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Life history and prey acceptance of commonly occurring spiders in sugarcane ecosystem

S. EASWARAMOORTHY, J. SRIKANTH, G. SANTHALAKSHMI and N. K. KURUP
Sugarcane Breeding Institute, Coimbatore 641 007, Tamil Nadu, India

ABSTRACT : Life-history and prey acceptance of commonly occurring spiders of sugarcane ecosystem were studied in the laboratory and field. In the laboratory, males and females of *Hippasa greenalliae* Blackwall passed through eight and nine instars, and the total life cycle lasted 263.3 and 371.6 days, respectively. In the field, females of *Cyrtophora cicatrosa* Stoliczka passed through nine instars and the total life cycle lasted 195.2 days. In laboratory no choice feeding tests, neonate larvae of shoot (*Chilo infuscatellus* Snellen), internode [*Chilo sacchariphagus indicus* (Kapur)] and pink (*Sesamia inferens* Walker) borers were the most accepted stage followed by third instar larvae for the spiders *H. greenalliae* and *Oxyopes shweta* Tikader. Amongst four sucking pests tested, aphid (*Melanaphis indosacchari* David), leafhopper (*Pyrilla perpusilla* Wlk.) and pink mealybug [*Saccharicoccus sacchari* (Ckll.)] were the most accepted preys while scale insect (*Melanaspis glomerata* Green) was completely avoided by the above two species of spiders. In field cage studies with *H. greenalliae* against *C. infuscatellus*, deadhearts formed by 10 neonate larvae were reduced by around 50 per cent by one spider per cage whereas the same number of third instar larvae needed four to six spiders per cage to reduce deadheart formation.

KEY WORDS : Life history, prey acceptance, spiders, sugarcane ecosystem

Spiders play an important role in the natural regulation of pest populations in several crops (Palanichamy, 1985) including sugarcane (David and Easwaramoorthy, 1985). Studies in Louisiana on sugarcane showed the occurrence of 107 species of spiders representing 18 families (Negm *et al.*,

1969) which was later updated to 135 species representing 23 families (Ali and Reagan, 1985). Positive correlations were found between spider numbers and per cent egg predation of *Diatraea saccharalis* (F.) (Negm and Hensley, 1972). In a study conducted at Coimbatore, 57 species of spiders belonging to 13 families inhabiting sugarcane ecosystem have been observed (Easwaramoorthy *et al.*, 1994). The life history and prey acceptance of two most dominant species, namely *Hippasa greenalliae* Blackwall (Lycosidae) and *Cyrtophora cicatrosa* Stoliczka (Araneidae), and a less abundant species *Oxyopes shweta* Tikader (Oxyopidae) were studied and the results are presented in this paper.

MATERIALS AND METHODS

Laboratory and field studies were carried out at the Sugarcane Breeding Institute, Coimbatore, in March / April planted crop in 1990-91 and 1991-92.

Life history

Adult females of *H. greenalliae* carrying egg sacs were collected from sugarcane fields and reared in the laboratory at 27 ± 1°C. Spiders were placed individually in glass bottles (12 x 6 cm) containing a bed of moist sand and the open end of the bottle closed with coarse cloth. The spiderlings were removed and reared individually in glass bottles. Early stages of the spiders were fed with adults of laboratory reared *Drosophila* maintained on artificial diet (Singh, 1977) and later stages fed with third instar larvae of sugarcane shoot borer, *Chilo infuscatellus* Snellen *ad libitum* every day. The food remains and excreta were removed everyday and the moist cotton swab placed in the bottle to provide water was changed every second day.

The life-history of the web-spinning spider *C. cicatrosa* was studied in the field during 1990-91 as it was not amenable to laboratory rearing. About 25 webs housing adult females were located, labelled and examined everyday. The number of egg sacs laid by a female and the number of eggs / sac were recorded. The webs spun by the spiderlings were labelled and examined daily for moulting. Observations on the number and duration of instars and adult longevity were recorded. The sex of the individuals was confirmed after they reached the adult stage and life-history data compiled retrospectively for each from five individuals.

Prey acceptance and predatory potential in the laboratory

In feeding tests with *H. greenalliae* and *O. shweta*, fifth to sixth instar nymphs (n=5) collected from the field were starved for one day, and were offered known numbers of different stages of the major borer species namely *Chilo infuscatellus*, *C. sacchariphagus indicus* and *Sesamia inferens* and four species of sucking pests of sugarcane namely *Melanaphis indosacchari*, *Pyrilla perpusilla*, *Saccharicoccus sacchari* and *Melanaspis glomerata* in no-choice tests. The number of prey killed was recorded after one hour. Webs of *C. cicatrosa* (n=10) were examined in the field for remnants of insect bodies.

Predatory potential in field cages

Field-cage experiments were conducted in March /April planted sugarcane crop during 1990-91 and 1991-92 to study the predatory potential of *H. greenalliae* against *C. infuscatellus*. At 45-60 days after planting, clumps with ten healthy shoots were selected at random and all the dried leaves and arthropods present, if any, were removed. Each clump was enclosed in a cotton cloth cage supported by a cylindrical iron frame. Ten neonate or third instar larvae of *C. infuscatellus* were released separately on each clump. Subsequently, adults of *H. greenalliae* were released @ one, two, four and six / clump and the cage closed at the bottom. All treatments were replicated five times. The per cent deadhearts formed in the treatments was recorded on the fifteenth day after release.

RESULTS AND DISCUSSION

Life history

Females of *H. greenalliae* laid one egg sac in their life time and each contained an average of 63.6 spherical creamy white eggs (range:34-94) (Table 1). The female attached the egg sac to her spinnerets 1 and carried it with her. The spiderlings emerging from the egg sacs aggregated and remained on the abdomen of the mother

Table 1. Life history of *H. greenalliae* in the laboratory

Stage	Duration (Days)			
	Female		Male	
Egg + 1 Instar	18.5	(18-19)[a]	17.0	(16-18)
II Instar	8.3	(7-10)	7.7	(7-8)
III Instar	19.0	(17-21)	18.7	(16-21)
IV Instar	26.5	(26-28)	26.3	(25-28)
V Instar	38.8	(35-42)	38.0	(36-41)
VI Instar	40.3	(37-47)	40.0	(38-42)
VII Instar	47.3	(45-50)	43.0	(40-45)
VIII Instar	44.3	(43-46)	39.0	(36-41)
IX Instar	50.7	(49-52)	-	-
Adults	78.0	(68-89)	33.7	(31-36)
Total life cycle	371.6	(345-404)	263.3	(245-280)
Fecundity	63.6	(34-94)	-	-

[a] Figures in parentheses are ranges

for a week and subsequently separated from the mother. The first moult occurred inside the sac as evidenced by the presence of exuviae in the egg-sac. After an incubation-cum-first instar period of 16 to 19 days, the second instar spiderlings climbed on to the dorsal and lateral sides of the abdomen of the mother and remained attached for two to three days. Gradually, the spiderlings moved away from the mother and settled at new sites. Males matured earlier, and lived for a shorter period than females and their life cycle lasted 263.3 (range : 245-280) and 371.6 (range : 345-404) days with eight and nine instars, respectively. Males of lycosids are known to show shorter developmental period and fewer instars than females (Anonymous, 1987).

Since very few males were encountered in the field the females were studied. Each female *C. cicatrosa* laid six to 11 egg sacs which were seen hanging like beads on a string. The number of eggs in a sac varied from 11 to 31 (mean = 20.2). After an incubation-cum-first instar period of 56-62 days (Table 2) in the sac, the second instar spiderlings remained huddled together in the same web for three to four days guarded by the mother. Gradually the spiderlings dispersed and started to spin new webs. The female completed nine instars and the total life cycle was completed in 195.2 (range : 176-227) days. *Cyrtophora cicatrosa* showed a longer incubation-cum-first instar period but the total life cycle was shorter than that of *H. greenalliae*.

Prey acceptance and predatory potential in the laboratory

All the test individuals of *H. greenalliae* fed on neonate and third

Table 2. Life history of *C. cicatrosa* female in the field

	Duration (Days)	
Stage	Mean	Range
Egg + 1 Instar	58.6	56-62
II Instar	7.6	7-10
III Instar	6.6	6-8
IV Instar	7.0	6-9
V Instar	7.8	6-10
VI Instar	7.6	7-10
VII Instar	9.4	7-12
VIII Instar	13.2	13-14
IX Instar	11.4	10-13
Adults	66.0	58-79
Total life cycle	195.2	176-227

Table 3. Acceptance of borers as food by fifth to sixth instar *H. greenalliae* in the laboratory

Stage of the prey	*Chilo infuscatellus*		*Sesamia inferens*		*Chilo sacchariphagus indicus*	
	% spiders fed on the host	No.fed/ spider	% spiders fed on the host	No.fed/ spider	% spiders fed on the host	No.fed/ spider
Egg	40.0	0.8	40.0	7.4	0.0	0.0
Neonate larvae	100.0	38.2	27.6	27.6	100.0	36.4
Third instar	100.0	3.4	100.0	3.8	40.0	1.0
Fifth instar	0.0	0.0	0.0	0.0	0.0	0.0
Pupa	80.0	2.4	0.0	0.0	56.0	2.8
Moth	100.0	4.0	100.0	3.2	72.0	3.6

instar larvae of *C. infuscatellus* while *S. inferens* and *C. sacchariphagus indicus* stages were accepted differentially (Table 3). Final instar larvae of these borers were completely avoided. Next to young larvae, moths were the most accepted stage. Pupae of *C. infuscatellus* and *C. sacchariphagus indicus* were accepted to varying degrees while *S. inferens* pupae were not accepted by the spider. Eggs were less suitable as only 40 per cent of the test spiders fed on *C. infuscatellus* and *S. inferens* eggs. The feeding rates of individual spiders were highest on neonate

Table 4. Acceptance of sucking pests as food by fifth and sixth instar *H. greenalliae* in the laboratory

Prey insect	Stage of insect			
	Adults		Nymphs	
	% spiders fed on the host	No.fed/ spider	% spiders fed on the host	No.fed/ spider
Saccharicoccus sacchari	30.0	1.5	46.7	3.7
Melanaphis indosacchari	60.0	4.8	100.0	18.0
Melanaspis glomerata	0.0	0.0	0.0	0.0
Pyrilla perpusilla	65.0	3.4	80.0	4.5

Table 5. Acceptance of borers as food by fifth and sixth instar *O. shweta* in the laboratory

Stage of the prey	*Chilo infuscatellus*		*Chilo sacchariphagus indicus*	
	% spiders fed on the host	No.fed/ spider	% spiders fed on the host	No.fed/ spider
Egg	12.0	1.2	12.0	2.6
Neonate larva	100.0	43.2	92.0	27.2
Third instar	90.0	4.5	100.0	4.0
Fifth instar	60.0	3.0	80.0	1.4
Pupa	50.0	1.0	60.0	1.8
Moth	60.0	3.0	55.0	2.8

larvae in all the three species of prey. In tests with sucking pests, more than 60 per cent of spiders fed on nymphs and adults of the aphids and leafhoppers (Table 4). The pink mealybug, *S. sacchari* was least accepted while the scale, *M. glomerata* was totally avoided. More nymphs than adults of *M. indosacchari* were consumed by a single spider while no such difference was noticed in *P. perpusilla*.

For *O. shweta*, neonate and third instar larvae of *C. infuscatellus* and *C. sacchariphagus indicus* were the most accepted stages (Table 5). This species was able to feed on the fifth instar larvae of the two borers. Amongst the sucking pests, nymphs and adults of *M. indosacchari, P. perpusilla* and *S. sacchari* were readily accepted as prey in the decreasing order, while, *M. glomerata* was not accepted (Table 6). Similar to *H. greenalliae*,

Table 6. Acceptance of sucking pests as food by fifth and sixth instar *O. shweta* in the laboratory

Prey insect	Stage of insect			
	Adults		Nymphs	
	% spiders fed on the host	No.fed/ spider	% spiders fed on the host	No.fed/ spider
Pyrilla perpusilla	100.0	3.6	100.0	4.8
Melanaphis indosacchari	100.0	13.0	100.0	31.0
Saccharicoccus sacchari	80.0	2.0	66.7	3.7
Melanaspis glomerata	0.0	0.0	0.0	0.0

individual spiders consumed more on nymphs than adults of *M. indosacchari*.

Cyrtophora cicatrosa webs in the field showed the presence of remnants like head capsules, legs, wings, etc. which indicated that they might be feeding on dispersing lepidopterous larvae and moths, and nymphs and adults of leafhoppers that are trapped in the webs. However, these observations need confirmation.

Hippasa greenalliae and *O. shweta* accepted neonate larvae of the borers more readily than the other stages which was evident from the higher feeding rates of individual spiders, even though equal proportions of test individuals fed on different stages of the prey. These differential feeding rates could be related to the ability of the spiders to handle the less active smaller prey as well as the resource quantity. Amongst the sucking pests, the spiders accepted the soft bodied aphid, leafhopper and pink mealybug but avoided the hard bodied scale insect. Spider food preferences are related to disagreeable odours and tastes, and morphological and seasonal factors in prey (Mansour *et al.*, 1980). However, factors other than preference, such as physiological state of hunger, strength, etc. also decide the readiness with which a spider takes food (Mansour *et al.*, 1980). These factors might decide the differential attack and feeding, if any, of sugarcane pests by these spiders.

Predatory potential in field-cages

In field-cage experiments conducted during 1990-91, in the presence of one to six *H. greenalliae*, 10 neonate larvae of *C. infuscatellus* produced 11.4 - 15.7 per cent deadhearts while in the absence of the spiders the larvae produced 22.9 per cent

Table 7. Evaluation of *H. greenalliae* against *C. infuscatellus* in field-cage experiments

No. of spiders released per cage	Per cent deadhearts formed 15 days after release			
	1990-91		1991-92	
	Neonate larvae	Third instar larvae	Neonate larvae	Third instar larvae
One	12.9	48.0	16.0	24.3
Two	11.4	26.0	12.0	26.7
Four	15.7	22.0	*	*
Six	11.4	26.0	*	*
Zero (Control)	22.9	44.0	22.0	34.3

* Not tested

deadhearts (Table 7) indicating a reduction in deadheart formation by about 50 per cent in cages containing spiders. However, with third instar larvae, more than one spider per cage was needed for a similar reduction in the deadheart formation obviously indicating the inability of the spider to handle larger prey. In both the cases, increase in the spider : larva ratio did not decrease deadheart formation proportionately. A similar trend was observed during 1991-92 crop season. Being a ground-dwelling hunting spider with apparent general feeding habits, *H. greenalliae* is less likely to prefer *C. infuscatellus* larvae in a free-choice situation despite the fact that neonate larvae spend considerable time on the leaf before entering into the shoot (Avasthy and Tiwari, 1986).

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