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Life table of *Chrysoperla zastrowi sillemi* (Esben-Petersen) on coriander aphid, *Hyadaphis coriandri* (Das)

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Abstract
Studies on the coriander aphid (*H. coriandri*) were conducted on the life table of *C. zastrowi sillemi* during the years 2020-21 at constant temperature of 25±1 °C. According to observations, the maximum ages of the egg, larva, pre-pupa, and pupa were 4, 13, 2, and 4 days, respectively. With a mean length of generation (Tc) of 42.68 days, the net reproductive rate (R0) of 68.05 was obtained. The population increased by 2.0784 times per week. The intrinsic rate of natural increase in numbers (rm) was 0.0989 females/female/day. The eggs, larvae, pre-pupae, pupae and adults each contributed 39.97, 47.76, 2.61, 3.84 and 5.81 percent when, it came to the stable age distribution. The life expectancy (ex) of newly deposited eggs was only 15.17 days.

Keywords: *Chrysoperla zastrowi sillemi*, life table, coriander aphid

Introduction
As a viable alternative to or complement conventional management strategies, natural enemies play a significant role in agro ecosystems. According to Sathe and Bhosale (2001) [8], the predators are widely dispersed and comprise 167 families across 14 orders of the insecta class. There are over 6,000 species of lacewings or net-winged insects in 18 families of the Neuroptera, which have delicate bodies and are typically medium-sized predators. Lacewings include mantispids (mantisflies), green lacewings, owlflies, antlions and their relatives. Order Neuroptera consists three suborders: Hemerobiiformia, Myrmeleontiformia and Nevrorthiformia. Suborder Hemerobiiformia comprises 11 families and Chrysopidae are one of them. Worldwide, it consists 1200 species (Devetak and Kral, 2016) [5]. In India, 65 species of chrysopids belonging to 21 genera have been recorded from various crop ecosystems (Yadav *et al.*, 1998) [10].

Materials and Methods
The culture of *C. zastrowi sillemi* was kept at a constant temperature of 25±1 °C using a B.O.D. incubator in order to develop the life table at AICRP on Biological control of Crop Pests, AAU, Anand during the year 2020-21. With the use of a wet camel hair brush, 100 newly deposited eggs were removed from the cage and divided into 10 groups of ten each. To make it easier to observe the eggs hatching, they were arranged in a row on the slides. The newly hatched larvae had fresh nourishment every morning. The entire larva after hatching was reared individually on coriander aphid. Daily observations of hatching, whole larval development, pupa formation, adult emergence and female fecundity were made. Age-specific mortality was seen in many developmental stages, including eggs, larvae, pre-pupae, pupae, and adults. The total number of adults that emerged on the same day was kept apart in oviposition wooden cages in order to calculate age-specific fecundity. The quantity of eggs laid on the following days was noted. Until every female passed away, fecundity observations were made continuously. The female birth rate was determined using the sex ratio. Life tables were constructed according to the methods of Atwal and Bains (1974) [1], Dabhi *et al.* (2009a) [3], Dabhi *et al.* (2009b) [4], Patel *et al.* (2016) [7] and Singh *et al.* (2022) [9]. A stable age distribution was determined by observing the population schedule of birth and death rates (mx and lx) when grown in a limited amount of time.

Results and Discussion

The data from Table 1 indicated that the number of individuals who survived during the development of coriander aphid (*H. coriandri*) was 100 percent development of the egg stage. Sixty-three individuals made it from 100 eggs to the emergence of adults. The longest documented periods for the egg, larva, pre-pupa, and pupa were 4, 13, 2, and 4 days, respectively. It is evident from the data presented in Table 2 that the pre-oviposition period was between the 23rd and 29th days of pivotal age. On the 48th day (lx= 0.30) after the emergence of adults, the cohort experienced its first female mortality; there was a subsequent rise in female adult mortality. The females contributed the highest egg production (mx= 10.37) in the life cycle on the 44th day of pivotal age and the lowest (mx=0.05) on the 63rd day of pivotal age. Data obtained from Table 3, the net reproductive rate (R0) representing the total female birth was 68.05, indicating that the weekly multiplication of population would 2.0784 times at the end of every generation. The generation took an average of 40.39 days to finish (T). The figures for the finite rate (λ) and innate capacity (rm) for an increase in population were calculated to be 0.0989 and 1.1102 females per female per day, respectively. The hypothetical F2 females of *C. zastrowi sillemi* was worked out to the tune of 4630.80.The stable age distribution was worked out by observing the age schedules of birth rate and death rate (mx and lx). The data (Table 4) revealed that adults contributed only 5.81 percent to the population of stable age, whereas eggs, larvae, pre-pupae and pupae contributed 39.97, 47.76, 2.61 and 3.84 percent, respectively. The data (Table 5) indicated that the life expectancy (ex) of newly deposited eggs was only 15.17 days. The mortality rate was comparatively high at the age of 40 to 45 days when the expectation of further life was reduced to 6.21 days from 15.17 days in the beginning.

Table 1: Survival of different life stages of *C. zastrowi sillemi* reared on coriander aphid, *H. coriandri*

Sr. No.	No. of eggs	Number of individual survived at different stages			
		Egg (0-3 days)	Larva (4-16 days)	Pre-pupa (17-18 days)	Pupa (19–22 days)
1	10	10	8	7	7
2	10	10	7	6	6
3	10	10	7	7	7
4	10	10	8	7	7
5	10	10	6	6	6
6	10	10	7	7	7
7	10	10	9	8	8
8	10	10	7	7	7
9	10	10	8	8	8
10	10	10	8	7	7
Total	100	100	75	70	70

Table 2: Life table and age specific fecundity of *C. zastrowi sillemi* reared on coriander aphid, *H. coriandri* (for female)

Pivotal age in days (x)	Survival of female at different age interval (l_x)	Age schedule for female births (m_x)	l_xm_x	xl_xm_x
0-22	**Immature stages**			
23-29	**Pre-oviposition period**			
30	0.55	1.35	0.74	22.28
31	0.55	2.23	1.23	38.02
32	0.55	3.16	1.74	55.62
33	0.55	3.37	1.85	61.17
34	0.54	4.31	2.33	79.13
35	0.54	4.81	2.60	90.91
36	0.54	5.31	2.87	103.23
37	0.53	5.92	3.14	116.09
38	0.53	6.48	3.43	130.51
39	0.53	7.40	3.92	152.96
40	0.53	7.61	4.03	161.33
41	0.48	8.50	4.08	167.28
42	0.41	9.10	3.73	156.70
43	0.35	9.85	3.45	148.24
44	0.31	10.37	3.21	141.45
45	0.31	10.06	3.12	140.34
46	0.31	9.47	2.94	135.04
47	0.31	8.94	2.77	130.26
48	0.30	8.02	2.41	115.49
49	0.30	7.76	2.33	114.07
50	0.30	6.89	2.07	103.35
51	0.30	6.31	1.89	96.54
52	0.30	5.76	1.73	89.86
53	0.28	5.11	1.43	75.83
54	0.28	4.42	1.24	66.83
55	0.28	3.98	1.11	61.29
56	0.28	3.06	0.86	47.98
57	0.27	2.23	0.60	34.32

58	0.27	1.60	0.43	25.06
59	0.26	1.35	0.35	20.71
60	0.20	1.03	0.21	12.36
61	0.16	0.81	0.13	7.91
62	0.10	0.34	0.03	2.11
63	0.01	0.05	0.05	0.03
Total			68.05	2904.27

Table 3: Mean length of generation, innate capacity for increase in numbers and finite rate of increase in numbers of *C. zastrowi sillemi* reared on coriander aphid, *H. coriandri*

Sr. No.	Growth statistics	Formula	Calculated values
1	Net reproductive rate	$R_0 = \Sigma lxmx$	68.05
2	Mean length of generation (days)	$Tc = \frac{\Sigma lxmx}{Ro}$	42.68
3	Innate capacity for increase in numbers (Females/female/day)	$rm = \frac{\log e^{Ro}}{Tc}$	0.0989
4	Arbitrary 'r_m' (rc) =0.10 and 0.11	-	-
5	Corrected 'rm' (Females/female/day)	$\Sigma e^{7} - ^{rmx.lxmx}$	0.1045
6	Corrected generation time (days)	$T = \frac{\log e^{Ro}}{rm}$	40.39
7	Finite rate of increase in numbers (Females/female/day)	$\lambda = antilog\ e^{rm}$	1.1102
8	Weekly multiplication of population (times/week)	$(\lambda)^7$	2.0784
9	Hypothetical F_2 females	$(R_0)^2$	4630.80

Table 4: Age specific distribution of *C. zastrowi sillemi* reared on coriander aphid, *H. coriandri* (r_m=0.0989)

Host	Percentage contribution of various stages				
	Eggs	Larvae	Pre-pupae	Pupae	Adults
Cotton aphid	39.97	47.76	2.61	3.84	5.81

Table 5: Life table for computing life expectancy of *C. zastrowi sillemi* reared on coriander aphid, *H. coriandri*

Pivotal age (Days)	Number surviving to the beginning of age interval	Number dying during 'x'	Mortality rate per hundred alive at beginning of age interval (dx*100/lx)	Alive between age 'x' and 'x + 1' $\frac{l_x + l_{(x+1)}}{2}$	No. of the individual's life days beyond 'x'	Expectation of further life $\frac{T_x}{l_x} \times 2$
(x)	(lx)	(dx)	(100 qx)	(Lx)	(Tx)	(ex)
0-5	100	13	13.0000	100.50	758.50	15.17
5-10	87	3	3.4483	87.50	658.00	15.13
10-15	84	7	8.3333	84.50	570.50	13.58
15-20	77	7	9.0909	77.50	486.00	12.62
20-25	70	7	10.0000	70.50	408.50	11.67
25-30	63	8	12.6984	63.50	338.00	10.73
30-35	55	1	1.8182	55.50	274.50	9.98
35-40	54	1	1.8519	54.50	219.00	8.11
40-45	53	22	41.5094	53.50	164.50	6.21
45-50	31	1	3.2258	31.50	111.00	7.16
50-55	30	2	6.6667	30.50	79.50	5.30
55-60	28	8	28.5714	28.50	49.00	3.50
60-65	20	20	100.0000	20.50	20.50	2.05

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