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Comparative Biology of Ladybird Beetle, M. Sexmaculatus Fab. on Different Aphid Species

R. A. Patel
* Dr. R. A. Patel, Subject Matter Specialist (Plant Protection),
Krishi Vigyan Kendra, District :Mehsana, Ganpat Vidyanagar-384012(Gujarat)

Abstract **:**Freshly laid eggs of *M. sexmaculatus* were cigar shaped, yellow in colour with smooth chorion without any reticulation. The average incubation period was varied from 3.08 to 3.60 days on different aphid species. Freshly emerged grub was dark grey in colour with shining dark head capsule and legs. The duration of first instar was maximum on *L. erysimi* (2.68 days), while duration of second instar was maximum recorded on *L. erysimi* and *A. nerri i.e.* 2.88 days. Minimum duration of first and second instar grub was observed on *A. nerri* (1.96 days) and on *A. gossypii* (2.32 days), respectively. The maximum duration of third and fourth instar grub was found on *L. erysimi* (3.00 days) and *H. coriandari* (3.20 days), respectively. The significantly lowest total larval duration was found on *T. maculata* (10.24 days) and was at par with *A. craccivora* (10.88 days), *A. gossypii* (10.56 days), *A. nerri* (10.36 days) and *B. brassicae* (10.36 days). Maximum pupal period was recorded on *A. craccivora* (5.16 days) and minimum on *B. brassicae* (4.08 days). The average egg laying capacity of single female was 311.10 to 346.50 eggs, when reared on different aphid species. Longevity of male beetle was found maximum on *A. gossypii* (16.60 days), while female beetle lived longer on *A. nerri* (22.10 days). *A. nerri* had highest growth index (2.71) followed by *A. craccivora* (2.68). Thus, *A. nerri* proved to be the most suitable host for the development of *M. sexmaculatus* followed by *A. craccivora, A. gossypii, H. coriandari, L. erysimi, T. maculata* and *B. brassicae*. The mean entire life span was 28.2 to 31.8 days for male and 35.2 to 39.8 days for female on different aphid species.

Key words*: biology, M. sexmaculatus, aphids, coccinellids, A. craccivora, A. gossypii, H. coriandari, L. erysimi, T. maculate, B. brassicae*

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I. Introduction

Naturally, for this our attention reverts back to the use of cultural and biological methods of pest control. In view of above complexities, the maximum utilization of predators and parasites for managing the insect pests of major valuable crops is most desirable. Among the insect predacious on aphids, coccinellids are considered to be efficient predators and keep aphid population under check (Gilkeson and Kelin, 2001). They are great economic importance because a majority of them are predaceous both in their grub as well as in adult stages on aphid.

Suppression of pest insects in agricultural crops by natural enemies is generally thought to be the result of direct density dependent process such as the functional and numerical response with increasing prey density(Elliott *et al*., 2002). Several aphid predators, primarily Coccinellidae, Chrysoidae and Nabidae, prey upon different aphid species (Anand, 1983; Elliott and Kieckhefer, 1990). The goal of conservation as a form of biological control is to enhance conditions for natural enemy's survival and reproduction in relation to pests so that pest population growth rates are lowered and pest densities reduced over time with increased effectiveness of natural enemies. Such conditions may be directed at mitigating harmful conditions over enhancing favourable ones. The present studies were planned to study the biological parameters by the *M. sexmaculatus* predation on seven aphid species under laboratory condition.

II. Materials And Methods

Laboratory experiments were conducted at Dept. of Entomology, C. P. College of Agriculture, Sardar Krushinagar Dantiwada Agriculture University, Sardar Krushinagar. The culture of *M. sexmaculatus* was established in the laboratory by collecting a large number of adults of *M. sexmaculatus* from the unsprayed field of mustard crop. Field collected adults of *M. sexmaculatus* were kept in plastic jars and reared on different species of aphids *viz.*, mustard aphid (*Lipaphis erysimi* Kalt.), lucerne aphid (*Therioaphis maculata* Buckton), indianbean aphid (*Aphis craccivora* Koch), fennel aphid (*Hydaphis coriandari* Das), cotton aphid (*Aphis gossypii* Glover), calotropis aphid (*Aphis nerri* Boyer), cabbage aphid (*Brevicoryne brassicae*). Separate sets were prepared and aphids were supplied as a food.

A cotton swab soaked in water was placed in the jar to maintain the humidity. The open end of the glass jar was covered with muslin cloth held in position with the help of rubber bands. The food (*i.e.* aphids) and cotton swab was changed daily in the morning. Leaves were provided to facilitate egg laying. The eggs of lady bird beetle laid on the leaves transferred individually with the help of moist fine camel hair brush and placed in separate plastic vials (3.5 cm in diameter and 7.5 cm in height) individually for further rearing and to avoid cannibalism. A special care was also taken to avoid mechanical injury during the transfer of eggs. The newly hatched grubs reared individually in plastic bowls (9 cm in diameter x 4 cm in height) by providing sufficient number of aphids.

Twenty five eggs were kept separately in small glass vials (2.5 cm in diameter and 15 cm in depth). This procedure carried out individually for different aphid species. The open end of the tube was covered by muslin cloth. The incubation period and hatching percentage determined by recording the number of eggs hatched and the date of hatching. Egg laying capacity of female beetle was also worked out by counting the number of eggs laid daily during its life span. After individual hatching of the grub,

different aphids species were provided separately daily as food. Initially, the counted number of 20 aphids was provided but subsequently the numbers of aphids were increased proportionately with the gradual development of grub in different set. The number of grub instars was determined on the basis of exuviae casted off. The duration of each instar was determined by recording the dates between two moultings. The full grown grub stop feeding and undergo a short pre-pupal period. Such larvae were closely observed at 6 hours interval and duration of pre-pupal period was recorded for different aphid species separately. Newly formed pupa was kept separately in a plastic bowls (9 cm in diameter and 4 cm in height) till adult emergence. The pupal duration was determined on the basis of the date of the formation of pupa to emergence of adult. The newly emerged male and female adults were killed using insect killing jar. They were pinned, dried and preserved in insect box. Such preserved adults were observed under the microscope to study the difference between male and female as well as shape, colour and appearance of adult beetle.

To study the pre-oviposition, oviposition and post-oviposition period, the freshly emerged twenty male and female adults were collected from each host aphid species and released in plastic jar (diameter 6cm, height 12 cm) containing respective aphid species as a food. The jars were covered with muslin cloth tied with rubber band. The food was changed every day. The eggs laid by each female on leaves, twigs and jar surface were removed and counted daily with the help of moist camel hair brush and total number of eggs laid during its entire life span considered as the fecundity. The period between the time of emergence of the female adult and commencing the egg laying was considered as pre-oviposition period. Period between starting and stopping of egg laying was noted oviposition period. While, period between endings of egg laying to the death of female was considered as post-oviposition period.

Longevity of male and female adults of *M. sexmaculatus* was observed separately from the date of emergence and the date of death of the adult. To study the sex ratio, laboratory reared adults were examined critically to determine the sex ratio by calculating male and female adults based on criteria. The growth index of *M. sexmaculatus* was calculated for different host aphid species using following formula.

$$\text{Growth Index} = \frac{\text{Percentage of adult emergence}}{\text{Average developmental period (days)}}$$

The percentage of adult emergence was worked out on the basis of total number of adults emerged out from the eggs kept initially. The period from eggs to death of adult was considered as developmental period. The duration of entire life span right from egg laying to the death of lady bird beetle, *M. sexmaculatus* was studied and recorded, when reared on different host aphid species.

III. Results And Discussion:

Eggs of *M. sexmaculatus* were mostly laid in cluster of 4 to 26 on the lower surface of the leaves near midrib though also rarely observed on stem or on upper surface of leaf. Freshly laid eggs were cigar shaped, yellow in colour with smooth chorion without any reticulation. The eggs turned black in colour with maturity and became completely black before hatching. At the time of eclosion, the chorion cracked irregularly in the subapical point and the grub wriggled out from the egg. Similar results were also reported by various workers in India (Gupta, 1966; Patel, 1985; Patel, 1989; Zala, 1995, Patel, 1998 and Islam, 2007). The results presented in Table 1 revealed that the average incubation period varied from 3.08 (*H. coriandari*) to 3.60 days (*T. maculata*). Though differences were non significant among the different aphid species. The more or less similar findings were also reported by Lefroy and Howlett (1909), Trehan and Malhotra (1959), Zala (1995) and Bhadauria *et al*. (2001).

A close perusal of data (Table 1) revealed that the hatchability of eggs was ranged from 80.00 (*H. coriandari* and *B. brassicae*) to 92.00 per cent (*A. craccivora*). Haque and Islam (1978) and Patel (1985) reported the similar results to the present findings. With a view to study the measurement, duration and number of larval instars of *M. sexmaculatus*, newly hatched larvae were reared on different aphid species. It was observed that the grub of *M. sexmaculatus* passed through four distinct instars, when they were reared on respective aphid species. Four larval instars of *M. sexmaculatus* were also reported by Ray (1967), Das and Rava (1968). The duration of first instar was maximum on *L. erysimi* (2.68 days), while duration of second instar was maximum recorded on *L. erysimi* and *A. nerri i.e.* 2.88 days(Table 1). Minimum duration of first and second instar grub was observed on *A. nerri* (1.96 days) and on *A. gossypii* (2.32 days), respectively. The maximum duration of third and fourth instar grub was found on *L. erysimi* (3.00 days) and *H. coriandari* (3.20 days), respectively. The significantly lowest total larval duration (Table 1) was found on *T. maculata* (10.24 days) and was at par with *A. craccivora* (10.88 days), *A. gossypii* (10.56 days), *A. nerri* (10.36 days) and *B. brassicae* (10.36 days).

Pre-pupa

The full grown grub stopped feeding and became sluggish and swollen. The larva clug /sticks its posterior abdominal segment with leaf surface and went under pupation within short times. The duration of pre-pupal stage (Table 2) varied from 0.5 to 1 days with an average of 0.80, 0.78, 0.84, 0.74, 0.76, 0.74 and 0.74 days when reared on *L. erysimi*, *T. maculata*, *A. craccivora*, *H. coriandari*, *A. gossypii*, *A. nerri* and *B. brassicae*, respectively. Results

are confirmed with the results reported by Zala (1995) and Patel (1998).

Colour and size

When the grub was about to pupate, turned dark brown in colour. Pupation usually takes place on the upper or lower surface of the leaf but may also takes place on the stem and inflorescence. On a fully formed pupa, the black spots were established symmetrically on the segments. The female pupa was distantly longer than the male ones. Only the abdominal segments of the pupa were capable for movement, when disturbed.

Pupal period

Duration of pupal stage for the grub reared on different host aphids was studied and the data are summarised in Table 2. It is cleared from the observations that the pupal period was differed significantly when grub reared on different aphid species. Significantly lowest pupal period was observed in *B. brassicae* (4.08 days) and was at par with *H. coriandari* (4.28 days), *A. gossypii* (4.20 days), *A. nerri* (4.36 days), whereas, the maximum duration was found in *A. craccivora* (5.16 days) and was at par with *L. erysimi* (4.92 days), *T. maculata* (4.92 days). According to Subramanyam (1923), pupal period was recorded to be 3 to 4 days, 4.0 days on *H. coriandari* (Bhadauria *et al*., 2001) and 3.6 days on *Therioaphis trifolii* (Mari, *et al*., 2004) as well as 3.1 to 5.5 days on different aphid species (Solangi, 2007). Thus, the results obtained through present investigations are more or less tally with the results of above workers.

Colour, appearance and size

The newly emerged adults were soft, yellowish in colour without marking and remained cluged to pupal cases during which the body hardened and turned shining yellow or warm buff with black spots which developed gradually. The beetle was small, oval, convex dorsally and flat ventrally. The elytra are warm buff in colour enclosing hind pair of wings. The abdomen and eyes were yellow in colour. The elytra and pronotum had zigzag markings. Similar characters of adults were also described by Patel (1985), Zala (1995) and Patel(1998).

Pre-oviposition, oviposition and post oviposition period

From the Table 2, data revealed that the average pre-oviposition period was 3.30, 2.80, 3.20, 3.10, 2.90, 3.10 and 3.20 days, oviposition period was 13.00, 14.40, 15.50, 15.80, 14.30, 16.30 and 14.50 days; and post oviposition period was 3.00, 2.70, 2.70, 2.70, 2.50, 2.70 and 2.50 days, when females of *M. sexmaculatus* fed on *L. erysimi*, *T. maculata*, *A. craccivora*, *H. coriandari*, *A. gossypii*, *A. nerri* and *B. brassicae*, respectively. The average pre-oviposition period was reported 2.43 days (Patel and Vyas, 1989), 2.8 days (Patel, 1989) and 2.64 days (Zala, 1995), which is more or less similar to the present findings. The oviposition period of *M. sexmaculatus* was reported to be 16.83 days (Patel and Vyas, 1989), 15.7 days (Patel, 1989) and 14.5 days (Zala, 1995), these results are close agreement with the present findings. The average post-oviposition period was 2.60 days (Patel and Vyas, 1989) and 3.0 days (Zala, 1995), which are similar to the present findings.

Data in Table 2 indicate that the average egg laying capacity of single female was 311.10 to 346.50 eggs, when reared on different aphid species. More or less similar finding reported by Saha, 1987. Longevity of male beetle was found maximum on *A. gossypii* (16.60 days), while female beetle lived longer on *A. nerri* (22.10 days). The sex ratio was ranged from 1 : 1.14 to 1 : 1.31 among different aphid species.

Survival percentage and growth index

The data on survival percentage of *M. sexmaculatus* (Table 3) indicated that the maximum survival percentage were recorded when the predator reared on *A. craccivora* (90.00 %) followed by *A. nerri* (85.00 %), *L. erysimi* (82.50 %), *T. maculata* (80.00 %), *A. gossypii* (80.00 %), *H. coriandari* (77.50 %) and *B. brassicae* (75.00 %). The mean developmental period of *M. sexmaculatus* was varied from 31.4 to 35.8 days on different host aphids. The data on growth index (Table 3) indicated that highest growth index was recorded when reared on *A. nerri* (2.71). It was followed by *A. craccivora* (2.68). The lowest growth index was observed when reared on *B. brassicae* (2.23) followed by *A. gossypii* (2.43), *H. coriandari* (2.38), *L. erysimi* (2.31) and *T. maculata* (2.27). Thus, on the basis of growth index, *A. nerri* proved to be the most suitable host for the development of *M. sexmaculatus* followed by *A. craccivora*, *A. gossypii*, *H. coriandari*, *L. erysimi*, *T. maculata* and *B. brassicae*.

Entire life span

It is evident from the data presented in Table 3 revealed that the mean entire life span was 31.8 ± 3.2, 31.4 ± 2.8, 28.2 ± 2.5, 28.9 ± 3.1, 30.8 ± 2.9, 28.5 ± 2.8 and 31.1 ± 2.6 days for male; and 39.6 ± 2.9, 39.8 ± 2.8, 35.2 ± 3.2, 37.8 ± 3.1, 38.7 ± 2.9, 36.9 ± 2.7 and 38.6 ± 2.9 days for female, when the *M. sexmaculatus* reared on *L. erysimi*, *T. maculata*, *A. craccivora*, *H. coriandari*, *A. gossypii*, *A. nerri* and *B. brassicae*, respectively. Among all the host aphid species, entire life span of both the sexes of *M. sexmaculatus* was found maximum when reared on *L. erysimi* and *T. maculata*, whereas, it was minimum found on *A. craccivora*. The entire life span of male and female of *M. sexmaculatus* was 25 ± 2.83 and 36.7 ± 2.77 days, respectively when reared on *A. craccivora* (Patel, 1989) and it was 31.9 and 36.6 days, respectively (Zala, 1995) on *L. erysimi*. Thus, the present findings are more or less similar to the previous workers.

Table 1 : Biological parameters of *M. sexmaculatus* reared on different aphid species

Aphid species	Hatchability (%)	Incubation period (Days)	grub instar (days)				
			I	II	III	IV	Total grub period
L. erysimi	84.00	3.56	2.68	2.88	3.00	2.96	11.44
T. maculata	84.00	3.60	2.08	2.52	2.72	3.16	10.24
A. craccivora	92.00	3.28	2.24	2.36	2.60	3.12	10.88
H. coriandari	80.00	3.08	2.44	2.56	2.92	3.20	11.12
A. gossypii	84.00	3.36	2.28	2.32	2.80	3.16	10.56
A. nerri	88.00	3.12	1.96	2.88	2.52	3.00	10.36
B. brassicae	80.00	3.16	2.08	2.48	2.64	3.16	10.36
S. Em. ±		0.18	0.16	0.17	0.17	0.19	0.234
C. D. at 5%		NS	0.45	NS	NS	NS	0.65

Table 2 : Biological parameters of *M. sexmaculatus* reared on different aphid species

Aphid species	Pre-pupal period (days)	Pupal period (days)	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Fecundity	Longevity of adults (Days)	
							Male	Female
L. erysimi	0.80	4.92	3.30	13.00	3.00	311.10	15.70	19.20
T. maculata	0.78	4.92	2.80	14.40	2.70	338.10	15.60	19.90
A. craccivora	0.84	5.16	3.20	15.50	2.70	346.50	14.80	21.20
H. coriandari	0.74	4.28	3.10	15.80	2.70	335.20	14.20	21.60
A. gossypii	0.76	4.20	2.90	14.30	2.50	327.20	16.60	19.70
A. nerri	0.74	4.36	3.10	16.30	2.70	333.20	14.30	22.10
B. brassicae	0.74	4.08	3.20	14.50	2.50	338.00	15.50	20.10
S. Em. ±	0.05	0.18	0.24	1.02	0.31	45.52	1.17	1.17
C. D. at 5 %	NS	0.50	NS	NS	NS	NS	NS	NS

Table 3: Biological parameters of *M. sexmaculatus* reared on different aphid species

Aphid species	Sex ratio (Male : Female)	Survival percentage (S)	Mean develop-mental period (D)	Growth Index (S/D)	Duration of entire life span (Days)	
L. erysimi	1 : 1.14	82.50	35.8	2.31	31.8 ± 3.2	39.6 ± 2.9
T. maculata	1 : 1.31	80.00	35.2	2.27	31.4 ± 2.8	39.8 ± 2.8
A. craccivora	1 : 1.14	90.00	33.6	2.68	28.2 ± 2.5	35.2 ± 3.2
H. coriandari	1 : 1.31	77.50	32.6	2.38	28.9 ± 3.1	37.8 ± 3.1
A. gossypii	1 : 1.31	80.00	32.9	2.43	30.8 ± 2.9	38.7 ± 2.9
A. nerri	1 : 1.14	85.00	31.4	2.71	28.5 ± 2.8	36.9 ± 2.7
B. brassicae	1 : 1.31	75.00	33.7	2.23	31.1 ± 2.6	38.6 ± 2.9

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