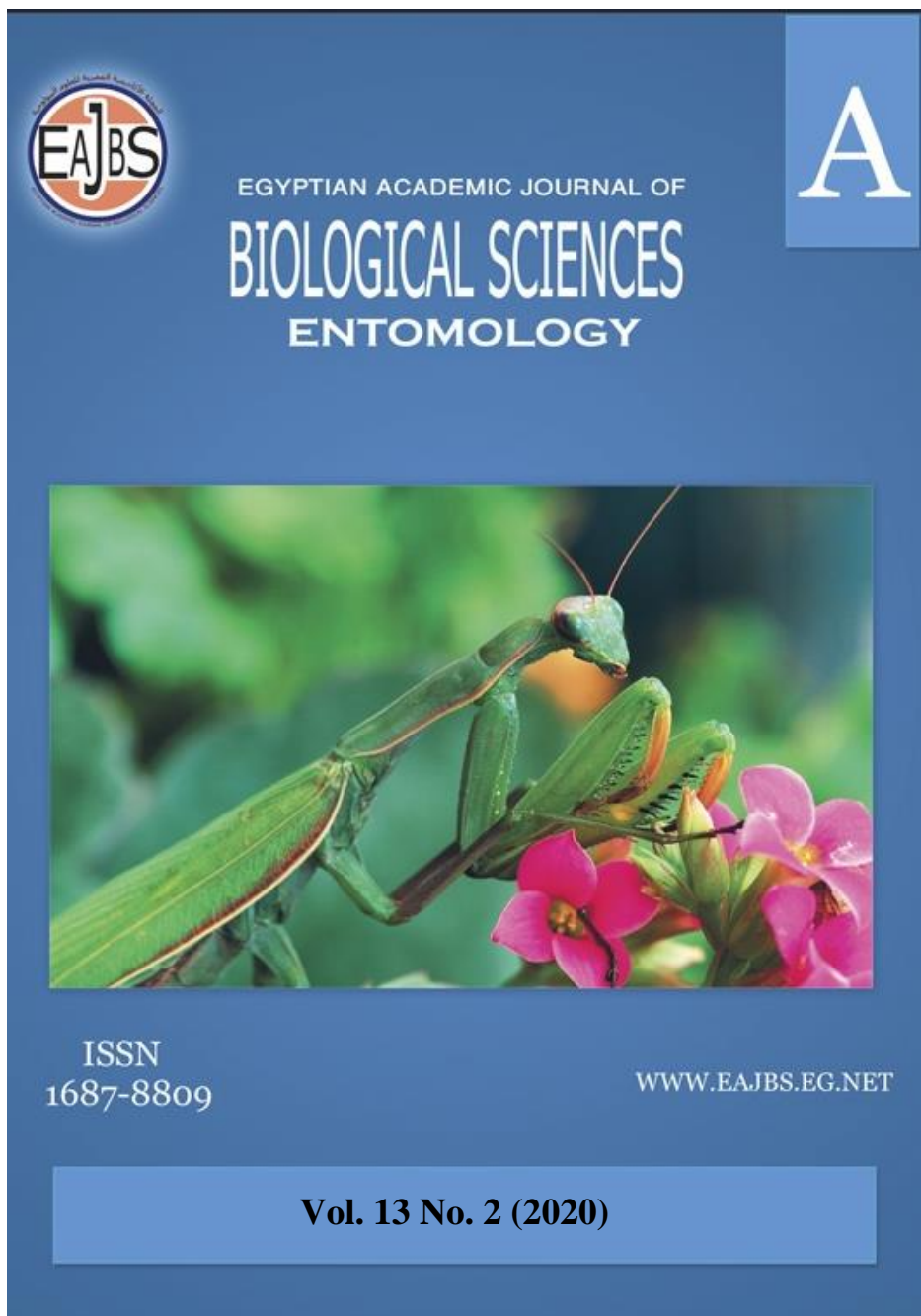


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**Identification and Taxonomic Notes of *Spodoptera species* (Lepidoptera: Noctuidae)
Known to Occur In Egypt**

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ABSTRACT

The genus *Spodoptera* is represented in Egypt by four species, which are: *S. ciliium*, *S. exigua*, *S. frugiperda*, and *S. littoralis*. A taxonomic account on these species is presented to assist in their identification. Diagnostic characters of the genus and description of the species together with an illustrated key based on male and female genitalia of the species are given.

INTRODUCTION

The Noctuidae, (owlet moths, cutworms or armyworms), are the most controversial in the superfamily Noctuoidea because many of the clades are constantly changing, along with the other families of the Noctuoidea (Fibiger *et al.*, 2005; Lafontaine, & Fibiger 2006; Regier *et al.*, 2017). The word Noctuidae is derived from the name of the type genus *Noctua*, which is the Latin name for the little owl, The names "armyworms" and "cutworms" are based on the behavior of the larvae of this group, which can occur in destructive swarms and cut the stems of plants (Marlin, 2004). Currently, Noctuidae is the second largest family in Noctuoidea, with about 1,089 genera and 11,772 species worldwide (Zhang, 2011).

The genus *Spodoptera* is first described by Guenée in 1852. Muddasar and Venkateshalu (2017), The larvae are called armyworms commonly green or brown, pudgy and smooth with rounded short heads and few setae (Wagner, 2010). About thirty species are distributed across six continents (Meagheret, 2008; Nagoshi *et al.*, 2011). Many species are considered an agricultural problem around the world. *Spodoptera* is totally polyphagous and therefore, has huge potential to invade new areas and to adapt to new climatic and or ecological situations.

In Egypt, the caterpillars of *Spodoptera* are of the most important insect pests feed on a wide range of plants and have been recorded from over 40 mostly dicotyledonous plant families. *Spodoptera* group consists of closely related species with similar ecology that are difficult to identify to species level. The genus *Spodoptera* is represented in Egypt by four species, which are: *S. ciliium* (grass lawn armyworm), *S. exigua* (beet armyworm), *S. frugiperda* (fall armyworm) and *S. littoralis* (cotton leafworm).

MATERIALS AND METHODS

The present taxonomic work started by the examination of the Egyptian Reference Insect Collections for materials regarded as *Spodoptera* Insect. These collections are: Collection of Ministry of Agriculture, Plant Protection Research Institute (MAC); Collection of Faculty of Science, Cairo University (CUC); Collection of Faculty of Science, Ain Shams University (ASUC) and Collection of the present author (Auth).

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 collected.

For preparing the genitalia of the adult moth, the abdomen was separated and boiled in 10% caustic soda solution for about 30-60 minutes, then washed in distilled water and dissected in 50% alcohol under the stereoscopic binocular microscope. Specimens were passed in a series of alcohol; stained in basic fuchsin dissolved in 70% alcohol, dehydrated gradually in 100% alcohol cleared in xylol and mounted in Canada balsam.

RESULTS AND DISCUSSION

Genus *Spodoptera* Guenee, 1852

(Figs. 1-3)

Calogramma Guenée, 1852

Douzdrina de Laever, 1985

Laphygma Guenée, 1852

Prodenia Guenée, 1852

Rusidrina Staudinger, 1892

Diagnostic Characters of The Genus:

Members of the genus *Spodoptera* can be characterized by mottled wing pattern and having an immensely developed tuft of hairs on the fore tibia. The eyes are not hairy, the tibia of the prothoracic leg is spineless, the eyes are not lashed below the antenna, the venation is trifold, and the last tarsal segment has two rows of strong spines.

Key to the *Spodoptera* Species Based on Female Genitalia:

- 1- Corpus bursae elongate length and width. (Fig.4)..... *Spodoptera exigua*
- Corpus bursae Bulbous. 2
- 2- Signum medium elongate in apical half of bursa. (Fig.5) *Spodoptera cilium*
- Signum short. 3
- 3- Signum short in basal half of bursa. (Fig.6) *Spodoptera frugiperda*
- Signum short in apical half of bursa. (Fig.7) *Spodoptera littoralis*

Key to The *Spodopteras* Species Based on Male Genitalia:

- 1- Uncus moderately short and Clavus absent 2
- Uncus fairly long and Clavus present 3
- 2- Uncus short scimitar-shaped, bent and tapered, valve broad, elongate, Oval, juxta rat-shaped, ampulla elongate, slightly curved, apex not split in two like deer antler. (Fig.8).
-*Spodoptera exigua*

- Uncus scythe-shaped with pointed end, bent and strong, valve broad, oval, apex of valve bent club-shaped, juxta sclerotized, thorn-shaped rod, ampulla apex split in two like deer antler. (Fig.9). *Spodoptera cilium*
- 3- Uncus fairly long like sword-shaped arched and tapered, valve broad, quadrate, juxta spade-shaped with two finger-shaped arms basally, ampulla short, curved with apex, clavus small bump. (Fig.10). *Spodoptera littoralis*
- Uncus fairly long like sword-shaped, valve very broad, juxta narrow rectangular, ampulla elongate, curved with apex, clavus minute round projection. (Fig.11). *Spodoptera frugiperda*.

***Spodoptera cilium* (Lederer, 1855)**

(Fig. 12)

Spodoptera latebrosa (Lederer, 1855)

Common name(s): greater regrassworm, bermuda grassworm.

General appearance of the moth: Typical as in *Spodoptera exigua* in its colouration and pattern, except the dark greyish orbicular stigma, while its coloured pale whitish-grey in *exigua*; general colour greyish-brown, patterned with deep grey colour and markings. Ventrally glossy whitish-grey. Wingspan about 24-28 mm.

Head: Vertex, antennae, and frons clothed with greyish – brown scales; ventrally smooth whitish-grey.

Thorax: Ash-grey on patagia, tegula, meso, and metathorax; ventrally smooth whitish-grey.

Forewing: General color greyish-black; costal margin spotted with deep greyish spots; orbicular stigma rounded, small colored with dark grey inside; termen and fringe with glossy grey ciliae, ventrally glossy grey-cream.

Hindwing: Translucent pearly-white; veins greyish; subterminal fasciae dark grey; fringe whitish; ventrally concolors.

Abdomen: Smooth dark grey sprinkled with whitish cream.

Male genitalia: Uncus strongly scythe-shaped, swollen and tapered towards apex and with few bristles; gnathos absent. Tegumen narrow bell-shaped with two rows of bristles at lateral sides, and with minute spicules inside; vinculum and saccus flask-shaped with rounded saccus. Valve obviously shorter than the dorsal surface of the uncus, costa arched; apex bent club-shaped separated from outer margin, cucullus with about eleven long stout setae and short bristles and minute spicules and short setae inside, clasper long curved thorn-like projection, and tapered apex and with attached strong thorn-shaped ampulla directed to costa, valvula club-shaped and setosed, editum present with short minute setae; sacculus femur-shaped with minute spicules and long setae towards the base of costa. Transtilla not seen; juxta sclerotized, thorn-shaped rod. Aedeagus spindle-shaped, sculptured with minute spicules and long reflexed thorn-like projection cornutus; vesica rounded and chitinized.

Female genitalia: Anal lobes bean-shaped and strongly setosed; apophyses thin and club-shaped; eighth segment long subquadrate; ostium and entrance (colliculum) crown-shaped like a lotus flower; ductus bursae tubular with trifurcate rodes; corpus bursae elongated striated with longitudinal lines and long snake-shaped signum.

Material examined:

22 moth, gebel Elba (Red sea), Kafr El-Sheikh, Giza, Bahtim (Qaliubiya) and Alexandria on light, clover, Bermuda grass throughout (Oct. Feb. Nov. Jan., April, Dec., March & June 1917, 1933, 1962, 1964, 1968 & 1973) respectively (Rev. Ins. Coll.).

5 moths from Alex., Beheira, Maadi and Cairo, on light, during (June and April 1921, 1927 & 1957. (Alfieri Coll., Fac. of Agric; Azhar Univ., Cairo).

3 moths from Cairo and El-Khatatba (Beheira) on light, during (April & Aug., 1951, 1953 & 1957). (Ain Shams Ins. Coll.).

By using light-trap about 893 moths were captured from Al-Arish, during 2005 and 1049 in 2006. In Beni-suef L.T, about 1206 moths were collected within 2005 and about 1281 moths within 2006-2007 (Rev. Ins. Coll.)

Host plants: Bermuda grass, & hard grass, Reygrass,

Distributions: This species is widely distributed in the Middle East and Egypt and in the Mediterranean region and in North Africa.

***Spodoptera exigua* (Hübner 1903)**

(Fig. 13)

Spodoptera caradrinoides (Walker, 1856)

Spodoptera fulgens (Geyer, 1832)

Spodoptera exigua Hubner, 1808

Caradrina junceti Zeller, 1847

Caradrina pygmaea Rambur, 1834

Caradrina flavimaculata Harvey, 1876

Spodoptera flavimaculata (Harvey, 1876)

Caradrina sebghana Austaut, 1880

Spodoptera antipodea (Warren, 1914)

Common name: lesser cotton leafworm, beet armyworm, small mottled willow moth, willow worm, lesser armyworm.

General appearance of moth: Greyish-brown mottled with whitish-cream and yellow iridescent; ventrally light grayish-brown. Wingspan about 16-27mm, and from 25-30 mm.

Head: Vertex and frons clothed with smooth greyish-brown scales; labial palpi upcurved, covered with cream-brown scales.

Thorax: Patagia, tegula, meso, and metathorax tufted with ash-grey brown tufts.

Forewing: Costa gently arched; apex rounded, termen arched; costal margin decorated with numerous ash-brown small dashes-like dots; ground color whitish-yellow sprinkled with greyish-brown scales; orbicular stigma yellowish-cream distinctly rounded colored by whitish-grey scales inside; reniform stigma kidney-shaped filled with grey scales and bordered by a whitish-yellow edge, termen with short glossy pale grey ciliae namely fringe; ventrally shining greyish-cream.

Hindwing: Translucent pearly-white and this a distinct character in *S. exigua*; veins dark brown, subterminal line dark grayish-brown; fringe with ciliae pearly-white; ventrally glossy concolours.

Abdomen: Clothed by tawny-brown mixed cream white tufts.

Male genitalia: Uncus curved scimitar-shaped with pointed thorn apex; gnathos absent. Tegumen bell-shaped, setosed at lateral sides of the base; vinculum and saccus vase-shaped with rounded saccus. Valve distinctly shorter than the dorsal surface of the uncus, costa arched, the apex of valve rounded with no cucullus and corona, about 12 long setae on the costa, apex and apical part of the outer margin, claspers curved thorn-shaped towards the apex and somewhat forked basally, digitus strong finger-like projection directed towards costa and ended finger-shaped transtilla towards; juxta; sacculus and valvula with fairly long hairs. Juxta rat-shaped with sclerotized bifid apex and a triangular base. Aedeagus tubular with sclerotized forked thorn-shaped cornuti and sclerotized pointed hand-like, with two rows of bristles laterally and short setae towards the base.

Female genitalia: Anal lobes subtriangular and strongly setosed; apophyses posterior long and thin, anterior short and stout; eighth segment subquadrate; ostium and colliculum vase-shaped; ductus bursae small funnel-shaped and chitinized; appendix bursae small with a rounded apex and thin ductus seminalis; corpus bursae elongated, sculptured with numerous

thin lines and minute spicules and armed by minute spicules vestigial forceps signum at the base.

Distribution: Southern USA, Canada, Europe, Africa and Egypt, South East Asia, Middle East, Australia, Hawaii, Pacific Islands, West Indies.

Material examined:

32 moths from Al-Sabahiya (Alex.); Kafr El-Sheikh, Ismailia, Bahtim (Qal.), Dokki (Giza) on clover, corn, tomatoes and on the light within Oct. July, Sep. Nov. Dec., April, May, June & March (1958, 1962, 1963, 1964, 1972 & 1973) respectively (Rev. Ins. Coll.).

8 moths on light from Cairo, March, 1914; Ramleh (Alex.), July, 1915; Aswan, Jan., 1923; Giza, June, 1925; Bir odeib (Helwan-Cairo) April, 1927, Suez Road, Nov., 1934 and Wadi Rishrash (Helwan) March, 1935. (Alfieri Ins. Coll.).

Eight moths from Cairo, (Beni Suef) on light within May & Aug. (1951 & 1953). (Ain Shams Ins. Coll.)

About 1685 moths were trapped to Light trap at Al-Arish (Siniai) within 2005 & about 2364 in 2006 – 2007. About 2432 moths were trapped to L. T., from Beni-Suef within 2005 and 3093 moths within 2006 – 2007. (Rev. Ins. Coll.).

Host plants: Rice, cotton, sugarcane, alfalfa tobacco, tomatoes, sugarbeet, and groundnut. clover, beetroot all cruciferous plants i.e. cabbage, cauliflower, turnip, broccoli & raddish; okra, hemp, and all malvaceous plants; flax, lentil, lettuce, onion, garlic, spinach; all Solanaceous plants, potatoes, eggplants, black night-shade; all legumes, i.e. broad bean, cowpea, garden peas, sweet pea, peas, desert pea, kidney bean, soybean, fenugreek, Egyptian lupin, chickpea (Gram), lebbek, pigeon pea, atropa, sesaban- mung bean, rice bean, and India bean (Lablab), all Cucurbitaceous plants, i.e., cucumber, squash, water and sweet melon., most of Compositae plant i.e., sunflower, safflower Chrysanthemum, pyrethrum, marsh fleabane; other hosts, lambs quarter, mullein pigweed, purslane, Russian thistle (Borror & Delong, 1964; Brown and Dewhurst, 1975; Hill, 1975; Stanoiu et al., 1979; Carter, 1992; Capinera, 2007; CAB, 2008).

***Spodoptera frugiperda* (Smith, 1797)**

(Figs. 14, 15)

Spodoptera autumnalis (Riley, 1871)

Spodoptera fulvosa (Riley, 1876)

Spodoptera inepta (Walker, 1856)

Spodoptera macra (Guenée, 1852)

Spodoptera obscura (Riley, 1876)

Common name: Fall armyworm, Alfalfa worm, corn leafworm, cotton leafworm, grass worm, maize budworm, wheat cutworm.

General appearance of the moth: Greyish-brown mottled dark brown; ventrally light greyish-brown. This species is smaller than the other species that have the bold forewing markings. The base of the wing does not have black dashes or bars. Males can have light brown orbital spots, oval, oblique, and not as narrow as in other species with strongly contrasting transverse lines; reniform spot indistinct, partially outlined in black, with a small, sideways V-shaped marking; a row of small hour-glass shapes marking near the apical margin of the wing. Wingspan about 25-40mm, **Head:** Vertex and frons clothed with greyish-brown scales; antennae greyish-cream.

Thorax: Dorsally clothed with greyish-brown and purplish tuft-like hairs on the collar patagia, tegula, and meso and metathorax; ventrally greyish-cream.

Forewing: Male body is mottled light brown, grey, straw with a discal cell containing straw colour on three-quarters of the area and dark brown on one-quarter of the area with triangular

white spots at the tip and near the center of the wing. Females are distinctly marked greyish brown.

Hindwing: is straw colour with a dark-brown.

Abdomen: Clothed by tawny-brown mixed cream white tufts.

Male genitalia: The combination of genitalic characters at valve level allows the identification of this species: the valve is very broad, almost quadrate; clavus short; costal process narrow, elongate, straight, inclined; ampulla only slightly curved; juxta concave at the base and with a dorsal process; coremata composed of a single lobe. The base of the valve resembles that of *S. littoralis*.

Female genitalia: Ventral plate of ostium bursa with a height greater than width; distal margin straight; ventrolateral invaginated pocket of 8th sternite absent.

Ductus bursae short (length less than twice width); completely sclerotized. Appendix bursae partially sclerotized. Corpus bursae bulbous, length less than twice width; striate convolutions. Signum in basal half of corpus bursae; short.

Host Plants: maize, rice, sugarcane, sugar beet, beans, bell pepper, cabbages, carnation, cauliflowers, chrysanthemum (florists'), clovers, common bean, cotton, cruciferous crops, cucumber, cucurbits, ginger, grasses, groundnut, lucerne, pelargoniums, potato, sorghum, soya bean, spinach, sweet potato, sweetcorn, tobacco, tomato, and turnip.

Spodoptera littoralis (Boisduval, 1833)

(Fig. 16)

Hadena littoralis Boisd., 1833.

Prodenia littoralis (Boisduval)

Prodenia litura Fabricius *Prodenia retina* (Freyer)

Prodenia testaceoides Guenee

Common name(s): greater cotton leafworm, Egyptian cotton leafworm, Mediterranean brocade moth, Mediterranean climbing cutworm.

General appearance of moth: Greyish-brown, speckled with purplish iridescent and with more sinuous transverse and oblique whitish-grey lines; ventrally shining bright dusty, grey. Wingspan about 28-36 mm.

Head: Vertex and frons clothed with greyish-brown scales; antennae greyish-cream.

Thorax: Dorsally clothed with greyish-brown and purplish tuft-like hairs on the collar patagia, tegula, and meso and metathorax; ventrally greyish-cream.

Forewing: Costa straight, gently arched near apex, decorated by short dark greyish-brown dash-like dots along its length; basal fascia formed from four subtriangular greyish-brown dashes; all lines, fasciae, dots, and dashes are bordered with whitish-cream scales; antemedian fascia somewhat sinuated and bent towards the inner margin, double lines and armed with rod-like claviform of brown colour and bordered with dark greyish-brown scales; orbicular stigma located above the claviform stigma, clothed with whitish-cream and with dark greyish scales; reniform stigma pushed near postmedian fascia and touched costal margin of long kidney-shaped and bordered with dark greyish scales; postmedian double sinuated line, the area between postmedian and subterminal fasciae are purplish-brown; subterminal fascia whitish-cream and decorated with eight thorn-shaped streaks, terminal line dotted by seven short streaks and eight crescent dark greyish-brown dashes; termen greyish; fringe with short glossy grey ciliae; ventrally shining greyish-purple.

Hindwing: Translucent pearl colour; all veins coloured with dark brown-purple scales; outer margin dark brown – purple from apex to termen, tornus, dorsum and inner margin with short whitish-pearl ciliae; ventrally glossy whitish.

Abdomen: Clothed with rough greyish-brown and purple tufts, the abdomen of female moth swollen with long hair-like tufts on ovipositor, while in male moth swollen on the external male genitalia with short fine hair around; ventrally shining concolours.

Male genitalia: Uncus distinctly fairly long like sword-shaped, arched and tapered. Tegumen narrow bell-shaped bristled with two rows of bristles on each lateral side; vinculum and saccus wide vase-shaped with large rounded saccus. Valve large with costa strongly arched and with rounded apex,

about five strong long setae on apex and with no cuculus or corona; valvula well-developed strongly hairy plate laterally; clasper bird-shaped, digitus long strong and bent reflexed on clasper finger-shaped process with sclerotized broad stem basally; ampulla short papilla-like extension and with short setae on apex; editum present with short setae; sacculus well developed to subtriangular plate separated from the apex of the valve and armed with about seven strong and long setae outwardly and with two short bristles near its apex and long bristles towards the base. Transtilla drive from the base of the valve in two separate plates like snake-shaped; juxta spade-shaped with two finger-shaped arms basally.

Female genitalia: Anal lobes subquadrate plates and setosed; posterior apophyses long; eighth segment subquadrate and large with short stout anterior apophyses; ostium and colliculum large sclerotized funnel-shaped; ductus bursae short, broad, sclerotized tube; two globular horn-shaped appendix bursae present on the lateral sides of corpus bursae, the right one chitinized and the left one with long thin ducts seminalis; corpus bursae large globular, sculptured apically with eight sclerotized rodes and some lines and one sclerotized quadrated stone-shaped signum.

Material examined: 74 moths from Shebin El-Kom (Minufiya), Minya Al-Qamh (Sharqiya), Dokki (Giza), Bahtim (Qaliub.) and Alex., On light within July, Sep., Dec. March & Aug. (1972-1973) (Rev. Ins. Coll.)

11 moths from Bahtim & Cairo within Aug., May (1945, 1951 & 1953). (Ain Shams Ins. Coll.).

About 1302 moths on L.T. from Al-Arish (North Sinai) within 2005 and 1303 moth within 2006-2007. About 8261 moths from Beni Suef by L.T., during 2005 and about 12826 moths within 2006-2007. (Rev. Ins. Coll.)

Host plants: Cotton, rice, tobacco, tomatoes, corn, castor oil plant, citrus, cruciferous plants, legumes, okra, groundnut, soybean, cucurbits, sugar beet and eggplant (Hill, 1975) (Borror Delong 1964; Brues et al., 1954) Forbes, 1954; Stanoiu et al., 1979; Brown & Dewhurst; 1975 Karrom et al., (1976).

Distribution: Africa, Mediterranean region and Egypt, Near East and Madagascar (Hill, 1975).

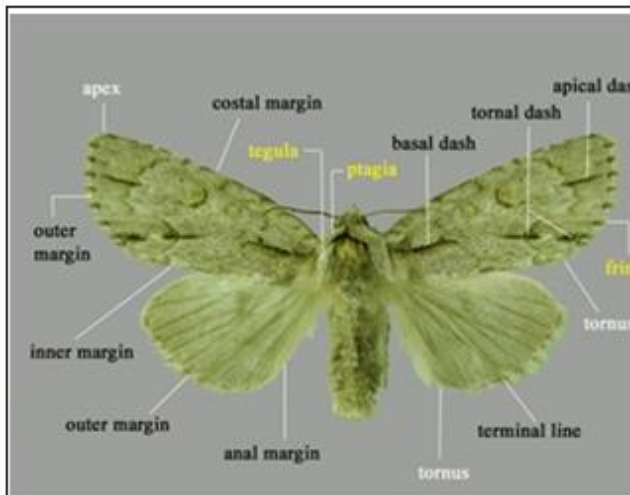


Fig. 1

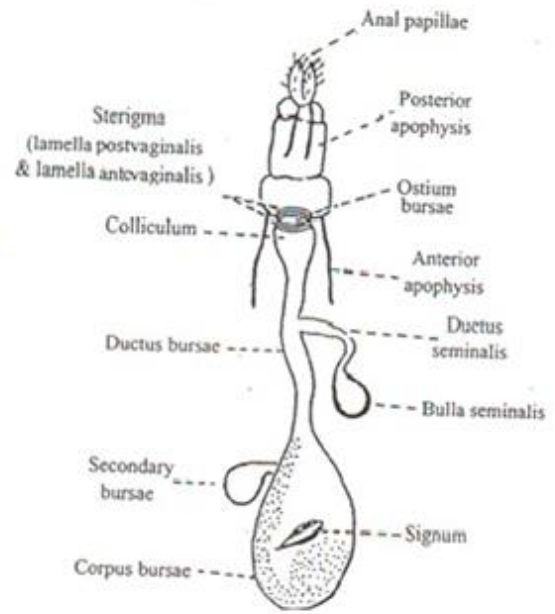


Fig. 2

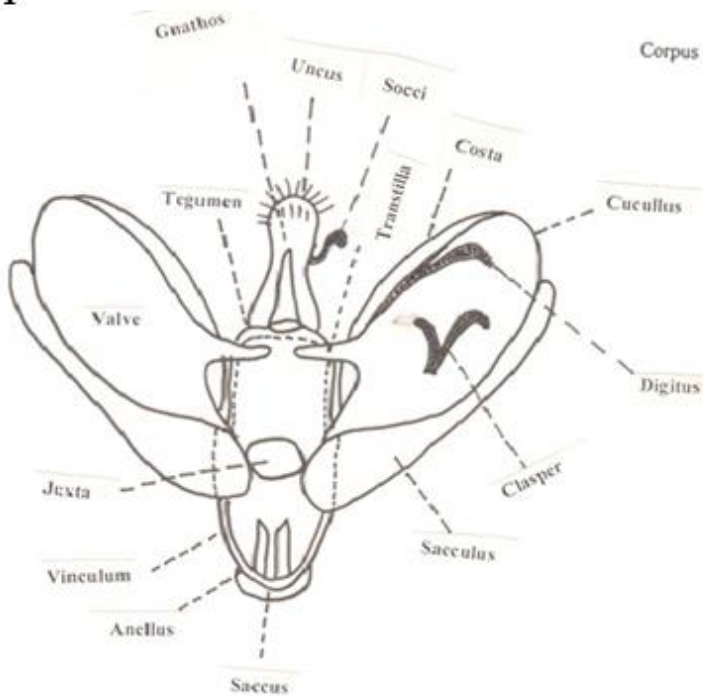


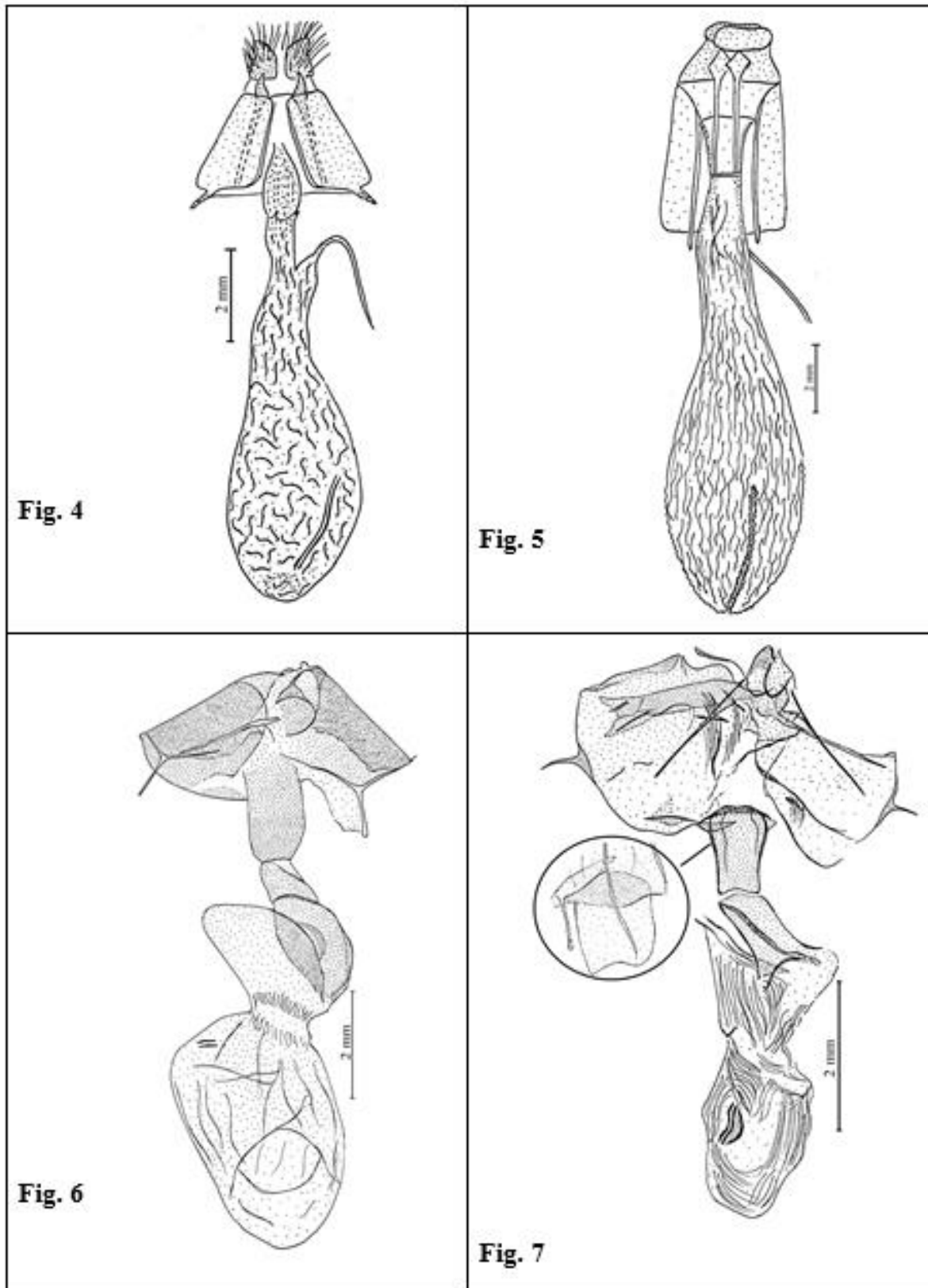
Fig.3

Figs. 1-3:

Fig. 1: Diagrammatic sketch of wing pattern Lepidoptera (Skinner 1984).

Fig. 2: Diagrammatic sketch of female genitalia

Fig. 3: Diagrammatic sketch of male genitalia



Figs. 4-7:

Fig.4: *Spodoptera exigua* female genitalia

Fig. 5: *Spodoptera ciliium* female genitalia

Fig. 6: *Spodoptera frugiperda* female genitalia

Fig. 7: *Spodoptera littoralis* female genitalia

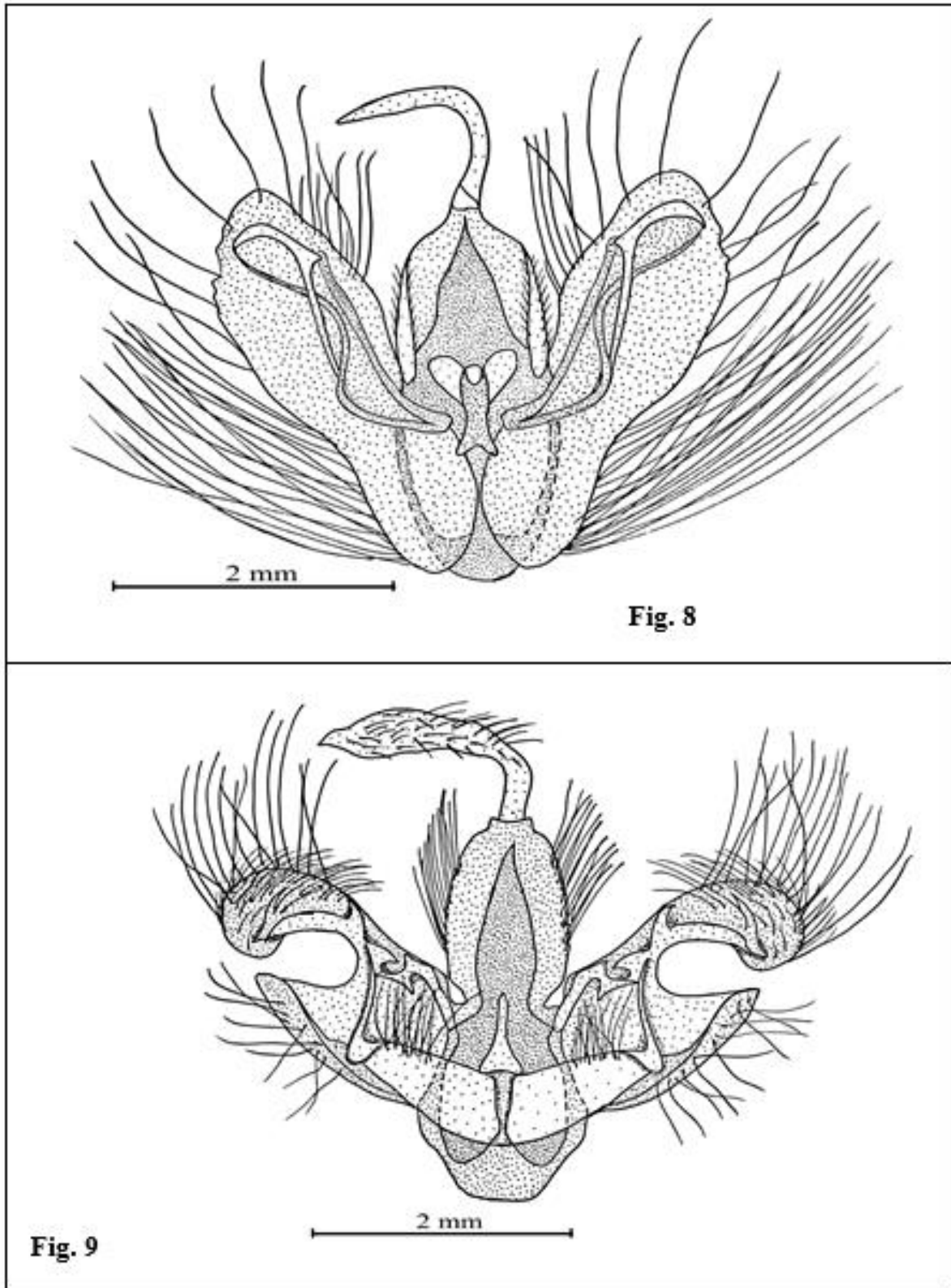
**Figs.8 &9:**

Fig. 8: *Spodoptera exigua* male genitalia

Fig. 9: *Spodoptera cilium* male genitalia

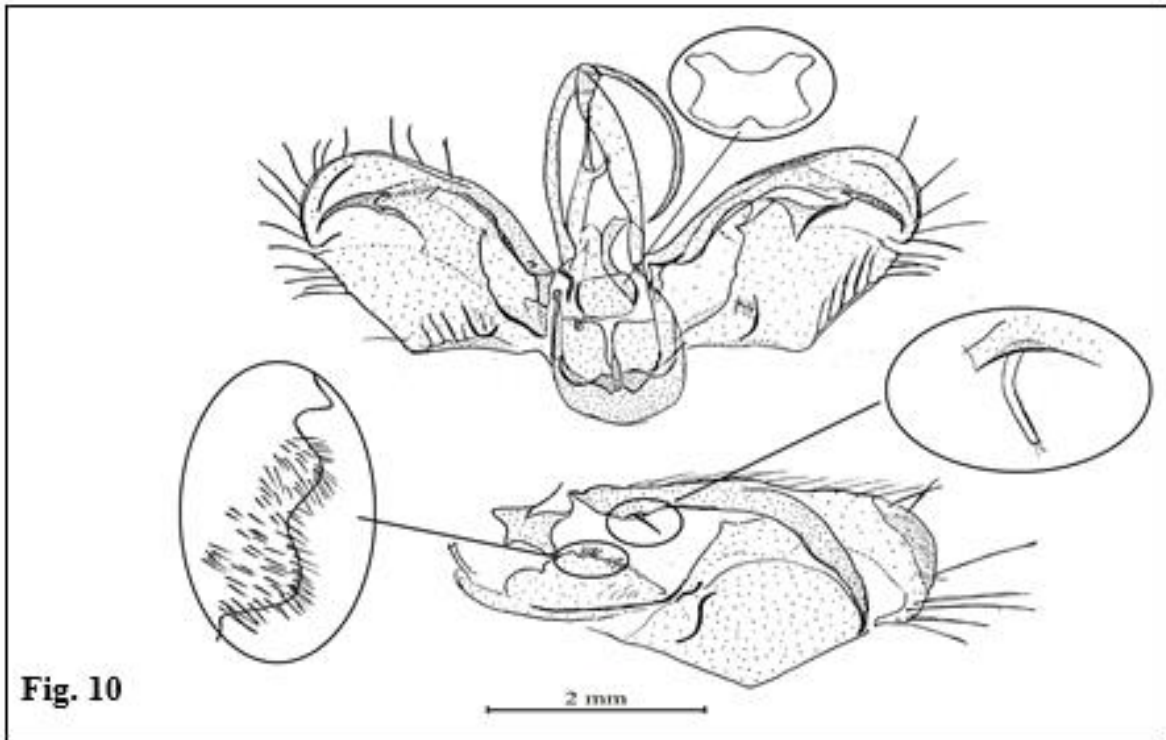


Fig. 10

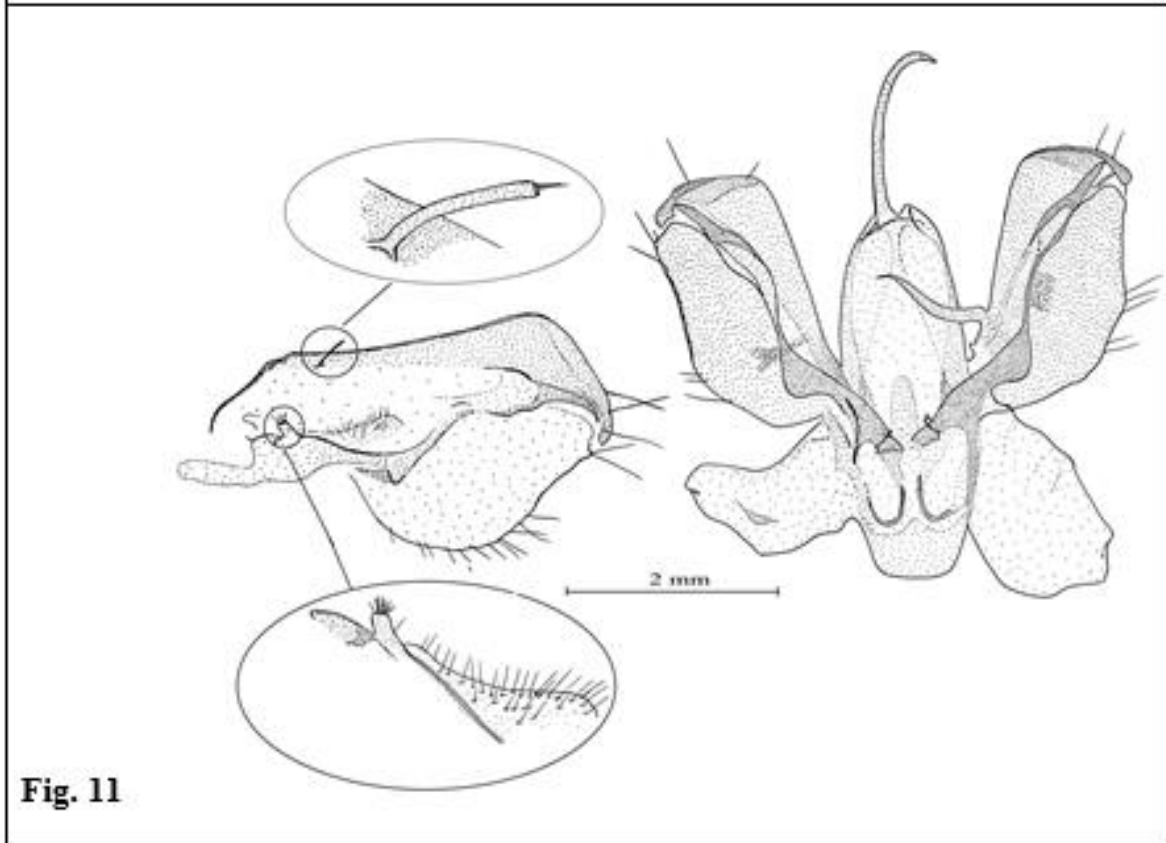


Fig. 11

Figs. 10&11:

Fig. 10: *Spodoptera frugiperda* female genitalia

Fig. 11: *Spodoptera littoralis* female genitalia

**Fig. 12***Spodoptera cilium***Fig. 13****Figs. 12 &13:**Fig. 12: *Spodoptera cilium* whole bodyFig. 13: *Spodoptera exigua* whole body



Fig.14 *Spodoptera frugiperda* (male)



Fig. 15 *Spodoptera frugiperda* (female)



Fig. 16 *Sopdoptera littoralis*

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