STUDIES ON SPECIES COMPOSITION, SEASONAL ABUNDANCE, FOOD PREFERENCES AND CONTROL OF STRUCTURE-INFESTING ANTS IN STUDENT HOUSINGS IN UNIVERSITI SAINS MALAYSIA, PULAU PINANG

NORASMAH BINTI BASARI

UNIVERSITI SAINS MALAYSIA

2007

STUDIES ON SPECIES COMPOSITION, SEASONAL ABUNDANCE, FOOD PREFERENCES AND CONTROL OF STRUCTURE-INFESTING ANTS IN STUDENT HOUSINGS IN UNIVERSITI SAINS MALAYSIA, PULAU PINANG

by

NORASMAH BINTI BASARI

Thesis submitted in fulfilment of the requirements for the degree of Master of Science

April 2007

ACKNOWLEDGEMENTS

Firstly, my outmost thanks go to Allah s.w.t for giving me strength to accomplish my Masters study.

I would like to express my deepest gratitude to my supervisor, Prof. Abu Hassan Ahmad for his constant guidance, support, advice and for his valuable suggestions in producing a more solid and compelling study.

I would also like to thank Prof. Chan Lai Keng for assisting me in statistical analysis. Thank you to En. Hadzri for his help and to Mr. Morita Masayuki and En. Hassan for sharing their valuable knowledge about ants with me.

A special thanks goes to my entomology laboratory members, Nur Aida, Nurita, Nor Adzliyana, Noratiny and Wan Zaki for helping me complete the writing of this dissertation and for sharing all the fun and the good time with me. I am also greatly indebted to my best friends, Khadijah, Iswarti, Mazniza, and Sharifah who are always there to help and encourage me.

Last but not least, I also want to express my sincere gratitude and thanks to my family for helping me at any time and had confidence in me when I doubted myself and most importantly, I would like to thank my parents, En. Basari Hj. Yunus and Pn. Siti Saharah Hj. Bakri who are always pray for my success in my life, for their sacrifice in making me what I am today and for believing in me. Thank you so much.

TABLE OF CONTENTS

CHAPTER 4: CONTROL OF STRUCTURE-INFESTING ANTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

KAJIAN KE ATAS KOMPOSISI SPESIES, KELIMPAHAN BERMUSIM, PEMILIHAN MAKANAN DAN KAWALAN TERHADAP SEMUT DI DALAM BANGUNAN DI KAWASAN KEDIAMAN PELAJAR DI UNIVERSITI SAINS MALAYSIA, PULAU PINANG

ABSTRAK

Kajian mengenai komposisi spesies, kelimpahan bermusim, pemilihan makanan dan kawalan terhadap semut yang menginfestasi bangunan kediaman pelajar telah dijalankan di Universiti Sains Malaysia, Pulau Pinang. Kajian ini telah dijalankan selama 13 bulan bermula dari bulan Januari 2005 sehingga Januari 2006. Bangunan H13, Desasiswa Bakti Permai setinggi 8 tingkat dan Rumah Antarabangsa yang setinggi 6 tingkat dipilih sebagai tempat kajian.

Sebelas spesies semut telah dijumpai di dalam bangunan yang tergolong dalam 9 genera dan 4 subfamili. Spesies-spesies tersebut adalah *Camponotus* sp., *Monomorium destructor* (Jerdon) , *Monomorium floricola* (Jerdon), *Monomorium pharaonis* (Linnaeus), *Odontoponera* sp., *Paratrechina longicornis* (Latreille), *Pheidole megacephala* (Fabricius), *Solenopsis geminata* (Fabricius), *Tapinoma melanocephalum* (Fabricius), *Tetramorium* sp. dan *Technomyrmex* sp. Bangunan H13, Bakti Permai merekodkan jumlah diversiti semut yang tinggi berbanding Rumah Antarabangsa. Spesies semut yang mendominasi bangunan adalah *P. longicornis* dan *M. pharaonis*. Bilangan semut yang paling banyak didapati di dalam bangunan H13, Bakti Permai adalah di aras tanah dan di aras 5 bagi Rumah Antarabangsa.

Kelimpahan bermusim bagi semua semut yang dijumpai adalah berbeza mengikut spesies dan tempat kajian. Kelimpahan tertinggi bagi spesies semut

yang mendominasi bangunan H13, Bakti Permai iaitu *M. pharaonis* dicatatkan pada bulan April manakala di dalam bangunan Rumah Antarabangsa, spesies semut yang sama mencatatkan kelimpahan tertinggi pada bulan May. Bagi *P. longicornis* pula*,* iaitu spesies semut yang mendominasi bangunan Rumah Antarabangsa, jumlah kelimpahan tertinggi juga dicatatkan pada bulan May. Walau bagaimanapun, kelimpahan bermusim bagi setiap spesies semut adalah tidak berkaitan dengan suhu di dalam bangunan dan kelembapan relatif kecuali bagi 3 spesies semut iaitu *P. longicornis*, *P. megacephala* dan *Technomyrmex* sp. Ketiga-tiga spesies semut ini yang didapati di dalam bangunan H13, Bakti Permai menunjukkan korelasi positif dengan kelembapan relatif ($p<0.05$).

Keputusan bagi pemilihan makanan membuktikan semua spesies semut lebih menggemari jem strawberi yang kaya dengan karbohidrat berbanding ikan bilis dan kuning telur ($p<0.05$). Walau bagaimanapun, semut menukar jenis makanan yang diambil dari makanan berkarbohidrat kepada makanan berprotein dan juga lipid apabila jumlah semut yang tidak matang di dalam koloni adalah tinggi.

PRESTO® 001 (a.i: fipronil 0.001%) dalam bentuk formulasi umpan didapati lebih berkesan untuk digunakan dalam pengawalan semut jika dibandingkan dengan Confidor® 200SC Insecticide (a.i: imidacloprid 200g/L) dalam bentuk cecair berkepekatan. Walaupun kesannya agak lambat disebabkan kepekatan bahan kimia yang sangat rendah, namun ia telah mengurangkan jumlah *P. longicornis* di dalam bangunan Rumah Antarabangsa selepas 30 hari kawalan dijalankan ($p<0.05$).

STUDIES ON SPECIES COMPOSITION, SEASONAL ABUNDANCE, FOOD PREFERENCES AND CONTROL OF STRUCTURE-INFESTING ANTS IN STUDENT HOUSINGS IN UNIVERSITI SAINS MALAYSIA, PULAU PINANG

ABSTRACT

A study on species composition, seasonal abundance, food preferences and control of structure-infesting ants was carried out in students housing in Universiti Sains Malaysia, Pulau Pinang. The study was conducted for a period of 13 months began on January 2005 until January 2006. Two multi-level buildings were chosen in this study namely H13, Desasiswa Bakti Permai and International House, an 8 and 6-storey building respectively.

Eleven ant species were found belonging to 9 genera and 4 subfamilies inhabiting in the buildings and they were *Camponatus* sp., *Monomorium destructor* (Jerdon), *Monomorium floricola* (Jerdon), *Monomorium pharaonis* (Linnaeus.), *Odontoponera* sp., *Paratrechina longicornis* (Latreille), *Pheidole megacephala* (Fabricius), *Solenopsis geminata* (Fabricius), *Tapinoma melanocephalum* (Fabricius), *Tetramorium* sp. and *Technomyrmex* sp. H13, Bakti Permai building recorded the highest diversity of ants when compared to International House. The dominant ant species in the building were *P. longicornis* and *M. pharaonis.* The highest numbers of ants were found on the ground floor in H13, Bakti Permai while the highest number of ants recorded in International House was on the fifth floor.

All of the ants' species were abundant only during certain months and depend on the study site. Highest abundance of the dominant ant species, *M. pharaonis,* in the H13, Bakti Permai was recorded in April while in the International House, this species recorded a highest abundance in May. *Paratrechina longicornis* which dominated the International House also showed a highest abundance in May. However, the abundance of the ants in the buildings was not correlated with temperature inside the building or relative humidity with exception to *P. longicornis*, *P. megacephala* and *Technomyrmex* sp. Only these species of ants found in the H13, Bakti Permai was positively correlated with relative humidity ($p<0.05$).

A result of food preferences revealed that the strawberry jam, a carbohydrate-base food was the most attractive food to all species of ants when compared to anchovy and egg yolk ($p<0.05$). However, the nutrient needs of the ants fluctuated during the study period. The ants changed their food preferences from carbohydrate-base food to protein-base and lipid-base food when the numbers of the broods in the colony were high.

PRESTO® 001 (a.i: fipronil 0.001%), a bait formulation, was found to be effective to control ants when compared to Confidor® 200SC Insecticide (a.i: imidacloprid), a suspension concentrates. Although the use of this bait takes time due to its low concentration, this bait decreased the number of *P. longicornis* in the International House building after 30 days post-treatment ($p<0.05$).

CHAPTER ONE

GENERAL INTRODUCTION

Ants are the dominant group of social insects related to bees and wasps. The term ‘social’ refers to the relationships among members of the same species (Michener and Michener 1951). Ants are increasingly being studied by entomologist for two reasons. Firstly, ants are a dominant part of many ecosystems; and secondly, their social organization serves as a model system for the studying of numerous ecological and evolutionary questions (Holldobler and Wilson 1990). Except for the polar region, they flourish on all land areas on the earth, from subarctic tundra to equatorial rainforest, from swamp to harsh desert, from sea coast to great altitude and from deep in the soil to the tips of the highest trees. They are among the most widespread and abundant of animals (Bolton 1994; Tobin 1994).

Ants are one of the most common insects found around us. All pest control technicians are involved with ant problems at some point in their career – most commonly because ants forage or nest inside structures. Ants are interesting organisms that should be studied to better understand their unique behaviors and their roles in the earth’s ecosystems. They can also be pest, however. Worker ants foraging for food and water become a concern when they infest food or other items in the home. Although most ants consume a wide variety of foods, certain species prefer some types of foods and some even change their preferences over time.

Ants in an urban environment are principally nuisance pest (Reimer et al. 1990). The activities of ants may interfere with those of man in four directions – first, through their feeding habits; second, through their habit of appropriating certain portions of the earth as nesting sites; third, through their aggressive, i. e, stinging and biting habits (Wheeler 1965) and fourth, because the ants can be a vector of pathogen. Fire ants, (*Solenopsis sp*.) and others may sting or bite people and animals. Carpenter ants, (*Camponatus sp.*) tunnel into structural wood. Mound-building ants mar the appearance of lawns and landscaped areas. Pharaoh ant, (*Monomorium pharaonis*) can transmit over a dozen pathogens such as *Salmonella* spp., *Staphylococcus* spp., and *Streptococcus* spp. (Smith and Whitman 1992; Nickerson et al. 2003). Pharaoh ant can also get into wounds and dressings in hospitals as well as in sterile supplies and intravenous fluid apparatuses. It's small size and ability to chew through many materials makes it a serious infection hazard in hospitals and residences (Reimer et al. 1990). A recent study by Olaya and Chacón (2001), found that the ghost ant, (*Tapinoma melanocephalum*) was also capable of transporting seven types of bacteria, such as *Enterobacter cloacae* and *Staphylococcus* sp.

Since many areas in Malaysia have become urbanized, many people from rural areas migrate to urban areas. The rapid development of urban areas has inadvertently contributed to the increase in numbers of pests such as rodents, cockroaches, mosquitoes, flies, termites and household ants.

In Penang, Malaysia, ants are the most abundant household pests after mosquitoes and cockroaches as reported by Lee et al. (1999). Structure-infesting ants are the cause of frequent pest problems in urban environments because of their violation of esthetic and economic thresholds, and their potential influences on human health (Hölldobler and Wilson 1990; Lee 2002). Therefore, many researches should be done to understand the behaviour of the house-infesting ants and structure-infesting ants in order to eliminate their nest from the premises. Many researches of the ants' behaviour and also a control of structure-infesting ants have been done in a laboratory conditions. Little is known of their behaviour and control in the field conditions. Thus, the objectives of this study were:

- To survey the species composition of structure-infesting ants in a multi-level building.
- To study the differences in the species composition for each level of a multi-level building.
- To study the seasonal abundance over a period of thirteen months and the effect of biotic and abiotic factors on their abundance.
- To study the food preferences and nutrient changes of structure-infesting ants in the field.
- To control structure-infesting ants in field conditions.

CHAPTER TWO

LITERATURE REVIEW

2.0 Ants.

Ants belong to the insect order Hymenoptera and the family Formicidae. There are about 20,000 living ant species, of which some 9,000 to 10,000 have been described (Bolton 1994; Hölldobler and Wilson 1990). In Malaysia, a preliminary survey of ants in Bario, Kelabit Highlands Sarawak found a total of 71 genera of ants. In this study, subfamily Formicinae had the highest number of species (29) represented by 6 genera and they were *Camponatus*, *Cladomyrma*, *Colobopsis*, *Eurenolepsis*, *Oceophylla* and *Polyrhachis* (Gunik 1999). A more recent study by Floren et al. (2005) found a total of 640 species of ants from 81 genera and 8 subspecies in Poring Hot Spring (Kinabalu Park), Sabah. Their abundance and stability make ants one of the most important groups of insects in ecosystems (Wang et al. 2000).

2.1 General biology of ant.

Ants undergo complete metamorphosis, passing through the egg, larva, pupa and adult stages. The egg is tiny, almost microscopic in size. The larva is legless and grub-like, very soft and whitish in color. It is also helpless and depends totally on workers for food and care. The pupa looks somewhat like the adult but is soft, unpigmented and immobile. Some are enclosed in a cocoon and some are not. A newly-emerged adult requires several days for its body to harden and darken.

Ants differ from most insects in that they are all based on a caste, or social class system, similar to termites and certain bees and wasps. They live in large cooperative groups called colonies. All the members in the colony have their own job. Adults take care of the young and are divided into castes or specialized groups that take care of certain tasks. Ants have reproductive castes (queens and males) and nonreproductive castes (workers).

A queen is generally the largest individual in the colony. She has wings until her mating flight after which she removes them and establishes a new colony. Mating flights usually occurs in the afternoon soon after a rainy period. The primary function of the queen is reproduction, but after establishing a new nest she may also care for and feed the first brood of the workers. A newly mated queen lays about a dozen eggs. Once she has produced her first brood, she becomes an ‘egg laying machine’, cleaned and fed by her offspring. She may live for many years until replaced by a daughter queen. Some ant species have more than one queen in the nest.

Male ants are generally winged and usually keep their wings until death. Apparently, the male ant’s only function is to mate with the queen. Once he does, he dies, generally within two weeks. Males are produced in old, mature colonies.

The workers are sterile, wingless females who build and repair the nest, care for the brood, defend the nest, forage outside for food and feed both immature and adult ants, including the queen. In many ant species, the worker class is further subdivided into sub-castes. These may include workers of different sizes, as well as large-headed, strong-jawed ants called soldiers, which are the defenders of the community (Simon 1962).

Ants can recognize their colony members through the ‘chemical cues’, a subset of overall colony odor. These cues can be derived from individual, queen and/or workers neural imprint or sensory template. If cues of intruders match the template of the resident, no aggression occurs however, agonistic behaviours may ensue if they do not match (Meer et al. 1990).

2.2 Ants classification.

Ants can be identified from subfamily to genera and finally to the species. Only 4 subfamilies are important in this study and they are Dolichoderinae, Formicinae, Myrmicinae and Ponerinae.

2.2.1 Subfamily Dolichoderinae.

Species of Dolichoderinae can be found in most regions of the world and in all major habitats. There are about 1000 described species and subspecies placed 22 genera world-wide (Shattuck and Barnett 2001). Most species of Dolichoderinae are general predators or scavengers. In these ants the petiole is composed of a single segment, the sting is absent and the tip of the gaster is slit-like and without a circular opening (an acidopore). Some genera that are important in this subfamily include *Bothriomyrmex*, *Dolichoderus*, *Iridomyrmex*, *Linepithema*, *Tapinoma* and *Technomyrmex*.

2.2.2 Subfamily Formicinae.

Species of Formicinaes are found world-wide, with over 3700 described species and subspecies and 49 genera (Shattuck and Barnett 2001). Most are general scavengers, foraging on the ground or on vegetation and can be found at all times of the day and night. They are generally active and fast moving and many will defend their nests vigorously, attacking intruders with their large mandibles and formic acid sprays. This ants can be recognized by having a single petiole, the sting is absent and the tip of the gaster has a small circular opening (an acidopore) which is often surrounded by a ring of short hairs. *Anoplolepis*, *Camponatus*, *Oechophylla* and *Paratrechina* are some of the important genera in this subfamily.

2.2.3 Subfamily Myrmecinae.

Myrmicines occur throughout the world in all major habitats except in artic and antarctic regions. They are the largest subfamily of ants with over 6700 species and subspecies and 155 genera (Shattuck and Barnett 2001). Myrmicines range greatly in size, with the smallest about 1mm long and the largest up to 10mm. Workers can be found foraging at all times of the day and night, sometimes in large numbers. Species of Myrmecines have two distinc segments, the petiole and postpetiole that attached the mesosoma to the gaster.