UNIVERSITI PUTRA MALAYSIA

BIOLOGY OF COCHLOCHILA BULLITA STAL AS POTENTIAL PEST OF ORTHOSIPHON ARISTATUS (BLUME) MIQ. IN MALAYSIA

TAN LI PENG

BIOLOGY OF *Cochlochila bullita* (STÅL) (HEMIPTERA: TINGIDAE), A POTENTIAL PEST OF *Orthosiphon aristatus* (BLUME) MIQ. (LAMIALES: LAMIACEAE) IN MALAYSIA

By

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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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Cochlochila bullita (Stål) is an importance pest in some Asia countries such as India, Kanpur and Thailand attacking plants form the genus *Ocimum*, herein its common name, ocimum tingid. *Cochlochila bullita* is first recorded in Malaysia in the year 2009, attacking one of the important medicinal herbs in this country, the *Orthosiphon aristatus* (Blume) Miq. Biology of this pest was studied to get a deeper understanding of this bug associated with *O. aristatus*, which will lead to better integrated management on this pest. Morphology and morphometric of *C. bullita* were described and measured from 15 samples of all developmental stages of this bug in order to provide the fundamental reference for identification. From here, *C. bullita* possessed a body length and width ratio for about 1.51 to 1.59 mm and the head capsule width was recommended to distinguish the instars. Life-tables of this pest on *O. aristatus* and *Ocimum basilicum* Linnaeus were constructed by analyzing the life-parameters from 10 cohorts on each plant. Results showed that on *O. aristatus* significantly higher finite rate of increase (λ), 1.07 and intrinsic rate of increase (r_m), 0.07 were obtained and thus suggest that *C. bullita* performed better on *O. aristatus*. The preferences of *C. bullita* toward these two plants were also examined, it preferred *O. aristatus*; with a notable feeding preference and relatively higher oviposition preference. The reason of this phenomenon was presumed related to the trichomes density of the plants; hence a further investigation on the correlation between the trichomes density and the number of eggs deposited was conducted. Strong, positive and significant correlation was found on the *O. aristatus*. Some behavioural studies were carried out, particularly the mating behaviour and maternal care of this species to comprehend how this bug adapts to produce and ensure the succession of its own kinds. One male was freely mixed around with five females in 7 days. Results showed that the male *C. bullita* was able to fertilize maximum up to four females within the given periods. In the other hand, females were tested for their maternal care, samples collected from the field were tested by provoking the females

with a standard protocol; no aggressive approach were shown by the females and hence concluded that this bug possessed only passive guarding behaviour. Injuries caused by this bug were assessed by measuring the injury area, chlorophyll content and faeces production. Results showed a significant higher injury area, faeces production and chlorophyll depletion on *O. aristatus*. Water content was presumed play a role in the susceptibility of *O. aristatus*; as *O. basilicum* having higher water content 91% than *O. aristatus* with only 88%. After all, *O. aristatus* is attractive to *C. bullita* but the tolerance of this plant towards the infestation of the bug is relatively low. Water content and the trichomes density of the plant were believed that contributed to this selectivity and susceptibility. Knowledge of the biology assists in identifying, recognizing and monitoring the insect pest is a important input towards develop a better management strategy for this pest.

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BIOLOGY OF *Cochlochila bullita* (STÅL) (HEMIPTERA: TINGIDAE), A POTENTIAL PEST OF *Orthosiphon aristatus* (BLUME) MIQ. (LAMIALES: LAMIACEAE) IN MALAYSIA

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Cochlochila bullita (Stål) merupakan salah satu perosak yang penting di negara-neagara Asia seperti India, Kanpur dan Thailand yang menyerang pokok bawah genus *Ocimum*, dengan ini, dapat namanya ocimum tingid. *Cochlochila bullita* juga didapati dan pertama kalinya direkodkan di Malaysia pada tahun 2009. Perosak ini menyerang salah satu pokok herba terkanal di negara ini, iaitu *Orthosiphon aristatus* (Blume) Miq. Oleh itu, biologi bagi perosak ini telah dikaji untuk mendapat informasi yang lagi mendalam bagi perosak yang menyerang pokok *O. aristatus*. Morfologi dan morfometrik serangga ini telah digambarkan dan diukur dari 15 sampel serangga bagi setiap instar supaya informasi ini dapat dijadikan satu rujukan untuk pengenalan spesis tersebut. Daripada kajian ini, ratio panjang bahagikan dengan lebar badan serangga ini adalah di antara 1.51 hingga 1.59 mm dan lebar kepala serangga ini adalah parameter yang disyorkan untuk digunakan untuk pengelasan peringakat nympha. Jadual hidup perosak ini juga dikaji dengan menggunakan 10 cohorts atas pokok *O. aristatus* dan *Ocimum basilicum* Linneaus. Adalah didapati kadar pertambahan finit harian (λ), 1.07 and kadar pertambahan intrinsik semula jadi (r_m), 0.07 bagi *C. bullita* yang hidup pada *O. aristatus* adalah lebih tinggi daripada *C. bullita* yang hidup pada *O. basilicum*. Dengan ini, serangga ini mempunyai prestasi yang lebih tinggi apabila hidup pada *O. aristatus.* Selain itu, perosak ini juga didapati lebih cendorong kepada *O. aristatus* dari segi pemakanan dan pemilihan tempat bertelur. Keadaan ini dijangka adalah disebabkan oleh kepadatan trichomes yang terdapat pada pokok tersebut; oleh itu kajian hubungan antara kepadaptan trichomes dan bilangan telur yang terdapat telahpun dijalankan. Satu hubungan yang rapat, positif dan ketara didapati pada serangga yang bertelur pada the *O. aristatus*. Tambahan pula, kelakuan perosak ini terutamanya dari segi pengawanan dan penjagaan telur juga dikaji. Keputusan menunjukkan apabila satu jantan dikenalkan dengan lima betina dalam tempoh 7 hari, jantan tersebut dengan maksimum berjaya mengawan dengan 4 betina. Manakala, betina yang dikaji dari

segi kebolehan menjaga telur tidak mempertahankan telurnya apabila dicabar. Dengan ini disimpulkan betina *C. bullita* hanya menlindungi telurnya secara pasif. Kecederaan pada pokok yang diakibatkan oleh perosak ini juga dinilai dengan mengukur kawasan kecederaan, pengurangan kandungan klorofil dan penghasilan perkumuhan. Data menunjukkan ketiga-tiga pembolehubah ini adalah lebih tinggi pada *O. aristatus*. Kandungan air dalam *O. aristatus* diramal memainkan peranan atas toleransi pokok tersebut terhadap seranggan serangga; ini dapat dijelaskan dengan *O. basilicum* yang mempunyai kandugan air sebanyak 91% dalamnya dan *O. aristatus* yang hanya mempunyai 88%. Secara kesimpulan, *O. aristatus* adalah lebih disukai oleh *C. bullita*, akan tetapi toleransi pokok ini terhadap serangan *C. bullita* adalah agak rendah. Akhirnya, kandungan air dan kepadatan trichomes untuk pokok tersebut dijangka merupakan faktor yang menyebabkan kecenderungan *C. bullita* kepada *O. aristatus* dan ketahanan pokok ini terhadap serangan *C. bullita*. Informasi biologi perosak ini penting untuk membina strategi pengurusan perosak yang lebih baik supaya dapat menandangi perosak secara lebih efisien dan selamat.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the Degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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USDA	United States Department of Agriculture
IPM	Integrated Pest Management
GRIN	Germplasm Resources Information Network

CHAPTER ONE

INTRODUCTION

Orthosiphon aristatus (Blume) Miq. is a well known medicinal plant from the family Lamiaceae. It can be found throughout Southeast Asia and also tropical Australia with several common names. The most widely used common name, cat's whiskers plant, is derived from the appearance of its flower with two-lipped and protruding stamens. *Orthosiphon aristatus* is a fast growing perennial herbaceous plant, 1 – 2 m tall, with multiple branches stem and oppositely growing ovate leaves (Dzulkarnain *et al.* 1999). Apart from its medicinal uses, the plant is planted ornamental as it has attractive solid-white or lavender flowers.

As an important plant with medicinal properties, the plant has been widely used among many communities. It has been trusted for many centuries for treating ailments of the kidney, kidney stone, urinary tract infection, liver and bladder problems, diabetes and many other ailments (Indubala and Ng 2000). Its effectiveness for treating bladder and kidney stone had given it a Chinese name "hua shi cao", which means stone dissolving plant. In Malaysia, it is a traditional herb often consumed as herbal tea. In a recent study, the extract form this plant has high anti-oxidant content and can be used to prevent and control the growth of cancer cells (Chin *et al.* 2009).

There are currently many products of *O. aristatus* marketed as herbal tea, supplement capsule and even soap. In Okinawa, Japan this plant is even systematically cultivated to produce and consume as a healthy tea (Awale *et al.* 2002). Presently, there is a shortage in this herbal resource as the demand of Malaysian consumers exceeds the supply of the product (Farhana *et al.* 2007). Although no mass planting of this plant is practiced in Malaysia, the potential of this plant to be widely produced is a certainty. Therefore, proper cultivation and management of this plant is required, especially when dealing with pests and diseases.

Since its establishment as an important crop, the herb has been notably free from serious insect problems until recently. In August 2009, the herb, grown in a backyard garden at Subang Jaya, Selangor, Malaysia, was heavily attacked by an unknown lace bug. A research station in Kelantan also reported that there is a similar insect pest infestation that kills the plant. Several photographs of the lace bug were sent to Dr. Thomas J. Henry, a research entomologist from United States Department of Agriculture (USDA), Systematic Entomology Laboratory, Washington, DC and Dr. Masaki Tomokuni, a researcher at the National Science Museum, Tokyo. Both scientists identified the lace bug, *Cochlochila bullita* (Stål), commonly known as the ocimum tingid.

The economic importance of the lace bug has been increasing since the last four decades (Neal and Schaefer 2000). The bugs once believed as a monophagous pest (Drake and Ruhoff 1965; Livingstone 1977; Cobben 1978) were found to attack other plants and indicating that many species may be oligophagous (Tomokuni 1983; Wheeler 1989; Qi, *et al.* 1991). With a relatively specific host range, lace bug, *Teleonemia scrupulosa* Stål was used as biological control agents for controlling weeds, such as *Lantana camara* (Linnaeus) (Harley and Kassulke 1971).

As a pest, *C. bullita* had caused outbreak in India in 1950 and 1983 respectively (Mohanasundram and Rao 1973; Palaniswami and Pillai 1983). To date no study has been conducted elsewhere on account of the quality and efficacy of any herbal functional product or medicine that is highly dependent on the source - the plant material, proper managements on this pest become a necessity. Thus a biological study was needed to clearly define the morphology, growth and development, damage caused, and behaviour of this pest in order to manage the pest.

The morphology of the insect pest needs to be studied thoroughly with pictures provided for correct identification. External appearance of the insect has to be described qualitatively (shape or colour) and quantitatively (measurement). Apart from morphological studies, the life cycle and growth pattern of an insect on a particularly host, represented by its life table, need to be investigated. By constructing a life table of the pest, a comprehensive description of the insect growth and survival could be gathered. This is useful information for estimating the insect population.

In order to accomplish an effective pest management, knowledge on the behaviour of the insect is very pertinent. Among the behaviours that allow an insect successfully thrive as a pest are reproductive behaviour and host preferences. These behaviours are a collective response to maximise the fitness of one species and an ultimate success throughout the evolution. This is vital information required for developing a management strategy to minimize the number of this pest under threshold level and prevent it from outbreak.

Feeding and oviposition behaviours have been shown to cause injury on the host plants. These injuries are reflected on the damages inflicted by the insect on the plants. Many methods have been used to appraise the level of damages of a particular insect on a crop. The result of the assessment provides fundamental information for developing the decision making guidelines such as the Economic Injury Level (EIL) and Aesthetic Injury Level (AIL) (Klingeman *et al*. 2001).

Even though, ocimum tingid, *C. bullita* has the potential to rise as a serious pest of *O. aristatus*. Heretofore, there were no studies on the life table parameters, development, fecundity and behaviours for this pest associated with *O. aristatus*. Thus this study

was aimed of gathering information on the full life table parameters and behaviours of *C. bullita* on *O. aristatus* with *O.basilicum* as a compare model. This is to provide a better understanding of the biology of the pest for the purpose of pest management. Therefore, the objectives of this study were to analyse the biology of *C. bullita*, in order to establish continuous rearing for biological control purposes.

The specific objectives of this thesis were:

i. to describe the external morphology of *C. bullita*.

ii. to establish the life table of *C. bullita* on *O. aristatus* and *O.basilicum.*

iii. to examine the mating behaviour and maternal care of *C. bullita*.

iv. to determine the host preference of *C. bullita* on *O. aristatus* and *O. basilicum* in response to the plants' trichomes.

v. to assess the injury pattern of *C. bullita* on *O. aristatus* and *O. basilicum.*

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