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# Biology and Morphometry of Molsari Leaf Webber, *Nephopteryx eugraphella* Ragonot (Lepidoptera: Pyralidae) on Molsari

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***Abstract*:** Molsari (*Mimusops elengi* Linn.) is a large-sized ornamental tree attacked by many insect-pests with leaf webber- *Nephopteryx eugraphella* Ragonot being the key pest. Biology of *N. eugraphella* was studied on Molsari leaves at PAU, Ludhiana. In all five generations per year were observed and incubation period increased from 3.17 to 4.54 days, while the percent egg hatchability decreased from 90.83 to 72.99 per cent in successive generations. Mean larval period varied from 15.28 days in June to 19.41 days in December. The size of the larvae varied from 1.18- 1.41 × 0.26-0.45 mm in I instar to 19.24-21.88 × 0.99-1.78 mm in full grown larva. Pre-pupal and pupal period ranged between 0.50-2.34 days and 5.89-9.62 days with pupal survival being the highest i.e. 92.79 % in the months of August and September. Adult female and male were 9.50-11.25 mm and 9.00-11.21 mm long and lived for 5.31 to 9.79 and 3.32 to 6.75 days respectively. Gravid female laid 42 to 101.80 eggs and the sex ratio (male: female) ranged between 1:1.13 to 1:1.40. The total life cycle of the insect ranged between 32-45 days. Pest was found to be more active during July, August and September.

***Keywords:*** *Mimusops elengi, Nephopteryx eugraphella,* Biology, Morphometry, Generation

*Mimusops elengi* Linn. commonly known as Molsari, is a native tree of the western Peninsular region of South India (Halder et al 2018). It is grown as a shade or avenue tree and has many medicinal properties (Ali et al 2008). Leaf webber, termites, grasshoppers, thrips, mealybug, and tent hairy caterpillar are among the insect pests that infest Molsari (Tripathy et al 2020). Foliage feeders (71.42%) are the major insect-pests attacking Molsari followed by bark and sap feeders (28.56%). *Nephopteryx eugraphella* Ragonot-a foliage feeder moth belonging to Pyralidae family is the most common insect pest species (Tripathy et al 2020). Its caterpillar damages the young leaves, apical shoots and flower buds of *M. elengi*. The larvae create a leaf fold within which it feeds, the leaf fold is held together with silken threads and excretal pellets are entrapped in the webs. Young larvae also tend to feed on the internal parts of flowers and flower buds. Thus, the injured flowers and floral buds dry up and do not bear any fruit. It causes immense damage during the rainy season. It was reported that about 90-100% of the plants and 60-80% of foliage were infested by this foliage feeder in Uttar Pradesh thereby giving burning appearance to the trees (Halder et al 2018). *N. eugrephella* has been reported from Bengal, Bihar, Punjab, Tamil Nadu and Madhya Pradesh (Cherian and Ananthanarayanan 1942 and Gupta and Gangrade 1955). Halder et al (2018) published their findings on the biology and bio-intensive management of this pest on Molsari trees in Uttar Pradesh. However, no such detailed and systematic studies have been conducted on biology of *N. eugraphella* on Molsari under Punjab conditions. Keeping in view the damage potential of this pest, the present study on the biology of *N. eugraphella* on Molsari under Punjab conditions has been attempted.

## MATERIAL AND METHODS

The study on biology of *N. eugraphella* was carried out during 2021-2022 at Punjab Agricultural University in Ludhiana, Punjab, India. Grown-up larvae of *N. eugraphella* were collected from the Molsari trees and were released on tender Molsari leaves in plastic vials under laboratory conditions. Until pupation, leaves were changed at regular intervals. The pupae were placed in glass jars (13.7 height and 11.4 cm diameter) with a layer of moist sand at the bottom and a sheet of blotting paper on top. In glass jars (15 cm diameter, 19.2 cm height) lined with tissue sheets, five pairs of newly emerged adult male and female were released. Apical shoots of *M. elengi* were provided as oviposition substrate inside the jars. Cotton swabs dipped in a 5 per cent honey solution were given to the moths as food source. The leaves containing freshly deposited eggs were employed for further biological research and five replications were kept. The incubation period and egg hatchability were recorded. Larval duration, larval survival, larval growth index, larval length and larval breadth were observed for larval stage. In case of pupa, duration of pre-pupal period, pre-pupal weight, pre-pupal length, pre-pupal breadth, pupal period, survival, pupation site, pupal weight, pupal length and

pupal breadth were measured. Pre-mating, mating, pre-oviposition, oviposition and post-oviposition periods were also recorded along with longevity of adults, adult length, wing expanse, site of oviposition, mating behaviour, sex ratio and fecundity per female in all the generations throughout the year.

**Statistical analysis:** The data was subjected to analysis using Statistical Package for the Social Sciences (SPSS) software.

## RESULTS AND DISCUSSION

### Biological Parameters

#### Egg stage

**Incubation period:** Incubation period under laboratory conditions ranged between 2.74 to 4.87 days when moths were reared from $G_1$ to $G_5$ (Table 1). Similar to our observations, incubation period of 3-5 days was reported by Shukla and Patel (2011).

**Egg hatchability:** Hatchability of eggs varied from 72.99 to 90.83 per cent among different generations (Table 1). There was a regular decrease in the hatchability of eggs from $G_1$ to $G_5$. Compared to this, 78 to 96 and 80 to 100 per cent viability of eggs was reported by Halder et al (2018) and Shukla and Patel (2011), respectively.

**Site and manner of oviposition:** Eggs were laid naked on any part of the tender shoots viz., branches, leaf-petioles and leaves. Leaves were the most preferred oviposition site. Even on the leaves, eggs were preferably laid along the midrib on the under surface of the leaf and along leaf-margins. The eggs were mostly laid singly and occasionally in batches of 2-6.

#### Larval stage

**Larval period:** The average larval periods in $G_1$, $G_2$, $G_3$, $G_4$ and $G_5$ varied from 15.28 to 19.41 days, respectively (Table 1). Halder et al (2018) reported the larval period of 18.38 days. Similarly, larval period of 15.76 days was observed by Shukla and Patel (2011).

**Larval survival and growth index:** The per cent larval survival varied from 41.44 to 55.47 per cent during different generations while the larval growth index ranged from 2.13 to 3.32 (Table 1). The most favourable period for larval development was from July-September as indicated by better larval survival and higher larval growth index.

#### Pre-pupal stage

**Pre-pupal period:** The average pre-pupal periods in $G_1$, $G_2$, $G_3$, $G_4$ and $G_5$ ranged from 0.60 to 2.11 days, respectively (Table 1). The pre-pupal period of 2 days was also reported by Patel (1996).

**Table 1.** Biological parameters of *Nephopteryx eugraphella* Ragonot on molsari

| Parameters | Generations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | I | | II | | III | | IV | | V | |
| | Mean | Range | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Incubation period (Days) | 3.17 | 2.74-3.63 | 3.48 | 2.96-3.77 | 3.87 | 3.55-4.05 | 4.15 | 3.85-4.55 | 4.54 | 3.97-4.87 |
| Egg hatchability (%) | 90.83 | | 87.64 | | 85.38 | | 78.42 | | 72.99 | |
| Larval period (Days) | 15.28 | 14.70-16.05 | 15.96 | 14.72-17.09 | 16.67 | 16.16-17.10 | 18.02 | 17.66-18.88 | 19.41 | 18.91-20.25 |
| Larval survival (%) | 48.88 | | 52.56 | | 55.47 | | 44.75 | | 41.44 | |
| Pre-pupal period (Days) | 0.60 | 0.50-0.72 | 0.75 | 0.68-0.80 | 1.07 | 0.87-1.44 | 1.86 | 1.50-2.12 | 2.11 | 1.97-2.34 |
| Pupal period (Days) | 6.52 | 5.89-7.09 | 7.14 | 5.90-7.82 | 8.27 | 7.69-9.13 | 8.81 | 7.86-9.36 | 9.24 | 8.75-9.62 |
| Pupal survival (%) | 85.19 | | 89.38 | | 92.79 | | 80.21 | | 76.25 | |
| Pre-mating period (Days) | 1.22 | (0.91-1.34) | 1.25 | (0.97-1.49) | 1.31 | (0.92-1.66) | 1.68 | (1.28-2.18) | 1.93 | (1.49-2.26) |
| mating period (Days) | 0.42 | (0.35-0.49) | 0.41 | (0.37-0.44) | 0.47 | (0.42-0.56) | 0.57 | (0.48-0.67) | 0.62 | (0.58-0.68) |
| Pre-oviposition period (Days) | 1.64 | (1.30-1.81) | 1.66 | (1.41-1.92) | 1.78 | (1.34-2.16) | 2.25 | (1.82-2.85) | 2.55 | (2.08-2.86) |
| Oviposition period (Days) | 2.28 | (1.84-2.55) | 2.38 | (2.01-2.85) | 2.80 | (2.29-3.32) | 3.29 | (2.88-3.86) | 3.62 | (3.44-3.92) |
| Post-oviposition period (Days) | 2.08 | (1.33-2.73) | 2.24 | (1.62-2.85) | 2.62 | (1.83-3.01) | 2.95 | (2.63-3.24) | 3.21 | (2.77-3.45) |
| Adult longevity (Male) | 3.86 | (3.32-4.75) | 4.28 | (3.88-4.76) | 4.82 | (3.90-5.28) | 5.53 | (4.89-5.84) | 6.33 | (5.78-6.75) |
| Adult longevity (Female) | 6.00 | (5.69-6.82) | 6.28 | (5.31-7.07) | 7.24 | (6.96-7.53) | 8.48 | (7.62-9.43) | 9.38 | (9.06-9.79) |
| Sex ratio (Male : Female) | 1:1.18 | | 1:1.30 | | 1:1.13 | | 1:1.40 | | 1:1.25 | |
| Fecundity (No. of eggs/female) | 101.80 | (94-110) | 88.60 | (75-105) | 70.40 | (60-90) | 53.60 | (42-65) | 42.00 | (34-52) |

**Pupal stage**

**Pupal period:** The average pupal periods in $G_1$ through $G_5$ was 6.52 to 9.24 days, respectively (Table 1). Similar to present study, the pupal period of 6-9 days was reported by Dongre (2011) and Shukla and Patel (2011).

**Pupal survival:** Pupal survival varied from 72.99 to 90.83 per cent among different generations (Table 1). Lowest pupal survival was in $G_5$ (76.25 %) while the highest in $G_3$ (92.79 %).

**Pupation site:** Pupation takes place in soil by preparing an earthen cell with an exit hole for the emergence of adult. The newly formed pupae were light green in colour which turned light to reddish brown within 24 hours and become dark brown prior to the emergence of adult. Pupa was broad anteriorly with a tapered posterior end. Compound eyes were prominent. Similar findings have been reported by Shukla and Patel (2011).

**Adult stage**

**Pre-mating and mating period:** The average pre-mating period in $G_1$, $G_2$, $G_3$, $G_4$ and $G_5$ ranged from 1.22 to 1.93 days, respectively while average mating periods was 0.42, 0.41, 0.47, 0.57 and 0.62 days (Table 1). Pre-mating and mating period of 1.26 and 0.44 days was reported by Shukla and Patel (2011).

**Pre-oviposition, oviposition and post-oviposition period:** The pre-oviposition, oviposition and post-oviposition periods were ranged from 1.30-2.86, 1.84-3.92 and 1.33-3.45 days, respectively during different generations (Table 1).

**Longevity of adults:** The longevity of male adults was slightly lesser than females in all the five generations. The average longevity of males in $G_1$, $G_2$, $G_3$, $G_4$ and $G_5$ varied between 3.86 to 6.33 days, respectively while female longevity varied between 6.00 to 9.38 days throughout the five generations respectively (Table 1). The average male and female longevity of 4.85 and 8.38 days respectively was reported by Halder et al (2018).

**Sex ratio:** The sex ratio of male: female in all the five generation was almost similar as it ranged only from 1:1.13 to 1:1.40 (Table 1). This indicates that inbreeding in this insect does not have any adverse effect on the sex ratio.

**Fecundity:** Fecundity of a moth during different generations ($G_1$ to $G_5$) varied from 34-110 eggs under laboratory conditions. However, there was a regular decrease in the fecundity from $G_1$ to $G_5$ generations (Table 1). Similar results have also been reported in this pyralid moth by Shukla and Patel (2011). This shows that inbreeding for longer duration causes an adverse effect on the fecundity of this pyralid moth.

**Mating behaviour:** Mating took place in end to end position and the moths were found mating at least twice during their life span .

**Morphometric Parameters**

***Larva*:** Length of newly hatched larva ranged between 1.22 to 1.35 mm and breadth ranged between 0.31 to 0.38 mm during different generations (Table 2). Newly hatched larvae were pink which eventually turn yellow within 24 hours. Larval head was pale yellow with one longitudinal median stripe and three purple dorso-lateral stripes on its either side of the body. Prolegs were present on 3$^{rd}$ to 6$^{th}$ and 10$^{th}$ abdominal segments. Prolegs were unjointed, conical and fleshy with crochets that were arranged in a circle. Dorsal surface of body was covered with micro hairs. The full-grown larva ranged from 19.40 to 21.61 mm in length and 1.19 to 1.51 mm in breadth during different generations (Table 2). Head and first thoracic segment were yellowish brown with black lines and spots. Dorsal side of body was pink in colour while ventral side was green. First and third pair of stripes were pink and blended with black spots on each segment while the second pair of stripes were purple in colour. On the second thoracic and eighth abdominal segment a pair of dorso-lateral prominent black spots was present. Prominent longitudinal stripes and hairs were present throughout the body of the larva. These observations are in general agreement with Shukla and Patel (2011).

**Pre-pupa:** After completion of larval development, final instar larvae stopped feeding and changed its colour from pinkish to greenish. This was the indication of larva undergoing pre-pupal stage. The average weight of pre-pupa in $G_1$ to $G_5$ ranged from 47.20 to 55.00 mg, respectively. The length and breadth of pre-pupa varied from 12.41 to 13.44 mm and 2.81 to 3.14 mm, respectively during different generations (Table 2). Patel (1996) also observed pre-pupal length and breadth of 12 to 13 mm and 2.25 to 2.75 mm .

**Pupa:** The average weight of pupa in $G_1$ to $G_5$ ranged between 45.20 to 60.20 mg, respectively. The pupal length varied from 9.72 to 10.88 mm and variation of 2.97 to 3.23 mm was observed in breadth, during different generations (Table 2). Shukla and Patel (2011) also reported pupal length of 9 to 11 mm and breadth of 2.6 to 2.8 mm.

**Adult:** Adult was greyish in colour with compound black eyes and setaceous antennae. Fore-wings were greyish in colour having four black transverse wavy lines. Hind-wings were membranous and white in colour. Both the wings were fringed at the outer margins. A brownish line was present near the outer margins of both the wings. In females, tip of abdomen was yellow or black with slit like genital aperture, while in males it was pointed and greyish in appearance. The body length varied from 9.00-11.21 mm in male with wing expanse of 18.56-20.60 mm during different generations while it ranged between 9.50-11.25 mm with wing expanse of 19.75-21.03 mm in case of adult females.

**Table 2.** Morphometrics of *Nephopteryx eugraphella* Ragonot on molsari

| Stages of development | Generations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | I | | II | | III | | IV | | V | |
| | Mean | Range | Mean | Range | Mean | Range | Mean | Range | Mean | Range |
| Length of I instar larvae (mm) | 1.22 | 1.18-1.28 | 1.29 | 1.22-1.38 | 1.35 | 1.26-1.42 | 1.26 | 1.19-1.40 | 1.31 | 1.20-1.41 |
| Length of II instar larvae (mm) | 4.18 | 4.00-4.30 | 4.41 | 4.28-4.51 | 4.65 | 4.57-4.74 | 4.52 | 4.15-4.68 | 4.48 | 4.20-4.71 |
| Length of III instar larvae (mm) | 13.22 | 13.10-13.32 | 13.27 | 13.19-13.40 | 13.34 | 13.16-13.54 | 13.32 | 13.14-13.50 | 13.36 | 13.22-13.52 |
| Length of IV instar larvae (mm) | 19.22 | 19.00-19.34 | 19.45 | 19.24-19.58 | 19.88 | 19.80-19.94 | 19.70 | 19.54-19.85 | 19.74 | 19.50-19.90 |
| Length of full-grown larvae (mm) | 19.40 | 19.24-19.58 | 20.01 | 19.60-20.30 | 21.49 | 20.72-21.56 | 20.92 | 19.90-21.88 | 21.61 | 19.87-22.50 |
| Breadth of I instar larvae (mm) | 0.31 | 0.26-0.38 | 0.32 | 0.27-0.40 | 0.38 | 0.26-0.45 | 0.35 | 0.31-0.42 | 0.33 | 0.27-0.38 |
| Breadth of II instar larvae (mm) | 0.46 | 0.40-0.55 | 0.53 | 0.44-0.60 | 0.67 | 0.49-0.78 | 0.56 | 0.45-0.66 | 0.58 | 0.46-0.67 |
| Breadth of III instar larvae (mm) | 0.66 | 0.52-0.78 | 0.67 | 0.55-0.84 | 0.76 | 0.57-0.90 | 0.72 | 0.54-0.98 | 0.74 | 0.58-0.95 |
| Breadth of IV instar larvae (mm) | 0.66 | 0.49-0.85 | 0.77 | 0.48-1.22 | 1.11 | 0.52-1.48 | 1.03 | 0.75-1.39 | 1.02 | 0.50-1.28 |
| Breadth of full-grown larvae (mm) | 1.19 | 0.99-1.44 | 1.21 | 0.98-1.39 | 1.48 | 0.99-1.69 | 1.44 | 1.08-1.78 | 1.51 | 1.21-1.74 |
| Pre-pupal weight (mg) | 47.20 | 42-52 | 49.60 | 45-53 | 53.80 | 49-58 | 49.20 | 42-59 | 55.00 | 47-59 |
| Pre-pupal length (mm) | 12.41 | 12.00-13.00 | 13.08 | 12.50-13.54 | 13.32 | 12.76-13.70 | 13.08 | 12.33-13.68 | 13.44 | 13.22-13.70 |
| Pre-pupal breadth (mm) | 2.81 | 2.35-3.37 | 2.96 | 2.25-3.54 | 3.05 | 2.43-3.55 | 2.94 | 2.29-3.60 | 3.14 | 2.64-3.58 |
| Pupal weight (mg) | 45.20 | 39-57 | 55.20 | 50-65 | 60.60 | 55-67 | 44.40 | 39-54 | 60.20 | 56-64 |
| Pupal length (mm) | 9.72 | 9.17-10.11 | 10.22 | 9.25-10.88 | 10.88 | 9.86-11.45 | 10.21 | 9.40-10.88 | 10.56 | 9.67-11.07 |
| Pupal breadth (mm) | 3.01 | 2.70-3.42 | 3.08 | 2.88-3.30 | 2.97 | 2.68-3.50 | 3.12 | 2.71-3.49 | 3.23 | 2.94-3.50 |
| Male adult length at resting (mm) | 9.62 | 9.10-10.04 | 9.89 | 9.12-10.34 | 10.44 | 9.00-11.19 | 10.07 | 9.67-10.85 | 10.32 | 9.00-11.21 |
| Female adult length at resting (mm) | 10.07 | 9.56-10.70 | 10.32 | 9.50-11.25 | 10.57 | 9.62-11.20 | 10.05 | 9.54-10.78 | 10.45 | 9.63-11.19 |
| Male adult length with wing expand (mm) | 19.03 | 18.56-19.78 | 19.63 | 19.10-20.09 | 19.71 | 18.56-20.60 | 19.65 | 18.72-20.30 | 19.73 | 18.56-20.55 |
| Female adult length with wing expand (mm) | 19.92 | 19.80-20.03 | 20.36 | 19.75-20.77 | 20.51 | 19.86-21.00 | 20.12 | 19.76-21.02 | 20.74 | 20.35-21.03 |

## CONCLUSION

The life cycle of insect was the shortest in the months of rainy season i.e. July and August which coincided with maximum rate of reproduction. The findings of this study will be useful in developing stage targeted pest control strategies that will successfully reduce the pest population by identifying the most vulnerable stage of the pest for effective management.

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