



Full Length Research Article

Studies on Biology and Morphometrics of Citrus Butterfly *Papilio demoleus* (Linnaeus) (Lepidoptera: Papilionidae) on Sathgudi Sweet Orange *Citrus sinensis* Swingle

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Accepted 17th February, 2015; Published Online 31st March, 2015

ABSTRACT

The biology of citrus butterfly was studied under laboratory conditions on sweet orange. Adult female laid eggs singly or in groups of two to five on the under surface of tender leaves and also on tender twigs. Oviposition usually took place during the night. The average number of eggs laid by a gravid female moth was 112 eggs. Based on the observations made in this study it is concluded that the average incubation period lasted for 2.90 days with a range of 2.75 to 3.00 days. The average first, second, third, fourth and fifth instar larvae lasted for 1.82, 0.86, 1.52, 1.99 and 2.42 days, respectively. The average total life cycle of citrus butterfly on sweet orange lasted for 20.64 days with a range of 20.00 to 21.00 days.

Key words:

INTRODUCTION

Citrus is one of the important commercial fruit crops of the world which is cultivated in the tropical and subtropical regions. Citrus industry is the third largest fruit industry in the world occupying six per cent of the total area under various fruits. Sweet orange grown in an area of 204.1 lakh hectares with an annual production of 30.61 lakh tonnes of fruits and productivity of 15 MT/Ha in Andhra Pradesh (Indian Horticulture Database - 2013). Pest problem is one of the major constraints in the production of sweet oranges.

Citrus in India are attacked by more than 250 insect pests alone at all stages of growth right from budlings and seedlings in nurseries (Bhutani 1979). Out of these, 165 species are important in India causing an estimated loss of 30 per cent in yields (Pruthi and Mani, 1945). Among the various insect pests that attack citrus, the citrus butterfly, *Papilio demoleus* Linnaeus is a regular pest in nurseries, young seedlings, and on new flush of full grown up trees. The caterpillars feed voraciously and cause extensive damage to nurseries and young seedlings leaving behind midribs only. Severe infestation results in defoliation of the tree (Bhutani and Jotwani, 1975) and leads to retard plant growth and decreases fruit yield (Pruthi, 1969). Information on the morphometric and biology of citrus butterfly on Sweet orange will be useful to evolve effective management strategy, against citrus leaf miner.

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MATERIALS AND METHODS

The biology of citrus butterfly, *Papilio demoleus* L. on sweet orange Cultivar was studied during November and December of 2013 in the insectary by collecting fifth instar larvae regularly from the sweet orange nurseries of A.I.C.R.P. on Tropical Fruits (Citrus), Tirupati (A.P.). The larvae were reared in glass jars by providing fresh sweet orange leaves daily. The male and female adults obtained were released in cages for egg laying. The adult moths were provided with 10 per cent honey solution in cotton swabs that were left suspended in the cages throughout the period of egg laying in which tender sweet orange twigs were placed in conical flasks containing water.

The twigs were changed after every 24 hours. After egg laying, the eggs were transferred to petridishes containing fresh tender leaves in petridishes at room temperature. A moistened filter paper was kept in each petriplate to prevent the drying of leaves. The caterpillars were maintained in petridishes upto third instar. Later on they were transferred and reared in separate glass troughs and allowed to complete first generation. Observations were recorded daily on the development of colour, size and the duration of different instars of larvae. The body length, width and width of head capsule of first instar (ten larvae) and eggs were measured by using ocular micrometer while second instar to fifth instar, pre-pupal and pupal morphometric data were recorded by using a standard graphic paper method and analyzed statistically (Sukhatme and Amble, 1985). Fecundity studies were made by releasing 5 pairs of freshly emerged adults kept separately in cages containing fresh twigs placed in Hoagland solution.

Observations regarding pre-mating, mating, pre-oviposition, oviposition and post-oviposition periods for females and adult longevity, body length, width, wing expanse and sex-ratio for both males and females were also recorded.

RESULTS AND DISCUSSION

The results of duration of different stages and morphometric data of *Papilio demoleus* L. on sweet orange were presented in Table 1 and 2.

Table 1. Duration of different stages of *Papilio demoleus* L. on Sweet Orange

S.No.	Particulars/State	Duration (in days)				
		Minimum	Maximum	Mean	SD	SEm
1	Pre-maturing period (Hours)	10.00	13.00	11.75	0.890	0.281
2	Mating period (Hours)	1.65	2.05	1.90	0.139	0.044
3	Pre-oviposition period (Days)	1.22	1.36	1.31	0.043	0.013
4	Oviposition period (Days)	4.12	4.58	4.33	0.213	0.067
5	Post-Oviposition period (Hours)	2.20	2.59	2.43	0.131	0.041
6	Incubation period (Days)	2.75	3.00	2.90	0.106	0.033
	Larval periods (Days)					
	a. First instar	1.75	1.90	1.82	0.059	0.019
	b. Second instar	0.90	1.00	0.86	0.038	0.012
	c. Third instar	1.48	1.59	1.52	0.039	0.012
	d. Fourth instar	1.98	2.06	1.99	0.042	0.013
	e. Fifth instar	2.39	2.48	2.42	0.035	0.011
8	Total larval period	8.50	9.03	8.80	0.191	0.061
9	Pre-pupae	0.95	1.00	0.98	0.316	0.100
10	Pupae	7.80	8.11	7.99	0.106	0.033
11	Longevity of adults (Days)					
	a. Male	3.50	4.00	3.73	0.197	0.062
	b. Female	6.50	7.00	6.80	0.196	0.062
12	Total life cycle (egg to adult)	20.00	21.00	20.64	0.400	0.126

Egg: Adult female laid eggs singly or in groups of two to five on the under surface of tender leaves and also on tender twigs by curling its abdomen. The freshly laid eggs measured 0.90 mm to 1.07 mm with an average of 0.99 mm and smooth, spherical creamy yellow in colour and they turned to grayish with brown streaks all over the chorion before hatching. This description was in agreement with the reports of Atwal (1964), Ganguli and Ghosh (1967) and Maheswarababu (1988). The average diameter of the egg was found to be 0.99 mm. Atwal (1964), Ganguli and Ghosh (1967), Resham *et al* (1986) and Maheswarababu (1988) also observed more or less similar trends in size of the egg. Incubation period ranged from 2.75 to 3.00 days which was slight variation with the findings of Maheswarababu (1988). He reported the average incubation period lasted 2.96 days. Sharifi and Zarea (1970), Badawi (1981), Resham *et al.* (1986) Singh and Gangwar (1989) and Radke and Kandalkar (1989) reported that the incubation periods varying from 3.24, 3.10 - 6.10 days, 3-7 days, 4-7 days and 5 days, respectively. The difference in the incubation period was due to variations in the weather factors of different regions.

Larval development: There were only five larval instars which totally lasted for 8.50 to 9.03 days. The average duration of first to fifth instars were 1.82, 0.86, 1.52, 1.99 and 2.42 days respectively.

First instar larva: Newly hatched caterpillars were less spiny, cylindrical in shape, light brown to brownish black in colour with thorax thicker than rest of the body having dirty white mark on dorsal side showing resemblance to birds excreta. The newly hatched caterpillar on an average measured 2.31 mm and 0.43 mm length and width.

The first instar larva recorded an average length and width of 5.23 mm and 1.62 mm respectively. The average duration of first instar larva was 1.82 days with range of 1.75 to 1.90 days. These findings were in agreement with the reports of Atwal (1964), Resham *et al.* (1986), Ganguli and Ghosh (1967) and Maheswarababu (1988).

Second instar larva: The second instar larvae were less spiny and dark brown in colour with a dirty white line present obliquely along lateral sides of the abdomen and with a break

on the dorsal side. A horn-like structure was present on the dorsal side of the last body segment. The average size of the second instar larvae in length and width was found to be 9.10 mm and 2.82 mm, respectively. The average second instar larval period was found to be 0.86 days with a range of 0.90 to 1.00 days. These results were differing with the observations made by Ganguli and Ghosh (1967) recording 7.00 mm and 2.00 mm in length and width. This deviation might be due to differences in climatic factors and also due to seasonal variations from year to year.

Third instar larva: Third instar larvae were resembled the second instar larvae except in size. Third instar larvae was recorded an average length and width of 13.38 mm and 3.72 mm, respectively. The average third instar larval period was 1.52 days with range of 1.48 to 1.59 days. Similar observations were made by Maheswarababu (1988).

Fourth instar larva: The fourth instar larvae were black in colour with a little greenish tinge and whitish bands could be seen on meso and meta thoracic segments laterally, anterior part of abdomen and on last anal segments. Two red coloured sacs or osmeteria opening in the first thoracic segment dorsally at the anterior portion. The average fourth instar larval period was found to be 25.03 mm in length and 5.66 mm in width. The average fourth instar larval period was found to be 1.99 days with a range of 1.98 to 2.06 days.

Fifth instar larva : Fifth instar larva were yellowish green or green in colour. Brownish stripes present on eighth and ninth sternites with two semi circular yellowish bands on elevated portion of the body. Two eye-like spots were present on second thoracic segment and a horn like structure was found

Table 2. Morphometric data of *Papilio demoleus* L. on sweet orange

S.No.	Particulars/State	Measurements in "mm"				
		Minimum	Maximum	Mean	SD	SEm
1	Egg (Diameter)	0.90	1.07	0.99	0.071	0.022
2	Newly hatched caterpillar					
	a. Length	2.05	2.56	2.31	0.222	0.070
	b. Width	0.30	0.50	0.43	0.076	0.024
3	First instar larva					
	a. Length	4.50	5.70	5.23	0.529	0.167
	b. Width	1.50	1.70	1.62	0.073	0.023
	c. Width of head capsule	0.51	0.81	0.70	0.130	0.041
4	Second instar larva					
	a. Length	8.80	9.30	9.10	0.225	0.071
	b. Width	2.50	3.00	2.82	0.196	0.062
	c. Width of head capsule	0.70	1.00	0.85	0.124	0.039
5	Third instar larva					
	a. Length	12.00	14.50	13.38	1.005	0.318
	b. Width	3.40	4.00	3.72	0.273	0.086
	c. Width of head capsule	1.40	1.60	1.52	0.080	0.025
6	Fourth instar larva					
	a. Length	22.00	28.00	25.03	2.426	0.767
	b. Width	5.40	6.00	5.66	0.263	0.083
	c. Width of head capsule	2.30	2.70	2.50	0.170	0.054
7	Fifth instar larva					
	a. Length	38.00	45.00	41.23	3.031	0.958
	b. Width	6.40	7.10	6.83	0.281	0.089
	c. Width of head capsule	3.30	3.80	3.59	0.210	0.066
8	Pre-pupae					
	a. Length	26.00	28.00	26.72	1.044	0.330
	b. Width	7.50	8.00	7.74	0.217	0.068
9	Pupae					
	a. Length	28.00	31.50	30.00	1.291	0.408
	b. Width	8.70	9.30	9.15	0.198	0.063
10	Adult moth					
	1.Male					
	a. Length (head to tip of abdomen)	25.00	29.00	26.95	1.657	0.524
	b.Width	5.90	6.20	6.02	0.111	0.035
	c. Wing expanse	87.00	92.30	90.57	2.057	0.650
	2.Female					
	a. Length	26.00	30.00	28.40	1.506	0.476
	b.Width	6.00	6.50	6.30	0.215	0.068
	c. Wing expanse	87.50	94.00	90.78	2.646	0.837

on the dorsal side of the last body segment. The average length and width of the fifth instar larva was found to be 41.23 mm and 6.83 mm respectively. The average duration of fifth instar larva was 2.42 days. Atwal (1964) and Maheswarababu (1988), Asokan (1997) also observed more or less similar observations. Fourth and fifth instar larvae had an osmeterial gland in the first thoracic segment and this organ was defensive in function. These description was in agreement with the Leslie and Berenbaum (1990) and Burger *et al.* (1978) reported that secretions produced by osmeterium contained iso-butyric acid, 2-methyl butyric acid and small quantities of methyl and ethyl esters. The average width of head capsule of *Papilio demoleus* L. during the first, second, third, fourth and fifth instars were 0.70, 0.85, 1.52, 2.50 and 3.59 mm, respectively. Madansuuri *et al.* (1979) and Asokan (1997) observed more or less similar trends in width of head capsule.

Habits of the larva: Larval stage of the pest causes damage by feeding voraciously on tender leaves and terminal shoots. As a habit, they feed from the margin reaching the midrib. Grown up larvae even fed on mature leaves and completely defoliated the nurseries. The damage is more predominant in the nursery than in orchard trees. The habit of the larva and nature of damage was inconformity with observations of Atwal (1964), Butani (1973).

Pre-pupa: Before changing to pre-pupa the caterpillar shrunk in side and it hangs from the twig with the help of a silken girdle. These were in agreement with Atwal (1964) and Ayyar (1963). The pre-pupal period was observed to be 0.95 to 1.00 days with an average of 0.98 days. The average pre-pupal length and width was found to be 26.72 mm and 7.74 mm, respectively. These observations were in conformity with Radke and Kandalkar (1988), Maheswarababu (1988) and Asokan (1977).

Pupa: Pupae were naked and varied in colour from green, straw to brown majority being green in colour with several black markings on the body. The pupa was initially green in colour and at the time of adult emergence it turned to light brown to brown colour. The wings and abdomen of the adult inside the pupal case were clearly seen at the end of the pupal stage. These observations were in conformity with Atwal (1964), Bhutani (1973) and Resham *et al.* (1986). The average length and width of the pupal period was found to be 30.00 mm and 9.15 mm, respectively. These were in conformity with the observations of Atwal (1964) and Resham *et al.* (1986). The duration of the pupal period was observed to be 7.80 days and 8.11 days with an average of 7.99 days. Ganguli and Ghosh (1967), Sharifi and Zarea (1970) and Radke and Kandalkar (1988) observed similar trends in the duration of pupal period. Total life cycle from egg to adult

was observed to be 20.00 days and 21.00 days with an average of 20.64 days.

Adult: Adult butterflies were large and beautiful with wide wing spread. Head, thorax and legs were black with creamy yellow streaks on either side, whole abdomen. The body was covered with black and yellow hairs. Fore wings were triangular in shape while hind wings were rounded. The wings were black with yellow markings. There were two rows of parallel yellow spots along outer margins of wings and a brick red oval patch on posterior angle of the hind wing. Antennae were black and club shaped. These descriptions were in agreement with the findings of Atwal (1964), Resham *et al.* (1986) and Maheswarababu (1988). The average length, width and wing expanse of male butterfly were found to be 26.95 mm, 6.02 mm and 90.57 mm while female butterfly was found to be 28.40 mm, 6.30 mm and 90.78 mm, respectively. These were in conformity with the findings of Atwal (1964), Resham *et al.* (1986) and Maheswarababu (1988). The male to female sex-ratio was found to be 1:2.25 on sweet orange.

Adult longevity: The female adults were lived longer than the male ones. The longevity of female and male was 6.50 to 7.00 and 3.50 to 4.00 days with an average of 6.80 and 3.73 days when provided with dilute honey as a food. The variation in adult longevity was in agreement with the findings of Atwal (1964). Singh and Gangwar (1989) reported the longevity female and male was 5.80 and 5.10 days.

Mating: Mating usually occurred in during early hours of the day on tender twigs. In the act of courting, male took the initiative and searched for female. At the time of mating, the pairs touched their bodies from end to end. The average pre-mating and mating period were found to be 11.75 hours and 1.90 hours. Atwal (1964) and Radke and Kandalkar (1988) also reported similar observations.

Pre-oviposition and oviposition period: The females were found to lay eggs within one to two days after mating and continued for one to five days. Preoviposition period ranged from 1.22 to 1.36 days with an average of 1.31 days. The oviposition usually took place during the night. The average number of eggs laid by a gravid female moth was 112 eggs. The average oviposition period lasted for 4.33 days with a range of 4.12 to 4.58 days. Atwal (1964) and Maheswarababu (1988) reported similar observations. The post oviposition was found to be 2.20-2.59 hours with an average of 2.43 hours. This was in agreement with the observations of Maheswarababu (1988), Radke and Kandalkar (1988).

SUMMARY

The biology of citrus butterfly was studied under laboratory conditions on sweet orange. Adult female laid eggs singly or in groups of two to five on the under surface of tender leaves and also on tender twigs. Oviposition usually took place during the night. The average number of eggs laid by a gravid female moth was 112 eggs. Based on the observations made in this study it is concluded that the average incubation period lasted for 2.90 days with a range of 2.75 to 3.00 days. The average first, second, third, fourth and fifth instar larvae lasted for 1.82, 0.86, 1.52, 1.99 and 2.42 days, respectively. The average total life cycle of citrus butterfly on sweet orange lasted for 20.64 days with a range of 20.00 to 21.00 days.

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