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DEVELOPING A DIET OF CATERPILLARS AND MEALWORMS FOR MASS REARING OF THE PREDATORY BUG CANTHECONIDEA FURCELLATA (WOLFF.) (HEMIPTERA: PENTATOMIDAE

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By

EVAWATY SRI ULINA

Thesis Submitted in Fulfilment of the Requirements for the
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UPM

To my beloved parents.....

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Agricultural Science

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Chairman : Professor Dr. Khoo Khay Chong

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The asopin bug, *Cantheconidea furcellata* Wolff., is a promising biological control agent against leaf-eating caterpillars of oil palms. Therefore, the bugs should be mass reared efficiently, effectively and economically. A major challenge to the rearing of the predatory bugs is to overcome the difficulty of keeping them fed with live prey. One approach to improve mass rearing is to reduce the dependence on live caterpillars as a food source.

A food item that is readily available and accepted by *C. furcellata* is the mealworms (larvae of *Tenebrio molitor*). In a series of experiments, mealworms were compared with the larvae of *Spodoptera litura* as food

sources. The larvae of *S. litura* were evaluated live, frozen, reared on artificial diet and natural diets. The results showed that larvae of *S. litura* reared on either fresh foliage or artificial diets were the best food sources and that mealworms should be used as a supplementary source.

The second part of the study determined the stage of the nymph during which it is critical to provide live larvae of *S. litura*. The results suggest that developmental and survival rates of second instar nymphs fed live larvae of *S. litura* was comparable to the control (bugs fed live larvae throughout the nymphal stage). However, in terms of the weight of adult females, the control was the best.

The third and final part of the study evaluated the effect of nymphal diet on the reproductive performance of the female bugs. In terms of fecundity and hatchability, feeding the second instar of *C. furcellata* with live larvae of *S. litura* was just as good as feeding the entire nymphal stage with the larvae.

It can be concluded that it is only necessary to feed the second instar nymphs of *C. furcellata* with quality food, i.e. the live larvae of *S. litura*, while other instars may be fed mealworms without affecting growth, survival, fecundity and hatchability of *C. furcellata*.

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

MEMAJUKAN SUMBER PEMAKANAN DARI ULAT DAN ULAT TEPUNG BAGI PEMBIAKAN BESAR-BESARAN KEPINDING PEMANGSA *CANTHECONIDEA FURCELLATA* (WOLFF.) (HEMIPTERA: PENTATOMIDAE)

Oleh

EVAWATY SRI ULINA

September 2000

Pengerusi : Professor Dr. Khoo Khay Chong

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Kepinding jenis asopin, *Cantheconidea furcellata* Wolff., merupakan agen kawalan biologi ulat pemakan daun kelapa sawit. Oleh itu, kepinding ini harus dipelihara secara besar-besaran dengan cekap, berkesan dan ekonomik. Namun begitu, kesulitan untuk membekalkan mangsa hidup sebagai makanan kepinding ini merupakan suatu cabaran utama yang perlu diatasi terlebih dahulu. Satu pendekatan untuk memperbaiki pembiakan besar-besaran ialah dengan mengurangkan ketergantungan kepada ulat pemakan daun yang hidup sebagai sumber pemakanan.

Bahan makanan yang tersedia ada dan boleh diterima oleh *C. furcellata* ialah sejenis ulat tepung (larva *Tenebrio molitor*). Dalam beberapa siri kajian yang

dilakukan, ulat tepung telah dibandingan dengan larva *Spodoptera litura* sebagai sumber pemakanan. Penilaian telah dilakukan ke atas larva *S. litura* yang masih hidup, dibekukan, dan dipelihara menggunakan diet tiruan dan asli. Hasil penilaian menunjukkan larva *S. litura* yang dipelihara sama ada menggunakan daun segar atau makanan tiruan adalah yang terbaik untuk dijadikan sumber pemakanan dan ulat tepung pula digunakan sebagai sumber pemakanan tambahan.

Bahagian kedua kajian ini menentukan peringkat nimfa yang paling kritikal bagi pembekalan larva *S. litura* yang hidup. Keputusan cadang kadar perkembangan dan kemandirian kepinding yang dibekalkan larva hidup *S. litura* diperingkat nimfa instar kedua adalah setanding dengan rawatan kawalan (kepinding yang dibekalkan larva hidup sepanjang peringkat nimfa). Walau bagaimanapun, dari sudut berat dewasa betina, rawatan kawalan adalah yang terberat.

Bahagian ketiga dan terakhir kajian menilai kesan diet nimfa terhadap keupayaan pembiakan kepinding betina. Dari segi fekunditi dan penetasan, pembekalan larva hidup *S. litura* kepada instar kedua *C. furcellata* adalah sama baiknya dengan pembekalan kepada semua peringkat nimfa yang ada.

Kesimpulan dibuat ialah peringkat instar kedua nimfa *C. furcellata* memerlukan pembekalan bahan makanan berkualiti, yakni larva *S. litura*, manakala peringkat instar yang lain memadai dibekalkan ulat tepung tanpa memberi kesan terhadap tumbesaran, kemandirian, fekunditi dan penetasan *C. furcellata*.

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CHAPTER I

INTRODUCTION

Oil palm is one of the most important plantation crops in Malaysia. In 1996, the country had more than 2.6 million ha of oil palm and produced 8.39, 1.11, 1.38 and 0.91 million tonnes of palm oil, palm kernel oil, palm kernel cake and oleochemicals, respectively. The exported products earned Malaysia RM 11.51 billion (Porla, 1997). The large export values illustrate the significant contributions of the oil palm industry in the socio-economic development of Malaysia.

The Gross National Product (GNP) could be higher if the oil palm industry can reduce the cost of production. According to Davidson (1991) improved agronomic practices could reduce or maintain the cost of production. An efficient and effective management system for oil palm pests could also reduce cost considerably.

Various pests attacking the oil palm have been described by Wood (1968). These include insects, particularly beetles and caterpillars, some mites and vertebrates. Amongst these pests, the defoliating caterpillars are the

major pests which have caused extensive outbreaks (Teh, 1996). Actually, these pests are classified as occasional pests (Hoong and Hoh, 1992; Chung *et al.*, 1995). They are normally kept under good control by natural enemies, but may flare up from time to time in the absence of natural control. When present in large numbers, they can cause extensive defoliation, eventually affecting yield. Hoong and Hoh (1978) reported that defoliation by nettle caterpillar (*Setora nitens*) caused a reduction in yield of 27 tonnes per ha of fresh fruit bunch (ffb) in severely defoliated palms (above 60% defoliation) during a 30 month period.

There are several factors that influence the increase of a pest population to outbreak levels. The main causes are unhealthy cultural practices and intensive spraying with contact-action insecticides (Hoong and Hoh, 1992; Teh, 1996; Chung, 1998).

Integrated pest management (IPM) is considered to be a suitable approach to avoid outbreaks of leaf-eating caterpillars in oil palm (Chung *et al.*, 1995; Chung, 1998). In IPM, recommendations for pest control are based on an ecological approach. In this way natural enemies are conserved and acute and chronic outbreaks of leaf-eating caterpillars can be avoided.

The term IPM has been defined by many experts. For example, Smith and Reynold (1966) defined IPM as: "A pest management system that in the context of the associated environment and the population dynamics of the pest species, utilises all suitable technique and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economic injury". The Council on Environment Quality (1972) explained that IPM is an approach that employs a combination of techniques to control the wide variety of potential pests that may threaten crops. It involves maximum reliance on natural pest population controls, along with a combination of techniques that may contribute to suppression - cultural methods, pest-specific diseases, resistant crop varieties, sterile insects, attractants, augmentation of parasites or predators, or chemical pesticides as needed. Flint and van den Bosch (1981) defined IPM as an ecologically based pest control strategy that relies heavily on natural mortality factors such as natural enemies and weather and seeks out control tactics that disrupt these factors as little as possible.

Biological control is an important component of IPM. Biological control can be defined as the action of parasites, predators, or pathogens in maintaining another organism's population density at a lower average than would occur in their absence (De Bach, 1964). In practice it involves (a) the

conservation or maximisation of the role of indigenous organisms in the pest population, (b) repeated release of a biocontrol agent, or (c) single or occasional release of organisms or gene products.

As already explained, leaf-eating caterpillars of oil palm are normally controlled by their natural enemies, including parasitoids, predators and entomopathogens. The common parasitoids are those from the family Chalcidoidea, Ichneumonidae, Braconidae and the order Diptera (Cock, 1987; Desmier de Chenon *et al.*, 1989). Amongst the fungal pathogens infecting leaf-eating caterpillars of oil palm, *Cordyceps* is the most common in Indonesia (Desmier de Chenon *et al.*, 1989) and Malaysia (Mackenzie, 1977). Viruses as entomopathogens belong to several groups, such as Baculoviridae, Reoviridae, Iridoviridae, Parvoviridae and Picornaviridae (Entwistle, 1987). The distribution of these pathogenic viruses are from Indonesia (Kalshoven, 1981; Desmier de Chenon, 1990) to Malaysia (Tiong and Munroe, 1977) and other places in South-east Asia, West Africa and South America (Entwistle, 1987). The important predators are not only the hemipterans from Pentatomidae, Pyrrhocoridae and Reduviidae (Dolling, 1987) but also from the order Coleoptera (Desmier de Chenon *et al.*, 1989).

Among the important predators of leaf-eating caterpillars, *Cantheconidea furcellata* Wolff. (Pentatomidae, Asopinae), also referred to as *Eocanthecona furcellata,* is the most promising. It lays eggs directly on the foliage of the palms, has high fecundity, nymphs and adults live on young and mature palms, and has a short life cycle of about two months (Sipayung *et al.*, 1992).

The use of indigenous biological control agents for the purpose of augmentation or inundation requires that the species can be successfully mass reared. Successful mass rearing requires that the insect species in question can be reared economically without jeopardising quality. Conditions for the nutrition of natural enemy is of special value in the success of insect mass rearing programmes. Inadequate nutrition usually results in great changes in the metabolism (Woodring *et al.*, 1979) and behaviour (Engelmann, 1970; Agarwala and Dixon, 1992) of the insect. These changes have a negative effect on the insects released. Therefore, improvements in a diet for both immature and mature bugs offer the greatest opportunity for improving the quality of mass rearing.

Normally, rearing of the predatory bug is done by feeding with live herbivorous insects. This technique can be difficult and costly if the