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BIOLOGY, MORPHOMETRY AND FEEDING POTENTIAL OF *COCCINELLA TRANSVERSALIS* FABRICIOUS

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ABSTRACT
Investigations on biology, morphometry and feeding potential of *Coccinella transversalis* Fab. (Coccinellidae : Coleoptera) were carried out at ordinary room temperature during 20010-11. Average egg, larval and pupal period were 9.27 ± 0.30, 21.33 ± 0.39 and 8.27 ± 0.15 days, respectively. Of the four larval instars average duration of first, second, third and fourth instar larvae was 4.73 ± 0.23, 3.93 ± 0.28, 5.13 ± 0.19 and 7.53 ± 0.22 days, respectively. Male and female beetle survived for 21.13 ± 1.02 and 22.17 ± 1.27 days, respectively. Female beetle laid 253.85 ± 38.76 eggs on an average during her adult period. Entire life of the predator was completed in 63.50 ± 1.15 (females) and 62.47 ± 1.05 (males) days. Sex ratio (M: F) was 1: 1.32. Average length and breadth of eggs were 1.06 ± 0.01 and 0.47 ± 0.01 mm, respectively. Mean length of first, second, third and fourth instar larvae were 2.49 ± 0.02, 3.47 ± 0.02, 5.72 ± 0.02 and 9.48 ± 0.06 mm, respectively. The corresponding values for breadth of the larvae were 0.76 ± 0.01, 1.03 ± 0.01, 1.47 ± 0.02 and 2.49 ± 0.01 mm, respectively. Average length of female and male beetles was 6.02 ± 0.01 and 5.96 ± 0.02 mm, whereas breadth was 4.62 ± 0.01 and 4.53 ± 0.03 mm, respectively. The beetle predated significantly maximum (528.47 ± 11.79) number of *Aphis craccivora* Koch. nymphs followed by *Aphis gossypii* Glover nymphs (402.67 ± 4.75) and *Lipaphis erysimi* Kalt. (223.27 ± 5.08).

INTRODUCTION

Coccinellids form an important group of predators. More than 4,500 predacious species of coccinellidae family have been described (Sathe and Bhosale, 2001). Indian coccinellid biodiversity comprises of approximately three hundred species with two hundred sixty one species of known prey record constituting fifty seven genera, which are predacious on various insect and acarine pests (Omkar and Pervez, 2000). *Coccinella transversalis* Fab. is a potential predator on many soft bodied insects (Chaudhary and Bhosale, 1982; Debaraj and Singh, 1990; Veeravel and Baskaran, 1995; Sarma *et al*. 1996; Omkar and James, 2003 and 2004). It has significant potential and use against a variety of crop pests in combination with other insect pest management tactics. Biology is an important parameter for every predator in order to efficient maintaining of laboratory culture. The knowledge of biology plays an important role in mass production and its utilization in pest management programme. To insight the information on description and duration of different stages of *C. transversalis*, the present study was undertaken in the Biological Control Research Laboratory, Anand Agricultural University, Anand during the year 2009-10 as there was a paucity of information on biology of the predator. Morphometry of the predator is also important for taxonomic point of view. Being a predator, the knowledge of its biotic potential is helpful in formulating the strategy of biological control of insect pests. Information on biology, morphometry and feeding efficiency of *C. transversalis* is meager and therefore the present investigations on such aspects were carried out in laboratory during the year 2009-10.

MATERIALS AND METHODS

Laboratory culture

Initial culture of *C. transversalis* was collected from different field crops and maintained on black aphid, *Aphis gossypii* Koch. The field collected adults were confined in a acrelic cage (60 cm × 30 cm × 30 cm). The adults were provided with black aphids. Eggs laid by the female coccinellids on leaves or periphery of the jar were collected after 2 to 3 days, by gently brushing with a soft camel hair brush and kept in glass vials (5 × 2 cm) with paper pieces to minimize cannibalism among emerging grubs. Initially the newly hatched grubs were reared in groups for two days in plastic jar and then reared individually in multi-celled plastic luer. Nymphs of aphids or crawlers of mealybugs were provided daily in each individual cell of multi-celled plastic luer to the predatory grubs until pupation. The adults emerged out from pupae were collected individually with the help of plastic tube (5 × 2 cm) and transferred to a acrelic cage (60 cm × 30 cm × 30 cm) for mating. Newly emerged adults were provided with host (prey) as described earlier. The culture of the predator maintained by above described method was used for further study of different biological parameters.

Eggs of *C. transversalis* were collected after 3 days of egg laying from acrelic cage as the freshly laid eggs breaks with slight touch of even soft camel hair-brush. The egg collection was made by using soft camel hair-brush and kept individually in transparent plastic tube (5 × 2 cm). The open ends of such

tubes were closed with cloth walled cotton plug. The eggs were critically observed under microscope for their colour, shape and changes in colour. Length and breadth of individual egg were measured by using software Magnus-pro. The incubation period as well as hatching of the eggs was also recorded.

Freshly emerged grubs were kept in multi-celled plastic luer to avoid cannibalism and provided daily with nymphs of black aphids. Initially, 10 to 15 nymphs per grub were provided, but the numbers were increased with the increase in grub age. Number of grub instars along with their duration of each coccinellid was determined on the basis of exuvie casted-off by the grubs. The grubs were observed under microscope for their morphological characters. Observations on instar-wise measurements of length, breadth, head width and length of legs for grubs were recorded with Magnus-pro.

Pupae formed inside the multi-celled plastic luer were kept separately and undisturbed for adult emergence. Date of pupation and date of adult emergence were recorded for individual pupa to work out pupal period. Morphological variations of pupae were studied under stereoscopic microscope. Length, breadth, inner curved diameter and area of pupae were measured with Magnus-pro.

Newly emerged adults of *C. transversalis* were confined in acrelic cage (60 cm × 30 cm × 30 cm), in pairs and provided with black aphids as food. Laboratory reared adults were sexed as male and female on the basis of their body size and structure of external genitalia. Longevity of males and females were studied separately. Similarly, fecundity, pre-oviposition, oviposition, post-oviposition periods of females and sex-ratio were studied. For the purpose, fifteen pairs of each predatory coccinellid species were kept individually and data were recorded. With a view to determine the fecundity, eggs laid by each mated female were counted daily in the morning and total number of eggs laid during entire adult period was considered as fecundity. The time after emergence of adult from pupae and starting of oviposition was considered as pre-oviposition period. The period of egg deposition was considered as oviposition period. Post oviposition period of female was recorded as period between the days of female ceased egg-laying to the day of death. Sex-ratio (Male : Female) was worked out for laboratory culture. Observations on duration of different life-stages of the predator were taken as per the methodology followed by Patil (2011) whereas the observations on morphometry were made by Magnus-pro software as suggested by Sangle *et al.* (2013).

Predatory potential *C. transversalis*

Newly hatched predatory grub and newly emerged adult of *C. transversalis* were confined individually in a glass vial (6.5 × 6.0 cm) and the open end was closed with white muslin cloth affixed with rubber band. Individual grubs as well as adults were reared in glass vial throughout their developmental stage. The grubs and beetles were fed individually in glass vial with four different species of aphids *viz;* cotton aphid, *Aphis gossypii* Glover, bean aphid, *Aphis craccivora* Koch, dodi aphid, *Aphis nerii* Boyer de Fonscolombe and mustard aphid, *Lipaphis erysimi* Kalt. Ten sets were used for each species of aphids used as prey. Required number of prey was provided daily in the morning hours throughout the grub and adult period and their numbers were increased according to developmental stage. Predatory efficiency was calculated by counting the preyed and un-preyed hosts (nymphs or adults of aphids). Instar-wise predatory efficiency of grubs was determined.

RESULTS AND DISCUSSION

Biology

Biology of *C. transversalis* was studied under laboratory conditions during November 2010 to January 2011 by providing nymphs of bean aphid, *A. craccivora* as host. Data

Table 1: Duration of different life stages of *C. transversalis* on bean aphid, *A. craccivora*

Stage	Period of study	Duration (days) Range	Mean
Egg	24.11.10 – 26.11.10	7 – 11	9.27 ± 0.30
Larva	26.11.10 – 04.12.10		
I instar		3 – 6	4.73 ± 0.23
II instar		3 – 6	3.93 ± 0.28
III instar		4 – 6	5.13 ± 0.19
IV instar		7 – 9	7.53 ± 0.22
Total		19 – 23	21.33 ± 0.39
Pre-pupa	04.12.10 – 06.12.10	2 – 3	2.47 ± 0.13
Pupa	06.12.10 – 10.12.10	7 – 9	8.27 ± 0.15
Adult	10.12.10 – 22.01.11		
Male		18 – 29	21.13 ± 1.02
Female		18 – 29	22.17 ± 1.27
Pre-oviposition		4 – 6	5.17 ± 0.24
Oviposition		8 – 19	12.20 ± 1.27
Post-oviposition		4 – 8	6.02 ± 0.29
Entire life span	24.11.10 – 22.01.11		
Female		59 – 70	63.50 ± 1.15
Male		58 – 69	62.47 ± 1.05
Fecundity (Eggs/ female)	14.12.10 – 22.01.11	173 – 528	253.85 ± 38.76
Hatching (%)	24.12.10 – 26.11.10	79 – 93	88.19 ± 1.67
Sex-ratio (M : F)		–	1 : 1.32

on duration of different life-stages, sex-ratio and fecundity were recorded and presented in Table 1.Data (Table 1) indicated that the egg-period of *C. transversalis* averaged 9.27 ± 0.30 days with a range of 7 to 11 days. This finding is in conformity with the report of Debaraj and Singh (1990) who reported 8 to 10 days incubation period. Grub passes its duration with four distinct instars. Grub period of first, second, third and fourth instar ranged from 3 to 6, 3 to 6, 4 to 6 and 7 to 9 days with an average duration of 4.73 ± 0.23, 3.93 ± 0.28, 5.13 ± 0.19 and 7.53 ± 0.22 days, respectively. Total grub period was varied from 19 to 23 days with a mean duration of 21.33 ± 0.39 days. The duration of individual instars noticed in present study is in close agreement with the finding of Debaraj and Singh (1990) who recorded 4.69, 3.92, 5.00 and 7.69 days duration for first, second, third and fourth larval instar of *C. transversalis*. Slight discrepancy in duration of different instars was observed by Deho (2009), when reared on *Aphis gossypii* Glover.

Average pre-pupal and pupal stage lasted for 2.47 ± 0.13 (2 to 3 days) and 8.27 ± 0.15 (7 to 9 days) days, respectively. More or less similar duration of pre-pupae (2.62 days) and pupae (8.6 days) for *C. transversalis* have been recorded by Debaraj and Singh (1990). Average longevity of male and female was 21.13 ± 1.02 and 22.17 ± 1.27 days, respectively. The report of Debaraj and Singh (1990) deviated from the present finding. They reported that the adult longevity of *C. transversalis* ranged from 38 to 45 days. This variation may be due to effect of food and climatic conditions where the studies are carried out. Pre-oviposition, oviposition and post-oviposition period of females ranged from 4 to 6, 8 to 19 and 4 to 8 days with an average of 5.17 ± 0.24, 12.20 ± 1.27 and 6.02 ± 0.29 days, respectively. In laboratory, individual female laid a minimum of 173 and maximum of 528 (av. 253.85 ± 38.76) eggs during her duration. Hatching percentage of the eggs ranged from 79 to 93 with an average of 88.19 ± 1.67. Similarly, Uma Devi *et al*. (2007) have reported a hatching percentage of 89.86 at higher prey density. Sex-ratio (M: F) of *C. transversalis* was revealed as 1: 1.32.

Morphometry

Measurements of different life-stages of *C. transversalis* were recorded and presented in Table 2. It indicated that the length and breadth of eggs was varied from 1.04 to 1.09 and 0.42 to 0.51 mm with an average of 1.06 ± 0.01 and 0.47 ± 0.01 mm, respectively. The length of eggs revealed in present study is in close agreement with the report of Debaraj and Singh (1990) that showed 1.06 ± 0.02 mm lengths of eggs in case of *C. transversalis*.

Total surface area of individual egg was ranged from 0.45 to 0.54 mm^2 with a mean value of 0.50 ± 0.01 mm^2. Length of first, second, third and fourth instar larvae ranged from 2.43 to 2.56, 3.41 to 3.57, 5.63 to 5.79 and 9.20 to 9.70 mm, with an average of 2.49 ± 0.02, 3.47 ± 0.02, 5.72 ± 0.02 and 9.48 ± 0.06 mm, respectively. The corresponding values for breadth of the larvae ranged from 0.72 to 0.82, 0.99 to 1.07, 1.41 to 1.54 and 2.45 to 2.56 mm with an average of 0.76 ± 0.01, 1.03 ± 0.01, 1.47 ± 0.02 and 2.49 ± 0.01 mm, respectively. The length and breadth of grubs of different instars measured in present investigation is in accordance with the observations recorded by Debaraj and Singh (1990) who

Table 2: Measurements of different life stages of *C. transversalis*

Stage	Length (mm)	Breadth (mm)	Head width (mm)		Total area (mm^2)								
	Range	Mean	Range	Mean	Range	Mean	Range	Mean					
Eggs	1.04 – 1.09	1.06 ± 0.01	0.42 – 0.51	0.47 ± 0.01	-	-	0.45 – 0.54	0.50 ± 0.01					
Larva							Fore leg length (mm)		Middle leg length (mm)		Hind leg length (mm)		
							Range	Mean	Range	Mean	Range	Mean	
I instar	2.43 – 2.56	2.49 ± 0.02	0.72 – 0.82	0.76 ± 0.01	0.28 – 0.34	0.31 ± 0.01	0.66 – 0.73	0.70 ± 0.012	0.65 – 0.69	0.67 ± 0.01	0.61 – 0.62	0.61 ± 0.01	
II instar	3.41 – 3.57	3.47 ± 0.02	0.99 – 1.07	1.03 ± 0.01	0.39 – 0.40	0.39 ± 0.02	0.94 – 0.95	0.94 ± 0.01	0.85 – 0.91	0.88 ± 0.01	0.82 – 0.87	0.84 ± 0.01	
III instar	5.63 – 5.79	5.72 ± 0.02	1.41 – 1.54	1.47 ± 0.02	0.66 – 0.67	0.668 ± 0.01	1.09 – 1.10	1.09 ± 0.02	0.97 – 1.04	1.01 ± 0.02	0.93 – 0.94	0.94 ± 0.01	
IV instar	9.20 – 9.70	9.48 ± 0.06	2.45 – 2.56	2.49 ± 0.01	0.88 – 0.89	0.89 ± 0.02	1.31 – 1.32	1.32 ± 0.02	1.14 – 1.16	1.15 ± 0.02	1.15 – 1.16	1.16 ± 0.02	
Pupa							Inner curved diameter (mm)		Total area (mm^2)		Length with appendages (mm)		
							Range	Mean	Range	Mean	Range	Mean	
	5.31 – 5.48	5.39 ± 0.02	3.36 – 3.65	3.46 ± 0.04	-	-	15.09 – 15.41	15.32 ± 0.18	17.84 – 19.82	18.67 ± 0.26	5.59 – 5.84	5.70 ± 0.05	
Adult													
Male	5.91 – 6.04	5.96 ± 0.02	4.44 – 4.65	4.53 ± 0.03	1.34 – 1.44	1.40 ± 0.01	-	-	-	-	-	-	
Female	5.97 – 6.06	6.02 ± 0.01	4.58 – 4.67	4.62 ± 0.01	1.18 – 1.191	1.18 ± 0.02	-	-	-	-	-	-	

Table 3: Feeding potential of *C. transversalis* on three different species of aphids

Aphid species	Mean number of aphids consumed by respective instar				Number of aphids consumed by		Total consumption
	I	II	III	IV	Grub	Adult	
A. gossypii	41.87 ± 1.05(33 - 49)*	55.93 ± 1.11(49 - 62)	110.33 ± 1.72(101 - 121)	144.13 ± 1.18(132 - 167)	352.27 ± 3.65(323 - 374)	50.40 ± 1.72(39 - 63)	402.67 ± 4.75(368 - 437)
A. craccivora	32.73 ± 1.04(27 - 41)	69.60 ± 1.07(61 - 77)	129.80 ± 1.72(121 - 141)	204.20 ± 11.15(159 - 303)	436.33 ± 13.16(384 - 559)	92.13 ± 4.26(52 - 113)	528.47 ± 11.79(477 - 626)
L. erysimi	22.33 ± 0.89(17 - 28)	37.20 ± 1.22(32 - 48)	47.93 ± 1.41(36 - 57)	66.47 ± 2.28(54 - 81)	173.93 ± 4.89(152 - 202)	49.33 ± 1.43(41 - 57)	223.27 ± 5.08(196 - 253)
S. Em. ±	1.22	1.19	1.90	9.22	11.04	3.68	8.42
C. D. at 5%	3.76	3.68	5.86	28.41	34.01	11.34	25.95
C.V.(%)	8.43	4.93	4.43	14.91	7.69	12.87	4.89

* Figures in bracket indicate range values

reported more or less similar results.

Measurements of head capsule width of *C. transversalis* grubs revealed that it ranged from 0.28 to 0.34 (av. 0.31 ± 0.01), 0.39 to 0.40 (av. 0.39 ± 0.02), 0.66 to 0.67 (av. 0.67 ± 0.01) and 0.88 to 0.89 (av. 0.89 ± 0.02) mm for first, second, third and fourth instar, respectively. Average length of four legs of first, second, third and fourth instar grubs was 0.70 ± 0.01, 0.94 ± 0.01, 1.09 ± 0.01 and 1.32 ± 0.01 mm, respectively. The corresponding values for middle and hind legs were 0.67 ± 0.01, 0.88 ± 0.01, 1.01 ± 0.02, 1.15 ± 0.02 and 0.61 ± 0.01, 0.84 ± 0.01, 0.94 ± 0.01, 1.16 ± 0.01 mm, respectively. From data, it evident that the length of legs progressively increased with the advancement of age/ instar. Four legs of grubs were relatively larger in their length and it progressively reduced from fore legs to hind legs.

Length and breadth of pupae ranged from 5.31 to 5.48 and 3.36 to 3.65 mm with an average of 5.39 ± 0.02 and 3.46 ± 0.04 mm, respectively. Inner curved diameter of the pupae was varied from 15.09 to 15.41 mm with a mean value of 15.32 ± 0.18 mm. Average surface area and length of pupae (with appendages) was 18.67 ± 0.26 mm^2 and 5.70 ± 0.05 mm, respectively.

Measurements of adults revealed that the length and breadth of male beetles ranged from 5.91 to 6.04 and 4.44 to 4.65 mm with an average of 5.96 ± 0.02 and 4.53 ± 0.03 mm, respectively. The corresponding values for females were 5.97 to 6.06 and 4.58 to 4.67 mm with an average of 6.02 ± 0.01 and 4.62 ± 0.01 mm, respectively. These measurements are in accordance with the report of Ali *et al.* (2012). They reported that the length and width of adults were 6.0 to 7.5 and 4.5 to 5.0 mm, respectively. These data indicated that the females were relatively larger in size than males. Average head widths of male and female beetles were 1.40 ± 0.01 and 1.18 ± 0.02 mm, respectively. Body size of beetles revealed in present study is in agreement with the findings of Chanmamla (2009) who stated more or less same measurements of males and females of *C. transversalis*. Further, she also showed that the body size of females was larger than males which are in accordance with the above results.

Feeding potential

Data (Table 3) on feeding potential of *C. transversalis* on three different species of aphids revealed that the first instar grub consumed significantly highest (41.87 ± 1.05) number of *A. gossypii* followed by *A. craccivora* (32.73 ± 1.04) and *L. erysimi* (22.33 ± 0.89). Second, third and fourth instar grub consumed an average of 69.60 ± 1.07, 129.80 ± 1.72 and 204.20 ± 11.15 individuals of *A. craccivora,* 55.93 ± 1.11, 110.33 ± 1.72 and 144.13 ± 1.18 individuals of *A. gossypii* and 37.20 ± 1.22, 47.93 ± 1.41 and 66.47 ± 2.28 individuals of *L. erysimi,* respectively. Significantly maximum (436.33 ± 13.16) numbers of *A. craccivora* were fed during entire grub period of *C. transversalis*. The grub consumed 352.27 ± 3.65 and 173.93 ± 4.89 individuals of *A. gossypii* and *L. erysimi,* respectively. Higher rate of predation by the grubs to *A. craccivora* over *A. gossypii* and *L. erysimi,* was also observed in adult stage. The beetle consumed more or less same (49.33 ± 1.43 to 50.40 ± 1.72) number of *L. erysimi* and *A. gossypii*.

From data (Table 3), it evident that the *C. transversalis* consumed significantly highest (528.47 ± 11.79) number of *A. craccivora* during its entire life, whereas the corresponding values for *A. gossypii* and *L. erysimi* were 402.67 ± 4.75 and 223.27 ± 5.08, respectively. Results of predatory potential of *C. transversalis* reveal that *A. craccivora* found to be the most preferred host followed by *A. gossypii* while *L. erysimi* proved least preferred by the predator. Chitra Devi *et al.* (2002) reported that the predatory potential of *C. transversalis* reared on *L. erysimi* was 244 ± 16.40, but Prabhakar and Roy (2010) reported *L. erysimi* as most preferred host.

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