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The Biology and Ecology of Valanga nigricornis *and Its Control in the Cover Plants under* Hevea brasiliensis *in Malaysia*

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Biological and ecological investigations of the pest Valanga *in leguminous cover plants under rubber were studied in the laboratory and field. Field studies were carried out by sampling the natural population of* Valanga *as well as its natural enemy,* Tenodera aridifolia. *Laboratory studies were based on field observations of the seasonal abundance of adults and nymphs predator-prey relationships to size and susceptibility of nymphal instar and field application rates of selected insecticides in wooden cages.*

Pueraria phaseoloides *was found to be not only an ideal trap-crop for the development of beneficial insects, but also* Valanga. *For the long-term control of* Valanga, *efforts should be made in controlling the nymphs before they became adults. Scouting for the presence of nymphs should be made as early as August. In the event of a population outbreak, chemical control should be exercised to kill adults as well as nymphs.*

For quick killing of Valanga *nymphs which were less mobile, insecticides in descending order of effectiveness were acephate (Orthene 75 S), chlorpyritos (Lorsban 40 EC), methamidophos (Tamaron 50 EC) and dieldrin (Dieldrex 15).*

Entomophagous insects play an important role in regulating the population of insect pest species and are an important component in pest management systems. Knowledge of predator and prey relationships is vital for the development of programmes for conservation or augmentation of the insects in an agricultural ecosystem. The future use of chemical control should not only rely on safer chemicals, but should also be based on the biology and ecology of the pest and its natural enemies.

Valanga nigricornis (grasshopper) is a well-known pest of cover plants and young rubber in commercial plantations[1,2]. At present there are no satisfactory methods of control for field grasshoppers including *Valanga*[3–6] other than insecticides. Although dieldrin and malathion have been recommended for grasshopper control, they have not been effective. These insecticides have been in use for a long time producing undesirable residues on cover plants and inducing resistance in pests. Therefore, there is an urgent need for safe and effective insecticides for use on cover plants.

The cultural practice of planting cover plants within rubber attracts insects especially *Valanga* and its natural enemies such as *Tenodera aridifolia* (mantis). Controlling the actively mobile *Valanga* adults has been difficult. Normally the covers are severely damaged before any control measures can be exercised *(Figure 1).*

This investigation reports on the seasonal abundance of *Valanga,* the predator-prey relationships within the cover plants and the effective biological and chemical control of *Valanga* on a long-term basis.

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Figure 1. Damage caused by Valanga nigricornis *on* Pueraria *and on rubber seedling.*

MATERIALS AND METHODS

Population Trends of *Valanga* and *Tenodera* in Leguminous Cover Plants

The seasonal trends of *Valanga* and *Tenodera* in a leguminous cover field of *Pueraria* near the Rubber Research Institute Experiment Station were monitored during the years 1984 and 1985. Weekly, from September 1984 to December 1985, four samples, each consisting of fifty sweeps were taken from each field using a standard sweep-net (40.6 cm in diameter, 66.0 cm handle, and 63.5 cm deep conical bag) swung in a 180° arc. The four sets of samples were taken at random from each field by sweeping the leguminous cover plants in the interrow of three-year-old rubber and the nymphs of *Valanga* and *Tenodera* were counted. The adults of both insects were counted by visual observation during sweeping. *Valanga* adults that flew from the interrow and *Tenodera* adults, which were less mobile and sometimes caught in the sweep-net, were counted along with those observed on the plants. Other entomophagous insects and pests were not counted but their abundance with *Valanga* and *Tenodera* in the samples were recorded. Records of field temperature and relative humidity were obtained from a thermo-hygrograph and rainfall from a rain gauge located near the Experiment Station.

Laboratory Studies on the Biology of *Valanga* and *Tenodera*

Adults of *Valanga* were collected from the fields and reared on diets of *Pueraria* leaves and chicken feed. The adults held in $1 \times 1 \times 1$ m^3 wooden cages with fine wire netting were provided with laying trays containing soil for oviposition. The eggs were collected and upon hatching, the nymphs were held in $0.5 \times 0.5 \times 0.5$ m^3 wooden cages with wire netting and the life cycle was thus studied.

Adults of *Tenodera* collected from *Pueraria* covers were housed in cages similar to those of *Valanga*. They were fed with crickets and grasshopper nymphs. Upon oviposition and hatching, the parents were transferred into the wooden cages. The young mantis were reared on pests of leguminous cover such as smaller nymphs of cricket and grasshoppers until adulthood. The life cycle, the generation interval of the nymphal instar and the size of the predator *(Tenodera)* and prey *(Valanga)* during the developmental period were studied.

Predator-prey Relationships between *Valanga* and *Tenodera*

Nymphal populations of *Valanga* and *Tenodera* were cultured in large numbers in the laboratory. Due to the abundance of nymphal populations of another grasshopper, *Stenocatantops* sp. with *Valanga* during sampling, the former nymphs were also reared in large numbers in the laboratory for the feeding trials. Selected life stages of the third, the sixth and the adult stage of praying mantis were given the choice of feeding on *Valanga* or *Stenocatantops* nymphs of the second and the fourth instar respectively. Each selected life stage of the praying manis was offered twenty prey of each species (preliminary test indicated that laying female mantis could consume at maximum ten second instar *Valanga* per day). The number of prey was maintained to twenty daily for three days. An assessment was carried out on the potential voracity of the two prey items commonly found in covers.

Laboratory Control Studies of *Valanga*

The less mobile stage of the second instar *Valanga* (presumed to be vulnerable to insecticides) was reared in sufficient numbers by the method described earlier for studies on the toxicity of selected insecticides. The insecticides selected were methamidophos (Tamaron 50 EC), acephate (Orthene 75 S), chlorpyritos (Lorsban 40 EC) and dieldrin (Dieldrex 15). They were selected for their capability in killing the adults and nymphs quickly while providing long-term activity. Two methods of exposure to insecticides were used to evaluate the potency. In the first method, *Valanga* nymphs were immediately introduced after leguminous cover of *Pueraria* was sprayed; in the second, the nymphs were introduced 2 h after the spraying of chemical. In both methods, assessment of the mortality of *Valanga* was carried out at 24 h and 48 h after introduction.

RESULTS

The data showing the abundance of adults and nymphs of *Valanga* and *Tenodera* for 1984 and 1985 are shown in *Figure 2*. Field and laboratory studies of *Valanga* showed that adults started laying eggs in the soil during August. These eggs remained dormant for more than two months, then hatched at the onset of the rainy season. Nymphal population began to build up in high numbers through June and once adulthood was reached they were long-lived.

In *Pueraria* three peaks of population occurred around September 1984, April 1985 and September 1985. The population of adults in April 1985 was as high as in September 1985. However oviposition in the soil occurred only around September in that year. In April, most of the egg cases were found openly laid on cover plants instead of the soil. This coincided with the wet season experienced at the Station.

Field and laboratory studies indicated that *Tenodera* lay eggs upon reaching adulthood. Nymphal population was generally lower in August, then peaked at the highest around May. By that time most *Valanga* had become adults.

Laboratory Studies on the Biology of *Valanga* and *Tenodera*

The developmental period of the life stages of *Valanga* as well as *Tenodera* under varying weather conditions in the cages of an open glasshouse at the Experiment Station is shown in *Table 1*.

In general, the developmental period of the nymphal stages of *Valanga* was much shorter than *Tenodera.* However, the incubation period of the egg stage of *Valanga* was twice as long as *Tenodera. Valanga* eggs took about two months to hatch. The day interval of each instar from the first through the seventh into adulthood was about one week. Relative to size, *Tenodera* in general is longer than *Valanga* in length throughout the nymphal stages and through adulthood except for the first instar. Nymphal predation by *Tenodera* occurred with the younger stages of *Valanga* especially the

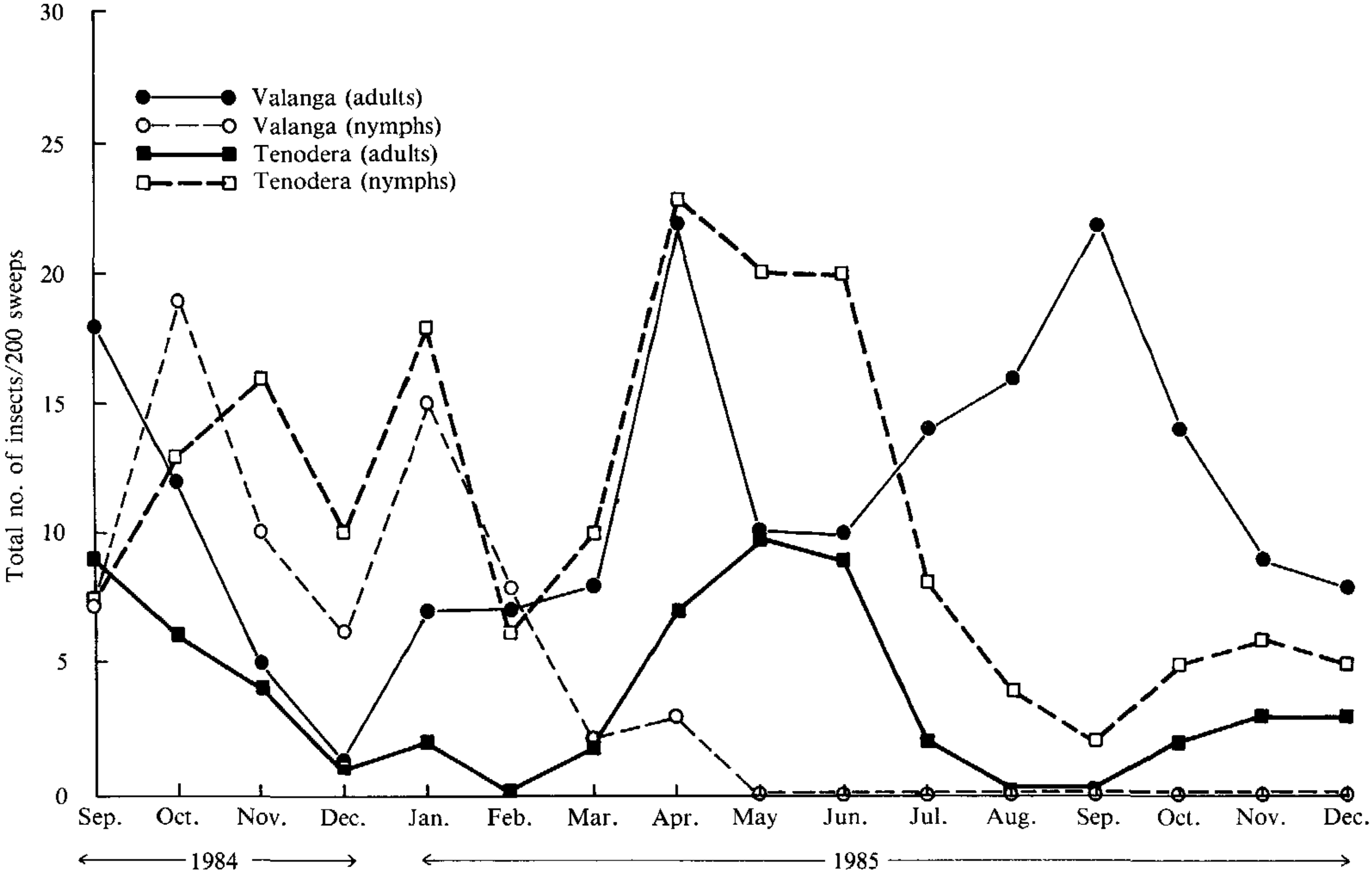

Figure 2. Monthly total of Valanga *and* Tenodera *under* Pueraria.

TABLE 1. DEVELOPMENTAL LIFE STAGES OF *VALANGA* AND *TENODERA* IN THE LABORATORY

Stage	Valanga $\bar{X}$ developmental period (days) S.E.	Tenodera $\bar{X}$ developmental period (days) S.E.
Egg hatching	67.5 ± 1.19	23.0 ± 0.71
1st instar	10.3 ± 0.25	8.8 ± 0.25
2nd instar	8.0 ± 0.41	7.8 ± 0.25
3rd instar	8.8 ± 0.25	5.8 ± 0.25
4th instar	8.8 ± 0.25	7.0 ± 0
5th instar	9.8 ± 0.25	8.0 ± 0
6th instar	10.8 ± 0.25	7.3 ± 0.25
7th instar	10.3 ± 0.25	8.0 ± 0
Adult	10.8 ± 0.25	13.8 ± 0.25
Premating	14.8 ± 0.25	8.3 ± 0.25
Preoviposition	31.8 ± 0.25	15.5 ± 0.25
Adult longevity	84.3 ± 3.61	116.3 ± 1.75

first, second, third and fourth instar, provided the size of the predator was larger than the prey. Although the subsequent stages of *Valanga* were shorter than *Tenodera,* observation indicated that *Tenodera* seldom feed on nymphs in the field.

Predator-prey Relationships between *Valanga* and *Tenodera*

When equal-sized grasshopper nymphs (second nymphal instar of *Valanga* and fourth nymphal instar of *Stenocatantops*) were offered to the third instar of *Tenodera,* there was no significant difference in the amount of the two prey consumed *(Table 2).* The third instar of mantis that was larger than its prey showed equal preference and the consumption was about seven individual prey per predator per 72 hours. As the size of the mantis became larger (sixth nymphal instar), their consumption of *Valanga* was significantly higher than their consumption of *Stenocatantops (Table 3).* The average amount of *Valanga* and *Stenocatantops* nymphs consumed was fourteen and fifteen per predator per 72 h respectively. Adult mantis consumed even higher numbers of *Valanga* than *Stenocatantops* nymphs *(Table 4).*

There was a strong correlation between the population of *Valanga* nymphs and *Tenodera* adults in the *Pueraria* covers in 1985 *(Figure 3).* The population of *Tenodera* increased over the prey from May through October, then nymphal population of *Valanga* increased over *Tenodera* adults.

Laboratory Controlled Studies of *Valanga*

The analysis of variance indicated that the toxicity of the chemical and time of application played a pivotal role in controlling adults and nymphs of *Valanga,* either upon contact or upon feeding on the residues left on the leaves of *Pueraria* covers after spraying. Chlorpyritos (Lorsban 40 EC) and acephate (Orthene 75 S) were significantly better than methamidophos (Tamaron 50 EC) and dieldrin (Dieldrex 15) in killing nymphs of *Valanga* upon contact *(Table 5).*

When residues of chemical were left on leaves 2 h after spraying, all the four chemicals tested were good in controlling *Valanga* nymphs. However, chlorpyritos (Lorsban 40 EC) caused significantly higher numbers of mortality among *Valanga* nymphs than methamidophos

TABLE 2. CONSUMPTION BY THIRD INSTAR *TENODERA* OF THE *VALANGA* AND *STENOCATANTOPS* NYMPHS WITHIN 72 H

Rep. no.	No. of prey consumed				Total
	Valanga		Stenocatantops		
	Observed	Expected	Observed	Expected	
I	8	7.5	7	7.5	15
II	9	7.5	6	7.5	15
III	7	7.0	7	7.0	14
IV	8	7.5	7	7.5	15
Total	32		27		59

$X^2 = 0.73$
$X^2_{0.05} = 7.82$

TABLE 3. CONSUMPTION BY SIXTH INSTAR *TENODERA* OF THE *VALANGA* AND *STENOCATANTOPS* NYMPHS WITHIN 72 H

Rep. no.	No. of prey consumed				Total
	Valanga		Stenocatantops		
	Observed	Expected	Observed	Expected	
I	13	8.0	3	8	16
II	16	12.5	9	12.5	25
III	10	6.5	3	6.5	13
IV	15	9.0	3	9.0	18
Total	54		18		72

$X^2 = 19.97$
$X^2_{0.05} = 7.82$

TABLE 4. CONSUMPTION BY ADULT *TENODERA* OF *VALANGA* AND *STENOCATANTOPS* NYMPHS WITHIN 72 H

Rep. no.	No. of prey consumed				Total
	Valanga		Stenocatantops		
	Observed	Expected	Observed	Expected	
I	14	10.5	7	10.5	21
II	19	13.5	8	13.5	27
III	15	10.0	5	10.0	20
IV	16	12.0	8	12.0	24
Total	64		28		92

$X^2 = 14.48$
$X^2_{0.05} = 7.82$

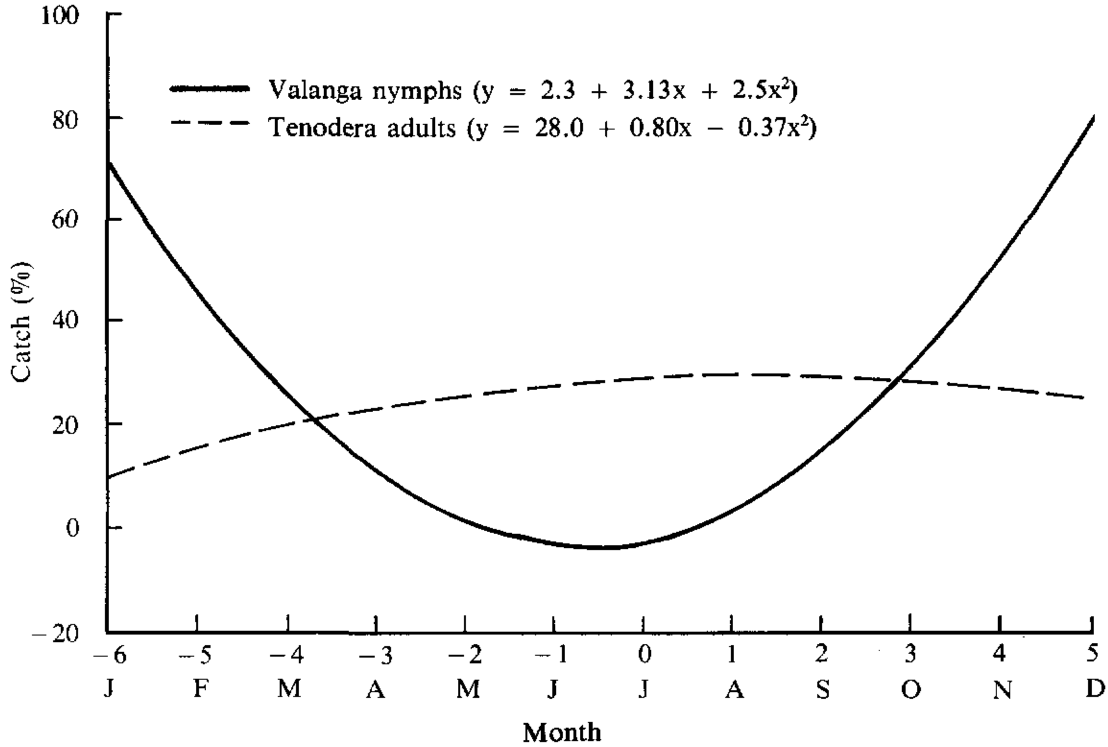

Figure 3. Monthly distribution of Valanga *nymphs and* Tenodera *adults in* Pueraria.

TABLE 5. EFFECT OF INSECTICIDES ON THE MORTALITY OF *VALANGA* NYMPHS INTRODUCED IMMEDIATELY AFTER SPRAYING OF *PUERARIA* COVER LEAVES

Treatment	Concentration	Dead Valanga after treatment (%)		
		24 h	48 h	Mean[a]
Control (water)	0	0	0	0
Methamidophos (Tamaron 50 EC)	5 ml/9 litres	50.0	80.0	65.0
Acephate (Orthene 75 S)	5 g/9 litres	75.0	100.0	95.0
Chlorpyritos (Lorsban 40 EC)	1:100	90.0	100.0	87.5
Dieldrin (Dieldrex 15)	1:400	45.0	100.0	72.5
Mean		65.0	95.0	80.0

[a]Mean and ANOVA do not include control.

L.S.D.$_{0.05}$ Time = 13.33

L.S.D.$_{0.05}$ Insecticide = 18.85

(Tamaron 50 EC), acephate (Orthene 75 S) and dieldrin (Dieldrex 15) upon contact as well as ingestion *(Table 6)*.

DISCUSSION

It was observed during field scouting that the younger stages of *Valanga*, especially the first

TABLE 6. EFFECT OF INSECTICIDES ON THE MORTALITY OF *VALANGA* NYMPHS INTRODUCED IMMEDIATELY 2 H AFTER SPRAYING OF *PUERARIA* COVER LEAVES

Treatment	Concentration	Dead Valanga after treatment (%)		
		24 h	48 h	Mean[a]
Control (water)	0	0	0	0
Methamidophos (Tamaron 50 EC)	5 ml/9 litres	55.0	90.0	72.5
Acephate (Orthene 75 S)	5 g/9 litres	55.0	95.0	75.0
Chlorpyritos (Lorsban 40 EC)	1:100	90.0	100.0	95.0
Dieldrin (Dieldrex 15)	1:400	50.0	95.0	73.0
Mean		53.3	93.0	73.0

[a]Mean and ANOVA do not include control and chlorpyritos (Lorsban 40 EC).

$L.S.D._{0.05}$ Time = 16.61

$L.S.D._{0.05}$ Insecticide = 20.34

and second instar, were consumed by assassin bugs, spiders, tiger beatles and robber flies as well as by *Tenodera*. Leguminous cover plant such as *Pueraria* is an ideal trap-crop for the development of beneficial insects, but such cover plants also attract *Valanga*. Since the nymphal stages of *Valanga* are less mobile and most vulnerable to insecticides, any control measures should be directed at the nymphs. The adults are highly dispersed, long-lived and difficult to control.

Field scouting for nymphs of *Valanga* should commence in August. In the event of a population outbreak, either chlorpyritos (Lorsban 40 EC) or acephate (Orthene 75 S) can be used effectively to kill adults and nymphs. The application of insecticides should be targeted at the nymphs that are normally found from September through June. With respect to control of leguminous cover plants such as *Pueraria* which are tolerant to damage, spraying can be delayed as long as the nymphs have not reached adulthood. This is to take advantage of predation by the natural biological agents. The study revealed that as the population of *Valanga* nymphs increased from around October through March, *Tenodera* started feeding on the two species of grasshopper nymphs. Rainfall had a detrimental effect on the survival rate of *Valanga* nymphs either directly or indirectly. The immediate effect of rainfall could either be suffocation or immobility of nymphs and thus increased changes of predation by biological agents. Indirectly, rainfall probably affected the ovipositional behaviour. It may be that the drier condition of the soil was ideal for oviposition and eggs laid in the soil were protected from their natural enemies, thus producing higher survival rates. For the long-term control of *Valanga* one should take into account the pests, preference for the particular crop, the time of application, the vulnerable stages of the insect, the natural enemies present and the biology of the pest and its natural enemies.

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