

**BIOLOGICAL STUDIES OF *LYMANTRIA OBFUSCATA*
WALKER (LEPIDOPTERA: LYMANTRIDAE) ON APPLE
PLANTATIONS (*MALUS DOMESTICA* BORKH.)
IN JAMMU REGION OF J & K, INDIA**

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ABSTRACT: *Lymantria obfuscata* Walker is a polyphagous pest infesting a wide variety of fruit and forest trees. The objective of this work is to study the detailed life cycle of Indian gypsy moth (*Lymantria obfuscata* Walker) on apple plantations (*Malus domestica* Borkh.), which is a cherished and economically important fruit crop in Jammu region of J & K State, India and is severely attacked by the larvae of Indian gypsy moths. Larvae defoliate apple plants, reduce their vigour and sometimes the infestation is so severe that it leads to mass destruction of apple plants. Thus, an attempt was made to study the biology of *this pest* in Jammu as no earlier record of the pest has been obtained from the region so far. Incidence of the pest was determined by the defoliated leaves fallen from the trees which indicates an identification mark for locating the pest. Biological studies include morphometric measurements of different stages from egg to adult. Incubation period varies from 286.0 to 329.0 days (305.2±5.26 days) (mean±SE). Larval period varies from 37 to 60 days (49.8±2.43) days. Pupal period ranges from 12 to 14 days (13.4±0.27 days). Adult longevity of male and female is 3.5 to 6 days (4.45±0.25) and 7 to 9 days (7.60±0.0.20 days) respectively. Besides biology, host plants and distribution of the pest are also included in the paper.

KEY WORDS: *Lymantria obfuscata* Walker, *Malus domestica* Borkh, biology, new, morphometric.

Indian gypsy moth *Lymantria obfuscata* Walker (Lepidoptera: Lymantridae), also known as hairy caterpillar is one of the most destructive pest of fruit and forest plantations across the world. The pest has been recorded by the montane and sub-montane regions of south western Himalayas, West Pakistan (Hampson, 1892; Beeson, 1941; Browne, 1968) and USA (Fuester et al., 2008) and Canada (Gries et al., 2007) have been reported causing frequent and severe defoliation.

In India the pest has been recorded from Kashmir, Himachal Pradesh (Beeson, 1941; Pruthi & Batra, 1960; Nair, 1970; Malik et al., 1972; Mishra & Basu Choudhuri, 1974; Sheikh, 1975; Dar et al., 1976; Butani, 1979; Shrivastava & Masoodi, 1985; Rishi & Shah, 1985; Singh & Singh, 1986; Masoodi, 1991; Bhardwaj & Bhardwaj, 2005; Mir & Wani, 2005), Tamilnadu (Rahman, 1941; Nair, 1970; Gupta, 1976; Verma et al., 1979; Butani, 1979; Masoodi et al., 1986; Bhardwaj & Bhardwaj, 2005; Singh et al., 2007;), Dehradun (Roonwal, 1954), Uttar Pradesh (Gupta, 1976), Karnataka (Nair & Premkumar, 1974) and Varanasi (Raju et al., 1994; Raju et al., 1995) on different host plants.

The biological studies of this pest have not been conducted in detail on apple although, some preliminary observations were made by Beeson (1941), Rahman & Kalra (1944) and Roonwal (1977). Kumar (1974) while observing this pest in South India on cocoa leaves made some observations about the hatching of eggs and feeding habits. Mishra & Basu Choudhuri (1974) while recording the occurrence of *Lymantria obfuscata* Walker on cashew in Tamil nadu described its

bionomics. Masoodi (1991) recorded its biology on willow leaves in Kashmir. These observations on its biology are either incomplete or were undertaken in different situations in India and no detailed and systematic information on its bionomics in Jammu province in India, where it has assumed serious dimensions, is available. The present work was therefore undertaken to study the detailed biology of *Lymantria obfuscata* Walker in Jammu, India which would be useful for development of management programme of the pest on the most important economic crop plant i.e. apple plantations of the area.

MATERIALS AND METHODS

Studies on the biology of *Lymantria obfuscata* were conducted under laboratory conditions in the field laboratory established at Bhaderwah area of Jammu Province from April to July during 2011-12. The insect larvae were collected from apple plantations of the area and reared in the laboratory. Adult moths were allowed to copulate separately in wire meshed cages. Each pair was observed for pre-mating, mating, pre-oviposition and oviposition behaviour and duration. Longevity of adult moths was also recorded. The egg masses were measured and eggs in each mass were dehaired, counted and their diameter measured by means of an ocular micrometer after calibration. Dehaired eggs were washed with distilled water; air dried and kept under laboratory conditions for incubation in Petri dishes.

Newly hatched larvae were then transferred to sterile paired petri dishes, lined with moist filter paper and provided with fresh apple leaves. The food and filter paper lining were changed after every third day during the first and second larval instars and later on food was changed daily and filter paper lining on alternate days. Larvae were observed daily and data was recorded with regards to moulting, duration and size of each larval instar, pupation and pupal period. All life stages were recorded morphometrically. Male and female pupae were placed in separate petridishes lined with filter paper. Pupae were segregated on the basis of size as female pupae were larger than the males. Observations were recorded with regards to emergence and fecundity.

Morphometric measurements were recorded using standard graphic paper method. For the study of different instars, the head capsule width was measured with the help of an oculometer. Data gathered during the experiment was analyzed statistically for calculating mean, standard deviation and standard error.

RESULTS

BIOLOGICAL STUDIES:

Emergence of the pest:

In the field, adult gypsy moths appeared in late May and remains till June on apple plantations in study areas. Before copulation the male shows some signs of pre-copulatory behaviour indicated by twitching of antennae and shaking of the body. Simultaneously female moth responds by protracted and retracted last abdominal segment of their body. Mating occurs during day time and lasts for about one and a half hour.

Oviposition:

Immediately after copulation female starts egg laying in batches on the bark of apple trees and other adjoining places and forms an egg mass covered with golden brown hair. Egg laying continued for 2.0 to 5.0 days and an average of 270.83 eggs are laid by each female in the area of investigator on apple trees. Egg laying

behaviour of the pest under study has also been observed by some earlier workers like Rahman & Kalra (1944) and Masoodi (1991) who gave a brief account of the oviposition of female moths of *L. obfuscata* and recorded 200-400 and 462.13 eggs laid by each female.

Egg masses are laid by female moths in clusters on the surface of the bark or leaves of trees, each egg mass usually being covered externally with a layer of hairs believed to be derived from the anal tufts of the ovipositing females. Exceptionally eggs were also laid on leaves, dried fruits, and even on the surface of brick walls, ceilings on the houses and metal wire gauze nettings. The egg masses of *Lymantria obfuscata* on apple plantations in the present area of study are sub ovoid, oval to quadrangle and semi linear and measures 26.0 ± 9.72 (SE: 2.80) and 19.66 ± 5.86 (SE: 1.69) mm in length and width respectively. The egg masses also assume a variety of other shapes. Freshly laid eggs were pale yellowish and rounded when seen from above, having a diameter of about 0.75 ± 0.070 (SE: 0.02) mm that ranged from a minimum of 0.65mm to a maximum of 0.85 mm.

Incubation Period:

Incubation period of the eggs as observed by the present author in the area under investigation on apple plantations as host ranged from 9 to 10 months with an average of 305.2 ± 16.63 days.

Hatching

From the incubated eggs of the previous season, young larvae start hatching from late March and continued till April in Jammu region of J&K State on apple plantations (*Malus domestica* Borkh.). Masoodi (1991) also recorded the same hatching period of the pest from 5.0 days to 24.0 days with an average of 9.8 ± 5.37 days and occurs during day time. After hatching first instar larvae wander about and started feeding on upper surfaces of leaves forming small perforations. They remain hidden during the night where they do not feed.

Larval Stages:

The author has recorded five larval instars in the life cycle of the pest.

First Instar

First instar larvae of *Lymantria obfuscata* were darker measuring 4.03 ± 0.80 (SE: 0.25) mm in length and 0.37 ± 0.05 (SE: 0.01) mm in width. Body covered with tuft of hairs, bearing a pair of small dots on each segment running all along the back. Newly hatched larvae feed on upper surfaces of leaves forming small perforations. They remain hidden during the night where they do not feed.

This stage lasted for 7.0 to 10.0 days with an average of 8.55 ± 0.92 (SE: 0.29) days while feeding on apple in the area of present investigator.

Second instar

Larvae brownish, with hairs covering the body and measured 8.43 ± 1.30 (SE: 0.41) mm long and 1.78 ± 0.27 (SE: 0.08) mm wide. Larva possess double row of small tubercles along the back. Feed usually in the morning hours by defoliating the leaves along their margins. During night or when not feeding, larvae rest under shade i.e. under leaves and cracks in the bark spaces of trees in the field and inside the filter paper of Petri dishes under lab conditions.

The second larval stage lasted for a period of 5.0 to 9.0 days with an average of 6.75 ± 1.37 (SE: 0.43) days by the investigator during her studies in Jammu region.

Third instar

Third instar larvae are dark grey. Double rows of tubercles are prominent with first five pairs of bluish and last six pairs brick red in color. The dark brown head of the larva had yellow markings and body measured 17.12 ± 3.17 mm in length and 3.89 ± 0.70 mm in width. Larvae usually feed during morning and cause massive

defoliation of the apple trees in study area of the present investigator. This stage lasted for 5.50 to 9.0 days with an average of 7.6 ± 1.41 days. The duration of third larval instar in the study area on to range between 5.0 to 9.0 days with an average of 7.6 days.

Fourth instar

Body becomes more hairy, brownish and double row of tubercles become more prominent and measured 25.67 ± 3.33 mm in length and 6.22 ± 0.33 mm in width. A light strip between the tubercles and the spiracles runs on each side of larva all along the length.

The feeding behaviour of fourth instar larvae vary much from the previous ones as larvae now start feeding during night hours also but remains confined to leaf margins and during the day larvae rest under the shade of the leaves. This larval stage varies between 8.0 - 14.0 days with an average of 11.6 ± 1.85 days.

Fifth instar

General appearance of the final instar larvae was similar to that of the fourth instar except variations in the length and width of the body that measured 39.94 ± 4.41 mm (SE: 1.39) and 8.30 ± 0.42 (SE: 0.13) mm respectively. It has short dorsal and long lateral tufts of hair. Duration of fifth instar lasted for a minimum period of 12.0 days to a maximum of 18.0 days with an average of 15.3 ± 2.16 days.

Average larval duration of the pest as recorded by the author in the study area on apple tree as a host ranged between 37.5 - 60.0 days with an average of 49.8 ± 7.71 (SE: 2.43) days.

Pupae

Fully fed and matured larvae stopped feeding, body start shrinking and thickening in size. It then spins some silken threads around its body and remains in this pre-pupal stage for about 3.35 ± 0.88 days. Larvae do not spin any cocoon around its body. Pupae almost naked, reddish brown with only a few strands of silken threads attached loosely to its body. Female pupa characteristically larger than male pupa measured 22.0 ± 1.58 mm and 6.20 ± 0.78 mm respectively. Pupal period ranged from 12.0 to 14.5 days with an average of 13.4 ± 0.87 days.

Adults

In adults of gypsy moth, sexual dimorphism is well distinct. Female moths larger in size and dirty creamish whereas males smaller than females and have brownish bodies. In males wings are well developed. Front and hind wings dissimilar in venation and in shape. R_s in hindwing unbranched; jugum and fibula absent; front and hind wings united by a frenulum; mouthparts usually in the form of a coiled proboscis. Wings entire; scaled throughout. Hindwings much broader than their fringe and usually wider than front wings; hind wings with two anal veins; front wing with a single complete anal vein Sc and R_s in hind wing not connected by a cross vein; M_2 in front wing arising closer to M_3 than to M_1 ; cubitus appear four branched; front wing with some branches of R and M fused beyond discal cell; hindwing without humeral veins; usually with a frenulum; Cu_2 in front wing arising in basal half; frenulum well developed; Sc in hindwing present and well developed; Hindwing with Sc and R_s widely separate beyond discal cell and base of R_s well developed; ocelli present; front wings smoothly scaled; Hindwing with a small basal areole and Sc and R_s fused for only a short distance at end of areole.

Female moths apterous possessing feebly developed wings and bulky body and therefore are unable to fly. Male moths have functional wings and can perform its normal flight in a zig zag manner during the day. The average length and width of male and female moths are 14.2 ± 1.64 (SE: 0.73) mm and 33.4 ± 4.21 (SE: 1.88) mm and 20.6 ± 2.96 (SE: 1.32) mm and 40.8 ± 2.94 (SE: 1.31) mm respectively.

Male and female moths lived for a period of about 3.5 to 6.0 days and 7.0 to 9.0 days with an average of 4.45 ± 0.79 (SE: 0.25) days and 7.60 ± 0.65 (SE: 0.20) days respectively when fed with 5% honey solution in the field lab established at study station at Bhaderwah.

Damage:

Indian gypsy moth is an important defoliator and a destructive pest of deciduous, shade and fruit trees in parts of Asia, Africa, Europe and North America (Berozoa et al., 1973 and Kumar (1974). Although the insect has a wide range of host plants but some host species such as willows, poplars and apples are extensively defoliated and support large larval populations. Butani (1979) reported that the larvae of Indian gypsy moth defoliates the trees completely and results in failure of fruit formation.

Present investigations in Jammu division of J&K State on apple plantations (*Malus domestica* Borkh.) as a host found the caterpillars of this pest to defoliate the leaves and their feeding increases with the subsequent instars and the caterpillars feed voraciously on the entire tender leaves including the veins. In the field, the first instar larvae usually remains on the underside of leaves and are carried by wind from tree to tree, suspended by long threads that they spin. Caterpillars are nocturnal and gregarious in habit. They aggregate in large numbers on the ground under the fallen dry leaves near the base of the trees, crevices of bark or on lower parts of well shaded main branches. After dusk the larvae start crawling through tree trunks and feed there. In severe attack the caterpillars defoliate the host plants completely thereby retarding the growth of the trees.

On the basis of above observations recorded by the author in the field *Lymantria obfusca* is recorded as an important pest of apples in Jammu province of J & K State. In the near future this pest may assume more serious and destructive position if adequate control measures were not undertaken immediately. This warrants attention of the orchardists of the region for its timely and proper control.

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Table 1. Morphometric measurements of various life stages.

STAGE	BODY LENGTH (mm)		BODY WIDTH (mm)	
	Mean±SD	(Min-Max)	Mean±SD	(Min-Max)
Egg mass	15.0-45.0	26.0±9.72	13.0-28.0	19.66±5.86
First instar	3.04-5.20	4.03±0.80	0.32-0.48	0.37±0.05
Second instar	6.00-9.80	8.43±1.30	1.20±2.06	1.78±0.27
Third instar	10.8-19.8	17.12±3.17	3.00-5.00	3.89±0.70
Fourth instar	25.0-30.0	25.67±3.33	6.22-7.50	6.20±0.33
Fifth instar	39.0-47.0	39.94±4.41	7.60-9.00	8.30±0.42
Pupa	20.0-25.0	22.0±1.58	5.00-7.00	6.20±0.78
Adult male	12.0-16.0	14.20±1.64	28.0-34.0	33.4±4.21
Adult female	18.0-25.0	2.06±2.96	36.0-47.0	40.8±2.94

Table 2. Duration of different stages in the life cycle of *Lymantria obfuscata* Walker on apple plantations.

STAGE	DURATION OF DAYS		MEAN±SD	SEM
	MIN.	MAX.		
Incubation period	286.0	329.0	305.2±16.63	5.26
First Instar	7.0	10.0	8.55±0.92	0.29
Second Instar	5.0	9.0	6.75±1.37	0.43
Third Instar	5.5	9.0	7.6±1.41	0.44
Fourth Instar	8.0	14.0	11.6±1.85	0.58
Fifth Instar	12.0	18.0	15.3±2.16	0.68
Total Larval Period	37.5	60.0	66.5 ±7.71	2.43
Prepupation	2.0	4.0	3.35±0.88	0.27
Pupation	12.0	14.0	13.4±0.87	0.27
Life cycle(egg to adult emergence)	38.0	59.0	48.8±6.98	2.20
Adult longevity (Male)	3.5	6.0	4.45±0.79	0.25
Adult Longevity (Female)	7.0	9.0	7.60±0.65	0.20