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ORIGINAL ARTICLE

Age Specific Survival, Death and Life Expectancy of *Menochilus sexmaculatus* Fabr (Coleoptera: Coccinellidae) on Different Aphid Species Under Natural Environment

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ABSTRACT

The observations with respect to age specific survival, death and life expectancy of Menochilus sexmaculatus on different aphid species revealed that it took maximum period of 56 days to complete generation on Aphis craccivora and shortest of 50 days on Lipaphis erysimi, respectively. The survivorship and the mortality exhibited an irregular pattern with high and low peaks. The high peaks reflecting maximum mortality and low peaks denote the negligible mortality on respective days. As far as the life expectancy was concerned, it declined gradually till the culmination of generation on all aphid species. In nature, the pupae of M. sexmaculatus were also found parasitized by Oomyzus scaposus, and Dinocampus coccinellae. Abiotic factors viz., temperature, relative humidity, rainfall, wind velocity and evaporation also play an additional role in the mortality of M. sexmaculatus in natural environment. Moreover, variation in the rate of mortality of M. sexmaculatus could also be influenced by the quality of foods or change in aphid species.

Key words: *A. craccivora, cocccinellid, H. coriandri, life table, L. erysimi, M. rosae, R. nymphae*

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INTRODUCTION

Age specific survival provides simple and more informative statistics for comprehensive description of survival of an organism. In nature, this table helps to record a series of sequential size that reveal population changes throughout the life of an organism. The survival of organism may, however, depend on numerous environmental factors such as, temperature, relative humidity, wind velocity, sunshine, evaporation and rainfall, which affect the natural population density of an organism (1 and 2). The collection of data for survival of natural enemies is an important factor for pest management strategies in biological control system (3 and 4). Obviously, predators reduce survival and fecundity of their specific prey, but at a higher level of organization, the populations of both predator and prey species interact with each other. The predators depend on prey for its survival and consequently affect their population (4 and 5).

Usually aphid attacks on many economically important crops. They propel their proboscis in the phloem system of plants for sucking the cell sap (6 and 7). Many aphids have a narrow host range, for example, mustard aphid, *Lipaphis erysimi*, feeds only on cruciferous plants; *Hyadaphis coriandri* on coriander plants; *Macrosiphum rosae* only on rose plants and *Rhopalosiphum nymphae* on duck-salad and some ornamental plants (8). However, some aphid species have broader host range and have been classified as polyphagous. For example, the host range of cowpea aphid, *Aphis craccivora* feed on more than 100 plant families (8). In the biosphere, aphids are known to migrate for a longer

distances that depends on the weather patterns. Both apterae and alatae aphids are widely distributed on many crucifers throughout the world. The attack is severe in those regions where the numbers of cloudy days are more during the pest activity period (6 and 7). The losses in yield, however, vary with quality of germplasms, environmental factors and agro-technological practices etc (6 and 7).

Therefore, to identify the numerical changes in age distribution and survival of *M. sexmaculatus*, on different aphid species, present experiment has been designed to introduce it in biological control program.

MATERIALS AND METHODS

To accomplish present objective, various crops *viz.*, Indian mustard, *Brassica juncea* L.; common bean, *Phaseolus vulgaris* L.; coriander, *Coriandrum sativum* L. and ornamental plant, verbena, *Verbena laciniata* L. were grown in a plot sized 10 x 10 meter (each replicated thrice). The five year old rose plants, *Rosa indica* L., maintained at experimental fields were also used for the study. The aphid species collected from the respective host plants were identified from the Laboratory of Aphidology, Department of Zoology, University of Kalyani, West Bengal, India. The aphid species attacking Indian mustard, common bean, coriander, verbena and rose plants were identified as *Lipaphis erysimi* Kaltenbach, *Aphis craccivora* Koch, *Hyadaphis coriandri* Das, *Rhopalosiphum nymphae* Linnaeus and *Macrosiphum rosae* Linnaeus, respectively. In natural infestation of ladybeetle complex, *M. sexmaculatus* were recorded as predominating species after *Coccinella Septempunctata* and *C. transversalis*.

Adult females of *M. sexmaculatus* were collected from respective crop and brought to the laboratory to keep separately in Petri dishes (90 x 10 mm). A blotting paper was spread over inner surface of Petri dishes for egg laying. Fresh infested cut twigs of respective plant along with particular aphid species were provided as food to beetles daily. The eggs laid by females were counted and transferred in other Petri dishes, with the help of soft camel hair brush. Further, counted number of zero day old eggs (approximately 100) obtained from *M. sexmaculatus* were placed in Petri dishes and allowed to hatch at a constant temperature (24±1°C) in the BOD incubator in the laboratory. One hundred, initially hatched grubs of *M. sexmaculatus* were collected and transferred to the respective pant attacked by aphids in the captivity under natural environment. The size of the cage was determined in accordance to the height of crop, for mustard plants, the cage was maintained at 5 x 3 x 3 m, whereas, for ornamental and other crop plants, the cage size was kept as 3 x 2 x 2 m. The survival and mortality of grubs were recorded daily and this procedure was followed till pupation.

After the emergence of adults (male and female), they were again remained in captivity under natural environment and also provided respective aphid species till their death. The record of the consumed, unconsumed as well as dead aphids was updated daily. The longevity and mortality of each larval instar, pre-pupa, pupa and adult during the course of investigation were also recorded daily on respective aphid species. This rearing procedure was followed for the study of two successive generations. This data collected during rearing of *M. sexmaculatus* was employed for construction of age specific life-table.

Age Specific Life-Table:

Observations on number of alive and dead out of hundred larvae were recorded daily. The following assumptions were used in the construction of age specific life-table of *M. sexmaculatus* under natural environment.

x = Age of the *M. sexmaculatus* in days.

l_x = Number surviving *M. sexmaculatus* at the beginning of each interval, out of 100

d_x = Number dying *M. sexmaculatus* during the age interval, out of 100

$100q_x$ = Mortality rate at the age interval x and calculated by using formula

$$100q_x = [d_x / l_x] \times 100$$

e_x = Expectation of life or mean life remaining for individuals of age x

Life expectation was calculated using the equation

$$e_x = T_x / l_x$$

To obtain e_x two other parameters L_x and T_x were also computed as below.

L_x = The number of individuals alive between age x and x + 1 and calculated by the equation.

$$L_x = l_x + 1 (x + 1) / 2$$

T_x = The total number of individual of x age units beyond the age x, and obtained by the equation;

$$T_x = l_x + (l_x + 1) + (l_x + 2) \ldots\ldots\ldots\ldots\ldots + l_w.$$

Where, l_w = The last age interval.

RESULTS AND DISCUSSION

The data on age of *Menochilus sexmaculatus* showed that it took maximum period of 56 days to complete life cycle on *Aphis craccivora* and minimum of 50 days on *Lipaphis erysimi*, respectively (Table 1-5). As far as other host species were concerned, the developmental duration was found as 53 days on *Hyadaphis coriandri* and 52 days on *Rhopalosiphum nymphae* as well as *Macrosiphum rosae*, respectively (Table 1-5). The survival and the mortality exhibited an irregular pattern with high and low peaks. The high peaks reflecting maximum mortality of *M. sexmaculatus* on 2, 3, 6, 7, 10, 14, 18, 22, 26, 27, 33, 34, 36, 37, 40, 41, 44, 45, 48 and 49th day while feeding on *L. erysimi* (Table 1). In addition, on *A. craccivora* high mortality was recorded on 2, 3, 7, 8, 11, 15, 23, 24, 38, 39, 42, 43, 46, 47, 50, 51, 52 and 54th day (Table 2). Similarly on *H. coriandri* maximum mortality was observed on 2, 3, 7, 8, 12, 16, 24, 28, 29, 36, 37, 39, 40, 43, 44, 47, 48 and 51st day; and on *R. nymphae* on 2, 3, 7, 8, 11, 15, 23, 27, 28, 38, 41, 42, 45, 46, 49 and 50th day; and on *M. rosae* on 2, 3, 6, 7, 10, 14, 22, 23, 27, 33, 34, 38, 39, 42, 43, 46, 50, 51st day, respectively (Table 3-5). In contrast, low mortality of negligible mortality was observed on 1, 5, 8, 9, 12, 13, 16, 17, 20, 21, 24, 25, 31, 32, 35, 39, 43 and 47th day on *L. erysimi*; on 1, 5, 6, 10, 13, 14, 17, 18, 21, 22, 26, 27, 30, 31, 33, 34, 36, 37, 41, 45, 49 and 53rd day on *A. craccivora*; on 1, 5, 6, 10, 11, 14, 15, 18, 19, 22, 23, 26, 27, 31, 32, 35, 38, 42, 46 and 50th day on *H. coriandri*; on 1, 6, 9, 10, 12, 13, 17, 18, 22, 25, 26, 31, 34, 37, 40, 44 and 48th day on *R. nymphae*; and on 1, 4, 5, 9, 12, 13, 17, 20, 21, 25, 26, 30, 31, 32, 36, 37, 41, 45 and 49th day on *M. rosae*, respectively (Table 1-5). As far as the life expectancy was concerned, it declined gradually till the culmination of generation on all aphid species. The intermittent pauses in life expectancy were, however, recorded on 3rd and 41st day on *L. erysimi*; on 3, 8, 24 and 39th day on *A. craccivora*; on 3rd & 8th day on *H. coriandri*; on 3, 8 & 28th day on *R. nymphae*; on 3, 7, 23, 39 and 43rd day on *M. rosae*, respectively (Table 1-5).

While determining the development period and adult longevity of *M. sexmaculatus* under natural environment on different aphid species, the fluctuation in temperature (minimum and maximum) and per cent relative humidity (minimum and maximum) with respect to population dynamics of *M. sexmaculatus* vis-à-vis aphid species was recorded as under:

L. erysimi = 18.20-28.40 °C and 59.10-78.80 % RH
A. craccivora = 17.10-29.40°C and 62.20-86.70 % RH
H. coriandri = 17.10-29.40°C and 62.20-86.70 % RH
R. nymphae = 17.50-28.60 °C 64.30-89.50 % RH
M. rosae = 17.50-28.60 °C 64.30-89.50 % RH

A comparative study on the age specific life-table of *M. sexmaculatus* revealed that it required minimum time to complete generation on *L. erysimi* and maximum on *A. craccivora*, respectively. Hodek and Honek (9), Kalushkov and Hodek (10), and Patel (11) also reported a similar variation in the generation time for different coccinellid species while feeding on a variety of aphids. The curve drawn between age and survivorship of *M. sexmaculatus* vis-à-vis aphid species produced a stair step like pattern.

Table 1: Age specific survival (l_x), death (d_x) and life expectancy (e_x) of *Menochilus sexmaculatus* on *Lipaphis erysimi* under natural environment

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
1	100	0	0.00	100.00	2596.00	25.96
2	100	6	6.00	97.00	2496.00	25.73
3	94	4	4.26	92.00	2399.00	26.08
4	90	1	1.11	89.50	2307.00	25.78
5	89	0	0.00	89.00	2217.50	24.92
6	89	6	6.74	86.00	2128.50	24.75
7	83	5	6.02	80.50	2042.50	25.37
8	78	0	0.00	78.00	1962.00	25.15
9	78	0	0.00	78.00	1884.00	24.15
10	78	4	5.13	76.00	1806.00	23.76
11	74	2	2.70	73.00	1730.00	23.70
12	72	0	0.00	72.00	1657.00	23.01
13	72	0	0.00	72.00	1585.00	22.01
14	72	3	4.17	70.50	1513.00	21.46
15	69	1	1.45	68.50	1442.50	21.06
16	68	0	0.00	68.00	1374.00	20.21
17	68	0	0.00	68.00	1306.00	19.21
18	68	3	4.41	66.50	1238.00	18.62
19	65	1	1.54	64.50	1171.50	18.16
20	64	0	0.00	64.00	1107.00	17.30
21	64	0	0.00	64.00	1043.00	16.30
22	64	3	4.69	62.50	979.00	15.66
23	61	2	3.28	60.00	916.50	15.28
24	59	0	0.00	59.00	856.50	14.52
25	59	0	0.00	59.00	797.50	13.52
26	59	5	8.47	56.50	738.50	13.07
27	54	3	5.56	52.50	682.00	12.99
28	51	2	3.92	50.00	629.50	12.59
29	49	1	2.04	48.50	579.50	11.95
30	48	1	2.08	47.50	531.00	11.18
31	47	0	0.00	47.00	483.50	10.29
32	47	0	0.00	47.00	436.50	9.29
33	47	4	8.51	45.00	389.50	8.66
34	43	3	6.98	41.50	344.50	8.30
35	40	0	0.00	40.00	303.00	7.58
36	40	6	15.00	37.00	263.00	7.11
37	34	3	8.82	32.50	226.00	6.95
38	31	2	6.45	30.00	193.50	6.45
39	29	0	0.00	29.00	163.50	5.64
40	29	6	20.69	26.00	134.50	5.17
41	23	4	17.39	21.00	108.50	5.17
42	19	2	10.53	18.00	87.50	4.86
43	17	0	0.00	17.00	69.50	4.09
44	17	4	23.53	15.00	52.50	3.50
45	13	3	23.08	11.50	37.50	3.26
46	10	2	20.00	9.00	26.00	2.89
47	8	0	0.00	8.00	17.00	2.13
48	8	4	50.00	6.00	9.00	1.50
49	4	3	75.00	2.50	3.00	1.20
50	1	1	100.00	0.50	0.50	1.00

The mortality trend of *M. sexmaculatus*, however, showed an irregular pattern with more number of high peaks (maximum mortality) at the later stage of development (pupae and adult), coinciding with pupal as well as adult mortality (12-16). The main cause of this high mortality could be due to parasitization of *M. sexmaculatus*, besides climatic as well as some intrinsic factors (4, 5 and 17).

Table 2: Age specific survival (l_x), death (d_x) and life expectancy (e_x) of *Menochilus sexmaculatus* on *Aphis craccivora* under natural environment

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
1	100	0	0.00	100.00	3099.00	30.99
2	100	5	5.00	97.50	2999.00	30.76
3	95	3	3.16	93.50	2901.50	31.03
4	92	2	2.17	91.00	2808.00	30.86
5	90	0	0.00	90.00	2717.00	30.19
6	90	0	0.00	90.00	2627.00	29.19
7	90	5	5.56	87.50	2537.00	28.99
8	85	3	3.53	83.50	2449.50	29.34
9	82	1	1.22	81.50	2366.00	29.03
10	81	0	0.00	81.00	2284.50	28.20
11	81	3	3.70	79.50	2203.50	27.72
12	78	1	1.28	77.50	2124.00	27.41
13	77	0	0.00	77.00	2046.50	26.58
14	77	0	0.00	77.00	1969.50	25.58
15	77	3	3.90	75.50	1892.50	25.07
16	74	2	2.70	73.00	1817.00	24.89
17	72	0	0.00	72.00	1744.00	24.22
18	72	0	0.00	72.00	1672.00	23.22
19	72	2	2.78	71.00	1600.00	22.54
20	70	1	1.43	69.50	1529.00	22.00
21	69	0	0.00	69.00	1459.50	21.15
22	69	0	0.00	69.00	1390.50	20.15
23	69	4	5.80	67.00	1321.50	19.72
24	65	3	4.62	63.50	1254.50	19.76
25	62	1	1.61	61.50	1191.00	19.37
26	61	0	0.00	61.00	1129.50	18.52
27	61	0	0.00	61.00	1068.50	17.52
28	61	2	3.28	60.00	1007.50	16.79
29	59	1	1.69	58.50	947.50	16.20
30	58	0	0.00	58.00	889.00	15.33
31	58	0	0.00	58.00	831.00	14.33
32	58	2	3.45	57.00	773.00	13.56
33	56	0	0.00	56.00	716.00	12.79
34	56	0	0.00	56.00	660.00	11.79
35	56	2	3.57	55.00	604.00	10.98
36	54	0	0.00	54.00	549.00	10.17
37	54	0	0.00	54.00	495.00	9.17
38	54	7	12.96	50.50	441.00	8.73
39	47	5	10.64	44.50	390.50	8.78
40	42	2	4.76	41.00	346.00	8.44
41	40	0	0.00	40.00	305.00	7.63
42	40	5	12.50	37.50	265.00	7.07
43	35	4	11.43	33.00	227.50	6.89
44	31	2	6.45	30.00	194.50	6.48
45	29	0	0.00	29.00	164.50	5.67
46	29	5	17.24	26.50	135.50	5.11
47	24	3	12.50	22.50	109.00	4.84
48	21	2	9.52	20.00	86.50	4.33
49	19	0	0.00	19.00	66.50	3.50
50	19	6	31.58	16.00	47.50	2.97
51	13	4	30.77	11.00	31.50	2.86
52	9	3	33.33	7.50	20.50	2.73
53	6	0	0.00	6.00	13.00	2.17
54	6	3	50.00	4.50	7.00	1.56
55	3	2	66.67	2.00	2.50	1.25
56	1	1	100.00	0.50	0.50	1.00

Table 3: Age specific survival (l_x), death (d_x) and life expectancy (e_x) of *Menochilus sexmaculatus* on *Hyadaphis coriandri* under natural environment

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
1	100	0	0.00	100.00	2971.00	29.71
2	100	5	5.00	97.50	2871.00	29.45
3	95	3	3.16	93.50	2773.50	29.66
4	92	2	2.17	91.00	2680.00	29.45
5	90	0	0.00	90.00	2589.00	28.77
6	90	0	0.00	90.00	2499.00	27.77
7	90	4	4.44	88.00	2409.00	27.38
8	86	3	3.49	84.50	2321.00	27.47
9	83	2	2.41	82.00	2236.50	27.27
10	81	0	0.00	81.00	2154.50	26.60
11	81	0	0.00	81.00	2073.50	25.60
12	81	3	3.70	79.50	1992.50	25.06
13	78	2	2.56	77.00	1913.00	24.84
14	76	0	0.00	76.00	1836.00	24.16
15	76	0	0.00	76.00	1760.00	23.16
16	76	3	3.95	74.50	1684.00	22.60
17	73	1	1.37	72.50	1609.50	22.20
18	72	0	0.00	72.00	1537.00	21.35
19	72	0	0.00	72.00	1465.00	20.35
20	72	2	2.78	71.00	1393.00	19.62
21	70	1	1.43	69.50	1322.00	19.02
22	69	0	0.00	69.00	1252.50	18.15
23	69	0	0.00	69.00	1183.50	17.15
24	69	3	4.35	67.50	1114.50	16.51
25	66	2	3.03	65.00	1047.00	16.11
26	64	0	0.00	64.00	982.00	15.34
27	64	0	0.00	64.00	918.00	14.34
28	64	4	6.25	62.00	854.00	13.77
29	60	3	5.00	58.50	792.00	13.54
30	57	1	1.75	56.50	733.50	12.98
31	56	0	0.00	56.00	677.00	12.09
32	56	0	0.00	56.00	621.00	11.09
33	56	2	3.57	55.00	565.00	10.27
34	54	1	1.85	53.50	510.00	9.53
35	53	0	0.00	53.00	456.50	8.61
36	53	6	11.32	50.00	403.50	8.07
37	47	4	8.51	45.00	353.50	7.86
38	43	0	0.00	43.00	308.50	7.17
39	43	7	16.28	39.50	265.50	6.72
40	36	5	13.89	33.50	226.00	6.75
41	31	2	6.45	30.00	192.50	6.42
42	29	0	0.00	29.00	162.50	5.60
43	29	6	20.69	26.00	133.50	5.13
44	23	4	17.39	21.00	107.50	5.12
45	19	2	10.53	18.00	86.50	4.81
46	17	0	0.00	17.00	68.50	4.03
47	17	4	23.53	15.00	51.50	3.43
48	13	3	23.08	11.50	36.50	3.17
49	10	2	20.00	9.00	25.00	2.78
50	8	0	0.00	8.00	16.00	2.00
51	8	5	62.50	5.50	8.00	1.45
52	3	2	66.67	2.00	2.50	1.25
53	1	1	100.00	0.50	0.50	1.00

Table 4: Age specific survival (l_x), death (d_x) and life expectancy (e_x) of *Menochilus sexmaculatus* on *Rhopalosiphum nymphae* under natural environment

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
1	100	0	0.00	100.00	2731.00	27.31
2	100	5	5.00	97.50	2631.00	26.98
3	95	4	4.21	93.00	2533.50	27.24
4	91	2	2.20	90.00	2440.50	27.12
5	89	1	1.12	88.50	2350.50	26.56
6	88	0	0.00	88.00	2262.00	25.70
7	88	6	6.82	85.00	2174.00	25.58
8	82	4	4.88	80.00	2089.00	26.11
9	78	0	0.00	78.00	2009.00	25.76
10	78	0	0.00	78.00	1931.00	24.76
11	78	4	5.13	76.00	1853.00	24.38
12	74	2	2.70	73.00	1777.00	24.34
13	72	0	0.00	72.00	1704.00	23.67
14	72	0	0.00	72.00	1632.00	22.67
15	72	3	4.17	70.50	1560.00	22.13
16	69	2	2.90	68.00	1489.50	21.90
17	67	0	0.00	67.00	1421.50	21.22
18	67	0	0.00	67.00	1354.50	20.22
19	67	2	2.99	66.00	1287.50	19.51
20	65	1	1.54	64.50	1221.50	18.94
21	64	1	1.56	63.50	1157.00	18.22
22	63	0	0.00	63.00	1093.50	17.36
23	63	4	6.35	61.00	1030.50	16.89
24	59	2	3.39	58.00	969.50	16.72
25	57	0	0.00	57.00	911.50	15.99
26	57	0	0.00	57.00	854.50	14.99
27	57	5	8.77	54.50	797.50	14.63
28	52	3	5.77	50.50	743.00	14.71
29	49	2	4.08	48.00	692.50	14.43
30	47	1	2.13	46.50	644.50	13.86
31	46	0	0.00	46.00	598.00	13.00
32	46	2	4.35	45.00	552.00	12.27
33	44	1	2.27	43.50	507.00	11.66
34	43	0	0.00	43.00	463.50	10.78
35	43	1	2.33	42.50	420.50	9.89
36	42	1	2.38	41.50	378.00	9.11
37	41	0	0.00	41.00	336.50	8.21
38	41	3	7.32	39.50	295.50	7.48
39	38	1	2.63	37.50	256.00	6.83
40	37	0	0.00	37.00	218.50	5.91
41	37	7	18.92	33.50	181.50	5.42
42	30	5	16.67	27.50	148.00	5.38
43	25	2	8.00	24.00	120.50	5.02
44	23	0	0.00	23.00	96.50	4.20
45	23	6	26.09	20.00	73.50	3.68
46	17	4	23.53	15.00	53.50	3.57
47	13	2	15.38	12.00	38.50	3.21
48	11	0	0.00	11.00	26.50	2.41
49	11	5	45.45	8.50	15.50	1.82
50	6	3	50.00	4.50	7.00	1.56
51	3	2	66.67	2.00	2.50	1.25
52	1	1	100.00	0.50	0.50	1.00

Table 5: Age specific survival (l_x), death (d_x) and life expectancy (e_x) of *Menochilus sexmaculatus* on *Macrosiphum rosae* under natural environment

x	l_x	d_x	$100q_x$	L_x	T_x	e_x
1	100	0	0.00	100.00	2709.00	27.09
2	100	6	6.00	97.00	2609.00	26.90
3	94	4	4.26	92.00	2512.00	27.30
4	90	0	0.00	90.00	2420.00	26.89
5	90	0	0.00	90.00	2330.00	25.89
6	90	6	6.67	87.00	2240.00	25.75
7	84	4	4.76	82.00	2153.00	26.26
8	80	1	1.25	79.50	2071.00	26.05
9	79	0	0.00	79.00	1991.50	25.21
10	79	3	3.80	77.50	1912.50	24.68
11	76	1	1.32	75.50	1835.00	24.30
12	75	0	0.00	75.00	1759.50	23.46
13	75	0	0.00	75.00	1684.50	22.46
14	75	3	4.00	73.50	1609.50	21.90
15	72	2	2.78	71.00	1536.00	21.63
16	70	1	1.43	69.50	1465.00	21.08
17	69	0	0.00	69.00	1395.50	20.22
18	69	2	2.90	68.00	1326.50	19.51
19	67	1	1.49	66.50	1258.50	18.92
20	66	0	0.00	66.00	1192.00	18.06
21	66	0	0.00	66.00	1126.00	17.06
22	66	6	9.09	63.00	1060.00	16.83
23	60	3	5.00	58.50	997.00	17.04
24	57	1	1.75	56.50	938.50	16.61
25	56	0	0.00	56.00	882.00	15.75
26	56	0	0.00	56.00	826.00	14.75
27	56	3	5.36	54.50	770.00	14.13
28	53	2	3.77	52.00	715.50	13.76
29	51	1	1.96	50.50	663.50	13.14
30	50	0	0.00	50.00	613.00	12.26
31	50	0	0.00	50.00	563.00	11.26
32	50	0	0.00	50.00	513.00	10.26
33	50	4	8.00	48.00	463.00	9.65
34	46	3	6.52	44.50	415.00	9.33
35	43	2	4.65	42.00	370.50	8.82
36	41	0	0.00	41.00	328.50	8.01
37	41	0	0.00	41.00	287.50	7.01
38	41	7	17.07	37.50	246.50	6.57
39	34	5	14.71	31.50	209.00	6.63
40	29	2	6.90	28.00	177.50	6.34
41	27	0	0.00	27.00	149.50	5.54
42	27	6	22.22	24.00	122.50	5.10
43	21	4	19.05	19.00	98.50	5.18
44	17	2	11.76	16.00	79.50	4.97
45	15	0	0.00	15.00	63.50	4.23
46	15	4	26.67	13.00	48.50	3.73
47	11	2	18.18	10.00	35.50	3.55
48	9	1	11.11	8.50	25.50	3.00
49	8	0	0.00	8.00	17.00	2.13
50	8	4	50.00	6.00	9.00	1.50
51	4	3	75.00	2.50	3.00	1.20
52	1	1	100.00	0.50	0.50	1.00

In nature, the pupae of *M. sexmaculatus* were parasitized by *Oomyzus scaposus* (Hymenoptera: Chalcidoidea: Euphidae), and the emergence of *Dinocampus coccinellae* (Hymenoptera: Braconidae) from beetles has also been reported, which supported by the findings of earlier workers (18, 19 and 20). Abiotic factors *viz.*, temperature, relative humidity, rainfall, wind velocity and evaporation also play an additional role in the mortality of *M. sexmaculatus* at different development stages. Variation in the rate of mortality of *M. sexmaculatus* could also be influenced by the quality of foods or aphid species on which they feed (1, 2, 3, 8, 10, 11 and 21).

CONCLUSION

The overall findings on age specific survival, death and life expectancy of *Menochilus sexmaculatus* on different aphid species showed that it took shorted time to complete generation on mustard aphid *Lipaphis erysimi*. The survival and mortality is depend on the abiotic factors *i.e.*, temperature, relative humidity, rainfall, wind velocity etc. The parasitization among the beetles is also responsible for reduction of their population in the natural environment. However, all the aphid species was found to be suitable for development of *M. sexmaculatus* and therefore, it can be introduced for management of any aphid species used in the present investigation.

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REFERENCES

1. Ali A. and Rizvi P.Q. (2007): Age specific survival and fecundity table of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on different aphid species. Ann. Pl. Protec. Sci., 15(2): 329-334.
2. Ali A. and Rizvi P.Q. (2008): Influence of aphid species on the development and predation of *Menochilus sexmaculatus* Fabricius (Coleoptera: Coccinellidae). J. Eco-friend. Agri., 3(2): 134-137.
3. Ali A. and Rizvi P.Q. (2008): Age specific survival and fecundity table of *Coccinella transversalis* F. (Coleoptera: Coccinellidae) on different aphid species. J. Eco-friend. Agri., 3(1): 34-39.
4. Ali A. and Rizvi P.Q. (2009): Life table studies of *Menochilus sexmaculatus* Fabr. (Coleoptera: Coccinellidae) at varying temperature on *Lipaphis erysimi* Kalt. World Appl. Sci. J., 7(7): 897-901.
5. Ali A. and Rizvi P.Q. (2010): Influence of varying temperature on the development and predation of *Menochilus sexmaculatus* fabr. (Coleoptera: Coccinellidae) on *Lipaphis erysimi* kalt. The Ecotech, 2(1): 46-48.
6. Ali A. and Rizvi P.Q. (2011): Screening of different cultivars of rapeseed-mustard against mustard aphid, *Lipaphis erysimi*, Kaltenbach with respect to sowing dates. Asian J. Pl. Sci., 10(8): 383-392.
7. Ali A. and Rizvi P.Q. (2012): Influence of abiotic and biotic factors on the population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) on Indian mustard, *Brassica juncea* with respect to sowing dates. Acad. J. Pl. Sci., 5(4): 123-127.
8. Ali A. and Rizvi P.Q. (2007): Development and predatory performance of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on different aphid species. J. Biol. Sci., 7(8): 1478-1483.
9. Hodek I. and Honek A. (1996): *Ecology of Coccinellidae*. Boston: Kiuwer Academic, pp: 464.
10. Kalushkov P., Hodek I. (2004): The effects of thirteen species of aphids (Sternorrhyncha: Aphididae) on some life history parameters of the ladybird *Coccinella septempunctata* (Coleoptera: Coccinellidae). Biocont., 49: 21-32.
11. Patel R.A. (2015): Feeding potentiality of *Menochilus sexmaculatus* Fab. on different aphid species. Internat. J. Rec. Innov. Tren. Comp. Communi., 3(7): 4426-4430.
12. Tank B.D. and Korat D.M. (2007): Biology of ladybird beetle, *Cheilomenes sexmaculata* (Fab.) in middle Gujarat conditions. Karnataka J. Agric. Sci., 20(3): 634-636.
13. Saleem M., Hussain D., Anwar H., Saleem M., Ghouse G. and Abbas M. (2014): Predation Efficacy of *Menochilus sexmaculatus* Fabricus (Coleoptera: Coccinellidae) against *Macrosiphum rosae* under laboratory conditions. J. Entom. Zool. Stud., 2(3): 60-63.
14. Ahmad R.M.E. (2015): Predatory efficiency of *Cheilomenes sexmaculata* (fabricius) (coleoptera: coccinellidae) against *Aphis craccivora* Koch on various host plants of family fabaceae. European Scie. J., 11(18): 154-161.

15. Priyadarshani T.D.C., Hemachandra K.S., Sirisena U.G.A.I. and Wijayaguasekara H.N.P. (2016): Developmental Biology and Feeding Efficiency of *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) (Fabricius) reared on *Aphis craccivora* (Hemiptera:Aphididae) (Koch). Trop. Agri. Res., 27(2): 115-122.

16. Mari J.M., Nizamani S.M., Lohar M.K. and Khuhro R.D. (2004): Biology of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* L. (Coccinellidae: Coleoptera) on Alfalfa aphid *Therioaphis trifolii* Monell. J. Asia-Pacific Entomol. 7(3): 297-301.

17. Khan J., Haq E.U. and Rehman A. (2015): Effect of temperature on the biology of *Harmonia dimidiata* FAB. (Coleoptera: Coccinellidae) reared on *Scizaphus graminum* (Rond.) aphid. J. Bio. Env. Sci., 7(5): 42-49.

18. Geoghegan I.E., Majerus T.M.O. and Majerus M.E.N. (2000): Interactions between *Coccinella 7-punctata* Linn. (Coleoptera: Coccinellidae) and cocoons of the parasitoid *Dinocampus coccinellae* (Schrank) (Hymenoptera: Braconidae). British J. Entomol. Nat. His., 10: 15-24.

19. Annabelle F., Guy B., Éric L. and Daniel C. (2005): First report of *Harmonia axyridis* Pallas being attacked by *Dinocampus coccinellae* Schrank in Canada. Biol. Invas., 7: 553-556.

20. Ali A., Rizvi P.Q. and Khan F.R. (2013): Hyper-parasitism in coccinellid and syrphid species on mustard aphid in rapeseed-mustard crop ecosystem. World J. Appl. Sci. Res., 3(2): 15-18.

21. Omkar and Srivastava S. (2003): Influence of six aphid prey species on development and reproduction of a ladybird beetle, *Coccinella septempunctata*. BioControl, 48: 379-393.