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Faunistic studies on Crambidae: Pyraloidea (Lepidoptera) associated with fruit and flower crops of zone-1 and 2 of Karnataka, India

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Abstract

The morphological and genital characters of Crambidae pests associated with fruit and flower crops were studied from zone-1 and 2 of Karnataka, India. During the study, a total 7 number of species were reared and documented on their respective hosts. On fruit crops, the most predominant species documented was *Conogethes punctiferalis* Guenée, which was collected and reared on three major fruit crops viz., pomegranate, guava and mango. While on remaining fruit crops grapevine and fig were recorded with single species on each, *Syllepte lunalis* Gunee and *Cirrhochrista brizoalis* Walker respectively. Among different flower crops surveyed, on jasmine 4 Crambidae pests were documented they are, *Nausinoe geometralis* Guenée, *Nausinoe perspectata* Fabricius, *Hendecasis duplifascialis* Hampson and *Glyphodes vertumnalis* Guenée

Keywords: Crambidae, fruit and flower crops, morphological and genital characters

1. Introduction

The diverse climatic condition of India guarantees the successful cultivation of agricultural as well as horticultural crops. India ranks second in fruits and vegetable production^[1], while the 18th position in the floricultural products just behind China^[2]. But India's contribution to the global export of floriculture has improved remarkably throughout the period from 1996 to till date. Karnataka is divided into 10 agro-climatic zones by considering the rainfall pattern, soil types, topography and major crops grown etc. The zone-1 (Eastern-transition zone) and zone-2 (North-Eastern dry zone) comprises of 4 districts namely, Bidar, Kalaburagi, Yadagir and Raichur with two districts under each zone, respectively. These zones having diverse soil types, climatic conditions, and good irrigation facilities through irrigation projects like Krishna, Tungabhadra etc. Hence, these zones are ideal for growing of agricultural as well as horticultural crops. The major horticultural crops growing in these zones include mango, banana, sapota, brinjal, chilli, onion, cucurbits, zinger, turmeric etc., with an area of 0.064 M. ha which represents 3.36 per cent of total horticultural area of Karnataka^[3].

The lower production and productivity in horticultural crops is as a result of biotic and abiotic pressure. Among biotic stresses, the damage and yield loss caused by insect pests are main contributory factors. Among insect pests, the super family Pyraloidea (Lepidoptera) has great economic importance as many of them cause serious damage either internally as borers, root feeders and seed feeders or externally as leaf rollers or webbers^[4]. The extent of yield loss due to Pyraloidea ranges from 10 to 100 per cent across the world^[5].

Crambidae is the largest family under super-family Pyraloidea with a total of 9,655 species described species across the world^[6]. This includes important pests, causing economic damage to the crops, forests, and stored products by acting as a leaf rollers leaf miners and stem borers. In the zone-1 and 2 of Karnataka, the information pertaining to the fauna of Crambidae associated with fruit and flower crops is not available. The major reasons could be lack of efforts for survey, documentation, and lack of taxonomic work. And also, earlier workers did not made any efforts to associate Pyraloidea species with their host plants. Description of species reared from actual hosts is the need of the hour for accurate identification. However, Nagaraj (2014) for his M. Sc. research work has made an effort to study and document the Pyraloidea fauna associated with major cereals of Hyderabad-Karnataka (zone-1, zone-2 and zone-3) region^[7]. In this background, the investigation has been undertaken with main

objective to study the morphological and genital characters of poorly described species of Crambidae associated with fruit and flower crops of zone-1 and 2 of Karnataka.

2. Materials and Methods:

2.1 Collection and rearing techniques:

Collections were made on Crambidae associated with on flower and fruit crops by undertaking a survey in different localities of zone-1 (Bidar, Humnabad, Kalaburagi, and Raddewadgi) and zone-2 (Naganoor, Kavadinatti, Raichur and Chandrabanda) of Karnataka, India. The survey was carried out in these locations once in a month from August 2015 to January 2016, and the places visited during the period are shown in Fig. 1. Since the present study was mainly focused on host based taxonomy, the various life stages of Pyralidae like eggs, larvae and pupae wherein external feeders, damaged plant specimens in case of internal feeders brought to the laboratory. The immature stages collected from the field were reared in the laboratory by adopting the methodology proposed by Nagaraj (2014), Juanz *et al.* (2016) with slight modification wherever required for further rearing to adult stage [7, 8].

2.2 Study of morphological and genital characters

After adult emergence, the adults were killed immediately after emergence using ethyl acetate and pinned through thorax using stainless anticorrosive insect pins (No.4) imported from Sphinx Company, Zech Republic. The specimens collected were identified to generic and species level based on the keys developed by Hampson in the Moths volumes of the Fauna of India [9] and adjacent countries series and also using recently available literature. The keys have been prepared from referring different sources like other published keys, descriptions, and an examination of specimens of the groups concerned. Some are taken largely from previously published keys based on study of different authors [9-12] like generally with some changes in wording or organization and adding some more morphological and genital characters. Genitalia of adults (male and female) were dissected using the techniques described by Kirti and Gill (2005), and Nagaraj (2014) with little modification wherever required [7, 13]. Later, the genitalia was stained by using standard staining procedure proposed by Lee and Brown (2009) [14]. Further, the stained genitalia was photographed with the help of Leica M205C with auto montage by keeping male genitalia in glycerine, and female genitalia in water.

3. Results and Discussion

During the survey, a total of 7 species of Crambidae were recorded, which were collected and reared on their respective hosts (Table 1; Plates 1-7). All the species represented 2 sub-families of Crambidae viz., Spilomelinae and Cybalomiinae. The sub-family Cybalomiinae was documented with single genera *Hendecasis* Hampson with one species *Hendecasis duplifascialis* Hampson. While subfamily Spilomelinae recorded with 5 genera viz., *Syllepte* Hübner, *Cirrhochrista* Lederer, *Conogethes* Meyrick, *Nausinoe* Hübner, and *Glyphodes* Guenée. Genus *Nausinoe* Hübner was documented with two identified species viz., *N. geometralis* Guenée and *N. perspectata* Fabricius. Remaining 4 genera were represented with single species under each viz., *Syllepte lunalis* Guenee, *Cirrhochrista brizoalis* Walker, *Glyphodes vertumnalis* Guenée, and *Conogethes punctiferalis* Guenée. Further, the results on Crambidae collected on horticultural crops from zone-1 and 2 of Karnataka revealed that morphological and genital characters of the adults found variation with respect to

diagnostic morphological characters. Morphological characters like frons, vertex, chaetosemata, labial and maxillary palps, wing colour, wing venation, structure of tympanum and tibia *etc.* genital characters like uncus, saccus, valvae, juxta, vinculum, gnathos, tegumen and phallus (aedeagus) in male, and in female, the corpus bursae, ductus bursae, ductus seminalis, ostium, anterior apophysis and posterior apophysis and signum *etc.*, were recorded. Similarly, Bhattacharjee (1962) made an extensive surveys on Indian Pyralidae for his *Ph.D.* research work, he collected 35 species belonging to 20 genera [10]. In another study, Rose (1982) collected 93 species of pyralid moths which belonged to 61 genera of sub-family Pyraustinae from North India [11]. Likewise, recently Nagaraj (2014) surveyed for Pyraloidea associated with cereals from Hyderabad-Karnataka region, and he documented 7 identified and 6 unidentified species [7]. Similar results were also reported by various authors like Du (2008) [15], Mey (2008) [16], Qi *et al.* (2011) [17], Sharma (2011) [18], Li (2012) [19], Zhang *et al.* (2014) [20] across the world.

Family Crambidae

Diagnosis: Crambids are mostly small to large sized moths; wingspan ranges from 10 to 100 mm; on the head, the scaling of the frons usually smooth; antennae thread-like, serrate, or sometimes pectinate or bipectinate; proboscis usually well developed but sometimes reduced; labial palpi three segmented, angled upward or upturned in front of face and often very long; maxillary palpi smaller (sometimes reduced or absent), often with a flattened tuft of scales at the tip; tympanal case open with a wide antero-medial aperture, conjunctiva and tympanum in a different plane and meet at a distinct angle; vein R_5 of the fore wing well separated from R_{3+4} ; male genitalia lack lateral arms at the base of uncus.

Key to subfamilies of Crambidae from zone-1 and 2 of Karnataka

1. Valvae of male genitalia without costal process.Spilomelinae
- Valvae of male genitalia with costal processCybalomiinae

Subfamily Cybalomiinae

Diagnosis: Chaetosemata absent; fore wing with concavity on the costal margin, *i.e.*, a costal crescent small cuplike depression or pit in between R_{3+4} and R_5 ; gnathos distally strongly sclerotised, spatulate or triangular.

Hendecasis duplifascialis Hampson (Plate 1)

Description: Labial palpi and frons blackish; fore wing with a light pale reddish yellow sub-basal band; hind wing with double sinuous black ante and post medial lines, becoming obsolete on costal half of wing and with brownish yellow between them.

Male Genitalia: Uncus short with curved apical portion and fringed with hairs at middle; proximal part stalk like; gnathos pointed towards tip; lateral arms of tegumen narrow, broad at middle and slightly sclerotized; vinculum 'U' shaped with middle bulged and lateral arms produced into a conical point; valvae short and broad at apex, narrow towards base.

Female Genitalia: Posterior apophysis strongly developed and longer than anterior apophysis; ductus bursae tubular and same size thought the length; sclerotized towards proximally; bursae copulatrix oval shape and bilobed slightly; signum lacking.

Materials examined: INDIA: Karnataka: Yadagir, Hattekuni, 1♀, 12.viii.2015, reared on jasmine, Shankaramurthy.; Hattekuni, 1♂, 12.viii.2015, reared on jasmine, Shankaramurthy.; Hattekuni, 1♀, 22. viii.2015, reared on jasmine, Shankaramurthy.; Hattekuni, 2♀, 3♂, 26.viii.2015, reared on jasmine, Nagaraj S. K.

Remarks: *Hendecasis duplifascialis* Hampson commonly known as jasmine bud borer, which is almost similar in appearance as like *H. fulviplaga* Hampson except labial palpi. Labial palpi orange yellow in colour as in case of *H. fulviplaga* Hampson, blackish in *H. duplifascialis* Hampson.

Sub family Spilomelinae

Diagnosis: Head with frons round; labial palpi upturned; proboscis well developed; maxillary palpi well developed and filiform; chaetosemata absent; praecinctorium bi-lobed. Fore wing with vein Cu_{1a} separate from Cu_{1b}; R₅ not stalked with R₃₊₄; hind wing with median nervure not pectinated on upperside; M₃ and M₂ from a point or rarely stalked; Rs usually anastomosing with Sc+R₁; spinula pointed; gnathos absent in male genitalia; and the female genitalia have no rhomboidal signum on the bursa copulatrix.

Genus *Nausinoe* Hübner, 1825

Diagnosis: Labial palpi obliquely upturned, the 2nd joint broadly scaled in front, the 3rd joint porrect; maxillary palpi filiform; antennae longer than fore wing; legs long and slender, outer tibial spur about two-thirds of inner.

Key to species of the genus *Nausinoe* Hübner from zone-1 and 2 of Karnataka

1. Fore wing discocellular with a Y- shaped band; in female genitalia, bursae copulatrix bulged.....

Nausinoe perspectata Fabricius

Fore wing discocellular with a Y- shaped band absent; in female genitalia, bursae copulatrix globular.....*Nausinoe geometralis* Guenée

Nausinoe geometralis Guenée, 1854 (Plate 2)

Description: General body colour yellowish or rather fulvous striated with black; fore wing apex subacute with two black-edged antemedial white spots below the cell; a spot at the middle of the cell and a pair at the end of it; one ovoid spot outside the cell at the base of the vein Cu_{1b}; male hind wing with one frenulum hook and female with two; one white spot in the subbasal area.

Male genitalia: Uncus short, round apically and covered with a circular tuft of dense hairs; posterior end of tegument rhomboidal with its sides slightly produced into conical lobes; tegumen long, about double the vinculum, narrow anteriorly and swollen in the middle; arms of vinculum narrow and slightly conical distally; valvae broad at the apex, fringed with short stiff hairs; a sclerotized bar, bearing a spine-like process runs across the distal end of valvae; phallus long, stout, having a cleft at the distal end; cornuti composed of a long rod-like sclerotized process.

Female genitalia: Ovipositor slit wide open; valvae of papillae analis fairly broad; sub-genital plate funnel shaped; ductus bursae thick, fairly long; corpus bursae sac like, no signum; ductus bursa narrow and slender; anterior apophyses with stout basal region; ovipositor short and the ovipositor lobes narrow.

Materials examined: INDIA: Karnataka: Yadgir, Bheemaranagudi, 2♂, 1.xi.2012, reared on jasmine, Shankaramurthy.; Bheemaranagudi, 2♀, 11.xi.2012, reared on jasmine, Venkateshalu.; Bheemaranagudi, 1♀, 11.xi.2012, reared on jasmine, Shankaramurthy.; Bheemaranagudi, 1♂, 11.xi.2012, reared on jasmine, Venkateshalu.; Bheemaranagudi, 2♀, 2♂, 29.viii.2014, reared on jasmine, Nagaraj, S. K.; Bheemaranagudi, 1♀, 29.xii.2014, reared on jasmine, Nagaraj, S. K.; Bheemaranagudi, 2♀, 7.i.2015, reared on jasmine, Parvathi.; Bheemaranagudi, 1♂, 8.i.2015, reared on jasmine, Basavaraj, K.; Bheemaranagudi, 2♂, 1♀, 11.i.2015, reared on jasmine Nagaraj, S. K.; Bheemaranagudi, 1♂, 12.viii.2015, reared on jasmine Shankaramurthy.; Bidar, Bidar, 1♀, 2♂, 26.viii.2015, reared on jasmine, Nagaharish.; Raichur, Raichur, 1♂, 26.viii.2015, reared on jasmine, Nagaharish.; Bidar, Bidar, 3♀, 2♂, 27.viii.2015, reared on jasmine, Nagaharish.; Bidar, 2♂, 30. viii.2015, reared on jasmine, Nagaharish.; Bidar, 1♀, 3♂, 31.viii.2015, reared on jasmine, Nagaharish.; Raichur, Raichur, 1♂, 31.viii.2015, reared on jasmine, Nagaharish.; Bidar, Bidar, 2♀, 1♂, 02.ix.2015, reared on jasmine, Nagaharish.; Bidar, 1♀, 1♂, 03.ix.2015, reared on jasmine, Nagaharish.; Raichur, Raichur, 2♂, 2♀, 04.ix.2015, reared on jasmine, Nagaharish.; Bidar, Bidar, 1♀, 2♂, 26.ix.2015, reared on jasmine, Nagaharish.; Bidar, 3♀, 4.ix.2015, reared on jasmine, Nagaharish.; Raichur, Raichur, 1♂, 2♀, 29.ix.2015, reared on jasmine, Nagaharish.; Kalaburagi, Raddewadgi, 1♂, 2♀, 13.x.2015, reared on jasmine Nagaharish.; Raichur, Raichur, 1♀, 09.x.2015, reared on jasmine, Nagaharish.; Raichur, 1♂, 1♀, 14.x.2015, reared on jasmine, Nagaharish.; Kalaburagi, Raddewadgi, 1♂, 15.x.2015, reared on jasmine Nagaharish.; Raddewadgi, 2♂, 2♀, 16.x.2015, reared on jasmine Nagaharish.; Raichur, Raichur, 2♂, 1♀, 10.xi.2015, reared on jasmine, Nagaharish.

Remarks: Externally, *Nausinoe geometralis* Guenée closely resembles to *N. perspectata* Fabricius. However, both are distinguished based on their morphological and genital characters. In *N. geometralis* Guenée, fore wing without a Y-shaped band, and in female bursae copulatrix is globular. While in *N. perspectata* Fabricius, fore wing with a Y-shaped band; bursae copulatrix is not globular.

Nausinoe perspectata Fabricius, 1775 (Plate 3)

Description: Pale yellowish brown or fuscous brown; labial palpi white below; abdomen banded with white; fore wing with two black-edged white subbasal bands not reaching the costa; a spot in cell; a wedge-shaped mark on inner margin; a discocellular white band forming with a patch below the cell a Y- shaped band, with its outer arm shortest; two large black-edged white crescent postmedial marks.

Male genitalia: not examined

Female genitalia: Ovipositor silt wide, oblong; valvae of papillae analis thick and hairy; apophyses short; subgenital plate cup-shaped; ductus bursae narrow, small in length, ring like at the beginning, fairly thick later; corpus bursae sac-like; signum absent; bursa copulatrix long, which at about the posterior end receive the duct of the receptaculum seminis; anterior apophyses longer than the posterior; ovipositor short.

Materials examined: INDIA: Karnataka: Yadgir, Bheemaranagudi, 1♀, 01.ix.2015, reared on jasmine, Venkateshalu.; Bheemaranagudi, 1♀, 26.i.2015, reared on

jasmine, Nagaharish.; Bheemaranagudi, 1♀, 2.ii.2015, reared on jasmine, Nagaharish.

***Glyphodes vertumnalis* Guenée, 1854 (Plate 4)**

Description: Body yellowish green, neither of the wings fulvous; marginal specks often obsolete; cilia fulvous; abdomen short and thick; male with a large, dark anal tuft of hairs; female without anal tuft of hairs; hind tibiae of male with large thick tufts of black hair on outer side at middle and extremity; hind wing of male with the inner area densely clothed below with tufts of yellowish hair.

Male Genitalia: Vinculum broad and 'V' shaped with a saccus point at centre; coremata with long thick as well as fine hair; valvae short, broad, fan-like with a chitinous hook-like clasper at the base on costa; phallus fairly long, uncus broad, slightly raised with short dorsal hoods and then bending forward giving beak like appearance; gnathos as long as uncus and broad; base of the uncus and gnathos darken laterally.

Female Genitalia: Ovipositor slit bulbous, broad dorsally and narrow ventrally; valvae of papillae analis thick; apophyses short; subgenital plate short, ductus bursae long, fairly thick; corpus bursae bulbous with two triangular signa on two sides near the apex.

Materials examined: INDIA: Karnataka: Kalaburagi, Raddewadgi, 2♂, 12.viii.2015, reared on jasmine Nagaharish.; Raddewadgi 1♂, 29.viii.2015, reared on jasmine Nagaharish.; Raddewadgi, 3♀, 15.x.2015, reared on jasmine, Nagaharish.

Remarks: *Glyphodes vertumnalis* Guenée closely resembles *G. marginata* Hampson. Both are distinguished by wing character. In *G. marginata* Hampson, wings are fulvous, but in case of *G. vertumnalis* Guenée wings are not fulvous. *Syllepte* Hübner, 1823

Diagnosis: Labial palpi upturned and reaching vertex of head, the 2nd joint moderately and evenly scaled in front, the 3rd joint short, naked and blunt; maxillary palpi filiform; frons rounded; tibia with outer spurs about half the length of inner.

***Syllepte lunalis* Gunee (Plate 5)**

Description: Body colour dark fuscous; vertex with slightly raised scales; antenna of male with a tooth of scales from

upperside of basal joint, shaft excised at a base; abdomen uniformly fuscous; fore wing fuscous with three prominent antemedial, medial and postmedial lines; hind wing also fuscous with two prominent dark antemedial and medial lines.

Male genitalia: Vinculum broad and 'V' shaped; coramata long and thick; valvae broad with sub-acute apex; uncus fairly long, broad with bulbous and spinulate at tip; gnathos thin and long nearly one and half times as long as uncus; phallus short with a fairly long vesica.

Female genitalia: Ovipositor slit broad and oval; valvae of papillae analis narrow rimed; apophyses short; anterior apophysis one and half times as long as posterior apophysis; ductus bursae long; corpus bursae broad.

Materials examined: INDIA: Karnataka: Raichur, Raichur, 3♀, 1♂, 08.x.2015, reared on grapevine, Nagaharish.; Raichur, 2♀, 2♂, 09.x.2015, reared on grapevine, Nagaharish.; Raichur, 5♂, 3♀, 11.x.2015, reared on grapevine, Nagaharish.; Raichur, 2♂, 3♀, 12.x.2015, reared on grapevine, Nagaharish.; Raichur, 7♀, 5♂, 14.x.2015, reared on grapevine, Nagaharish.; Raichur, 3♀, 5♂, 15.x.2015, reared on grapevine, Nagaharish.

Remarks: *Syllepte lunalis* Gunee is closely appears *S. ridopalis* Swinhoe, both are easily distinguished by their wing character. Post medial line of both wings minutely denate in *S. ridopalis* Swinhoe. While in *S. lunalis* Gunee, both the wings are not minutely denate.

4. Conclusion: In India, most of the pyralid taxonomists have undertaken taxonomic studies predominantly by relying on light trap collections and they did not made any efforts to associate Pyraloidea species with their host plants except Nagaraj (2014) [7] who made a first effort to survey and document the Pyraloidea fauna associated with major cereals of Hyderabad-Karnataka region for his *M. Sc.* research work. So in the current study attempt was made to survey and study the Crambidae taxa associated with fruit and flower crops from zone- 1 and 2 of Karnataka. The current study was carried out by host based taxonomy, which helps in accurate identification of the pest species and authentication of its host from representative locations. The morphological and genital characters of poorly described species were studied in detail and discussed here.

Table 1: Species of Crambidae collected through survey and reared on fruit and flower crops from zone-1 and 2 of Karnataka

Crops	Common name	Scientific name	Sub-family	Family
Grapevine	Leaf roller	<i>Syllepte lunalis</i> Gunee	Spilomelinae	Crambidae
Pomegranate	Fruit borer	<i>Conogethes punctiferalis</i> Guenée	Spilomelinae	Crambidae
Guava	Fruit borer	<i>Conogethes punctiferalis</i> Guenée	Spilomelinae	Crambidae
Mango	Inflowerescence webber	<i>Conogethes punctiferalis</i> Guenée	Spilomelinae	Crambidae
Fig	Fruit borer	<i>Cirrhochrista brizoalis</i> Walker	Spilomelinae	Crambidae
Jasmine	Leaf webber	<i>Nausinoe geometralis</i> Guenée	Spilomelinae	Crambidae
	Leaf webber	<i>Nausinoe perspectata</i> Fabricius	Spilomelinae	Crambidae
	Bud borer	<i>Hendecasis duplifascialis</i> Hampson	Cybalomiinae	Crambidae
	Leaf webber	<i>Glyphodes vertumnalis</i> Guenée	Spilomelinae	Crambidae

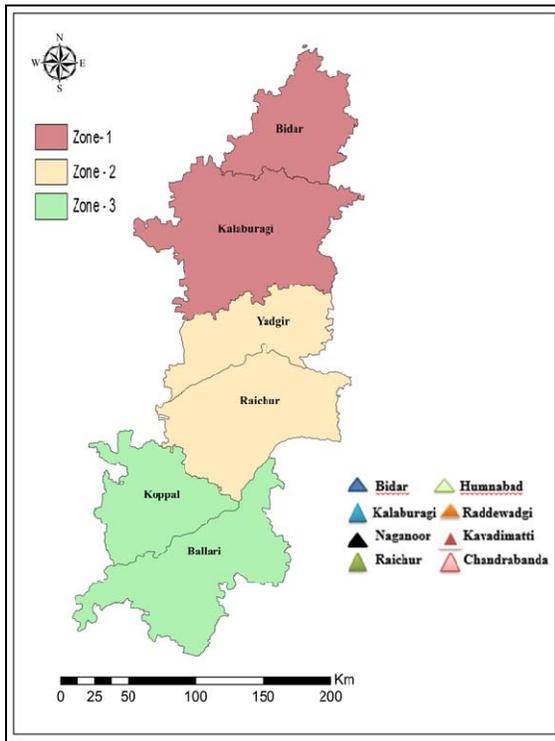


Fig 1: Locations from where Crambidae were collected for taxonomic studies



Plate 1: Morphological and genital characters of *Hendecasis duplifascialis* Hampson a) Male; b) Male genitalia; c) Phallus; d) Female; e) Female genitalia

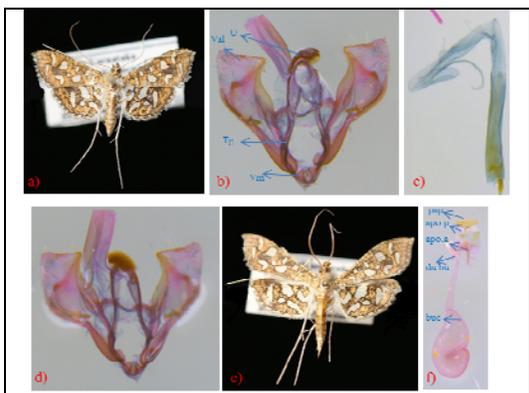


Plate 2: Morphological and genital characters of *Nausinoe geometralis* Guenée a) Male; b) Male genitalia dorsal view; c) Phallus; d) Male genitalia ventral view; e) Female; f) Female genitalia



Plate 3: Morphological and genital characters of *Nausinoe perspectata* Fabricius a) Female; b) Female genitalia

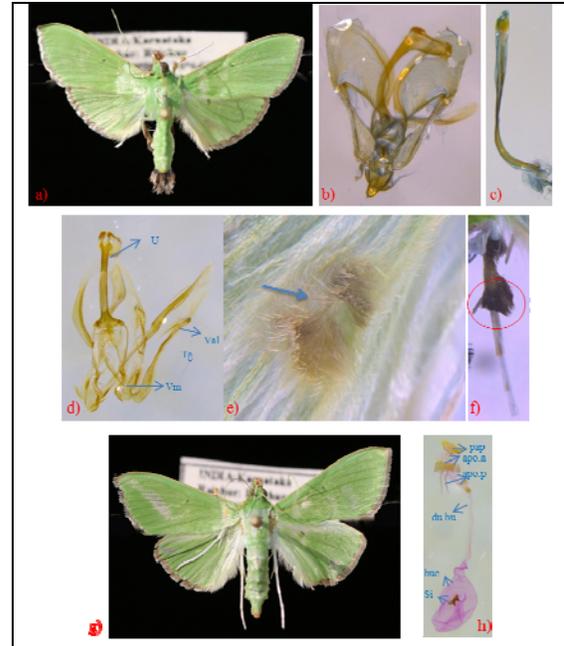


Plate 4: Morphological and genital characters of *Glyphodes vertumnalis* Guenée a) Male; b) Male genitalia dorsal view; c) Phallus; d) Male genitalia ventral view; e) Group of hairs on ventral side of hind wing; f) Group of hairs on basi tarsus; g) Female; h) Female genitalia

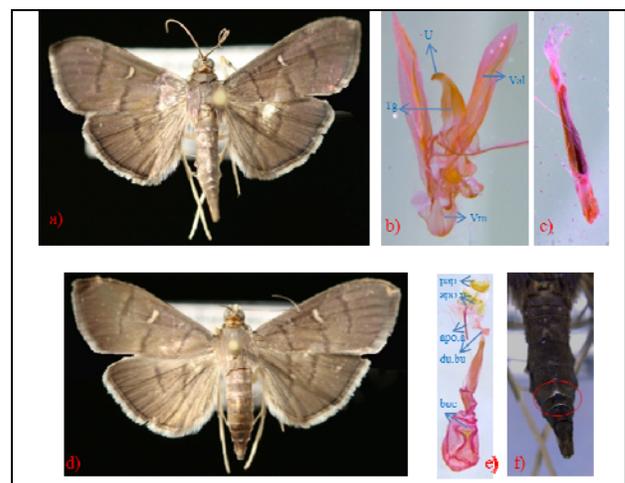


Plate 5: Morphological and genital characters of *Syllepte lunalis* Guenee a) Male; b) Male genitalia; c) Phallus; d) Female; e) Female genitalia; f) White speck on dorsal side of abdomen



Plate 6: Morphological and genital characters of *Cirrhochrista brizoalis* Walker a) Male; b) Male genitalia ventral view; c) Phallus; d) Male genitalia dorsal view; e) Female; f) Female genitalia

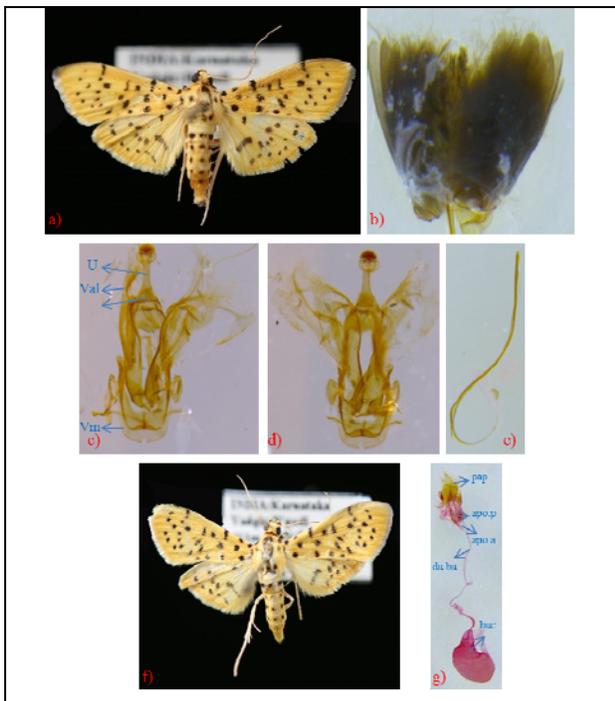


Plate 7: Morphological and genital characters of *Conogethes punctiferalis* Guenée a) Adult male; b & c) Male genitalia dorsal view; d) Male genitalia ventral view; e) Phallus; f) Female; g) Female genitalia

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