



Original article

## Taxonomy and distribution of agriculturally important plusiinae (Lepidoptera: Noctuidae) from southern Punjab, Pakistan

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### ABSTRACT

Taxonomic identification and classifications of insect pest genera *Chrysodeixis* and *Ctenoplusia* of the subfamily Plusiinae is very compulsory due to their phytophagous nature and potential to damage the cash as well as cereal crops. Taxonomy plays a key role in proper not only in identification and classification of the pest but also in designing a successful managing strategy. In current study, specimens of *Chrysodeixis* and *Ctenoplusia* genera were collected from different geographical areas of south Punjab, Pakistan and their diagnostic features were examined following taxonomic keys. The data of temperature, relative humidity and rainfall were also recorded during the study period. Genitalia was extracted by dissecting of the abdomen and inspected under Stereo microscope. The results revealed two new species, *Chrysodeixis maxus* and *Ctenoplusia oleraceus*, from south Punjab region in addition to previously reported species: *Chrysodeixis furihatai*. Suitable management of the voracious insect pest at appropriate time may help in sustaining the agriculture in Pakistan.

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### 1. Introduction

The subfamily Plusiinae (Lepidoptera: Noctuidae) is distributed throughout tropical, temperate and arctic regions of the world with more than 500 cosmopolitan species (Ronkay and Behounek, 2010; Zahiri and Fibiger, 2008). This subfamily was first time arisen in the south-eastern Palearctic/northeastern Oriental regions because in this area are currently found the most plesiomorphic plusiine (Kitching 1987). Most of the defoliators are inclusively found from

this subfamily. The species are small to medium in size with characteristic metallic specks at middle of the forewing (Twinkle et al., 2018). The Plusiinae was first time erected by de Boisduval (1829) as a subfamily with its type species *Plusia* (Ochsenheimer, 1816). Members of this subfamily are economically very important because larvae of many species are polyphagous that vigorously attack on the agricultural crops including soybean (*Glycine max* L), cauliflower (*Brassica oleracea* var. botrytis), cabbage (*Brassica oleracea* var. capitata), potato (*Solanum tuberosum* L), tomato (*Solanum lycopersicum* L), radish (*Raphanus sativus* L), bean (*Phaseolus vulgaris* L), cowpea (*Vigna unguiculata* L.), brinjal (*Solanum melongena* L) and several aromatic and oleraceous plants (Twinkle et al., 2018; Bhat and Ahanger, 2018).

Most of the destructive genera in this subfamily are the *Chrysodeixis* and *Ctenoplusia* due to their polyphagous larvae that feed on vegetables, fruit, and ornamental plants (Rolim et al., 2013). Soybean is one of the most preferable host (Specht et al., 2015).

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Genus *Chrysodeixis* was first time erected by Hubner (1821) as a type species of *Phalaena chalcites*. after that studied by Dyar (1922) from Italy. Its name was replaced with genus *Neoplusia* (Okano, 1963). Later on, *Chrysodeixis* Agassiz and *Neoplusia* Okano were merged as junior synonyms in genus *Chrysodeixis* Hubner by Poole (1989) and also added 23 species. Genitalia is considered the most reliable source for identification and classification because many of the species are morphologically alike and cant identified. Genital features of *C. furihatai* Okano and *C. eriosoma* Doubleday were described in detail from Kashmir Himalaya (Singh and Sekhon, 2015).

Genus *Ctenoplusia* was first time described by Dufay (1970) with *Plusia limbirena* Guenee as a type species. About 16 species were identified into this genus by Dufay (1972) and after three years *C. etiennei* and *C. perplexa* were also studied (Dufay, 1975). Male genitalia of *C. sigillata* Dufay and *C. albostrata* Bremer and Grey were studied by Holloway (1985) and *C. microptera* was examined by Ronkay (1989) from Vietnam. *Ctenoplusia oxygramma* Greyer was first time reported on genitalia basis from Mexico (Schmidt and Lafontaine, 2010). Male and female genital characteristics *C. fracta* were studied from north East India (Singh, 2015) and *C. albostrata* Bremer and Grey from Himalaya Kashmir, India (Singh and Sekhon, 2015). But such studies are lacking from Pakistan. The current study was conducted to identify and classify the species of subfamily Plusiinae on the basis of their morphological and genital characteristics of the *Chrysodeixis* and *Ctenoplusia* genera from Multan, Khanewal and Bahawalpur districts of southern Punjab, Pakistan.

## 2. Materials and methods

### 2.1. Study site

The study site consists of three districts of south Punjab, Pakistan. The climatic conditions including temperature and relative humidity of the selected districts recorded during the research are given in Tables 1 and 2.

### 2.2. Multan

It is situated on Chenab river bank at longitude 71.5249° E and latitudes 30.1575° N. It plays a significant role in agricultural production and manufacturing of cotton textiles. It is also called The Mango City due to its stiffling hot climatic conditions that provide suitable environment for fruit ripening, thickness and most aromatic mangoes in the world. The area consists of highly fertile cultivated land covered with different seasonal crops. In winter season, wheat, barley, onion, cabbage and tomatoes crops are

grown. In summer, cotton and rice are the dominant cultivated crops. In case of fruits, mango and citrus fruits are quite common.

### 2.3. Khanewal

This district is mainly located on main railway line of Peshawar-Karachi and also on national highway. It lies between longitude 71° 55'00"E and latitude 30° 18'00"N. Its two main tehsils Kabirwala and Mian Channu are located along the bank of Ravi and Chenab. It has very fertile soil it is famous for wheat and cotton. Canal water system and underground water fulfill the need of crops. In cultivated areas, winter crops such as wheat, clover, bean, cabbage and tomatoes in summer, cotton and maize are dominantly cultivated crops. Trees such as citrus and mango are largely grown.

### 2.4. Bahawalpur

It is located between longitudes 71.6911° E and latitudes 29.3544° N. The area consists of excellent cultivated as well as desert land. In winter, wheat, barley, soybean and clover are grown in cultivated areas. While in summer season, cotton, sugarcane and rice are the dominant cultivated crops. Trees such as date palm, citrus, berry and mango are grown. Agricultural lands are mainly irrigated by canal irrigation system while in desert areas system of irrigation depends upon underground water pumped from the depth of about 150 to 250 m.

### 2.5. Collection and identification of specimens

The fluorescent light traps were installed at different localities including Basti Maluk, Bahawalpur Bypass, Qadirpur Ran of district Multan, Kabirwala, Jahanian, Makhdoom pur of district Khanewal and district Bahawalpur like Lal Suhara, Yazman, Khanqah Sharif and Ahmedpur southern Punjab, Pakistan during 2016 to 2018. Light trap is the most substantial approach for assemblage of noctuids moths (Ayberk et al., 2010). The specimens were collected carefully to avoid damage to body scales. Freshly killed moths were pinned and set on the stretching board (Sajjad et al., 2020a, 2020b).

To study the species genital characteristics, male and female genitalia were extracted by detaching the abdomen and dissected with fine needles and forceps. The abdomen was dipped in 10% potassium hydroxide solution for overnight to soften the chitin and other unnecessary parts. Excess of KOH was eliminated by abdomen and cleaned the genitalia by two to three time washing in distilled water before dissecting. Stereomicroscope (Meiji EMZ-5TR) was used for dissection and extraction of genitalia and then washed for 15 to 20 min in 50%, 60%, and 70% solutions of ethanol for more clearing parts (Triplehorn and Johnson, 2005). Finally, the genitalia was washed with glycerol for more clearance.

**Table 1**  
Meteorological records of three districts of southern Punjab during 2017.

	Temperature (°C)			Relative Humidity (%)			Rainfall (%mm)		
	Multan	Khanewal	BWP	Multan	Khanewal	BWP	Multan	Khanewal	BWP
<b>Jan</b>	14	14	16	48	48	41	12.04	6.87	2.43
<b>Feb</b>	19	19	21	28	29	22	0.15	0.22	0.14
<b>Mar</b>	24	23	26	29	29	22	1.68	0.92	0.08
<b>April</b>	32	32	34	18	19	15	3.21	5.49	0.95
<b>May</b>	38	37	38	17	17	16	5.02	2.19	1.08
<b>Jun</b>	39	38	39	28	27	27	10.12	7.22	10.49
<b>Jul</b>	39	38	36	16	33	33	5.64	2.39	3.71
<b>Aug</b>	38	37	37	31	33	32	1.64	1.33	5.37
<b>Sep</b>	35	34	35	23	25	24	1.25	0.46	0.29
<b>Oct</b>	29	29	30	14	15	13	0.00	0.00	0.00
<b>Nov</b>	23	22	23	22	22	21	0.86	0.00	1.02
<b>Dec</b>	20	18	19	22	23	22	6.13	8.66	6.88

**Table 2**  
Meteorological records of three districts of southern Punjab during 2018.

	Temperature (°C)			Relative Humidity (%)			Rainfall (%mm)		
	Multan	Khanewal	BWP	Multan	Khanewal	BWP	Multan	Khanewal	BWP
<b>Jan</b>	17	17	18	22	22	20	0.00	0.00	0.00
<b>Feb</b>	20	19	21	31	31	27	0.96	1.34	0.17
<b>Mar</b>	26	25	27	27	28	22	0.40	1.65	0.02
<b>April</b>	31	31	32	22	23	18	3.56	4.04	2.77
<b>May</b>	37	37	38	15	15	13	4.95	2.27	3.65
<b>Jun</b>	40	40	40	23	24	24	10.28	5.89	8.11
<b>Jul</b>	39	39	38	33	34	34	14.03	13.72	8.84
<b>Aug</b>	37	37	37	35	36	36	1.71	1.08	0.63
<b>Sep</b>	34	33	34	32	34	32	2.66	2.59	0.07
<b>Oct</b>	35	28	29	16	18	17	0.20	0.07	0.00
<b>Nov</b>	28	23	24	20	22	20	0.00	0.00	0.00
<b>Dec</b>	22	17	18	23	24	23	0.00	0.12	0.00

Permanent mounting of fore and hind wings and copulatory organ was carried out through canada balsam on glass slides along with appropriate description tags. Photography of specimens and genitalia was done by using of digital camera (HD 1500 T Meiji) that mounted on stereomicroscope (Meiji EMZ-5TR). The available taxonomic literature was used to identify the moths, followed Dufay (1972), Kitching (1984,1987), Ronkay and Behounek (2008, 2010). Length of different body parts was measured with the help of stage micrometer placed under the stereomicroscope (EMZ-5RT Meiji).

## 2.6. Biodiversity indices

Species richness and evenness of subfamily Plusiinae were estimated from above mention localities. Data was analyzed through Past 3 software and results were represented in graphical form.

Following abbreviations have been used in description and morphometric analysis of the genitalia

- AED: Aedeagus
- TG: Tegumen
- UN: Uncus
- JX: Juxta
- CRN: Cornuti
- VES: Vesica
- DU, EJ: Ductus Ejaculatorious
- HRP: Harp
- VIN: Vinculum

## 3. Results

### 3.1. Diagnostic characters of subfamily Plusiinae

Eyes were huge and round with cilia, scales covered the thoracic dorsal and abdominal anterior sides of insect body. Palpi were upturned and modest in length. Legs tibiae were entirely or fairly spine. Prothorax and dorsum of the thorax were highly fringed with tuft hairs. Metallic blotches were located at forewings and their anal angles are also covered with toothed scales. Uncus is muscular but differ in shape and size. Tegumen length varied in species but usually shorter than vinculum. Both saccus and juxta were well formed. Aedeagus was membranous or scobinated with cornuti that intensely erected by vesica. Female genitalia was considered the most important characteristics in identification of the species. Posterior and anterior apophyses were equal in length. Corpus bursae were membranous and lager than ductus bursae.

### 3.2. Key of the different genera of subfamily Plusiinae

1. Proboscis is moderate in length, 2nd segment of the vertex is almost short in length while ductus bursae in female is long and bag like **Chrysodeixis** Hubner (1821)
  - Proboscis is long and well formed. 2nd segment of vertex is smooth and extended up to the vertex head. Oblong, elongated and membranous ductus bursae ..**Ctenoplusia** Dufay (1970)

### 3.3. Diagnostic attributes of the *Chrysodeixis*

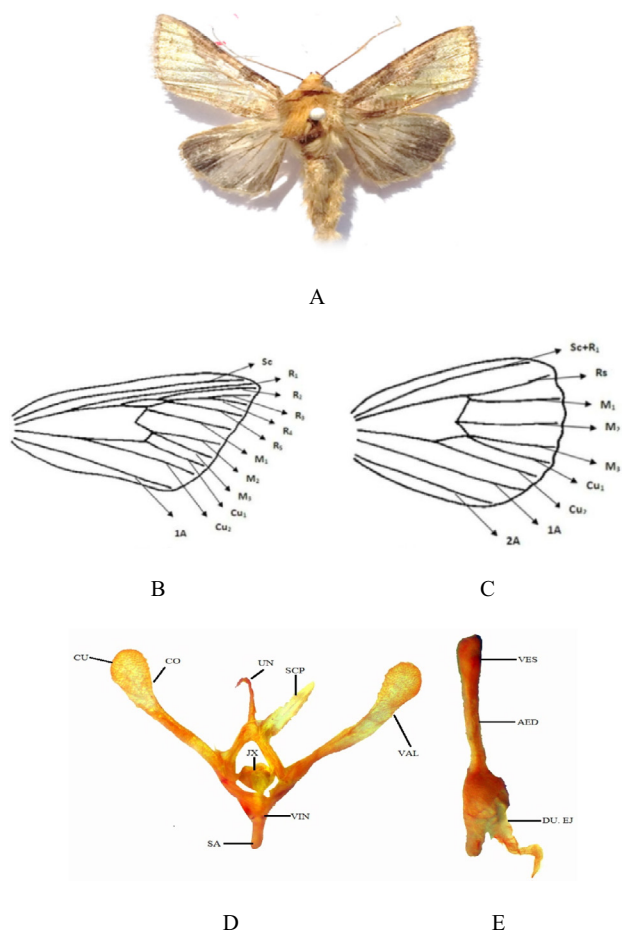
Normally the species belong to the genus *Chrysodeixis* are brown color marked with white silvery shade. Head is irregular and frons bended to anterior body parts. Vertex is inverted, basal segment is shorter than 2nd but larger than 3rd segment of palpi. Proboscis is well-developed, eyes are smooth and hairy. Thoracic segments are crested with scales. Forewings anterior margins are sinuate and crenulated apical margins with curved apical sub angles. Hind wings have sinuated anterior and apical margins. Posterior tibia is fringed with spines but absent at middle tibia. In female genitalia, ductus bursae is long bag like.

### 3.4. Key of different species of the genus *Chrysodeixis*

1. Uncus is consistently long, narrow and needle-like without penicular hairs. Tegumen short and narrow. Broad and rod shape saccus round tip. Juxta is extensive and just like candle flame .....**Chrysodeixis maxus** Sp. Nov.
  - Uncus is long and slenderical fringed with penicular hairs. Tegumen long and broad in length. Saccus long and needle-like with a pointed tip. Juxta is oval shape.**Chrysodeixis furihatai** Okano (1963)

### 3.5. Taxonomic characteristics of *Chryodeixis maxus* Sp. Nov.

**Head:** Head is brown color that covered by dense brown hairs.  
**Thorax:** Thoracic segments are crested with yellowish brown scales. Pectus are yellowish white color. Lateral anal has small brown tuft hairs and the tip of the apexes are yellowish brown. Light brown forewings with golden shad and lower cell angle has reniform. Yellowish brown hind wings and their terminal veins are dark brown color. **Abdomen:** Abdominal segments are fringed by small brown hairs (Fig. 1A).



**Fig. 1.** *Chrysodeixis maxus* Sp. Nov. (A) Adult dorsal view (B) Forewing (C) Hind wing (D) Genitalia (E) Aedeagus.

### 3.6. Male genitalia

Uncus is curve, evenly elongated and narrow with needle-like tip. Tegumen is fine and short, scaphium long and well-developed. Base of the valva is fine but gradually become wider toward the caudal, harp absent. Cucullus area is covered with spines. Vinculum is long, narrow and well sclerotized, wide and rod shape saccus with round tip. Broad and candle flame like juxta (Fig. 1D). Aedeagus is long rod-like and swollen base while their distal end has several spines like cornuti and proximal end tube like. Ejaculatory ductus is short and enter near the base (Fig. 1E). The measurement of wingspan, antennae, genital parts is given in Table 3.

**Table 3**  
Dimension of body parts (% mm) and standard error (SE) of *C. maxus* Sp. Nov.

Characters	<i>C. maxus</i> Sp. Nov.-SE
Wingspan	351.5
Antenna	150.93
Uncus	2.20.12
Tegumen	1.60.14
Scaphium	-----
Valva	4.30.10
Juxta	0.70.11
Saccus	1.00.07
Aedeagus	5.70.08
Ductus ejaculatorius	8.70.13

### 3.7. Type species

**Holotype:** , 02.vii.2017 Yazman, (Muhammad Sajjad) Bahawalpur through light trap and conserved in plant protection department, Bahauddin Zakariya University (BZU), Multan.

**Paratype:** Punjab: Multan: Basti Maluk, 01 , 09.vii.2017 and Qadirpur Ran, 02 , 24.ix.2017. Khanewal: Kabirwala, 02 , 12. ix.2017 and Jahanian, 02 , 27.vii.2018. Bahawalpur: Ahmedpur, 02 , 16.ix.2017, Lal sunhara, 02 , 28.vii.2017, Yazman, 01 , 18. x.2017 and Khanqah Sharif 03 , 27.x.2017.

## 4. Etymology

Species was epithet from their suitable host plant soybean (*Glycine max*)

**Sexual dimorphism:** Unknown.

**Remarks on morphology s:** This species is generally resembled to previously described species, *Chrysodeixis furihatai*. In this study, *Chrysodeixis furihatai* was also studied both species were alike but *C. maxus* Sp. Nov. varied from *C. furihatai* due to subsequent features. (i) Head and thorax are light brown color in *C. maxus* Sp. Nov and fringed with long brown dense hairs while in *C. furihatai* both regions are greyish color that covered with small hairs. (ii) In *C. maxus* Sp. Nov. patagia of medial line is light brown but black in *C. furihatai*. (iii) Forewings are light brown with golden shade and lower cell angle has reniform in *C. maxus* Sp. Nov. while greyish brown with dark brown and reniform is silvery spots like at lower cell angle in *C. furihatai*. (iv) All fore and hindwings margins are lacking the hairs in *C. maxus* Sp. Nov. but anal margins of wings are fringed with hairs in *C. furihatai*. (v) In *C. maxus* Sp. Nov. anal portion of abdomen without hairs while in *C. furihatai* these portions fringed with long tuft of hairs.

**Remarks on Physiological attributes:** This species is different from *C. furihatai* due to genitalia (i) Tegumen is fine and short in *C. maxus* Sp. Nov. but broad and elongated in *C. furihatai*. (ii) Saccus in *C. maxus* Sp. Nov. is wide and rod shape with round tip while fine and needle shape with sharp tip in *C. furihatai*. (iii) Juxta is camel flam like in new to science *C. maxus* Sp. Nov. has but oval shape in *C. furihatai*. (iv) Scaphium is narrow and large in *C. maxus* Sp. Nov. and small, broader in *C. furihatai*. (v) Aedeagus is rod shape with slightly short ductus ejaculatory that enter near the base in *C. maxus* Sp. Nov. but bulb like with large ductus that enter from lateral side in *C. furihatai*.

***Chrysodeixis furihatai* Okano, 1963**

### Diagnostic characteristics

**Head:** Head is greyish brown and patagia (Sensory organ) has black color medial line. **Thorax:** Thoracic fragments are yellowish brown. Dark brown and salivary marks present on greyish brown forewings that represent the reniform at lowee cell angle. Costal margin of forewing is black while yellowish brown on hind wings. Terminal veins in hind wings are dark brown. **Abdomen:** Abdomen is also dark brown crested with light brown hairs (Fig. 2A).

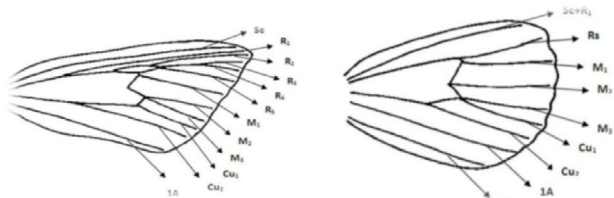
### Male genitalia of *Chrysodeixis furihatai*

Evenly long and slender shape uncus covered with penicular hairs. Tegumen is broad and large with long, slender and well developed scaphium. Proximal end of the valvae are symeterical and consistently extended up to the corona. Cucullus is spiny. Clavus is long and thin, harp absent. Vinculum is highly sclerotized, slim and elongated. Saccus is needle shape with pointed tip, juxta is oval like (Fig. 2D). Aedeagus is large and bulb like, cornuti found at the distal end and basal area is slender and cylindrical. Ductus ejaculatorious is elongated and enter from he t crosswise (Fig. 2E). The difference in measurement of wingspan, antenna and genital parts is given in Table 4.



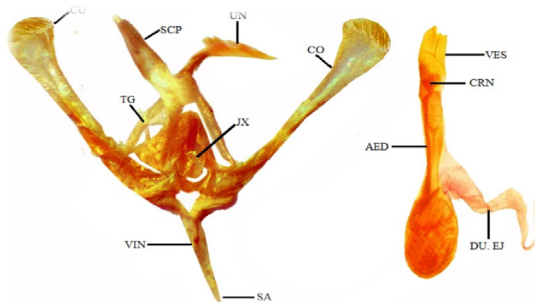


A



B

C



D

E

Fig. 2. *Chrysodeixis furihatai* (A) Adult dorsal view (B) Forewing (C) Hind wing (D) Genitalia (E) Aedeagus.

Table 4

Dimension of body parts (% mm) and standard error (SE) of *C. furihatai*.

Characters	<i>C. furihatai</i> SE
Wingspan	211.06
Antenna	8.00.99
Uncus	1.40.13
Tegumen	1.70.10
Scaphium	1.20.11
Valva	2.60.13
Juxta	1.00.07
Saccus	1.20.08
Aedeagus	3.60.11
Ductus ejaculatorius	10.00.12

**Sexual dimorphism:** Unknown.

**Material examined**

**Paratype:** Punjab: Khanewal: Makhdoom pur, 11, 07.ix.2017, Jahanian, 09, 29.vi.2018. Multan: Bahawalpur Bypass, 04, 26.vi.ii.2017 Basti Maluk, 06, 16.ix.2017, Qadirpur Ran, 09, 16.ix.2017. Bahawalpur: Khanqah Sharif 12, 17.viii.2017, Lal sunhara, 04, Yazman, 06, 29.v.2017 and Ahmedpur, 04, 11.vii.2017. M. Sajjad.

*Ctenoplusia* Dufay, 1970

**Diagnostic characteristics**

Proboscis elongated and well established, palpi are inverted and their 2nd segment is smooth and reached up to the head vertex. Both thorax and vertex are hidden with cluster of hairs. Abdominal basal segments are fringed with dorsal tuft of hairs while lateral and anal tufts are also well established.

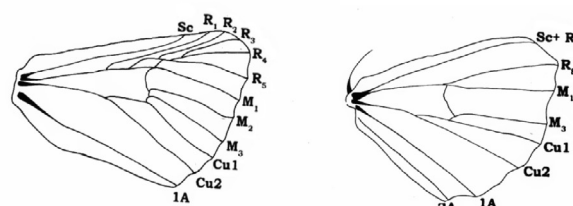
***Ctenoplusia oleraceus* Sp. Nov.**

**Diagnostic characteristics**

**Head:** Proboscis is well formed, palpi are inverted, their 2nd segment smooth and extended to head vertex fringed with long tuft hairs. **Thorax:** Thorax is hairy. Dark brown forewing striated with black color and both middle and sub terminal lines are dark color. Middle area and sub terminal line stain with dark brown color. Black pits and veins found along the tremens. Inner lines with two bends one is below middle line and other at outer lines. Fesica has black marks on sub median line but sub terminal line is weakly developed and pale grey. Stigmata edges are narrow and pale. Costal and anal margins are lacking the hairs but at apical margin has small hairs on forewings. In case of hind wings anal margins has small hairs. **Abdomen:** dark brown, at basal segments have dorsal tufts of hairs and both lateral and anal segments are well developed. (Fig. 3A).

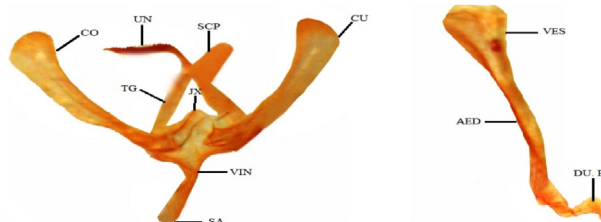


A



B

C



D

E

Fig. 3. *Ctenoplusia oleraceus* Sp. Nov. (A) Adult dorsal view (B) Forewing (C) Hind wing (D) Genitalia (E) Aedeagus.

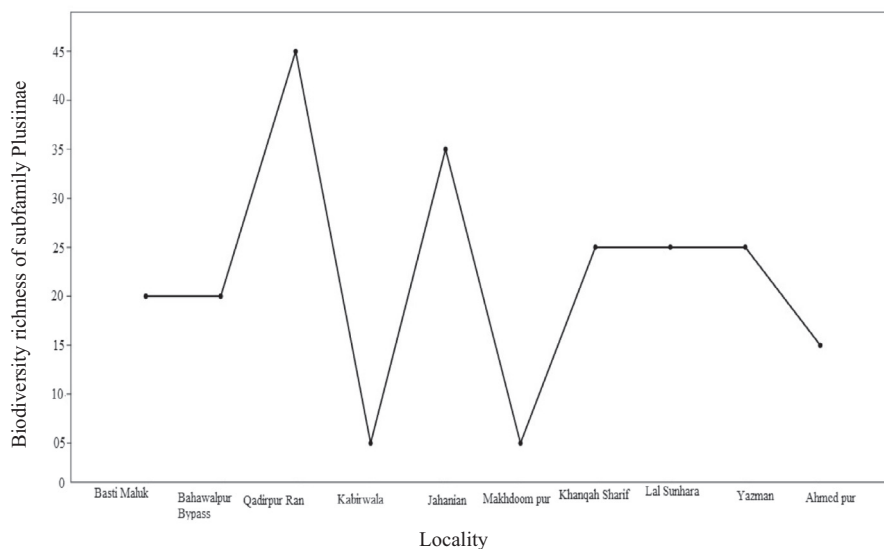


Fig. 4. Species richness of subfamily Plusiinae from different localities of southern Punjab.

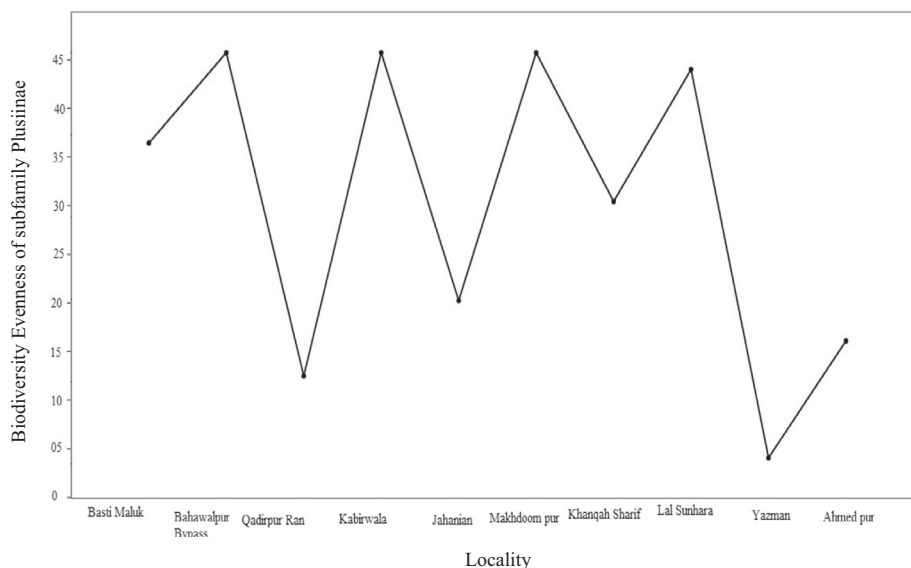


Fig. 5. Species evenness of subfamily Plusiinae from different localities of southern Punjab.

#### Male genitalia of *Ctenoplusia oleraceus*

Uncus is long, curve and fringed with penicular hairs. Arms of tegumen are wide and highly sclerotized. Scaphium is long, wide and well-structured. Vinculum is large, firm and broad, saccus is tube like. Valva is lengthened and planned without seta and harp. Costa is concave. Juxta is vessel shape, cucullus broad and corona sclerotized with well-formed straight bar (Fig. 3D). Aedeagus is long that has broad proximal portion, tubular and sclerotized cornuti found at distal end (Fig. 3E). The variations in measurements of wingspan, antennae and genital parts in shown in Table 5.

#### Etymology

This species was epithet on their vegetable host Cauliflower (*Brassica oleracea*).

#### Type species

**Holotype:** ♂, 20.viii.2017 Basti Maluk, (Muhammad Sajjad) district Multan, Punjab, Pakistan, through light trap and stored in the Department of Plant Protection (Entomology), BZU, Multan.

**Paratype:** Punjab: Bahawalpur: Khanqah Sharif 14 ♂♂, 17.ix.2017, Lal sunhara, 04 ♂♂, Yazman, 06 ♂♂, 29.v.2017 and Ahmedpur, 04 ♂♂, 11.vii.2017. Khanewal: Kabirwala, 02 ♂♂, 21.vii.2018

Table 5

Dimension of body parts (% mm) and standard error (SE) of *C. oleraceus* Sp.Nov.

Characters	<i>C. oleraceus</i> Sp.Nov.-SE
Wingspan	261.32
Antenna	100.47
Uncus	1.90.09
Tegumen	1.90.11
Scaphium	0.90.03
Valva	2.70.11
Juxta	0.60.05
Saccus	1.30.07
Aedeagus	3.60.09
Ductus ejaculatorius	4.80.14

and from Makhdoom pur, 01 ♂, 02.x.2017. Multan: Basti Maluk, 01 ♂♂, 26.vii.2017 and from Qadirpur Ran, 09 ♂♂, 16.ix.2017.

**Sexual dimorphism:** Unknown

**Remarks morphological characteristics.** Present species is similar to already species, *C. albostrata* but *C. oleraceus* Sp. Nov. diverge from *C. furihatai* by the following features. (i) Palpi are inverted and their 2<sup>nd</sup> segment smooth, fringed with tuft of hairs and long that reached to the vertex of the heat in *C. oleraceus* Sp. Nov. but short and non-hairy in *C. albostrata*. (ii) Thorax region is dark brown and covered with hairs *C. oleraceus* Sp. Nov. while dark grey and non-hairy in *C. albostrata*. (iii) Forewings are dark brown striated with black color and both middle and sub terminal lines are dark brown color in *C. oleraceus* Sp. Nov. but grey color with both lines are also dark grey color in *C. albostrata*. (iv) Anal margin of hind wing has small hairs in *C. oleraceus* Sp. Nov. while wanted in *C. albostrata*. (v) Abdomen is also dark brown and, its basal segments have dorsal tuft of hairs *C. oleraceus* Sp. Nov but in old sp. Abdomen is grey color without tuft of hairs at basal segments. *C. albostrata*.

**Remarkd physiological characteristics** *C. oleraceus* Sp. Nov. species is highly associated with already described species *Ctenoplusia albostrata* but varied by these features. (i) Long and broad uncus with penicular hairs of *C. oleraceus* Sp. Nov. but narrow and short uncus without penicular hairs in *C. albostrata*. (ii) In *C. oleraceus* Sp. Nov. has scaphium while absent in *C. albostrata*. (iii) Valva is smooth without seta in *C. oleraceus* Sp. Nov. but sickle like with spine like seta located at lateral side of the valva in *C. albostrata*. (iv) One end of the aedeagus is rod like with broad head found in *C. oleraceus* Sp. Nov. while narrow and slim in *C. albostrata*. (v) Harp is wanted in new to science *C. oleraceus* Sp. Nov. while highly sclerotized in *Ctenoplusia albostrata*.

**Biodiversity indices of subfamily Plusiinae**

Highest numbers of different species of Plusiinae were recorded from Qadirpur Ran (Multan) while lowest was found from Kabirwala and Makhdoom pur (Khanewal). (Fig. 4). In case of species evenness maximum relative abundance of different species were observed from Bahawalpur bypass (Multan), Kabirwala, Makhdoom pur (Khanewal) and Lal Sunhara (BWP) but the minimum from Qadirpur Ran (Multan) and Yazman (BWP) (Fig. 5).

## 5. Discussion

Taxonomic identification of particular species is the baseline for the development of suitable management techniques to sustain the agricultural crops (Sajjad et al., 2020a). Each species has been affected by different factors like environmental variability, agricultural practices and planted crops (Amer et al., 2006). Levels of taxonomy have been associated ecological and environmental differences (Warwick, 1993). Species are more precisely identified with aid of genital features than the morphological characteristics because most of the species are morphological similar due to same climatic conditions and host habitats. *Chrysodeixis* and *Ctenoplusia* genera were identified on the base of genitalia from different districts (Multan, Khanewal and BWP) of Southern Punjab, Pakistan. These districts have different climatic conditions and ecological attributes.

Due to favorable conditions members of these genera are quickly multiplied and drastically damaged several cash crops. Species richness and evenness of these species were also determined. Exchange commodities by local markets is considered one of the main factor in distribution insect pests. Genus *Chrysodeixis* has the potential to become a major insect pest of different crops especially beans and tomatoes while *Ctenoplusia* is also damaged the crops (Murillo et al., 2013). During this study, two new to science species such as *Chrysodeixis maxus* Sp. Nov. and *Ctenoplusia*

*oleraceus* Sp. Nov. and one already described *Chrysodeixis furihatai* on genitalia basis. These distractive pests are managed by integrated pest management (IPM) techniques with the help of limited resources.

## 6. Conclusion

In present study, we understand the selected localities not represent such large geographical districts of Sothern Punjab, Pakistan. Therefore, we have focused the main areas of and till now this is the inclusive faunistic study of subfamily Plusiinae from Pakistan. In future, our study will provide basic platform for the extensive taxonomic revisions ahead.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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