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BIOLOGY OF CITRUS BUTTERFLY (*Papilio demoleus* L.) IN ACID LIME

Hemangi Chaudhari^{1*}, Sushma Deb², Anjali Patel³ and Koosi Sai Thilak¹

¹Department of Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari- 396 450, Gujarat, India

²Department of Entomology, College of Agriculture, Anand Agricultural University, Vaso- 387 380, Gujarat, India

³Cotton Research Station, Sardarkrushinagar Dantiwada Agriculture University, Talod- 383 215, Gujarat, India

*Corresponding author E-mail: hemangichaudhari071@gmail.com

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ABSTRACT

The experiment was conducted at Laboratory of Department of Agricultural Entomology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar on acid lime during 2022-23. The female butterfly laid eggs singly on the tender leaves and tender twigs on both upper and lower surfaces. Freshly laid eggs were pale yellow colour which turned into dark brown colour before hatching. The mean diameter of egg was 1.11 ± 0.01 mm with the mean incubation period of 2.00 ± 3.00 days. The larvae moulted four times and thus had five larval instars. The average duration of first, second, third, fourth and fifth instar was 1.73 ± 0.44 , 1.57 ± 0.50 , 2.40 ± 0.49 , 2.53 ± 0.50 and 4.17 ± 0.37 days, respectively while the total larval period was 12.40 ± 0.88 days. Pupation occurs on the stem of host plant and the total pupal period was 7.03 ± 0.71 days and the average length of pupae was 32.65 ± 0.12 mm. Longevity of male and female adult was 4.50 ± 0.50 and 6.50 ± 0.50 days, respectively while the total life span of male and female was 27.70 ± 1.35 and 29.67 ± 1.51 days, respectively. The total fecundity of citrus butterfly was 23.90 ± 2.04 eggs per female. The pre-oviposition, oviposition and post-oviposition periods of citrus butterfly varied was 1.30 ± 0.46 , 1.43 ± 0.50 and 2.41 ± 0.49 days, respectively.

Keywords : Citrus butterfly, Acid lime, *Papilio demoleus* L.

Introduction

Citrus, a member of the Rutaceae family, is indigenous to tropical and subtropical regions of Asia, including China and India, with northeast India serving as a major hub for diversification. After China and Nigeria, India is the world's third-largest producer of citrus, growing grapefruit, sweet orange, lime and mandarins (Saljoqi *et al.*, 2006). The Citrus family is truly special because it has more different shapes, sizes and types than almost any other fruit in the world. These plants are very "tough" and can grow in many different climates from hot tropical areas to cooler regions (Shimizu and Nonaka, 2025).

Kagzi lime is a premier horticultural crop in India, with Gujarat serving as a central hub contributing 15.2% of national production. The state manages an extensive cultivation area of 52,410 hectares, yielding 531,360 metric tonnes annually (Anon., 2025b). North

Gujarat-specifically the districts of Mehsana, Gandhinagar, Banaskantha, Sabarkantha, Patan and Aravalli-remains a critical production zone. These six districts collectively encompass 21,150 hectares and produce 234,840 metric tonnes, accounting for a substantial portion of the state's total citrus output (Anon., 2025).

Citrus crops face devastating yield losses of 83% to 95% due to a wide array of specialized pests. Major threats include defoliators like the citrus butterfly and leaf miner, alongside sap-sucking insects such as blackflies, psylla, aphids, thrips and whiteflies. The crop is further compromised by structural pests like the trunk borer and ash weevil, as well as infestations from red scales, mealybugs and mites, all of which collectively cause severe agricultural damage (Afzal *et al.*, 2023). States like Maharashtra, Andhra Pradesh, Punjab and Haryana are important production hubs in

India. There were two subspecies of *P. demoleus*, and *P. malayanus*, which are found throughout the Asia-Pacific region (Guerrero *et al.*, 2004).

Numerous insect pests attack citrus plants in both nurseries and established orchards, causing significant economic losses. Some of the most devastating pests of citrus include *Papilio demoleus* L. and *Papilio polytes* L., *Diaphorina citri* K., *Phyllocnistis citrella* Stainton, *Aonidiella aurantii* Maskell, and *Dialeurodes citri* Ash. Among these, *Papilio demoleus* L. (Papilionidae: Lepidoptera) commonly known as orange dog, chequered swallowtail, lemon butterfly, is found throughout tropical and subtropical areas of Southern and Southeast Asia (Guerrero *et al.*, 2004). Citrus butterflies were found throughout the year, though rare during winter and is a serious citrus pest in India (Pathak and Rizvi, 2002). Infestations of the citrus butterfly, *Papilio demoleus* L., are most severe in nursery settings and young plantations, where larval feeding can lead to total defoliation of seedlings and young trees (Yadav and Pal, 2025).

Materials and Methods

The biology of citrus butterfly, *P. demoleus* on acid lime was carried out in the laboratory of Department of Entomology, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar during the year 2022-23 at an average temperature of 27 to 32 °C and relative humidity of 58 to 80 per cent. The results obtained on duration and measurements of various life stages of *P. demoleus* are presented in Tables 1 and 2, respectively.

Method of recording observations

A pair of freshly emerged adults was released on potted plant covered with wire mesh for mating and oviposition. The pure culture of the insect was maintained on the acid lime plant grown in nursery. Cotton soaked in ten per cent honey solution was kept in the rearing cage which serve as food for the adults and further to know the longevity of male and female moths. The freshly laid eggs were allowed for hatching on the leaves of acid lime and only one larva per potted plant were allowed to study the biology of the insect and replicated five times.

Results and Discussion

Egg

The female butterfly laid eggs on the tender leaves and tender twigs on both upper and lower surfaces. Female butterfly laid eggs singly rather than in cluster. Freshly laid eggs were pale yellow colour, smooth and round in shape with a flattened base. The eggs turned into dark brown colour before hatching. The egg shell

after hatching remains attached to the leaves and appeared white in colour.

The average incubation period was 2.50 ± 0.31 days which ranged from 2 to 3 days (Table 1). The egg diameter ranged from 1.10 to 1.13 mm with an average of 1.11 ± 0.01 mm (Table 2). Jahnavi *et al.* (2018) studied on biology of citrus butterfly on acid lime and found that the incubation period was 2.87 days. In another study, Ramakrishna (2015) observed that the average incubation period of citrus butterfly was ranged from 2.75 to 3.00 days on sweet orange. These references corroborated with the findings of present study.

Larva

During the larval period, the caterpillar moulted four times and thus had five larval instars.

First instar

Neonate larva emerges from egg by making a small hole and fully emerged larva usually eats the empty eggs shell. The first instar larva was dark brown in colour with white stripes on the dorsum and resembled to bird droppings but head was reddish brown in colour. Its thoracic region was thicker than the rest of body. It also protect itself when disturbed by thrusting out a fork like fleshy coloured structure “Osmeterium” at the back of its head and emitting an unpleasant odour. Osmeterium is found in all instar. The thorax consisted of three distinct segments. The abdomen consists of ten segments of which third, fourth, fifth, sixth and tenth segments bear a pair of prolegs. Both the thoracic and abdominal segments covered with hard hairs on its dorsal side.

The duration of the first instar larvae ranged from 1.00 to 2.00 days with the average of 1.73 ± 0.44 days (Table 1). The length of the larva ranged from 3.00 to 3.15 mm, the average being 3.11 ± 0.07 mm (Table 2).

Second instar

Second instar larva was closely more or less like the first instar larvae except that it was bigger in size and with more developed mandibles. The hairs on thorax and abdomen became more prominent. The duration of second instar larva ranged from 1.00 to 2.00 days with an average of 1.57 ± 0.50 days (Table 1). The length of the larvae varied from 5.00 to 5.25 mm, the average length being 5.12 ± 0.09 mm (Table 2).

Third instar

The freshly formed third instar larvae were longer than second instar larva. The hairs on the thorax and abdomen were more prominent and spiracles were

visible. The duration of the instar ranged from 2.00 to 3.00 days with an average of 2.40 ± 0.49 days (Table 1). The length of the third instar larva ranged from 8.00 to 8.20 mm with an average of 8.13 ± 0.07 mm (Table 2).

Fourth instar

In case of fourth instar larva, it was more or less like the third instar larva except in size. The white stripes on the dorsum were changed into the light green colour. The duration of the instar ranged from 2.00 to 3.00 days with an average of 2.53 ± 0.50 days (Table 1). The length of the fourth instar larva ranged from 10.50 to 10.75 mm with an average of 10.63 ± 0.09 mm (Table 2).

Fifth instar

Fifth instar larvae were cylindrical in shape and tapered anteriorly. Two pairs of fleshy spine located immediately behind the head and again posteriorly at tip of the abdomen and the spines are short gradually changes their colour from yellow orange to green. They have rows of orange or pink spots laterally and sub dorsally. The osmeterium was yellow at the base and orange at tips. They were normally hidden but can be everted when they were disturbed. They emit smelly odour as a defense from predators (Fig. 1).

The duration of the instar ranged from 4.00 ± 5.00 days with an average of 4.17 ± 0.37 days (Table 1). The length of the larva ranged from 20.20 to 20.40 mm with an average of 20.31 ± 0.08 mm (Table 2).

Devi *et al.* (2019) found that the incubation period was of 4.24 ± 0.69 days and the mean larval durations of 1st, 2nd, 3rd, 4th and 5th larval instar were 2.7 ± 0.48 , 2.6 ± 0.52 , 2.9 ± 0.31 , 3.2 ± 0.42 and 5.2 ± 0.42 days, respectively. According to Islam *et al.* (2019), the egg period was 2.5-3.0 days and larval period was 12.0-16.5 days, respectively. The present finding are somewhat vary with the earlier worker which may be due to different environmental conditions at different locations.

Pre-pupa

At the end of fifth instar, larvae became inactive and stopped feeding. Pre-pupal stage was characterized by shortening of larva in length. The larvae become sluggish and contracted their body. In prepupal phase, larva forms silk pad (cremaster) on substrate to which anal prolegs are anchored. A silk girdle is formed, passing over the metathoracic region and holding the pre-pupa in position. The colour of the larva in pre-pupal stage was dark green.

The pre-pupal period ranged from 1.00 to 2.00 days with an average of 1.27 ± 0.44 (Table 4.1). The length of the pre-pupa ranged from 28.00 to 28.25 mm with an average of 28.17 ± 0.12 mm (Table 2).

Pupa

Pupation occurs on the stem of host plant; sites vary and include cage net, wood structures, potted plants and pots. The freshly formed pupa was soft and green to brown in colour, which later turned dark green with white. The pupa was triangular in shape.

The total pupal period ranged from 6.00 to 8.00 days with an average of 7.03 ± 0.71 days (Table 1). The length of the pupa ranged from 32.50 to 32.80 mm with an average of 32.65 ± 0.12 mm (Table 2).

Phartiyal *et al.* (2012) found that the pupal period of citrus butterfly was completed in 20.8 days. Similarly, Dharavath *et al.* (2021) observed that the pupal stage of *P. demoleus* was 6 ± 0.57 days under laboratory condition. Thus, the present findings more or less in accordance with past works.

Adult

Adult butterflies were large and beautiful with wide wing spread. Head, thorax and legs were black with creamy white streaks on either side of whole abdomen. Antennae were black and club shaped. The body was covered with black and white hairs. Fore wings were triangular in shape while hind wings were rounded. The wings were black with white markings. There were two rows of parallel white spots along outer margins of wings and a brick red oval patch on posterior angle of the hind wing. Red spot at anal angle, capped with a blue-black spot and light blue iridescent crescent was observed. Blue-black spot and crescent often absent in males, but prominent in females. The tip of abdomen was pointed in case of male, while it was blunt in case of female. Wing color becomes a dull brown with age. Mean wing expanse (spread forewings apex to apex) of males was 93 mm whereas in case of females 104 mm (Fig. 3).

Male adult longevity ranged from 4.00 to 5.00 days with an average of 4.50 ± 0.50 days. While, female adult longevity ranged from 6.00 to 7.00 days with an average of 6.50 ± 0.50 days (Table 1).

The results are in agreement with Patel *et al.* (2017) reported that *P. demoleus* completed its development on lemon with a mean egg period of 2.6 days and 70.48% hatchability. The larval stage lasts 16.56 days across five instars, followed by a 7.16-day pupal period. Adults exhibited a 1:2.14 sex ratio, with females living 6.80 days and laying 110.80 eggs, while males live 3.92 days. The total life cycle was recorded

with 24.68 days for males and 27.56 days for females. Devi *et al.* (2019) who found that the adult male insect lived for 4.07 days while, female butterfly lived for 6.84 days. Islam *et al.* (2019) also found similar results with adult longevity as 4.13 ± 0.48 days for male and 7.24 ± 0.77 days for female. Dharavath *et al.* (2021) found that average adult longevity of *P. demoleus* was 3.00 ± 0.57 days on citrus. Thus, the results are in concurrence with present findings. Devkar and Chati (2025) recorded an incubation period of 3.0 to 7.0 days with an average of 5.0 days and a total larval duration of 14.0 to 19.0 days with an average of 16.5 days across five instars. The first instar lasted 2.0 to 3.0 days, while the subsequent four instars each spanned 3.0 to 4.0 days. With a pupal period of 4.0 to 9.0 days and adult longevity of 3.0 to 6.0 days, the total life cycle was completed in 39.0 to 41.0 days with an average of 40.0 days. Sowbagya and Venkata Ramana (2026) recorded that in forest ecosystems, the incubation period of *P. demoleus* was 4.2 ± 0.7 days. The larval stage progressed through five instars over a total of 15.0 to 18.0 days, with the first four instars each spanning 2.5 to 3.5 days and the fifth instar requiring 4.0 to 5.5 days. With a pupal period of approximately 8.0 to 10.0 days, the total developmental duration from egg to adult was completed within 29 to 30 days. Final instar larvae in this habitat reached a maximum length of 45.0 mm.

Table 1: Duration of life stages of citrus butterfly, *Papilio demoleus* L. reared on acid lime

Sr. No.	Life stage	Period (days)		
		Min.	Max.	Mean $\pm$ S. D.
1.	Incubation period	2	3	2.50 ± 0.31
2.	Hatching (%)	77	90	82.68 ± 5.04
3.	Larva			
	I instar	1	2	1.73 ± 0.44

	II instar	1	2	1.57 ± 0.50
	III instar	2	3	2.40 ± 0.49
	IV instar	2	3	2.53 ± 0.50
	V instar	4	5	4.17 ± 0.37
	Total larval period	10	15	12.40 ± 0.88
4.	Pre-pupa	1	2	1.27 ± 0.44
5.	Pupa	6	8	7.03 ± 0.71
6.	Adult			
	Pre-oviposition period	1	2	1.30 ± 0.46
	Oviposition period	1	2	1.43 ± 0.50
	Post-oviposition period	2	3	2.41 ± 0.49
	Longevity			
	Male	4	5	4.50 ± 0.50
	Female	6	7	6.50 ± 0.50
	Fecundity (eggs/female)	22	26	23.90 ± 2.04
7.	Total life span			
	Male	23	33	27.70 ± 1.35
	Female	25	35	29.67 ± 1.51
8.	Temperature ($^{\circ}\text{C}$)	27	32	26.81 ± 1.53
9.	Relative humidity (%)	58	80	67.82 ± 8.13

Note: S. D.: Standard Deviation

Table 2: Morphometrics of citrus butterfly, *Papilio demoleus* reared on acid lime

Insect stage	length (mm)	
	Range	Mean $\pm$ S. D.
Egg (Diameter)	1.10-1.13	1.11 ± 0.01
I instar	3.00-3.15	3.11 ± 0.07
II instar	5.00-5.25	5.12 ± 0.09
III instar	8.00-8.20	8.13 ± 0.07
IV instar	10.50-10.75	10.63 ± 0.09
V instar	20.20-20.40	20.31 ± 0.08
Pre- pupal length	28.00-28.25	28.17 ± 0.12
Pupal length	32.50-32.80	32.65 ± 0.12
Male	24.90-25.20	25.04 ± 0.11
Female	26.00-26.40	26.22 ± 0.14

Note: S. D.: Standard Deviation



Fig. 1 : Larva of the citrus butterfly, *P. demoleus* with the osmeterium exposed

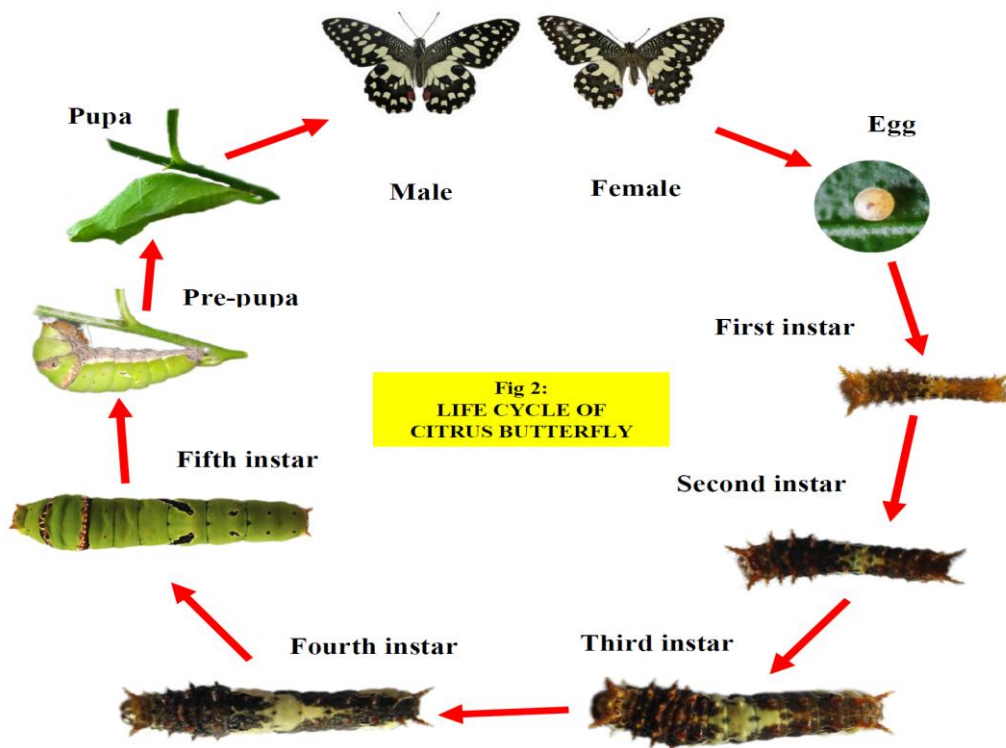
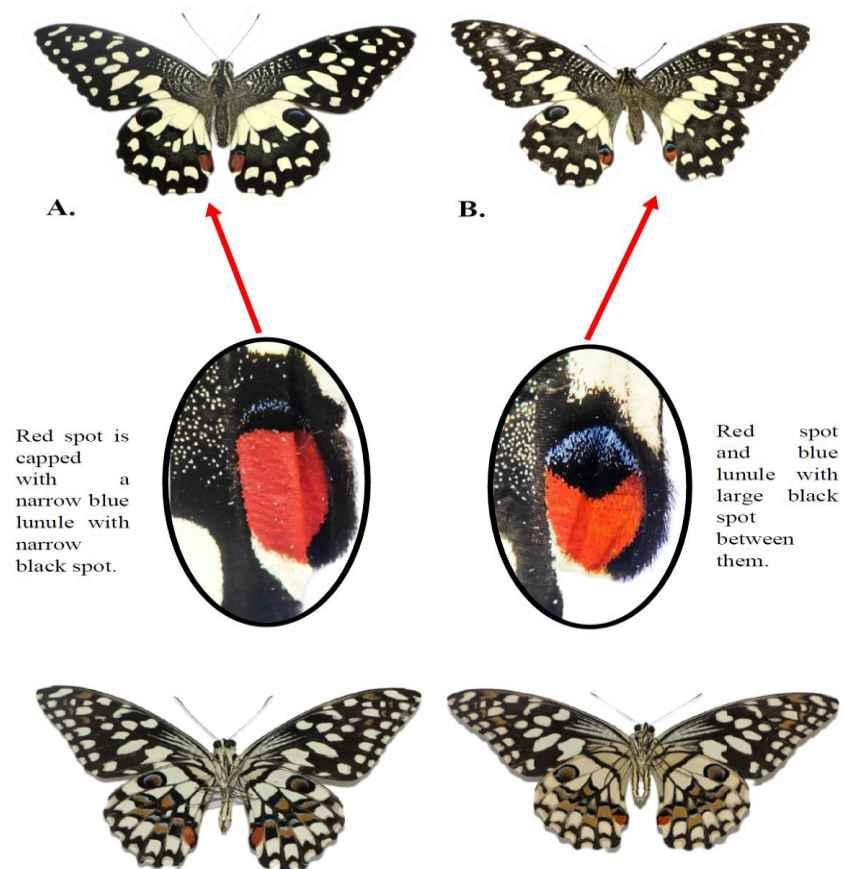


Fig 2:
LIFE CYCLE OF
CITRUS BUTTERFLY



Ventral view of citrus butterfly

Fig 3: Sexual diamorphism (A) Male (B) female

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