



UNIVERSITI PUTRA MALAYSIA

**PREY - PREDATOR RELATIONSHIP BETWEEN THE ASIAN CITRUS
PSYLLID (*DIAPHORINA CITRI* KUWAYAMA) AND THE METALLIC
BLUE LADYBEETLE (*CURINUS COERULEUS* MULSANT**

ALBERTUS SOEMARGONO

FP 2007 4



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By

ALBERTUS SOEMARGONO

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
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ALBERTUS SOEMARGONO

**DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA**

2007



DEDICATION

I dedicate this thesis to my loving wife, Fiet Afiatie and my daughters, Dyah Kallista Sofia and Riska Dewanti Sofia.



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

PREY – PREDATOR RELATIONSHIP BETWEEN THE ASIAN CITRUS PSYLLID (*DIAPHORINA CITRI* KUWAYAMA) AND THE METALLIC BLUE LADYBEETLE (*CURINUS COERULEUS* MULSANT)

By

ALBERTUS SOEMARGONO

April 2007

Chairman : Associate Professor Rohani Ibrahim, PhD

Faculty : Agriculture

The Asian citrus psyllid, *Diaphorina citri* Kuwayama is one of the citrus most notable pests of economic importance, owing not only to the direct damages caused but also indirect ones. It is the principal vector of the greening disease which is considered as the most serious disease of citrus in the world. It was noted that the greening disease has destroyed an overall estimate of 50 millions trees, most of this loss being accounted for by South and South East Asian countries in 1980's. A survey conducted by the Department of Agriculture, Malaysia in 2001 showed that 52% of *Citrus suhuensis* cv. Limau madu grown in Peninsular Malaysia indicated positive symptom of the greening disease. To overcome this problem, pest control measures including biological control have been attempted. The metallic blue ladybird beetle, *Curinus coeruleus* Mulsant, one of the predaceous coccinellids, is known to reduce the population of *D. citri*.



However, its potential as a biological control agent has never been evaluated. Results obtained from the present laboratory and field studies showed that: (1) Demographic parameters of *C. coeruleus* fed *D. citri* nymphs are: the development of immature stages took 19.1 ± 0.3 days; adult females lived for 34.2 ± 4.7 days, produced a mean of 80.3 ± 13.6 progeny per female during an oviposition period of 21.3 ± 1.4 days; the sex ratio was 0.36 : 0.64 or 1 : 1.8 ($\text{♂} : \text{♀}$); while the intrinsic rate of natural increase (r_m) was 0.116/female/day; the net reproductive rate (R_0) was 59.08; the capacity of increase (r_c) was 0.113, and the finite rate of increase (λ) was 1.122 female/day. Hence, each female contributed 60.24 individuals to the population within a mean generation time (T) of 35.33 days. On reaching the stable age distribution, about 50 % of the population consisted of the nymph-preying larvae and adult stages. (2) In general, the predator exhibited the Type II functional response. The attack rates increased with the increase in predator stages but varied with prey instars. The handling times changed inversely to the attack rate. (3) *Curinus coeruleus* exhibited body size preference for *D. citri* nymphs comparable to or slight smaller than the predator's size (stages). This preference appeared to be due to the probability of success in capturing preys. (4) The distribution pattern of *D. citri* in the host plants followed a negative binomial distribution, while that of *C. coeruleus* could not be evaluated since it was hardly ever found concurrently with *D. citri* in the field. The population of *D. citri* tended to be higher in the upper canopy than in the lower one, and (5) The citrus psyllids were found on orange jasmine (in the field and potted plants) and citrus plants at every occasion during the study. In

contrast, the predator, *C. coeruleus* was found only on the potted orange jasmine plants (*Murraya paniculata*) where pruning and insecticide application was not practiced. Not only did the flushing condition appear to regulate the psyllid population, but also rainfall, the only one climatic factor that significantly influenced the psyllid population fluctuation. Beside the predator, two nymphal parasitoids, *Tamarixia radiata* and *Diaphorencyrtus aligarhensis*, were found in the ecosystem of the potted orange jasmine plants. Simultaneous parasitism by both parasitoids against the citrus psyllids reached as high as 49%. The results implied that *C. coeruleus* could establish well only in the stable habitat. Hence, in practice, it may be utilized as a biological control agent against *D. citri* when releasing this predator is carried out on the plants neither pruned nor sprayed with insecticide. For example, releasing *C. coeruleus* is on *Leucaena* trees planted as hedge or windbreak crops surrounding citrus orchards.



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

**HUBUNGAN ANTARA KUTU LOMPAT LIMAU (*DIAPHORINA CITRI*
KUWAYAMA) DAN KUMBANG BIRU METALIK (*CURINUS*
COERULEUS MULSANT)**

Oleh

ALBERTUS SOEMARGONO

April 2007

Pengerusi : Profesor Madya Rohani Ibrahim, PhD

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Kutu lompat limau Asia, *Diaphorina citri* Kuwayama ialah salah satu perosak limau yang terpenting dari segi ekonomi, bukan hanya merosakkan pokok secara langsung, tetapi juga merosak secara tidak langsung. Ia adalah vector utama bagi penyakit greening limau yang dianggap sebagai penyakit limau paling serius di seluruh dunia. Pada dekad 80an penyakit ini dianggarkan memusnahkan hampir 50 juta pokok limau yang mana sebahagian besar ditanam di Asia Selatan dan Asia Tenggara. Satu bancian yang dilaksanakan oleh Jabatan Pertanian Malaysia pada tahun 2001 telah mendapati bahawa 52% pokok Limau madu (*Citrus suluensis*) di seluruh Semenanjung Malaysia menunjukkan simptom positif kepada penyakit greening limau. Untuk mengatasi masalah ini berbagai cara pengawalan termasuk pengawalan secara biologi telah diusahakan. Kumbang



ladybird biru metalik, *Curinus coeruleus* Mulsant, yang merupakan salah satu coccinellid pemangsa ke atas kutu lompat limau, telah diketahui dapat mengurangkan populasi kutu tersebut. Meskipun demikian, nilai potensinya sebagai agen pengawal biologi belum pernah dikaji. Dari hasil kajian kini di makmal dan di lapangan telah menunjukkan bahawa: (1) Parameter demografi *C. coeruleus* yang diberi makan nimfa *D. citri* ialah: perkembangan peringkat bukan dewasa mengambil masa 19.1 ± 0.3 hari; betina dewasa dapat hidup selama 34.2 ± 4.7 hari, menghasilkan purata 80.3 ± 13.6 progeneri setiap ekor betina selama masa bertelur 21.3 ± 1.4 hari; nisbah jantainya ialah $0.36 : 0.64$ atau $1 : 1.8$ (σ^7 : ♀); kadar pembiakan net (R_0) ialah 59.08, keupayaan pertambahan (r_c) ialah 0.113; kadar pertambahan finit (λ) ialah 1.122/betina/hari, manakala pertambahan intrinsik semulajadi (r_m) ialah 0.116/betina/hari. Dengan demikian, setiap betina menyumbang 60.24 individu kepada populasi dalam masa purata generasi (T) selama 35.33 hari. Apabila mencapai keadaan populasi di mana distribusi umur adalah stabil, lebih kurang 50% merupakan peringkat yang memangsa iaitu peringkat larva dan dewasa. (2) Secara amnya, mempamerkan respon fungsian jenis II. Kadar serangan meningkat selaras dengan meningkatnya peringkat pemangsa, tetapi berbeza-beza dengan peringkat instar mangsa. Masa menangani pemangsaan berubah-ubah songsong dengan kadar serangan. (3) *Curinus coeruleus* menunjukkan kecenderungan terhadap saiz nimfa *D. citri* sama ada sama atau kecil sedikit berbanding saiz (peringkat) pemangsa. Kecenderungan ini nampaknya berhubung kait dengan kebarangkalian kejayaan penangkapan mangsa. (4) Pola taburan *D. citri* pada pokok perumah mengikuti

taburan binomial negatif, sementara taburan pemangsa, *C. coeruleus* tidak dapat dikaji kerana sangat sedikit jumlahnya dan sukar diperhatikan pada pokok perumah di lapangan. Populasi *D. citri* lebih cenderung berkerumun di bahagian atas sudur berbanding di bahagian bawah. (5) Sepanjang penyelidikan, kutu lompat limau selalu dapat dijumpai baik pada pokok limau mahupun pada pokok kemuning, *Murraya paniculata* (di lapangan dan dalam pasu). Sebaliknya, pemangsa, *C. coeruleus* hanya didapati pada pokok kemuning yang di dalam pasu sahaja, di mana ianya tidak pernah dicantas mahupun disembur dengan racun. Populasi *D. citri* nampaknya tidak hanya dipengaruhi oleh keadaan penambahan tunas muda pada pokok perumah, tetapi juga dipengaruhi oleh curahan hujan, satu-satunya faktor iklim yang mempengaruhi fluktuasi populasi kutu lompat dengan bererti. Selain daripada pemangsa, pada pokok perumah kemuning yang ditanam di dalam pasu juga dijumpai dua jenis parasitoid nimfa, iaitu *Tamarixia radiata* and *Diaphorencyrtus aligarhensis*. Kedua parasitoid tersebut secara serentak dapat memparasit nimfa *D. citri* sebanyak 49%. Hasil kajian menunjukkan bahawa *C. coeruleus* dapat menetap dengan baik pada habitan yang mantap. Dengan demikian, secara praktik, ia boleh dimanfaatkan sebagai ejen pengawalan biologi terhadap *D. citri* apabila pelepasan pemangsa tersebut dilaksanakan pada pokok-pokok yang tidak dipangkas mahupun disembur dengan racun serangga. Sebagai contoh, pelepasan *C. coeruleus* pada pokok petai belalang yang ditanam untuk pagar atau penahan angin di sekitar ladang limau.



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I certify that an Examination Committee has met on April 27, 2007 to conduct the final examination of Albertus Soemargono on his Doctor of Philosophy thesis entitled “Prey-Predator Relationship between the Asian Citrus Psyllid (*Diaphorina citri* Kuwayama) and the Metallic Blue Ladybeetle (*Curinus coeruleus* Mulsant)” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

ALBERTUS SOEMARGONO

Date: 26 June 2007



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