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Biology and morphometrics of citrus butterfly *Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae) on *Citrus limon* (L.) osbeck

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Abstract

The biology of citrus butterfly was studied under laboratory conditions on lemon. 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 mean developmental period in days for the different life stages (egg to adult) of the lemon butterfly on citrus were 2.6 (egg), 16.56 (larval), 7.16 (pupal), 3.92 (adult male) and 6.80 (adult female). The total life cycle was completed in 24.68 days for males and 27.56 days for female. There were more females than males with a sex ratio of 1: 2.14. The morphometric variations of different life stages of the lemon butterfly have been recorded. The lemon was the most preferred host/ food plant as larval development could be completed in minimum period of 16.56 days.

Keywords: morphometrics, citrus butterfly, *citrus limon*

Introduction

Citrus is native to a large area, which extends from Himalayan foot hills of northeast India to north-central China, the Philippines in east and Burma, Thailand, Indonesia and New Caledonia in Southeast. In India, in terms of area under cultivation, citrus is the third rank after Banana and Mango. Over the last 30 years, the area and production under citrus cultivation has increased at the rate of 11 and 9%, respectively, which shows that the expansion of citrus industry was quite sustainable. The average yield of citrus fruits in India is alarmingly low (10.1 t/ha) compared to other developed countries like Brazil, USA, China, Mexico and Spain (30-40 t/ha). Among mandarins, Nagpur mandarin (Central India), Kinnow mandarin (North-West India), Coorg mandarin (South India) and Khasi mandarin (North-East India) are the commercial cultivars of India. Whereas, Mosambi (Maharashtra), Sathgudi (Andhra Pradesh) and Malta and Jaffa (Punjab) are the sweet orange cultivars traditionally grown.

A number of insect pests attack citrus plants both in the nurseries as well as in the orchards inflicting heavy economic losses. Some of the most serious pests of citrus includes *Papilio demoleus* Linnaeus and *Papilio polytes* Linnaeus (citrus caterpillar), *Diaphorina citri* Kuwayama (citrus psylla), *Phyllocnistis citrella* Stainton (citrus leaf miner), *Aonidiella aurantii* Maskell and (citrus red scale) and *Dialeurodes citri* Ashmead (citrus whitefly) (Saljoqi *et al.*, 2006) [17].

The citrus swallowtail butterfly also known as orange dog, chequered swallowtail, lemon butterfly (*P. demoleus*) belongs to the family Papilionidae. The citrus butterfly is one of the economically important pests whose larval forms cause serious damage by devouring large quantity of foliage of rutaceae, rhamnaceae, anacardiaceae, apiaceae, sapindaceae and fabaceae family with special preference towards both wild and cultivated species of citrus during the later stages of their development. The genus *Papilio* is widely distributed all over the world. Different species of citrus butterfly occurs in different parts of the world. However, *P. demoleus* is the most prevalent species and was found in greater parts of Asia, Formosa and Japan etc. The biology and developmental period is mainly dependant on the climate, location and plant species on which it is feeding. Such information on biology and morphometrics of lemon butterfly is lacking in south Gujarat condition.

Material and Methods

The investigation on Biology and morphometrics of lemon butterfly (*Papilio demoleus*

Linnaeus) under south Gujarat condition were conducted at the P.G. Laboratory, Department of Entomology, ASPEE College of Horticulture and Forestry, NAU, Navsari during 2015-16 which is situated at 72° 54' East longitude and 20° 57' North latitude and it is situated at an average elevation of 9 m above sea level. Growing season was normal and favourable for growth. The materials used and techniques employed for conducting various experiments are presented here under.

Rearing of *Papilio demoleus* Linnaeus

For studying the biology of lemon butterfly, larva of butterfly was being collected from the citrus orchard, reared in separate petri-dishes and fed on fresh lemon leaves. The pupae from such petri-dishes were carried to mosquito net structure (10×10×10 ft) to get the adults of lemon butterfly. After mating, pairs of male and female were collected from mosquito net structure and transferred to wooden cage structure. The adults of lemon butterfly were provided with cotton soaked in sugar solution as their food. Leaves having eggs were collected and kept in petri dish. Leaf petioles were covered with wet cotton swab. The newly hatched larva were provided having lemon plants for egg laying tender leaves of citrus twice in a day. The subsequent instars were fed on citrus leaves and the observation of development was recorded daily. There by mass rearing of lemon butterfly were been carried out.

Eggs period

Egg period of *P. demoleus* were considered as a period between date of egg laying and date of egg hatching. The colour and shape of eggs were observed. The diameters of eggs were measured under microscope with the help of stereoscope microscope with attached computer accessory.

Larva period

The larva of *P. demoleus* was reared in a glass petri-dish. The number and duration were determined on the basis of exuviae casted off. The duration of each larval instar were determined by recording between two moulting. Observation for the colour and shape of the larvae were recorded for each instar. Length and breadth of larvae were measured under microscope with attached computer accessory. The total larval period were calculated from the date of egg hatching to the date of formation of pupa.

Pupal period

For recording pupal period of *P. demoleus*, the observations were taken every day at morning till the end of larval development. To record the pupal period, the larva were observed from the time when it stopped feeding and become sluggish to the time when it turned into pupa. The formation of pupa to the emergence of adult was considered as pupal period. The colour and shape of pupa were observed. The length and breadth of *P. demoleus* pupae were measured under stereoscope microscope with attached computer accessory.

Adult period and fecundity

Adults of *P. demoleus* emerged from pupae were observed till its death. Their colour, shape and sex differences were recorded. The adult male and female were measured with the help of scale. The fecundity of *P. demoleus* the number of eggs laid by single female were recorded till the death of adult female.

Pre-oviposition, oviposition and post-oviposition period

In order to study the pre-oviposition, oviposition and post-oviposition period, the newly emerged adults of *P. demoleus* were reared separately in wooden cage. Pre-oviposition period were calculated from the date of emergence of adult female to the date of commencing the egg laying. Oviposition period was calculated from date of commencing the egg laying to the ceasing of the egg laying by individual female. Post-oviposition period were calculated from the date of egg laying stop to the death of adult female.

Longevity and sex ratio

Longevity of *P. Demoleus* was calculated separately from the date of emergence to the death of adults. In order to determine the sex ratio (Male: Female) under the laboratory condition counted after emergence, number of pupae were kept in mosquito net structure and after emergence, the male and female adults were identified on the basis of morphological features.

Results and Discussion

The results of duration of different stages and morphometrics data of *P. demoleus* on citrus are presented here.

Egg: The female butterfly of *P. demoleus* laid eggs singly or in batches of 8 to 10 eggs. The eggs were glued on tender leaf lower surface and shoots of the citrus plant. The egg laying was slow and low in number in the initial stage, but it increased gradually and slower down at the later part of the oviposition period. The present observation is more or less similar with that of Alturi *et al.* (2002) [2]. The freshly laid eggs were pale yellow in colour, and become dark brown prior to hatching. Eggs were spherical with flat and smooth (Schmutterer 1969; Homziak, 1992 and Grund, 2002) [18, 9, 8]. The diameter of freshly laid eggs measured was 1.5 to 4.2 mm (2.29 ± 0.59 mm) (Maheswarababu, 1988 and El Khidir and Badawi, 1968) [10, 7]. Egg period varied from 1 to 4 days with an average of 2.6 ± 0.71 days (Alturi *et al.*, 2002) [2]. The hatchability of 70.48 per cent was observed when reared on citrus (Table 1).

Larva: The larvae passed through five distinct instars, when reared initially on citrus leaves, till they pupated. Singh and Gangwar (1989) [19], Grund (2002) [8] and Phartiyal *et al.* (2012) [11] also recorded five instars in *P. demoleus* reared on citrus, respectively.

First instar larva: The duration of first instar larva ranged from 2 to 4 days on citrus (2.80 ± 0.50 days). Similarly, it was also reported as 5.3 days Singh and Gangwar (1989) [19], 3 days Ackery *et al.* (1995) [1], 5.7 days Rajendra *et al.* (1957) [15] and 1.82 days Rao (2015) [14] on citrus, respectively (Table 1). The larvae ranged between 2.6 mm to 3.5 mm in length, with a mean of 3.17 ± 0.22 mm and 2.1 mm to 3.8 mm breadth, with a mean of $2.96 \text{ mm} \pm 0.44$ mm (Table 2).

Second instar larva: Second instar larva was morphologically resembled to the first instar larva. Second, instars are dark brown, shiny, with the anterior, middle and posterior parts having broad transverse off-white bands, giving the larva 'a bird dropping' camouflage pattern typical for the swallowtail group of butterflies. The larva was more active than previous instar. It was also observed that, larva of this instar preferred fresh and tender citrus leaves to feed. Grund (2002) [8] also observed similar characteristics in *P.*

demoleus when reared on citrus. The duration of second instar larva was ranged from 2 to 4 days (2.72 ± 0.61 days (Singh and Gangwar, 1989) ^[19], 3 days (Ackery *et al.*, 1995) ^[1], 5.5 days (Rajendra *et al.*, 1957) ^[15] and 0.86 days (Rao, 2015) ^[14] on citrus, respectively (Table 1). The larval length measured 6.5 to 9.9 mm (8.13 ± 0.80 mm) in length and 2.80 to 4.20 mm (3.48 ± 0.39 mm) in breadth (Table 2).

Third instar larva: The third instar larva was similar to

second instar in general appearance but differed in size. The colour of the body was light brown, but it was darker than previous instar (Grund, 2002) ^[8]. The duration required to complete third instar ranged between 2 to 4 days (2.92 ± 0.40 days) (Rajendra *et al.*, 1957 and Rao, 2015) ^[15, 14] (Table 1). The length of third instar larva measured from 14.70 to 17 mm (15.61 ± 0.76 mm), while that of the breadth from 2.80 to 4.50 mm (3.38 ± 0.51 mm) (Table 2).

Table 1: Duration of different stages of *P. demoleus*

S. No.	Particulars/State	Minimum	Maximum	Duration (in days)	
				Mean	±SD
1	Egg period (days)	1.00	4.00	2.6	0.71
2	Pre-oviposition period (Days)	1.00	2.00	1.04	0.20
3	Oviposition period (Days)	4.00	5.00	4.12	0.33
4	Post-Oviposition period	2.00	3.00	2.24	0.44
5	Larval instar				
	a. First instar	2.00	4.00	2.8	0.50
	b. Second instar	2.00	4.00	2.72	0.61
	c. Third instar	2.00	4.00	2.92	0.40
	d. Fourth instar	2.00	4.00	3.8	0.49
	e. Fifth instar	4.00	6.00	5.04	0.35
6	Total larval period	14.00	18.00	16.56	1.08
7	Pupae	6.00	9.00	7.16	0.99
8	Longevity of adults (Days)				
	a. Male	3.00	4.00	3.92	0.28
	b. Female	6.00	7.00	6.8	0.196
9	Total life cycle (egg to adult)	23.00	26.00	24.68	1.11

Fourth instar larva: The fourth instar larva was similar to third instar in general appearance but differed in size. Variation in colour was observed in fourth instar larva. It was of green in colour. Grund (2002) ^[8] also observed similar characteristics in *P. demoleus* when reared on citrus. The duration of fourth instar larva ranged from 2 to 4 days (3.80 ± 0.49 days). The present findings are more or less in

confirmation with those of 4.2 days Singh and Gangwar (1989) ^[19], 3 days Ackery *et al.* (1995) ^[1], 1.9 days Rajendra *et al.* (1957) ^[15] and 1.99 days Rao (2015) ^[14] on citrus (Table-1). The length of fourth instar larva was ranged from 23.50 to 25.30 mm (24.32 ± 0.49 mm), while that of breadth ranged from 2.70 to 4.70 mm (3.82 ± 0.54 mm) (Table 2).

Table 2: Morphometric data of *P. demoleus*

S. No.	Particulars/State	Minimum	Measurements in "mm"		
			Maximum	Mean	±SD
1	Egg (Diameter)	1.5	4.2	2.29	0.59
2	First instar larva				
	a. Length	2.6	3.5	3.17	0.22
	b. Width	2.1	3.8	2.96	0.40
3	Second instar larva				
	a. Length	6.5	9.9	8.13	0.80
	b. Width	2.8	4.2	3.48	0.39
4	Third instar larva				
	a. Length	14.7	17.00	15.61	0.76
	b. Width	2.8	4.5	3.38	0.51
5	Fourth instar larva				
	a. Length	23.5	25.3	24.32	0.49
	b. Width	2.7	4.7	3.82	0.54
6	Fifth instar larva				
	a. Length	46.4	48.3	47.50	0.46
	b. Width	3.1	5.2	4.20	0.62
7	Pupae				
	a. Length	27.2	31.7	30.03	1.07
	b. Width	8.7	9.6	9.22	0.24
8	Adult moth: Male				
	a. Length (head to tip of abdomen)	24.3	28.7	26.75	1.46
	b. Width	87.3	94.3	90.75	2.04
	Adult moth: Female				
	a. Length	24.7	30.8	28.4	1.51
	b. Width	87.8	95.6	90.78	2.65

Fifth instar: The fifth instar larva was green in colour and cylindrical in shape and tapered anteriorly. Two pairs of fleshy spines are located posteriorly and again immediately behind the head. These spines are very short, and gradually change from yellowish-orange to green. Braby (2000) also observed similar characteristics in *P. demoleus* when reared on citrus. The duration of fifth instar larva ranged from 4 to 6 days with an average of 5.04 ± 0.35 mm. (Gangwar, 1989; Ackery *et al.*, 1995; Rajendra *et al.*, 1957) ^[19, 15, 1] (Table 1). The length and breadth of fifth instar larva was ranged from 46.40 to 48.30 mm (47.50 ± 0.49 mm) and 3.10 to 5.20 mm (4.20 ± 0.62 mm), respectively (Grund, 2002) ^[8] (Table 2).

Total larval period: The total larval development period of *P. demoleus* varied from 14 to 18 days (16.56 ± 1.08 days). Earlier, this period of was recorded as 17 to 40 days on citrus by Phartiyal *et al.* (2012) ^[11] The variation in the larval period may be because of different hosts (Table 1).

Pupa: The pupa is first greenish-brown and it changes to dark brown later. The pupa is naked and typical of butterfly, and there is no silken cocoon round the pupa. Similar observations were made by Depury (1968) ^[5]. Pupae are stout, rugose, and about 30 mm long. They are attached to the thicker stems of the host plant, or to adjacent sticks and rocks. Similar results were also observed by Guerrero (2004) when *P. demoleus* reared on citrus.

The pupal period varied from 6 to 9 days with an average of 7.16 ± 0.99 days. In past, Alturi *et al.* (2002) ^[2] recorded average pupal period of 10 to 12 days of *P. demoleus* on citrus. The length of pupa measured from 27.20 to 31.70 mm (30.04 ± 1.07 mm), while that of breadth measured from 8.70 to 9.60 mm (9.22 ± 0.24 mm). Closely, the length and breadth of pupa measured as 30 mm and 9.15 mm on citrus by Resham *et al.* (1986) ^[16] respectively. (Table 2).

Adult: The adult is a large-sized butterfly; forewings are long and narrow with brown and cream chequers colour with blue eyes and red spots on the hind wings. Wing-span is 80-90 mm; total body length from 23 to 25 mm and the antenna was 15.00 mm long. There is no tail on the hind wing. Upper forewing is largely black and outer wing margin with a series of irregular yellow spots in a discal band. Female butterfly is larger in a size than male butterfly. These observations are more or less in agreement with those reported by Schmutterer (2009) ^[18] and Poorten (2004) ^[12], when *P. demoleus* was reared on citrus.

The data on measurement of adult butterfly are given in (Table 2). The length of adult male varied from 24.30 to 28.70 mm (26.75 ± 1.46 mm) and the width varied from 87.30 to 94.30 mm (90.75 ± 2.04 mm). Whereas, in case of female, the length varied from 24.70 to 30.80 mm (28.40 ± 1.51 mm) and the width varied from 87.80 to 95.60 mm (90.78 ± 2.65 mm). These observations on length and width are almost similar to the observations recorded by Schmutterer (1969) ^[18] and Eastwood (2010) ^[6], when *P. demoleus* was reared on citrus.

Fecundity: The egg laying capacity recorded during the study was varied from 103 to 121 eggs (110.80 ± 4.46 eggs) per female on citrus. Almost similar fecundity of 112 eggs per female on citrus was recorded by Maheswarababu (1988) ^[10] (Table 1).

Longevity of adult: The longevity of male ranged from 3 to 4 days (83.92 ± 0.28 days) while mated female lived for 6 to 7

days (6.80 ± 0.20 days). Similar observations were made by Atwal (1964) ^[3] and Rafi *et al.* (1989) ^[17] (Table 1).

Sex ratio: Based on morphological characters mentioned earlier, the adults were differentiated into their sexes. The sex ratio of male to female was 1: 2.14. Rao (2015) ^[14] also recorded similar sex ratio of 1: 2. When reared on sweet orange (Table 1).

Total life period: The total life period from eggs to the death of adult occupied by male (Table 1) was 23 to 26 days (24.68 ± 1.11 days). However, female occupied 26 to 29 days (27.56 ± 1.19 days). Thus, a total life period of male was shorter than female recorded during present investigation. The present findings are more or less in agreement with those of Rao (2015) ^[14].

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References

- Ackery PR, Smith CR, Van-Wright RI. Carcasson's African Butterflies. An Annotated Catalogue of the Papilionoidea and Hesperioidea of the Afrotropical Region. CSIRO, Australia, 1995.
- Alturi JB, Ramona SPV, Rudi CS. India. J Natl. Taiwan Mus. 2002; 55:27-32.
- Atwal AS. Punjab Hort. J. 1964; 4(1):40-44.
- Badawi A. Bull. Soc. Ent. 1968; 11:397-402.
- Depury JMS. Crop pests of East Africa. Oxford University Press Nairobi. 1968, 227.
- Eastwood R, Boyce SL, Farrell BD. The provenance of Old World swallowtail butterflies, *Papilio demoleus* (Lepidoptera: Papilionidae), recently discovered in the New World, Annals of the Entomological Society of America. 2010; 99:164-168.
- El Khidir E. A note on the biology of the citrus butterfly, *Papilio demodocus* Esp. in the Sudan, The Entomologist, 1968; 101:8-10.
- Grund R. South Australian butterfly's data sheet. *Papilio demoleus*. Sthenelus W.S. Macleay Chequered swallowtail, 2002.
- Homziak MT, Homziak J. *Papilio demoleus* (Lepidoptera: Papilionidae): A new record for the United States, Commonwealth of Puerto Rico, Florida *Entomologists*, 2006; 89:485-488.
- Maheswarababu P. Thesis, M.Sc. (Ag.), Archarya N.G. Ranga Agricultural University, Hyderabad. 1988, 117.
- Phartiyal T, Srivastava P, Khan MS, Srivastava RM. J Ent. Res. 2012; 36(3):255-258.
- Poorten GV. The lime butterfly *Papilio demoleus* L. www.srilanka insect.net/ butterfly/ Papilionidae/ lime butterfly htm, 2004.
- Radke SG, Kandalkar HG. Observations on the lemon butterfly, *Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae) PKV Res. J. 1988; 13(2):176-177.
- Rao RA. Int. J Cur. Res. Life Sci. 2015; 4(3):168-171.
- Rajendra B, Kirpal S, Bhan R, Shing K. Bionomics of lemon butterfly, *Papilio demoleus* L. on Citrus reticulata,

- Pest Management and Economic Zoology in India. 1997; 5(1):37-41.
16. Resham B, Fanindra PN, Butani DK. Insect pests of citrus in Nepal and their control. *Pestology*, 1988; 10(4):24-27.
17. Saljoqi N, Rafi MA. *Environ Mon.* 2006; 6:40-43.
18. Schmutterer H. *Pest of crops in North, East and Central Africa.* Gustar Fischer Verlag Stuttgart, Port land, USA. 1969, 296.
19. Singh YP, Gangwar SK. *J Andaman Sci. Assoc.* 1989; 5(2):151-153.