

Biology and morphometrics of lemon butterfly *Papilio demoleus* (Lepidoptera: Papilionidae) on bael, *Aegle marmelos* in Arid Region of Rajasthan

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Abstract

Biology and morphometrics studies of lemon butterfly, *Papilio demoleus* L. were carried out on bael. Adult female laid eggs singly on the under surface of tender leaves and also on tender twigs. The pooled mean duration of the different stages of lemon butterfly viz. the incubation period of 2.80 days, larval period of 9.23 days, pre-pupal period of 0.99 days, pupal period of 8.11 days, female adult longevity period of 6.95 days and male longevity period of 3.85 days respectively. The average length, width and wing expanse of male butterfly were found to be 27.961 mm, 5.997 mm and 88.518 mm while female butterfly was found to be 29.015 mm, 6.327 mm and 91.072 mm, respectively. The morphometric variations of different life stages of the citrus butterfly have been recorded.

Key words: *Papilio demoleus*, *Aegle marmelos*, biology, morphometrics.

Introduction

Bael (*Aegle marmelos* Correa) belongs to family Rutaceae is an important indigenous fruit crop to dry forest in hills, plains of central and southern parts as well as arid and semi arid regions of India. It also called as Bengal quince or Indian quince. Fruits are famous for its medicinal values as well as edible fruit quality. The different parts of bael are used for various therapeutic purposes, such as for treatment of asthma, anaemia, fractures, healing of wounds, swollen joints and diarrhoea. The unripe dried fruit of bael is astringent, digestive, stomachic and dysentery. Sweet drink prepared from the pulp of fruits produce a soothing effect on the patients who have just recovered from bacillary dysentery. The *bael* is gaining popularity among the farmers of arid and semi arid areas for economic cultivation. However, the quality of fruits and productivity is not obtained up to the standard (Samadia and Haldhar, 2017).

One of the reasons for it is infestation of insect-pests on the vegetative as well as developing fruits which ultimately leads to significant yield loss and quality attributes of the fruits. About 30 species of insect and mites have been reported feeding on *bael* in India (Lakra, 2004). Various types of insect-pests are found to be infesting bael in which *P. demoleus* is major one which defoliate the plant. Pathak and Rizvi (2002) reported that the *P. demoleus* is a serious citrus pest in India. Among various insects of bael lemon butterfly commonly known as the lime or citrus swallowtail, has a successful dispersal and becoming a major pest of citrus plants throughout Asia. The infestation of *P. demoleus* appeared from August to February. The highest egg, larval population and plant infestation were observed 12.75, 6.15/ 10 branches and 65.0 %, respectively. The relationship between lemon butterfly egg, larval population and

maximum temperature was negatively correlated whereas the maximum relative humidity was positively in arid region (Haldhar *et al.*, 2010). *P. demoleus* feeds on the foliage of citrus trees and is regarded as a major citrus pest especially in nurseries the larval forms cause serious damage to citrus family by devouring large quantity of foliage during the later stages of their development. The biology and developmental period is mainly dependant on the climate, location and plant species on it feeding. The defoliation was observed 83 per cent in sweet oranges grown in the Southern zone of Andhra Pradesh (Narayanamma *et al.*, 2001). Severe infestation results in defoliation of the tree and leads to retarding of plant growth and decreases fruit yield. Keeping in view its economic importance, the study has been carried out for biology and morphometrics of lemon butterfly, *P. demoleus* on bael to develop a tool for eco-friendly management.

Materials and methods

The larval populations of lemon butterfly were collected on bael plants from entomological experimental field of ICAR-Central Institute for Arid Horticulture, Bikaner (N 28° 06' E 73° 21') situated in western parts of Rajasthan and brought to entomology laboratory to study the biology and morphometric of lemon butterfly. The biology of lemon butterfly on bael was studied during September to November of 2015-16 and 2016-17 in the entomology laboratory by collecting fifth instar larvae regularly from the bael plants from entomological experimental field. The larvae were reared in glass jars by providing fresh bael 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 bael twigs were placed in conical flasks containing water. The twigs were changed after one day. The eggs were transferred to petridishes containing fresh tender leaves in petridishes at room temperature ($28 \pm 2^\circ\text{C}$). 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.

Ten samples (egg, larval stages, pupa and adult) were used for observation and measurements. The larvae were reared under laboratory condition for measurement of different stages. The average linear measurements of various body parts of male and female butterfly were obtained under a stereo binocular microscope (Radical Instruments, Ambala, Haryana, India) using Jenoptic Pro 2.8.0 software. The terminology used to denote different parts of the body of the butterfly (Haldhar, 2012; Haldhar and Singh, 2014; Haldhar *et al.*, 2015; Haldhar *et al.*, 2016). Transformations were used as necessary to achieve normality in the data before analysis. The data on biology and morphometrics of lemon butterfly were analyzed through one-way ANOVA using SPSS software. The standard error of the mean was calculated by this

formula $\frac{s}{\sqrt{n}}$ where, 's' is the sample standard deviation and 'n' is the size (number of observations) of the sample.

Results and discussion

The field experiments were conducted during 2015-16 and 2016-17 with bael (*Aegle marmelos*) to determine the biology and morphometrics studies of lemon butterfly, *Papilio demoleus* L. On the basis of pooled data of 2015-16 and 2016-17, adult female laid eggs singly on the under surface of tender leaves and also on tender twigs by curling its abdomen. The freshly laid eggs measured 0.91 mm to 1.04 mm with an average of 0.98 mm and smooth, spherical creamy yellow in colour and they turned to grayish with brown streaks all over the chorion before hatching. Incubation period ranged from 2.38 to 3.25 days. There were only five larval instars which the average duration of first to fifth instars were 2.21, 1.03, 1.55, 1.93 and 2.51 days respectively. 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 (Table 1, 2, 3 & 4). Resham *et al.* (1986), Singh and Gangwar (1989), Radke and Kandalkar (1989) and Ramakrishna Rao (2015) reported that the incubation periods varying from 3-7 days, 4-7 days, 5 days and 2.90 days, respectively. The difference in the incubation period was due to variations in the weather factors of different regions.

The first instar larva recorded an average length and width of 5.56 mm and 1.55 mm respectively. The average duration of first instar larva was 2.21 days with range of 1.63 to 3.13 days. 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. The average size of the second instar larvae in length and width was found to be 9.05 mm and 2.71 mm, respectively. The average second instar larval period was found to be 1.03 days with a range of 0.75 to 1.38 days. Third instar larvae were resembled the second instar larvae except in size. Third instar larvae was recorded an average length and width of 13.25 mm and 3.659 mm, respectively. The average third instar larval period was 1.55 days with range of 1.25 to 1.88 days. 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. The average fourth instar larval period was found to be 26.56 mm in length and 5.74 mm in width. The average fourth instar larval period was found to be 1.93 days with a range of 1.63 to 2.25 days. Fifth instar larva were yellowish green or green in colour. The average length and width of the fifth instar larva was found to be 42.86 mm and 5.74 mm respectively. The average duration of fifth instar larva was 2.51 days (Table 1, 2, 3 & 4). The results of the present investigation are also comparable with Madansuri *et al.* (1979) who recorded the mean head capsule width of first, second, third, fourth and fifth instars of *P. demoleus* as 0.61, 0.95, 1.49, 2.33 and 3.64 mm respectively. Sharif *et al.* (1989) recorded the durations for egg, larva and pupal stages as 3.24, 18.24 and 11.7 days respectively and the butterfly had four generations in a year with a life cycle of 33.19 days and similarly Jahnvi *et al.* (2018) recorded duration of total larval period varied from 17.16 to 17.66 days with an average of 17.53 days on acid lime.

Before changing to pre-pupa the caterpillar shrunk in size and it hangs from the twig with the help of a silken girdle. The pre-pupal period was observed to be 0.75 to 1.25 days with an average of 0.99 days. 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 average length and width of the pupal period was found to be 30.48 mm and 8.88 mm, respectively. The duration of the pupal period was observed to be 7.38 days and 8.50 days with an average of 8.11 days. 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 average length, width and wing expanse of male butterfly were found to be 27.96 mm, 6.00 mm and 88.52 mm while female butterfly was found to be 29.02 mm, 6.33 mm and 91.07 mm, respectively. The female adults were lived longer than the male adult. The longevity of male and female was 3.38 to 4.25 and 6.38 to 7.38 days with an average of 3.85 and 6.95 days when provided with dilute honey as a food (Table 1, 2, 3, 4 & Plate 1). The variation in adult longevity was in agreement with the findings of Ramakrishna Rao (2015) and Jahnvi *et al.* (2018). Singh and Gangwar (1989) reported the longevity female and male was 5.80 and 5.10 days. Smith *et al.* (2008) studied the taxonomy and morphological characters of 5 species of *P. demoleus*, *P. demodocus*, *P. erithonioides*, *P. groesmithi*, and *P. morondavana* based

on features of the wings, male and female genitalia. The results revealed that the tail on hind wing vein M3 is rudimentary or very short, less than twice as long as those of neighbouring veins in *P. demoleus*.

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Table 1 Biology of different life stages of the lemon butterfly, *Papilio demoleus* in 2015-16

| S. No. | Life stages | Duration in days | | | | |
|--------|------------------------------|------------------|---------|-------|-------|-------|
| | | Minimum | Maximum | Mean | SD | SEm |
| 1 | Incubation period | 2.250 | 3.250 | 2.750 | 0.312 | 0.099 |
| 2 | 1 st instar larva | 1.500 | 3.000 | 2.150 | 0.444 | 0.141 |
| 3 | 2 nd instar larva | 0.750 | 1.250 | 0.975 | 0.219 | 0.069 |
| 4 | 3 rd instar larva | 1.250 | 1.750 | 1.500 | 0.204 | 0.065 |
| 5 | 4 th instar larva | 1.750 | 2.250 | 1.900 | 0.175 | 0.055 |
| 6 | 5 th instar larva | 2.250 | 2.750 | 2.475 | 0.219 | 0.069 |
| 7 | Pre-pupal period | 0.750 | 1.250 | 0.950 | 0.197 | 0.062 |
| 8 | Pupal period | 7.500 | 8.500 | 8.050 | 0.329 | 0.104 |
| 9 | Male adult longevity | 3.250 | 4.250 | 3.800 | 0.307 | 0.097 |
| 10 | Female adult longevity | 6.250 | 7.250 | 6.900 | 0.337 | 0.107 |

Mean of ten samples

Table 2 Biology of different life stages of the lemon butter fly, *Papilio demoleus* in 2015-16

| S. No. | Life stages | Duration in days | | | | |
|--------|------------------------------|------------------|---------|------|------|------|
| | | Minimum | Maximum | Mean | SD | SEm |
| 1 | Incubation period | 2.50 | 3.50 | 2.85 | 0.34 | 0.11 |
| 2 | 1 st instar larva | 1.75 | 3.25 | 2.28 | 0.46 | 0.15 |
| 3 | 2 nd instar larva | 0.75 | 1.50 | 1.08 | 0.29 | 0.09 |
| 4 | 3 rd instar larva | 1.25 | 2.00 | 1.60 | 0.27 | 0.09 |
| 5 | 4 th instar larva | 1.50 | 2.50 | 1.95 | 0.28 | 0.09 |
| 6 | 5 th instar larva | 2.25 | 3.00 | 2.55 | 0.28 | 0.09 |
| 7 | Pre-pupal period | 0.75 | 1.50 | 1.03 | 0.25 | 0.08 |
| 8 | Pupal period | 7.25 | 8.25 | 8.18 | 0.41 | 0.13 |
| 9 | Male adult longevity | 3.50 | 4.50 | 3.90 | 0.32 | 0.10 |
| 10 | Female adult longevity | 6.50 | 7.50 | 7.00 | 0.33 | 0.11 |

Mean of ten samples

Table 3 Pooled data of biology of different life stages of the lemon butter fly, *Papilio demoleus* in 2015-16 and 2016-17

| S. No. | Life stages | Duration in days | | | | |
|--------|------------------------------|------------------|---------|------|------|------|
| | | Minimum | Maximum | Mean | SD | SEm |
| 1 | Incubation period | 2.38 | 3.25 | 2.80 | 0.31 | 0.10 |
| 2 | 1 st instar larva | 1.63 | 3.13 | 2.21 | 0.45 | 0.14 |
| 3 | 2 nd instar larva | 0.75 | 1.38 | 1.03 | 0.25 | 0.08 |
| 4 | 3 rd instar larva | 1.25 | 1.88 | 1.55 | 0.23 | 0.07 |
| 5 | 4 th instar larva | 1.63 | 2.25 | 1.93 | 0.21 | 0.07 |
| 6 | 5 th instar larva | 2.25 | 2.75 | 2.51 | 0.23 | 0.07 |
| 7 | Pre-pupal period | 0.75 | 1.25 | 0.99 | 0.21 | 0.07 |
| 8 | Pupal period | 7.38 | 8.50 | 8.11 | 0.35 | 0.11 |
| 9 | Male adult longevity | 3.38 | 4.25 | 3.85 | 0.30 | 0.10 |
| 10 | Female adult longevity | 6.38 | 7.38 | 6.95 | 0.33 | 0.10 |

Mean of ten samples

Table 4 Linear morphometric measurements of different life stages of the lemon butter fly, *Papilio demoleus*

| S. No. | Life stages | Measurement in 'mm' | | | | |
|--------|---|---------------------|---------|-------|------|-------|
| | | Minimum | Maximum | Mean | SD | SEm |
| | Egg diameter | 0.91 | 1.04 | 0.98 | 0.04 | 0.013 |
| | Length of 1 st instar larva | 4.78 | 6.91 | 5.56 | 0.63 | 0.199 |
| | Width of 1 st instar larva | 1.47 | 1.65 | 1.55 | 0.07 | 0.021 |
| | Length of 2 nd instar larva | 8.45 | 9.78 | 9.05 | 0.51 | 0.161 |
| | Width of 2 nd instar larva | 2.44 | 3.01 | 2.71 | 0.20 | 0.063 |
| | Length of 3 rd instar larva | 12.05 | 14.89 | 13.25 | 0.84 | 0.266 |
| | Width of 3 rd instar larva | 3.12 | 4.01 | 3.65 | 0.27 | 0.085 |
| | Length of 4 th instar larva | 24.59 | 27.89 | 26.56 | 1.06 | 0.334 |
| | Width of 4 th instar larva | 5.45 | 6.02 | 5.74 | 0.15 | 0.049 |
| | Length of 5 th instar larva | 40.15 | 45.78 | 42.86 | 1.95 | 0.616 |
| | Width of 5 th instar larva | 6.52 | 7.14 | 6.78 | 0.22 | 0.068 |
| | Length of pupa | 29.58 | 31.25 | 30.47 | 0.55 | 0.175 |
| | Width of pupa | 8.45 | 9.25 | 8.88 | 0.21 | 0.066 |
| | Length of adult male | 25.36 | 29.68 | 27.96 | 1.24 | 0.392 |
| | Width of adult male | 5.88 | 6.12 | 5.10 | 0.09 | 0.028 |
| | Width of adult male with wing expanse | 86.99 | 90.25 | 88.52 | 1.17 | 0.369 |
| | Length of adult female | 27.28 | 30.89 | 29.02 | 1.08 | 0.342 |
| | Width of adult female | 6.01 | 6.55 | 6.33 | 0.19 | 0.060 |
| | Width of adult female with wing expanse | 88.97 | 93.58 | 91.07 | 1.62 | 0.511 |

Mean of ten samples



Plate 1 Different life stages of the lemon butter fly, *Papilio demoleus* on bael