OBSERVATIONS

Lepidoptera is the second largest order in the class Insecta (Roelofs and Rooney, 2003) and contains forty-seven superfamilies (Krenn, 2010). The superfamily Pyraloidea has most diverse life history adaptations. It can be identified from characters such as presence of paired tympanal organs situated ventrally on the 2nd abdominal segment, head bears long and upturned labial palpi, presence of two setae in the prespiracular group of the prothorax, crochets being arranged in a complete circle or penellipse and three subventral setae being present on A3-A6 segments.

Key to the families of superfamily Pyraloidea

Sclerotized ring around seta SD1 on A8 (missing in some Phycitinae), three (sometimes two) setae in the L group of A9; forewing vein R5 stalked or fussed with R3+4; tympanum and conjunctiva in the same plane-----------------------------Pyralidae

- No sclerotized ring around seta SD1 on A8, only one seta in the L group of A9; forewing vein R5 free; tympanum and conjunctiva lying at a blunt angle-----------------------------Crambidae

SUPERFAMILY: PYRALOIDEA

FAMILY: PYRALIDAE

Forewing vein R5 stalked or fused with R3+4, tympanum and conjunctiva in the same plane, praecinctorium absent, A8 of larvae almost always with sclerotized ring around base of SD1 and three (sometimes two) setae in the L group on A9.
Key to the subfamilies of family Pyralidae

Sclerotized ring around seta SD1 of A1, D1 dorsad to spiracle on A3-A6------------------------- Galleriinae
- Sclerotized area encircling the base of seta SD1 on mesothorax, D1 anterodorsad to spiracle on A3-A6------------------------------------- Phycitinae

Key to the genera of subfamily Galleriinae

Larval head with four stemmata, three setae in L group on A9, feeds on honey bee combs and wax--------------------------------------------- Galleria Fabricius
- Larval head with six stemmata, two setae of L group on A9, feeds on dry vegetable matter and stored products--------------------------- Corcyra Ragonot

SUBFAMILY: GALLERIINAE

Galleria mellonella (Linnaeus)
(Pl. 2, Photos. 3-8)
Tinea mellonella Linn. 1758, Syst. Nat. edit. 10:537

Study sites: Bhadurgarh, Rajpura.

Study period: March to October.

LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

Egg (Photo. 4): Incubation period 9.50±1.75 days; length 0.38±0.02 mm, width 0.30±0.01 mm; ovoid, smooth, creamish white in colour; laid in crevices or cracks of bee hive; in cluster of 50-100 eggs; chorion with poorly developed ridges showing polygonal cells.

Larva: Number of instars: 07.

Larval duration: 24.25±3.81 days.
**First instar:** Duration: 2.75±0.70 days.

**Head:** Width 0.24±0.05 mm, watery brown, shining.

**Body:** Length 1.08±0.08 mm, width 0.35±0.02 mm; dirty white in colour.

**Second instar:** Duration: 3.00±0.18 days.

**Head:** Width 0.45±0.04 mm; same as in first instar.

**Body:** Length 4.11±0.10 mm, width 0.45±0.03 mm; other observations resemble with first instar.

**Third instar:** Duration: 3.00±0.18 days.

**Head:** Width 0.57±0.03 mm; same as above.

**Body:** Length 6.83±1.04 mm, width 1.04±0.33 mm; same as above.

**Fourth instar:** Duration: 3.25±0.70 days.

**Head:** Width 0.85±0.23 mm; same as above.

**Body:** Length 9.50±0.07 mm, width 1.13±0.05 mm; same as above.

**Fifth instar:** Duration: 2.75±0.20 days.

**Head:** Width 1.05±0.07 mm; same as above.

**Body:** Length 12.00±1.00 mm, width 1.29±0.10 mm; dirty white in colour and more thickness than previous instars.

**Sixth instar:** Duration: 3.25±0.10 days.

**Head:** Width 1.35±0.07 mm; same as above.

**Body:** Length 15.50±0.40 mm, width 2.12±0.21 mm; otherwise same as before.

**Seventh instar (Photos. 5-6):** Duration: 6.25±1.75 days.

**Head:** Width 1.40±0.09 mm, brown.

**Body:** Length 20.75±0.10 mm, width 2.50±0.01 mm; pale honey coloured.

**Pupa (Photo. 7):** Duration: 6.75±1.25 days; length 16.10±0.04 mm, width 3.50±0.30 mm; last instar makes white thick silken cocoons in hive, shield the pupa, the latter orange in colour; segmentation clearly visible in mature pupae before eclosion.
Observations on various life history aspects

**Adult longevity:** 9.25±2.75 days.

**Adult (Photo. 3):** Frons and vertex ochreous; antennae simple, light brown; forewing with costa straight, apex rounded, outer margin convex, tornus rounded, anal margin almost straight, concave near base, ground colour ochreous; hindwing with ground colour white ochreous, costa straight, apex rounded, outer margin concave, tornus rounded, anal margin straight, cilia white; abdomen pale yellow; legs covered with white scales.

**Material examined:** 2♀, 2♂, 13.ix.2006, Rajpura; 1♀, 1♂, 15.ix.2006, Bahadurgarh.

**Larval host (Photo. 8):** Honeybee hives.

**OBSERVATIONS ON BEHAVIOUR**

**Larval behaviour:** The first instar larva comes out of the egg shell by breaking it from one side. The early stages of larvae feed on pollen, wax and abandoned hives or hives where the colony has become weakened. The larvae make tunnels through the combs and start feeding on pollen, wax and honey. The larva takes about 5-8 hours to complete the process of moulting.

**Pupation:** The last instar larvae make a thick silken cocoon either in the hive itself or grooves in the beehive or frame before pupation. In case of heavy infestation, the whole bee comb appears white in colour.

**Eclosion:** Eclosion takes place in between 8.00 am to 10.00 am.

**Adult behavior:** The adults mostly rest on the outer shady part of the beehive or on the nearby objects. The mating takes place outside the beehives. The adults have been seen flying during warmer season of the year.

**Remarks:** The immature stages of *Galleria mellonella* (Linnaeus) are available in the field in the months of March to October.
Observations on various life history aspects

*Corcyra cephalonica* (Stainton)
*(Pl. 3, Photos. 9-14)*
*Melissoblate cephalonica* Sttn. 1866, Ent. Mo. Mag. 2: 172

**Study sites:** Ludhiana, Patiala.

**Study period:** April to September.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** *(Photo. 10):* Incubation period 6.50±0.40 days; length 0.52±0.02 mm, width 0.36±0.01 mm; creamish white in colour; somewhat rounded; laid in clusters of 7 to 12 on the grains: smooth chorion with weak ornamentation.

**Larva:** Number of instars: 05.

- Larval duration: 19.75±2.58 days.

**First instar:** Duration: 3.75±0.50 days.

- **Head:** Width 0.65±0.08 mm; light brown in colour.
- **Body:** Length 2.70±0.82 mm, width 0.62±0.12 mm; creamish white in colour.

**Second instar:** Duration: 3.25±0.25 days.

- **Head:** Width 1.09±0.11 mm; same as in first instar.
- **Body:** Length 4.75±0.20 mm, width 1.20±0.30 mm; same as first instar.

**Third instar:** Duration: 3.75±0.33 days.

- **Head:** Width 1.36±0.20 mm; same as above.
- **Body:** Length 12.60±4.12 mm, width 2.00±0.02 mm; same as above.

**Fourth instar:** Duration: 4.25±1.25 days.

- **Head:** Width 1.25±0.35 mm; same as above.
- **Body:** Length 14.25±0.60 mm, width 2.25±0.83 mm; prolegs seems to be larger in size; body comparatively thicker as compared to previous instars.

**Fifth instar** *(Photo. 11):* Duration: 4.75±0.25 days.

- **Head:** Width 2.45±0.14 mm; same as above.
- **Body:** Length 14.50±1.03 mm, width 2.26±1.25 mm; dirty creamish white in colour and active in nature; more thickness than previous instars.
Observations on various life history aspects

**Pupa (Photos.12-13):** Duration: $7.25\pm1.65$ days; length $13.50\pm0.30$ mm; width $3.98\pm1.14$ mm; the caterpillars make dirty white silken cocoons among the grains and faecal matter and pupates in it.

**Adult longevity:** $6.75\pm1.25$ days.

**Adult (Photo. 9):** Frons and vertex light brownish gray; antennae light brownish grey; forewing with costa concave, apex rounded, outer margin concave, tornus rounded, anal margin concave; ground colour light brownish gray without any spot; hind wing with ground colour dark brownish grey without any spot, costa straight, apex rounded, outer margin oblique, tornus rounded, anal margin straight; cilia long, gray; Abdomen brown; legs covered with light brown scales.

**Material examined:** 9♂, 1♀, 21.iv.2007, Ludhiana; 13♂, 1♀, 19.vi.2007, Patiala.

**Host stored product (Photo. 14):** Pennisetum typhoides (Graminae).

**OBSERVATIONS ON BEHAVIOUR**

**Larval behaviour:** Prior to hatching, the first instar larva devours half of the egg shell from near the micropylar region. Then it starts wriggling in the splitted grains and starts feeding there. The larvae spin silken thread amongst the grains and all the successive instars feed in it upto pupation. It takes about 8 to 9 hours by the larva to change to the next instar.

**Pupation:** The larvae make dirty white silken cocoons amongst the grains which are thin in texture and pupate in it. The freshly formed pupae are light brown in colour and become darker near maturity. The wing demarcations and body segmentation can be clearly seen in the mature pupae.

**Eclosion:** The adult emergence has been observed to take place anytime during the daytime.

**Adult behavior:** The adults are rather more active at night and live for 6-7 days. They fly for a short distance and have been observed to sit mostly on the grain bags.
Remarks: The immature stages of *Corcyra cephalonica* (Stainton) have been found to be available in the godowns and warehouses during the months of April to September. While rearing of *C. cephalonica* in the laboratory, it has been found that larvae made the silken cocoons on the walls of the container and also made a solid webbed mass by joining all the grains.

**SUBFAMILY: PHYCITINAE**

*Emmalocera depressella* Swinhoe

*(Pl. 4, Photos. 15-20)*


**Study sites:** Haripur, Moii, Noormahal.

**Study period:** April to October.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** *(Photo. 16):* Incubation period: 5.60 ± 0.38 days; length 0.48±0.01 mm, width 0.31±0.01mm; the eggs creamish white in colour; scale like; laid singly or in group of 2-3 eggs near the base of stem; the egg surface sculptured with wavy ridges without any ornamentation.

**Larva:** Number of instars: 05.

Larval duration: 15.60±3.50 days.

**First instar:** Duration: 2.75±0.70 days.

**Head:** Width 0.13±0.20 mm; head somewhat golden brown in colour.

**Body:** Length 1.85±0.38 mm, width 0.17±0.01 mm; body creamy or dirty white in colour.

**Second instar:** Duration: 2.75±0.70 days.

**Head:** Width 0.30±0.00 mm; rest same as first instar.

**Body:** Length 3.05±0.32 mm, width 0.22±0.01 mm; same as above.

**Third instar:** Duration: 2.60±0.25 days.

**Head:** Width 0.37±0.04 mm; same as above.
Body: Length 7.70±1.06 mm, width 0.45±0.02 mm; larval body wrinkled and of loose type; dirty light yellowish in colour.

Fourth instar: Duration: 3.25±0.65 days.

Head: Width 0.54±0.01 mm; rest as above.

Body: Length 13.25±1.06 mm, width 0.75±0.21 mm; same as in third instar.

Fifth instar (Photo. 17): Duration: 4.25±1.20 days.

Head: Width 1.10±0.21 mm; similar to as mentioned above.

Body: Length 22.75±0.15 mm, width 0.24±0.02 mm; rest as in fourth instar.

Pupa (Photo. 18): Duration: 7.25±0.65 days; length 7.90±0.37 mm, width 2.50±0.32 mm; pupae thicker towards head, the latter clearly visible; cremaster dark brown, flattened, rounded caudally, naked without any setae or spines.

Adult longevity: 5.80±1.25 days.

Adult (Photo. 15): Frons and vertex pale yellow, antennae ciliated, pale yellow; forewing with costa straight, apex rounded, outer margin oblique, tornus rounded, anal margin straight, ground colour pale yellow, without any spot; hindwing with ground colour pale yellow without any spot, costa slightly concave, apex rounded, outer margin oblique, tornus rounded, anal margin slightly concave, ground colour pale yellow, without any spot; abdomen light brown; legs studded with pale yellow scales.

Material examined: 1♂, 1♀, 3.x.2006, Noormahal, Haripur; 1♂, 20.x.2006, Moii.


OBSERVATIONS ON BEHAVIOUR

Larval behavior: The first instar larva eats up a small portion of the egg shell to make an exit-hole for hatching. The remaining portion of the egg shell is left intact. Just after hatching, the early instars bore into the stem of their host plant below the soil surface and make their way into the roots and starts feeding there. They make an exit hole near the base of the plant just above the soil surface and continuously change
the tillers for their feeding. The larvae have been observed to spin a silken gallery inside the tillers and rest there up to pupation. It takes about 7 to 11 hours by the larva to transform into the next instar.

**Pupation:** The mature larvae stop feeding and eventually shrink in size but remain inside the silken tunnel and the process of pupation begins there itself. The freshly formed pupae are brown in colour but as the development proceeds ahead it becomes dark blackish brown in colour.

**Eclosion:** The adult emergence may take place anytime in the morning.

**Adult behavior:** It has been seen that the adults generally rest on the lower part of the plant near the soil surface. After mating, the mated females start laying the eggs there. The adults also show nocturnal behavior as they get attracted to light between 8 pm to 10 pm.

**Remarks:** The immature stages of *Emmalocera depressella* Swinhoe are available in the field in the months of April to October.

**FAMILY: CRAMBIDAE**

Forewing with vein R5 free; tympanum and conjunctiva lying at blunt angle; praecinctorium present; larvae with A8 without sclerotized ring around base of SD1, L group with a single seta on A9.

**Key to the subfamilies of the family Crambidae**

1. Prothoracic coxae with membranous sac--------  
   - Prothoracic coxae without membranous sac -------------------------------------------  
   2

2. Mesothorax with single transverse plate posterior to dorsal pinacula, crochets arranged in complete circle-----------------------------------------------  
   - Mesothorax with a pair of transverse plates posterior to dorsal pinacula or sometimes absent, crochets arranged in mesal pennellipse--------------  
   3
Observations on various life history aspects

3 Head blackish with whitish areas along adfrontal suture, body marked with pinkish or orange tinge stripes on the dorsal side------------------------ Glaphyriinae
   - Head brownish or golden brown without whitish areas, body with pinkish tinge middorsal stripe and two lateral stripes on each side--------- 4

4 Setal pinacula concolorous with body, larval body without black spots, A1 with two subventral setae ------------------------------- Pyraustinae
   - Setal pinacula not concolorous with body, larval body with or without black spots, A1 with one subventral seta------------------------- Spilomelinae

SUBFAMILY: SCHOENOBIINAE

*Scirphophaga nivella* (Fabricius)
(Pl. 5, Photos. 21-26)
*Tinea nivella* F., 1794, Ent. Syat, 3 (2): 296

Study sites: Haripur, Moaii, Noormahal.

Study period: March to November.

LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

Egg (Photo. 22): Incubation period: 6.62 ± 0.35 days; length 0.70±0.01 mm, width 0.58±0.02 mm; female lay eggs on the lower surface of the leaves; eggs covered with light brown tuft of hairs and can easily identify on leaves; dirty white; lay in clusters of 40 to 70 eggs.

Larva: Number of instars: 05.
   Larval duration: 20.95±1.34 days.

First instar: Duration: 3.20±0.35 days.
   Head: Width 0.17±0.02 mm; light watery-brown; body dirty white in colour.
   Body: Length 1.75±0.42 mm, width 0.20±0.07 mm; dirty white; body loosely segmented; skin very thin and loose.
Observations on various life history aspects

**Second instar:** Duration: 3.50±0.18 days.

**Head:** Width 0.62±0.06 mm; rests same as first instar.

**Body:** Length 3.90±0.35 mm, width 0.82±0.17 mm; same as in first instar.

**Third instar:** Duration: 3.25±0.18 days.

**Head:** Width 1.07±0.08 mm; same as above.

**Body:** Length 9.90±0.72 mm, width 1.58±0.45 mm; same as in second instar.

**Fourth instar:** Duration: 4.25±0.45 days.

**Head:** Width 2.20±0.20 mm; rest as above.

**Body:** Length 16.25±1.65 mm, width 2.92±0.60 mm; same as in third instar.

**Fifth instar (Photo. 23):** Duration: 6.75±0.18 days.

**Head:** Width 3.52±0.10 mm.

**Body:** Length 20.50±1.90 mm, width 6.50±0.70 mm; rest as in fourth instar.

**Pupa (Photos. 24-25):** Duration: 8.75±0.70 days. Length 16.30±0.51 mm, width 3.20±0.24 mm; freshly formed head region of pupa uniquely pinkish in colour; rest of the pupal body whitish; changes to light brown near eclosion; thorax wider as compared to head; maxillary palpi present; labial palpi not clearly visible; cremaster with hooked setae.

**Adult longevity:** 5.75±0.35 days.

**Adult (Photo. 21):** Frons and vertex fuscous; antennae simple, light brown; forewing with costa straight, apex rounded, outer margin oblique, tornus rounded, anal margin straight, ground colour and cilia white; hindwing with ground colour white, costa straight, apex rounded, outer margin oblique, tornus rounded, anal margin straight, cilia white; abdomen white with tip being yellow; legs furnished with white scales.

**Material examined:** 1♂, 1♀, 27.vii.2006, Noormahal; 2♂♂, 1♀, 3.viii.2006, Haripur, Moii.

**Host plant (Photo. 26):** *Sachcharum officinarum* Linnaeus (Poaceae).
OBSERVATIONS ON BEHAVIOUR

Larval behavior: The first instar larvae break the shell in order to hatch. Immediately after hatching, the first instar larvae bore into the midrib and then feed towards the base and make a tunnel in the cane. Subsequently, they make their way to the growing part of the cane. All the five instars feed in the tunnels and make an emergence whole near the node. The larva moults into next instar in about 6 to 7 hours.

Pupation: When the larva reaches maturity, it stops feeding and made a silken chamber to begin with the process of pupation.

Eclosion: It has been observed that the adult mostly emerged in the morning hours.

Adult behavior: The adult moths become active at night hours and converge on the light trap in between 8.30 pm to 11.00 pm. The mating adults were also seen around the light. The adults were also seen sitting in the early morning hours on the top of the canes.

Remarks: The immature stages of *Scirpophaga nivella* (Fabricius) are available in the field during March to November.

SUBFAMILY: CRAMBINAE

Key to the species of the genus *Chilo* Zincken

1. Prothoracic shield with XD1 seta well above XD2, head with P2 posterodorsad to P1-------- 2
   - Prothoracic shield with XD1 seta posterodorsad to XD2, head with P2 seta posteromesad to P1----

2. Prothoracic shield with SD2 seta anterodorsad to spiracle, head with P2 seta posterodorsad to P1--
   ---------------------------------------------- *partellus* Swinhoe
   - Prothoracic shield with SD2 seta anterad to spiracle, head with P2 seta posterior and almost in straight line to P1----------------

---------------------------------------------- *infuscatellus* Snellen
   - Prothoracic shield with SD2 seta posterad to spiracle, head with P2 seta posterior and almost in straight line to P1----------------

---------------------------------------------- *auricillia* Dudgeon
Observations on various life history aspects

*Chilo partellus* (Swinhoe)
(Pl. 6, Photos. 27-32)
*Crambus partellus* Swinhoe, 1885, P.Z.S.: 879

Study sites: Haripur, Phillaur.

Study period: April to October

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** (Photos. 28-29): Incubation period 6.25±0.35 days; length 0.58±0.02 mm, width 0.35±0.01 mm; the eggs are flat, somewhat oval; creamy yellow in colour; laid on the underside of the leaves in clusters of 18-25.

**Larva:** Number of instars: 06.

- Larval duration: 19.49±1.78 days.

**First instar:** Duration: 2.37±0.18 days.

- **Head:** Width 0.23±0.07 mm; head appears black in colour just like pinhead.
- **Body:** Length 1.80±0.70 mm, width 0.25±0.01 mm; pinkish yellow in colour, with black spots present on each segment; skin shiny.

**Second instar:** Duration: 3.25±0.35 days.

- **Head:** Width 0.43±0.01 mm; same as in first instar.
- **Body:** Length 4.23±1.45 mm, width 0.39±0.01 mm; other observations resemble with first instar.

**Third instar:** Duration: 2.87±0.50 days.

- **Head:** Width 0.61±0.04 mm; shiny; rest is same as above.
- **Body:** Length 6.72±0.85 mm, width 0.70±0.16 mm; pinkish yellow in colour.

**Fourth instar:** Duration: 3.00±0.18 days.

- **Head:** Width 0.92±0.11 mm; same as above.
- **Body:** Length 13.00±1.40 mm, width 1.78±0.03 mm; same as above.

**Fifth instar:** Duration: 3.75±0.18 days.

- **Head:** Width 1.32±0.05 mm; same as above.
- **Body:** Length 13.42±1.90 mm, width 2.50±0.70 mm; same as above.
Observations on various life history aspects

**Sixth instar (Photo. 30):** Duration: 4.25±0.39 days.

- **Head:** Width 1.35±0.02 mm; same as above.
- **Body:** Length 21.25±0.10 mm, width 2.35±0.65 mm; pinkish yellow in colour from dorsal side.

**Pupa (Photo. 31):** Duration: 8.50±0.70 days; length 10.90±0.35 mm, width 2.40±0.35 mm; freshly formed pupae brown in colour.

**Adult longevity:** 6.25±1.25 days.

**Adult:** Frons and vertex light brown, antennae simple, light brown; forewing with ground colour straw colour, costa straight, concave near apex, apex pointed, outer margin oblique, tornus rounded, anal margin concave, some black scales scattered; hindwing with ground colour white tinged with brown, costa slightly concave, apex rounded, outer margin concave, tornus rounded, anal margin concave, abdomen light brown; legs furnished with light brown scales.

**Material examined:** 2♂♂, 1♀, 2.ix.2006, Haripur, Phillaur.

**Host plant (Photo. 32):** *Zea mays* (Graminae).

**OBSERVATIONS ON BEHAVIOUR**

**Larval behaviour:** The first instar larvae before hatching break the egg shell in order to come out. After hatching, the first instar larvae feed on the leaves and bore into the shoots and subsequently find their way towards new coming shoots and feed there. All the larval instars feed inside these shoots and grow to maturity and the plant develop dead hearts. Each larval instar moults into the next instar within 4-7 hours.

**Pupation:** Before pupation, it has been seen that the mature larvae stop feeding and become sluggish while remaining inside the host plant. The pupation starts inside the stem of the host plant.

**Eclosion:** Eclosion takes place in between 6.00 am to 8.00 am.

**Adult behavior:** The adults mostly rest on the lower surface of the shoots and become after dusk. They get attracted to light and most of them were observed inbetween 9.30 pm to 10.15 pm.

**Remarks:** The immature stages *Chilo partellus* (Swinhoe) are available in the field in the months of April to October.
Observations on various life history aspects

_Chilo infuscataellus_ Snellen
(Pl. 7, Photos. 33-40)

_Chilo infuscataellus_ Snell.1890 Tijds.Ent, 34:347

Study sites: Nakoder, Patiala, Phillaur.

Study period: May-June, October-November.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

Egg (Photo. 34): Incubation period: 4.65±0.20 days; length 0.61±0.07 mm, width 0.65±0.01 mm; scale-like; creamy white, become darker after four days; laid in group of 12 to 35 on lower surface of leaf; somewhat smooth egg surface and weak ornamentation.

 Larva: Number of instars: 05.

  Larval duration: 12.37±1.11 days.

 First instar: Duration: 2.70±0.31 days.

  Head: Width 0.25±0.03 mm; light watery-brown; laterally black; hypognathous.

  Body: Length 1.90±0.70 mm, width 0.15±0.04 mm; cream coloured.

 Second instar: Duration: 1.25±0.18 days.

  Head: Width 0.37±0.11 mm; rests same as first instar.

  Body: Length 8.14±1.75 mm, width 0.38±0.02 mm; dirty white; very light five violet longitudinal lines present on the body; larval skin very loose, somewhat transparent; otherwise same as in first instar.

 Third instar: Duration: 2.62±0.20 days.

  Head: Width 0.77±0.04 mm; same as above.

  Body: Length 15.00±1.02 mm, width 086±0.37 mm; head appears to be shining; light brown in colour; rest same as in second instar.

 Fourth instar: Duration: 2.55±0.38 days.

  Head: Width 1.10±0.24 mm; same as above.

  Body: Length 19.25±1.20 mm, width 1.85±0.22 mm; anterior margin of the larvae tapered.
Observations on various life history aspects

Fifth instar (Photo. 35): Duration: 3.25±0.35 days.

**Head:** Width 1.12±0.22 mm.

**Body:** Length 22.20±2.21 mm, width 1.85±0.23 mm; rest as in fourth instar.

Pupa (Photo. 36): Duration: 7.25±0.65 days. Length 12.50±0.26 mm, width 2.46±0.05 mm; freshly formed pupa whitish green, become to light mud coloured after 6 to 7 hours; changes to light brown near eclosion; thorax broader as compared to head; maxillary palpi present, labial palpi visible; cremaster with hooked setae, mesothoracic legs and antennae extend beyond caudal margin of wings.

**Adult longevity:** 6.15±0.25 days.

Adult (Photo. 33): Frons and vertex white, antennae simple, light brown; forewing with straw coloured ground, costa almost straight, concave near apex, apex rounded, outer margin concave, tornus rounded, anal margin convex near tornus, rest half concave; hindwing with ground colour whitish, costa concave, apex rounded, outer margin slightly wavy, tornus rounded, anal margin concave, with apical light-buff areas; abdomen light brown; legs densely covered with scales.

**Material examined:** 1♂, 2♀♀, 22.vi.2005, Nakodar; 2♂♂, 1♀, 24.vi.2005, Patiala; 1♀, 15.xi.2005, Phillaur.

**Host plant (Photos. 37, 38, 39, 40):** *Sachcharum officinarum* Linnaeus (Poaceae).

**OBSERVATIONS ON BEHAVIOUR**

**Larval behaviour:** The first instar larvae before hatching break the dorso-anterior part of the egg shell in order to come out. Just after hatching, the larvae reach the base of the plant and then bore into the shoots and start feeding there. The successive instars then bore into the adjoining canes and make hole in it by feeding and ultimately live inside the host till pupation. The moulting from one to the next instar takes 8 to 9 hours.

**Pupation:** After reaching maturity, the larva stops feeding while remaining inside the tunnel. Its size becomes smaller before transforming into the pupa.
**Eclosion:** The emergence of adults was noticed in the morning hours mostly between 8.00 am to 9.00 am.

**Adult behaviour:** The adult of the species, under reference mostly sit on the underside of the sugarcane shoots and have short flight from one shoot to the other. The females were seen to depositing their eggs on the lower surface of the leaves. The adults get attracted to light traps in between 9 pm to 11pm.

**Remarks:** The species is available in the field in the months of May-June and then in October-November.

*Chilo auricillia* Dudgeon

*(Pl. 8, Photos. 41-48)*  
*Chilo auricillia* Dudgeon.1905. J.Bombay Soc.16:405

**Study sites:** Guraya, Nakoder, Patiala, Phillaur.

**Study period:** March to September.

### LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

**Egg (Photos. 42-43):** Incubation period: 5.35±1.65 days; length 0.32±0.07 mm, width 0.39±0.01 mm; scale-like; dirty white in colour; soon becomes darker; laid in group of 50 to 75 on underside of leaves; alternating and longitudinal ridges reaches the micropylar area of the egg, irregularly reticulate egg surface.

**Larva:** Number of instars: 05.

- Larval duration: 14.06±1.15 days.

**First instar:** Duration: 3.25±0.25 days.

- **Head:** Width 0.60±0.02 mm; slightly brown in colour.
- **Body:** Length 2.24±0.32 mm, width 0.62±0.03 mm; cream colored with five faint longitudinal strips.

**Second instar:** Duration: 2.65±0.45 days.

- **Head:** Width 0.90±0.02 mm; head becomes darker; rest same as first instar.
- **Body:** Length 5.25±1.34 mm, width 0.91±0.28 mm; dirty white; five very light violet longitudinal lines present on the dorsal surface of the body; otherwise same as in first instar.
Observations on various life history aspects

**Third instar**: Duration: 2.57±0.14 days.

  **Head**: Width 1.90±0.14 mm; same as above.
  **Body**: Length 13.00±0.35 mm, width 2.00±0.72 mm; same as in second instar.

**Fourth instar**: Duration: 2.72±0.30 days.

  **Head**: Width 1.20±0.35 mm; same as above.
  **Body**: Length 14.50±0.41 mm, width 2.12±0.70 mm; larval colour becomes slightly pinkish as it growing mature; anterior margin of the larvae tapered; otherwise same as in third instar.

**Fifth instar (Photos. 44-45)**: Duration: 2.87±0.01 days.

  **Head**: Width 2.40±0.20 mm; head appears dark brown in colour.
  **Body**: Length 15.50±0.90 mm, width 2.50±1.32 mm; rest as in fourth instar.

**Pupa (Photo. 46)**: Duration: 9.25±0.75 days. Length 14.96±0.10 mm, width 3.42±0.10 mm; changes to light brown near eclosion; thorax and head width almost equal; cremaster with hooked setae; maxillary palpi and labial palpi present.

**Adult longevity**: 5.67±0.30 days.

**Adult (Photo. 41)**: Frons and vertex light brown; antennae simple, light brown; forewing with ground colour light grey with some black scales, costa concave, apex somewhat pointed, outer margin straight, tornus rounded, anal margin straight; hindwing with ground colour light fuscous, costa straight, apex rounded, outer margin straight, tornus rounded, anal margin straight, cilia white; abdomen dark brown; legs covered with light brown scales.

**Material examined**: 1♂, 1♀, 10.iii.2005, Patiala; 1♂, 2 ♀♀, 13.iii.2005, Guraya, Phillaur.

**Host plant (Photos. 47-48)**: *Sachharum officinarum* Linnaeus (Poaceae).
OBSERVATIONS ON BEHAVIOUR

Larval behaviour: Before hatching the first instar larvae were seen cutting a small portion of the egg shell for their escape. Just after hatching, they start feeding on the midrib and then bore into the canes of the host plant. The larvae show specific behavior as they move from one internode to other and keep on moving up to maturity. The larvae feed inside the canes up to successive instars and becomes fully mature here. It takes 12 to 14 hours for moulting from one to the other instar.

Pupation: The fully mature larvae start constructing a silken chamber inside the tunnel near the circular exit point and pupate there.

Eclosion: The emergence of adult moths takes place in early hours.

Adult behaviour: The adults are fast fliers rest on underside of the leaf blades of the sugarcane.

Remarks: The species, under reference, is available in the field during March to September.

SUBFAMILY: GLAPHYRIINAE

*Hellula undalis* Fabricius

*(Pl. 9, Photos. 49-53)*

*Phalaena undalis* Fabricius, 1781 Syec. Ins. 2:272

Study sites: Amargarh, Malerkotla.

Study period: September to February.

LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

Egg *(Photo. 50)*: Incubation period: 3.25±0.65 days; length 0.41±0.01 mm, width 0.84±0.01 mm; the eggs are ovoid and becomes flattened slightly from the surface of deposit; eggs pearly white in colour and become pinkish and subsequently turned into dark brown near hatching; laid singly or in clusters of 4 or 5 near the bud of its host plant; the egg chorion with very fine and prominent ridges and longitudinal ridges reaching the micropyle except alternating ridges.

Larva: Number of instars: 04.

Larval duration: 13.62±1.82 days.
Observations on various life history aspects

**First instar**: Duration: 3.50±0.45 days.

- **Head**: Width 0.13±0.03 mm; black coloured.
- **Body**: Length 1.20±0.06 mm, width 0.17±0.07 mm; larval body somewhat creamish yellow in colour; with longitudinal reddish brown and somewhat orange tinge strips extends the length of the body.

**Second instar**: Duration: 2.75±0.35 days.

- **Head**: Width 0.28±0.01 mm; rests same as first instar.
- **Body**: Length 2.45±0.90 mm, width 0.30±0.09 mm; same as above.

**Third instar**: Duration: 2.45±0.04 days.

- **Head**: Width 0.41±0.04 mm; same as above.
- **Body**: Length 5.03±1.60 mm, width 0.59±0.01 mm; same as above.

**Fourth instar (Photo. 51)**: Duration: 4.92±0.98 days.

- **Head**: Width 0.58±0.05 mm; same as above.
- **Body**: Length 7.50±0.25 mm, width 1.16±0.15 mm; same as above

**Pupa (Photo. 52)**: Duration: 6.50±0.50 days. Length 5.70±0.30 mm, width 2.00±0.20 mm; pupae yellowish white in colour; colour changed in to dark brown near maturity.

**Adult longevity**: 5.50±0.25 days.

**Adult (Photo. 49)**: Frons and vertex fuscous, antennae simple, light brown, forewing with ground colour light grey with some white markings, costa almost straight, apex rounded, outer margin nearly straight, tornus rounded, anal margin slightly concave, a black spec near outer anger of cell, cilia light grey; hindwing with costa slightly concave, apex rounded, outer margin concave, tornus rounded, anal margin concave, ground colour white, black lining near outer angle; cilia white; abdomen light brown; legs beset with white scales.

**Material examined**: 2♂♂, 1♀, 11.xi.2007, Malerkotla, Amargarh.

**Host plant (Photo. 53)**: *Brassica oleracea* (Brassicaceae).

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OBSERVATIONS ON BEHAVIOUR

**Larval behaviour:** It has been observed that the first instar larvae just eat only a small portion of the egg shell to hatch. After hatching from the egg, the early instars have been found to feed on the buds and upper epidermis of the leaves, especially the young and tender leaves of the bud. The larvae usually spin a web between two leaves. The moulting process was carefully observed and it took 5 to 8 hours for the larva to moult from one instar to next instar.

**Pupation:** The pupation has been observed to take place in a silken cocoon. The freshly formed pupae are soft and yellowish-white in color. After a few hours, the pupae get hardened and become light brown in colour.

**Eclosion:** In this particular species, it has been noted that the adults generally emerged in the evening and rarely during the day time.

**Adult behaviour:** The nocturnal behavior of adults happened to be very well pronounced.

**Remarks:** The species, under reference, is available in the fields in the months of September to February.

SUBFAMILY : PYRAUSTINAE

*Pyrausta bambusivora* Moore

(Pl. 10, Photos. 54-59)

*Ebulea bambusivora* Moore, 1888, Lep. Atk: 224

**Study sites:** Lemlehri, Hoshiarpur.

**Study period:** June to September.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** (*Photo. 55*): Incubation period 5.60±0.18 days; length 0.38±0.02 mm, width 0.36±0.01 mm; eggs deposited in singly or groups 5-6 eggs on the lower surface of leaves or on culms, oval, dirty white in color; chorion with ill-define ridges.

**Larva:** Number of instars: 05.

Larval duration: 19.33±2.16 days.
Observations on various life history aspects

First instar: Duration: 3.75±0.50 days.
   Head: Width 0.20±0.02 mm; black in colour.
   Body: Length 1.25±0.30 mm, width 0.18±0.90 mm; larvae very light pinkish white in colour.

Second instar: Duration: 3.75±0.18 days.
   Head: Width 0.35±0.06 mm; same as in first instar.
   Body: Length 3.27±1.25 mm, width 0.30±0.03 mm; same as first instar.

Third instar: Duration: 3.25±0.25 days.
   Head: Width 0.39±0.01 mm; same as above.
   Body: Length 6.05±0.35 mm, width 0.43±0.15 mm; same as above.

Fourth instar: Duration: 4.33±0.19 days.
   Head: Width 0.60±0.05 mm; same as above.
   Body: Length 10.74±1.20 mm, width 0.78±0.25 mm; pinkish tinge appears on the body.

Fifth instar: Duration: 4.75±1.04 days.
   Head: Width 1.50±0.07 mm; same as above.
   Body: Length 14.50±0.70 mm, width 1.35±0.07 mm; colour turns in to light green with pinkish tinge after feeding on host plant.

Sixth instar: Duration: 4.75±0.40 days.
   Head: Width 1.53±0.01 mm; same as above.
   Body: Length 20.75±0.39 mm, width 1.40±0.35 mm; upon feeding, larval colour turns light green with pinkish tinge.

Seventh instar (Photo. 56): Duration: 5.06±0.09 days.
   Head: Width 1.58±0.04 mm; same as above.
   Body: Length 23.40±1.01 mm, width 1.40±0.35 mm; colour changes in to slightly dark green with pinkish tinge.

Pupa (Photo. 57): Duration: 6.75±0.75 days; length 9.70±0.24 mm, width 2.00±0.31 mm; brown in colour; various developmental markings clearly seen on the pupal body.
Observations on various life history aspects

**Adult longevity**: 5.50±0.70 days.

**Adult (Photo. 54)**: Frons and vertex fuscous; antennae simple, fuscous; forewing with costa straight, concave near apex, apex pointed, outer margin oblique, tornus rounded, anal margin straight, ground colour fuscous, cilia dark fuscous; hindwing with costa concave, apex rounded, outer margin oblique, tornus rounded, anal margin almost straight; ground and cilia colour dark fuscous; abdomen fuscous; legs studded with white scales.

**Material examined**: 2♂, 1♀, 13.vi.2007, Lemlehri; 1♂, 1♀, 15.vi.2007, Hoshiarpur.

**Host plant (Photos. 58-59)**: *Dendrocalamus giganteus* (Graminae).

**OBSERVATIONS ON BEHAVIOUR**

**Larval behaviour**: The first instar larvae make an exit-hole after consuming a small portion of the egg shell for hatching. The newly hatched larvae are light green in colour with pinkish tinge. They observe gregarious mode of feeding during first two instar stages and the third instars tend to feed individually on the host plant. After consuming about half of the epidermal tissues of the leaves, they leave the old leaves and shift to the new ones and spun a silken thread and join the either side of the leaf blade and make a leaf roll. They feed inside the rolled leaves and severely attacked bamboo trees not only become completely deskeletonized but are webbed together in bunches. Each of the larval instar takes about 7 to 11 hours for transformation from one stage to the next instar.

**Pupation**: The fully mature larvae show specific behavior of spinning silken threads inside the rolled leaves and pupate there.

**Ecclosion**: The adult emergence has been observed to take place in the early morning in the laboratory conditions.

**Adult behavior**: The adults reveal strong phototaxic behavior as evident from their presence on various light sources at night time.
Remarks: The adults and immature stages of the species, under reference, are available in the field during the months of June to September.

*Diaphania indica* (Saunders)  
(*Pl. 11, Photos. 60-64*)  

Study sites: Sanour, Devigarh.

Study period: March to October.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** (*Photo. 61*): Incubation period: $4.12 \pm 0.18$ days; length $0.57\pm0.01$ mm, width $0.30\pm0.01$ mm; female moth laid eggs on the lower surface of the leaves; singly or in small groups of 5-6 eggs; the eggs are ovoid and smooth; creamish white in colour; chorion finely reticulated and sculptured with wavy ridges.

**Larva**: Number of instars: 05.

Larval duration: $16.00\pm1.40$ days.

**First instar**: Duration: $2.25\pm0.35$ days.

**Head**: Width $0.15\pm0.01$ mm; brown in colour.

**Body**: Length $1.20\pm0.30$ mm, width $0.21\pm0.02$ mm; light greenish white in colour.

**Second instar**: Duration: $2.25\pm0.35$ days.

**Head**: Width $0.20\pm0.03$ mm; rests same as first instar.

**Body**: Length $2.30\pm0.86$ mm, width $0.38\pm0.10$ mm; same as in first instar.

**Third instar**: Duration: $2.25\pm0.35$ days.

**Head**: Width $0.63\pm0.90$ mm; same as above.

**Body**: Length $6.25\pm1.02$ mm, width $0.50\pm0.03$ mm; green; two white longitudinal strips extending from thoracic to last abdominal region.

**Fourth instar**: Duration: $2.25\pm0.35$ days.

**Head**: Width $1.00\pm0.02$ mm; rest as above.

**Body**: Length $11.30\pm2.58$ mm, width $1.28\pm0.03$ mm; same as in third instar.
Fifth instar (Photo. 62): Duration: 7.00±0.00 days.

   **Head:** Width 1.60±0.15 mm.

**Body:** Length 14.60±1.50 mm, width 2.20±0.02 mm; rest as in fourth instar.

**Pupa (Photo. 63):** Duration: 13.50±0.70 days. Length 14.01±0.40 mm, width 3.50±0.30 mm; freshly formed pupae greenish in colour and then changed into golden brown.

**Adult longevity:** 7.25±0.39 days.

**Adult (Photo. 60):** Frons and vertex light brown; antennae simple, brown; forewing with costa almost straight, concave near apex, apex rounded, outer margin oblique, tornus quadrate, anal margin straight, a brown band with red tinge covers the costal region and outer margin, rest of the wing white; hindwing with costa almost straight, concave near apex, apex rounded, outer margin oblique, tornus quadrate, anal margin straight, outer margin with brown broad band, rest of the wing white; abdomen white with a black and a yellow band at posterior end; legs covered with white scales.

**Material examined:** 4♂♂, 1♀, 20.vi.2006, Sanour; 1♀, 22.x.2006, Devigarh.

**Host plant (Photo. 64):** *Luffa cylindrica* (Cucarbitaceae).

**OBSERVATIONS ON BEHAVIOUR**

**Larval behavior:** After hatching, the first instar larvae feed on the upper epidermis of leaves in a group of four to five larvae near the midrib. All stages of the larvae have been seen to be quite sensitive to touch and drop downwards upon disturbance. The moment a larva is touched, it fall down with the help of silken thread. It takes about 5 to 8 hours for a larva to moult into next instar.

**Pupation:** The larva stops feeding and tend to rest in the corners before initiation of pupation. The newly formed pupae show movements on external stimuli. Initially the pupae are brownish green but after reaching maturity they turns brown.

**Eclosion:** The adult emergence has been observed only in the morning.
**Observations on various life history aspects**

**Adult behavior:** In the daytime the adults rest on the lower surface of the host plant by spreading their wings. As soon as the lights are on in the evening, the adults become active and fly swiftly around the light sources.

**Remarks:** The immature stages of *Diaphania indica* (Saunders) are available in the field during March to October on all the plants belonging to the family Cucurbitaceae.

**SUBFAMILY: SPILOMELINAE**

*Nausinoe geometralis* (Guenée)  
*(Pl. 12, Photos. 65-72)*  
*Lepyrodes geometralis* Guen. 1854, Delt. & Pyr. : 278, pl. 8 .f.6

**Study sites:** Lamlehri, Patiala.

**Study period:** June to August.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg** *(Photo. 66):* Incubation period 3.25±0.45 days; length 0.52±0.02 mm, width 0.47±0.01 mm; the eggs laid singly or in small groups of 5-6 eggs on the leaf lamina; spherical; yellowish green and shiny in colour; irregular ridges present on chorion join the rosetts which surrounds the micropyle.

**Larva:** Number of instars: 05.

Larval duration: 24.71±3.46 days.

**First instar:** Duration: 2.70±0.35 days.

- **Head:** Width 0.20±0.01 mm; light black in colour.
- **Body:** Length 1.00±0.17 mm, width 0.32±0.10 mm; spindle-shaped, creamy yellow; after feeding turns green; a pair of black subdorsal spots present on prothorax.

**Second instar:** Duration: 2.16±0.18 days.

- **Head:** Width 0.31±0.04 mm; same as in first instar.
- **Body:** Length 2.50±0.30 mm, width 0.54±0.01 mm; other observations resemble with first instar.

**Third instar:** Duration: 2.62±0.18 days.

- **Head:** Width 0.42±0.03 mm, same as above.
- **Body:** Length 4.70±0.01 mm, width 0.74±0.20 mm; green in colour.
**Fourth instar:** Duration: 3.65±0.35 days.

- **Head:** Width 0.74±0.10 mm; same as above.
- **Body:** Length 6.50±0.25 mm, width 1.13±0.11 mm; same as above.

**Fifth instar (Photos. 67-68):** Duration: 4.33±0.70 days.

- **Head:** Width 1.06±0.10 mm; same as above.
- **Body:** Length 12.95±1.70 mm, width 1.45±0.20 mm; dark green in colour.

**Pupa (Photo. 69):** Duration: 6.00±1.25 days; length 9.30±0.24 mm; width 2.00±0.32 mm; freshly formed pupae green in colour; the eyes appear very prominent as black spots on the anterior margin of the pupa.

**Adult longevity:** 7.45±2.33 days.

**Adult (Photo. 65):** Frons and vertex pale yellow; antennae light brownish grey; forwing with costa almost straight; concave near apex, apex pointed; outer margin convex near apex; tornus rounded; anal margin straight; ground colour yellow with black spots; hind wing with costa almost straight; apex rounded; outer margin oblique; tornus rounded; anal margin straight; ground colour yellow with white hyaline spots; cilia long whitish brown; abdomen brown; legs covered with light brown scales.

**Material examined:** 2♂♂, 1♀, 25.vi.2006, Lemlehri; 1♂, 2.viii.2007, Patiala.

**Host plant (Photos. 70, 71, 72):** *Jasminum sambac* (Nyctaginaceae).

**Observations on Behaviour**

**Larval behaviour:** The first instar larva escapes out of the egg shell by eating and making a hole at micropyler region. During early stages, the larvae are light yellowish in colour but as they become mature, their colour changes to green and this also depends upon their feeding on specific host plant. It has been noticed that the larvae spins web in the darker area of the host. They become fully mature by passing through five instar stages. The feeding by the larvae is conspicuous in the sense that they feed on the epidermis of the leaves and the infested plants appears fully deskeletonised. In certain cases, the larvae were also seen feeding on the unopened buds, thus making them unfit for marketing. The larva moult within 7-9 hours into the next stage.
Pupation: The last instar larva feeds and lives inside the web made in the lower shady part of the plant. The mature larva stops feeding and starts shrinking before it changes into a pupa. The pupae have been found to be hanging in the webbed mass.

Eclosion: The eclosion takes place in between 7.00 am to 9.00 am.

Adult behavior: The adults resting have been seen on the lower surface of the leaves.

Remarks: The immature stages of *Nausinoe geometralis* (Guenée) are available in the field in the months of June to August.

*Sylepte derogata* (Fabricius)
*(Pl. 13, Photos. 73-79)*

*Phalaena derogata* Fabricius, 1775, *Syst. Ent.* : 641

Study sites: Lemlehri.

Study period: March to October.

**LIFE HISTORY STAGES AND DEVELOPMENTAL TIME**

**Egg (Photo. 74):** Incubation period 4.65±0.35 days; length 0.47±0.02 mm, width 0.42±0.01 mm; eggs laid in rolled leaf cases singly or in smaller groups; rounded; creamish white in colour; the egg surface rough with small reticulations.

**Larva:** Number of instars: 07.

Larval duration: 20.19±1.70 days.

**First instar:** Duration: 2.50±0.35 days.

**Head:** Width 0.12±0.01 mm; black.

**Body:** Length 1.42±0.02 mm, width 0.27±0.01 mm; whitish creamy.

**Second instar:** Duration: 2.75±0.25 days.

**Head:** Width 0.24±0.01 mm; same as in first instar.

**Body:** Length 2.16±0.70 mm, width 0.26±0.09 mm; larval colour turned green as they feeds on host plant.

**Third instar:** Duration: 3.62±0.18 days.

**Head:** Width 0.42±0.02 mm; same as above.

**Body:** Length 4.75±0.03 mm, width 0.40±0.07 mm; same as above.
Fourth instar: Duration: 3.88±0.20 days.

Head: Width 0.57±0.07 mm; same as above.

Body: Length 6.50±1.01 mm, width 1.04±0.08 mm; same as above.

Fifth instar: Duration: 4.20±0.39 days.

Head: Width 0.95±0.06 mm; same as above.

Body: Length 11.25±2.53 mm, width 1.27±0.03 mm; pinkish tinge appears on the dorsal median surface of the larvae; otherwise larvae appears light green in colour.

Sixth instar: Duration: 3.24±0.33 days.

Head: Width 1.50±0.10 mm; same as above.

Body: Length 14.00±0.10 mm, width 1.90±0.10 mm; same as above.

Seventh instar (Photo. 75): Duration: 5.20±0.50 days.

Head: Width 1.52±0.10 mm; same as above.

Body: Length 22.75±0.05 mm, width 1.85±0.01 mm; body somewhat transparent as rolls of faecal matter can be seen inside the body of the larvae.

Pupa (Photo. 76): Duration: 7.25±1.25 days; length 14.30±0.50 mm; width 2.50±0.50 mm; pupation occurs with in the rolled leaves.

Adult longevity: 6.50±0.70 days.

Adult (Photos. 73, 77): Frons and vertex white; antennae simple, brown; forewing with costa straight, apex rounded, outer margin concave, tornus rounded, anal margin almost straight, concave near base, ground colour white, some light brown reticulations present; hindwing with costa straight, apex rounded, outer margin concave, tornus rounded, anal margin straight, ground colour white, some light brown reticulations present, cilia white; abdomen white; legs white scaled.


Host plant (Photos. 78-79): Gossypium hirsutum (Malvaceae).
OBSERVATIONS ON BEHAVIOUR

Larval behaviour: The first instar larva wriggles out of the egg shell by lifting up the micropyle. On hatching, the larvae feed gregariously on a rolled leaf whose ends were fixed with a silken thread and subsequently they migrate to new leaves to form their own undivided roll, where they feed up to maturity. It takes about 6-10 hours to complete the process of mouling in each instar.

Pupation: The last instar larvae residing inside the rolled leaves stop feeding and prepare for pupation there. While the developmental activities proceed, the structures such as the antennae, eyes, wing demarcations and body segmentation can be clearly seen on the pupal body.

Eclosion: The emergence of the adult has been observed to take place during the day time.

Adult behavior: During the day time, adults were mostly seen resting on the inner surface of the leaves. They get attracted to light at night in between 9.00 pm to 10.30 pm.

Remarks: The immature stages of *Sylepte derogata* (Fabricius) are available in the field in the months of March to October.

*Antigastra catalaunalis* (Duponchel)  
(Pl. 14, Photos. 80-85)  
*Botys catalaunalis* Duponchel. 1833, Hist. Nat. Lep. Fr. 8(2) (Noct. 5 pt. 2): 330 pl. 232. f. 8

Study sites: Lemlehri.

Study period: June to August.

LIFE HISTORY STAGES AND DEVELOPMENT TIME

Egg (Photo. 81): Incubation period 4.75±1.45 days; length 0.32±0.02 mm, width 0.42±0.01 mm; pale yellowish green; shiny; deposits on tender leaves and pods; oval; lay singly; the egg chorion having irregular reticulations with alternating ridges reaching the micropyle end.

Larva: Number of instars: 05.

Larval duration: 14.49±1.25 days.
Observations on various life history aspects

First instar: Duration 3.25±0.35 days.
   Head: Width 0.17±0.01 mm; black in colour.
   Body: Length 1.10±0.50 mm, width 0.46±0.01 mm; pale yellowish in colour.

Second instar: Duration: 2.87±0.19 days.
   Head: Width 0.32±0.02 mm; same as in first instar.
   Body: Length 2.70±1.25 mm, width 0.66±0.04 mm; becomes green coloured after feeding on host plant and body acquires prominent black spots on all over the body.

Third instar: Duration: 2.37±0.18 days.
   Head: Width 0.65±0.05 mm, same as above.
   Body: Length 5.16±0.70 mm, width 0.80±0.10 mm; same as above.

Fourth instar: Duration: 2.75±0.35 days.
   Head: Width 0.85±0.00 mm; same as above.
   Body: Length 6.75±0.21 mm, width 1.58±0.38 mm; same as above.

Fifth instar (Photo. 82): Duration: 3.25±0.18 days.
   Head: Width 1.60±0.15 mm; same as above.
   Body: Length 14.60±1.58 mm, width 2.20±0.02 mm; same as above.

Pupa (Photo. 83): Duration: 8.75±0.45 days; length 10.90±0.35 mm, width 2.40±0.35 mm; freshly formed pupae light brownish in colour.

Adult longevity: 12.30±3.04 days.

Adult (Photo. 80): Frons and vertex pale yellow; antennae simple, brown; forewing with costa almost straight, concave near apex, apex rounded, outer margin oblique, tornus rounded, anal margin straight, ground colour bright rusty red, tinged with yellow, without any spot; hindwing with costa almost straight, concave near apex, apex rounded, outer margin oblique, tornus rounded, anal margin straight, ground colour bright rusty red with yellow tinge, without any spot, white near base; legs having white scales.


Host plant (Photos. 84-85): *Sesamum indicum* (Linaceae).
OBSERVATIONS ON BEHAVIOUR

Larval behaviour: The larvae after hatching from the egg by breaking egg shell start feeding on the upper epidermis of the freshly formed leaves and subsequently spin silken threads to join the leaves together. Then they restart their feeding inside the webbed mass till they reach maturity. The larvae are very sensitive to touch. Within a period of 7-9 hours, each of the larval instar transforms itself into the next stage.

Pupation: The last instar larvae feeding on the host plant remain within the silken threads stop feeding to enter into pupation. In certain cases, it has been observed that the larvae drop down to soil and pupate there.

Eclosion: Eclosion takes place in between 7.00 am to 9.00 am.

Adult behavior: Though the adults are fast fliers and active in the evening hours, yet they rest on the lower surface of the leaves during the day time. During dusk the adults get attracted towards the light sources.

Remarks: The immature stages of Antigastra catalaunalis (Duponchel) are available in the field in the months of June to August.

Leucinodes orbonalis Guenée
(Pl. 15, Photos. 86-92)

Leucinodes orbonalis Guen. 1854, Delt & Pyr. : 223

Study sites: Malerkotla, Sirhand.

Study period: March to June.

LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

Egg (Photo. 87): Incubation period: 4.75 ± 0.70 days; length 0.76±0.01mm, width 0.42±0.02mm; whitish cream in colour; laid on the undersurface of leaves; females also seen laid eggs on the walls of container in a laboratory observation; singly or in clusters of 5-6; oval.

Larva: Number of instars: 05.

Larval duration: 16.75±1.65 days.
Observations on various life history aspects

First instar: Duration: 3.00±0.50 days.
   Head: Width 0.19±0.03 mm; light brown.
   Body: Length 2.01±0.40 mm, width 0.32±0.01 mm; body off white in colour.

Second instar: Duration: 2.75±0.39 days.
   Head: Width 0.25±0.01 mm; rests same as first instar.
   Body: Length 3.63±0.75 mm, width 0.49±0.05 mm; same as in first instar.

Third instar: Duration: 2.75±0.18 days.
   Head: Width 0.43±0.02 mm; same as above.
   Body: Length 8.50±0.55 mm, width 0.85±0.15 mm; body colour slightly changes in to light pink.

Fourth instar: Duration: 3.25±0.33 days.
   Head: Width 0.73±0.03 mm; rest as above.
   Body: Length 11.12±1.65 mm, width 1.20±0.09 mm; same as in third instar.

Fifth instar (Photos. 88-89): Duration: 6.00±0.25 days.
   Head: Width 0.74±0.07 mm
   Body: Length 17.87±1.19 mm, width 1.35±0.07 mm; rest as in fourth instar.

Pupa (Photo. 90): Duration: 12.25±2.75 days. Length 9.60±0.40 mm, width 2.80±0.24 mm; pupae light brown in colour but later on changes in to dark brown; packed in a case.

Adult longevity: 5.75±0.35 days.

Adult (Photo. 86): Frons and vertex variegated with black and brown; antennae simple, somewhat brownish; fore wing with the base fulvous, ferruginous and black, followed by an incomplete sinuous black line; large fulvous orbicular and reniform patches with some black on their edges and almost extending to costa; a black edged ferruginous triangular patch from lower angle of cell to inner margin with a sinuous line beyond it; a pale fulvous sinuous postmedial band not reaching costa; a sinuous black submarginal line obsolescent towards outer angle and with a ferruginous and
Observations on various life history aspects

fuscous band beyond it, from below costa to vein 2; some black specks on margin; hind wing opalescent, with black speck at upper angle of cell and spot at lower angle; an ill defined postmedial black line nearly straight from costa to vein 3, then recurved and sinuous; some ill defined pale fulvous submarginal patches and some black specks on margin.

Material examined: 2♂♂, 3♀♂, 29.v.2006, Malerkotla; 1♀, 3.vi.2006, Sirhind.

Host plant (Photos. 91-92): Solanum melongena (Solanaceae).

OBSERVATIONS ON BEHAVIOUR

Larval behavior: While making observations, it has been recorded that the major damage to the fruit is caused by the larvae during different stages of development. The larvae after hatching crawl to the nearest shoots or fruits and bore in the fruit while feeding. The larvae usually enter just below the calyx and make tunnels. The whole larval development takes place within the fruit which become unfit for consumption due to infestation. It takes about 5 to 8 hours for larva to complete the process of moulting.

Pupation: After moulting, the fifth instar larvae stop feeding and become sluggish and then they tend to come out of the tunnels. It has been noted that the pupation either takes place near the mouth of the tunnel or between the fallen twigs or the leaves with the silken threads woven by the last instar larvae.

Eclosion: The adult emergence has been observed to take place anytime in the daytime.

Adult behavior: The adults mostly sit and rest on the lower surface of the brinjal leaves. In captivity, it was noted that the adult did not show any flight activity but continue to sit along the sides of the container.

Remarks: The immature stages of Leucinodes orbonalis Guenee are available in the field in the months of March to June.
Syngamia abruptalis Walker
(Pl. 16, Photos. 93-98)
Asopia abruptalis Walker. 1859, Cat.Lep.17: 371

Study sites: Patiala, Sanaour.
Study period: June to October.

LIFE HISTORY STAGES AND DEVELOPMENTAL TIME

Egg (Photo. 94): Incubation period: 4.58 ± 0.38 days; length 0.29±0.01 mm, width 0.33±0.02 mm; dirty creamish in colour; somewhat cylindrical; laid singly or in groups of 5-6 eggs on the lower surface of leaves near the buds; irregular ridges reaching to the rosette near the micropyle with prominent and longitudinal ridges.

Larva: Number of instars: 05.

Larval duration: 13.12±2.03 days.

First instar: Duration: 3.25±0.30 days.

Head: Width 0.17±0.02 mm; black in colour; more elongated and two black spots on the prothoracic region.

Body: Length 1.25±0.70 mm, width 0.22±0.05 mm; larval body dirty white in colour.

Second instar: Duration: 1.25±0.65 days.

Head: Width 0.29±0.01 mm; rest same as first instar.

Body: Length 2.75±0.50 mm, width 0.47±0.05 mm; turns into light yellowish green.

Third instar: Duration: 2.60±0.18 days.

Head: Width 0.47±0.04 mm; same as above.

Body: Length 6.40±0.55 mm, width 0.68±0.02 mm; same as in second instar.

Fourth instar: Duration: 2.52±0.70 days.

Head: Width 0.67±0.11 mm; rest as above.

Body: Length 8.72±1.31 mm, width 1.02±0.35 mm; same as in third instar.

Fifth instar (Photo. 95): Duration: 3.50±0.20 days.

Head: Width 1.02±0.34 mm

Body: Length 14.00±1.02 mm, width 1.20±0.35 mm; rest as in fourth instar.
**Pupa (Photo. 97):** Duration: 5.50±0.75 days. Length 13.50±0.32 mm, width 3.00±0.44 mm; brown in colour; head appears very prominent on the anterior part of pupae; antennae extend from head towards thoracic region.

**Adult longevity:** 6.25±1.25 days.

**Adult (Photo. 93):** Frons and vertex fuscous; antennae simple, fuscous; forewing with costa almost straight, apex quadrate, outer margin concave, tornus rounded, anal margin almost straight, ground colour yellow with grayish tinge, three oblique lines near basal, middle and outer area; cilia grey; hindwing with costa almost straight, apex rounded, outer margin oblique, tornus rounded, anal margin almost straight, ground colour yellow with grayish tinge, some black scales present, cilia grey; abdomen fuscous; legs studded with fuscous scales.

**Material examined:** 2♂, 1♀, 26.x.2006, Patiala, Sanour.

**Host plant (Photo. 98):** *Acyranthus aspara* Linnaeus (Amrantaceae)

**OBSERVATIONS ON BEHAVIOUR**

**Larval behavior:** In order to hatch, the first instar larvae wriggle out of the egg shell by lifting up the micropyle. The first instar larvae then start feeding immediately on the fresh leaves. They feed gregariously and almost consume the whole leaves. The later instars are very active and immediately drop down on slight disturbance. It takes about 4 to 7 hours by the larva to moult into the next instar.

**Pupation:** When the larvae reach maturity, they stop feeding and pupate inside the leaves by rolling the outer margin inwards and then tied this wrapped leaf with the help of silken thread secreted by the larvae.

**Eclosion:** The adults were seen emerging from the pupal cases anytime during the day time.

**Adult behavior:** The adults avoid rest on light and lower surface of the leaves of the host plant during the daytime. They get attracted to light in between 9 pm to 11 pm.

**Remarks:** The immature stages of *Syngamia abruptalis* Walker are available in the field in the months of June to October.