



P-ISSN: 2349-8528
 E-ISSN: 2321-4902
 IJCS 2018; 6(3): 2455-2459
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 Received: 06-03-2018
 Accepted: 07-04-2018

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Biology of ladybird beetle, *propylea sp.* (Coccinellidae: Coleoptera) on Lucerne aphid, *Acyrtosiphon pisum* (Harris) (Aphididae: Hemiptera) under laboratory conditions

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Abstract

Biology of ladybird beetle, *Propylea sp.* on Lucerne aphid, *Acyrtosiphon pisum* (Harris) was investigated under laboratory conditions. Biology of *Propylea sp.* on *A. pisum* revealed that mean incubation period of eggs was 2.66 ± 0.48 days. The egg hatching percentage was 83.87 ± 5.32 per cent. The total larval duration was 10.48 ± 1.01 days; first, second, third and fourth instar durations were 1.64 ± 0.48 , 2.28 ± 0.45 , 3.06 ± 0.31 and 3.50 ± 0.51 days, respectively. The pre-pupal and pupal periods were 1.10 ± 0.30 and 4.90 ± 0.76 days, respectively. The adult emergence of *Propylea sp.* was 86.81 ± 3.10 per cent. Mean longevity of male and female beetles were 31.10 ± 2.70 and 35.46 ± 2.62 days, respectively. The average pre-oviposition, oviposition and post-oviposition period were 8.01 ± 0.89 , 21.04 ± 1.76 and 6.30 ± 1.34 days, respectively. The fecundity of the female was 355.84 ± 52.90 eggs/female. Total life cycle of *Propylea sp.* completed within 44.58 ± 3.59 days by male and 46.42 ± 4.64 days by female. The sex ratio of male: female was 1:1.40.

Keywords: Biology, morphometrics, ladybird beetle, *propylea sp.*, Lucerne aphid, *Acyrtosiphon Pisum*

Introduction

Lucerne (*Medicago sativa* L.), is a most important cosmopolitan forage crop, so it is called "Queen" of forage crops. It is originated in Asia. It was first observed to be cultivated in Iran before 700 BC. Lucerne belongs to family leguminaoae of genus *Medicago*. The genus includes 65 species, distributed in Europe, Asia and Africa. Among these, *M. sativa*, *M. lupulina* and *M. falcata* are useful species for fodders. *Medicago sativa* L. is known as prized green fodder. Lucerne suffers damage both qualitatively and quantitatively by aphid (*A. pisum*). The quantitative losses recorded in India are about 37.7 per cent due to Lucerne aphid, *A. pisum* in lucerne (Ingawale and Tambe, 2007) [2]. With regard to diversity and significance of biological control, coccinellids, commonly known as ladybird beetles belongs to the family coccinellidae of order coleopteran ranks first. The members of the family occupy all the habitats and niches of their prey and distributed worldwide. Coccinellid beetles due to high foraging performance, immense predatory potential and high reproductive efficacy; they possess the potential to be effectively employed in biological control programme for controlling several destructive insect such as aphids, whiteflies, mealy bugs, thrips, mites, psyllids and scale insects (Rakhshan and Ahmad, 2015) [10]. It has significant potential and use against 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 *Propylea sp.*, the present study was undertaken in the PG Research Laboratory, Navsari Agricultural University, Navasri during the year 2017 as there was a paucity of information on biology of the predator.

Method and materials

Initial culture of *Propylea sp.* was maintained in the laboratory by collecting a large number of adults of *Propylea sp.* from Forage Research Scheme, College farm, NAU, Navsari. Field collected adults of *Propylea sp.* were kept in plastic containers and reared on Lucerne aphid, *A. pisum*. The present investigation was carried out in room temperature at 23.40 to 35.35 °C (Av:

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30.15±3.22 °C) and relative humidity 23.50 to 61.00 per cent (Av: 41.81±7.41%). The eggs of lady bird beetle laid on the leaves, inner side of container as well as on muslin cloth were transferred individually with the help of moist fine camel hair brush and placed in separate plastic vials (6x4cm) individually for further rearing and to avoid cannibalism. Parameters like the incubation period as well as hatching percentage of the eggs were also recorded. On hatching neonate larvae were collected with a fine point camel hair brush, placed in plastic vials (6x4cm) individually and provided with sufficient number of aphids. Number of larval instars along with its duration was determined on the basis of exuviae casted-off by the larva. Observations were also recorded on the duration of pre-pupal period i.e. period when fourth instar grub stopped feeding to the period when it was completely transformed in to pupal stage. The duration between formations of pupa to the emergence of coccinellid beetle was considered as pupal period. Pupae were separated and kept in individual vials for adult emergence. Pupal period was calculated by date of pupation to date of adult emergence. Newly emerged adults of *Propylea sp.* were confined in plastic vials (6x4cm) in pairs and provided with *A. pisum* as food. Longevity of males and females were studied separately. Similarly, fecundity, pre-oviposition, oviposition, post-oviposition periods of females and sex-ratio (male: female) for laboratory culture were also recorded. For the purpose, fifty adults of *Propylea sp.* were kept individually in plastic container (7x5cm) and data were recorded. Eggs laid by each 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 laying 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. To study the sex ratio counted numbers of pupae were kept in different plastic container (7x5cm). Male and female adults emerged were differentiated based on sex and also with their morphological characters. Thus, sex ratio was determined. Morphometric measurement such as length and breadth of, egg, larva (all four instars), pre-pupa, pupa, male and female were made by using thirty individuals under dissecting stereo-trinocular microscope.

Results and Discussion

The results of biology of *Propylea sp.* reared on Lucerne aphid, *A. pisum* was presented in Table 2.

Eggs

The eggs were laid on both surface of leaf, singly or in mass either in small cluster of 8 to 12 eggs. Eggs were small, cigar shaped and pale yellow in colour with smooth chorion and without any reticulations and were laid in vertical position. The eggs turned completely black before hatching (Fig-1). A data presented in table-1 indicated that size of the eggs varied from 1.27 to 1.56 mm (Av.1.43±0.06 mm), whereas the breadth varied from 0.45 to 0.61 mm (Av. 0.53±0.04 mm). Priyadarshani (2016)^[9] also reported that mean length of eggs of *Menochilus sexmaculatus* (Fabricius) was 1.0±0.4 mm and width was 0.4±0.1 mm. The present findings are tally with the report of Priyadarshani (2016)^[9]

Incubation period

An incubation period of *Propylea sp.* varied from 2 to 3 days with an average of 2.66±0.48 days (Table-2). According to

Omkar and Pathak (2009)^[5], incubation period of *Propylea dissecta* (Mulsant) was 2.13±0.02 days.

Hatching percentage

The data presented in Table-2 indicated that hatching percentage of eggs of *Propylea sp.* varied from 75.75 to 93.22 per cent (Av. 83.87±5.32). Which is in agreement with the findings of Pervez and Omkar (2004)^[8] who reported that hatching percentage of *P. dissecta* with an average of 83.77±1.42 per cent. Mishra and Omkar (2012)^[4] reported that hatching percentage of *P. dissecta* was 84.98 ± 6.01 per cent. However, there was a variation when compared with the reports of Omkar and Pervez (2005)^[6] who recorded that hatching percentage of *P. dissecta* was 72.42±2.97. The slight variation in hatching percentage might be due to prevailing weather condition existing in a particular locality and methodology used for the investigation.

First instar larva

First instar larva was dark brown in colour with shining dark head capsule and legs. The legs were relatively long and articulated with body eggs (Fig-1).

The duration and measurements of various instars of *Propylea sp.* are presented in Table 1 and 2. The data given in Table-1 showed that the length of first instar larva ranged from 1.75 to 2.07 mm with an average of 1.91±0.07mm, while breadth varied from 0.67 to 0.88 mm with an average of 0.73±0.09mm. Priyadarshani *et al.* (2016)^[9] reported that an average length and breadth of first instar larva of *Menochilus sexmaculatus* Fab. Was 1.9±0.1 mm and breadth was 0.4±0.1mm. These reports support the present finding.

The duration of first instar larva varied from 1 to 2 days with a mean duration of 1.64±0.48 days (Table-2). Omkar and Pathak (2009)^[5] reported that average duration of first instar larva of *P. dissecta* was 2.82±0.02 days. So present findings are disagrees with reports of Omkar and Pathak (2009)^[5]. The disagreement in first instar larval period of *Propylea sp.* might be due to variation in food on which larvae reared, disparity in methodology adopted for the study and prevailing ecological conditions.

Second instar larva

Freshly emerged second instar larva gradually changed from dark brown to yellowish brown in colour. The white coloured patches were developed on meso and metathorax and also on first and forth abdominal segments. Larva was ventrally flat and somewhat convex dorsally (Fig-1). The data presented in Table-1 indicated that length of second instar larva varied from 3.30 to 3.60 mm (Av. 3.44±0.19mm) while breadth varied from 0.97 to 1.23 mm (Av. 1.12±0.07mm). Present results are in line with the observations of Chakraborty and Korat (2014)^[1] who reported that average length of second instar larva of *Coccinella transversalis* Fab. Was 3.41 to 3.57 mm and breadth was 0.90 to 1.40 mm.

The duration of second instar larva varied from 2 to 3 days with an average of 2.28±0.45 days (Table-2). According to Omkar and Pathak (2009)^[5], average duration of second instar larva of *P. dissecta* was 2.48±0.31 days. Thus, the present findings are more or less confirmation with the reports of Omkar and Pathak (2009)^[5].

Third instar larvae

Third instar larva was deep black in colour. The colour pattern was more intensified with additional development of

white spots on mid dorsal line of meso-metathorax and on abdominal segment (Fig-1).

Data depicted in Table-1 revealed that the length of third instar larva varied from 4.40 to 4.62 mm with an average of 4.50 ± 0.07 mm, while breadth varied from 1.96 to 2.14 mm with an average of 2.05 ± 0.05 mm. These results are in corroboration with findings of Shanmugapriya *et al.* (2017)^[12] who reported that the length and breadth of third instar larva of *Cheilomenes sexmaculata* Fab. Varied from 5.16 to 7.13 mm (Av. 6.03 ± 0.72 mm) and 1.72 to 1.86 mm (Av. 1.78 ± 0.04 mm), respectively.

Mean duration of third instar larva varied from 2 to 4 days with an average of 3.06 ± 0.31 days (Table-2). Earlier, Omkar and Pathak (2009)^[5] reported that fourth instar larval period of *P. dissecta* was 2.23 ± 0.52 days. The finding of above workers supports the present investigation.

Fourth instar larvae

The fourth instar larva was larger in size than third instar. Colour changed from deep black to dull black before pre pupation. White spots present on thorax and abdomen segments were turned in to light yellowish colour (Fig-1).

Measurements on length and breadth of fourth instar larva of *Propylea sp.* were recorded and presented in Table-1. It can be seen from the data that the length of fourth instar larva varied from 6.10 to 7.05 mm with an average of 6.70 ± 0.27 mm, while the breadth varied from 2.90 to 3.20 mm with an average of 3.09 ± 0.08 mm. Yadav *et al.* (2016)^[12] who reported that length and breadth of *C. septempunctata* were 7.38 ± 0.52 mm and 1.99 ± 0.23 mm, respectively. The slight variation in measurement might be due to different test insect and prey insects used in their studies as well as weather conditions existing in a particular locality.

Fourth instar larval period varied from 3 to 4 days with an average of 3.50 ± 0.51 days (Table-2). Present findings disagree with reports of Omkar and Pathak (2009)^[5] who reported that the fourth instar larval period of *P. dissecta* was 2.38 ± 0.47 days.

The results presented in Table-2 revealed that the total larval developmental period of *Propylea sp.* varied from 9 to 12 days with mean duration of 10.48 ± 1.01 days when reared on *A. pisum*. However, present findings is more or less in close agreement with the Omkar and Pathak (2009)^[5] who reported it as 9.93 ± 1.23 days for *P. dissecta*.

Pre-pupal stage

The full grown larva stopped feeding, became sluggish and swollen and searching for a suitable place. The larva sticks its posterior abdominal segment with walls of plastic vials or on leaf surface and it underwent in to pupal stage within a short time. The colour of prepupa was similar to the last larval instar (Fig-1).

The data presented in Table-1 indicated that pre-pupal length of *Propylea sp.* varied from 4.11 to 4.36 mm (Av. 4.23 ± 0.07 mm), while breadth ranged from 3.20 to 3.70 mm (Av. 3.46 ± 0.11 mm).

Data presented in Table-2 revealed that pre-pupal stage, lasted for about 1 to 2 days with an average of 1.10 ± 0.30 days. A pre-pupal period was 0.86 ± 0.18 days as reported by Omkar and Pathak (2009)^[5]. The finding of above workers supports the present investigation.

Pupa

Freshly formed pupa appeared shining yellowish in colour which later on became brownish yellow in colour. There were

dark black spots seen in pair on abdominal segments as well as on thorax (Fig-1).

The data presented in the Table-1 indicated that pupa was measured about 4.20 to 4.69 mm in length (Av. 4.37 ± 0.1 mm) and 3.26 to 3.84 mm in breadth (Av. 3.47 ± 0.13 mm).

Data pertaining to pupal period presented in Table-2 revealed that the duration of pupal stage ranged from 3 to 6 days with an average of 4.90 ± 0.76 days. According to Pervez and Omkar (2004)^[8], pupal period of *P. dissecta* was 3.05 ± 0.05 days. Omkar and Pathak (2009)^[5] reported that pupal period of *P. dissecta* was 3.28 ± 0.57 days. However, present findings is more or less in agreement with the Pervez and Omkar (2004)^[8] and Omkar and Pathak (2009)^[5]

Adult

The newly emerged adults were soft, yellowish in colour and the adults remain cluded for few hours in the pupal cases during which their body hardened and turned pale orange in appearance. The male beetle was small, oval, convex dorsally and flat ventrally. Pronotum was black except along the front edge which was white in colour. Black spots on each elytra, many of them were connected. Males were smaller in size than female (Fig-1).

The measurements of adult length and breadth of *Propylea sp.* were recorded and presented in Table-1. The data revealed that the length of female varied from 4.65 to 4.90 mm (Av. 4.77 ± 0.09 mm) and breadth varied from 3.70 to 4.01 mm (Av. 3.79 ± 0.08 mm). The length of male varied from 4.20 to 4.69 mm (Av. 4.42 ± 0.12) and breadth varied from 3.26 to 3.58 mm (Av. 3.43 ± 0.08).

Observations made on adult emergence are presented in Table-2 which indicated that the per cent adult emergence varied from 80.00 to 91.67 with an average of 86.81 ± 3.10 . Omkar and Pathak (2009)^[5] who reported that per cent adult emergence of *P. dissecta* were 76.00 ± 16.73 .

The data given in Table-2 indicated that the male longevity was 26 to 38 days with an average of 31.10 ± 2.70 days, while that of female varied from 30 to 41 days with a average of 35.46 ± 2.62 days. Earlier, Pervez and Omkar (2004)^[8] noted that adult longevity of male and female of *P. dissecta* were 40.70 ± 1.44 and 45.80 ± 1.17 days, respectively. The finding of above workers supports the present investigation.

Pre-oviposition, Oviposition and Post oviposition period

Pre-oviposition period presented in Table-2 revealed that the pre-oviposition period varied from 7 to 10 days with an average of 8.01 ± 0.89 days. The present investigation is more or less in agreement with findings of Pervez and Omkar (2004)^[8] who noted that pre oviposition period of *P. dissecta* was 9.90 ± 0.66 . Oviposition period varied from 18 to 25 days with an average of 21.04 ± 1.761 days. Pervez and Omkar (2004)^[8] reported that oviposition period of *P. dissecta* were 24.40 ± 1.07 . Post oviposition period lasted for 4 to 9 days with a mean duration of 6.30 ± 1.34 days. More or less similar observations were reported by Omkar and Pervez (2005)^[6] who suggested that post oviposition period of *P. dissecta* was 11.50 ± 0.69 days. The finding of above workers supports the present investigations.

Fecundity

The egg laying capacity of mated female ranged from 257 to 470 eggs with an average of 355.84 ± 52.90 eggs (Table-2). Present study is in more or less agreement with Pervez and Omkar (2004)^[8] who observed the total fecundity was 278.50 ± 22.77 eggs/female for *P. dissecta*. The present

findings differed with reports of Mishra and Omkar (2012) [4] who noted that fecundity of *P. dissecta* was 785.55 ± 47.59 eggs. The finding of above workers supports the present investigation.

Total life cycle

The data depicted in the table-2 indicated that the male lasted for 40-52 days with an average life span of 44.58 ± 3.59 days, where as female survived longer with an average life span of 46.42 ± 4.64 days. Patel (2015) [7] revealed that mean entire life span of *M. sexmaculatus* was 31.8 ± 3.2 and 31.4 ± 2.8 days for male; and 39.6 ± 2.9 and 39.8 ± 2.8 days for female when adults reared on *Lipaphis erysimi* (Kaltenbach) and *Therioaphis maculate* (Buckton), respectively. Manpoong *et al.* (2016) [3] recorded that average total life span of male and female of *C. septempunctata* was 47.00 ± 2.00 and 41.00 ± 2.00 days, respectively. The variation in entire lifespan might be due to different predatory insect and host insects used in their study

as well as prevailing ecological conditions existing in a particular locality.

Sex ratio

The sex ratio was worked out from laboratory reared mass culture during the study period. The results obtained were summarized in Table-2 indicated that out of 410 adults emerged from laboratory mass culture, 239 were females and 171 were males, which implies that the preponderance of female adult. The sex ratio of male: female was varied from 1:1.14 to 1:1.80 with an average of 1:1.40. In past, similar results were also narrated by Sattar *et al.* (2008) [11] who reported sex ratio (male: female) was 1:1.50 for *C. septempunctata* and Chakraborty and Korat (2014) [1] who recorded it as 1:1.32 for *C. transversalis*. Yadav *et al.* (2016) [12] found that sex ratio (male: female) of *C. septempunctata* was 1:1.39. The finding of above workers supports the present investigation

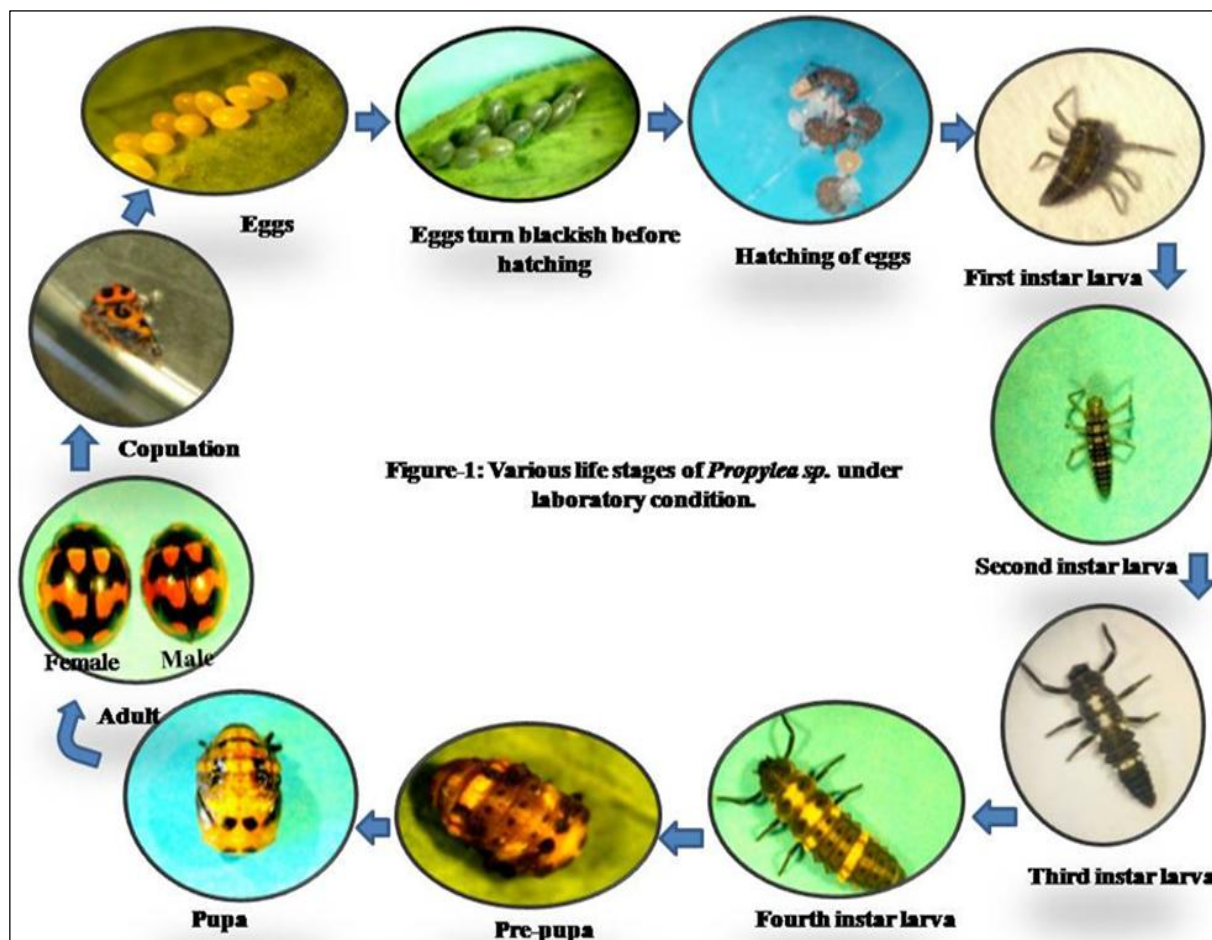


Table 1: Morphometrics of different life stages of *Propylea sp.*

Stage	Length (mm)			Breadth (mm)		
	Min	Max	Av. ± S.D.	Min	Max	Av. ± S.D.
Eggs	1.27	1.56	1.43±0.06	0.45	0.61	0.53±0.04
Larva						
I instar	1.75	2.07	1.91±0.07	0.67	0.88	0.73±0.09
II instar	3.30	3.60	3.44±0.19	0.97	1.23	1.12±0.07
III instar	4.40	4.62	4.50±0.07	1.96	2.14	2.05±0.05
IV instar	6.10	7.05	6.70±0.27	2.90	3.20	3.09±0.08
Pre-pupa and pupa						
Pre pupa	4.11	4.36	4.23±0.07	3.20	3.70	3.46±0.11
Pupa	4.20	4.69	4.37±0.11	3.26	3.84	3.47±0.13
Adult						
Male	4.20	4.69	4.42±0.12	3.26	3.58	3.43±0.08
Female	4.65	4.90	4.77±0.09	3.70	4.01	3.79±0.08

Table 2: Biology of Ladybird beetle, *Propylea sp.* on Lucerne aphid, *A. pisum* under laboratory condition

Sr. No.	Particulars	No. observed	Period (Days)		
			Min.	Max.	Av. \pm S.D.
1	Incubation period (Days)	50	2	3	2.66 \pm 0.48
2	Hatching percentage	895	75.75	93.22	83.87 \pm 5.32
3	Larval period (Days)				
	I instar	50	1	2	1.64 \pm 0.48
	II instar	50	2	3	2.28 \pm 0.45
	III instar	50	2	4	3.06 \pm 0.31
	IV instar	50	3	4	3.50 \pm 0.51
	Total larval period (Days)	200	9	12	10.48 \pm 1.01
4	Pre-pupal (Days)	50	1	2	1.10 \pm 0.30
5	Pupal period (Days)	50	3	6	4.90 \pm 0.76
6	Pre-oviposition perio (Days)	50	7	10	8.01 \pm 0.89
7	Oviposition period (Days)	50	18	25	21.04 \pm 1.76
8	Post-oviposition period (Days)	50	4	9	6.30 \pm 1.34
9	Adult emergence (%)	465	80.00	91.67	86.81 \pm 3.10
10	Sex ratio (Male: Female)	410	1:1.14	1:1.80	1:1.40
11	Adult longevity (Days)				
	Male	50	26	38	31.10 \pm 2.70
	Female	50	30	41	35.46 \pm 2.62
12	Total life cycle (Days)				
	Male	50	40	52	44.58 \pm 3.59
	Female	50	44	56	46.42 \pm 4.64
13	Fecundity (Nos.)	50	257	470	355.84 \pm 52.90

Acknowledgement

The authors are thankful to Professor and Head, Department of Entomology, and Principal, N.M. College of Agriculture, Navsari, and Director of Research and Dean Post Graduate Studies, Navsari Agricultural University, Navsari for providing necessary facilities and also thankful to Prof (Dr.) Samiran Chakrabarti, Principal Investigator, MOEF & CC-Aicoptax Project on Eriophyoid Mites and ICAR-NPIB project on 'Insect Biosystematics', Gov. of India, Kolkata Centre, Vidyasagar College, Kolkata (West Bengal) for identifying aphid species.

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