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Taxonomic description of the genus *Spodoptera* (Lepidoptera: Noctuidae) from Karnataka

Muddasar and Venkateshalu

Abstract

A comprehensive and a comparative studies were carried out during 2015-16 on taxonomic account of species of the genus *Spodoptera* Fabricius is provided with three species are recognized in the genus *S. exigua*, *S. litura* and *S. mauritia*. Morphological characters viz., frons, vertex, antennae, labial palpi, compound eyes, ocelli, proboscis, wing venation, Male and female genitalic attribute, identification keys with photographs and illustrations are provided and discussed in detail.

Keywords: Taxonomy, *Spodoptera*, genitalia, species, Noctuidae

Introduction

The Noctuidae, commonly known as owlet moths, cutworms or armyworms, is the most controversial family in the super family Noctuoidea because many of its clades are constantly changing, along with the other families of Noctuoidea. Currently, Noctuidae is now the second largest family in Noctuoidea, with about 1,089 genera and 11,772 species [9].

The caterpillars of *Spodoptera* are most important insect pests of agricultural crops in the Asian tropics. It is widely distributed throughout tropical and temperate Asia, Australasia and the Pacific Islands. *Spodoptera* are totally polyphagous and therefore have huge potential to invade new areas and to adapt to new climatic and or ecological situations [3]. The *Spodoptera* group consists of closely related species with similar ecology that are difficult to identify to species level. It is also known as the cluster caterpillar, cotton leaf worm, tobacco cutworm, and tropical armyworm [10]. The larvae feed on a wide range of plants and have been recorded from over 40 mostly dicotyledonous plant families. It is a major pest of many crops in India and hence accurate species identification is necessary. Therefore, keeping these points in view the present investigation was carried out on taxonomic and genitalic studies of the genus *Spodoptera* (Lepidoptera: Noctuidae) from Karnataka.

Material and Methods

Investigations on collection of *Spodoptera* occurring was undertaken in different localities of Karnataka. Different life stages like larva and eggs were collected from the vegetable crops along with their host plants and were brought to laboratory for further rearing to adults at the Department of Entomology, COH, Bagalkot during 2015-16. The larval cultures were transferred to rearing cages of size 20×20×20 cm along with its host leaves and were maintained in the laboratory by providing fresh leaves until they reached pupal stage. When the larva reached maturity, a bed of sand was laid at the bottom of cages to facilitate pupation.

Collection of adults by using light traps/light source: Light source of 200 watt mercury vapour lamp was used with white cloth background in the vegetable fields at Haveli and Udyanagiri COH, Bagalkot. A white cloth of 10 ft. x 6 ft. was hung between two vertical poles with lamp at the centre. The noctuid moths which were attracted to light trap were collected.

Processing and preservation of adult moths: The emerged adults in the laboratory and moths collected from light trap were killed by using ethyl acetate and pinned through thorax using stainless anticorrosive insect pins. The insects were mounted on mounting boards, the antenna and wings were stretched properly in order to facilitate identification. Each specimen was labelled with the information pertaining to date of collection, locality, latitude, longitude, elevation, name of collector and host on which it was reared or ecosystem from which it was

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collected. The specimens were dried in hot air oven at 40° C and preserved in insect wooden cabinet boxes (45 x 30 cm) for further study.

Identification and classification: Identification of adult specimens was initially done by picture booking with various online resources, available relevant literature, using the Fauna of British India, Moths of Borneo and Moths of Australia. The identification was confirmed by sending the photographs or specimens of the collected insects to Dr. Shashank P. R, Scientist, IARI, New Delhi

Studies on morphological and genital characters: Morphological characters viz., frons, vertex, antennae, labial palpi, compound eyes, ocelli, proboscis, wing characters, venation of both fore and hind wing, morphology of tympanum, leg modification and genitalia were recorded in detail for each of the species using standard procedures given by [2].

The adults were sorted into male and female based on wing coupling i.e. single frenulum in male and two or three frenular spines in females. Genitalia of adults (male and female) were dissected using the technique described by [6].

Results and Discussion

During the present study 3 species belonging to single genera were documented and studied the morphological and genital characters. The genus, *Spodoptera* can be characterized by mottled wing pattern and having immensely developed tuft of hairs on fore tibia [8]. The eyes are not hairy, the tibia of the prothoracic leg is spineless, the eyes are not lashed below the antenna, the venation is trifid, and the last tarsal segment has two rows of strong spines [11].

1a. Metathoracic spiracle in medial concavity and visible; mid and hind tibial piliform scales uniform dorsally; hind wing Sc+Rs form basal fork (Fig. 1)

1b. Metathoracic spiracle anteriorly placed and not visible; mid and hind tibial piliform scales not uniform dorsally; hind wing Sc+Rs do not form basal fork (Fig. 2)*Spodoptera exigua*



Fig 1

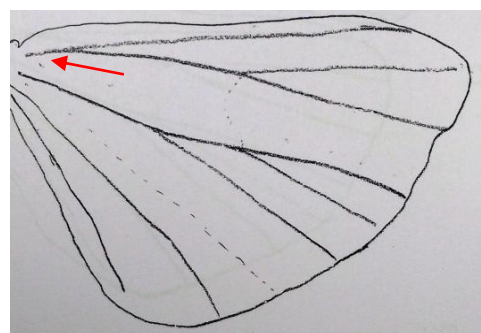


Fig 2

2a. Vertex scales blunt ended over frons; inner tibial spurs longer than 2/3rd of basitarsus (Fig. 3)

..... *Spodoptera mauritia*

2b. Vertex scales irregular, inner tibial spurs shorter than 2/3rd of basitarsus (Fig. 4)

Spodoptera litura



Fig 3



Fig 4

1. *Spodoptera exigua* Hubner, 1808

Caradrina junceti Zeller, 1847

Caradrina pygmaea Rambur, 1834

Caradrina flavimaculata Harvey, 1876

Caradrina sebghana Austaut, 1880

Caradrina venosa Butler, 1880

Diagnosis: Pale ochreous brown, fore wing with sub basal, ante and post medial double line, indistinct some times. Orbicular spot small, round, pale and ochreous. Reni form spot usually less prominent with ochreous or dark centre. Sub marginal line pale, angled below costa with some slight dark streaks before it at middle, marginal series of black specks. Hind wing semi hyaline opalescent white, veins and outer margin tinged with fuscous. Females usually darker than males (Plate 1).

Head: Vertex relatively smooth, scales irregular. Frons wider than length and raised above the plane of eyes. Labial palpi moderate size, porrect with 3rd segment shorter than half of the 2nd segment. Proboscis well developed with dorso lateral cilia, tip sparsely spinose. Antennal base wider than frons and ciliate in males.

Thorax: Tympanum with post spiracular hood medially concave and spiracle not visible. Tympanal sclerite folded and digitate. Mid tibia basally tufted. Hind tibia proximally tufted.

Wing span: 24-26 mm

Fore wing: with areole, R₂, R₃, R₄, R₅ from areole. R₃ and R₄ stalked and connate with less than 1/3rd length of R₃. M₁ at

upper angle. M₂ close to lower angle. M₃ at lower angle. CuA₁ below lower angle. CuA₂ away from the middle of the cell. Disco cellular cross vein indistinct. R₁ originates from upper arm, CuA₂ from lower arm of the discal cell.

Hind wing: Wings sub triangular, three frenular spines in females. M₂ absent. Disco cellular cross vein indistinct, present at medial portion, and lower angle slightly forward than upper angle.

Abdomen: Smoothly scaled with two or three mid dorsal scale tuft.

Male genitalia: uncus long sickle shaped, tegumen triangular longer than uncus inverted V-shaped, vinculum well sclerotised, shorter than the tegumen, U- shaped without saccus. Vulva well developed membranous with well-defined parts, with a distinct triangular opening at the base, ventral margin strongly convex with macro setae whereas costal margin straight without setae. Clavus and costal process absent, ampula elongate, thin and curved. Juxta with a base narrow, ventral margin convex, dorsal process narrow. Aedeagus cylindrical narrow and elongated. Vesica membranous with a single large spine/ cornuti dorsal and slightly bent at the tip, coremata composed of single lobe.

Female genitalia: corpus bursae round to oval, membranous with striate convolutions. Signum small elongate, present dorsally at the apical half of corpus bursae. Ductus bursae elongate 2X longer than the width, sclerotised at the middle half and remaining membranous. Ostium bursae slightly sclerotised, narrow at the base and broader at the base of ductus bursae. Anterior apophyses very short, posterior apophyses long narrow with a pointed tip extending up to anterior margin of 8th abdominal segment. Papilla analis bilobed small flattened and triangular weakly sclerotised with numerous macro and micro setae.

Material examined: INDIA: Karnataka: Bagalkot, 6 ♂, 22. xi.2015, Reared on capsicum, Muddasar; 02. xi. 2015, light trap, Muddasar; 07. xi. 2015, light trap, Muddasar; 6 ♀, 24. ix. 2015, light trap, Muddasar; 19. ix. 2015, light trap, Muddasar.

2. *Spodoptera litura* Fabricius, 1775

Noctua elata Fabricius, 1781

Noctua histrionic Fabricius, 1775

Noctua litura Fabricius, 1775

Prodenia ciligera Guenee, 1852

Prodenia tasmanica Guenee, 1852

Prodenia declinata Walker, 1857

Prodenia glaucistriga Walker, 1856

Prodenia subterminalis Walker, 1856

Prodenia evanescense Butler, 1884

Diagnosis: Head and thorax pale ochreous much suffused with a dark brown, abdomen paler. Fore wing with some ochreous streaks at the base. Whitish medial band from the coastal margin arched towards terminal margin. Terminally whitish double line at the lower half of the wing Orbicular resembles letter A, reniform spot longitudinal, convex and angled towards outer margin. Series of dark triangular specks along outer margin. Males with a greyish black patch at the sub terminal area. Hind wings opalescent and semi hyaline white with dark marginal line (Plate 2).

Head: Vertex relatively smooth with lamellar scales. Frons wider than length and raised above the plane of eyes. Labial palpi moderate size and porrect. Proboscis well developed with dorso lateral cilia, tip sparsely spinose.

Thorax: Tympanum with post spiracular hood medially concave and spiracle located at medial concavity. Tympanal sclerite folded and digitate. Mid and hind tibia dorsally covered with piliform scales and tarsi with prominent tarsal spines in three rows.

Wing span: 32-36 mm

Fore wing: with areole. R₂, R₃, R₄, R₅ and M₁ from areole. R₃, R₄ and R₅ from tip of areole and stalked, gives off R₅ at a short distance. M₂ close to lower angle. M₃ at lower angle. CuA₁ below lower angle. CuA₂ away from the middle of the cell. Disco cellular cross vein indistinct. R₁ and CuA₂ from equidistant at upper and lower arm respectively.

Hind wing: Wings sub triangular, three frenular spines in females. M₂ absent. Disco cellular cross vein indistinct, present at medial portion. Lower angle and upper angle at equidistant.

Abdomen: Smoothly scaled with two or three mid dorsal scale tuft.

Male genitalia: uncus long and slightly curved. Tegumen inverted U-shapes almost equal to the length of uncus. Vinculum broader and shorter than the tegumen and V-shaped. Vulva elongate, well developed membranous with well differentiated parts, two windows are present one triangular and another rectangular, separated by a right angle in centre of vulva. Clavus small, costal process small elongate narrow and curved. Ampula slightly curved, cucullus slightly truncate nearly square edged. Juxta triangular with a narrow base and a pointed process. Coremata with two lobes one shorter and another longer.

Female genitalia: corpus bursae bulbous, length as twice as width, striate convolutions. Signum present in apical half of corpus bursae, small circular. Ductus bursae elongate length 3X greater than width, completely sclerotised. Appendix bursae membranous. 8th abdominal sternite sclerotised, ostium bursae broad, less sclerotised. Two sclerotised lobes at the ostium bursae, almost near to the anterior apophyses or middle of anterior margin of 8th abdominal sternite. Anterior apophyses shorter than the posterior. Papilla analis short and slightly wider, weakly sclerotised with macro and micro setae.

Material examined: INDIA: Karnataka: Bagalkot, 15 ♂, 30. viii.2015, Reared on potato, Muddasar; 25. xi. 2015, reared on Okra, Muddasar; 3. xi. 2015, reared on Okra, Muddasar; 12. xi. 2015, reared on caster, Muddasar; 20. xi. 2015, light trap, Muddasar; 16. xi. 2015, reared on caster, Muddasar; 20. xi. 2015, reared on caster, Muddasar; 10 ♀, 5.ix.2015, Reared on tomato, Muddasar; 16.x.2015, Reared on tomato, Muddasar; 3.x.2015, Reared on tomato, Muddasar.

3. *Spodoptera mauritia* Boisduval, 1833

Hadena mauritia Boisduval, 1833

Agrotis transducta Walker, 1857

Agrotis aliena Walker, 1865

Agrotis bisignata Walker, 1865

Agrotis yernauxi Hulstaert, 1924

Euxoa ogaswarensis Matsumura, 1926

Diagnosis: Dark grey brown with a rusty tinge, abdomen fuscous. Fore wing with sub basal, ante medial and post medial double waved lines indistinct. Orbicular spot small and ochreous, reniform spot blackish. Sub marginal line whitish and irregularly waved. Oblique white patch between orbicular and reniform, dark patch on the marginal area in middle of the wing. Hind wing opalescent and semi hyaline white with a dark marginal line (Plate 3).

Head: Vertex relatively smooth scales irregular. Frons wider than length and raised above eyes. Labial palpi moderate size and porrect. Proboscis well developed with dorso lateral cilia, tip sparsely spinose. Antenna wider than frons and ciliate in males.

Thorax: Tympanum post spiracular hood medially concave and spiracle in medial cavity, tympanal sclerite folded and digitate. Mid and hind tibia dorsally covered with piliform scales and tarsi with prominent tarsal spines in three rows. Hind tibial anterior spurs equal in length with posterior and not spinose.

Wing span: 33-35 mm

Fore wing: with areole. R_2 , R_3 , R_4 , R_5 and M_1 from areole. R_3 and R_4 connate, less than half the length of R_3 and stalked with R_5 at tip of areole. M_2 close to lower angle. M_3 at lower angle. CuA_1 below lower angle. CuA_2 away from the middle of the cell. Disco cellular cross vein distinct. R_1 arises before CuA_2 from upper and lower arm respectively.

Hind wing: Wings sub triangular, three frenular spines in females. Sc and Rs anastomosed at base forming fork. M_2 absent. Disco cellular cross vein indistinct, present at medial portion. Disco cellular cross vein indistinct, lower angle slightly forwarded than upper angle.

Abdomen: Smoothly scaled with two or three mid dorsal scale tuft.

Male genitalia: uncus long curved ventrally swollen at the apical end for nearly half the length and tapered to a point. Tegumen inverted V-shaped with both arms broad. Vinculum narrowly U-shaped. Vulva is elongated and narrow, middle part of vulva is provided with a patch of long hairs on mid-dorsal surface of vulvulla, angle is present between the cucullus and vulva, vulvular depressions is present. Transtilla slender, a small finger like lobes with a few hairs at tip. Ampulla is narrow and possess a finger like apical spines. Aedeagus slightly bent and narrow at proximal end, dilated at the distal end. Apex narrow and bifurcated. Vesica bears three cornuti.

Female genitalia: corpus bursae round, membranous with striate convolutions and finger like sclerotised structures present inside near the base. Signum elongated and dentate, present dorsally at middle of corpus bursae. Ductus bursae elongate 2X longer than the width, with three nodes, slightly sclerotised at the middle half and basal half, remaining is membranous. Ostium bursae reduced. Anterior apophyses very short, posterior apophyses long narrow with a pointed tip extending up to anterior margin of 8th abdominal segment. Papilla analis bilobed small flattened and triangular weakly sclerotised with numerous macro and micro setae.

Material examined: INDIA: Karnataka: Bagalkot, 2 ♂, 19. ix. 2015, light trap, Muddasar. Mudigere, 1 ♂, 20. x. 2014, collected from light, Prasanna, R. Y.

Discussion

The species *Spodoptera litura*, *S. exigua* and *S. mauritia* can be separated based on wing pattern and shape of male genitalia, *S. litura* is having mottled fore wing pattern and A shaped reniform spot on fore wing, uncus long and strongly curved, vulva rounded at the end and coremata with two lobes [2]. While, *S. exigua* is having a prominent orange coloured orbicular spot medially without any pattern. Uncus small and weakly curved compare to *litura* and end of vulva rounded [11]. and coremata with a single lobe [2]. *Spodoptera mauritia* is having a prominent golden yellow coloured orbicular spot medially with brown and black markings on fore wing. Uncus long and strong with setose dorsally [5].

Acknowledgement

The authors are thankful to Dr. Shashank, Pathour, Scientist, Dept. of Entomology, IARI, New Delhi. for helping in identification and dissection of genitalia. The present study was carried out by host based collection, which helps in accurate identification of the pest and confirmation of its host. The morphological and genital characters of collected species were studied in detail and discussed here.

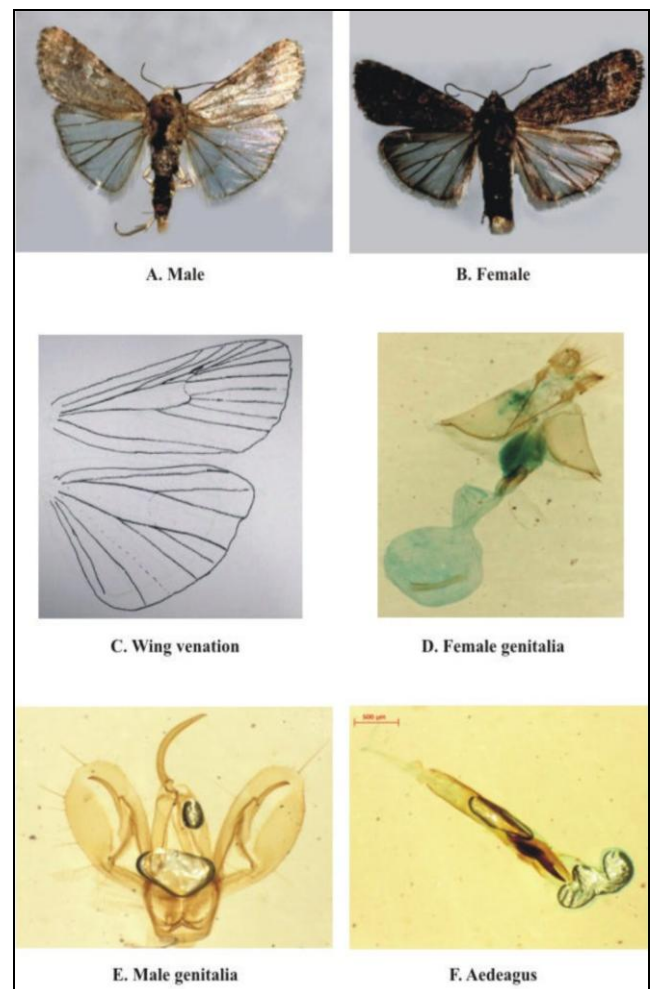


Plate 1: Wing venation and Genitalia of *Spodoptera exigua* Hubner. 1808

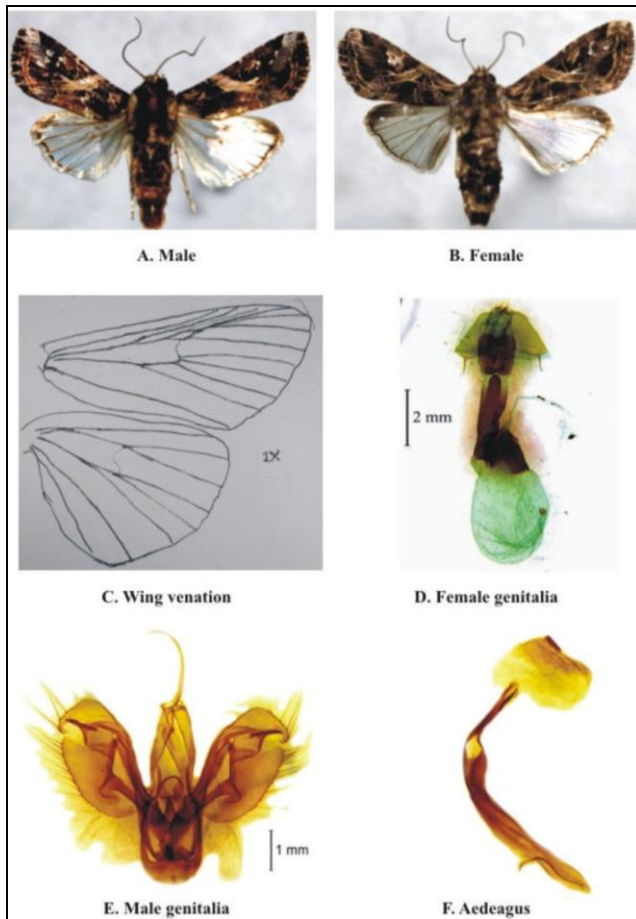


Plate 2: Wing venation and Genitalia of *Spodoptera litura* Fabricius, 1775

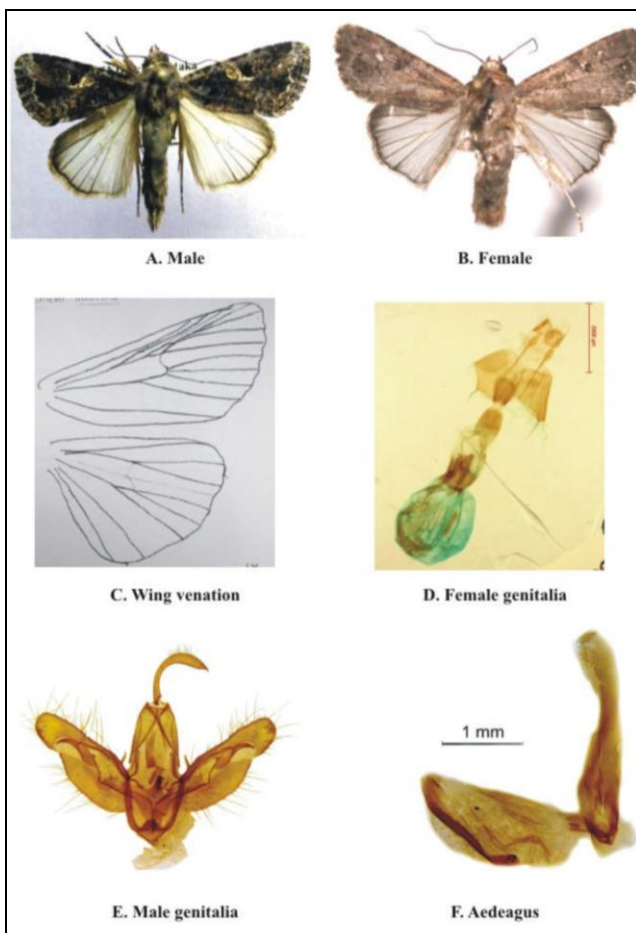


Plate 3: Wing venation and Genitalia of *Spodoptera mauritia* Boisduval, 1833

Conclusion

The present study documented with 3 species from Karnataka, identification key has been developed for identification of 3 species of *Spodoptera*. Diagnostic characters of each species along with their identification characters are provided. Photographic illustration of dorsal and ventral aspect of the body and different parts.

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