) (Cook *et al.*, 2002) and *S. molesta* (thief ant) (Lee, 2002). Based on research done Pulau Pinang by Lee (2002), the *Solenopsis* species that found in Malaysia were *S. geminata*, *S. invicta* and *S. molesta*. The *S. geminata* is active 2-4 hours after sunset and it will forage at this period (Lee, 2002).

Fire ants are adapted to human activity areas. They found inside buildings as well as in the forests. Their diet consists of dead animals, including insects, earthworms and mammals. Workers also collect honeydew and will forage for sweets, proteins and fats in homes

(Anonymous, 2010). They make loose mounds near pond, river, highway, garden, orchard, field and house.

Lee (2002) stated that the foraging activity of *S. geminata* peaked two to four hours after sunset (10 o'clock in the night), and the activity gradually cease around 3 o'clock in the afternoon. Its foraging activity patterns are negatively correlated with ambient temperature. As cited in Lee (2011), Hooper and Rust (1997) reported that foraging activity of *S. xyloni* start about four hours before sun-set and maximal activity occurred two to seven hours after sunset. The ants preferred to reduce foraging in day times due to higher ground surface temperature cause by sun-light.

According to Gaskill (2011), *S. geminata* is a native fire ant Texas and the native seldom bother most people as well as its numbers are kept in tolerable level by natural enemies (wasps, nematode worms, pathogens) and competitions. Red Imported fire ants (*S. invicta*) are native to South America (such as Brazil). They start to spread to United State in 1930 as stowaways on a ship from northern Argentina that docked at Mobile, Alabama. There no natural enemies for this species of fire ants in U.S. Besides being life-threatening animal, the invasive fire ants displace native insect population, build mounds in farms and damage electrical circuits in Texas (Gaskill, 2011).

2.2 Decapitating Fly

The phorid flies are very small about 0.5-6.0 mm in size. Based on Marshall (2006), they more prefer to run rapidly on the surface than fly using their wings. Few only have the wings in this family. The one has wing, the heavy veins seem squeezed onto the basal front half of the wing (Marshall, 2006). The small head is usually covered with large, backward-

pointing bristles, giving the appearance of a “slicked back” hairstyle. They also have large, spiny palpi sticking out from the mouthpart like armed clubs (Marshall, 2006). They mostly are black or brown in colour. The females have an elaborately shaped ovipositor (Appendix 3). It is look like knives or pitchforks.

Estrada *et al.* (2006) stated that there are more than 27 species of phorid flies under genus *Pseudacteon*. Some of them are *P. nudicornis* Borgmeiner, *P. nocens* Borgmeier, *P. obtusus*, *P. borgmeieri*, *P. curvatus* (Estrada *et al.*, 2006) and *P. calderensis* (Calcaterra, 2007).

Morrison (2011) stated that *Pseudacteon* species are widely distributed in the natural range of their hosts. They are active all the year and able to survive all type of season except winter. Adult *Pseudacteon* species is generalists, feeding on honeydew, plant sap, nectar and dead insects like other phorids (Morrison, 2011). Based on Porter (1998) statement, the adult fly life span is 1-3 days only (Porter *et al.*, 2004). According to Porter and Gilbert (2004), the decapitating flies appear to be common and active throughout most of the year, but different species active at different times of the day and during different seasons. Most of the species are broadly distributed across a wide range of habitats and climates (Porter & Gilbert, 2004).

2.3 Reproduction and parasitism

According Zacaro and Porter (2003), each female *Pseudacteon* capable of produce 100-300 eggs (Morrison, 2011). The *Pseudacteon* females will attack the fire ants by hover over them (Appendix 4). Their target is the adult ants. The female is first attracted to worker fire ants under a number of conditions, such as at disturbed mounts, mating flights, or when

they are foraging for food (Folgarait *et al.*, 2006). Folgarait continued that the female will inject an egg in mid-flight into the fire ant thorax by using species-specific ovipositors once she found an appropriate host. He added that she will inject an egg or more than an egg per fire ant. Then, the eggs hatch into tiny maggots that burrow in and feed on the internal contents of the fire ant, ultimately consuming the contents of the ant head (Calcaterra *et al.*, 2007).

Gaskill (2011) stated that the whole process takes about 45 days. After attacked, the ant will look normal for two to three weeks. Then, the ant will wander around or is staying in a place without move after 25 days had attacked by the fly. Before pupation, the maggot will release an enzyme that dissolves the connective tissue between the fire ant's head and thorax. This causes the detachment of the ant head. The pupation takes place in the shelter of the detached head capsule and about three weeks later the adult fly emerges (Marshall, 2006) (Appendix 5).

The development of the pupae of phorid fly is depends on the temperature too. The fly's total developmental periods lengthened by 17%-32% at 22°C. The Argentinean *Pseudacteon* that tested, *P. nocens* was able to successfully develop on both species of imported fire ants, *S. invicta* and *S. richteri*, although immature performances differed substantially across populations and temperature regimes, and to some extent according to hosts (Folgarait *et al.*, 2006).

2.4 Host-parasite Relationship

Disney (1994) said that several ant genera serve as host for phorid flies, including *Crematogaster*, *Lasius*, *Linepithema* and *Solenopsis* (Morrison, 2011). Most of

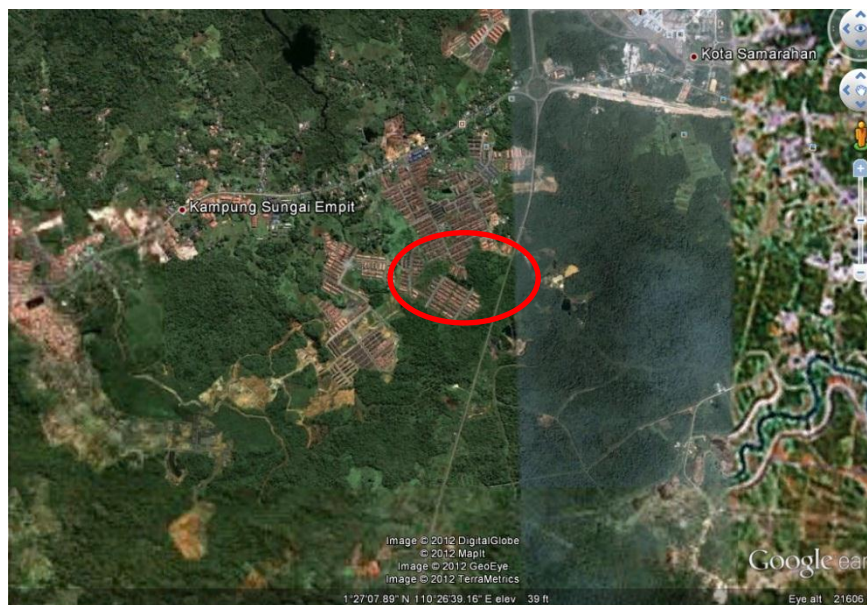
the fly species is parasite on *Solenopsis* than other genus. Based on Gaskill (2011), the phorid flies will attack native fire ants, but do not make them hosts.

A total of 130 phorid flies were recorded attacking ants approximately 33% (44/134) of the mounds in the study that done in Northeast Mississippi May-September, 2004. Each of 44 mounds had from 1 to 14 flies with average of 3.0 ± 2.7 flies (Thead *et al.*, 2005). Normally, the female *Pseudacteon* flies less attracted to the fire ants which produce alarm pheromone (Thead *et al.*, 2005).

3.0 Materials and Methods

3.1 Location

The sampling was conducted in village and residential houses areas in Samarahan Division and inside Universiti Malaysia Sarawak campus (Appendix 1). The sites involves roadsides, gardens, plantations and dumping areas were surveyed to search for the fire ants. Main sampling was conducted in Tmn. Samarindah and Kpg. Sebayor. Tmn. Samarindah (Figure 1) is a residential housing area. The sampling locality was a pumpkin plantation of a resident there while Kpg. Sebayor (Figure 2) is a village. The sampling locality was in small garden of a resident of the village. Another site was Kpg. Meranek (Figure 3) where the sampling locality was dumping place of the village.



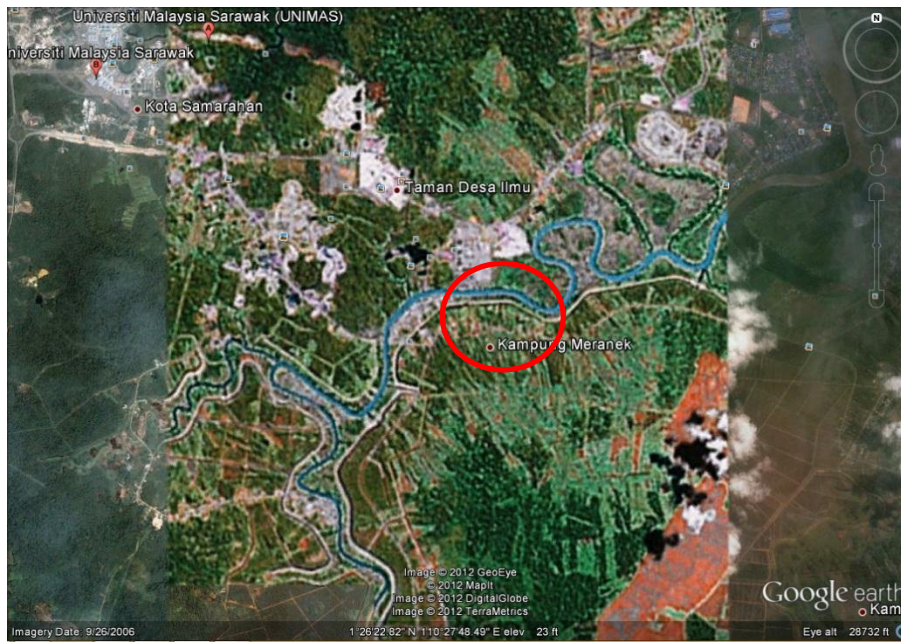
Source: Google Earth

Figure 1: Tmn. Samarindah



Source: Google Earth

Figure 2: Kpg. Sebayor



Source: Google Earth

Figure 3: Kpg. Meranek

3.2 Procedures (Sampling of Fire Ant and Detection of Decapitating Fly)

The sampling was conducted from 7 November 2011 until 14 April 2012. Tupperware and transparent containers were used to collect as well as to rear fire ants. Sampling started with identifying location to investigate the presence of fire ants. Roughly *Solenopsis*-like ants were collected from surveyed places. Then, confirmed their identification by using identification key from Journal of Porter (1998) and Cook *et al.* (2002). After the genus was confirmed as *Solenopsis*, the work proceeded to (i) field sampling and baiting, (ii) rear in laboratory and (iii) dissection.

Field sampling and bait trial was carried out to detect presence of *Pseudacteon* fly and also to collect fire ants for species identification and to rear them in laboratory to observe. The sampling was carried out in the early morning, late afternoon, evening and at night by baited the ants with food, for example, sugar and bread at their nest and foraging places. The foraging pattern of the ants and presence of fly were observed by looked at ants' defend behaviour. Porter and Gilbert (2004) stated that the ants will retreat rapidly to holes or curl into a stereotypical c-shaped posture as self -defend when attacks by this phorid fly. The observation was done for 30 minutes. Changes in feeding-ant-numbers and defend behaviour were recorded for every 10 minutes. The coordinate, surrounding condition, time and date of sampling conducted were recorded. Then, ~50-100 ants were collected and were placed into a container for identification and to rear in laboratory. The container was labelled as well.

Five to ten ants were keep in 70% alcohol contained vials and some were pinned to identify its species. The balance ants were reared in laboratory to detect the presence of the

decapitating fly. Since the fly only about 0.3 mm in size, it is hard to see or sample in the field. Therefore, the host was brought and reared. There is possibility where the ants had been attacked by the fly before baiting sampling. To see the possibility, they were kept alive for 30 to 45 days in laboratory. According to Gaskill (2011), the fly will merge from the host between that duration.

The ants were reared in transparent plastic container which already made holes on the cover for air movement for that period. The containers were placed in basin and the basin was filled up with water till 10% of the plastic container immerse in the water. Retort stand was used to hold bulb on top of the container. Half top of container was covered with not transparent paper, so that only food exposed to the light (Appendix 6) because ants tend to foraging under sunlight mostly and they also receive heat from the bulb since the laboratory is functioning under air condition. Water was used to control the heat admission and accumulation in the container.

Furthermore, the temperature was controlled based on survivorship of fire ants and growth of decapitating flies (20°C-30°C). Thermometer was used to measure the heat inside the container. Every two times per day the temperature was measured and recorded. Ants in the container were feed with sugar, dead insects, bread, plant parts (fruit, germinating seeds, young plant stems) and water (Figure 4). In addition, small dead woods (Figure 4) were placed inside the container as the ants usually shelter in dark areas. The woods were checked free from mites, fungus and dry using magnifying glass lens. This is to avoid infection on ants during captivity.