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BIOLOGY AND PREDATORY POTENTIAL OF GREEN LACEWING (APERTOCHRYSA SP.)

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BY

MOHAMMED A. ALI HUSSAIN

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DEDICATION

بسم الله الرحمن الرحيم

I dedicate this thesis to my parents, my wife Layla S. Hashim, my daughter Sara, and my sons Habib, Ahmed, Yassir, Bashir for their patience during my study in Malaysia,

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy.

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Chairman: Professor Dzolkhifli Omar, PhD

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The green lacewings being active polyphagous predatos, can be mass reared in the laboratory and used for classical, inundative and augmentative release against crops pests. The green lacewings are also resistant to wide range of pesticide and one of the most important biological control agents in integrated pest management.

The studies were conducted at University Putra Malaysia (UPM), to establish the laboratory culture of *Apertochrysa* sp. The studies comprised of the following new and original contributions: 1- Identified the important species of green lacewing and surveyed the occurrence of *Apertochrysa* sp. in field and within the plants 2- Studied the effect of temperature and type of prey on survival and development time of immature stages 3- Established nest of life table studies 4- Determined axon of the functional responses 5- Studied the effect of storage on eggs and pupae, and 6- Determined the effect of insecticides on different stages of *Apertochrysa* sp.

A total of 43 local plants were surveyed and only 18 plants were found with eggs of *Apertochrysa* sp. The citrus trees showed the highest number of eggs of *Apertochrysa* sp. recorded, 65.84% (4 eggs/ plant). The *Telenomus* sp. was highly affecting the eggs of *Apertochrysa* sp. and the highest parasitism was recorded on the eggs collected from corn plants (14%), while the parasitism was 9.2% on eggs collected from citrus trees.

No significant differences between the heights (0-1 m, 1-2 m and 2-3 m) above the ground on occurrence of eggs, but the east side recorded 79.8% of laid eggs, which seemed to be more attractive to the females of *Apertochrysa* sp. for oviposition. In sweet corn,100% of eggs were found on the height of 1-2 m above the ground, and no significant differences on the number of eggs laid between the east and west side of the plant. The number of eggs of *Apertochrysa* sp. was found to be significantly different on the lower and upper surface of the citrus and corn leaf. At 60 days after planting of sweet corn the number of eggs of *Apertochrysa* sp. was found to be the highest.

The larval developmental times of *Apertochrysa* sp. at15°C, 20°C, 25°C, and 28±3°C (laboratory condition) were 50.54, 41.9, 11.3, and 15.7 days respectively, and the total developmental times from egg to adult were 88.36, 68.8, 29.5 and 33.3 days respectively. The *Apertochrysa* sp. was successfully cultured and complete it's life cycle on *Corcyra cephalonica* eggs, *Rapolasiphum maidis*, *Aleurodicus disperses* Russell and *Aleurocanthus woglumi* Ashby and the total developmental times were 29.5, 25.4, 22.8 and 30 days respectively.

The survivorship (l_x) of *Apertochrysa* sp. for three different cohorts indicates to high mortality occurring during eggs, larvae (particularly 2nd instar) and pupae. The intrinsic rate of natural increase (r) was 0.02 (females / female / day) with mean generation time (T) was 40.6 days. The net reproductive rate (R□) of the population was 2.3. The population double time (DT) was within 14.8 days.

The highest number of aphids, *R. maidis,* was consumed by the third instar larva (42.95 aphids/ larva), followed by second instar (36 aphids/ larva), then the first instar (31.14 aphids/ larva). While the eggs of *C. cephalonica* were consumed by first, second and third instar of larvae of *Apertochrysa* sp. are 68.4, 232.1, 494.6 eggs/larva respectively.

The longest storage period of eggs of *Apertochrysa* sp. was 9.49 days at 15°C followed by 7.31 days at 20°C. While the pupae following 20 days of storage at 20°C showed the lowest mortality (16.2%) with good percentage of good quality adults produced (67.52%). However the pupae stored at 15°C for 40 days gave 100% disability.

The four insecticides (carbaryl, cypermethrin, azadirachtin, and imidacloprid) tested on eggs of *Apertochrysa* sp. in the laboratory showed slightly harmful effect with eggs mortality ranged from 43.33% to 63.33%.

When the insecticides were treated on the third instars larvae, the mortality at 72h was less than 13.33% and all insecticides were categorized as harmless. The effect based on successful pupation was categorized as harmless also for carbaryl (7% mortality),

cypermethrin (10% mortality), azadirachitin (23.15% mortality) and imidacloprid (25.92% mortality).

Based on the successful molt to adults of the treated third instars larvae, cypermethrin , azadirachitin and imidacloprid were harmless while carbaryl was harmful. The insecticides when treated on pupae showed harmless effect (mortality ≤ 20%), however, when the effect was based on the successful molting to adults from the treated pupae, azadirachitin (10% mortality) was harmless, slightly harmful for cypermethrin (50% mortality) and imidacloprid (56.7% mortality) and harmful for carbaryl (100% mortality).

All four insecticides recorded harmful effect (100% mortality) when treated on the adults of *Apertochrysa* sp. within 72h.

The newly recorded green lacewing *Apertochrysa* sp. is an important predator in Malaysian agro-ecosystem environment. High tolerance to insecticides, high potential on different insect pest and successfully mass culture of *Apertochrysa* sp. in laboratory make it a good biological control agent can be used to control different lepidopteran and homopteran pests.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

BIOLOGI DAN POTENSI PEMANGSA GREEN LACEWING (*APERTOCHRYSA* SP.)

Oleh

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'Green lacewing' sebagai pemangsa polyphagous aktif, boleh diternak secara besar-besaran dalam makmal dan boleh digunakan untuk gerak gempur klasik bagi menentang haiwan perosak. Green lacewings juga mempunyai tahap ketahanan yang tinggi bagi kebanyakan racun serangga dan merupakan satu agen kawalan biologi yang amat penting dalam pengurusan haiwan perosak.

Kajian ini dilakukan di Universiti Putra Malaysia (UPM), untuk menyediakan kultur makmal *Apertochrysa* sp. Kajian tersebut meliputi mengenalpasti 1- Spesis penting 'green lacewing' dan meninjau kewujudan *Apertochrysa* sp. di lapangan dan dalam tumbuhan-tumbuhan. 2- Kesan suhu dan jenis mangsa terhadap jangka kehidupan dan tempoh perkembangan tahap belum matang 3- Kajian jadual jangka hayat 4- Rangkaian fungsi tindakbalas 5- Kesan penyimpanan terhadap telur dan pupa, dan 6- Kesan racun serangga ke atas *Apertochrysa* sp. pada peringkat yang berlainan.

Daripada 43 tumbuhan tempatan yang dikaji selidik hanya 18 tumbuhan mempunyai telur *Apertochrysa* sp. Pokok limau menunjukkan bilangan telur *Apertochrysa* sp. yang tertinggi, 65.84% (4 telur/ tumbuhan). *Telenomus* sp. memberi kesan yang tinggi keatas telur *Apertochrysa* sp. dan kesan parasitisma yang tinggi direkodkan pada telur yang di kumpul dari pokok jagung (14%), manakala kesan parastisma pada telur yang dikumpul dari pokok limau, 9.2%.

Tiada perbezaan ketara antara ketinggian dari paras tanah (0-1 m, 1-2 m dan 2-3 m) dengan kehadiran telur, tetapi bahagian sebelah timur tumbuhan melaporkan 79.8% telur seolah lebih menarik bagi *Apertochrysa* sp. betina untuk proses oviposisi. Pada pokok jagung manis, 100% telur dijumpai pada ketinggian 1-2 m dari paras tanah, dan tiada perbezaan ketara antara bilangan telur yang dijumpai pada bahagian sebelah timur atau barat. Bilangan telur *Apertochrysa* sp. yang dijumpai pada permukaan atas dan bawah daun menunjukkan perbezaan yang ketara bagi kedua-dua pokok limau dan jagung. Bilangan telur *Apertochrysa* sp. yang paling tinggi dijumpai pada hari ke-60 selepas penanaman pokok jagung manis.

Tempoh pertumbuhan larva *Apertochrysa* sp. pada suhu 15°C, 20°C, 25°C, dan 28°C dengan ±3°C (keadaan makmal) masing-masing adalah 50.54, 41.9, 11.3, dan 15.7 hari, manakala jumlah tempoh pertumbuhan dari peringkat telur ke dewasa adalah 88.4, 68.8, 29.5 dan 33.3 hari. *Apertochrysa* sp. telah berjaya dikulturkan dan menyempurnakan kitaran hidup dengan telur *Corcyra cephalonica*, *Rapolasiphum maidis*, *Aleurodicus disperses* Russell dan *Aleurocanthus woglumi* Ashby. Jumlah tempoh pertumbuhannya masing-masing adalah 29.5, 25.4, 22.8 dan 30 hari.

Jangka hidup (l_x) *Apertochrysa* sp. bagi tiga kelompok yang berlainan menunjukkan angka kematian yang tinggi semasa peringkat telur, larva (khususnya instar ke-2) dan pupa. Kadar pertambahan semulajadi (r) adalah 0.02 (betina / betina / hari) dengan purata tempoh penghasilan (T) 40.6 hari. Jumlah kadar pembiakan purata (R□) bagi populasi tersebut adalah 2.3 hari. Tempoh bagi mengganda dua (DT) populasi adalah 14.8 hari.

Bilangan tertinggi aphid, *R. maidis,* yang dimakan berlaku pada peringkat larva instar ke-3 (42.95 aphid/ larva), diikuti dengan peringkat instar ke-2 (36 aphid/ larva), kemudian peringkat instar pertama (31.14 aphid/ larva). Bilangan telur *C. cephalonica* yang telah dimakan pada peringkat larva instar pertama, ke-2 dan ke-3 *Apertochrysa* sp. adalah masing-masing sebanyak 68.4, 232.1, 494.6 telur/larva.

Tempoh penyimpanan telur *Apertochrysa* sp. yang paling lama adalah 9.49 hari pada 15°C diikuti dengan 7.31 hari pada 20°C, manakala pupa yang telah disimpan untuk 20 hari pada 20°C menunjukkan angka kematian yang paling rendah (16.2%) dengan menghasilkan peratusan dewasa berkualiti tinggi yang baik (67.52%). Walaubagaimanapun, pupa yang disimpan pada suhu 15°C selama 40 hari menghasilkan 100% kecacatan.

Empat jenis racun serangga (carbaryl, cypermethrin, azadirachtin, dan imidacloprid) yang telah diuji ke atas telur *Apertochrysa* sp. dalam makmal menunjukkan kesan yang agak berbahaya di mana julat angka kematian telur adalah dalam lingkungan 43.33% hingga 63.33%. Apabila racun serangga tersebut digunakan ke atas peringkat larva instar

ke-3, angka kematian pada jam ke-72 adalah kurang daripada 13.33% dan semua racun serangga dikategorikan sebagai tidak berbahaya. Berdasarkan kesan-kesan racun serangga terhadap kejayaan proses menjadi pupa, carbaryl (angka kematian 7%), cypermethrin (angka kematian 10%), azadirachitin (angka kematian 23.15%) dan imidacloprid (angka kematian 25.92%) telah dikategorikan sebagai tidak berbahaya.

Berdasarkan kejayaan proses menjadi dewasa daripada larva instar ke-3 yang diracuni, cypermethrin, azadirachitin dan imidacloprid adalah tidak berbahaya sementara carbaryl adalah berbahaya. Racun serangga yang digunakan ke atas pupa menunjukkan kesan yang tidak berbahaya (angka kematian $\leq$ 20%). Namun begitu, berdasarkan kesan terhadap kejayaan proses menjadi dewasa daripada pupa yang diracuni, azadirachitin (angka kematian 10%) adalah tidak berbahaya, cypermethrin (angka kematian 50%) dan imidacloprid (angka kematian 56.7%) adalah sedikit berbahaya dan carbaryl (angka kematian 100%) adalah berbahaya.

Keempat-empat jenis racun serangga mencatatkan kesan berbahaya (angka kematian 100%) apabila digunakan ke atas *Apertochrysa* sp. dewasa dalam tempoh 72 jam.

Green lacewing *Apertochrysa* sp.yang terbaru di rekodkan adalah pemangsa yang penting dalam persekitaran agro-ekosistem Malaysia. *Apertochrysa* sp. mempunyai toleransi yang tinggi terhadap racun serangga, berpotensi tinggi terhadap serangga perosak yang lain dan berjaya di kultur secara besar besaran di makmal. Ciri ciri ini membolehkannya berfungsi sebagai agen kawalan biologi dan digunakan untuk mengawal berbagai perosak lepidopteran dan homopteran.

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