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**PATHOGENICITY OF SPODOPTERA LITURA NUCLEAR
POLYHEDROSIS VIRUS TO S. LITURA F. LARVAE AND ITS IMPACT
ON SYCANUS LEUCOMESUS W.**

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PATHOGENICITY OF *Spodoptera litura* NUCLEAR POLYHEDROSIS
VIRUS TO *S. litura* F. LARVAE AND ITS IMPACT
ON *Sycanus leucomesus* W.

By

JAMES RUBINSIN KOTULAI

Thesis Submitted in Fulfilment of the Requirements for the Degree of Master
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====>>>>> Dedicated to my son, Moruling <<<<<====
==>>>>> and daughters, Dowini and Nowilin <<<<<==



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LIST OF ABBREVIATIONS

EDTA	=	Ethylenediaminetetra-acetic Acid
LC	=	Lethal Concentration
LD	=	Lethal Dose
LT	=	Lethal Time
MARDI	=	Malaysian Agricultural Research and Development Institute
NPV	=	Nuclear Polyhedrosis Virus
PIB	=	Polyhedral Inclusion Body
Probit	=	Probability Unit
SAS	=	Statistical Analysis System
SDS	=	Sodium Dodecyl Sulfate
TA	=	Tris-acetate
TE	=	Tris-EDTA
Tris	=	Tris(hydroxymethyl)aminomethane



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By

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Chairman: Assoc. Prof. Dr. Ahmad Said Sajap

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Spodoptera litura Fabricius (Lepidoptera: Noctuidae) is a pest of many agriculture and forestry crops in several parts of the world including Malaysia. One of the natural enemies responsible for regulating field population of *S. litura* is a nuclear polyhedrosis virus (NPV).

In this study, the *S. litura* NPV was tested for its actual pathogenicity to *S. litura* larvae using eight viral doses ranging from 60 to 6×10^8 PIBs/larva. The result of bioassay shows that LD_{50} , LD_{90} and LD_{99} was 5.50×10^4 , 5.26×10^8 and 9.26×10^{11} PIBs/larva, respectively. The regression equation, $Y = 3.47 + 0.32X$, indicates that an increase of larval mortality was due to an increase in viral doses. The LT of the doses was eight, six and five days, respectively, with a regression equation of $Y = 13.59 - 9.41X$.



The impact of the NPV to a predator *Sycanus leucomesus* Walker (Hemiptera: Reduviidae) was studied by providing either healthy or NPV-infected prey. The survival rate of the predator fed on infected prey was critical in first instar. However, the developmental time was not affected, even though, their length of tibia and width of head capsule were significantly reduced. The preoviposition period of the female predator fed infected prey was 12 days longer and the fecundity rate was reduced by 41%. The longevity of adults was also significantly shortened.

A single deposit of *S. leucomesus* excreta contained 1.42×10^{10} PIBs. The infectivity of the defecated NPV was comparable to that of the virus isolated directly from *S. litura* larvae. Both isolates could cause 96 larval mortality.



Abstrak tesis ini telah dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi keperluan bagi ijazah Master Sains.

**KEPATOGENAN VIRUS POLIHEDROSIS NUKLEUS *Spodoptera litura*
KEPADA LARVA *S. litura* F. DAN KESANNYA KEATAS *Sycanus
leucomesus* W.**

Oleh

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FEBUARI 1994

Pengerusi: Prof. Madya Dr. Ahmad Said Sajap

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Spodoptera litura Fabricius (Lepidoptera: Noctuidae) merupakan perosak kepada beberapa jenis tanaman pertanian dan perhutanan yang penting di beberapa tempat di dunia termasuk Malaysia. Satu daripada musuh semulajadi yang bertanggungjawab mengatur populasi *S. litura* di lapangan ialah virus polihedrosis nukleus (NPV).

Di dalam kajian ini, NPV *S. litura* telah diuji kepatogenan sebenarnya keatas larva *S. litura* dengan menggunakan lapan dos virus dari 60 ke 6×10^8 PIBs/larva. Keputusan biocerakinan menunjukkan bahawa LD_{50} , LD_{90} dan LD_{99} masing-masing bernilai 5.50×10^4 , 5.26×10^8 dan 9.26×10^{11} PIBs/larva. Persamaan regresi, $Y = 3.47 + 0.32X$, menunjukkan bahawa

peningkatan kematian larva adalah disebabkan oleh peningkatan dos virus. LT bagi dos-dos tersebut ialah masing-masing bernilai lapan, enam dan lima hari dengan persamaan regresi $Y = 9.99 - 5.44X$.

Kesan NPV kepada pemangsa, *Sycanus leucomesus* Walker (Hemiptera: Reduviidae) telah dikaji dengan memberikan mangsa sama ada yang sihat ataupun dijangkiti NPV. Kadar kemandirian nimfa pemangsa yang telah memakan mangsa yang dijangkiti adalah kritikal di dalam instar pertama. Bagaimanapun, jangkamasa perkembangan tidak terganggu, walaupun, panjang tibia dan lebar kapsul kepala telah berkurangan dengan bererti. Jangkamasa prapengoviposian betina pemangsa yang memakan mangsa yang dijangkiti adalah 12 hari lebih lama dan kadar fekunditi telah berkurangan sebanyak 41%. Lanjut-usia dewasa juga telah dipendekkan dengan bererti.

Satu butir tahi *S. leucomesus* mengandungi 1.42×10^{10} PIBs. Infektiviti NPV yang terkandung di dalam tahi adalah setanding dengan virus diasing terus daripada larva *S. litura*. Kedua-dua virus boleh menyebabkan 96% kematian larva.

CHAPTER I

GENERAL INTRODUCTION

Natural population of insects living in a particular ecosystem is being maintained to a more or less equally distributed among species over a period of time by the action of both biotic and abiotic factors. The biotic factors include entomophagous insects such as parasitoids and predators and entomopathogens such as viruses, bacteria and fungi. While abiotic factors include climate, soil, air, space, and light (Hostetter and Bell, 1985). Disturbance of the naturally balanced ecosystems by means of clear-cutting and then burning of vast areas of natural forest have caused outbreaks of several economically important insect pests.

Chemical insecticides have been used widely in combating insect pest outbreaks in Malaysia. Excessive use of insecticides could not only aggravate outbreaks due to the destruction of natural enemies, but could also cause other effects such as resistance of target insects and deterioration of environment (Kurstak and Tijssen, 1982; Malaysian Agricultural Research and Development Institute, 1991).

The growing concerns by the society to the harmful effects of chemical insecticides have led to the interest of using natural enemies such as parasitoids, predators and pathogens in maintaining the population density of the pests at economically acceptable levels. However, the specificity of

microbial control agents such as viruses and bacteria to their original host means that they are unsuitable for controlling complexes of insects. Therefore, to overcome this limitation, an integrated pest management is deemed necessary.

The concept of integrated pest management is based on an optimum exploitation of indigenous and introduced mortality factors in maintaining pest species at economically acceptable densities. Insect pathogens can play a major role in pest management but their effective integration into such systems depends on their compatibility with the other components of the systems.

The polyphagous leaf-eating caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), like other insects, has its own natural enemies which keep its population density to a level below economic importance. The pathogenic nuclear polyhedrosis virus (NPV) for instance, has been observed to cause rapid mortality to its host, *S. litura* larvae. In addition, several parasitoids and predatory insects have been identified to play a key role in the regulation of the pest population. One of the predators is a generalist predator, *Sycanus leucomesus* Walker (Hemiptera: Reduviidae).

The relationship between *S. litura* and its natural enemies may be illustrated by taking the combination of *S. litura*, virus and *S. leucomesus* as one of the elements of the ecosystem. The larval stage of the pest feeds on a host plant, at the same time, its population density is reduced by the predation of *S. leucomesus*. Accidentally, the healthy larvae may also ingest polyhedra by feeding on viral-contaminated foliage.

Studies on interactions of several other economically important insect pests and their natural enemies have been carried out in detail. However, the contradicting findings between positive and negative impacts of viruses to parasitoid and predatory insects clearly suggest the need to study the interaction between specific NPV with a specific insect predator. This study was therefore, conducted with the following objectives:

1. To carry out pathogenicity test of *Spodoptera litura* NPV to its host *S. litura* Fabricius larvae.
2. To study the impacts of the NPV to a predator, *S. leucomesus* Walker.

CHAPTER II

LITERATURE REVIEW

Spodoptera litura (Fabricius)

Host Range

The polyphagous leaf-eating caterpillar, *Spodoptera litura* Fabricius (= *Prodenia litura*) is a serious pest of several economic crops in Pakistan, India, Bangladesh, Sri Lanka, East Asia, Korea, Japan, Philippines, Australasia, Pacific Islands and Fiji (Malaysian Plant Protection Society, 1989). The pest feeds on 112 cultivated food plants all over the world (Moussa *et al.*, 1960). Among the major hosts are tobacco, rice, groundnut, cotton, coffee, rubber, castor, citrus, chillies, sugarbeet, soybean, maize and many other vegetables (Singh and Sachan, 1991). In Malaysia, at least 50 different species of plants have been listed to be hosts of *S. litura* which include tobacco, groundnut, cabbage, chillies, papaya, musk melon, rubber, sweet potato, bitter gourd, banana, sugarcane, cowpea, maize and rice (Ahmad Yunus and Ho, 1980). The extent of damage was alarming. In India for instance, the pest was reported to have caused a reduction of up to 50% of tobacco leaf production (Patel *et al.*, 1971). Apart from attacking agricultural crops, *S. litura* has also been reported to cause severe damage to forest plantation species, namely, *Acacia mangium* Willd. and *Paraserianthes falcataria* Back. (Braza, 1990; Tho, 1990; Sajap, 1991).



Biology

The biology and ecology of *S. litura* have been studied and well documented by Patel *et al.* (1986), Yamanaka *et al.* (1972), Md. Jusoh and Lim (1982) and Malaysian Plant Protection Society (1989). The adults are light to dirty brown with about 14 - 16 mm body length and wing span of 35 - 88 mm. The lifespan of male and female are 6 and 12 days, respectively. Oviposition occurs 24 hours after emergence. Md. Jusoh and Lim (1982) however, recorded a shorter lifespan of the adults with male and female having two to four and five to eight days, respectively. Eggs of about 200 - 300 were laid in clusters on the beneath of the host leaves and covered with abdominal hairs (Malaysian Plant protection Society, 1989). The total number of eggs laid by single female throughout its lifespan ranges from 2507 to 3467 in about 13 clusters. The incubation periods of eggs averaged 4.80 days with 87% of them hatched (Patel *et al.*, 1986).

The newly hatched larva is tiny, blackish green with a distinct black band on the first abdominal segment. The larva undergoes six instars with 1st, 2nd, 3rd, 4th, 5th and 6th averaging 3.1, 2.6, 2.8, 3.6, 3.7 and 2.8 days, respectively. Pupation, which lasts for 7 to 11 days, normally occurs just below the soil surface (Patel *et al.* 1986). Other studies (Patel and Chari, 1987) also recorded six instars except that of Md. Jusoh and Lim (1982) and Malaysian Plant Protection Society (1989) where only five instars were recorded. The variation in growth of *S. litura* has been found to be affected by the type of host plant being eaten (Balasubramanian *et al.*, 1984; Bhalani, 1989; Izani, 1992).