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Effects of Parasitism on the Development and Food Consumption of Larva of *Spilosoma obliqua* (Walker) by its Parasitoid *Apanteles obliquae* Wilkinson

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Abstract: The effects of parasitism of braconid wasp, *Apanteles obliquae* Wilkinson (Hymenoptera: Braconidae) on the developmental stages and food consumption of larva of *Spilosoma obliqua* (Walker) were studied in the laboratory. The differences in growth and development of host larvae were marked with regard to ecdysis (moult) and size in parasitised larvae. The reduction in host size due to parasitism was observed in parasitised larvae. *S. obliqua* larvae that were parasitised consumed significantly less leaf area than the non-parasitised larvae. The greater portion (96.95 sq.cm. of jute leaf) of feeding by non-parasitised larva occurred after the host larva reached the 5th instar stage, whereas feeding by parasitised larva of same age remained at low level (32.54 sq.cm. of jute leaf). Results indicated that larva parasitised at 3rd instar stage cause considerably less damage (one third of healthy larva) to the host plant than non-parasitised larva.

Key words: *Apanteles obliquae*, food consumption, parasitism, *Spilosoma obliqua*

Introduction

The physiological interrelationships between parasitoids and their hosts now- a- days drawn attention among the researchers to see the mechanisms associated with regulation of development of a host or parasitoid (Jones and Lewis, 1971; Smilowitz and Iwantsch, 1973 and Smith and Smilowitz, 1976). The explanation of physiological changes occurring during development in the host parasitoid systems would facilitate a better understanding of defining the requirements of the parasitoid during a successful relationship. *Apanteles obliquae* Wilkinson, a gregarious parasitoid of larvae of jute hairy caterpillar, *Spilosoma obliqua* (Walker) prefer to parasitised young larvae and generally oviposit in 1st to 3rd instar stages of the host (Lall, 1958; Kabir, 1975; Jalil and Sultana, 1988; Sultana, 2002). Development of jute hairy caterpillar larvae parasitised by *A. obliquae* follows the same pattern as non-parasitised individuals. On the other hand, *Trichoplusia ni* (Hubner), when parasitised by the ichneumonid wasp *Hyposoter exiguae* (Viereck) has different pattern of growth and development than non-parasitised counterpart (Smilowitz, 1974; Smilowitz and Iwantsch, 1973). Again, parasitism eventually removes a host larva from the population but also may change the host's feeding behaviour. For example foliage consumption by parasitised larva may be reduced (Rahman, 1970; Parkman and Shepard, 1981), increased (Rahman, 1970; Hunter and Stoner, 1975; Brewer and King, 1981) or variable (Brewer

and King, 1980), depending on the stages of the host parasitised and number of parasitoid per host. Reduced feeding by the parasitised pest larva could be important in reducing the damage to the host plant. Lewis (1970) observed that larvae parasitised by ***M. croceipes*** continued to moult on the same schedule as non-parasitised larvae, but feeding stopped within 2-3 day after they were 5th instar. Parker and Pinnell (1973) observed that larvae of ***Pieris rapae*** (L.) parasitised by ***Apanteles rubecula*** Marshall consumed significantly less leaf area than similar non-parasitised larvae. Powell (1989) reported significantly less consumption of artificial diet, parasitised by ***Microplitis demolitor*** or ***M. croceipes*** than non-parasitised host larvae of ***Heliothis virescens***. Such study is not available in jute hairy caterpillar parasitised by ***A. obliquae***. Therefore, the present study was made to determine the effects of parasitism on the larval development and on the food consumption of jute hairy caterpillar larvae when parasitised by ***A. obliquae***. This information could explain some physiological and ecological observations in biological control studies.

Materials and Methods

Effect of parasitism on host larvae

For the study, jute hairy caterpillar larvae were categorized in to 2-3, 4-5, 7-8, 9 and 10-11 days ages. Five hundred larvae of each age group were placed separately in five polystyrene containers (2 L capacity) and were allowed to parasitised by adult females of ***A. obliquae*** for 48 h in the laboratory at 29 ± 2^{0}C and 68±3% RH. The open ends of the containers were closed by nylon cloth with rubber bands. The larvae were fed on jute leaves. Effect of attack on host larvae by the parasitoid was observed by regular checking of the activity of host larvae and dissecting them whenever necessary. The moulting behaviour was studied by selecting some larvae from the parasitised larvae of each age group and keeping them separately in glass containers with foods. The larvae were reared till to the emergence of parasitoid larvae from the host body and examined daily for moults. The number of moult under went by the host larvae and measurements of host larval instars were recorded. The larvae of jute hairy caterpillar were dissected and the number of parasite larvae available in each larva after dissection was recorded. Many times the host larvae contained no parasite larva. The host larvae used in this experiment were almost of the same stage and age in each category at the time of exposure. Fifty such larvae were measured before the dissection and if it was found to contain parasite larva it was put under a group "parasitised hosts". If the same did not contain any parasite larva, its measurement was recorded under the group "non-parasitised hosts". Same time larval age in days was also recorded.

Effect of parasitism on the food consumption

Jute hairy caterpillar larvae were categorized into 1, 2, 3, 5, 7 and 9 days age groups. Twenty-five larvae of each age group were placed in six polystyrene containers (each 1 liter capacity) with jute leaves as food for the larvae. One mated female parasite was introduced to each container for parasitisation. Split raisin was given as food for the parasitoids. After 24 h the caterpillars were removed and reared separately. Every day the larvae were supplied with fresh jute leaves and the process continued till the emergence of final instar parasitoid larvae or

pupation or death of host larvae. Every day, fresh jute leaves were provided and the leaf area consumed by the larvae was measured placing the leaves on squared paper and estimating the total leaf area and the missing area in square centimeter, the measurement of both fresh and eaten leaf areas were recorded. The experiment was replicated twice. The larvae from which parasite larva did not emerged considered as non-parasitised larvae in the experiment.

Results

Effect of parasitism on host larvae

It was observed that the female parasites of *A. **obliquae*** deposit their eggs under the integument of the host larvae mostly at the last abdominal segment. After hatching the parasite larvae were found to feed on the body fluid and on the fat bodies. The parasite larvae moult inside the host body and emerged out when full grown. The dissection of larvae showed that the parasite larvae never attacked any vital part of the host body. In the earlier stage of parasitisation, the parasitised larvae cannot be recognized from the non-parasitised larvae. However, the 1st and 2nd instar parasitised larvae can be recognized at the 3rd day of parasitisation by their deep yellowish and sickly appearance and also of slow movement. It must, however, be said that a trained experienced eye can only make out the colour differences.

The differences in growth and development are marked with regard to moulting and size of the parasitised larvae. It was seen from the results that the moulting behaviour of the parasitised larvae changes when compared to the non-parasitised host larvae (Table 1). The number of moults were not fixed and the parasite larvae emerged out from any instar of the host ranging from second instar to fourth instar of the host larvae, the majority being found to emerge from

Table 1: Number of moults undergone in the parasitised and non-parasitised larvae of *S. obliqua*

Particulars of host larva	Number of larvae observed	Number of moults undergone in each cases						
		0	1	2	3	4	5	Natural death
2-3 days old (1st instar)								
Parasitised	27	13	14	0	00	00	00	00
Non-parasitised	25	00	00	00	13	9	00	3
4-5 days old (2nd instar)								
Parasitised	23	00	16	9	00	00	00	
Non-parasitised	30	00	00	00	11	15	00	4
7-8 days old (3rd instar)								
Parasitised	27	-	-	11	15	00	00	0
Non-parasitised	30	-	-	-	13	9	4	4
9 days old (3rd instar)								
Parasitised	26	-	-	10	11	00	00	5
Non-parasitised	25	-	-	-	11	8	3	3
10-11days old (4th instar)								
Parasitised	21	-	-	-	4	15	00	2
Non-parasitised	25	-	-	-	7	10	6	2

Table 2: Measurements of parasitised and non-parasitised larvae of *S. obliqua*

9 days old larvae (5 days after parasitisation) (n = 50)						14 days old larvae (10 days after parasitisation) (n = 50)					
Parasitised			Non- Parasitised			Parasitised			Non- parasitised		
(n)	Length (cm)	Width (cm)	(n)	Length (cm)	Width (cm)	(n)	Length (cm).	Width (cm)	(n)	Length (cm).	Width (cm)
4	1.0	0.25	6	1.33	0.35	3	2.0	0.5	2	3.3	0.65
1	1.0	0.29	2	1.35	0.33	2	2.0	0.8	2	3.3	0.70
3	1.0	0.30	2	1.35	0.35	3	2.1	0.8	9	3.5	0.65
2	1.1	0.25	4	1.35	0.37	8	2.2	0.5	7	4.0	0.60
2	1.1	0.28	9	1.50	0.40	7	2.2	0.6	3	4.0	0.70
3	1.1	0.29	3	1.80	0.44	-	-	-	4	3.5	0.60
3	1.2	0.25	5	1.80	0.40	-	-	-	-	-	-
1	1.2	0.30	-	-	-	-	-	-	-	-	-
n=19	$\bar{x}$±SE = 1.08±0.02	$\bar{x}$±SE = 0.27±0.00	n=31	$\bar{x}$±SE = 1.51±0.03	$\bar{x}$±SE = 0.38±0.01	n=23	$\bar{x}$±SE = 2.14±0.02	$\bar{x}$±SE = 0.60±0.02	n=27	$\bar{x}$±SE = 3.65±0.05	$\bar{x}$±SE = 0.65±0.01

x = mean, SE = standard error, n = number of observation

Table 3: Effect of parasitisation on the food consumption of larva of *S. obliqua*, parasitised by *A. obliquae*

Larval conditions						
At the time of parasitisation (n=50)		Parasitised (n=25)			Non-parasitised (Healthy) (n=25)		
Age (h/days)	Stage (instar)	Duration from the date of parasitisation	Feeding behaviour	Leaf area consumed (sq. cm) x ± SE	Duration from the date of parasitisation	Feeding behaviour	Leaf area consumed (sq. cm) x ± SE
24hrs	1st	6-7	Do not took food	--	6-7	2nd	1.68±0.06
48hrs	1st	6-7	Took food	0.67 a±0.13	6-7	2nd or 3rd	6.86±0.24
72hrs	1st	5-6	Stopped feeding and took food	1.82 b±0.12	5-6	3rd	8.23±0.55
5th day	2nd	5-6	Took food	8.23 c±0.00	5-6	4th	31.2±0.13
7th day	3rd	5-6	Took food	16.87 d±0.00	5-6	4th	38.06±0.24
9th day	3rd	4-6	Took food	32.54 e±0.00	4-6	5th	96.95±0.73
Mean (x) ± SE	--	--	--	12.07 f±0.05	--	--	30.48±0.30

Means (x) followed by a common letter are not significantly different at the 5% level by DMRT.

n = number of observation, SE = standard error.

the 3rd instar of the host larvae. On the contrary the non-parasitised host larvae underwent full development by moulting 4 to 5 times.

The parasitised larvae of jute hairy caterpillar measured less not only in length but also in width. The parasitised larvae of 9 days old measured 1.0 to 1.2 cm in length and 0.25 to 0.30 cm in width, with an average of 1.08 cm in length and 0.27 cm in width. The non-parasitised larvae, however, measured 1.33 to 1.80 cm in length and 0.33 to 0.44 cm in width, the averages of length and width being 1.51 and 0.38 cm respectively. Similarly 14 days old parasitised larvae measured to an average of 2.14 cm in length and 0.64 cm in width where as non-parasitised one measured to 3.65 cm in length and 0.60 cm in width (Table 2).

Effects of parasitism on food consumption

The food consumption of host larva during first 3 to 4 days (1st and early 2nd instar stages) was negligible. The larva at those stages ate so little that even on 3rd day the feeding area made by the non-parasitised larva was too small to be measured. During 1st instar the larva moved very little and also ate very little. The food consumption became conspicuous in the 2nd instar that started on 4th day. Food consumption increased gradually with the advancement of the age of the larva and bulk of food was eaten by 4th to 6th instar stages. A day or two before pupation, the rate of food consumption decreased and the larvae did not take food for some hours before moult and after each moult it took food voraciously. For this reason the total feeding period of the larva was less than the larval period by more than a day.

The larvae parasitised by *A. **obliquae*** ate nothing when parasitised at one day-old stage. Two days old (48 h) larvae when parasitised did not grow much for the next few days and ate only a negligible portion of leaves (0.67 sq. cm. area). Whereas healthy larvae of same age reached to third instar stage and ate an average of 6.86 sq. cm. leaf area. The mean food consumption by parasitised and non- parasitised larvae for different stages is shown in the Table 3. In the present study consumption of food by non-parasitised larva was slightly lower than that estimated for *S. **obliqua*** by Ara ***et al.***, 1989. The 9-day old larva when parasitised consumed about 3 times less food (32.54 sq. cm. area) than the healthy non- parasitised larva (96.95 sq. cm. area) of the same age at its developmental time (Table 3).

Discussion

The parasitised larva of *S. **obliqua*** could not be identified in the early stages from the non-parasitised larva as it continued its normal activity of feeding. But at the time of parasite larvae emerged from its host body, the parasitised larva became sickly in appearance and sluggish in movement. The 1st and 2nd instar host larvae became yellowish in color from its normal greenish colour and do not moult to next instar stages. The parasitisation of late 2nd and 3rd instar larvae lead to moult the larvae to their next instar stages and also discoloration became more evident. The parasitised larvae differ in moulting and size. There is, however, no published record on *S. **obliqua*** to show this fact. The parasitised host larvae do not moult regularly and underwent less number of moults than non-parasitised (healthy) host larvae. The size is greatly reduced on account of the parasite larvae, which develops within the host. Gangrade (1954) also made such

observation on pink bollworm, ***Pectinophora (= platydra) gossypiella*** (Saunders) when parasitised by *A. angaleti*. He stated that the parasite larva takes up all the nourishment from host body and probably this is the reason why the size of the parasitised larva is reduced. After emerging the parasite larvae from its host body of 3rd or 4th instar stages of *S. obliqua*, the dissection of parasitised larvae showed that there present no fat bodies inside the host larval body and only the thin cuticle of skin remained. In each case the host larvae remained alive for few days. Same was observed for ***Pieris brassicae*** parasitised by *A. glomeratus* (Gatenby, 1919); European corn borer by ***Apanteles thompsoni*** (Vance, 1931), soybean looper, ***Pseudoplusia includens*** by ***Apanteles ruficrus*** (Hafez, 1947) and differed from *P. gossypiella* by *A. angaleti* (Gangrade, 1954), where host larva was outright killed on the emergence of the parasite larva. Lewis (1970) observed that larva parasitised by *M. croceipes* continued to moult on the same schedule as non-parasitised larva.

Information on the food consumed by parasitised larvae of *S. obliqua* is rather scanty too. The food consumption throughout the larval stages of parasitised larvae of *S. obliqua* was significantly less. Powell (1989) also made such observation on tobacco budworm parasitised by ***Microplitis demolitor*** or *M. croceipes*. The present result suggests that parasitised *S. obliqua* larvae caused considerably less damage to the host plant than non-parasitised larvae. Frank and Robart (1973) found that larva of ***Pieris rapae*** parasitised by *A. rubecula* consumed significantly less leaf area than similar non-parasitised larva and cause much less plant damage than non-parasitised larva. Tower (1916) concluded that the parasitised larva of ***Cirphis unipuncta*** ate only half of the quantity of food eaten by an unparasitised larva. However, Rahman (1970) observed that larvae of *P. rapae* parasitised by gregarious parasite *A. glomeratus* ate more than the non-parasitised larva and normal larva consumed more food than larva parasitised by *A. rubecula*. Parker and Pinnell (1973) also observed that *P. rapae* parasitised by *A. rubecula* consumed less leaf area than non-parasitised one. Guillot and Vinson (1973) stated that reduction in food consumption occurred for ***Heliothis virescens*** when parasitised by ***Cardiochiles nigriceps*** while Plarre ***et al.*** (1999) mentiomed that young hosts (***Tineola bisselliella*** and ***Tinea pellionella***) of *A. carpatus* do not stop feeding when parasitised.

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