

**BIOLOGY AND MORPHOMETRICS OF CITRUS LEAF MINER,  
*PHYLLOCNISTIS CITRELLA* STAINT.**

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**ABSTRACT**

A detailed study on the biology and morphometrics of citrus leaf miner, *Phyllocnistis citrella* Staint. (Lepidoptera: Gracillariidae) was conducted in laboratory and citrus nursery. The leaf miner completed its life cycle on an average of 16.26 days. The female had a mean pre-mating and mating period of 12.7 hours and 11.5 minutes, respectively and a mean fecundity of 12.10 eggs in 2.46 days adult longevity. The eggs required an average of 2.42 days to hatch. Larva passed three instars in serpentine mines in the leaves in 4.5 days. The pre-pupal and pupal periods were 5.9 hours and 6.55 days, respectively. The egg measured 0.25 x 0.17 mm in size. The length, breadth across thorax and abdomen measured 5.04, 0.71 and 0.84 mm for last instar larva; 3.35, 0.52 and 0.68 mm for pupa and 3.04, 0.66 and 1.00 mm for adult respectively. Antenna, leg, and wing length and wing span measured 2.40 to 3.00, 2.66 to 3.38, 2.18 to 2.72 and 2.90 to 3.68 mm, respectively.

**Keywords:** Biology, morphometrics, *Phyllocnistis citrella*.

**INTRODUCTION**

The citrus leaf miner, *Phyllocnistis citrella* was described by Stainton as early as 1856, in India. The pest inflicts considerable economic damage to various *Citrus* spp. in the South and South-East Asian countries (Alam 1962, Atwal 1976, Hill 1987). Ali (1989) recorded it as a serious pest of young lemon and lime trees. The leaf miner attacks the tender leaves of new flushes of citrus severely and causes damage by making zig-zag gallery in the leaf lamina which inturn reduces the photosynthetic activity and encourages the incidence of 'citrus canker' (Prodhan 1992, Patel & Patel 2001). Notes on the general biology were made by several workers (Huang *et al.* 1989, Das *et al.* 1998, Boughdad *et al.* 1999, Pinto

& Fucarino 2000) but the biology was not studied thoroughly in Bangladesh. Therefore, an attempt was made to study the detailed biology and morphometrics of the leaf miner, *P. citrella*.

## MATERIALS AND METHODS

The biology and morphometrics of *P. citrella* were studied on lemon, (*Citrus limon*) in the laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh and a nearby citrus nursery during March to June, 2002. The pest was reared successfully in petriplates using leaves of lemon. The infested leaves or small twigs of lemon having immature stages of *P. citrella* were collected from the nursery. The petiole of each detached leaf/twig was wrapped properly with white tissue paper and soaked in 5% sugar solution. Individual leaf /twig was then placed in a single petriplate. A filter paper soaked in sugar solution was also placed at the bottom of petriplate. Regular moisturising of filter paper as well as wrapped tissue paper was made by sugar solution to keep the leaf/twig fresh.

Different life stages of the pest were studied on the above treated leaves. However, sometimes it was not possible to study all developmental stages on a single leaf as it gets dry within 4-5 days. In such situation the pest of its standing developmental stage was collected before drying the leaves and preserved in 70% alcohol for studying morphometrics. Additional collection of egg, larva (different instars) and pupa were also made from the same nursery and preserved in alcohol solution for measurements.

The study of life cycle was also supplemented with regular observation on rearing of the pest on standing lemon plant in the nursery. Adult male and female of citrus leaf miner which were obtained from laboratory culture or from the en-caged infested twigs in the field were released on lemon twig of new flush containing 4-5 leaves for mating and egg laying. Each twig was en-caged in finely meshed nylon net and observed at 6 hours interval for recording egg laying. The moths were then placed on new twigs at 24 hours interval until the death of female. After removal of the adults the leaves were checked using magnifying glass for eggs. Once the egg was detected, it was marked and observed for hatching. The eggs laid by a female were counted from different twigs. The duration of different stages from egg to adult and the longevity of the adult were recorded without detaching the leaves from the plant.

After hatching, the individual larva was observed every day for its development and measuring the length of mine. The instar change was identified with the colour, size, shape and the presence of little exuviae in the mine. Pre-pupal and pupal stage were marked and left for adult emergence. Data on the duration of different developmental stages were recorded at 6 hrs intervals and measurements were made using a microscope with graticles. Means and standard errors (SE) of data were calculated from ten observations for each case.

## RESULTS AND DISCUSSION

The data on the biology and morphometrics of citrus leaf miner, *P. citrella* are presented in Tables 1 & 2.

**Mating:** After emergence from pupa, the citrus leaf miner passes through a pre-mating period of 8 to 16 hrs. Mating occurs in the morning usually at 6 to 10 am and mating period lasts for 9 to 15 minutes with an average of 11.5 minutes. The moths mate once in their life. Both male and female remain silent and stand in opposite direction during mating period. The lower surface of citrus leaf is usually the mating site. Shady conditions also encourage their mating. After mating, male dies and the female searches for a suitable site for oviposition by crawling over the leaf surface.

**Egg:** The eggs are soft, light green, flattened and oval measuring about 0.25 mm in length and 0.17 mm in breadth. Pandey & Pandey (1964) reported the size as 0.31 x 0.21 mm. The female laid 10 to 18 eggs with an average of 12.1 eggs. Radke & Kandalkar (1987) reported the range as 21-28 per female. The eggs are laid singly on the lower surface of new leaves, particularly near the mid-rib region. But eggs may also be laid on upper surface. Garrido & Gascon (1995) reported that the female preferred to lay eggs on the lower surface when leaf length was less than 10 mm. Generally 1-3 eggs are laid per leaf. Egg laying occurs just after dusk or very early in the morning. Before hatching the eggs become yellow, opalescent and turgid. The incubation period ranged from 2 to 3 days with an average of 2.42 days. Radke & Kandalkar (1987) reported it 2.0 days. Das *et al.* (1998) recorded 3.2 days, Pinto & Fucarino (2000) recorded 2.4 days. After hatching, the larva starts feeding along the mid-rib to create serpentine mine through epidermal tissue.

**Larva:** In the present study, three larval instars were observed. Instarwise descriptions of the larvae are given below.

First instar larva is cylindrical, more or less creamy-white. The average length

is 1.74 mm, and breadth across thorax and abdomen are 0.25 and 0.31 mm, respectively. Head is slightly brown and prognathous. Eyes are not visible. Prothorax is fused with mesothorax and separated from metathorax by a distinct suture. Thoracic legs are absent. Abdomen is 11 segmented and gradually tapered posteriorly. All segments are equal in size except 1st and last. First segment is the widest. The first instar larva mines a distance of 1.2 – 1.8 cm in about one day.

The second instar larva is dorsoventrally flattened and pale yellow in colour. The average length is 3.70 mm, and breadth across thorax and abdomen are 0.47 and 0.68 mm, respectively. Head is dark brown. Eyes are not visible. Intersegmental suture is prominent. Legs are not developed yet. Abdomen is 11-segmented and tapered gradually. During this instar the larva becomes more active in mining and mines 1.9 – 5.5 cm in 2 – 3 days duration.

The third and last instar larva is bright yellow, dorsoventrally flattened and is tapered gradually anteriorly and posteriorly. The average length is 5.04 mm and breadth across thorax and abdomen 0.71 and 0.84 mm respectively. Head is almost dark and eyes are not visible. Thorax is 3- segmented, intersegmental suture well developed and prominent. Thoracic legs are also absent. Abdomen is 11-segmented with dorsolateral depression along each side of the body, extending from 1st to tenth abdominal segment. The caudal segment is twice as large as the previous one and projects into two elongated caudo-lateral lobes. Prolegs start to develop. Initially, the larva is very much active but it gradually slows down. The larva makes the longest mine from 5.6 – 12.2 cm in 1-2 days duration.

Following moulting, the larva stops feeding and passes into prepupal stage. In the present study the total length of mine from oviposition site to the position of prepupal moulting ranged from 9 – 16 cm with an average duration of 4 – 6 days. The average larval period lasted for 4.55 days. Bhutani (1979) reported this period as 5 - 10 days. Radke & Kandalkar (1987) showed the range as 5-6 days, Das *et al.* (1998) reported 8.5 days. Larvae are abundant on the lower surface of leaves but it also occurs in the upper surface through mining.

**Pre-pupa:** Pre-pupa does neither feed nor mine into the leaf. It is yellow to creamy in colour and cylindrical in shape. Thoracic legs are absent. Last abdominal segment bi-lobed. In this stage the insect remains near the margin of leaf with no movement. The duration of pre-pupa is 5 to 7 hours with an average of 5.9 hours.

**Pupa:** The pupa is obrect, cylindrical and bright yellow. It measures on average

3.35 mm in length, breadth across thorax and abdomen 0.52 and 0.68 mm respectively. Pandey & Pandey (1964) reported the pupal size as 3.06 – 3.52 x 0.52 – 0.53 mm. The pupa forms a silken cocoon. Dorsally head is elongated and pointed to cut cocoon. Mesothoracic wings extend laterally. Pupal period ranged from 5.96 to 7.17 days with an average of 6.55 days. Radke & Kandalkar (1987) reported the range as 6 – 7 days. Das *et al.* (1998) reported it to be 9.0 days. Huang *et al.* (1989) recorded 5 – 17 days.

**Adult:** Adult *P.citrella* are silvery white moths with prominent black spot near the margin of each fore wing. The male and female similar in appearance. The average length of body is 3.04 mm and breadth across thorax and abdomen are 0.66 mm and 1.0 mm respectively. Head is light brown and pointed, with two black compound eyes, and siphoning type of mouth-parts. Antennae filiform, 20-25 segmented.

Prothorax constricted, meso- and metathorax are almost equal. The average length of pro, meso and metathoracic legs are 2.66, 2.94 and 3.38 mm respectively. Coxa large, tibia with spurs, tarsi five segmented with a pair of claws and pulvilli. The average length and span of fore and hind wings are 2.72 and 2.18 mm, 3.68 and 2.90 mm respectively. Frenulum present, fore wing longer than hind wing, contains brown stripes and two black spots towards the tip. Hind wings are white. Both pairs of wing are fringed with hairs and cover the 8- segmented abdomen, which tapers posteriorly.

Adults are short lived and the longevity varied from 2.04 – 3.04 days with an average of 2.46 days. Das *et al.* (1998) reported adult longevity of the leaf miner as 3.8 days. The total life span varies from 15 – 18.42 days. Huang *et al.* (1989) reported it 1 – 22.5 days, Wilson (1991) recorded 14 – 18 days.

In the present study, the citrus leaf miner was found to complete its life cycle within 2-3 weeks time. Out of four life stages, pupal period was the longest. Although a wide range of duration of different life stages of the leaf miner have been reported by several authors but in the present study the range of developmental periods was comparatively short. This difference could be due to the different environmental conditions of the study sites. The environmental condition of Bangladesh appears to be favourable for the growth and development of the leaf miner and the availability of new flushes with favourable environmental conditions could lead to rapid multiplication of the pest which in turn may develop overlapping generations.

**Table 1.** Duration of different life stages of citrus leaf miner, *P. citrella*

Life stages	Duration	
	Range	Mean SE
Pre-mating period (hour)	8.00 – 16.00	12.70 0.83
Mating period (minute)	9.00 – 15.00	11.50 0.063
Fecundity (egg number/female)	10.00 – 18.00	12.10 1.17
Incubation (day)	2.00 – 3.00	2.42 0.13
Larva (days)	4.08 – 5.50	4.55 0.15
Pre-pupa (hour)	5.00 – 7.00	5.90 0.23
Pupa (day)	5.96 – 7.17	6.55 0.15
Longevity (day)	2.04 – 3.04	2.46 0.15
Life span (day)	15.0 – 18.42	16.26 0.31

**Table 2.** Morphometrics of citrus leaf miner, *P. citrella*

Life stages	Range (mm)	Mean $\pm$ SE (mm)
<b>Egg</b>		
Length	0.20-0.30	0.25 $\pm$ 0.02
Breadth	0.10-0.25	0.17 $\pm$ 0.03
<b>Larva</b>		
<b>First instar</b>		
Length	1.20-2.25	1.74 $\pm$ 0.18
Breadth		
- Across thorax	0.15-0.40	0.25 $\pm$ 0.04
- Across abdomen	0.20-0.45	0.31 $\pm$ 0.04
<b>Second instar</b>		
Length	3.25-4.25	3.70 $\pm$ 0.18
Breadth		
- Across thorax	0.35-0.60	0.47 $\pm$ 0.04
- Across abdomen	0.60-0.80	0.68 $\pm$ 0.37
<b>Third instar</b>		
Length	4.50-5.50	5.04 $\pm$ 0.16
Breadth		
- Across thorax	0.60-0.80	0.71 $\pm$ 0.03
- Across abdomen	0.80-0.90	0.84 $\pm$ 0.02
<b>Pupa</b>		
Length	2.75-4.0	03.35 $\pm$ 0.27
Breadth		
- Across thorax	0.50-0.60	0.52 $\pm$ 0.02
- Across abdomen	0.60-0.80	0.68 $\pm$ 0.04
<b>Adult</b>		
<b>Body</b>		
Length	2.50-3.50	3.04 $\pm$ 0.17
Breadth		
- Across thorax	0.50-0.80	0.66 $\pm$ 0.07
- Across abdomen	0.80-1.0	01.00 $\pm$ 0.06
<b>Antenna</b>		
Length	2.40-3.00	2.68 $\pm$ 0.13

<b>Leg length</b>		
Prothoracic	2.20-3.00	2.66 ± 0.14
Mesothoracic	2.50-3.50	2.94 ± 0.18
Metathoracic	3.00-4.00	3.38 ± 0.17
<b>Wing length</b>		
Fore	2.40-3.70	2.72 ± 0.24
Hind	2.00-2.50	2.18 ± 0.09
<b>Wing span</b>		
Fore	3.20-4.0	03.68 ± 0.15
Hind	2.50-3.20	2.90 ± 0.12

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