TAXONOMIC AID TO MAJOR CRAMBID VEGETABLE PESTS FROM NORTH INDIA (LEPIDOPTERA: CRAMBIDAE)

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[Kumar, R., Mittal, V., Kumar, N. & Ramamurthy, V. V. 2013. Taxonomic aid to major crambid vegetable pests from North India (Lepidoptera: Crambidae). Munis Entomology & Zoology, 8 (2): 858-875**]**

ABSTRACT: The six insect pest *Crocidolomia binotalis* Zeller, *Hellula undalis* (Fabricius), *Leucinodes orbonalis* Guenee, *Maruca testulalis* (Geyer), *Spoladea recurvalis* (Fabricius), *Syllepte derogata* (Fabricius) (Lepidoptera: Crambidae) reported as major pests on vegetable from North India. These pests have been reviewed taxonomically and compiled with diagnostic features. In the manuscript superfamily Pyraloidea, family Crambidae, and subfamilies Spilomelinae, Glaphyriinae, Evergestinae, characters and their major vegetable pests species treated taxonomically and illustrated with diagnostic features. Besides these, world wide distribution, host range and North Indian distribution discussed.

KEY WORDS: *Crocidolomia binotalis*, *Hellula undalis*, *Leucinodes orbonalis*, *Maruca testulalis, Spoladea recurvalis, Syllepte derogata.*

India is the second largest producer of vegetables in the world next only to China with an estimated production of about 50 million tonnes from an area of 4.5 million hectares at an average yield of 11.3 tonnes per hectare (Sidhu, 1998). Vegetables are valuable sources of nutrients and they are also being recognised for their antioxidant properties (Salawu et al., 2006; Chipurura et al., 2010) and also recognized for the production of vegetable oils (soybean oil, sunflower oil, sesame oil, rice bran oil and olive oil), which are utilized in cooking and pharma industry (Pogori et al., 2008). Vegetables are more prone to insect pests and diseases mainly due to their tenderness and softness as compared to other crops. Perusal of literature reveals that no consolidated account is available on the Lepidopterous insects associated with vegetables in India, though the major contribution by Lefroy (1909), Fletcher (1914, 1921), Pradhan (1969), Nair (1970), Butani & Jotwani (1984), Gupta (1990), David (2001), Sharma et al. (2008), Kumar et al. (2007a,b), Kumar et al. (2008). In this paper an attempt has been made to provide the current status, illustrated diagnostic tools such as field diagnostics and taxonomically diagnostic tools with updated classification. Besides this, the superfamily, family and subfamily level characters have been reviewed and presented in illustrated from, which are helpful for taxonomists and in Insect Pest Management.

MATERIAL AND METHODS

The adults were collected in the field with aspirator, manually and aerial sweep net, and at night with the help of portable light traps of different light

sources (ultra violet, black light and mercury vapour light) (Atay, 2006; Abdullah & Shamsulaman, 2008) during year 2005 to 2008. The collected insects were killed by using tetrachloro ethane. These were stretched, pinned, labeled, identified, preserved in the wooden collection boxes and deposited in the National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi. The insect pest was identified as *Crocidolomia binotalis* Zeller, *Hellula undalis* (Fabricius), *Leucinodes orbonalis* Guenee, *Maruca testulalis* (Geyer), *Spoladea recurvalis* (Fabricius), *Syllepte derogata* (Fabricius). The collected / reference specimens preserved in the National Pusa Collection were also examined. The collected specimens were examined taxonomically and studied for diagnostic characters including genitalia. The standard technique given by Robinson (1976) and Zimmerman (1978) has been followed for wing venation and genitalia, respectively. To write the taxonomic descriptions on various morphological characters (Hampson, 1892; Kitching, 2003), wing venation (Common, 1970; Zimmerman, 1978) and external genitalia (Klots, 1970; Kitching, 2003) has been followed. For naming of various veins, Comstock-Needham system has been adopted. For external genitalia, the terminology used for various parts as suggested by Klots (1970), Robinson (1976), Winter (2000), Kitching & Cadiou (2000) and Kitching (2003) has been followed. All illustrations were made by using a drawing tube attached to a Nikon SMZ10 stereoscopic zoom microscope and finalized in plate (prepared in 300 pixels/inch) through Adobe Photoshop Element 2.0 software. In the field and laboratory observation, specimens were photographed prior to studies, using a Sony Mavica MVC FD 97, Sony DSC R1 10.3 mega pixel Cyber-shot and Canon DSC 5.0 mega pixel Powershot S50 cameras.

Taxonomic Study

(A). Super family: Pyraloidea

Pyraloidea, the third largest superfamily of the Lepidoptera following Noctuoidea and Geometroidea, are comprised two families Pyralidae and Crambidae. The group includes 16,000 species worldwide, with greatest richness in the tropics. Pyraloidea moths are ditrysian moths characterized by the following morphological features, paired tympanal chambers on second sternite, each with a tympanum and a conjunctiva and a basally scaled proboscis (Figs. 1-2).

(a). Family: Crambidae

The Crambidae is the larger family with just under approximately 10,000 described species worldwide. The moths of this family are small to medium size and wingspan usually 10-35 mm. The proboscis basally scaled (Plate I, Fig. B). Tympanal organs present at the base of abdomen ventrally and 'opened' anteriomedially. Praecinctorium is present, structure in the ears, which joins two tympanic membranes in the Crambidae, and is absent in Pyralidae (Fig. 3).

(i). Subfamily: Spilomelinae

This subfamily is represented by highest species among pyraloides. The moths are characterized by the absence of chaetosemata, a bilobed praecinctorium, projecting fornix tympani, pointed spinula, absence of a gnathos, and the female genitalia have no rhomboidal signum on the bursa copulatrix (Figs. 4-6).

1. *Leucinodes orbonalis* Guenée (Figs. 14-28)

Diagnosis

Alar expanse: Male/Female 22- 26 mm.

Male and Female: head and thorax variegated with black and brown. Forewing 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 subarmginal line obsolescent towards outer angle and with a ferruginous and fuscous band beyond it, from below costa; some black specks on margin. Hindwing opalescent, with black speck at upper angle of cell and spot at lower angle; an postmedial black line nearly straight from costa, then recurved and sinuous; some pale fulvous submarginal patches and some black specks on margin. Palpi banded with fuscous; thorax marked with ferruginous or fuscous. Forewing more or less suffused in parts with ferruginous and fuscous; male with the costal tuft ochreous and black; a double antemedial line highly dentate in and below cell; prominent dark-edged white spots at the angles of cell; a highly curved minutely dentate postmedial line, with a series of black specks on it and distinct line beyond it; an indistinct minutely waved submarginal line; cilia leaden coloured at tips; the fringe of hair below median nervure ochreous. Hindwing semihyaline ochreous white; the apical area often more or less suffused with fuscous.

Wing venation: Forewing: vein Sc straight; R_1 and R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2, M_3 free, from lower angle of cell; M_3 and Cu_{1a} close to the lower angle, nearer to M_3 than to Cu_{1b}; Cu_1 much before the cell angle, about thrice as far from Cu_1 the latter from M_3, and nearly in line with origin of R_1 above, 1A+2A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2 – M_3 stalked, from lower angle, Cu_{1a} and Cu_{1b} present and free arising from middle lower angle of discal cell.

♂ **genitalia:** uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter than uncus; scaphium developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anteriroly into a rounded saccus. Valva broad, almost uniformly broad symmetrically curved distally; costa with poorly defined inner lining; sacculus developed; harpe present. Transtilla with each half long; juxta narrow anteriorly and broad posteriorly, with a round shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with three well defined and with one cornutus.

♀ **genitalia:** Corpus bursae more rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization; anterior apophyses short, each with a sharp and fine angular prominence near base based pointed; posterior apophyses longer than anterior apophyses; ovipositor lobes fringed.

Material examined: Delhi: Trans Yamuna 8.x.2006, 8.x.2007, IARI, New Delhi 17.xii.2006, 27.iv.2007; **Haryana**: Ballabhgarh 12.iv.2007, Palwal 14.iv.2007, Ferozepur 16.iv.2007, Jhirka 17.v.2007, Sohna 13.iv.2007, Pataudi 9.iv.2007; **Himachal Pradesh**: Sarol 12.x.2006, Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007, Tira 14.viii.2007, Sujanpur 15.viii.2007; **Jammu & Kashmir**: Achabal 10.x.2006, Shangus 11.x.2006, Kulgam 12.x.2006, Dachnipora 13.x.2006, Sopore 14.x.2006, SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006; **Punjab**: Phool 10.ix.2006, Rampura 10.x.2006, Abohar 11.x.2006, Khanna 20.x.2006, Raikot 21.x.2006, Balur 21.x.2006, Madhoke 26.x.2006,

Rajpura 28.x.2006, Nabha 29.x.2006; **Uttarakhand**: FRI Dehradun 20.vi.2007, Rishikesh 27.vi.2006, Jakholi 15.vi.2006, Rudraprayag 28.vi.2006, Ranichauri 30.x.2006, Pantnagar 1-7.x.2006, Haldwani 3.x.2006, Kashipur 4.x.2006; **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006.

Distribution: Through out Southern India (Fletcher, 1914); S. Africa, throughout India, Sri Lanka, Myanmar, Java, Duke of York Island (Hampson, 1896); widely distributed not only in the Indian sub-continent but also in South Africa, Congo and Malaysia (Butani & Jotwani, 1984).

Host Range: Brinjal, potato and other solanaceous crops (Butani & Jotwani, 1984 and during present study).

2. *Maruca testulalis* (Geyer) (Figs. 29-43)

Diagnosis

Alar Expanse: Male/Female: 20 to 30 mm

Male and Female: Head, thorax, and abdomen fuscous brown; palpi white below forewing fuscous brown; the costal area tinged with fulvous; indistinct subasal and antemedial lines across the cell and white spots below the cell; a lunulate black edged white spot in end of cell; a maculae black edged semihyaline band beyond the cell from below the costa to vein Cu_{1b}. hindwing semi hyaline white; the basal costal area fuscous and a spot at upper angle of cell; two upper angle of cell; two indistinct sinuous postmedial lines; a marginal fulvous brown and fuscous band from costa to vein Sc, its inner ledge very irregular.

Wing venation: Forewing: vein Sc straight; R_1 and R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2, M_3 free, from lower angle of cell; M_3 and Cu_{1a} close to the lower angle, nearer to M_3 than to $Cu_{1a;}$ Cu_{1a} much before the cell angle, about thrice as far from Cu_{1a} the latter from M_3, and nearly in line with origin of R_1 above, 1A+2A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2 – M_3 stalked, from lower angle, Cu_{1a} and Cu_{1b} present and free arising from middle lower angle of discal cell.

♂ **genitalia**: Uncus very long, narrow and strongly curved, dilated at tip, tip conspicuously fringed with flat scales dorsally and with setae ventrally, along with half ventro-distal portion setose; gnathos absent; tuba analis shorter than uncus; scaphium absent; subscaphium well developed and straplike; tegumen dome shaped, longer than broad and well sclerotized; vinculum moderately long and produced anteriorly into a blunt saccus. Valva long and almost egg shaped distally; costa broadly inflated, with seclerotized area produced into a beak-like thickening at its middle; sacculus prominent; harpe short and strongly sclerotized. Transtilla very reduced and membranous; juxta long and more or less triangular at distal end, weakly but uniformly sclerotized. Aedeagus comparatively short, with a thick sclerotized strap in one wall; vesica armed with loosely arranged denticles.

♀ **genitalia**: corpus bursae more or less dropper shaped, membranous; signum missing; ductus bursae moderately long and straight, membranous, with a sclerotized collar at ostial end; anterior apophyses long and stout, each with an angular thickening near base; posterior apophyses short and thin; ovipositor lobes densely fringed with array of long and short setae.

Material examined: Delhi: IARI, New Delhi 17.xii.2006, 27.iv.2007; **Haryana**: Palwal 14.iv.2007, Ferozepur 16.iv.2007, Jhirka 17.v.2007, Sohna 13.iv.2007, Pataudi 9.iv.2007;

Himachal Pradesh: Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007, Tira 14.viii.2007, Sujanpur 15.viii.2007; **Jammu & Kashmir**: Achabal 10.x.2006, Shangus 11.x.2006, Kulgam 12.x.2006, Dachnipora 13.x.2006, Sopore 14.x.2006, SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006; **Punjab**: Rampura 10.x.2006, Abohar 11.x.2006, Khanna 20.x.2006, Raikot 21.x.2006, Balur 21.x.2006, Madhoke 26.x.2006, Rajpura 28.x.2006, Nabha 29.x.2006; **Uttarakhand**: FRI Dehradun 20.vi.2007, Rishikesh 27.vi.2006, Jakholi 15.vi.2006, Rudraprayag 28.vi.2006, Ranichauri 30.x.2006, Pantnagar 1-7.x.2006, Haldwani 3.x.2006, Kashipur 4.x.2006; **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006.

Distribution: Neotropical and Ethiopian regions, Japan, throughout the Oriental and Australian regions (Hampson, 1896); throughout Southern India (Fletcher, 1914); widespread in tropical and subtropical regions of the world (Butani & Jotwani, 1984).

Host Range: Indian beans, cowpea, castor, groundnut, rice, tobacco, green gram and red gram (Fletcher, 1914; Butani & Jotwani, 1984 and during present study).

3. *Spoladea recurvalis* (Fabricius) (Figs. 44-58)

Diagnosis

Alar Expanse: Male/Female: 15 to 20 mm.

Male and Female: Head and thorax of Adults are small sized black colour ochreous suffused with rufous and abdomen is suffused with ruscous; labial palpi upcurved, three segmented, antennae thin long filiform, tibial spurs 0-2-4 (foreleg-midleg-hindleg) and foreleg with epiphysis.

Wing venation: Forewing: vein Sc straight; R_1 and R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2, M_3 free, from lower angle of cell; M_3 and Cu_1 close to the lower angle, nearer to M_3 than to Cu_1; Cu_1 much before the cell angle, about thrice as far from Cu_1 the latter from M_3, and nearly in line with origin of R_1 above, 1A+2A fused, 3A present; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2 – M_3 stalked, from lower angle, Cu_1 and Cu_2 present and free arising from middle lower angle of discal cell.

♂ **genitalia:** Uncus extremely reduced, broad at based and rounded at distal end, apex crowned with short and thick setae; tuba nails not examined; tegumen broader than long, heavily scleroized; vinculum produced into a rounded rudimentary saccus. Valva leaf like; costa narrowly inflated, produced into a small finger like process from its middle towards inner side, with very long setae on costal margin; sacculus poorly differentiated at base only; cucullus subrounded. Transtilla inconspicuous; juxta U-shaped. Aedeagus long, moderately narrow and slender, with a sclerotized strap in one wall and the other one membranous; vesica with a long sclerotized plate, representing the cornutus.

♀ **genitalia:** Corpus bursae long, narrow and rounded anteriorly slightly broadend posteriorly, with areas of sclerotization, signum heavily sclerotized; ductus brusae very reduced; anterior apophyses long and stout; posterior apophyses short and thin; ovipositor lobes narrow, densely setose with long setae.

Material examined: Delhi: Trans Yamuna 8.x.2006, 8.xii.2007, IARI, New Delhi 17.xii.2006, 27.iv.2007; **Haryana**: Ballabhgarh 12.iv.2007, Palwal 14.iv.2007; **Punjab**: Ferozepur 16.iv.2007, Jhirka 17.v.2007; **Himachal Pradesh**: Sarol 12.x.2006, Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007; **Jammu & Kashmir**: SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006; Punjab: Phool 10.ix.2006, Rampura 10.x.2006, Abohar 11.x.2006, Fazilika 11.x.2006; **Uttarakhand**: FRI Dehradun 20.vi.2007,

Rishikesh 27.vi.2006, Gurukul Kangri University Campus Haridwar 26.vi.2006; **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006, Dhampur 17.iv.2006, Chandpur 18.iv.2006, Anupshahar 1.iv.2006.

Distribution: Throughout India.

Host range: Amaranthus, spinach; beet root, koorkan (Fletcher, 1914; Nair, 1970; Butani & Jotwani, 1984; Gupta, 1990; David, 2001; Capinera, 2001 and during present study)

4. *Sylepta derogata* Lefroy (Figs. 59-73)

Diagnosis

Alar Expanse: Male/Female 28 to 40 mm.

Male and Female: Yellowish white; the head and thorax spotted with black and brown; abdomen with segmental brown rings; a pair of black spots or dorsal band on 2nd segment and one or two black spots towards extremity. Forewing with two subbasal series of black-brown spots often developed into lines; an oblique antemedial line; an annulus in cell and smaller one below it; a large reniform discocellular mark; a postmeidal sinuous line highly bent outwards between veins M_2 and Cu_1, and usually with a line across its sinus; the veins of outer area streaked with brown; a minutely dentate sumarginal line slightly angled on vein Cu_1; a marginal line. Hindwing with discocellular annulus touching an oblique minutely dentate antemedial line; a sinuous postmedial line, highly excurved and dentate between veins M_2 and Cu_1, its sinus crossed by a dentate line; a minutely dentate subarmginal line bent outwards to anal angle.

Wing venation: Forewing: vein Sc straight; R_1 and R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2, M_3 free, from lower angle of cell; M_3 and Cu_1 close to the lower angle, nearer to M_3 than to $Cu_{1a;}$ Cu_1 much before the cell angle, about thrice as far from Cu_{1b} the latter from M_3, and nearly in line with origin of R_1 above, 1A+2A+3A fused; Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2 – M_3 stalked, from lower angle, Cu_{1a} and Cu_{1b} present and free arising from middle lower angle of discal cell.

♂ **genitalia**: Uncus very long, narrow and strongly curved, dilated at tip, tip conspicuously fringed with flat scales dorsally and with setae ventrally, along with half ventro-distal portion setose; gnathos absent; tuba analis shorter than uncus; scaphium absent; subscaphium well developed and straplike; tegumen dome shaped, longer than broad and well sclerotized; vinculum moderately long and produced anteriorly into a blunt saccus. Valva long and almost egg shaped distally; costa broadly inflated, with seclerotized area produced into a beak-like thickening at its middle; sacculus prominent; harpe short and strongly sclerotized. Transtilla very reduced and membranous; juxta long and more or less triangular at distal end, weakly but uniformly sclerotized. Aedeagus comparatively short, with a thick sclerotized strap in one wall; vesica armed with loosely arranged denticles.

♀**genitalia**: corpus bursae more or less dropper shaped, membranous; signum present; ductus bursae moderately long and straight, membranous, with a sclerotized collar at ostial end; anterior apophyses long and stout, each with an angular thickening near base; posterior apophyses short and thin; ovipositor lobes densely fringed with array of long and short setae.

Material examined: Delhi: Trans Yamuna 8.x.2006, 8.xii.2007, IARI, New Delhi 17.xii.2006, 27.iv.2007. **Haryana**: Ballabhgarh 12.iv.2007, Palwal 14.iv.2007, Ferozepur

16.iv.2007, Jhirka 17.v.2007, Sohna 13.iv.2007, Pataudi 9.iv.2007, Hansi 10.iv.2007. **Himachal Pradesh**: Sarol 12.x.2006, Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007, Tira 14.viii.2007. **Jammu & Kashmir**: Achabal 10.x.2006, Shangus 11.x.2006, Kulgam 12.x.2006, Dachnipora 13.x.2006, Sopore 14.x.2006, Gurez 15.x.2006, Bandipore 16.x.2006, Jammu University Campus 02.x.2006, Keller 05.x.2006, Tral 06.x.2006, SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006. **Punjab**: Phool 10.ix.2006, Rampura 10.x.2006, Abohar 11.x.2006, Fazilika 11.x.2006, Bhallonwal Shonkri 14.x.2006, Mukerian 15.x.2006, Phagwara 17.x.2006, PAU 18,19.x.2006, Khanna 20.x.2006, Raikot 21.x.2006, Balur 21.x.2006, Madhoke 26.x.2006, Rajpura 28.x.2006, Nabha 29.x.2006. **Uttarakhand**: FRI Dehradun 20.vi.2007, Rishikesh 27.vi.2006, Gurukul Kangri University Campus Haridwar 26.vi.2006. **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006, Dhampur 17.iv.2006, Chandpur 18.iv.2006, Anupshahar 1.iv.2006.

Distribution: The tropical and warmer temperate zones (Hampson, 1896); throughout the plains of Southern India (Fletcher, 1914); India (Butani & Jotwani, 1984).

Host Range: Okra, cotton and other malvaceous plants (Fletcher, 1914; Butani & Jotwani, 1984).

(ii). Subfamily: Evergestinae

Evergestinae is a fairly small subfamily of the lepidopteran family Crambidae, the crambid snout moths. It contains roughly 140 species on all continents and continental islands. Evergestine moths resemble Pyraustinae; however, the male genitalia have a long uncus and long, slender gnathos. The larvae feed mostly on plants of family Brassicaceae (Figs. 10-13)

5. *Crocidolomia binotalis* Zeller (Figs. 74-88)

Diagnosis

Alar expanse: Male/Female 24- 28 mm.

Male and Female: Palpi banded with fuscous; thorax marked with ferruginous or fuscous. Forewing more or less suffused in parts with ferruginous and fuscous; male with the costal tuft ochreous and black; a double antemedial line highly dentate in and below cell; prominent dark-edged white spots at the angles of cell; a highly curved minutely dentate postmedial line, with a series of black specks on it and distinct line beyond it; an indistinct minutely waved submarginal line; cilia leaden coloured at tips; the fringe of hair below median nervure ochreous. Hindwing semihyaline ochreous white; the apical area often more or less suffused with fuscous.

Wing venation: Forewing: vein R_1 curved towards Sc and closely approximated to the latter but sometimes touching or shortly anastomosing with it; R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2-M_3 close to each other, from lower angle of cell; Cu_{1a} close to the lower angle, nearer to M_3 than to Cu_{1a}, three veins, i.e. M_2, M_3 and Cu_{1a} equidistantly placed; Cu_{1a} much before the cell angle, about thrice as far from Cu_{1a} the latter from M_3, and nearly in line with origin of R_1 above, 1A and 2A present. Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2 – M_3 stalked, from lower angle, Cu_{1a} and Cu_{1b} present and free arising from middle lower angle of discal cell.

♂ **genitalia:** uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter

than uncus; scaphium not developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anteriroly into a rounded saccus. Valva long, almost uniformly broad unsymmetrically rounded distally; costa with poorly defined inner lining; sacculus poorly demarcated; harpe absent. Transtilla with each half long and ribbon like, weakly sclerotized; juxta narrow anteriorly and broad posteriorly, with a v-shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with three well defined and heavily sclerotized cornuti.

♀ **genitalia:** Corpus bursae more or less rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization any-where; anterior apophyses long, each with a sharp and fine angular prominence near base based pointed; posterior apophyses short and thing; ovipositor lobes fringed with different.

Material examined: Delhi: Trans Yamuna 8.x.2006, 8.x.2007, IARI, New Delhi 17.xii.2006, 27.iv.2007, **Haryana**: Ballabhgarh 12.iv.2007, Palwal 14.iv.2007, Ferozepur 16.iv.2007, Jhirka 17.v.2007, Sohna 13.iv.2007, Pataudi 9.iv.2007. **Himachal Pradesh**: Sarol 12.x.2006, Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007, Tira 14.viii.2007, Sujanpur 15.viii.2007, KVK Kangra 16.viii.2007, Dera 17.viii.2007, HPKV, Palampur 18.viii.2007, Nagar 19.viii.2007, Manali 20.viii.2007, Keylong 20.viii.2007, Dalang 22.viii.2007, Kufri 7.viii.2007, Brachhawar 27.viii.2007, Kandhaghat 29.viii.2007, Kassauli 01.ix.2007. **Jammu & Kashmir**: Achabal 10.x.2006, Shangus 11.x.2006, Kulgam 12.x.2006, Dachnipora 13.x.2006, Sopore 14.x.2006, Gurez 15.x.2006, Keller 05.x.2006, Tral 06.x.2006, SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006 **Punjab**: Phool 10.ix.2006, Rampura 10.x.2006, Abohar 11.x.2006, Khanna 20.x.2006, Raikot 21.x.2006, Balur 21.x.2006, Madhoke 26.x.2006, Rajpura 28.x.2006, Nabha 29.x.2006. **Uttarakhand**: FRI Dehradun 20.vi.2007, Rishikesh 27.vi.2006, Jakholi 15.vi.2006, Rudraprayag 28.vi.2006, Ranichauri 30.x.2006, Pantnagar 1-7.x.2006, Haldwani 3.x.2006, Kashipur 4.x.2006. **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006, Dadri 4.iv.2006, Badalpur 5.iv.2006, Sikandrabad 4.iv.2006, Kasna 6.iv.2006, Muradnagar 7.iv.2006, Modinagar 8.iv.2006, Garh, Sahibabad 9.iv.2006, Modipuram 3.iv.2006, Vehalana 11.iv.2006, Shamli 12.iv.2006, Saharanpur 12.iv.2006.

Distribution: South Africa, Formosa, throughout India, Ceylon, Burma, Java, Australia and Norfolk Island (Hampson, 1896); widely distributed in Indian sub-continent as also in South-east Asia, Australia and Africa (Butani & Jotwani, 1984).

Host Range: All brassica crops and specially cabbage (Butani & Jotwani, 1984 and during present study).

(iii). Subfamily: Glaphyriinae

Adults are mostly small and broad-winged; labial palpus short; cheatosemata absent. In the male genitalia the uncus is usually well developed and slender, but sometimes modified or reduced; gnathos absent (Figs. 7-9).

6. *Hellula undalis* Fabricius (Figs. 89-103)

Diagnosis

Alar expanse: Male/ Female 18 to 22 mm.

Male and Female: Grey and brown suffused with fuscous. Forewing with pale dentate subasal line; a dark antemedial line on a pale band excurved between subcostal and median nervures; a pale-edged dark discocellar lunule; a pale postmedial line excurved from vein R_5 to Cu_2; a pale apical spot and series of pale and dark marginal specks. Hindwing pale, with slight fuscous suffusion on apical area.

Wing venation: Forewing: Sc straight and attached with discal cell, vein R_1 straight and arising from upper middle discal cell; R_2 free; R_{3+4} stalked; R_5, M_1 free, from below the upper angle of cell; M_2-M_3 close to each other, from lower angle of cell; Cu_1 close to the lower angle, nearer to M_3 than to Cu_{1a}, three veins, i.e. M_2, M_3 and Cu_{1a} equidistantly placed; Cu_{1a} much before the cell angle, about thrice as far from Cu_{1b} the latter from M_3, and nearly in line with origin of R_1 above, 1A and 2A present. Hindwing: Sc dilated at base anastomosing with Rs after its origin from upper angle for some distance; both ending at costal margin before the apex, with the free part of Rs a little over the length of common stalk; M_1 from a little below the angle; M_2–M_3 stalked from lower angle of discal cell, Cu_{1a} and Cu_{1b} present and arising from middle lower angle of discal cell.

♂ **genitalia:** uncus unique, long, distal end bent and more or less triangular, bearing six group of setae on dorsal surface, the ventral ending naked; gnathos conspicuous, very well developed, moderately long, curved and pointed at distal end, with six short but prominent dents on dorsal surface; tuba analis shorter than uncus; scaphium not developed; subscaphium thin and well sclerotized; tegumen broad; vinculum produced anteriroly into a rounded saccus. Valva long, almost uniformly broad symmetrically rounded distally; costa with poorly defined inner lining; sacculus poorly demarcated; harpe absent. Transtilla with each half long and ribbon like, weakly sclerotized; juxta narrow anteriorly and broad posteriorly, with a v-shaped sclerotization at basal portion. Aedeagus moderately long, much broader in the posterior half; vesica armed with sclerotized cornuti.

♀ **genitalia:** Corpus bursae more or less rounded, partially sclerotized; signum absent; ductus bursae long, with posterior portion quite broadened, without any sclerotization any-where; anterior apophyses long, each with a sharp and fine angular prominence near base based pointed; posterior apophyses same size as anterior apophyses; ovipositor lobes fringed.

Material examined: Delhi: Trans Yamuna 8.x.2006, 8.x.2007, IARI, New Delhi 17.xii.2006, 27.iv.2007; **Haryana**: Ballabhgarh 12.iv.2007, Palwal 14.iv.2007, Ferozepur 16.iv.2007, Jhirka 17.v.2007; **Himachal Pradesh**: Sarol 12.x.2006, Saho 12.x.2006, Bhanota 13.x.2006, Krishi Vigyan Kendra 13.viii.2007; **Jammu & Kashmir**: SKUAST Shalimar 7, 8.x.2006, Ganderbal 9.x.2006; **Punjab**: Phool 10.ix.2006, Rampura 10.x.2006, Abohar 11.x.2006, Fazilika 11.x.2006; **Uttarakhand**: FRI Dehradun 20.vi.2007, Rishikesh 27.vi.2006, Gurukul Kangri University Campus Haridwar 26.vi.2006; **Uttar Pradesh**: AMU Aligarh 27.iv.2006, Loni 13.iv.2006, Barot 12.iv.2006, Jawli 13.iv.2006, Ramnagar 15.iv.2006, Bhojipura 16.iv.2006, Dhampur 17.iv.2006, Chandpur 18.iv.2006, Anupshahar 1.iv.2006.

Distribution: ASIA- Bangladesh, Brunei, Burma, Cambodia, Cocos-Keeling Islands, Hong Kong, India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam; AFRICA- Ghana, Kenya, Madagascar, Malawi, Mali, Mauritius, Mozambique, Nigeria, Rhodesia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Uganda, Upper Volta, Zaire, Zambia; AUSTRALASIA and PACIFIC ISLANDS - Australia, Caroline Islands, Cook Islands, Fiji, Mariana Islands, New Caledonia, Niue Island, Norfolk Island, Papua New Guinea, Western Samoa Solomon Islands, Tonga (CAB Map, 1979).

Host Range: Cabbage, cole crops and some root crops as well (Butani & Jotwani, 1984 and during present study).

DISCUSSION

Survey-cum-collection works on crambid lepidopterous insects associated with vegetables in North India were undertaken. On the basis of collected /

reference specimens Crambid insects associated with vegetables in India examined in the National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi, seven states / union territories of North India had been covered. In the present study integrating taxonomic aspects incorporation of the superfamily, family and subfamilies illustrated keys is the unique feature of study. The surveys led to the collection of six species on the following crops namely, brinjal, potato, Indian beans, cowpea, castor, groundnut, rice, tobacco, green gram, red gram, amaranthus, spinach, beet root, koorkan, okra, cabbage and cole crops.

The present study provided all the existing information on crambid insects associated with vegetables in North India, their host range, distribution and taxonomically identification tools, so that it will be helpful in identification. Management programs to the control of vegetable pests and for the higher productivity of vegetables.

The superfamily, family and subfamilies identification characters were reviewed earlier (Holloway et al., 1987), which was published in black and white as line diagrams. Now, all the characters of higher level taxa reviewed and illustrated in color, which will help in identification. Beside these characters, the major pests falls under these superfamilies were reviewed for the proper identification upto lower (species) level taxa. These illustrated diagnostic aid major crambid vegetable pests will help in proper identification to farmers and researchers.

ACKNOWLEDGEMENT

The authors are grateful to the Indian Council of Agricultural Research, New Delhi for funding the project entitled “Network Project on Insect Biosystematics”.

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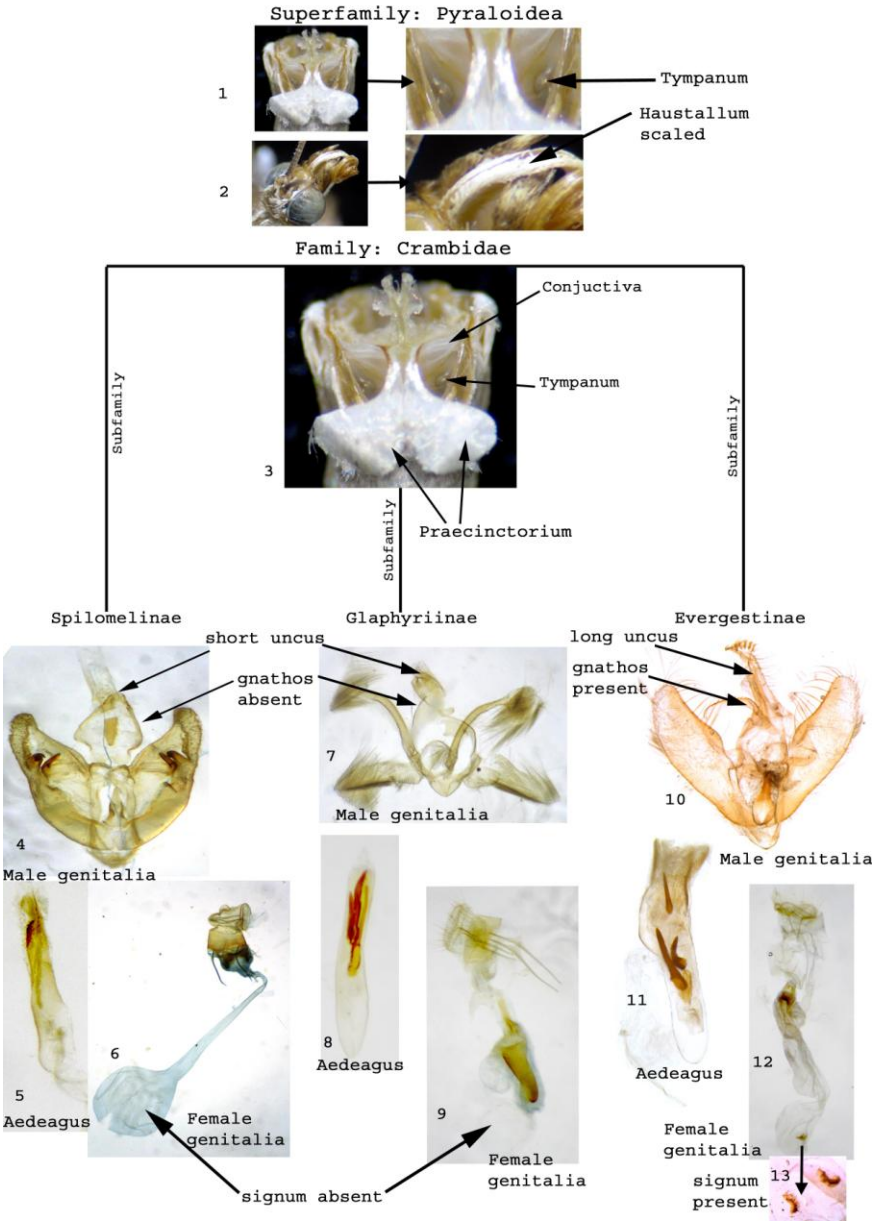
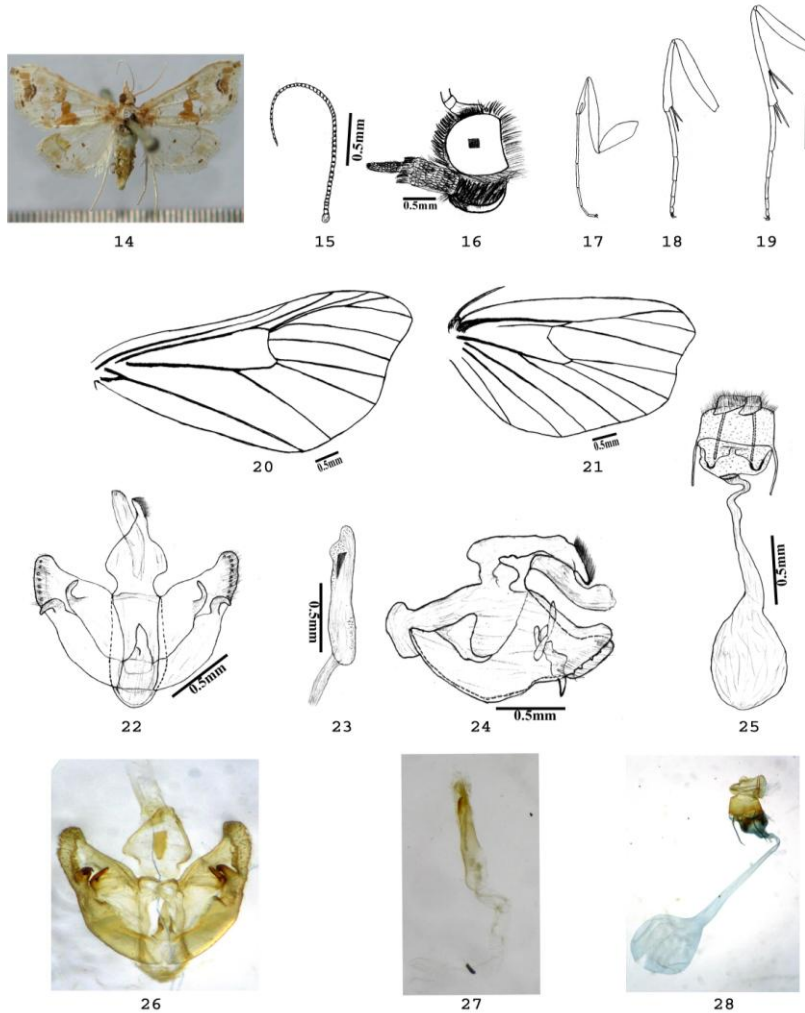
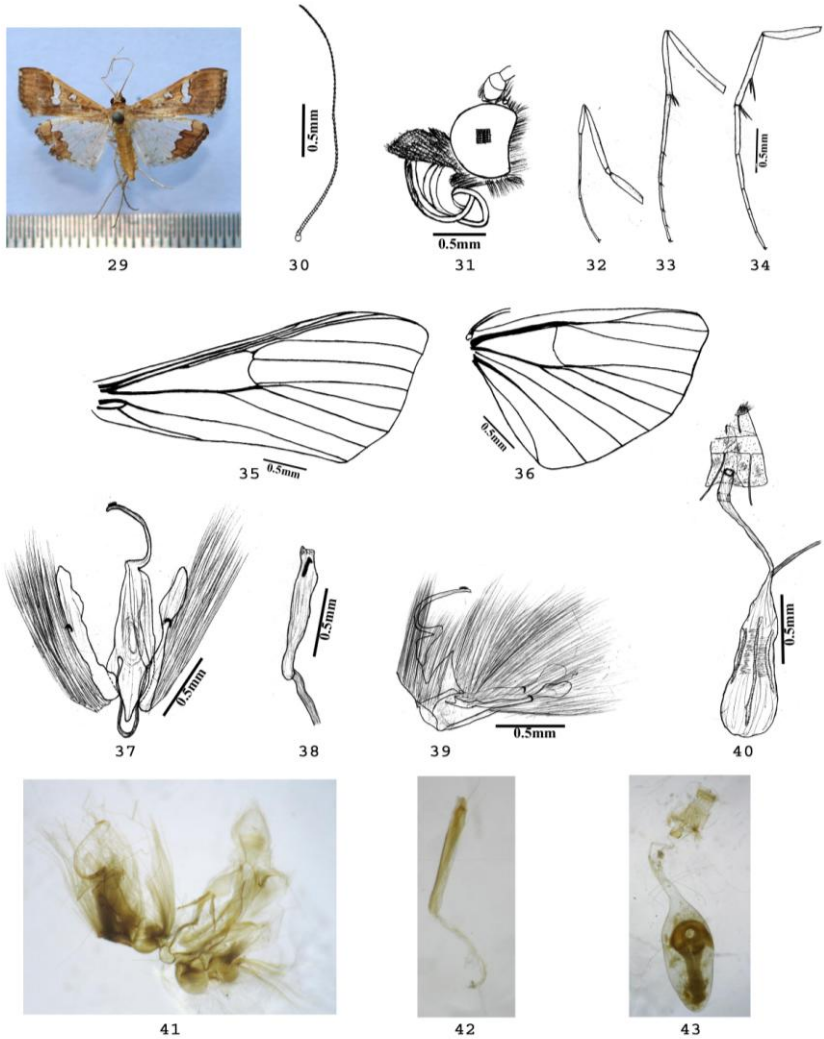


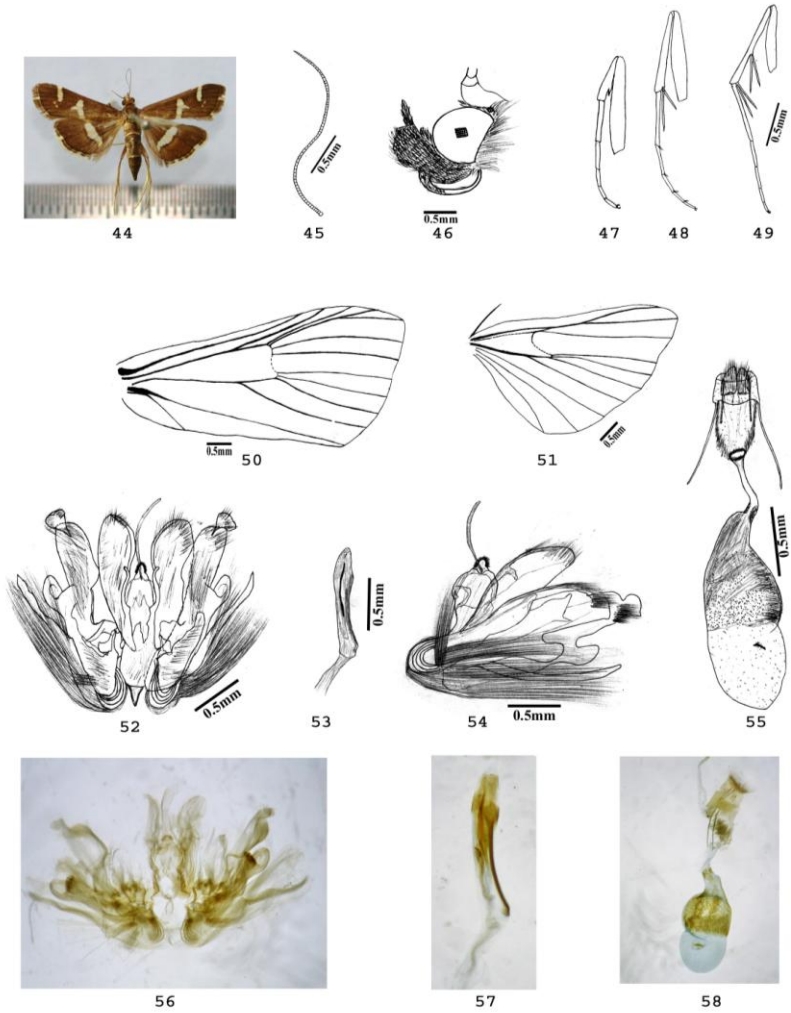
Figures 1-13. 1. Tympanum, 2. Haustellum, 3. Family Crambidae characters, 4. male genitalia (Spilomelinae), 5. Aedeagus (Spilomelinae), 6. Female genitalia (Spilomelinae), 7. Male genitalia (Glaphyriinae), 8. Aedeagus (Glaphyriinae), 9. Female genitalia (Glaphyriinae), 10. Male genitalia (Evergestinae), 11. Aedeagus (Evergestinae), 12. Female genitalia (Evergestinae), 13. Signum on corpus bursae of female genitalia (Evergestinae).



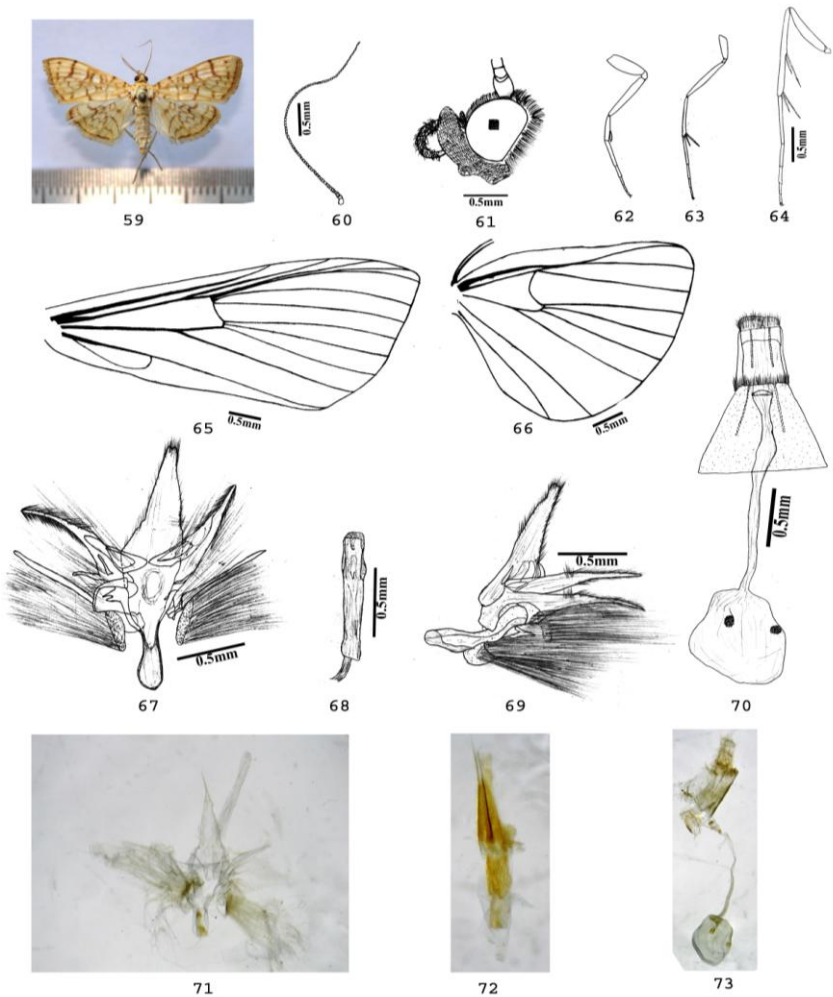
Figures 14-28. *Leucinodes orbonalis* Guenee 14. adult (habitus) 15. antenna 16. head (lateral view) 17. fore leg 18. middle leg 19. hind leg 20. fore wing 21. hind wing 22, 26. male genitalia-ventral view 23, 27. aedeagus 24. male genitalia-lateral view 25, 28. female genitalia.



Figures 29-43. *Maruca testulalis* (Geyer) 29. adult (habitus) 30. antenna 31. head (lateral view) 32. fore leg 33. middle leg 34. hind leg 35. fore wing 36. hind wing 37, 41. male genitalia-ventral view 38, 42. aedeagus 39. male genitalia-lateral view 40, 43. female genitalia.



Figures 44-58. *Spoladea recurvelis* (Fabricius) 44. adult (habitus) 45. antenna 46. head (lateral view) 47. fore leg 48. middle leg 49. hind leg 50. fore wing 51. hind wing 52, 56. male genitalia-ventral view 53, 57. aedeagus 54. male genitalia-lateral view 55, 58. female genitalia.



Figures 59-73. *Sylepta derogata* (Fabricius) 59. adult (habitus) 60. antenna 61. head (lateral view) 62. fore leg 64. middle leg 65. hind leg 66. fore wing 51. hind wing 52, 56. male genitalia-ventral view 53, 57. aedeagus 54. male genitalia-lateral view 55, 58. female genitalia.

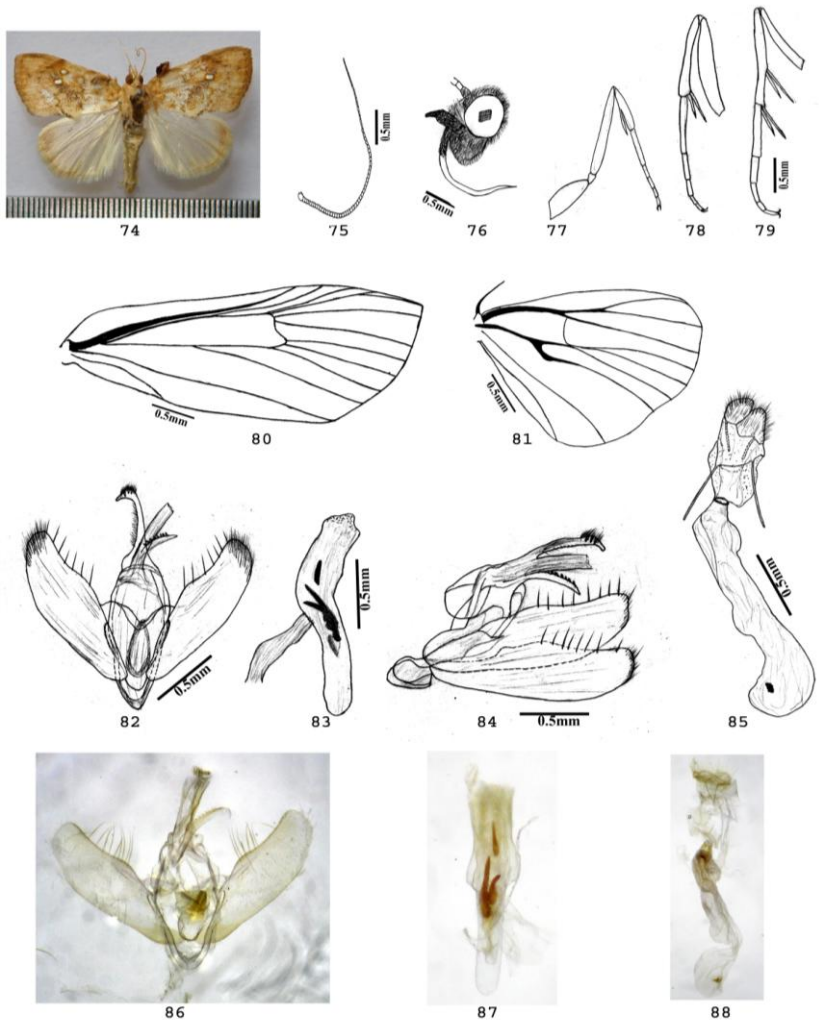
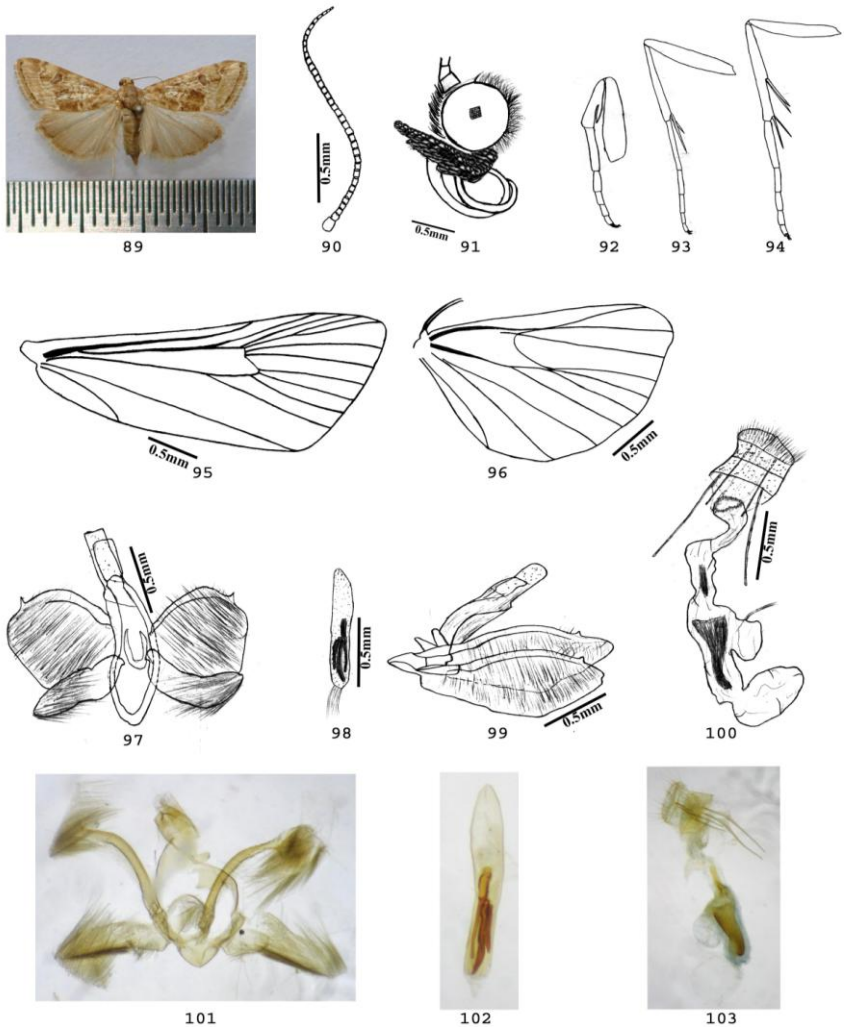


Figure 74-88. *Crocidolomia binotalis* Zeller 74. adult (habitus) 75. antenna 76. head (lateral view) 77. fore leg 78. middle leg 79. hind leg 80. fore wing 81. hind wing 82, 86. male genitalia-ventral view 83, 87. aedeagus 84. male genitalia-lateral view 85, 88. female genitalia.



Figures 89-103. *Hellula undalis* (Fabricius) 89. adult (habitus) 90. antenna 91. head (lateral view) 92. fore leg 93. middle leg 94. hind leg 95. fore wing 96. hind wing 97, 101. male genitalia-ventral view 98, 102. aedeagus 99. male genitalia-lateral view 100, 103. female genitalia.