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Effects of Food Plants on Development of *Spirama retorta* (Lepidorptera: Noctuidae)

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ABSTRAK

Pembesaran Spirama retorta *(Lepidoptera: Noctuidae) larva yang diberi makan daun tiga spesies* Acacia, *iaitu* A. mangium, A. auriculiformis *dan* A. crassicarpa, *dan* Paraserianthes falcataria *telah dinilai di makmal. Larva yang didedahkan kepada daun* A. crassicarpa *dan* P. falcataria *kesemuanya mati pada instar pertama. Lebih daripada 64% larva yang memakan daun* A. mangium *dan* A. auriculiformis *mencapai peringkat pupa. Jangkamasa larva pada daun* A. auriculiformis *ialah 22.10 hari manakala pada* A. mangium *ialah 24.83 hari. Jangkamasa pupa dari* A. auriculiformis *ialah 10.51 hari dan dari* A. mangium *ialah 11.32 hari. Ini menghasilkan rama-rama dewasa yang hidup selama 36.51 dan 37.94 hari. Walaupun pada keseluruhannya, angkaubah pembesaran tidak signifikan, rama-rama betina yang pada peringkat larva memakan daun* A. auriculiformis *menghasilkan lebih banyak telur daripada yang memakan* A. mangium *iaitu 412 telur// dari* A. auriculiformis *dan 255 telur// dari* A. mangium. *Kajian ini menunjukkan daun* A. auriculiformis *dan* A. mangium *sesuai untuk pemakanan larva* S. retorta. *Oleh itu, spesies ini boleh menjadi sumber alternatif makanan penting untuk dinamik populasi rama-rama ini jika ketiadaan tumbuhan hos asli.*

ABSTRACT

Development of Spirama retorta *(Lepidoptera: Noctuidae) larvae fed on foliage of three* Acacia *spp., namely* A. mangium, A. auriculiformis *and* A. crassicarpa, *and* Paraserianthes falcataria *was assessed in the laboratory. The larvae did not survive when fed on either* A. crassicarpa *or* P. falcataria. *More than 64% reached pupal stage when fed on* A. auriculiformis *and* A. mangium. *The larval period was completed in 22.10 and 24.83 days when the larvae fed on* A. auriculiformis *and* A. mangium *foliage, respectively. The average pupal period was 10.51 and 11.32 and, the resulting adults lived for 36.51 and 37.94 days on* A. auriculiformis *and* A. mangium, *respectively. Even though the overall development variables were not significantly different, females from larvae fed* A. auriculiformis *had a significantly higher fecundity than those females from* A. mangium. *A total of 412 eggs// was recorded from those fed* A. auriculiformis *as compared to 255 eggs// on* A. mangium. *This study thus shows that foliage of* A. auriculiformis *and* A. mangium *provided a suitable diet for* S. retorta *larvae. As such, these species may serve as alternative food resources important in the population dynamics of the moth in the absence of indigenous host plants.*

INTRODUCTION

The declining supply of timber from natural forests has led many tropical countries including Malaysia replenish their timber resource by adopting a reforestation program involving planting of fast-growing exotic species. In Malaysia, about 500,000 ha of unproductive forest has been alienated for establishment of forest plantations. To date, approximately 100,000 ha of forest plantations have been established. Ninety percent of this was planted with *Acacia mangium.* While *Gmelina arborea* and *Paraserianthes falcataria* were planted on a smaller scale.

A. mangium is a fast growing leguminous tree indigenous to Northern Australia, Papua New Guinea and Irian Jaya (Anon. 1983). The

tree can grow up to 30 m high with a straight bole measuring 40 cm in diameter at breast height. It can be harvested for pulpwood in five to seven years or sawlog production in 12 to 15 years. In addition to *A. mangium*, *A. auriculiformis* and *A. crassicarpa* have also been the subject of many researches in Malaysia. Results from provenance trial plots indicated that these trees have the potential to be grown for commercial plantations (Nor Aini *et al.* 1994; Kamis *et al.* 1995).

Even though trees like *Acacia* often perform very well when grown as exotics, they are, however, prone to attack by diseases and insects. To date, many indigenous insects have been reported to be associated with these *Acacia* and some could pose serious threats to the plantations (Abe 1983; Hutacharern 1993; Chey 1996, Sajap *et al.* 1997). One of these insects was a rare moth, *Spirama retorta* (Lepidoptera: Noctuidae). The larvae of this insect were found in an outbreak where they defoliated a one-year old *A. mangium* stand in an area of 800 ha at Gunung Besaut Forest Plantation, Sungkai, Perak. The biology of this insect was described by Sajap *et al.* 1996. Apart from *A. mangium*, no other host plant has yet to be associated with this insect in Malaysia. *Albizzia lebbek* was the only recorded host plant elsewhere (Beeson 1961).

In this study, we examined the suitability of three *Acacia* spp. and *P. falcataria* for the development of *S. retorta*. *Paraserianthes falcataria* was included as it was related to the reported host plant, *A. lebbek*. This information is pertinent in determining the host range of the insect in view of its becoming a potential pest of Acacia spp.

MATERIALS AND METHODS

Insect Rearing

A colony of *S. retorta* was established from larvae collected from *A. mangium* plantation at Gunung Besaut, Perak. The larvae were kept in 11 × 15 × 25 cm plastic boxes provided with fresh *A. mangium* foliage. The foliage was changed everyday. When the larvae reached the fifth instar, vermiculite which acted as a substrate for pupation, was added into the box. The pupae were collected, sexed and surface-sterilized with 1% sodium hypochlorite. Five pairs of male and female pupae from the same cohort were held in a cage for adult emergence, subsequent mating and oviposition. The oviposition cage consisted of a cylindrical wire mesh, 9 × 12 cm, internally lined with a netting cloth which was used oviposition site. Ten percent honey solution in a cotton-plugged vial and a slice of very ripe papaya were placed in the cage and served as food sources. Eggs collected from the colony were kept in 9 cm petri dishes for hatching.

Feeding experiment

Test Plants

A. mangium, *A. auriculiformis* and *A. crassicarpa*, and *P. falcataria* plant materials were obtained from provenance trial plots located at Universiti Putra Malaysia, Serdang.

Experimental Procedure

Fresh foliage was placed in 9 cm petri dishes lined with two pieces of moistened filter papers. One neonate was introduced into each petri dish. The foliage and the filter papers were changed daily and weekly, respectively. Vermiculite was added into the petri dishes when the larvae reached the end of the fifth instar. Growth and development parameters: mortality, molting period, pupal weight and size of the head capsule, were recorded. Faeces defaecated throughout the larval stages were collected daily, oven-dried at 80°C for 24 h, cooled and weighed. Newly emerged adults were sexed and paired. Each pair was placed in a cage for oviposition. Eggs were collected and counted daily. A total of 100 larvae per treatment in four replicates, 25 per replicate, were used in this study. All experiments were carried out in a room at 27 - 32°C and 70 - 80% RH.

Data Analysis

Statistical analysis of all the developmental variables was conducted by t-test ($\alpha = 0.05$)

RESULTS

Larval Mortality

The result from this feeding study shows that *S. retorta* could feed and develop on foliage of *A. mangium* and *A. auriculiformis*. They failed to feed on *A. crassicarpa* and *P. falcataria* and died in the first stadium. The total mortality for larvae fed on *A. mangium* and *A. auriculiformis* were 36% and 31%, respectively, with more than 22% dead before reaching the third instar. All the larvae that pupated emerged into adults (Table 1).

TABLE 1
Developmental time (days) and percent mortality of *S. retorta* larvae fed on *A. auriculiformis* and *A. mangium* foliage

Stage	*A. auriculiformis* days *	%	*A. mangium* days *	%
I	3.07 ± 0.26a	13.00	3.11 ± 0.31a	15.00
II	3.12 ± 0.32a	9.18	3.36 ± 0.55a	10.00
III	3.46 ± 0.53a	2.23	3.64 ± 0.57a	3.00
IV	3.48 ± 0.53a	2.59	3.61 ± 0.58a	3.00
V	3.91 ± 0.61a	2.66	4.06 ± 0.94a	3.00
VI	6.39 ± 1.90a	5.48	5.19 ± 1.41a	4.00
VII	7.52 ± 0.72a	1.00	7.81 ± 0.82a	1.00
Pupa	10.51 ± 1.85a	0	11.32 ± 1.24a	0
Adult /	10.11 ± 0.90a	-	9.60 ± 0.51a	-
?	9.11 ± 0.51a	-	7.70 ± 0.68a	-
Egg	4.00 ± 0.87a		4.20 ± 0.84a	

* Means in the same row followed by the same letter are not significantly different (α =0.05)

Developmental Period

The development time of *S. retorta* larvae fed on *A. mangium* and *A. auriculiformis* is shown in Table 1. The larval period was completed in 22.10 ± 2.42 days and 24.83 ± 2.71 days when the larvae fed on *A. auriculiformis* and *A. mangium* foliage, respectively. The larvae went through either six or seven instar before pupation. On *A. mangium*, 22% and 78% attained their pupal stage after the sixth and seventh instars, respectively. On *A. auriculiformis*, 56% attained pupal stage after the sixth instar and 44% after the seventh instar. The average pupal period was 10.51 ± 1.85 days and 11.32 ± 1.24 days when the preceeding larvae were fed on *A. auriculiformis* and *A. mangium*, respectively. The longevity of the adults emerging from larvae previously fed on *A. auriculiformis* stages was relatively shorter than those fed on *A. mangium*. With *A. auriculiformis* their longevities were 10.11 ± 0.90 days and 9.11 ± 0.51 days for the females and the males, respectively. With *A. mangium* the longevities were 9.60 ± 0.51 days and 7.70 ± 0.68 days for the females and the males, respectively.

Head Capsule Size and Pupal Weight

Head capsule size and pupal weight were not significantly different for individuals fed on either foliage. The width of head capsule increased from 0.30 mm in the first instar to about 3.00 mm in the seventh instar (Table 2). The resultant pupae also had similar sizes and weights. The pupal wieght and length from larvae fed on *A. auriculiformis* were 0.90 ± 0.11 g and 2.65 ± 0.10 mm, respectively and those fed on *A. mangium* attained pupal weight and length of 0.89 ± 0.10 g and 2.66 ± 0.13 mm, respectively.

TABLE 2
Means of head capsule width (mm) of *S. retorta* larvae fed on A. mangium and *A. auriculiformis* foliage

Instar	*A. mangium* (mm)*	*A. auriculiformis* (mm)*
I	0.30 ± 0.00a	0.30 ± 0.00a
II	0.54 ± 0.05a	0.55 ± 0.50a
III	0.86 ± 0.10a	0.85 ± 0.06a
IV	1.40 ± 0.18a	1.40 ± 0.12a
V	2.07 ± 0.21a	2.08 ± 0.14a
VI	2.69 ± 0.23a	2.75 ± 0.24a
VII	2.92 ± 0.16a	2.94 ± 0.17a

*Means in the same row followed by the same letter are not significantly different (α =0.05)

Faeces Production

S. retorta consumed about the same amount of either *A. auriculiformis* or *A. mangium* foliage except in the seventh instar (Table 3). This was shown by the amount of faeces defaecated throughout the larval period. The weight of faeces obtained from the larvae in the seventh stadium feeding on *A. auriculiformis* was significantly higher than those larvae feeding on *A. mangium* foliage. The total amount faeces defecated by a larva fed on *A. auriculiformis* and *A. mangium* was 773.49 and 724.71 mg, respectively.

Fecundity

The number of eggs laid by females previously fed on *A. auriculiformis* (412//) was almost double those females previously fed on *A. mangium* (255//) foliage during their larval stages. The daily oviposition rates of the moths is shown in Figure 1. Moths emerging from *A. auriculiformis*-reared larvae laid an average number of eggs varied from 50 on the first day, reached its

TABLE 3
Means of faecal weight (mg) produced by *S. retorta* larvae fed on *A. mangium* and *A. auriculiformis* foliage

Instar	*A. mangium* (mg)*	*A. auriculiformis* (mg)*
I	8.98 ± 0.98a	8.58 ± 0.90a
II	10.93 ± 1.00a	11.02 ± 1.10a
III	24.21 ± 5.72a	24.19 ± 5.92a
IV	50.88 ± 9.59a	48.28 ± 10.43a
V	137.41 ± 59.88a	137.23 ± 58.45a
VI	296.79 ± 92.66a	305.22 ± 94.31a
VII	195.52 ± 70.51a	238.97 ± 83.55b

* Means in the same row followed by the same letter are not significantly different (α =0.05)

maximum of 115 on the second day and dropped to 38 eggs on the seventh day. Although a similar trend of oviposiotion pattern was also observed on moths emerging from *A. mangium*-reared larvae but the average number of eggs laid daily was lower. On the first day, 43 eggs were laid. The number increased to 90 on the third day and dropped to 22 on the fifth day. All eggs hatched in three days with hatching rates exceeding 90% for both batches.

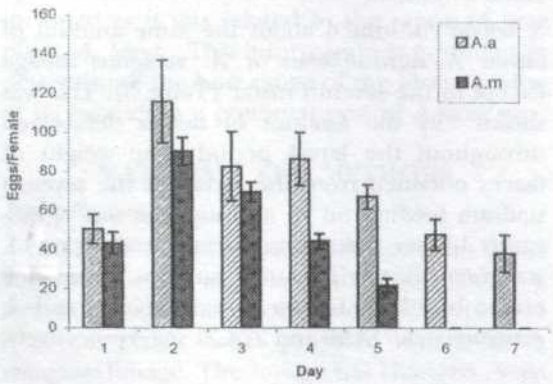

Fig. 1. Fecundity of S. retorta *moths previously fed on* A. mangium *and* A. auriculiformis *foliage during the larval stage*

DISCUSSION

Host plants play an important role in growth and development of an insect. The resultant impact of the nutritive value of the plant consumed by the insect could be reflected in the larval development rate, pupal weight, female fecundity, survivorship and behaviour of the insect (Beck and Reese 1976; Slansky 1982; Hagen *et al.* 1984.). In this study, even though the larvae initiated feeding, indicated by the many biting marks on *P. falcataria* foliage, they, however, failed to continue feeding and died in the first stadium. The rejection of the foliage by the larvae could be due to the absence of token stimuli or the presence of deterrent chemicals that inhibit them from further feeding on the foliage despite the very tender foliage texture (Ehrlich and Raven 1964). This phenomenon commonly occurred in insects that were exposed to non-host plants (Hough and Pimentel 1978). When offered foliage of *A. crassicarpa*, *S. retorta* larvae did not initiate feeding and left no biting marks on the foliage. This could be attributed to the toughness of the foliage that led to a 100% mortality at the early stage.

Even though, there were no significant differences in the overall developmental period and growth parameters between individuals fed on *A. auriculiformis* and *A. mangium*, larvae fed on *A. auriculiformis* apparently developed relatively faster than on *A. mangium*. The larvae that developed through seventh instar defaecated more faeces when fed on *A. auriculiformis* than on *A. mangium*. Consequently, the adults had a relatively longer reproductive period and laid a higher number eggs than those previously reared on *A. mangium* foliage. This result suggests that *A. auriculiformis* presumably has a superior nutritive value and thereby served a better host plant than *A. mangium*.

In summary, the foliage of *A. auriculiformis* and *A. mangium* provided a suitable diet for *S. retorta* larvae. As such, these tree species may serve as food resources important in the population dynamics of the moth in the absence of the indigenous host plants.

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