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Oviposition behaviour of *Meteorus Sp.* (Hymenoptera : Braconidae) on *Spilarctia obliqua* (Walker) (Lepidoptera: Arctiidae)

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ABSTRACT

Oviposition behaviour of the braconid parasitoid *Meteorus sp.* in *Spilarctia obliqua* (Lepidoptera : Arctiidae) was studied. The parasitoid was highly attracted to the olfactory cue (kairomone) of the solid mandibular portions of the hosts, exhibiting movements of antennae, flying, walking and running, cleaning body parts after completion of oviposition. The treatment with dried mandibular powder also had positive influence on the parasitoid for oviposition. Other treatments using hosts exuviae and faeces in different forms showed negative influence. It could be concluded that the solid and powdered mandibular portions of hosts contained some chemicals which influenced the parasitoid to oviposit more causing higher parasitization.

Keywords *:Meteorus*, Oviposition behaviour, *Spilarctia obliqua.*

INTRODUCTION

Meteorus is a solitary and primary endoparasitoid of caterpillars and larvae of beetles (Huddleston 1980). This parasitoid can be found in many parts of the world and is currently used as a successful biocontrol agent against several lepidopterous pests (Miller 1996). At present, emphasis is laid on biological control in pest management programs. The indiscriminate use of chemical pesticides has led to the problems of environmental pollution, pesticide resistance, secondary pest outbreaks, direct toxicity to beneficial insects, fish and humans (Goodland *et al.* 1985). Pest control experts are becoming more inclined towards the non-chemical methods of pest management including the use of biological agents. Parasitoids play an important role in biological control of insect pests. *Meteorus* is the most important parasitoid of the larvae of *Spilarctia obliqua* both in field and laboratory conditions (Kabir 1976). This parasitoid could be utilized as an alternative to synthetic insecticides in controlling *S. obliqua* if it proved successful in biocontrol. But before releasing this parasitoid, a detailed knowledge on their behavioural activities including ovipositional frequency would be helpful in a successful biocontrol programme of this pest. The present study was conducted to understand the ovipositional behaviour of *Meteorus* in the presence of its host and host materials.

MATERIALS AND METHODS

The research was carried out to study the oviposition behaviour of *Meteorus* using host *S. obliqua* in the laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during June-September 1997. The laboratory was well ventilated having enough light source. The temperature and relative humidity were maintained at 29 ± 2°C and 70% respectively. The host materials used in the study were solid and powder of exuviae, faeces (fresh and with fungus) and mandibular portions.

Mass culture of *Spilarctia obliqua* and *Meteorus sp.*

Eggs of *S. obliqua* were collected from the infested jute field and placed in Petridishes (11cm diam.x1.5cm ht.) for hatching. Water soaked cotton pads were placed in the petridishes to maintain relative humidity. The tiny larvae of *S. obliqua* were reared in Petridishes (15 cm diam x 2.5 cm ht.) using fresh jute leaves which were supplied to the larvae as food. Petridishes were changed daily by transfering the larvae to new dishes to provide proper sanitation. The larvae usually pupate after sixth instar. The newly emerged adults were paired for mating and kept in glass jelly jars whose inner walls were lined with paper for oviposition and mouth was closed with markin cloth. The jelly jars were kept in the dark and 10% sugar solution was offered as food to the moths. Eggs laid by the females were collected and allowed to hatch. The hatched larvae were again reared and mass rearing procedure continued up to the completion of the experiment.

The mass culture of *Meteorus sp.* was initiated using second and/or third instar larvae of *S.obliqua* as host collected from the infested jute field. They were reared in Petridishes (15 cm diam. x 2.5 cm ht.), keeping 40-50 larvae per Petridish. Rearing continued upto fifth instar larvae as mentioned earlier. Meanwhile, parasitoid larvae emerged from host larvae and pupated after few hours. The following day parasitoid pupae were transferred to small jelly jars and kept undisturbed until adult emergence. The mouth of the jelly jars were covered with markin cotton cloth tied with a rubber band. Afterwards the emerged adults were paired and kept in a separate jelly jar (12 cm diam. X 6 cm ht.) for mating. Honey solution (water : honey = 3:1) was supplied in small cotton pads in the jar as food. The mated females were separated from males and released on second and/or third instar host larvae in jelly jar individually for oviposition. This laboratory mass rearing procedure continued till the end of the experiment.

Preparation of Materials

Fresh moulted skins of second to sixth instar host larvae were collected from the mass culture and dried in oven at 42°C for two days. The dried skins were powdered using mortar and pastle. A 25 mesh sieve was used to obtain the fine dust.

Fresh faeces were collected before use in the treatment and dried in oven at 42°C. Powder of faeces was prepared by pulverizing the dried faeces in an electric blender. For finest powder a 25 mesh sieve was used and preserved in a reagent bottle till their use in the experiment.

Faeces injected with fungus, *Eryria meopyralidarum* (Bewziev) were used in the experiment. The collected faeces with fungus were oven dried at 42°C and powdered in an electric blender. Finest powder were obtained by using 25 mesh sieve. Identification of fungus was done in the Plant Pathology Department of BAU.

Before starting the experiment, the mandibular portions of *S. obliqua* were collected using a sharp blade. The collected mandibular portions were dried in oven at 45°C. Powder was prepared by pulverizing the dried mandibular portions in an electric blender. A 25 mesh sieve was used to obtain fine powder and preserved in a bottle for further use until the completion of the experiment.

Observations

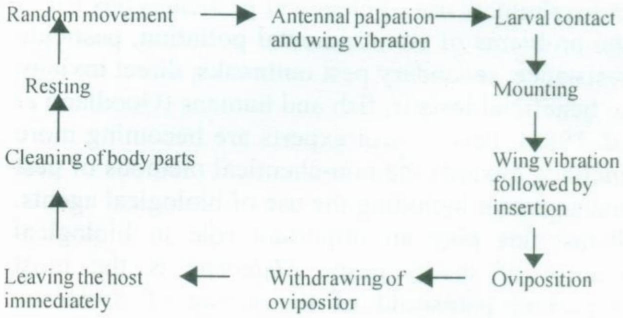
Ten host larvae of second and/or third instar were kept in a 500 ml beaker containing 0.5 g of faeces powder. A mated female of *Meteorus sp.* was released into the beaker and observations were made on the host finding and ovipositional behaviour. Initially single observations were continued for two hours. Observations were made on 5 separate mated females of *Meteorus sp.* following the same procedure. All the host larvae were kept in Petridishes separately and reared up to the maturity for recording the parasitism and mortality. The same procedure was followed for the treatment with fresh faeces, faeces and faeces powder with fungus, solid and powder of mandibular portions, fresh exuviae and exuviae powder of *S. obliqua*.

Statistical Analysis

Analysis of the experimental data was done following Completely Randomized Design (CRD). Treatment relationships were determined using ANOVA, Simple Correlations and Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

The behavioural ethogram of *Meteorus sp.* during host encounter



It was found that *Meteorus sp.* selected the host at random within the surrounding environment. The host selection was also influenced by the chemical and physical cues (kairomones) from mandibular portions, faeces and exuviae (Ngi *et al.* 1996). Miller (1996) reported that host acceptance or rejection depends on antennal response. Flanders (1953a) suggested that parasitoid's success depended not only on host location but also the acceptance and suitability of the host. Doutt (1959) combined these ideas into four steps (1) habitat location, (2) host location, (3) host acceptance and (4) suitability. A fifth step, referred to as host regulation has been added by Vinson (1975a).

During this study, it was observed that *Meteorus sp.* preferred (1) the environment with hosts mandibular portions, (2) the lower density of host, (3) it usually located the host by visual observation, (4) encountered and examined the host, (5) touched the host with mouth parts or by antennae and if the host dispersed they tried again to touch it, (6) at the same time they vibrated the wings and (7) finally inserted the ovipositor. Most of the above steps were similar to the oviposition of *Anagyrus pseudococci* (Risso) on mealy bugs studied by Islam (1992).

Ovipostion period and event

The data showed (Table 1) that the highest ovipositional period of 109.4 sec and that of events (29.0) were covered by *Meteorus* in presence of fresh mandibular portions. In the treatments with powdered mandibular portions these periods and events were 79.2 sec. and 20.6 sec. respectively and all these were significantly higher than the period of 64.8 sec and events of 17.2 of the control treatment. The least ovipositional period of 6.8 sec and events of 2.0 were observed when solid exuviae were used in the treatment which were significantly ($P<0.01$) lower than that of other treatments.

The experimental results revealed that the solid and powdered mandibular portions of host had significantly ($P<0.01$) positive influence on ovipositional period and events of the parasitoid. Wang and Zong (1991) reported that the kairomones elicited from the host insect influenced the oviposition period and event of the parasitoid. The saliva, haemolymph and other enzymes of mandibular portions might contain kairomones which influenced the parasitoid spending longer period for oviposition and subsequent more events than the control.

Period before first oviposition

The period before first oviposition varied significantly ($P<0.01$) from each other among the treatments (Table 1). The least time of 36.2 sec spent before first oviposition was found when solid mandibular portions were used which was significantly less than the control. In all other treatments the time spent was significantly ($P<0.01$) higher. This may have an important linkage with the kairomone lure or cue from the host insects which influenced the behaviour of *Meteorus.* Emelyanov and Goncharenko (1991) analyzed 10 enzymes of *Dendrolimus pini,* where 3 were found suitable for *Meteorus versicolor.* The enzymes and saliva content of mandibular portion from *S. obliqua* may have been attractive for *Meteorus* to spend longer period around the host complex with shorter period before first oviposition. The treatments with mandibular portions also indicate the presence of kairomone which influenced the parasitoid spending less time for host encounter. The maximum period covered before first oviposition resulted in minimum oviposition and was observed in the treatments of exuviae and faeces. This might be perhaps due to detterent chemicals present in those materials.

Antennation period and events

The highest antennation period of 340.4 sec and events of 46.2 were found on the treatment of solid mandibular portions (Table 1). The antennation period and events on mandibular portion treatments were significantly higher than all other treatments (Table 1). Just after release in the experimental arena it was found a common event for the parasitoid to do antennation.

Flying period and events

The flying period was highest using 18.6 sec in solid mandibular portions treatment and lowest using 5.8 sec in faeces with fungus treatment. This period was identical in exuviae and faeces powder treatment followed by solid exuviae and faeces (Table 1). The highest flying event of 5.8 was found on solid mandibular portion treatment which followed by powdered mandibular portion and the least of 2.4 found on solid exuviae. There were no statistical differences among the treatments where exuviae powder, solid faeces and faeces with fungus were used (Table 1). Flying behaviour related to oviposition may include those flight made for finding suitable sites for oviposition (Haskell 1966). Flying effect of *Meteorus* was not common in oviposition sites to its host insect. Flying time increased with the presence of material contained kairomone such as mandibular portions, faeces etc.

Effect of cleaning

The data in Table 1 indicated that maximum period of 186.8 sec and event of 44.8 was spent in solid mandibular portion treatment. The cleaning periods and events among the treatments varied significantly ($P<0.01$). The period of cleaning and number of events were minimum of 26.4 sec and 6.0 respectively in solid exuviae treatment (Table 1). The cleaning periods without the solid mandibular portion treatments were significantly lower ($P<0.01$)

Table 1. Mean values (second) of different parameters (period and event) affected by treatments.

Treatments	Oviposition period	Period before first oviposition	Antennation period	Flying period	Cleaning period	Walking and running period	Resting period
T_1, Solid mandibular portions	109.4a (29.0a)	36.2i	340.4a (46.2a)	18.6a (5.8a)	186.8a (44.8a)	2636.0a (73.8a)	3908.8i (78.8a)
T_2, Powder mandibular portions	79.2b (20.6b)	122.0g	239.6b (32.6b)	13.0b (5.0ab)	131.0c (35.6b)	2044.8b (55.0b)	4702.2h (63.2b)
T_3, Solid exuviae (frass)	6.8i (2.0g)	3611.0a	25.6i (7.8g)	6.0ef (2.4d)	26.4i (6.0g)	256.0i (17.4h)	6879.4a (21.8h)
T_4, Exuviae-powder	51.2e (13.8d)	723.0c	158.4e (22.8d)	8.0d (2.6cd)	85.0e (20.4ef)	1200.8e (42.2d)	5696.6e (47.6e)
T_5, Fresh faeces	15.0h (4.0f)	1861.2b	33.6h (8.6g)	7.2de (2.6cd)	48.6g (9.2g)	650.0h (30.8f)	6445.6b (29.2g)
T_6, Faeces-powder	47.0f (13.0d)	685.4e	124.8f (19.6e)	7.8d (3.2c)	68.8f (16.8f)	1129.6f (39.6e)	5822.0d (45.4e)
T_7, Faeces with fungus	25.6g (6.8e)	704.0d	78.6g (10.8f)	5.8f (2.6cd)	43.6h (10.2g)	702.6g (28.4g)	6343.8c (33.4f)
T_8, Faeces powder with fungus	57.2d (16.2c)	661.0f	176.0d (23.6d)	9.6c (4.0bc)	95.4d (23.4de)	1403.6d (47.2c)	5458.2f (51.6d)
T_9, Control	64.8c (17.2c)	75.2h	204.6c (28.4c)	11.8b (4.0bc)	133.8b (26.8 cd)	1605.2c (47.2c)	5179.8g (55.6c)

Means having same letter(s) in same column did not differ significantly at 1% level.
Data in parentheses shows event.

than the control. Cleaning or preening of the body parts of *Meteorus* was found mostly after successful oviposition. In cleaning she preened the ovipositor and wing with hind legs, antennae with mouthparts and front legs, hind legs with midlegs and lastly midlegs with the hindlegs. Cleaning of antennae and ovipositor were also observed before ovipositon. Thelen & Farish (1976) described the grooming behaviour of *Bracon hebetor* after oviposition. Ibrahimn (1988) observed that *Scutellisa cyanea* spent most of their allocated time on walking, host drilling and preening.

Walking and running period and events

The data shown in Table 1 represented the highest period of 2636 sec and event of 73.8 in solid mandibular portion treatment. The least period of 256 sec and event of 17.4 were found in solid exuviae treatment. The period and event of walking and running significantly ($P<0.01$) varied among the treatments. Mostly it went to the host by walking. To and fro movement with running was observed in presence of the treatment of mandibular portions. These findings closely related to the findings of Ibrahimn (1988) who observed same behaviour using *Metaphysus helvolus* and *Scutelliesta cyanea,* parasitoids of coccid *Saissetia coffeae* on leaves of *Aphelendra squorrosa* in the laboratory at 18 and 26^0C. As discussed earlier, the mandibular treatment influenced more activities of *Meteorus* than the control indicating kairomonal response. The faeces and exuviae reduced the parasitoid activities like walking and running and proving themselves as materials containing chemicals which acted as a repellent to *Meteorus*.

Resting period and event

The lowest period of 3908.8 sec and highest of 6879.4 sec were spent for resting in the treatment of solid mandibular portions and solid exuviae respectively (Table 1). The period for resting among different treatments varied significantly ($P<0.01$). The parasitoid enjoyed maximum number of events of 78.8 in solid mandibular portions but events were least of 21.8 with the treatment of solid exuviae (Table 2). All the treatments were significantly different ($P<0.01$) except exuviae and faeces powder. It could be concluded from the above discussion that in those treatments where *Meteorus* was much active and performed more events and it enjoyed less resting time. Even the duration of resting periods were short with much number of resting events, the parasitoid was less active for oviposition. All the variables were observed symmetrically dependent. However the correlations were also observed with the treatments (Tables 2 & 3).

On release of the parasitoid, the caterpillars ceased feeding. Most of them gathered together. The parasitoid always tried to oviposit on those larvae which were in dispersed conditon. When the parasitoid came near to the host larvae, they showed defensive mechanism. During oviposition the attacked larvae twisted their head, even those were in the surroundings did the same. This might be the cause of alarm pheromone secreted by the host larvae or the secretion of venom released by the parasitoid (Edson *et al.* 1982).

Atkins (1980) described self defense of host insects against parasites. He stated that it is a basic biological problem faced by all species of natural enemies in nature. However, many parasitoids have

Table 2. Correlation matrix showing relationship of different characters with ovipositional period and events.

	*x_1	x_2	x_3	x_4	x_5	x_6	Y
x_1	1.00 (1.00)						
x_2	0.945 (0.835)	1.00 (1.00)					
x_3	0.983 (1.928)	0.964 (0.805)	1.00 (1.00)				
x_4	0.990 (0.975)	0.953 (0.818)	0.984 (0.937)	1.00 (1.00)			
x_5	-0.993 (0.987)	-0.954 (0.835)	-0.987 (0.925)	-1.00 (0.984)	1.00 (1.00)		
x_6	-0.779 -	-0.628 -	-0.755 -	-0.792 -	0.790 -	1.00 -	
Y	0.997 (0.988)	0.940 (0.833)	0.979 (0.917)	0.994 (0.980)	-0.996 (0.993)	-0.796 -	1.00 (1.00)

Determinant of Matrix = 3.712403 E-10
(2.575068 E-05)

*	x_1	Stands for Antennation, Period (Events)
	x_2	... ... Flying, P (E)
	x_3	... ... Cleaning, P (E)
	x_4	... ... Walking & running, P (E)
	x_5	... ... Resting, P (E)
	x_6	... ... Period after 1st oviposition, P
	Y	... ... Oviposition, P (E)

Data without parenthesis shows the relationship between oviposition period and flying/cleaning/walking and running of parasitoid were highly correlated while that between oviposition and resting period before 1st oviposition were negatively correlated.

Data in parenthesis shows the relationship between oviposition events were also highly correlated.

Table 3. Correlation matrix showing relationslip of different characters with parasitization.

	*x_1	x_2	x_3	x_4	x_5	x_6	x-	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
x_1	1.000														
x_2	0.997	1.000													
x_3	0.940	0.945	1.000												
x_4	0.979	0.983	0.964	1.000											
x_5	0.994	0.990	0.953	0.984	1.000										
x_6	-0.996	-0.993	-0.954	-0.987	-1.000	1.000									
x-	-0.796	-0.779	-0.628	-0.755	-0.792	0.790	1.000								
x_8	0.996	0.992	0.935	0.972	0.987	-0.989	-0.789	1.000							
x_9	0.993	0.994	0.956	0.984	0.988	-0.991	-0.743	0.988	1.000						
x_{10}	0.838	0.841	0.879	0.841	0.850	-0.849	-0.586	0.833	0.835	1.000					
x_{11}	0.933	0.930	0.895	0.927	0.942	-0.939	0.729	0.917	0.928	0.805	1.000				
x_{12}	0.984	0.976	0.938	0.971	0.988	-0.988	-0.795	0.980	0.975	0.818	0.937	1.000			
x_{13}	0.997	0.993	0.935	0.979	0.994	-0.995	-0.809	0.993	0.987	0.835	0.925	0.984	1.000		
x_{14}	0.948	0.949	0.907	0.933	0.941	-0.944	-0.721	0.940	0.950	0.787	0.869	0.926	0.944	1.000	
x_{15}	0.913	0.912	0.893	0.898	0.911	-0.912	-0.647	0.902	0.918	0.737	0.877	0.909	0.903	0.963	1.000

Determinant of Matrix = 4.075554 E-25

* x_1 Stands for ovipostion (Period)
x_2 ... ... Antennation (P)
x_3 ... ... Flying (P)
x_4 ... ... Cleaning (P)
x_5 ... ... Walking and running (P)
x_6 ... ... Resting (P)
x- ... ... Period before 1st Oviposition (P)
x_8 ... ... Oviposition (Event)
x_9 ... ... Antennation (E)
x_{10} ... ... Flying (E)
x_{11} ... ... Cleaning (E)
x_{12} ... ... Walking and running (E)
x_{13} ... ... Resting (E)
x_{14} ... ... Mortality (Trans)
x_{15} ... ... Parasitization (Trans)

Table shows the relationship between parasitism and all other parameters were highly correlated except those of resting/period after 1st oviposition were negatively correlated. Similarly, oviposition events and the rest of the parameters were negatively correlated with resting/period before 1st oviposition.

evolved countermeasures, such as long ovipositors (*Meteorus)*, that have reduced the effectiveness of some protective measures of host insect.

Further, it revealed that the materials used in the experiment had influence on the behaviour of the parasitoid. In comparison with the other host materials used in the experiment the solid and powdered mandibular portions of the host larvae of *S.obliqua* attracted the parasitoid. The parasitization was maximum (70%) with the fresh mandibular portions. The behavioural activities like antennation, oviposition, flying, cleaning, walking and running were also found significantly high ($P<0.01$). Moreover, the treatment with dry mandibular powder gave more parasitization than the control. Therefore, it seemed that the fresh and dry mandibular portions might have the kairomonal effect on the parasitoid.

The treatment with the solid exuviae, fresh faeces resulted in least performance and the faeces with fungus, exuviae powder, faeces powder had less influence than the control. So all these experimental materials might contain such repellent chemicals which caused the parasitoid spending longer time away from the host. Further more, the use of 2-6 instar host faeces and that of exuviae might have contained high quantity of kairomones which could be the cause of repellency and might be similar to the observations of Carton, 1976 and Greany *et al.* 1977.

The findings of this research work indicate that the cumulative effects of mandibular powder of host species and the parasitoid *(Meteorus)* may enhance the activities of other pest management tactics or practices if they are successfully monitored in pest management.

It needs chemical analysis of host materials to know the exact substances which influence the oviposition or act as a repellent to the parasitoid.

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