Indian Journal of Entomology 84(3): 541-545 (2022) DoI No.: 10.55446/IJE.2021.35

COMPARATIVE BIOLOGY OF THREE COCCINELLID PREDATORS ON COWPEA APHID *APHIS CRACCIVORA*

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ABSTRACT

Laboratory experiment was conducted to study the biology of coccinellid predators from agroecosystems of Odisha. About 17 species were identified, the most important being *Coccinella septempunctata, Coccinella transversalis* and *Cheilomenes sexmaculata* predating on aphids infesting cowpea. The biology of these when evaluated indicated that *C. septempunctata* was the largest, and *C. sexmaculata* the smallest; grubs of all the three are susceptible to the rising temperature. The total developmental period was maximum during January and the least during May for all species. Total larval period was 11.9± 2.34, 12.1± 6.19 and 12.6± 0.01 days in January and 8.2± 0.07, 7.00± 0.01 and 7.9± 0.06 during May with *C. septempunctata*, *C. transversalis* and *C. sexmaculata*, respectively; developmental periods for these were observed to be 22.4± 0.67, 20.2± 1.46 and 17.4± 0.82 days during January, and 15.2± 0.01, 11.5± 0.39 and 12.3± 0.61 days during May, respectively. Prepupae and pupae were the least affected by the fluctuations in temperature.

Key words: *Cocinella septempunctata*, *C.transversalis*, *Cheilomenes .sexmaculata*, life stages, size, duration, larval period, developmental period, mortality, morphometrics, temperature

Insect pests have always been a threat to agriculture, and various chemicals are applied against these. Due to the intensive and indiscriminate use of pesticides, there are many hazards to humans. Hence, there is a need for ecofriendly, safe and cheap control methods. This can only be achieved by IPM ensuring environmental safety (Solangi, 2004). Ladybird beetles are important agents in biological control in pests of many economically important crops (Obrycki and Kring, 1998). They are predators in both adult and larval phases, presenting an intense search for food and predatory capacity (Vandenberg, 2002). Aphids are one of the most injurious insect pests which suck the cell sap affecting crop yield (Fondren et al., 2004), as these affect the general vigour of plant (Dixon and Kindlmann, 1998). Coccinellids are very effective predators of homopteran pests, and predate upon sucking pests like aphids, jassids, thrips, scales, mealy bugs, planthoppers and whiteflies besides other insect eggs and neonate larvae. The present study evaluates the biology of three coccinellids and their predation on aphids under laboratory conditions.

MATERIALS AND METHODS

In order to assess the relative abundance of various predaceous coccinellids in Bhubaneswar, a regular field survey of crop fields was conducted at the Central Research Station, OUAT, Bhubaneswar from September, 2014 to March, 2015. The beetles collected were reared in the laboratory for maintaining their culture. Stock culture of *Aphis craccivora* was maintained on cowpea raised in earthen pots. Adults of *Coccinella septempunctata* L., *C. transversalis* F. and *Cheilomenes sexmaculata* F., the predominant species around Bhubaneswar collected from the field were and reared on aphid infested cowpea seedlings in the laboratory @ 10 beetles/ jar and were observed for presence of both males and females. It was ensured that at least 50% females were present in each jar. Five mated females were released in the jar containing aphid infested cowpea seedlings for egg laying. Next day, the beetles were removed to separate jars and the previous jars were examined for eggs. Eggs were usually laid on under surface of leaves and sometimes on inner wall of the jars. Eggs were removed carefully along with the leaves and were kept in petridishes for hatching and development of the grubs. For pupation, paper pieces were provided in each of the jars. After emergence of adults, the beetles were placed separately in other jars, containing aphid infested seedlings and thus, cultures were maintained.

Biology of the three species was studied during January, March, May, July, September and November, 2015. Ten freshly laid eggs of each were separated out and kept in petridishes (10 cmx 1.5 cm) for hatching and further rearing. Three replications were maintained for each species. The early instar grubs were provided with early instar nymphs of *A. craccivora* on cowpea twigs. Each grub was provided with sufficient number of aphids every 24 hr, after removing it to a new petridish, so that there was no dearth of food. Observations were made on the duration of instars. This procedure was followed till all the grubs pupated. Developmental period of stages and measurement of egg and larval instars were also observed. Ten prepupa of were separated in petridishes. Three replications were maintained. Prepupal and pupal periods and their measurements were also observed. Ten freshly emerged adult mating pairs of each species were removed from the stock culture and were reared individually in petridishes on *A craccivora*. Fresh cowpea twigs were provided for egg laying. Eggs laid were counted on daily basis, replicated thrice times. Observations on fecundity, longevity of females and male beetles and their measurements were also made. In case of natural death of any individual in the experimental stages, the same was replaced with an individual of the same age simultaneously maintained in the stock culture. Observations on morphometrics of life stages were also made. Data obtained were statistically analysed by descriptive method as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Among the coccinellids, *C. septempunctata*, *C. transversalis* and *Chilomenes sexmaculata* were observed in large numbers (Table 1). The life stages of *C. septempunctata* were the largest as observed from their egg and other life stages. While length and breadth of *C. sepempunctata* eggs were 1.2± 0.17 mm and 0.49± 0.00 mm respectively it was 1.05± 0.01 mm and 0.46± 0.07 mm eggs were spindle shaped with both ends evenly rounded; for *C. transversalis* and 0.61± 0.01 and 0.03± 0.00 mm, eggs were cigar shaped for *C. sexmaculata* respectively. Similarly, all the larval stages of *C. septempunctata* were found to be larger. The fourth instar grubs of *C. septempunctata* measured 6.7± 0.61 in length and 3.4± 0.02 mm in breadth whereas the same for *C. transversalis* were 6.12± 0.17 mm and 2.5± 0.08 mm and *C. sexmaculata* were 3.9± 0.07 mm and 1.8± 0.06 mm, respectively. Similarly the pupae of *C. septempunctata* were 4.5± 0.43 mm in length and 4.2± 0.39 mm in breadth as compared to 5.31± 0.42 mm length and 3.41± 0.08 mm in breadth of *C.transversalis* and 3.7± 0.11 mm length and 2.4± 0.06 mm breadth of *C. sexmaculata*. Adult male of *C. septempunctata* were 4.8± 0.67 mm in length and 4.5± 0.42 mm in breadth. *C. transversalis* male were 4.5± 0.31 mm in length and 4.0± 0.06 mm in breadth. The measurements for *C. sexmaculata* male were 3.8± 0.11 mm in length and 3.1± 0.09 mm in breadth. The female of *C. septempunctata* measured about 5.2± 0.13 mm in length and 5.1± 0.64 mm in breadth whereas *C. transversalis* male was 4.9± 0.17 mm in length and 4.8± 0.17 mm in breath and that of *C. sexmaculata* 3.7± 0.37 mm in length and 3.3± 0.43 mm in breadth, respectively (Table 2). Tank and Korat (2007) observed the biological parameters of *C. sexmaculata* similar to the present ones, and Ullah et al. (2012) also got similar observations on the morphometrics of *C. transversalis* and *M. sexmaculata.*

Duration of lifestages were studied during different months (January, March, May, July, September and November) representing different environmental conditions of the year, the corresponding temperatures being 21.7, 28.5, 37.2, 30.1, 28.1 and 27.6°C. Among the coccinellids *C. septempunctata* had the longest developmental period followed by *C. transversalis* and *C. sexmaculata.* It was observed that during the cooler months of January and November, the lifestages are prolonged and in the warmer months of March and May the life stages shorter. In January, when the mean temperature was 21.7°C, the total developmental period, i.e., from egg to adult stage, took 22.4± 0.67 days in *C. septempunctata*, whereas, it took 20.2± 1.46 and 17.4± 0.82 days in case of *C. transversalis* and *C. sexmaculata*, respectively. When temperature increased in May (mean 32.7°C) the total developmental periods were 15.2± 0.01, 11.5± 0.39 and 12.3± 0.61 days, respectively. When temperature increased in September, the developmental periods increased to 16.7± 0.64, 16.2± 0.41 and 14.7± 0.64 days. Adult longevity also exhibited the same trend (Table 3). In their study on the biology of *C. septempunctata*. Rauf et al. (2013) reported that with increasing temperature, developmental duration decreases significantly. The fecundity indicated the same trend, more eggs being laid in cooler months of November and January and less eggs being laid in warmer months of March and May. It was also observed that *C. septempunctata* laid more eggs; and more eggs were viable in the cooler months; eggs of *C. septempunctata* were more viable as compared to *C. transveralis* and *C. sexmaculata*. Wang et al. (2013) observed that egg hatchability and fecundity of *C. sexmaculata* are more at 30°C in China. Krengel et al. (2012) on *C. septempunctata* feeding on the grain aphid *Sitobion avenae* found that compared

Table 1. Predaceous coccinellids observed in Bhubaneswar (September 2014- March 2015)

Crop	Month	*Adults/ 10 plants				
		C. septempunctata	*C. transversalis*	*C. sexmaculata*	*B. suturalis*	*S. coccivora*
Okra	Feb.	1.6	0.6	0.3	1.3	0.3
	Mar.	1.2	0.8	0.7	0.4	0.1
	April	1.3	0.9	0.8	0.3	0.4
	May	0.4	0.1	0.3	1.2	0.8
	June	1.0	0.3	0.7	0.5	0.7
	July	1.3	0.2	0.9	0.6	1.0
	Aug.	1.5	1.3	1.1	0.7	0.9
Green gram	Sept.	2.4	1.3	2.9	1.6	0.9
	Oct.	2.2	2.5	1.9	1.8	1.3
	Nov.	2.3	1.8	2.2	0.3	0.2
	Dec.	0.3	1.7	1.6	1.0	0.9
	Jan.	1.5	1.3	1.2	1.8	0.7
	Feb.	1.2	0.9	2.5	1.9	0.4
	Mar.	1.7	0.7	2.7	0.2	1.3
Cowpea	Sept.	2.2	1.5	1.2	1.0	0.7
	Oct.	1.3	1.2	1.1	0.8	0.4
	Nov.	1.7	1.1	0.7	0.5	0.3
	Dec.	1.8	0.9	0.5	0.9	0.6
Groundnut	Sept.	1.4	1.7	0.7	0.3	0.8
	Oct.	1.3	1.5	1.3	0.4	0.3
	Nov.	1.9	1.2	1.1	0.7	0.5
	Dec.	1.7	1.1	0.8	0.5	0.9
	Jan.	1.2	1.8	0.9	1.1	0.6
	Feb.	1.0	1.4	1.1	1.0	1.2
	Mar.	1.1	1.2	0.7	1.2	0.7
Mustard	Nov.	2.3	2.1	2.0	0.8	0.9
	Dec.	3.1	2.7	1.7	1.6	2.0
	Jan.	4.8	2.2	1.2	0.5	1.3
	Feb.	3.2	1.6	0.6	0.2	0.3
	Mar.	3.9	2.3	1.3	0.0	0.8
Cabbage	Dec.	5.0	3.6	2.0	1.3	1.5
	Jan.	4.3	4.2	2.7	1.5	1.3
	Feb.	3.3	2.3	2.1	0.9	2.1
	Mar.	2.7	1.9	1.6	1.3	0.8

Table 2. Morphometrics of life stages of aphidophagous coccinellids (n=10)

Developmental stages	*Measurements (mm) (Mean ± S.E.)					
	C. septempunctata		*C. transversalis*		*C. sexmaculata*	
	Length	Breadth	Length	Breadth	Length	Breadth
Egg	1.2± 0.17	0.49± 0.00	1.05± 0.01	0.46± 0.07	0.61± 0.01	0.03± 0.00
I instar grub	1.69± 0.21	0.6± 0.02	2.45± 0.00	0.75± 0.01	1.1± 0.03	0.7± 0.01
II instar grub	3.48± 0.11	0.82± 0.01	3.45± 0.01	1.05± 0.03	2.2± 0.01	0.6± 0.02
III instar grub	5.9± 0.13	2.5± 0.14	5.71± 0.01	1.45± 0.14	2.9± 0.04	1.3± 0.01
IV instar grub	6.7± 0.61	3.4± 0.21	6.12± 0.17	2.5± 0.08	3.9± 0.07	1.8± 0.06
Pupa	4.5± 0.43	4.2± 0.39	4.31± 0.42	3.41± 0.08	3.9± 0.6	2.4± 0.06
Adult male	4.8± 0.67	4.5± 0.42	4.5± 0.31	4.0± 0.06	3.8± 0.11	3.1± 0.09
Adult female	5.2± 0.13	5,1± 0.64	4.9± 0.17	4.8± 0.17	3.7± 0.37	3.3± 0.43

Table 3. Duration of lifestages of *C. septempunctata* , *C. transversalis and C. sexmaculata* on *A. craccivora*

Stages of development	*C. septempunctata* *Developmental period in days (Mean± S.E.)						*C. transversalis* *Developmental period in days (Mean± S.E.)						*C. sexmaculata* *Developmental period in days (Mean± S.E.)					
	January	March	May	July	Sept-ember	Nov-ember	January	March	May	July	Sept-ember	Nov-ember	January	March	May	July	Sept-ember	Nov-ember
Egg	5.5± 0.13	4.9± 0.37	2.1± 0.13	3.1± 0.19	2.7± 0.31	3.2± 0.53	2.9± 0.71	2.0± 0.00	1.8± 0.03	2.1± 0.11	1.9± 0.17	2.4± 0.13	3.1± 0.27	2.4± 0.13	1.2± 0.01	2.0± 0.17	2.2± 0.04	2.6± 0.29
Grub																		
I instar	2.3± 0.11	1.8± 0.01	1.2± 0.01	2.6± 0.06	2.7± 0.32	2.1± 0.31	2.1± 0.37	2.9± 0.07	1.2± 0.01	2.0± 0.00	2.7± 0.01	2.8± 0.00	2.9± 0.46	2.7± 0.01	1.6± 0.16	2.7± 0.06	2.4± 0.12	2.8± 0.11
II instar	2.0± 0.00	1.8± 0.03	1.1± 0.02	2.5± 0.02	1.6± 0.07	2.0± 0.00	2.5± 0.14	2.8± 0.62	1.2± 0.29	2.4± 0.19	2.8± 0.00	2.6± 0.43	2.4± 0.41	2.1± 0.16	1.8± 0.01	2.3± 0.01	2.8± 0.00	2.3± 0.13
III instar	3.6± 0.31	3.1± 0.03	3.0± 0.01	3.9± 0.43	1.9± 0.04	3.4± 0.19	3.2± 0.91	3.1± 0.04	2.2± 0.01	3.2± 0.04	3.8± 0.07	2.7± 0.01	3.7± 0.11	2.5± 0.64	2.4± 0.14	2.7± 0.17	2.7± 0.11	2.9± 0.01
IV instar	3.7± 0.41	3.2± 0.17	3.9± 0.00	2.4± 0.19	3.0± 0.00	3.6± 0.04	4.2± 0.13	3.8± 0.13	3.1± 0.03	3.7± 0.01	3.0± 0.00	3.8± 0.11	3.5± 0.17	2.7± 0.11	1.8± 0.16	2.9± 0.11	2.1± 0.01	3.2± 0.11
Total larval period	11.9± 2.34	10.8± 0.94	8.2± 0.07	11.9± 1.36	10.6± 0.32	11.0± 0.00	12.1± 0.19	13.2± 0.22	7.0± 0.01	11.5± 0.07	13.0± 0.00	13.7± 0.67	12.6± 0.01	10.9± 0.67	7.9± 0.06	11.2± 0.61	10.8± 0.06	11.9± 0.12
Prepupa	1.9± 0.01	1.4± 0.06	1.0± 0.00	1.7± 0.03	1.3± 0.23	1.2± 0.07	2.5± 0.41	2.1± 0.19	1.5± 0.11	1.4± 0.13	1.0± 0.00	1.6± 0.62	1.2± 0.02	1.0± 0.00	1.0± 0.00	1.1± 0.01	1.0± 0.00	1.1± 0.01
Pupa	6.2± 1.37	4.7± 0.03	3.8± 0.01	4.9± 0.09	4.3± 0.31	3.1± 0.98	3.3± 0.93	2.3± 0.17	2.4± 0.16	2.5± 0.32	1.1± 0.39	2.6± 0.17	2.2± 0.34	2.8± 0.43	2.1± 0.01	3.1± 0.11	2.4± 0.03	3.2± 0.03
Total Development	22.4± 0.67	20.1± 0.21	15.2± 0.01	17.3± 0.09	16.7± 0.64	17.5± 0.34	20.2± 1.46	18.2± 0.17	11.5± 0.39	15.8± 0.74	16.2± 0.41	17.1± 0.83	17.4± 0.82	16.1± 0.24	12.3± 0.61	15.3± 0.32	14.7± 0.64	16.8± 0.32
Adult male	38.2± 2.91	35.2± 0.91	26.3± 0.43	36.4± 1.43	34.8± 0.09	37.3± 1.86	19.2± 3.47	16.3± 0.37	16.8± 0.64	17.2± 0.11	16.1± 0.31	17.4± 0.99	17.6± 0.42	15.8± 0.17	13.6± 0.14	16.2± 0.51	15.6± 0.62	16.8± 0.61
Adult female	44.2± 1.9	40.2± 3.2	32.7± 0.07	41.9± 0.97	39.9± 0.87	43.4± 2.7	35.7± 0.14	28.4± 0.13	22.0± 0.00	30.0± 0.00	20.2± 0.61	32.9± 1.67	22.4± 0.91	19.8± 0.31	19.0± 0.00	18.0± 0.00	19.4± 0.37	21.3± 0.07

to the normal temperatures, elevated temperatures resulted in significant decrease of the lifestages. The adult beetles lived for more days in cooler months. Balikai et al. (2000), Sukla and Jadav (2014) observed similar life history in coccinellids.

ACKNOWLEDGEMENTS

The authors acknowledge the Head of the Department, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar for providing necessary laboratory facilities.

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(Manuscript Received: January, 2021; Revised: April, 2021;
Accepted: April, 2021; Online Published: July, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e21022