



UNIVERSITI PUTRA MALAYSIA

**REPRODUCTIVE MORPHOLOGY AND BEHAVIOUR OF
MENOCHILUS SEXMACULATUS FABR.
(COLEOPTERA: COCCINELLIDAE).**

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MENOCHILUS SEXMACULATUS FABR.
(COLEOPTERA: COCCINELLIDAE).**

BY

NAVIES MAISIN

**Thesis Submitted in Fulfilment of the Requirements for
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1997



*to my father, Onoi, Oyong, Ison, Lina
and grandma*

*thanks for your love, prayer and
patience*



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**REPRODUCTIVE MORPHOLOGY AND BEHAVIOUR OF
MENOCHILUS SEXMACULATUS FABR.
(COLEOPTERA: COCCINELLIDAE)**

By

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Chairman : Associate Professor Syed Tajuddin Syed Hassan, Ph.D
Faculty : Science and Environmental Studies

Reproductive behaviour of ladybird, *Menochilus sexmaculatus* Fabr. (Coleoptera: Coccinellidae) reared on aphid infesting groundnut, *Aphis craccivora* Koch (Homoptera: Aphididae) was studied. The sex of adult *M. sexmaculatus* can be morphologically distinguished by comparing the edge of last visible segment (8th sternite); where it is concave in male and round in female. Additional characteristics that can be used to determine the sex of the adult are the trachea arrangement in the abdomen (irregular in male and nearly straight longitudinal line in female), the shape of the posterior part of the body (rounded in male and oval in female), and the relative size of the adult (the male smaller than the female). The males recognize their mate visually (body shape and movement), chemically (body odour and chemical on the body surface of the female) and by tactile (body surface texture). The male also displays aggression during mating. The bigger male appeared dominant over

the smaller one. The sequence of behaviour of male during mating is, “approach”, “walk or run”, “examine” by vibrating its maxillary pulps, “mount” and “copulate”. While copulating, the male shook its body, licked, tapped (by its maxillary pulps) and rubbed (by its front and middle tarsi) the dorsal surface of female’s elytra. The function of body shaking was to ensure a successful sperm transfer and likewise the licking and tapping behaviours are for copulatory courtship. The duration of copulation was not significantly different between virgin (97.6 ± 9.1 minutes) and mated (101.8 ± 5.4 minutes) pairs. The latent period of body shaking and the duration of post-copulation mounting were 3.7 ± 0.2 seconds and 51.0 ± 5.8 seconds, respectively. The number of body shaking was significantly ($P < 0.01$) determined by the duration of copulation, and the relationship can be expressed as a logistic function.

Mating behaviour in *M. sexmaculatus* occurred mostly during the day with two peaks at 0900 hr to 1100 hr and 1500 hr to 1900 hr. Oviposition activity fluctuated following the day and night cycles with no regular patterns. Mating and oviposition activity may be regulated by temperature and relative humidity as expressed by a quadratic function. The predicted optimum temperature and relative humidity for reproductive activity were 31.7 ± 0.5 °C and 53.1 ± 4.3 %RH, respectively. When food became scarce, the percentages of mating and oviposition were low as the adult predators spent more time in searching for food. Frequent mating in *M. sexmaculatus* did not influence

fecundity, percent egg hatch and egg weight. The number of eggs laid per day, percent egg hatch and egg weight of *M. sexmaculatus* were influenced by age of the adult female and nutrient quality. The relationship between percent egg hatch with egg weight, percent egg hatch with total eggs laid per female per day, and total eggs laid per female per day with egg weight were expressed by the increasing linear equation, decaying exponential equation and decreasing linear equation, respectively. Younger females of *M. sexmaculatus* produce more viable eggs.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan untuk mendapatkan ijazah Master Sains.

MORFOLOGI DAN KELAKUAN PEMBIAKAN *MENOCHILUS SEXMACULATUS* FABR. (COLEOPTERA: COCCINELLIDAE)

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JANUARI 1997

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Kajian biologi pembiakan kumbang kura-kura, *Menochilus sexmaculatus* Fabr. (Coleoptera: Coccinellidae) yang dikultur dengan afid, *Aphis craccivora* Koch (Homoptera: Aphididae) telah dibuat. Dalam kajian ini aspek pembiakan yang lain juga diambil kira, tetapi penumpuan diberikan kepada kelakuan pembiakan. Daripada kajian ini jantina *M. sexmaculatus* dewasa telah dapat ditentukan dengan membandingkan hujung segmen terakhir yang kelihatan (sternit ke-8); iaitu cekung ke dalam pada jantan dan bulat ke luar pada betina. Ciri-ciri lain yang juga boleh digunakan dalam penentuan jantina ialah susunan trakea dalam abdomen (berserabut pada jantan dan membentuk garis lurus membujur pada betina), bentuk di bahagian posterior badan (bulat pada jantan dan bujur pada betina) dan perbandingan saiz dewasa (jantan lebih kecil dibandingkan dengan betina). Jantan dapat mengenali pasangannya secara visual (bentuk badan dan pergerakan), secara kimia (bau badan dan bahan

kimia pada permukaan badan betina) dan secara sentuhan (bentuk permukaan badan). Ketika pengawanan, jantan menunjukkan sifat agresif dan jantan yang bersaiz besar lebih dominan daripada jantan bersaiz kecil. Urutan proses pengawanan yang ditunjukkan oleh jantan ialah “mendekati”, “berjalan atau berlari” ke arah betina, “memeriksa” dengan menggetarkan maksilanya, “melekap” di atas badan betina dan “senggama”. Ketika senggama, jantan akan menggoyangkan badannya, “menjilat”, menyentuh (dengan maksila) dan meraba (dengan tarsus depan dan tengah) permukaan dorsal elitra betina. Fungsi goyangan badan ialah untuk memastikan kesempurnaan pemindahan sperma dan begitu juga untuk kelakuan menjilat, sentuh dan raba fungsinya juga adalah sebagai ‘courtship’ ketika senggama. Masa satu senggama bagi pasangan dara (97.6 ± 9.1 minit) dan pasangan yang telah mengawan (101.8 ± 5.4 minit) didapati tiada perbezaan yang bererti. Masa sebelum jantan menggoyangkan badan dan masa pelekapan selepas senggama ialah 3.7 ± 0.2 saat dan 51.0 ± 5.8 saat. Masa senggama berlangsung dan bilangan goyangan badan oleh jantan mempunyai hubungan yang rapat dan dijelaskan dengan persamaan logistik. Aktiviti pengawanan *M. sexmaculatus* berlaku selalunya pada siang hari dengan dua puncak pada jam 0900 ke 1100 dan pada jam 1500 ke 1900. Aktiviti oviposisi pula tidak bergantung kepada pertukaran siang malam dan tidak menunjukkan corak turun naik yang tetap. Hubungan antara aktiviti mengawan dan oviposisi dengan suhu dan kelembapan relatif dijelaskan dengan persamaan kuadratik. Suhu dan kelembapan optima yang

diramalkan bagi aktiviti mengawan bersama dengan oviposisi ialah 31.7 ± 0.5 °C dan 53.1 ± 4.3 %RH. Bagi rawatan densiti makanan yang rendah, peratusan mengawan dan oviposisi adalah rendah disebabkan lebih masa digunakan untuk mencari makanan. Kekerapan mengawan *M. sexmaculatus* tidak mempengaruhi fekunditi, peratus penetasan dan berat telur. Peneluran, peratus penetasan dan berat telur *M. sexmaculatus* dipengaruhi oleh umur betina dan kualiti nutrient. Hubungan antara peratus telur menetas dengan berat telur, peratus telur menetas dengan bilangan telur yang dihasilkan oleh betina, dan bilang telur yang dihasilkan oleh betina dengan berat telur, masing-masing diwakili oleh persamaan linear, eksponen menyusut dan linear menurun. Betina *M. sexmaculatus* yang muda mengeluarkan telur yang lebih mandiri.

CHAPTER I

INTRODUCTION

The coccinellid beetle (*Menochilus sexmaculatus*), formerly known as *Cheilomenes* Mulsant and *Coccinella sexmaculata* Fabricius (Timberlake, 1943). However, Timberlake (1943) renamed the genus as *Menochilus* with two species. *Menochilus sexmaculatus* (Fabricius) specimen collected from Ceylon, Formosa and Manila; and *Menochilus quadriplagiatus* (Schönherr) specimen collected from China and Hongkong.

M. sexmaculatus is widely distributed from Iran to Japan including Southeast Asia (Cartwright et al., 1977). This coccinellid species is also commonly found in Australia (Booth et al., 1990). It is an important aphidophagous predator among the coccinellids found in Malaysia (Hussein, 1991), especially on maize (corn) during the tasselling and silking stage (Parker et al., 1976). *M. sexmaculatus* is also found on chilli infested by *Aphis gossypii* (Maisin et al., 1994).



The importance of *M. sexmaculatus* as a biological control agent of aphid has been reported by several authors (Hussein et al. 1994; Patel and Vyas 1984; Campbell et al. 1980; and Cartwright et al. 1977). It is an efficient biological control agent of aphid. It showed the highest feeding rate and great fecundity among the coccinellids found in Malaysia (Parker and Singh, 1973).

Even though a number of studies have been done on *M. sexmaculatus*, especially the biology, prey requirement and artificial diet (Hussein, 1991), toxicity by conventional insecticides (Hussein and Fong, 1989; and Tewari and Moorthy, 1985 and ecology Varma et al. 1990; Saha 1987; and Reddy and Rao 1984). Parker et al. (1976) studied the reproduction and while Song (1994) integrated the oviposition. However, detailed reproductive behaviour of *M. sexmaculatus*, has not been studied.

The objectives of this study were:-

- i. To develop an identification scheme to sex the adult *M. sexmaculatus* by examining their morphological characteristics and to examine morphology of the reproductive system.
- ii. To examine the mechanism of mate recognition by the male *M. sexmaculatus*.

- iii. To study the aggression of the male *M. sexmaculatus* during mating, mating behaviour (sequence), correlate the body shaking bout, latent period and post-copulation mounting to the duration of copulation.
- iv. To examine the influence of environmental factor (temperature's and humidity's daily fluctuation and food density) and mating frequency on reproductive behaviour.
- v. To fit mathematical models that show the relationship between the reproductive activity and environmental factor and the relationship between the number of eggs laid per day, percent egg hatch and egg weight.

CHAPTER II

LITERATURE REVIEW

The Reproductive System of Coccinellidae.

The female reproductive organs in coccinellid consist of a pair of ovaries, two lateral oviducts, a median oviduct, a vaginal part, a bursa copulatrix and spermatheca according to Hodek (1973). The number of ovarioles is not constant even within one species. The male reproductive organs consist of the testis, vas deferens and ejaculatory duct. The number of testis follicles also varies. Accessory glands are also found in the reproductive system of the coccinellid.

In coccinellid, the parts of the ninth and tenth abdominal segments are designated as genitalia (Hodek, 1973). In female, the genitalia consist of a pair pleurites, a pair of coxites and the tenth tergite. In male, the genitalia consist of a basal piece, a median lobe, a pair of parameres, trapes and siphon. Male genitalia are species specific and are often used for taxonomic purposes.



Mating Behaviour in Coccinellidae

Behaviour can be defined as the way a living thing behaves, acts, conducts, including the manner or function in response to stimulation (Webster's New World Dictionary, 1972). According to Matthews and Matthews (1978), behaviour represents ways in which an organism adjusts to and interacts with its environment thus covering a wide range of activities including locomotion, grooming and feeding for maintenance or survival. Survival implies to contribute to reproduction and escape from enemies.

Mating behaviour in insect includes all those events surrounding fertilization or insemination (Matthews and Matthews, 1978); mating location (finding of mates), recognition, selection, reception, courtship, copulation, and post-copulatory behaviour (Gillot et al., 1992).

Studies on coccinellid mating behaviour have been done by Obata (1988), Kearns et al. (1990), Osawa and Nishida (1992), Kearns et al. (1992) and Osawa (1994). However their studies were limited to mating preference and mating refusal, though Obata (1987) provided a complete report of mating behaviour on the coccinellid *Harmonia axyridis* Pallas. Five stages of behaviour in male *H. axyridis* prior to copulation were identified; "approach", "watch", "examine", "mount" and "copulatory attempt". During the actual

