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STUDIES ON CHAETOTAXY OF LEPIDOPTERAN PEST COMPLEX IN CASTOR

B. KEERTHANA*, M.S.V. CHALAM, P. RADHIKA, P. LAVANYA KUMARI AND K. MANJULA

Department of Entomology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

A study was carried out at the Department of Entomology, S.V. Agricultural College, Tirupati on the larval taxonomy of lepidopteran pest complex in castor. Four lepidopteran larvae *viz., Spodoptera litura* (Fabricius)*, Achaea janata* (Linnaeus), *Ergolis merione* (Cram) and *Conogethes punctiferalis* (Guenee) collected from castor crop and were identified based on the morphological characters and chaetotaxy of thoracic and abdominal segments, especially third abdominal segment and the arrangement of crochets on the ventral prolegs. The measurements *viz.,* total length and width of the larva, length and width of head capsule, width across the compound eyes, length and width of thorax as well as abdomen were recorded for confirmation of species.

KEYWORDS: *Spodoptera litura, Achaea janata, Ergolis merione, Conogethes punctiferalis*, morphological characters.

INTRODUCTION

Castor, *Ricinus communis* (Linneaus) is mostly cultivated in the semi-arid and arid regions in India as a non-edible oilseed crop. It belongs to the family Euphorbiaceae and is native to the South-East Mediterranean Basin, Eastern Africa and India. The production of castor in India is about 1.51 million metric tonnes and mean productivity of castor in 2022 is 1962 kg ha^{-1}(www.statista.com). Gujarat is the major castor producing state accounting for 70 per cent area and 86 per cent production in the country followed by Rajasthan and Andhra Pradesh. Total area of castor in Andhra Pradesh in 2021-22 is 0.18 lakh ha and the total production is 0.37 lakh tonnes with a productivity of 432 kg ha^{-1} (Directorate of Economics and Statistics, 2022). In Andhra Pradesh castor is mainly grown in Rayalaseema region which receives minimum rainfall and the crop suffers frequent drought spells. Apart from abiotic stress, castor crop is subjected to ravages of insect pests and damage caused by lepidopteran pest complex is considered as major limiting factor. Among different lepidopteran pests, *Spodoptera litura, Achaea janata, Ergolis merione* and *Conogethes punctiferalis* are noteworthy.

The knowledge on biology and accurate identification of a pest allows to formulate the management strategies effectively. Larval stages of these lepidopterous pests are economically significant as they are the damaging stage of the insect. The destructive larval stage poses considerable difficulties in their identification. The intensive studies on chaetotaxy of different lepidopteran larvae are necessary to formulate a comprehensive account on external morphological features and to provide standard identification features which will be helpful for easy identification of larvae to the researchers and the students.

MATERIAL AND METHODS

The lepidopteran pest complex of castor (third instar larvae) were collected from the field during *rabi* 2021-22, taken to the laboratory and reared upto final instar. Some of the larvae were reared for emergence of adults. The collected larvae were killed with K.A.A.D mixture (kerosene-1 part, 95 percent ethyl alcohol-7 parts, dioxan-1 part and glacial acetic acid-2 parts). The killed larvae were immersed in 10 per cent solution of potassium hydroxide for maceration overnight, washed in water and passed through different grades of alcohol *viz.,* 60, 80 and 95 per cent consecutively for about 10-15 minutes to facilitate dehydration. The digested soft tissues were removed with the help of a pair of blunt needles and the specimens were transferred to clove oil for clearing. A 1:1 mixture of phenol + xylol was used to retain the specimens until the slides are prepared with Canada balsam permanently. The photographs of head capsule, thorax, abdominal segments, depicting the setal formula, crochets were taken with the help of photographic attachment in Olympus trinocular stereo zoom microscope. The measurements *viz.,* width and length of the head capsule, thorax as well as abdomen of the identified larvae were taken with an Olympus trinocular stereo zoom microscope.

*Corresponding author, E-mail: keerthananov896@gmail.com

RESULTS AND DISCUSSION

In the present study, four species of lepidopteran pest complex of castor *viz., Spodoptera litura* (Fabricius), *Achaea janata* (Linnaeus), *Ergolis merione* (Cram) and *Conogethes punctiferalis* (Guenee) were collected, identified and described. The list of identified lepidopteran pest complex was given here under.

Description of Different Lepidopteran Larvae

A. Tobacco Caterpillar, *Spodoptera litura* (Fabricius)

Family: Noctuidae

Order: Lepidoptera (Fig. 1 and Plate 1)

Colouration and External Morphology: Caterpillar is stout, cylindrical and brownish with dorsal, subdorsal, sub spiracular and supra spiracular stripes of different colours. The general colour of the larvae is brown or sometimes greenish. Larvae often have a bright yellow or orange middorsal line, but also possess a less conspicuous subdorsal line marked by yellow or orange spots or dashes. The spiracular line often has a yellowish or orange-pink reticulate colouration with more intense orange or yellow accents.

Head: The head is brown to black with a reticulate pattern on the lateral side. Head sclerotized and projected ventral (hypognathous) with inverted "Y" shaped epicranial suture. Lateral ocelli six in number adjacent to the base of mandibles. Antennae short, three segmented. Mandibles well developed and prominent. A distinct protruding spinneret present on the labium. Adfrontal sclerites present, two in number and distinct. Adfrontal areas well developed.

Thorax: Thorax three segmented with three pairs of four segmented true legs. The fourth segment bears a single curved claw with a distinct arolium. One pair of spiracles present on prothorax at the junction of pro and mesothorax and another pair at the junction of meso and metathorax. Meso and metathoracic segments are often black with dorsal patches. The black patch on mesothoracic segment is comparatively larger; both the patches, however, are smaller than the one on the first abdominal segment. Whitish or pale whitish middorsal stripe and two white dorsolateral stripes are present on prothoracic shield.

Chaetotaxy of prothorax and mesothorax

Prothorax: Prothoracic shield much chitinized, dark extended up to the margin of XD2. Anterior dorsal setae XD1 and XD2, dorsal setae D1 and D2 distinct and present on prothoracic shield. Lateral setae L1 and L2 are present. Subventral setae SV1 and SV2 distinct. Microscopic seta MV1 and ventral seta V1 present.

Mesothorax: Dorsal setae D1 and D2 and subdorsal setae SD1 and SD2 distinct. Lateral setae L1, L2 and L3 present. Subventral seta SV1, ventral seta V1 and microscopic setae MV1 and MV2 present.

Abdomen: Ten segmented. Abdominal legs fleshy, paired non-segmented which are called prolegs exists on 3rd, 4th, 5th, 6th and on last segments. Dark patches are present on the dorsal side of abdominal segments 1 and 8. Eight pairs of spiracles present on 1st to 8th abdominal segments. There is a small white or light coloured spot caudal to the spiracle on the abdominal segments.

Chaetotaxy of 3rd abdominal segment: Third abdominal segment is with dorsal setae D1 and D2. Subdorsal seta SD1 distinct. Lateral setae L1, L2 and L3 present below the spiracle. Subventral setae SV1, SV2, SV3 and ventral seta V1 are present.

Crochets: Crochets on abdominal prolegs are uniordinal mesoseries.

Adult: The moth is stout, greyish brown in colour. The forewings are grey to reddish-brown with dark wavy white markings. The hindwings are greyish-white with grey margins, often with dark veins.

Measurements (average of 10 third instar larvae): Total length of the larva 33.42 mm, total width (maximum width) of the larva 5.47 mm, length of the head capsule 5.57 mm, width (maximum width) of the head capsule 4.14 mm, width across the compound eyes 3.21 mm, length of the thorax 11.02 mm, width (maximum width) of the thorax 5.21 mm, length of the abdomen 22.62 mm, width (maximum width) of the abdomen 5.47 mm.

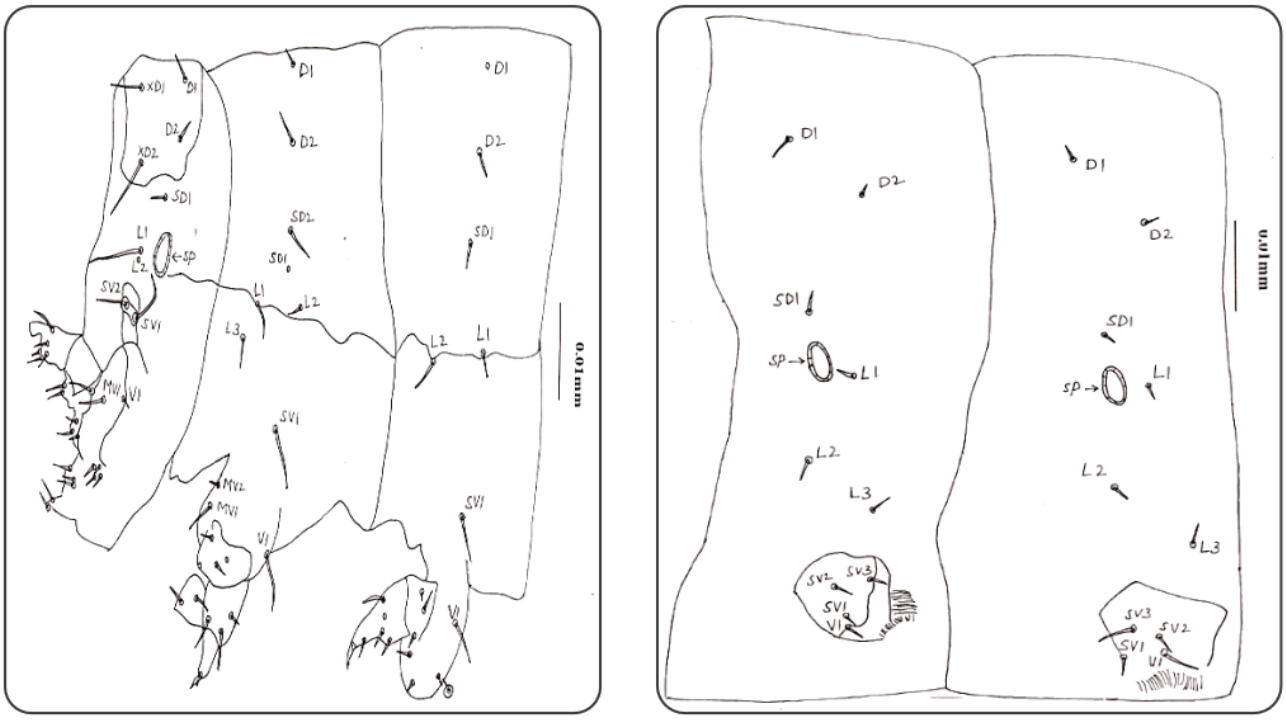
B. Castor semilooper, *Achaea janata* (Linnaeus)

Family: Noctuidae

Order: Lepidoptera (Fig. 2 and Plate 2)

Colouration and External Morphology: *A. janata* is a pale reddish brown moth, stoutly built with black hindwings having white band medially and three large white spots on the outer margins. Caterpillar is a semilooper, long, smooth, greyish brown in colour. The first pair of prolegs is reduced. Caterpillar posess red or whitish side stripes. Full grown larva has black head, a red spot on the black loop and red anal tubercles.

Head: The Head is sclerotized and projected ventrad (hypognathous) with inverted "Y" shaped epicranial suture. Ocelli six in number adjacent to the base of



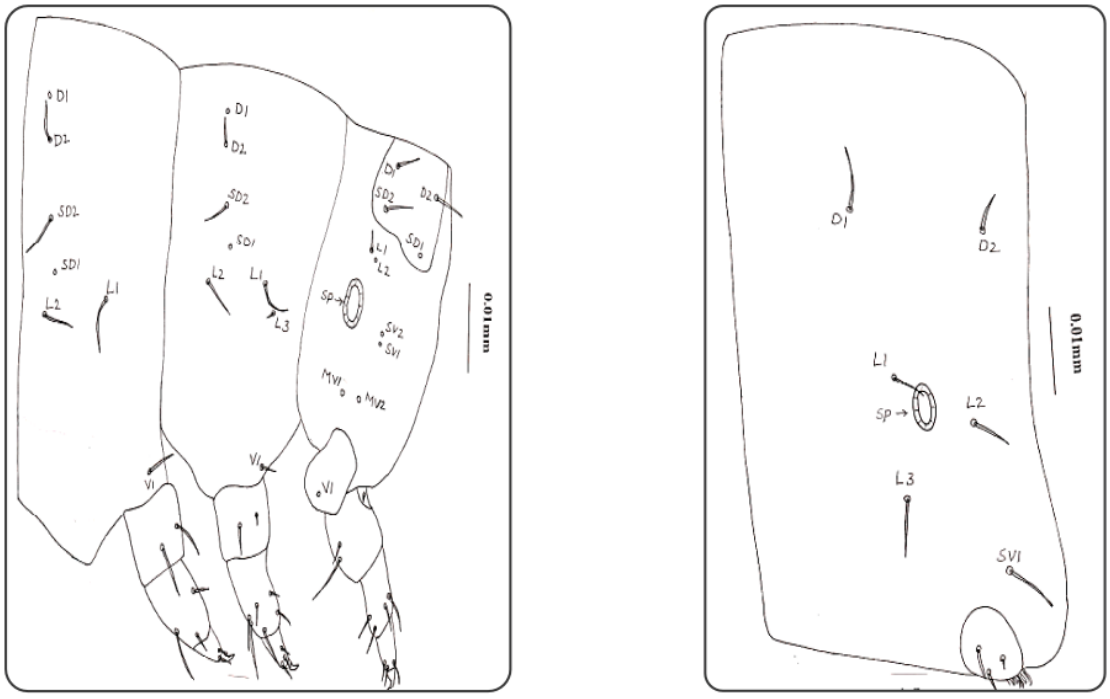
(a) Thoracic segments (b) Abdominal segments

Fig. 1. Chaetotaxy of *Spodoptera litura* (Fabrcius)

(a) Head Capsule (b) Thoracic segments (c) Abdominal segments

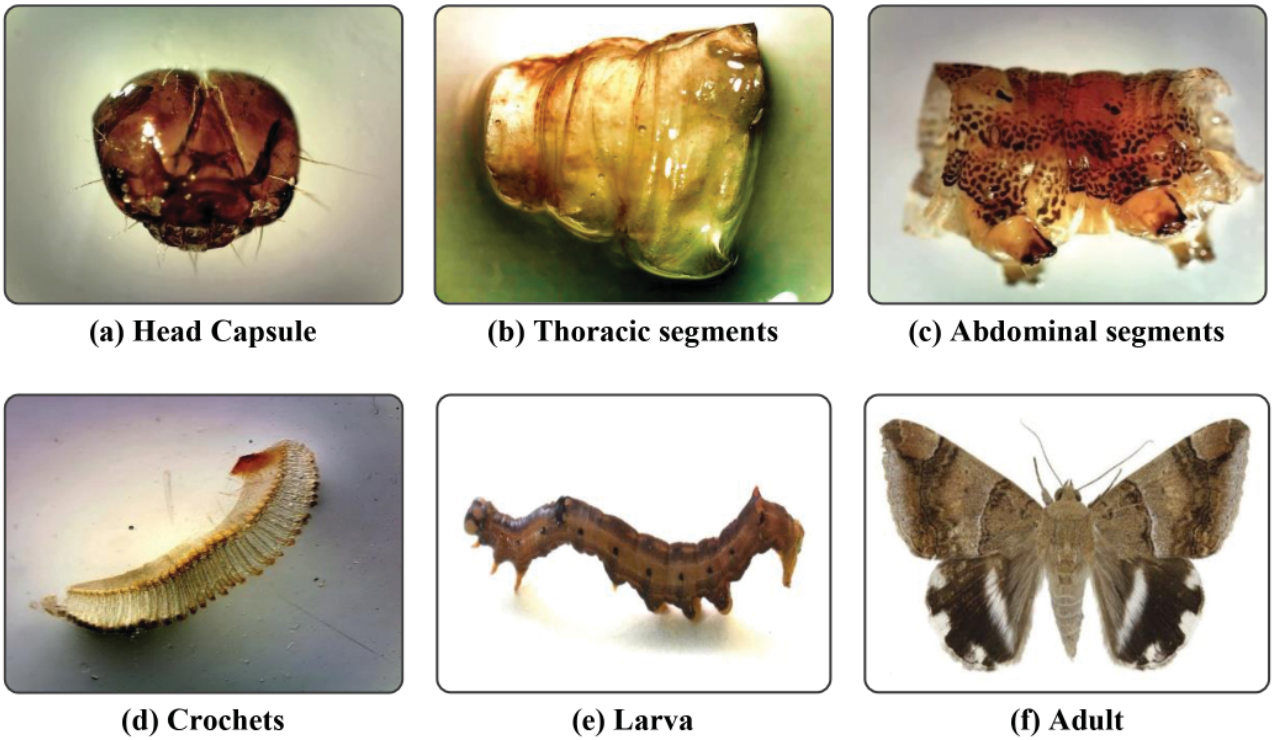
(d) Crochets (e) Larva (f) Adult

Plate 1. *Spodoptera litura* (Fabricius)



(a) Thoracic segments (b) Abdominal segments

Fig. 2. Chaetotaxy of *Achaea janata* (Linneaus)



(a) Head Capsule (b) Thoracic segments (c) Abdominal segments

(d) Crochets (e) Larva (f) Adult

Plate 2. *Achaea janata* (Linneaus)

mandibles. Antennae three segmented. Mandibles are well defined and prominent. A distinct protruding spinneret present on the disto-meson of the labium.

Thorax: Three segmented thorax with three pairs of four segmented legs. The fourth segment bears a single curved claw. One pair of spiracles present on prothorax.

Chaetotaxy of prothorax and mesothorax

Prothorax: Prothoracic shield is much sclerotized, extended upto the margin of SD1. Dorsal setae D1, D2 and subdorsal setae SD1, SD2 distinct. Lateral setae L1 and L2 present above the spiracle. Subventral setae SV1, SV2 and microscopic setae MV1 and MV2 are present and ventral seta V1 distinct.

Mesothorax: Dorsal setae D1 and D2 and subdorsal setae SD1 and SD2 distinct. Lateral setae L1, L2 and L3 present. Ventral seta V1 distinct.

Abdomen: Ten segmented. Fleshy, paired non-segmented abdominal legs called prolegs present on 4th, 5th, 6th and on last segments. Prolegs are absent on 3rd abdominal segment. Eight pairs of spiracles present on 1st to 8th abdominal segments.

Chaetotaxy of 3rd abdominal segment: Third abdominal segment is with dorsal setae D1, D2 distinct. Lateral setae L1, L2 and L3 are present around the spiracle. Subventral seta SV1 present.

Crochets: Crochets on abdominal prolegs are uniordinal lateropenellipse.

Adult: The moth is pale reddish brown with black hind wings having a medially white and three large white spots on the outer margin.

Measurements (average of 10 third instar larvae): Total length of the larva 62.05 mm, total width (maximum width) of the larva 10.25 mm, length of the head capsule 6.68 mm, width (maximum width) of the head capsule 9.09 mm, width across the compound eyes 2.69 mm, length of the thorax 11.14 mm, width (maximum width) of the thorax 8.35 mm, length of the abdomen 44.23 mm, width (maximum width) of the abdomen 10.25 mm.

C. Castor butterfly, *Ergolis merione* (Cram)

Family: Nymphalidae

Order: Lepidoptera (Fig. 3 and Plate 3)

Colouration and External Morphology: Caterpillar is green with sharp branching hairs arising from the warts all over the body.

Head: Head is sclerotized and well defined head having two horn like processes projected towards ventrad (hypognathas), epicranial suture present. Ocelli six in number and present on the lateral aspect of the head capsule adjacent to the base of mandibles. Antennae three segmented.

Thorax: Three segmented thorax with three pairs of four segmented legs with single curved claw. One pair of spiracles present on prothorax and are bigger than the other abdominal spiracles.

Abdomen: Ten segmented. Abdominal legs fleshy, paired non-segmented which are called prolegs present on 3rd, 4th, 5th, 6th and on last segments. Eight pairs of spiracles present on 1st to 8th abdominal segments.

Chaetotaxy of 3rd abdominal segment: The setae on 3rd abdominal segment are numerous and their arrangement is irregular to describe.

Crochets: Crochets on abdominal prolegs are triordinal mesopenellipse.

Adult: The adult is dark brown in colour with wavy lines on the wings.

Measurements (average of 10 third instar larvae): Total length of the larva 20.62 mm, total width (maximum width) of the larva 5.82 mm, length of the head capsule 4.6 mm, width (maximum width) of the head capsule 4.2 mm, width across the compound eyes 1.01 mm, length of the thorax 5.01 mm, width (maximum width) of the thorax 7.33 mm, length of the abdomen 11.01 mm, width (maximum width) of the abdomen 5.82 mm.

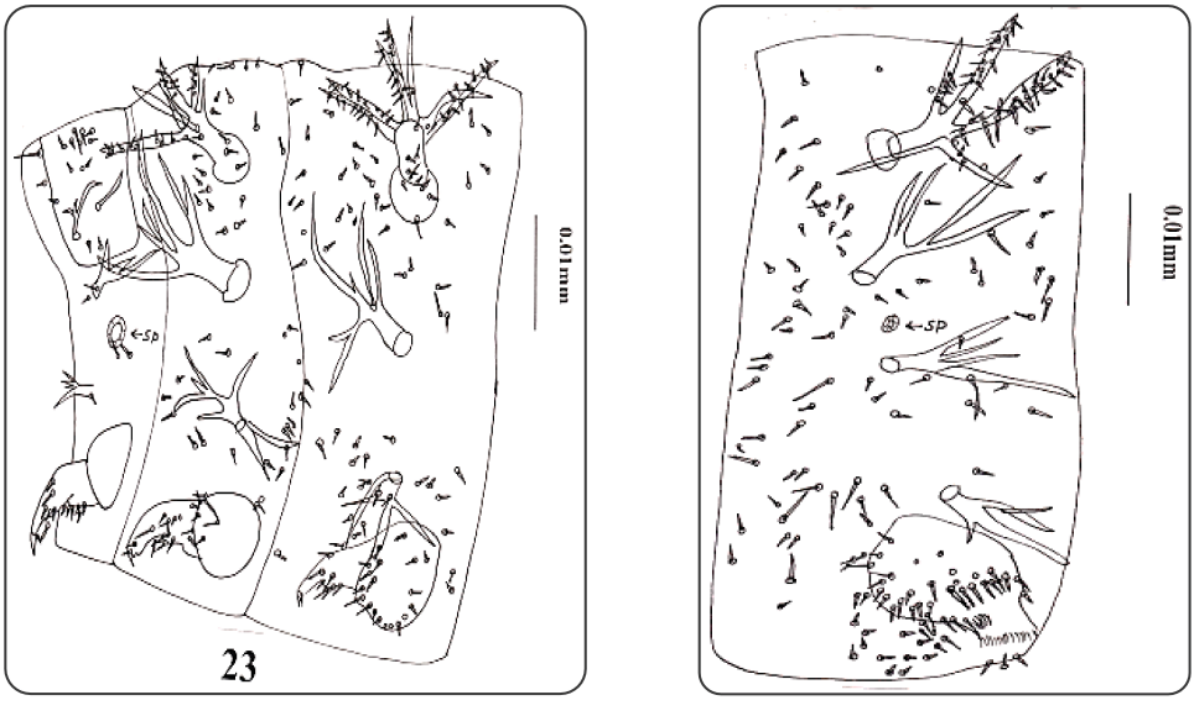
D. Castor shoot and capsule borer (Guenee)

Family: Pyralidae

Order: Lepidoptera (Fig. 4 and Plate 4)

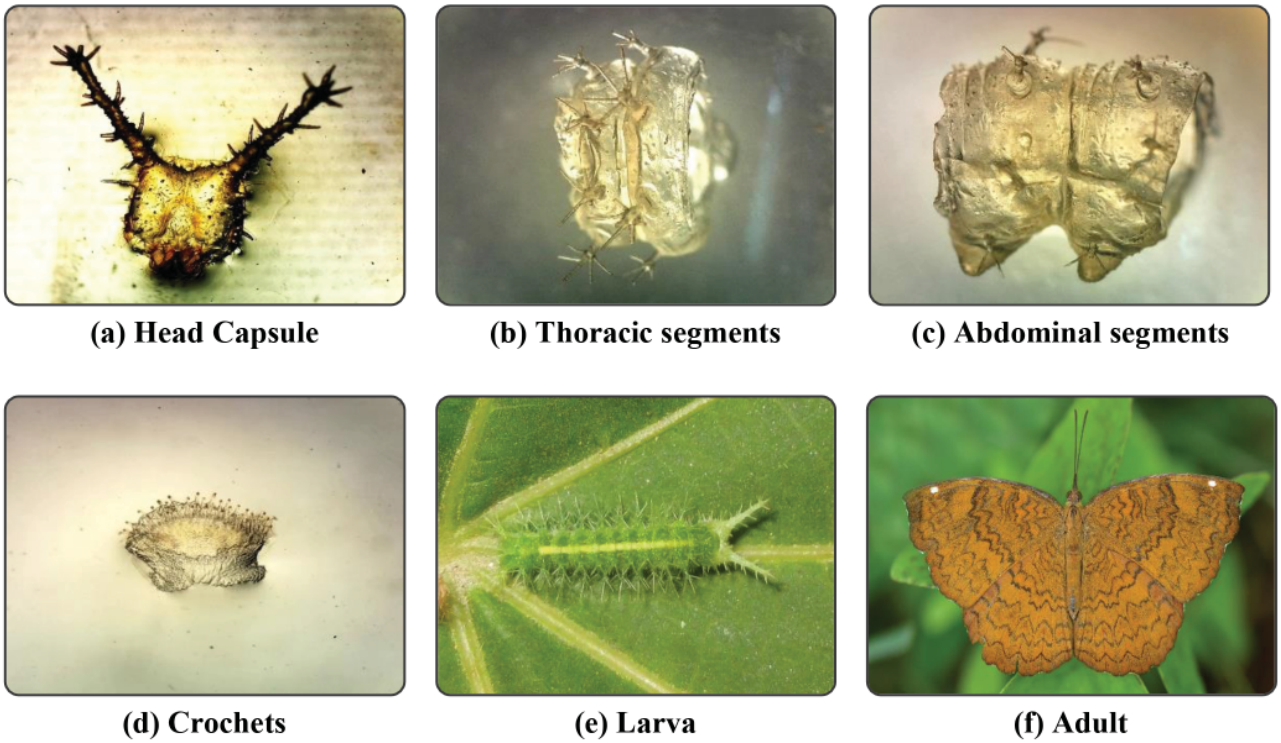
Colouration and External Morphology: Caterpillar is small to medium sized with light pink or reddish pink or pale greenish in colour. Head and prothoracic shield brown to dark brown in colour. Larve are with numerous flattened warts on which short bristly hairs are present. The dark spots are clearly evident in final instar.

Head: Head capsule is dark brown to black in colour, sclerotized, hypognathus with inverted "Y" shape epicranial suture which is not distinct. Lateral ocelli six in number, arranged in a semicircular fashion adjacent to the base of the mandibles. Antenna short, three segmented. Mandibles well developed, prominent blackish in colour. A distinct protruding spinneret is present on labium. Adfrontal sclerite is present but not quite distinct.



(a) Thoracic segments (b) Abdominal segments

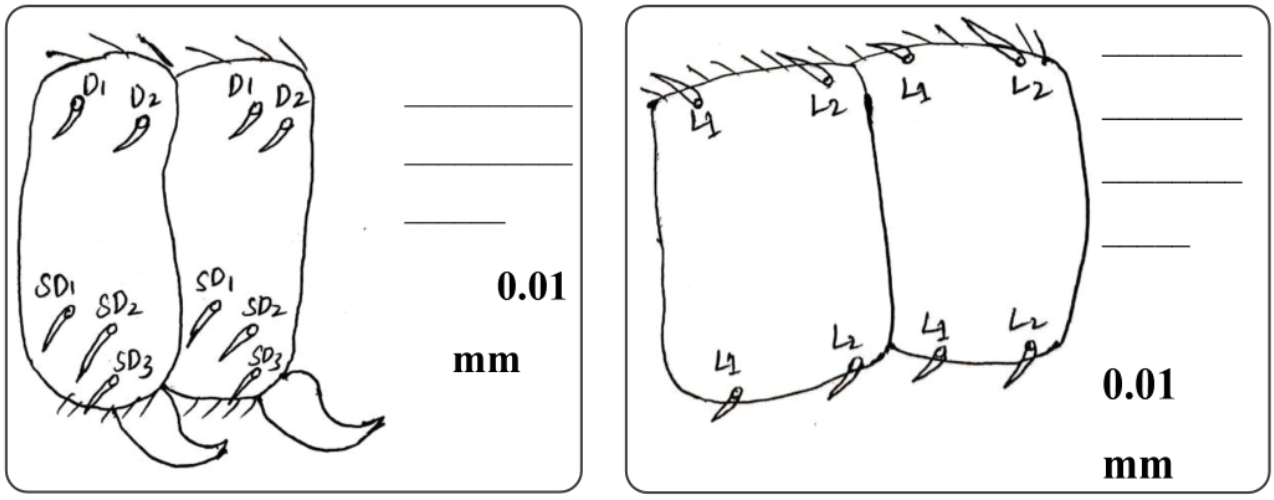
Fig. 3. Chaetotaxy of *Ergolis merione* (Cram)



(a) Head Capsule (b) Thoracic segments (c) Abdominal segments

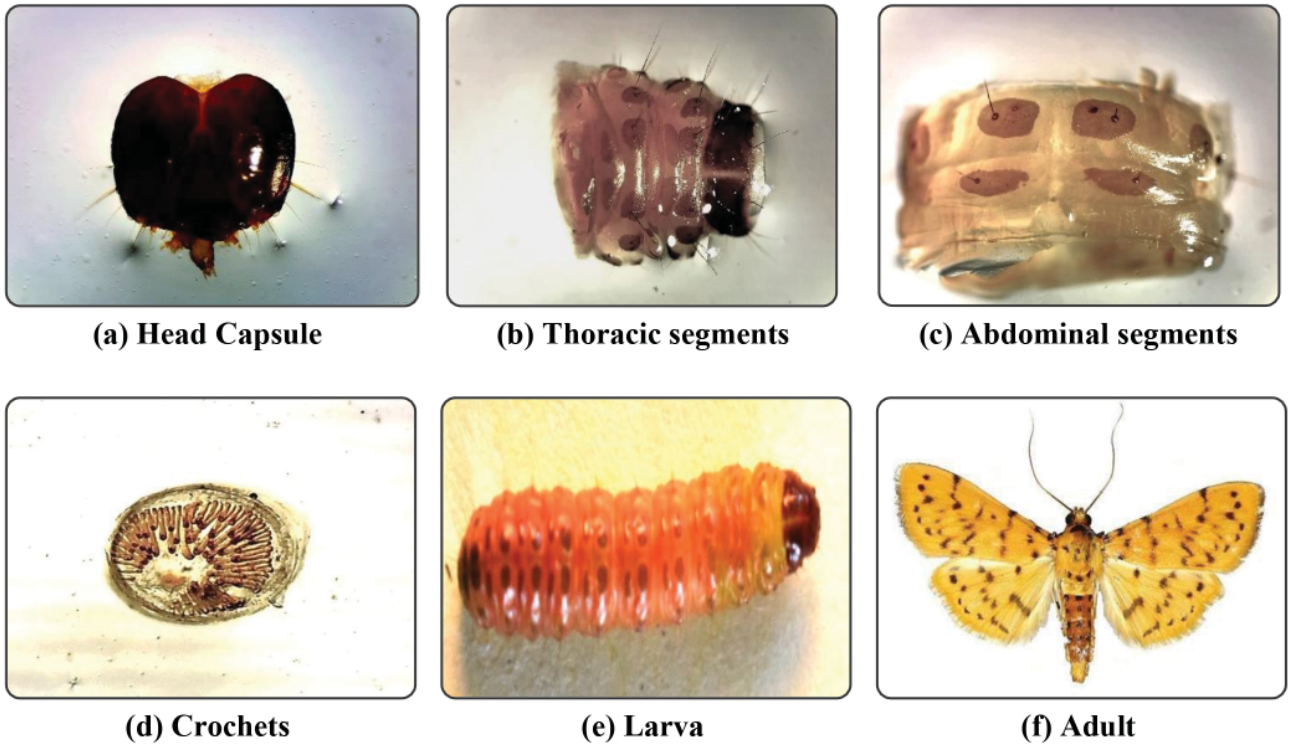
(d) Crochets (e) Larva (f) Adult

Plate 3. *Ergolis merione* (Cram)



(a) Thoracic segments (b) Abdominal segments

Fig. 4. Chaetotaxy of *Conogethes punctiferalis* (Guenee)



(a) Head Capsule (b) Thoracic segments (c) Abdominal segments

(d) Crochets (e) Larva (f) Adult

Plate 4. *Conogethes punctiferalis* (Guenee)

Thorax: Three segmented thorax with three pairs of four segmented true legs. Prothoracic shield prominent dark brown to black in colour. Tip of the legs have a distinct arolium with a pair of claws. One pair of spiracles present on prothorax.

Chaetotaxy of prothorax and mesothorax: Prothoracic shield is sclerotized and distinct. Numerous hair like bristles/setae can be observed on prothoracic shield. Dorsal setae D1 and D2, subdorsal setae SD1, SD2 and SD3 are distinct. Each wart like structure possess a single setae (WD). Spiracles distinct on the lateral side.

Abdomen: Ten segmented. Abdominal legs fleshy, paired non-segmented which are called prolegs present on 3rd, 4th, 5th, 6th and on last segments. Eight pairs of spiracles present on 1st to 8th abdominal segments.

Chaetotaxy of 3rd abdominal segment: Each wart like structure possess a single setae (WD). Lateral setae L1 and L2 present. Lateral side devoid of warts however small microscopic bristles cam be observed on lateral side.

Crochets: Crochets on abdominal prolegs are triordinal lateropenillepse.

Adult: Moth is medium sized having bright orange yellow coloured wings with numerous black dots or spots.

Measurements (average of 10 third instar larvae): Total length of the larva 23.50 mm, total width (maximum width) of the larva 5.48 mm, length of the head capsule 7.58 mm, width (maximum width) of the head capsule 7.29 mm, width across the compound eyes 2.25 mm, length of the thorax 8.89 mm, width (maximum width) of the thorax 8.36 mm, length of the abdomen 7.32 mm, width (maximum width) of the abdomen 6.19 mm.

Dionisio (1987) studied the immature stages and chaetotaxy of the anal plate and position of the setae L1 and L2 in the superfamilies Gelechioidea, and Pyraloidea of order Lepidoptera. Bustillo and Gomez (1986) provided identification, coloured photographs of eggs and larvae of last instar of the family Noctuidae. Chakravorty and Mandal (1989) studied the morphology of three jute eating Lepidopteran larvae viz., *Diacrisia obliqua* (Walker) (Arctiidae), *Spodoptera exigua* (Hubner) (Noctuidae) and *Anomis sabulifera* Guenee (Noctuidae). They differentiated the three final instar caterpillars based on thoracic and abdominal chaetotaxy.

Gupta (1991) published a key for the separation of 50 Lepidopterous pests on rice in India. The key is based on morphological characters like shape and structure of antennae, chaetotaxy, external colour patterns and venation of fore and hind wings of adults. Sidhu and Rose (2004) described chaetotaxy of first instar caterpillars of the families Lycaenidae and Papilionoidea of Lepidoptera. They studied the cephalic, thoracic and abdominal chaetotaxy in detail. They described cephalic chaetotaxy; prothoracic shield, XD group of setae, dorsal group of setae, sub dorsal setae, lateral group of setae, sub ventral group of setae and ventral group of setae in thoracic chaetotaxy.

Venugopal (2005) studied ten lepidopteran larvae of rice and sugarcane crops. All these larvae were described based on different characters like colour, armature on the body, chaetotaxy of prothorax, mesothorax and 3rd abdominal segment, arrangement of crochets on abdominal and anal prolegs. An identification key for distinguishing all these lepidopteran larvae was prepared and is supplemented with the line diagrams and colour photographs for easy identification of these larvae.

Arunasri (2006) identified eighteen Lepidopteran larvae belonging to families, Noctuidae, Pyralidae, Nymphalidae, Lymantriidae, Arctiidae, Gelechiidae, Pterophoridae, Eupterotidae, Ctenuchidae (Syntomidae) and Yponomeutidae. All these Lepidopteran larvae were identified and described based on the morphological characters and chaetotaxy of thoracic and abdominal segments especially 3rd abdominal segment and arrangement of crochets on the ventral prolegs.

Chamundeswari (2021) who identified four species of pod borers in field bean belonging to four genera of the order Lepidoptera *viz.,* spotted pod borer (*Maruca vitrata*) (Family: Pyralidae), tobacco caterpillar (*Spodoptera litura*) (Family: Noctuidae), blue butterfly (*Lampidus boeticus*) (Family: Lycaenidae) and pea pod borer (*Etiella zinckenella*) (Family: Pyralidae). All these Lepidopteran larvae were identified and described based on the morphological characters and chaetotaxy of thoracic and abdominal segments especially 3rd abdominal segment and arrangement of crochets on the ventral prolegs.

All these lepidopteran larvae *viz., S. litura, A. janata, E.merione* and *C. punctiferalis* were identified and described based on the morphological characters and chaetotaxy of thoracic and abdominal segments, especially 3rd abdominal segment and arrangement of crochets on the ventral prolegs.

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