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BIOLOGY OF *SPIRAMA RETORTA* (LEPIDOPTERA: NOCTUIDAE), A NEW PEST OF *ACACIA MANGIUM* IN PENINSULAR MALAYSIA

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SAJAP, A.S., YAACOB, A.W. & AIDAH, M. 1997. Biology of *Spirama retorta* (Lepidoptera: Noctuidae), a new pest of *Acacia mangium* in Peninsular Malaysia. An outbreak of *Spirama retorta* (Lepidoptera: Noctuidae), affecting 800 ha of a one-year-old *Acacia mangium* plantation, occurred in May to October 1992 in Gunung Besaut Forest Reserve, Perak, Peninsular Malaysia. In the laboratory, more than 60% of larvae reared on *A. mangium* leaves reached adult stage. Development from egg to adult took 42 days through seven instars requiring 27 days. The moth was medium - sized, having red abdomen and an eyespot on its forewing. The female ($\bar{x}$ = 64.4 mm), bigger than the male, had greyish-orange forewings with prominent eyespots. The male($\bar{x}$ = 58.8 mm) had dark brown to almost black forewings with less conspicuous eyespots. The life table parameters recorded from laboratory population were: the net reproductive rate (Ro) of 203.2, the mean generation time (Tc) of 43.3 days, the intrinsic rate of increase (r_m) of 0.1 and the doubling time of 5.6 days. Results from biweekly sampling showed that the infestation, indicated by the number of trees with larvae, varied from 30% at the beginning of the study, rose to more than 60% in the fourth week and dropped to less than 10% at the end of the fourteenth week. Three tachinids, *Carcelia* sp., *Exorista* sp. and *Blepharella* sp., emerged from field collected larvae. Larval-pupal mortality due to parasitism was 5.6 - 43.3%. Predators, *Sycanus leucomesus* (Reduviidae), *Cantheconidea furcellata* (Pentatomidae), *Mallada basalis* (Chrysopidae) and *Vespa affinis indosinensis* (Vespidae) were observed feeding on the larvae.

Keywords: *Acacia mangium* - outbreak - *Spirama retorta*

SAJAP, A.S., YAACOB, A.W. & AIDAH, M. 1997. Biologi *Spirama retorta* (Lepidoptera: Noctuidae), serangga baru *Acacia mangium* di Semenanjung Malaysia. Satu wabak serangan rama-rama *Spirama retorta* (Lepidoptera: Noctuidae), berlaku di ladang 800 ha *Acacia mangium* berumur setahun pada Mei hingga Oktober 1992 di Hutan Simpan Gunung Besaut, Perak, Semenanjung Malaysia. Di makmal lebih daripada 60% larva yang diberi makan daun *A. mangium* mencapai ke peringkat dewasa. Pembesaran daripada telur ke dewasa mengambil masa selama 42 hari melalui tujuh instar dalam masa 27 hari. Rama-rama ini berukuran sederhana, abdomen berwarna merah dan mempunyai tanda berbentuk mata pada sayap hadapan. Rama-rama betina (x = 64.4 mm) lebih besar daripada rama-rama jantan, mempunyai sayap berwarna kelabu oren dengan tanda mata yang jelas. Rama-rama jantan ($\bar{x}$ = 58.8 mm) mempunyai sayap berwarna perang hitam dengan tanda matanya tidak jelas. Parameter jadual hayat yang direkodkan dalam makmal menunjukkan nilai kadar pembiakan bersih bersamaan (Ro) 203.2, min tempoh generasi (Tc) 43.3 hari, kadar pembiakan intrinsik (r_m) 0.1 dan tempoh mengganda bersamaan 5.6 hari. Keputusan dari penyampelan setiap dua minggu menunjukkan kadar serangan naik dari 30% di

awal kajian ke 60% di minggu keempat dan terus menurun ke 10% di akhir minggu ke empat belas. Tiga lalat tachinid, *Carcelia*sp., *Exorista*sp. dan *Blepharella*sp.,menjelma daripada larva yang diambil dari lapangan. Parasitisma ini menyebabkan kematian larva-pupa diantara 5.6 - 43.3%. Pemangsa, *Sycanus leucomesus* (Reduviidae), *Cantheconidea furcellata* (Pentatomidae), *Mallada basalis* (Chrysopidae) dan *Vespa affinis indosinensis* (Vespidae) didapati memakan larva serangga ini.

Introduction

Many developing countries including Malaysia replenish their diminishing forest resources by adopting a reforestation programme involving the planting of fast-growing exotic species. In Malaysia, about 500 000 ha of unproductive forest have been alienated for establishment of forest plantations. To date approximately 100 000 ha of forest plantations have been established, 90% of which are being planted with *Acacia mangium* Willd. *Acacia mangium* is a fast-growing leguminous tree indigenous to Northern Australia, Papua New Guinea and Irian Jaya. The tree can grow to 35 m high with a straight bole measuring 35 cm in diameter at breast height (Lim 1993). It can be harvested for pulpwood in five to seven years, or sawlog production in 12 to 15 years.

Like many exotic plants, *A. mangium* trees are exposed to the risk of diseases and insect pests. Many indigenous insects are associated with this tree and some of these insects may pose a serious threat to the forest plantation industry (Abe 1983, Hutacharern 1993, Chey 1996). One insect discovered attacking *A. mangium* plantation recently was *Spirama retorta* (Clerck) (Lepidoptera: Noctuidae). In May 1992, a major outbreak of this pest occurred in a one-year-old *A. mangium* stand at Gunung Besaut Forest Plantation, Sungkai, Perak. The outbreak affected an area of about 800 ha.

Spirama retorta is a relatively rare indigenous moth. Heretofore, very little information on its distribution and host plants was available. Yunus and Ho (1980), Barlow (1982), Robinson *et al.* (1994) and Chey (1996) did not document this moth in their respective books. The moth, however, was present in Thailand but no host plant was given (Hutacharern & Tubtim 1995). An early report showed that this insect had been found to feed on *Albizzia lebbek* elsewhere (Beeson 1961). This is the first record of *S. retorta* defoliating *A. mangium* in Peninsular Malaysia. Thus, this study was carried out with the following objectives: (i) to determine the developmental biology of the insect in the laboratory, (ii) to examine the extent of infestation on affected stands, and (iii) to document the natural enemies associated with the moth. Such information is very pertinent for the development of an integrated pest management of the defoliator.

Materials and methods

Laboratory colony establishment

A colony of *S. retorta* was established from field-collected larvae. They were reared on fresh *A. mangium* leaves contained in plastic containers lined with moist toilet papers. The leaves and the papers were changed daily. When the larvae reached the fifth instar, vermiculite was introduced into the container. The vermiculite served as a medium for pupation. Three-day-old pupae were surface-sterilised with 1% sodium hypochlorite and transferred to rearing cages for adult emergence, mating and oviposition. The moths were given 10% honey solution and a slice of ripe papaya as food. Eggs, oviposited on netting cloth lining the inside part of the cage, were collected every day and placed in plastic cups for hatching.

Life cycle and life table study

To determine the biological and developmental parameters of the insect, a cohort of 100 eggs laid within 24 h were allowed to hatch. Larvae were reared individually in 9 cm diameter Petri dishes lined with two layers of moist filter papers and fed on young *A. mangium* leaves. The leaves and the filter papers were changed daily. When the larvae reached the fifth instar, vermiculite was introduced into the Petri dishes. Pupae were sexed and placed individually in plastic cups for adult emergence. Female and male moths were paired and placed in an oviposition cage. This oviposition cage consisted of a cylindrical wire mesh, 9 cm diameter × 12 cm height, internally lined with netting cloth which served as oviposition site and covered at the top with a Petri dish lid carrying a cotton-plugged vial containing 10% honey solution. These cages were kept in room temperature of 27± 3 °C and relative humidity 80 ± 10%.

The mortality rates, developmental stages and their durations and fecundity were recorded by following the insect development from the egg stage until all the moths died. Growth increments were determined by measuring the width of the head capsules of each instar. Fecundity of the moths was calculated from the total number of eggs laid per female. Life table parameters were calculated according to methods described by Southwood (1978).

Field study

Field study, which included population sampling and evaluation of natural enemies associated with the defoliators, was carried out during the insect outbreak from May to September 1992. Three plots consisting of 100 trees per plot were selected at random, and boundaries of each plot were demarcated. Routine biweekly counting of the larval population was carried out. Each tree, about two metres high, was examined for the presence of larvae. The larvae found on the tree and on the ground under each tree were recorded. The study was terminated when no more larvae were detected.

Natural enemies associated with the defoliator were evaluated in an area outside the plot under study. About 100 larvae were sampled biweekly at random. In the laboratory the larvae were held separately in Petri dishes to evaluate survival and parasitism. Predation of larvae was observed directly in the field. Predators encountered feeding on the larvae were noted.

Results and discussion

The insect and its life cycle

The newly eclosed larva was yellowish-brown in colour and measured about 10 mm. The larva underwent seven instars in a period of about 27 days (Table 1). The mature larva, dull yellowish-brown in colour, reached 65 mm body length and 5.0 mm head capsule width. The head was brown with white lateral stripes on the vertex. The larva, very active at night, fed particularly on young leaves. At first, the larva chewed minute holes in the leaves, but later consumed all the leafy parts except the veins. During the day the larva hid in leaf litter, where its body colour camouflaged the larva. The mature larva pupated in an earthen cell at 10 to 20 mm depth. The pupa, 30 mm in length, was dark brown in colour. The pupal stage lasted from 7 to 13 days. Table 1 shows the life cycle and developmental stages of the moth.

Table 1. Developmental times and sizes of head capsules of *Spirama retorta*

Life stages	Duration (days)	Head capsule (mm)
Egg	3.00 ± 0.00	-
Larva		
I	2.78 ± 0.07	0.41 ± 0.03
II	2.51 ± 0.08	0.66 ± 0.03
III	2.78 ± 0.10	1.02 ± 0.01
IV	2.82 ± 0.15	1.54 ± 0.07
V	3.88 ± 0.15	2.41 ± 0.16
VI	3.75 ± 0.16	3.32 ± 0.11
VII	8.07 ± 0.36	4.49 ± 0.10
Pupa	12.56 ± 0.15	-
Adult male	5.18 ± 0.34	-
Adult female	6.33 ± 0.55	-

The moth was medium sized, having a red abdomen and an eyespot on its forewing. Apart from those visible features, the moth exhibited wide sexual dimorphism. The female, relatively bigger than the male, had greyish-orange forewings with very prominent eyespots and a wingspan ranging from 58.0 to 69.0 mm ($\bar{x}$ = 64.4 mm). The male had dark brown to almost black forewings ranging from 54.0 to 66.0 mm ($\bar{x}$ = 58.8 mm). The eyespots on its forewings were inconspicuous. The sex ratio of male to female from field collected insects was 1 : 1.5.

Mating, which occurred at dawn, began two days after emergence. This was followed by the female moth laying eggs one to two days after mating. In the field, the eggs were laid singly on new shoots. The egg was greyish-brown in colour, hemispherical in shape with ridges and measured about 1 mm in diameter. A female moth reared in the laboratory had a fecundity rate ranging from 208 to 307 eggs ($\bar{x}$ = 254 eggs). The average number of eggs laid daily varied from 42 on the first day, reached its maximum of 90 on the third day and subsequently declined to 13 on the sixth day. Even though some females could live up to 10 days, their reproductive period lasted within one week. The eggs hatched in three days with hatching rates exceeding 80.0% (Figure 1).

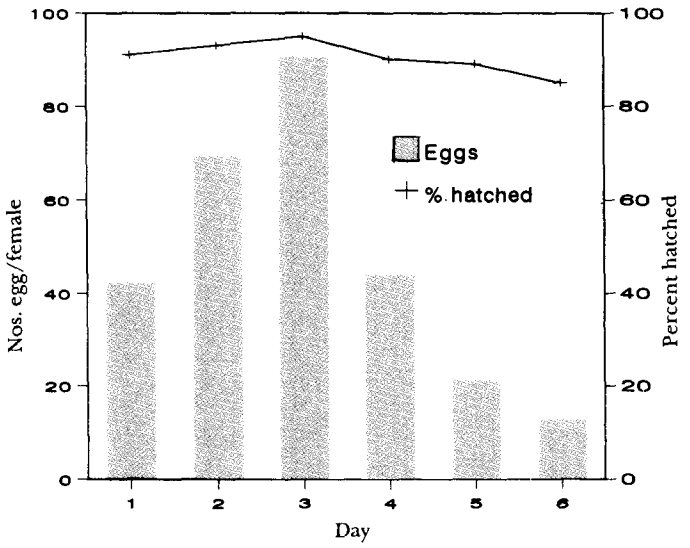

Figure 1. Fecundity of *Spirama retorta* and hatching percentage of the eggs

Life table

Less than 30% mortality occurred in the larval stage, with more than 60% individuals reaching the adult stage (Table 2). The moth had a mean net reproductive rate (Ro) of 203.2, a mean generation time (Tc) of 43.3 days, an intrinsic rate of increase (r_m) of 0.1 and a doubling time of 5.6 days.

Field population

Results from the biweekly sampling show that the infestation rate and pest population density fluctuated over time. The extent of infestation, indicated by the number of trees with larvae, varied from 30% at the beginning of the sampling week, rose to more than 60% in the fourth week and subsequently dropped to

less than 10% at the end of fourteen week (Figure 2). The insect density increased from 2 larvae/tree at the beginning of the sampling week to 7 larvae/tree in the fourth week. About 8% of the infested trees had more than 20 larvae/tree during this period. After the fourth week the pest population density began to decline. By the sixteenth week no larva was found on the tree (Figure 3). Such an eruptive outbreak, according to Speight and Wainhouse (1989), could be attributed to the breakdown in natural control or rapid reproduction of the pest as a consequent of favourable changes in the environment.

Although the number of larvae per tree was low, the *A. mangium* trees suffered defoliation rates of 20 to 30%. Such substantial damage was due to the voracious feeding habit of the relatively large-sized and long-lived larvae.

Table 2. Partial life table of *Spirama retorta* reared in the laboratory

Life stages	No. surviving (l_x)	No. dying (d_x)	Mortality rate ($100q_x$)	Survival rate ($100s_x$)
Egg	100 (N)	2	2.00	98.00
Larva				
I	98	3	3.06	96.94
II	95	17	17.89	82.11
III	78	2	2.56	97.44
IV	76	1	1.32	98.68
V	75	1	1.33	98.67
VI	74	0	0.00	100.00
VII	74	0	0.00	100.00
Pupa	74	10	13.51	86.49
Adult	64	-	-	-

l_x = number surviving at the beginning of age class x
d_x = number dying during the age interval x
q_x = mortality rate per age interval
s_x = survival rate per age interval

Natural enemies

Natural enemies evidently played an important role in regulating the population of this insect pest. The larvae and pupae were parasitised by three species of tachinids, *Carcelia* sp., *Exorista* sp. and *Blepharella* sp. A chalcid, *Brachymeria* sp., emerged from one tachinid pupa. *Brachymeria* is a common facultative hyperparasite of tachinid (Cock 1987). The tachinids, which are generally less host specific than hymenopteran parasitoids, are known to parasitise other noctuid larvae such as *Heliothes* and *Spodoptera* (Kalshoven 1981). Figure 3 shows pooled parasitism rates in relation to host population. The parasitism rates showed a delayed density dependence (Varley *et al.* 1973) which contributed towards a larval mortality ranging from 5.56 to 43.33%. The rate of parasitisation, however, varied according to the parasitoid species and time (Figure 4). *Carcelia* sp., the most

dominant parasitoid, was present in 5 -40.5% of larvae ($\bar{x}$ = 18.0%). *Exorista* sp. was present in 0 - 12.5% ($\bar{x}$ = 5.0%) and *Blepharella* sp,. collected once during the sampling time, contributed only 1.0% of the parasitism. The tachinids were larval-pupal parasitoids. All were gregarious, with more than one adult emerging from one host (Table 3).

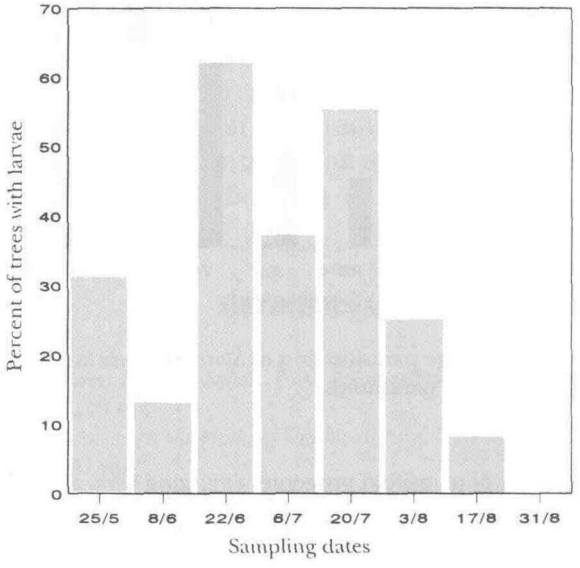

Figure 2. Percentage of *Acacia mangium* trees infested by *Spirama retorta* larvae

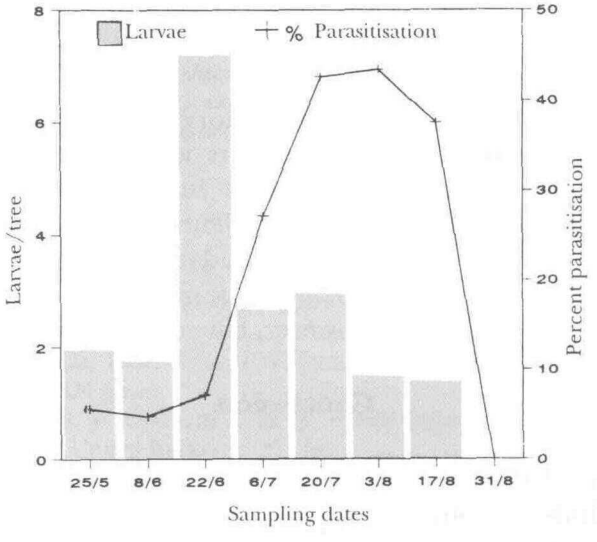

Figure 3. Population density and pooled parasitisation rate of *Spirama retorta* larvae

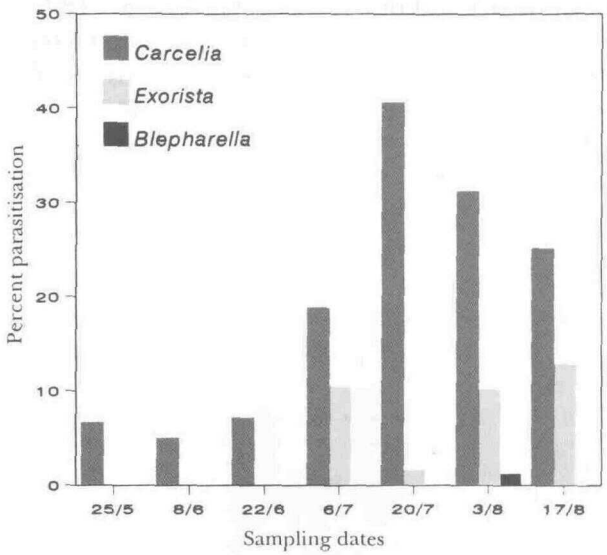

Figure 4. Percentage parasitisation of *Spirama retorta* larvae by three species of parasitoids

Table 3. Number of parasitoid progenies emerging from a parasitised host

Parasitoids	No. parasitised host	No. parasitoid emerged	
		Mean	Range
Carcelia sp.	111	2.38 ± 1.61	1 - 9
Exorista sp.	18	3.67 ± 2.34	1 - 8
Blepharella sp.	1	2	

Apart from parasitoids, a number of predatory insects were recorded from the vicinity of the pest outbreak. The predators were *Sycanus leucomesus* Walker (Hemiptera: Reduviidae), *Cantheconidea furcellata* (Wolff) (Hemiptera: Pentatomidae), *Mallada basalis* (Kimmins) (Neuroptera: Chrysopidae) and *Vespa affinis indosinensis* Perez. (Hymenoptera: Vespidae). These predators were seen feeding on soft bodied arthropods, including *S. retorta* larvae. The impact of these predators on *S. retorta* population, however, has yet to be determined.

Conclusion

Although *Spirama retorta* is a relatively rare moth in Malaysia, it could pose a real threat to plantations of young *A. mangium*. This indigenous insect survived very well on young leaves of less than one-year-old trees. The pest outbreak lasted only for about four months or for two generations despite the abundance of food resource. Its disappearance might have been influenced by many factors. Natural

enemies, particularly the tachinid parasitoids which contributed significantly to the mortality of *S. retorta*, might be one of the primary factors in causing the population to collapse. Such ecological significance should be considered in formulating a management strategy for the pest.

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