Diversity of the Ulidiidae Family (Insecta: Diptera)

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Abstract

Ulidiidae makes their nests on the ground, making their eggs and young often very vulnerable to predation. They walk steadily on strong legs and big toes, pecking for food as they go. Many have interesting mating displays, such as inflating throat sacs or raising elaborate feather crests. The female lays three to five dark, speckled eggs in a scratch in the ground and incubates them on her own. In addition to the damage caused by the larvae themselves, their activity facilitates the entry of pathogens into plants, which may cause losses of up to 100% of production. They also carry enteric bacteria, being responsible for the transmission of infections. This mini-review aims to describe the Ulidiidae Family. The methodological basis of the present work consists of bibliographical research of scientific articles published in national and international academic scientific journals classified by the Coordination for the Improvement of Higher Education Personnel. The search criterion for articles was to prioritize articles that dealt with the topic. Document analysis was used as a data collection method to gather information on theoretical books, theses banks, university dissertations, scientific journals, documents, and websites: https://www.researchgate.net/post/How_to_increase_the_research_results_visibility. (https://goo.gl/gLTTTs), HAL (https://hal.archives-ouvertes.fr/submit/index), SSRN (https://hq.ssrn.com/login/pubsigninjoin.cfm) and ResearchGate (https://www.researchgate.net/signup.SignUp.html).

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1. Introduction

Flies belong to the families Anthomyiidae, Cecidomyiidae, Drosophilidae, Sciaridae, Lonchaeidae, Psilidae, Richardiidae and Tephritidae, and constitute an important group of pests in world agriculture, as they have a life cycle in which their larval period develops mainly in plants, feeding up, roots, leaves and fruits. Flies as agricultural pests: Flower bud flies, attack different plants, both cultivated and ornamental, making serpentine-shaped galleries in the foliage, flies whose larvae are pests of various fruits. Sorghum flies whose larvae damage flowers and buds [1][2].

The "picture-winged flies" (Ulidiidae) are one of the larger families of the Diptera superfamily Tephritoidea, numbering approximately 800 species total, about 135 of which are found in the United States or Canada (some uncertainty remains regarding the exact number, due to limited research, taxonomic revisions, and the high number of *Euxesta* Loew). They are a family of acalyptrate flies, generally small to medium, and broadly recognizable by the distinctively patterned wings that grant the family its common name, though this trait is neither universal among nor exclusive to them [1][2][3].

1.1. Description

The Ulidiidae (formerly Ottidae) (Acalyptratae, Tephritoidea) are predominantly neotropical dipterans, small to medium (2 to 14 mm), yellow to black in color, may have blue or green iridescence and wings usually spotted (Figures 1-10) [4].

Figure 1. Diptera-Ulidiidae-*Euxesta*-Picture winged Flies, Female.

Sources: https://www.biodiversity4all.org/taxa/125458-Ulidiidae and Photo Katja Schulz

Figure 2. *Tetanops flavescens* Macquart, 1835

Sources: https://www.biodiversity4all.org/taxa/125458-Ulidiidae and Photo Jeremy Collison

Figure 3. *Callopistromyia annulipes* (Macquart, 1855)

Sources: Photos Luis Stevens, Katja Schulz and Lorin Timaeus and https://www.biodiversity4all.org/photos/142070

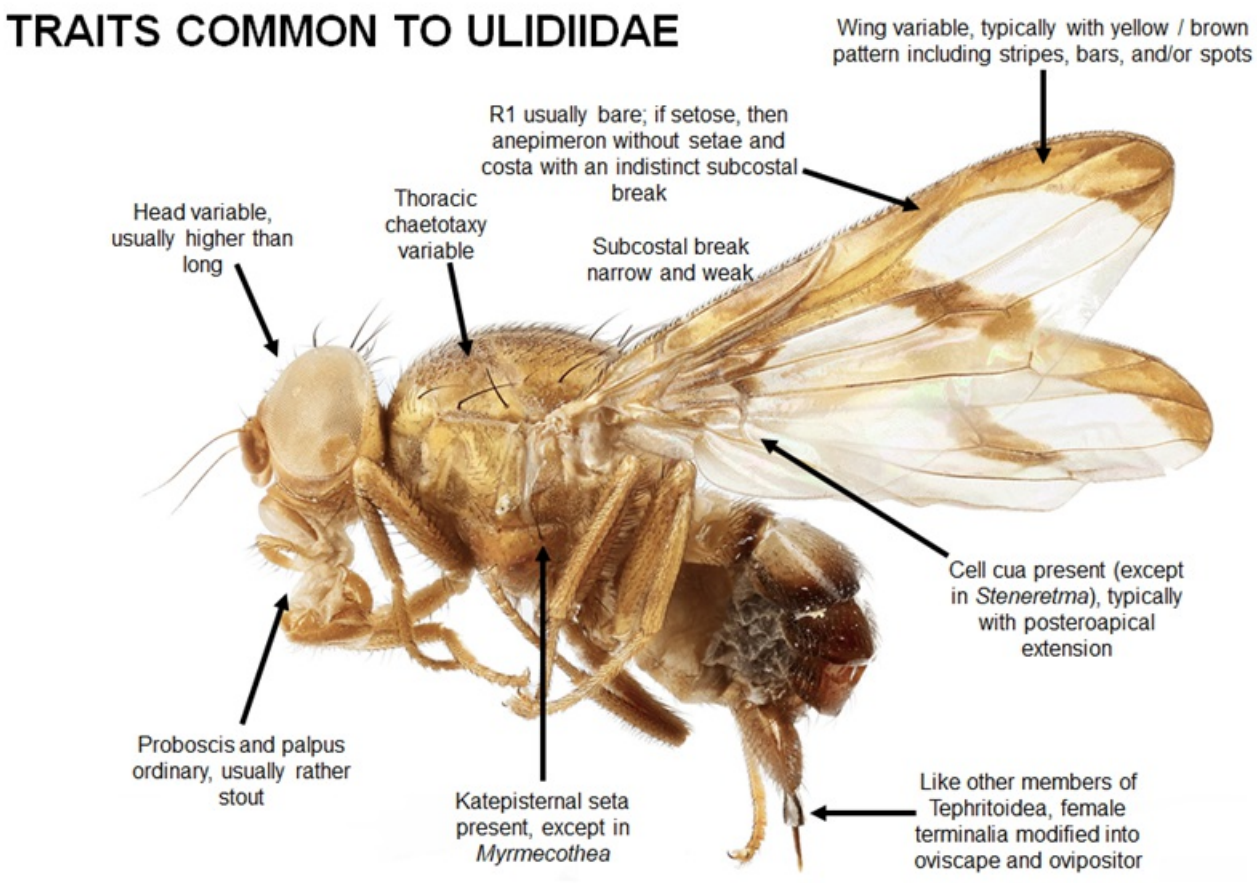

Figure 4. *Xanthacrona bipustulata* Wulp, 1899

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

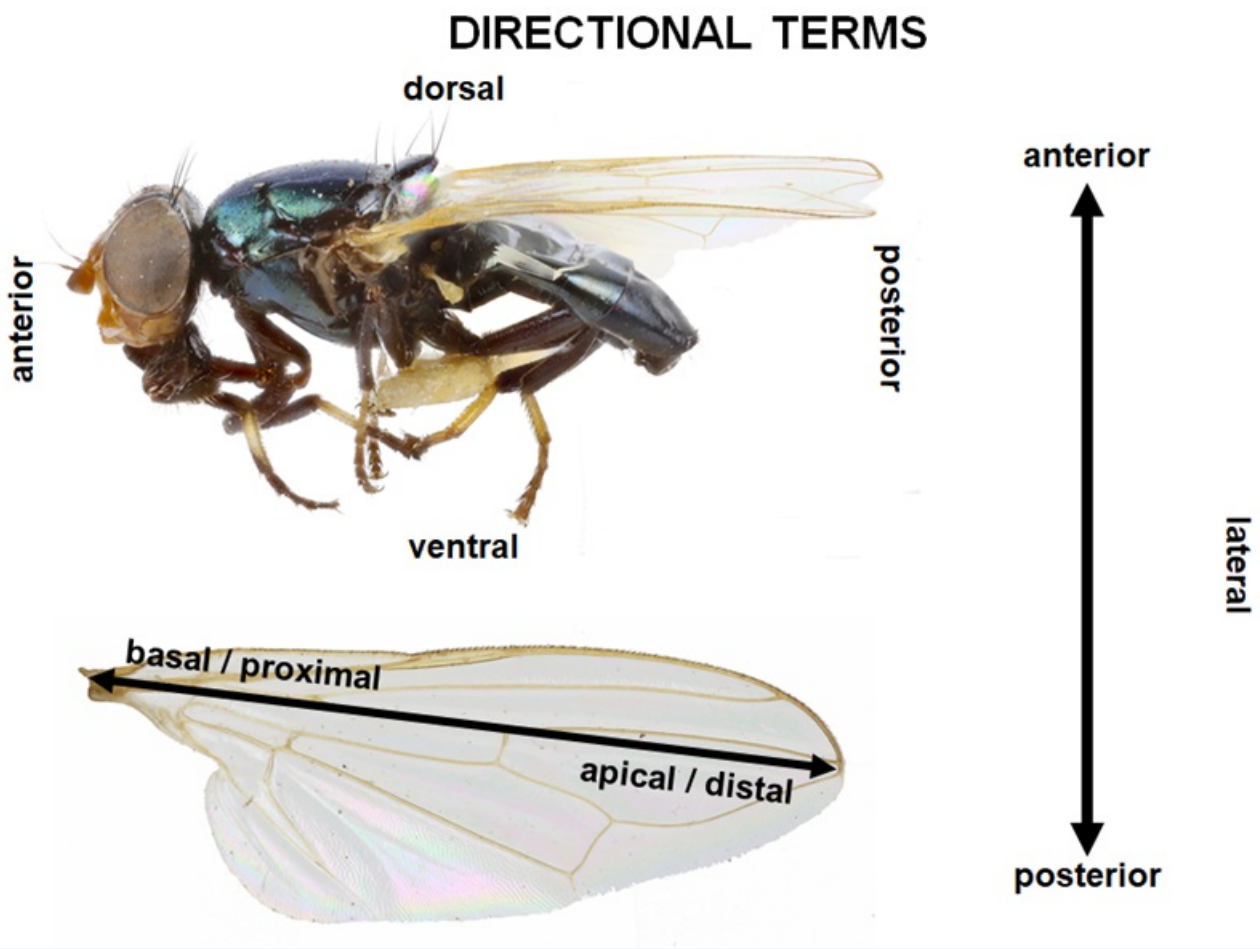

Figure 5. *Physiphora alceae* (Preyssler, 1791) from the Florida State Collection of Arthropods labeled with directional terms used throughout the text. The double-headed arrow indicates directional terms for the dorsal view

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

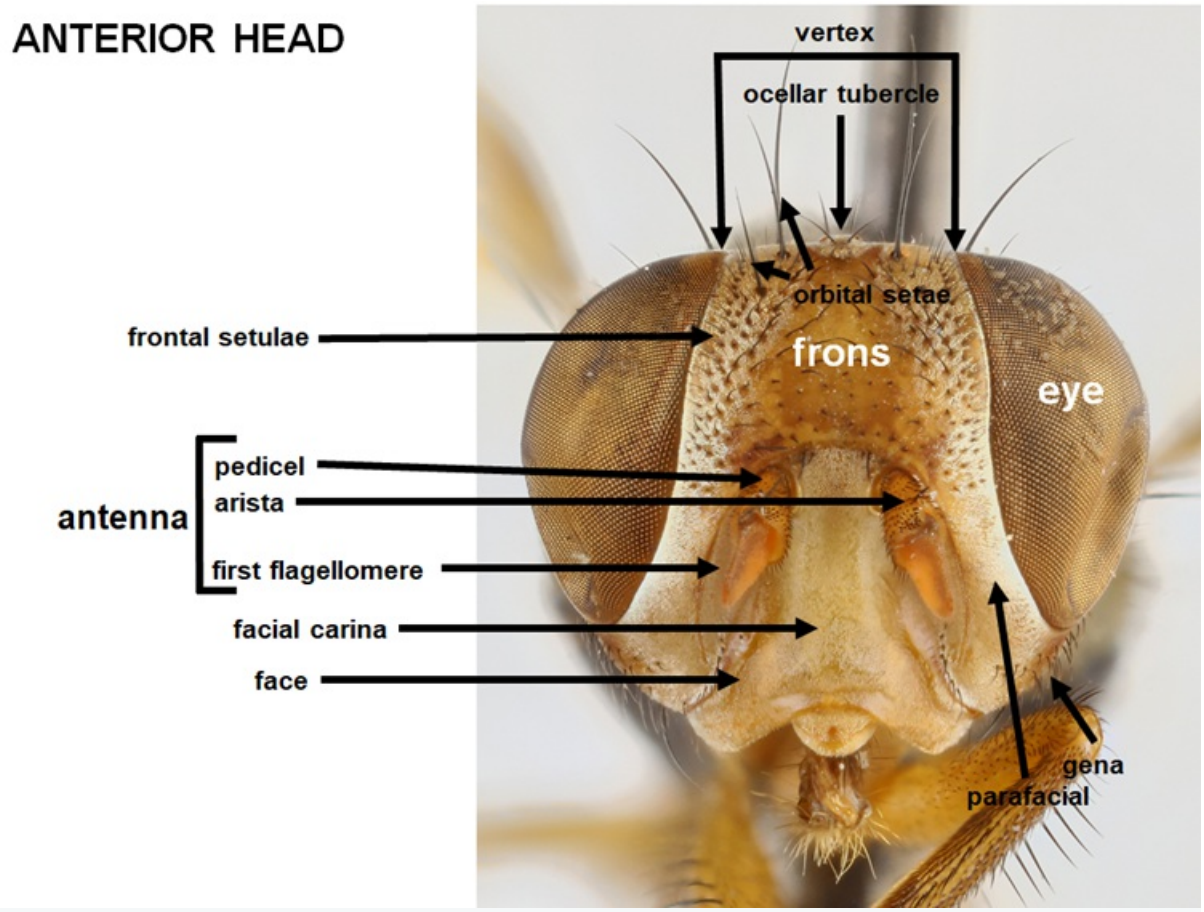

Figure 6. *Ceroxys latiusculus* (Loew, 1873) from the Florida State Collection of Arthropods, labeled with terms for different characters of the head

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

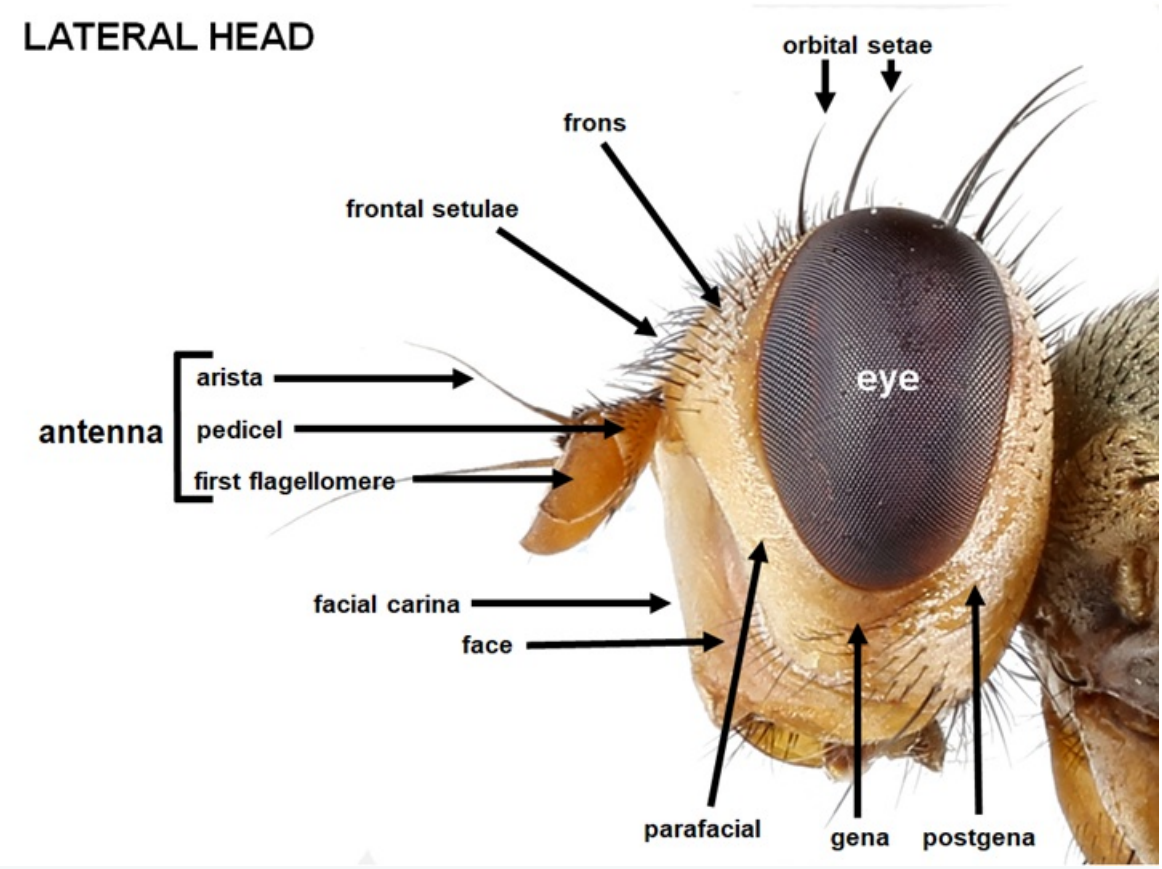

Figure 7. *Ceroxys latiusculus* (Loew, 1873) from the Florida State Collection of Arthropods, labeled with terms for different characters of the head

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

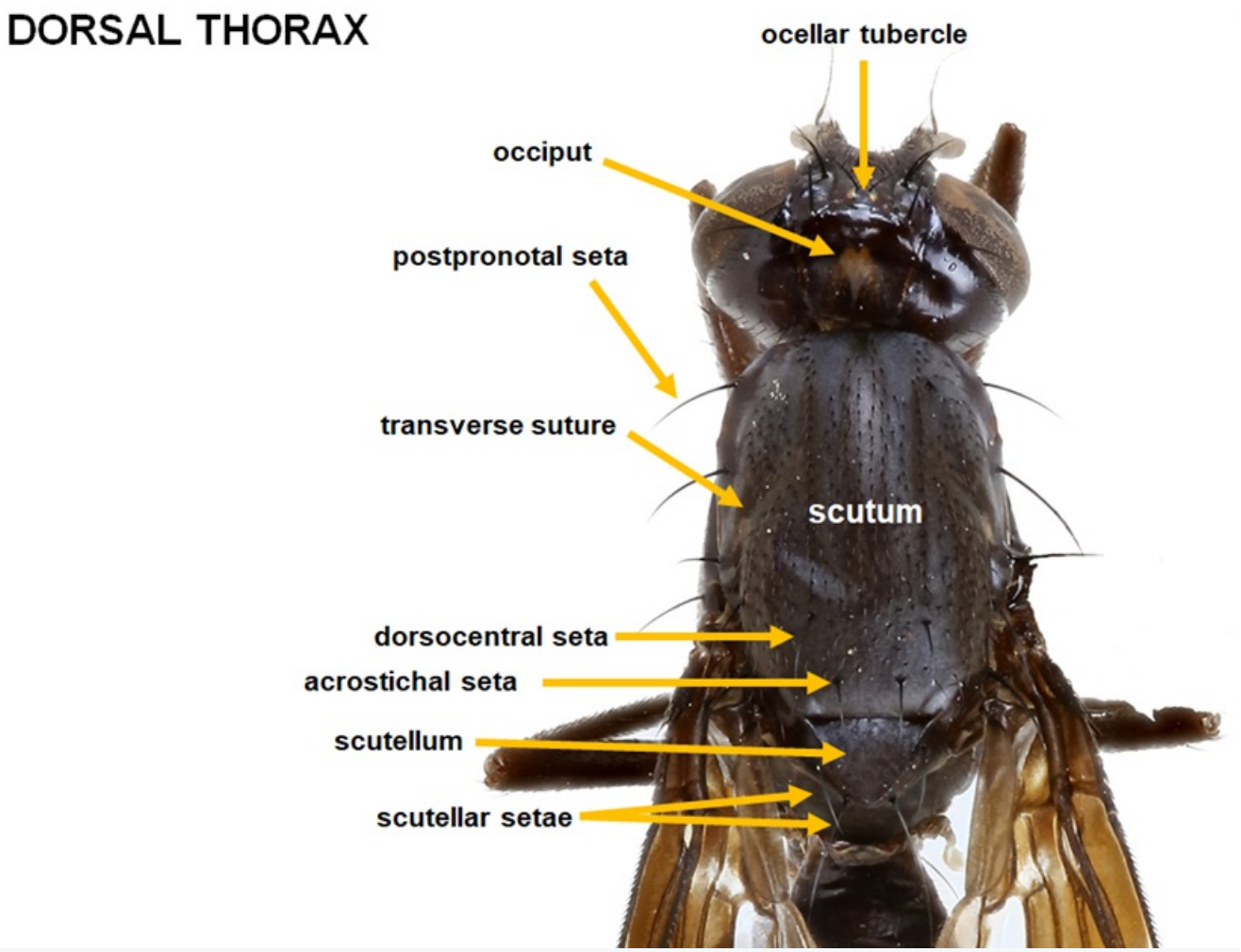

Figure 8. *Tritoxa flexa* (Wiedemann 1830) from the Florida State Collection of Arthropods, with labels for characters visible dorsally

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

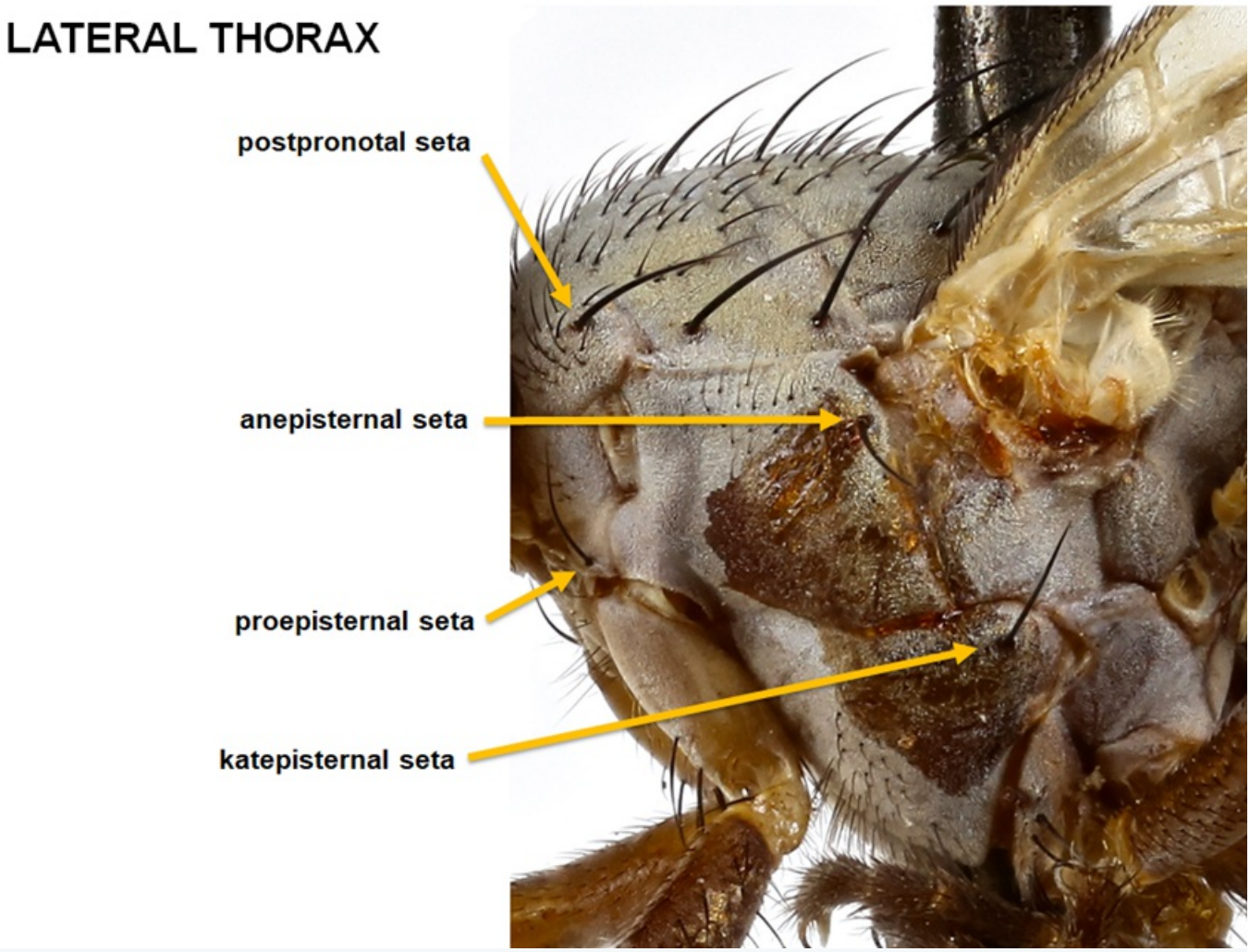

Figure 9. *Melieria picta* (Meigen, 1826) from the Smithsonian National Museum of Natural History Collection with thoracic setae used in this key labeled

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

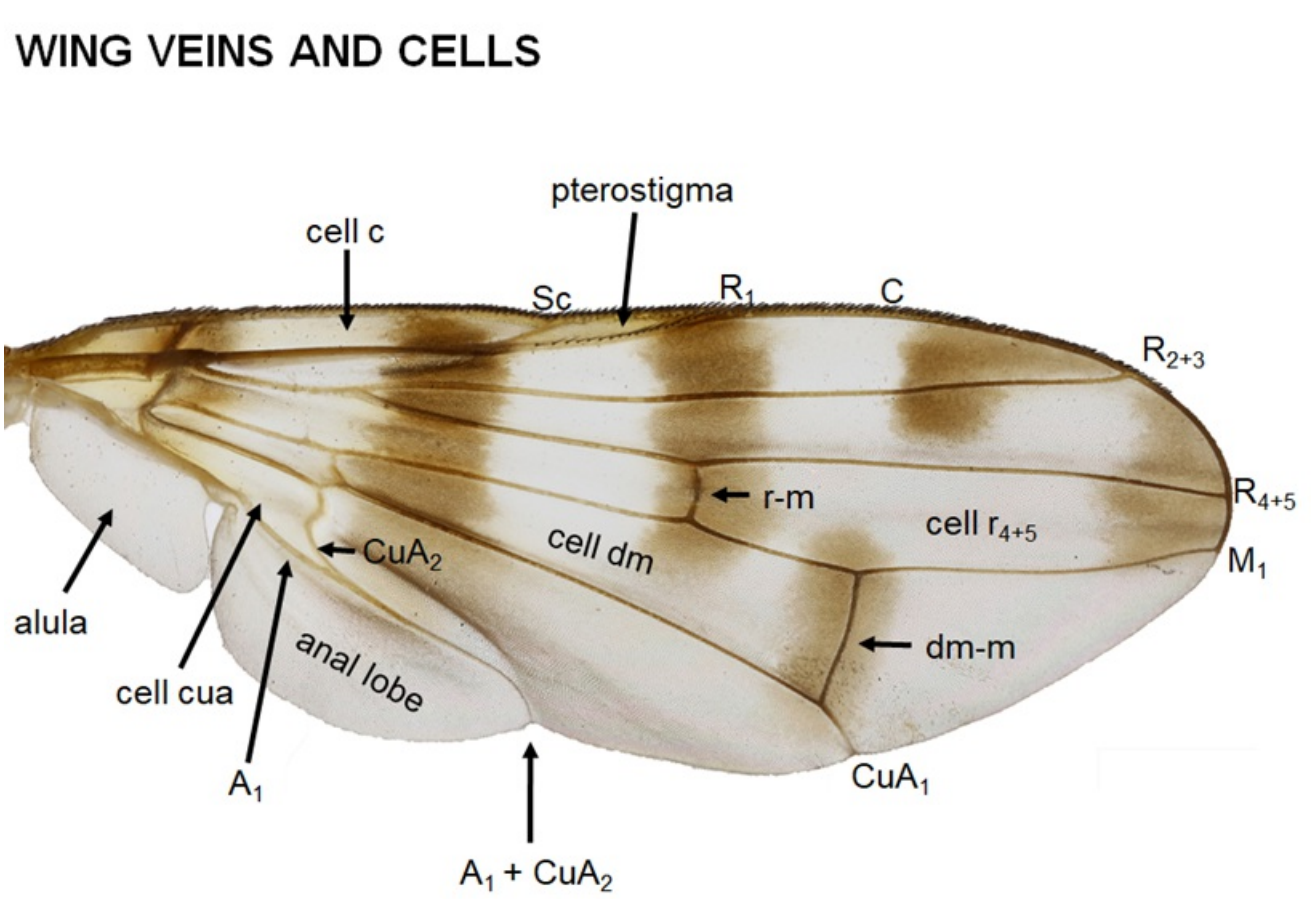

Figure 10. Wing of *Ceroxys latiusculus* (Loew, 1873) from the Florida State Collection of Arthropods with veins, crossveins, and cells used for identification in this key labeled

Source: https://cjai.biologicalsurvey.ca/articles/w-45/

1.2. Forensic Entomology

The Utilidae are also the most important carrion insects, several species of which colonize human cadavers, and therefore, are potentially useful in forensic studies.

Key to South American families of Diptera with forensic importance:

1. Antenna usually longer than thorax with six or more flagellomeres. Palpus usually with 3–5 segments. Body and legs usually elongated ..... Nematocera Antenna usually shorter than thorax with fewer than six flagellomeres, the first one usually enlarged and distal modified to stylus or arista. Palpus with 1–2 segments. Body and legs usually stronger (Brachycera) ..... 2 2. Ptilinal fissure and lunule absent. CuA2 vein usually reaching wing margin or joining A1 vein near its apex ..... 3 Ptilinal fissure and lunule present. CuA2 vein usually joining A1 near wing base..... 4 3. Empodia pulvilliform Antenna longer than head; terminal flagellomere flat and long sometimes longer than the other flagellomeres. Wing with a small discal cell in the center ..... Stratiomyidae Empodia usually setiform. Antenna short. Wing without discal cell; radial veins positioned in anterior margin and distinctly

stronger than remaining veins ..... Phoridae 4. Antennal pedicel with a complete dorsal seam. Greater ampulla present Calypters usually well developed ..... 5 Antennal pedicel usually without dorsal seam. Greater ampulla absent. Calypters usually small or undeveloped ..... 9 5. Meron without a row of setae; rarely with scattered weak setulae ..... 6 Meron with a row of setae ..... 8 6. Scutellum usually with setulae on ventral apex Wing vein A1 +CuA2 reaching wing margin. Hind leg with strong seta at lower base of first tarsomere .... Anthomyiidae Scutellum without setulae on ventral apex. Wing vein A1 +CuA2 not reaching wing margin. Hind leg without strong seta at lower base of first tarsomere .....7 7. Wing with vein subcostal smooth. Vein A1 +CuA2 short and strong; vein A2 long and in shape of sigmoid curve ..... Fanniidae Wing with vein subcostal reaching vein costal usually nearly in straight angle. Vein A1 +CuA2 and vein A2 in different shape not as above .... Muscidae 8. Abdomen and usually thorax with shining metallic blue, green or bronze. Mesonotum sometimes with three dark vittae. Notopleura usually with two setae ... Calliphoridae Abdomen and thorax dull gray or brown. Mesonotum with three conspicuous dark vittae on gray background. Notopleura usually with two strong setae and two small ones ..... Sarcophagidae 9. Hind leg with first tarsomere usually swollen and shorter than the second ..... Sphaeroceridae Hind leg with first tarsomere longer than the second ..... 10 10. Vein subcostal incomplete not reaching vein costal and usually fusing with vein R1 distally ..... Drosophilidae Vein subcostal complete reaching vein costal or just for it freely from vein R1 distally ..... 11 11. Vein costal complete without break. Head rounded. Palpus short, vestigial. Abdomen usually elongate and basally constricted (ant-like shape) ..... Sepsidae Vein costal incomplete with one or two breaks. Head not rounded. Palpus normal, not vestigial. Abdomen without basal constriction ..... 12 12. Vibrissa absent. Wing variably shaped; cup cell usually with pointed or extended to posterior apex .... Ulidiidae (=Ulidiidae) Vibrissa present. Wing moderately broad, with well-developed anal lobe and alula; cup cell never pointed or extended to posterior apex……..... Piophilidae

1.3. Bioecology

Some adults in this family are pollinators but are generally attracted to decomposing plant organic matter such as logs, leaves, fruits, and feces, among others. Some species present phytophagous larvae and behave like agricultural pests of cultivars such as corn, agave, passion fruit, and beets (Figures 11-14) [5][6][7].

Figure 11. *Euxesta notata* (Wiedemann, 1830), on dog poop

Source: https://www.wikiwand.com/fr/Euxesta

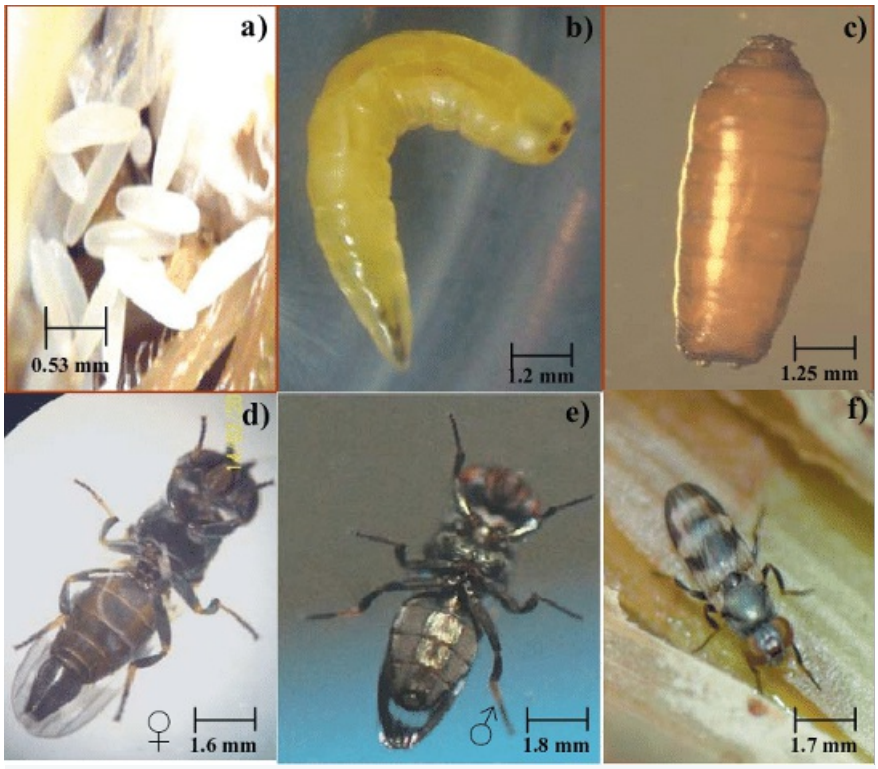

Figure 12. *Euxesta stigmatias* Loew, 1868, (a) eggs, (b) larva, (c) pupa, (d) adult, (e) adult ventral view, and (f) adult dorsal view

Source: https://www.researchgate.net/figure/Euxesta-stigmatias-a-huevecillos-b-larva-c-pupa-d-adulto-e-adulto-vista_fig1_276214202

Figure 13. Pollination carried out by specimen of the Family Ulidiidae (= Otitidae)

Source: Lorin Timaeus

Figure 14. Damage to sweet corn kernels by *Euxesta* spp. and *Chaetopsis massyla* (Walker, 1849) larvae

Source: Photograph by Gregg Nuessly, University of Florida

Information about *Neomyennis*, however, the larvae of Ottidae (Utilidae) usually develop in organic matter at the beginning of decomposition. *Euxesta* species and Pterocerine are normally associated[8].

With monocotyledonea plants, which in a way justifies their abundance. Some*Euxesta* species, even, can affect corn cob candy damaged by caterpillars of Lepidoptera [8].

1.4. Damage

In addition to the damage caused by the larvae themselves, their activity facilitates the entry of pathogens into plants, which may cause losses of up to 100% of production. They also carry enteric bacteria, being responsible for the transmission of infections (Figures 15-17) [9].

Figure 15. *Euxesta sp.* on sweet corn ear

Source: Photograph by Gregg Nuessly, University of Florida

Figure 16. Damage to sweet corn silk by *Euxesta* spp. and *Chaetopsis massyla* (Walker, 1849) larvae

Source: Photograph by Gregg Nuessly, University of Florida

Figure 17. Damage by *Chaetopsis massyla* (Walker, 1849), larvae to sweet corn tassel within or just emerging from corn whorl

Source: Photograph by Gregg Nuessly, University of Florida

Flies as agricultural pests: Flower bud flies, attack different plants, both cultivated and ornamental, making serpentine-shaped galleries in the foliage, flies whose larvae are pests of various fruits. Sorghum flies, whose larvae damage flowers and buds.

1.5. Life cycle

Adults were found from May until late summer. The premating period averaged less than two days; the preoviposition period after mating was three to seven days. Field-collected females each deposited 400 to 500 eggs in decaying herbaceous vegetation. Eggs hatch in four to seven days, and larvae given rotting vegetation completed their development in 20 to 31 days. Larvae of the first generation pupated, with adults emerging 12 to 15 days later, but increasing percentages of the larvae of the second and subsequent generations entered diapause (Figures 18-21) [10].

Figure 18. *Euxesta stigmatias* Loew, 1868, eggs in cornsilk

Source: Photograph by Megha Kalsi, University of Florida

Figure 19. Last instar larvae of the cornsilk fly, *Euxesta stigmatias* Loew, 1868

Source: Photograph by Matthew Hentz, USDA, ARS, Ft. Pierce, Florida

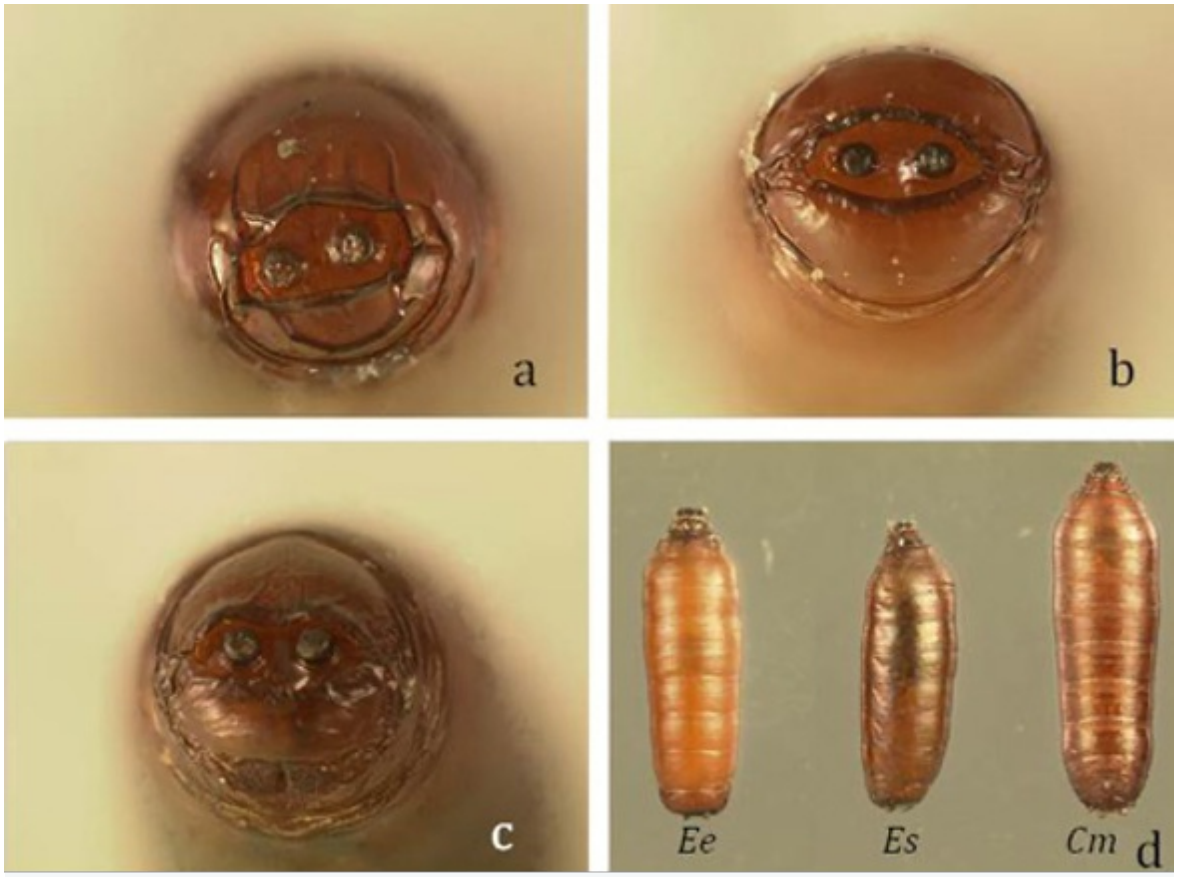

Figure 20. (a, b, c) larva (d) pupa of the Family Ulidiidae

Source: Photograph by Gaurav Goyal, University of Florida

Figure 21. *Euxesta stigmatias* Loew, 1868, male (left) and female (right)

Source: Photograph by Gaurav Goyal, University of Florida

1.6. Taxonomy

It is the third family with the highest number of species within Tephritoidea, presenting 678 species in the World of which at least 285 are present in the Neotropics and about 60 species occur in Brazil [11].

Subfamily: Otitinae Aldrich, 1932, and Ulidiinae Macquart, 1835 (Figure 22).

Figure 22. Subfamily Ulidiinae, *Melieria* sp.1 and sp.2

Source: https://www.semanticscholar.org/paper/New-Data-on-the-Subfamily-Otitinae-(Diptera%2C-in-the-Namin-Nozari/a22599eeb89720ff3da5f88d4f57914c1eb65e11/figure/3

Some Genus: *Eupterocerina* Blanchard, 1938, *Ophryoterpnomyia* Hendel, 1936, *Paragoniaeola* Blanchard, 1938, *Plagiocephalus* Wiedemann, 1830b, *Stylophthalmyia* Frey, 1926, *Terpnomyia* Hendel, 1909 and *Willineria* Blanchard, 1951 [12].

Some species: *Achias lobularis* Wiedemann, 1830, *Dorycera melanotica* Hennig, 1939, *Euxesta sororcula* (Wiedemann, 1830), *Neomyennis appendiculata* (Hendel 1909), *Neomyennis* sp., *Neomyennis zebra* Hendel, 1909, *Tetrapleura picta* Schiner, 1868 and *Willineria orfilai* Blanchard, 1951 (Figure 23) [13].

Species collected in Brazil: *Euxesta eluta* Loew, 1868, *Euxesta mazorca* Steyskal, 1974, *E. sororcula*, *N. appendiculata*, *Notogramma cimiciforme* Loew, 1868 (Uchôa-Fernandes et al., 2002), *N. zebra*, *Pterocerina scalaris* Blanchard, 1938 and *T. picta*

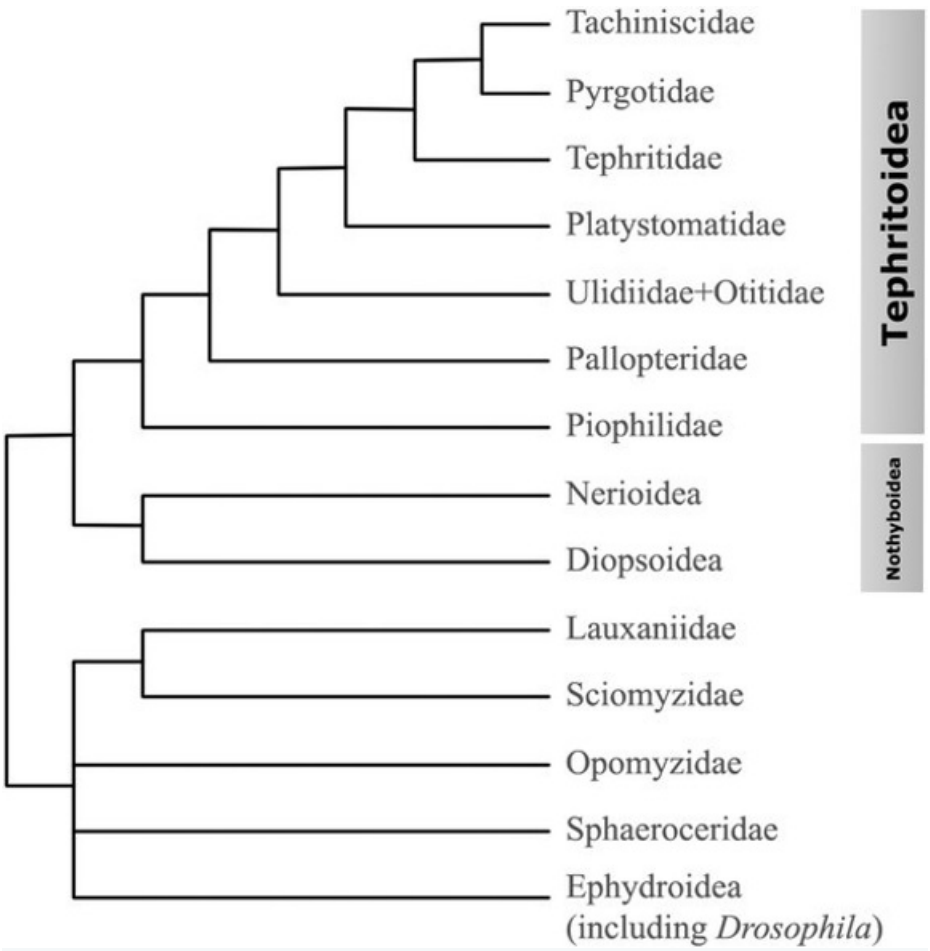

Figure 23. Phylogenetic relationships of Tephritoidea, Nothyboidea, and Ephydroidea flies (based on McAlpine (1981); Gibson et al. (2010); Wiegmann et al. (2011)). Outgroups were selected based on current hypotheses of phylogeny: the superfamily Nothyboidea (including Psilidae) forms a sister group to the superfamily Tephritoidea (including Ulidiidae). Drosophilidae (superfamily Nothyboidea) is a sister group to Nothyboidea ephritoidea.

Source: https://zoologicalstudies.springeropen.com/articles/10.1186/s40555-014-0051-1

1.6. Objective

This mini-review aims to describe the Utilidae Family.

2. Methods

The methodological basis of the present work consists of bibliographical research of scientific articles published in national and international academic scientific journals classified by the Coordination for the Improvement of Higher Education Personnel. The search criterion for articles was to prioritize articles that dealt with the topic. Document analysis was used as a data collection method to gather information on theoretical books, theses banks, university dissertations, scientific journals, documents, and websites:

https://www.researchgate.net/post/How_to_increase_the_research_results_visibility. (https://goo.gl/gLTTTs), HAL (https://hal.archives-ouvertes.fr/submit/index), SSRN (https://hq.ssrn.com/login/pubsigninjoin.cfm) and ResearchGate (https://www.researchgate.net/signup.SignUp.html).

3. Selected Manuscripts

3.1. Study 1

3.1.1. Management: Control agents/parasitoids

Eggs and larvae are consumed by earwigs (Dermaptera: Forficulidae), mites (Acarina), minute pirate bugs (Hemiptera: Anthocoridae: *Orius* spp.), lacewings (Neuroptera: Chrysopidae: *Chrysoperla* spp.) and rove beetles (Coleoptera: Staphylinidae). Rove beetle adults, lacewing larvae, and *Orius insidiosus* (Say, 1832). (Hemiptera: Anthocoridae) adults consumed 20 eggs and up to 35 1st and 2nd instar *Euxesta* spp. larvae per day in petri dish bioassays. *Orius insidiosus* nymphs also fed on eggs and small *Euxesta* spp. larvae. Assassin bugs, such as *Zelus longipes* (Linnaeus, 1767) (Hemiptera: Reduviidae) and many spider species feed on adults of all four 'cornsilk fly' species. *Zelus longipes* need 40 to 85 minutes to complete feeding on a *Euxesta* spp. adult depending on the sex of the predator and the fly species (Figures 24-27) [14][15].

Figure 24. Adult *Orius insidiosus* (Say, 1832). (Hemiptera: Anthocoridae) feeding on a third instar larva of *Euxesta stigmatias* Loew, 1868

Source: Photograph by Megha Kalsi, University of Florida

Figure 25. First instar *Orius insidiosus* (Say, 1832) (Hemiptera: Anthocoridae) nymph feeding on a *Euxesta* spp. egg

Source: Photograph by Megha Kalsi, University of Florida

Figure 26. *Zelus longipes* (Linnaeus, 1767) Fabricius (Hemiptera: Reduviidae) feeding on *Euxesta stigmatias* Loew, 1868 in a sweet corn field

Source: Photograph by Megha Kalsi, University of Florida

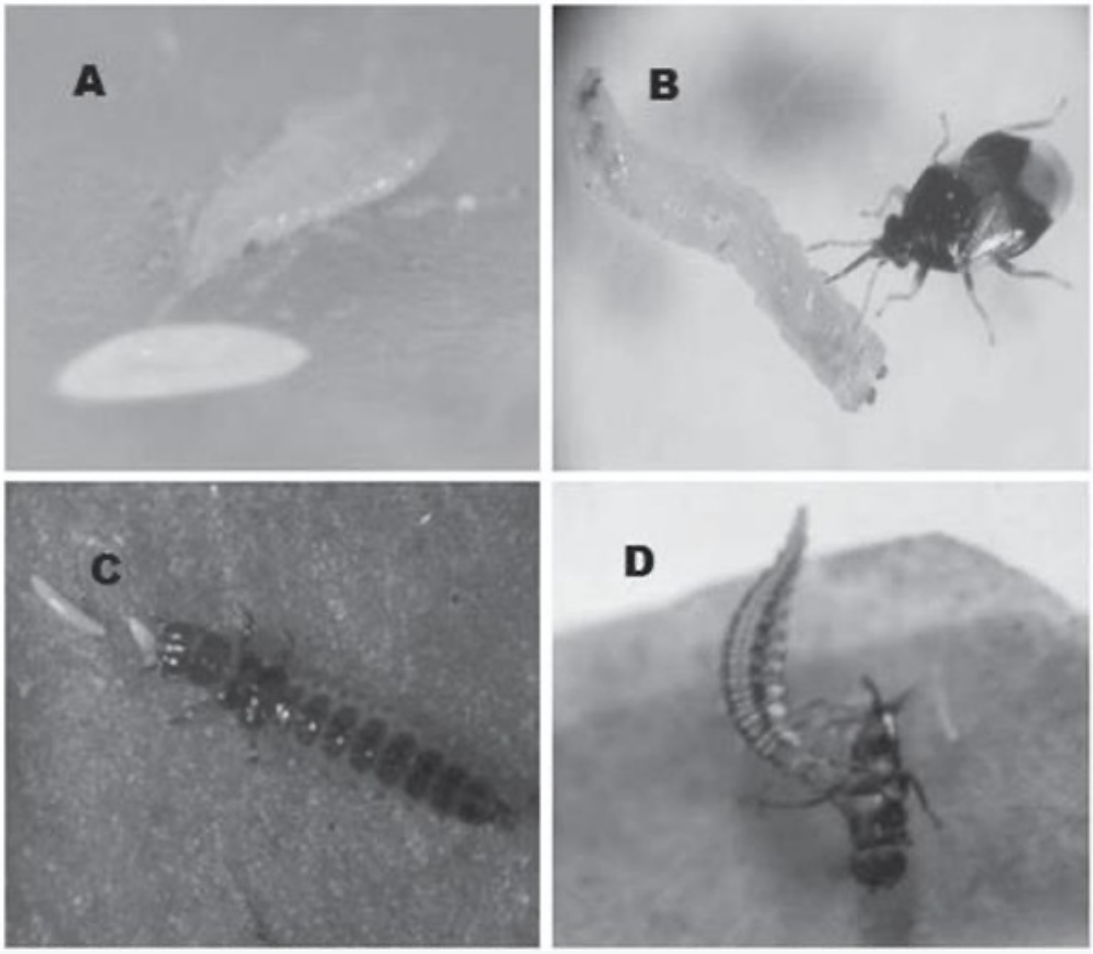

Figure 27. Predators of *Euxesta* spp. (A) First instar nymph of *Orius insidiosus* (Say, 1832) feeding on a *Euxesta* sp. egg. (B) Adult of *O. insidiosus* feeding on a third instar larva of *Euxesta stigmatias* Loew, 1868. (C) *Anotylus insignitus* (Gravenhorst, 1806) (Coleoptera: Staphylinidae) larva feeding on *Euxesta* sp. eggs. (D) Larva of *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) feeding on an adult *Euxesta* sp. fly

Source: https://bioone.org/journals/florida-entomologist/volume-97/issue-1/024.097.0123/Seasonal-Timing-Abundance-and-Predatory-Status-of-Arthropods-Associated-with/10.1653/024.097.0123.full

3.2. Study 2

3.2.2. Diagnostic features

Tephritoidea and Ulidiidae Russia

The abdomen of tephritoid flies consists of 1-11 segments. In females, segments 1-6 are preabdomen (in males, the preabdomen is 1-5th segments). Abdominal tergites 1 and 2 fused to form syntergite. The first and the second sternite are not fused. The postabdomen of female tephritoid flies consists of modified 7th–11th segments forming a telescopic non-retractile ovipositor. The ovipositor consists of 7 syntergosternitis, an eversible membrane (covered with scales or spines, with two pairs of sclerotized strands), and an apical segment, aculeus, or blade of the ovipositor (consisting of derivatives of the 8th–11th segments and including 2 parts - an elongated base and a cercal segment). The membrane of the

ovipositor is considered to be a derivative of the 7th segment (Figures 27-28) [16].

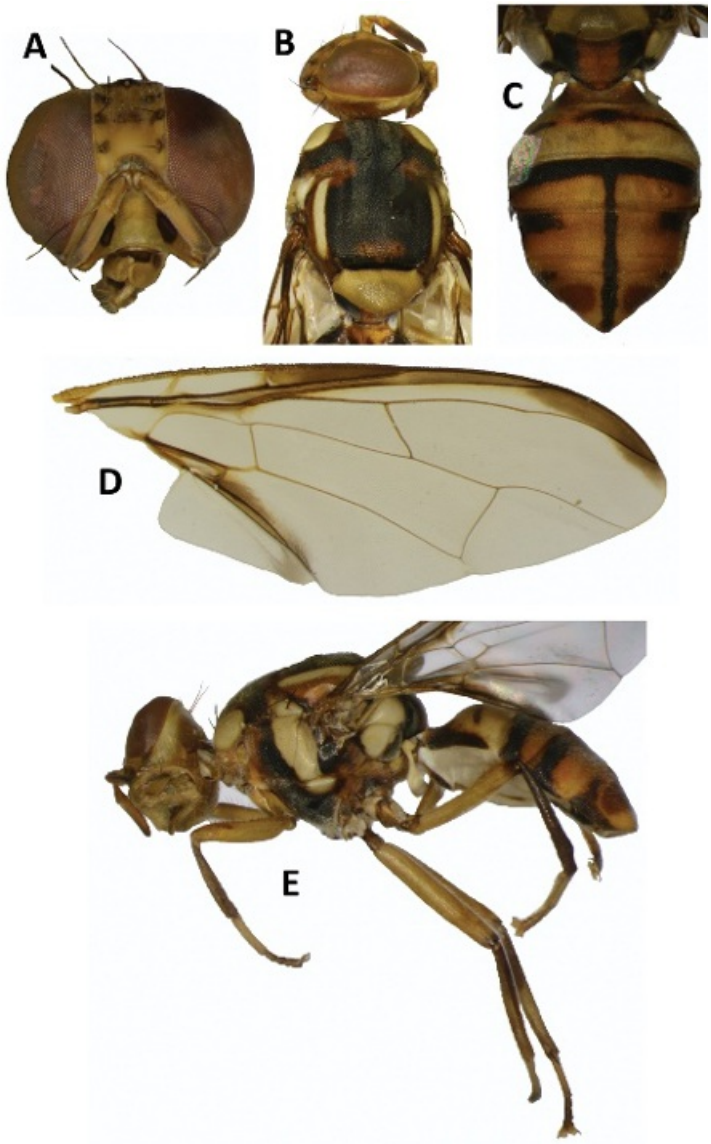

Figure 28. Tephritoidea collected in Bangladesh (A) head (B) head and scutum (C) abdomen (D) wing (E) lateral view

Source: https://zookeys.pensoft.net/article/38096/zoom/fig/14/

Ulidiidae, unlike the sister and more advanced group of Tephritidae, in the larval stage are mainly aprophages or coprophages and lay eggs directly into the substrate. The eversible membrane of the female ovipositor studied representatives of these genera does not carry cuticular outgrowths or bears sparse small (5-10 µm long) microtrichia. This structure of the membrane does not prevent the free penetration of the ovipositor under the surface of various substrates and allows this fly to remain polyphagous (Figure 29) [16].

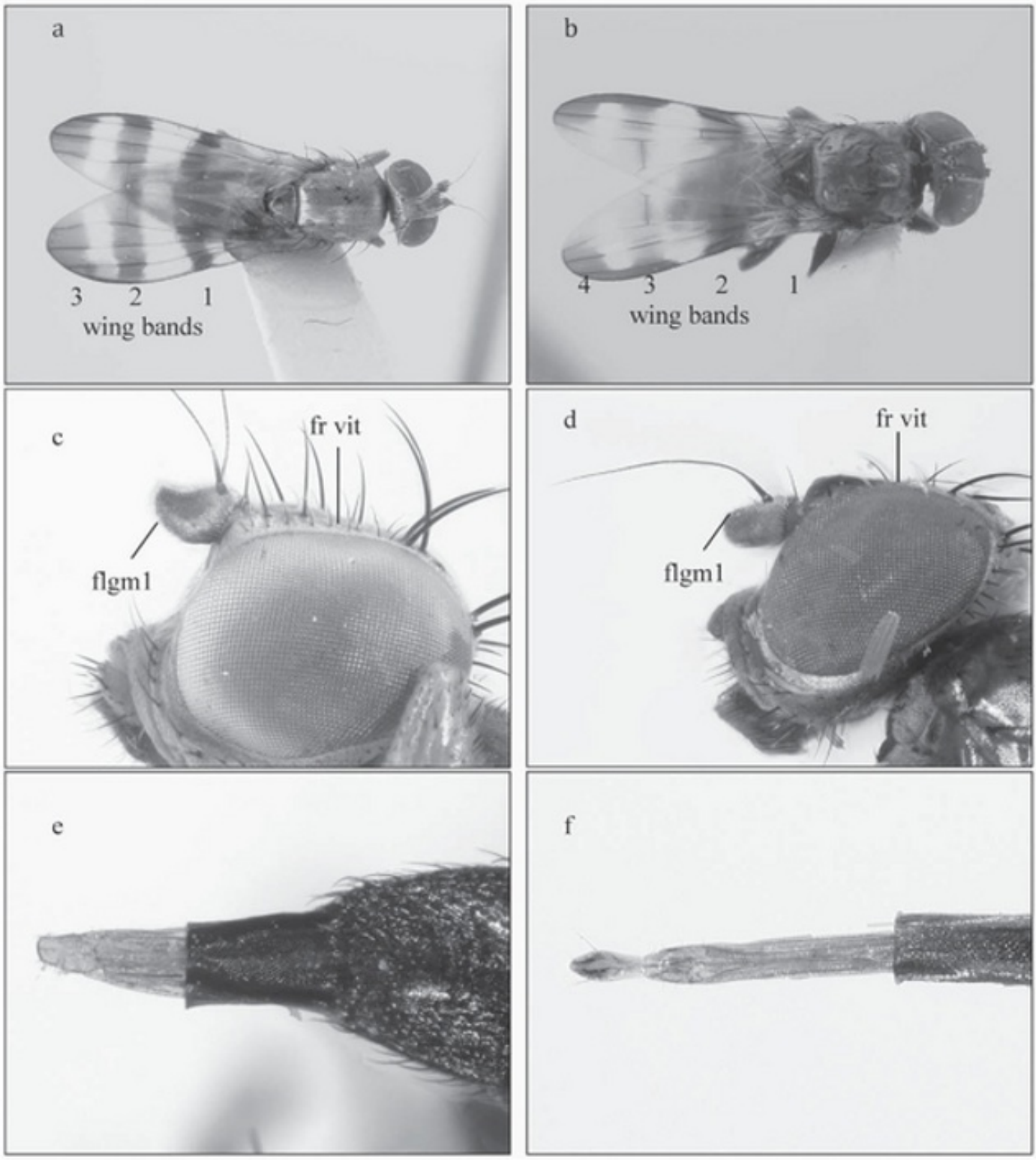

Figure 29. Adult females of *Chaetopsis massyla (Walker, 1849)* (a) and *Euxesta stigmatias Loew, 1868 (Diptera: Ulidiinae)* (b); heads of *C. massyla* (c) and *E. stigmatias* (d); ovipositors of *C. massyla* (e) and *E. stigmatias* (f); flgm1, first flagellomere

Source: https://journals.scholarsportal.info/details/00154040/v93i0002/198_nrocmuppocif.xml

Larvae of the genus *Homalocephala* develop under the bark of deciduous n and coniferous trees; the ovipositor membrane bears short (3-5 µm) microtrichia. Larvae genus *Melieria* develop on stems and roots of plants, and have

species preferences by substrate. The membrane of the ovipositor of this species genus bears long (15-20 µm) microtrichia. [16].

Probably, laying eggs in decaying plant substrates is associated with a greater need to anchor the ovipositor. The specificity of the shape of microtrichia on the eversible membrane of the egg is probably due to the fact that different *Melieria* species develop on different plant species and can serve as a reliable identification feature in the study of closely related species of the genus (Figure 30) [16].

Figure 30. genus *Melieria*

Source: https://en.wikipedia.org/wiki/Melieria

3.3. Study 3

The genus *Euxesta* Loew has the largest number of species in the family Ottidae (Steyskal 1968). Usually found in humid places, it is an abundant group in tropical and neotropical regions. Most species are saprophagous, although some feed on ripened fruits and vegetables and can cause economic damage [17].

Euxesta stigmatias Loew, 1868, is found in the American continent. In North and Central America, this species is considered a pest in corn (Figures 31-32) [17].

Figure 31. *Euxesta stigmatias* Loew, 1868

Source: https://bugguide.net/node/view/1312283

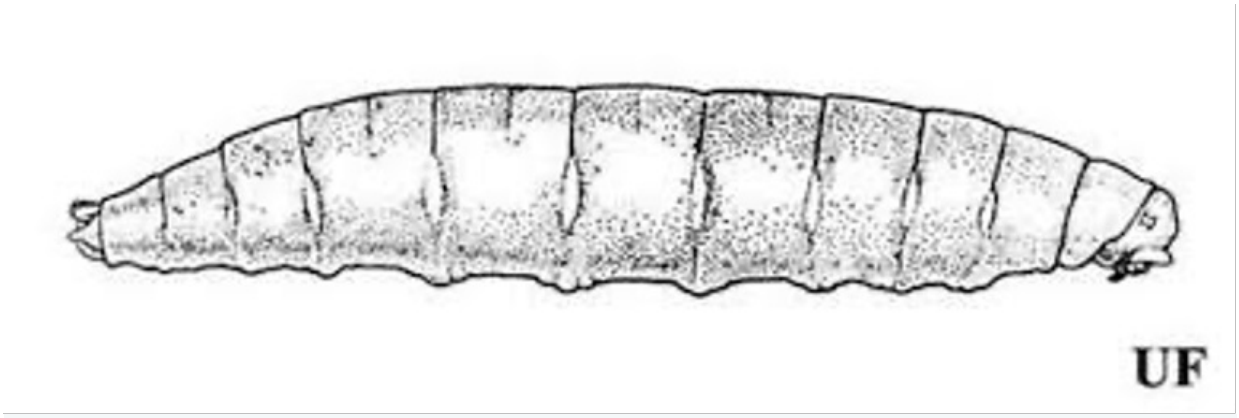

Figure 32. Larva of the cornsilk fly, *Euxesta stigmatias* Loew, 1868

Source: Credits: University of Florida

In collecting insects associated with sweet corn (*Zea nays* L.) (Poaceae), during the summer of 1982183. in Brasília, DF, the authors found the presence of Diptera larvae of the species: *Euxesta sororcula* Wiedemann (1830), *Euxesta eluta* Loew (1868), and *E. stigmatias*, feeding on the tips and hairs of the ear, in an environment of partial deterioration. In April 1983 at CNPH/EMBRAPA, located near Brasília, DF, it was observed, in an area destined for the production of carrot seeds. Brasília, that some roots had rotted shoulders (Figure 33) [17].

Figure 33. *Euxesta stigmatias* damage to corn *Zea mays* (Poaceae)

Source: http://panorama.cnpms.embrapa.br/insetos-praga/identificacao/pragas-da-espiga/mosca-da-espiga-euxesta-spp-diptera-otitidae

Inside the damaged area, the presence of Diptera larvae was observed, whose adults were determined to be the species *E. stiginatias*. In carrots (*Daucus carota* L.) cv. (Apiaceae), two types of damage were caused by the larvae of this species: 1) total destruction of the root shoulder, which prevents sprouting, making it impossible to development of the aerial part and subsequently resulting in the death of the subterranean part of the plant; 2) partial destruction of the root shoulder with subsequent suppression of the initial shoot of the plant, which forces the appearance of lateral shoots and causes a delay in the vegetative and reproductive development of the plant (Figures 34-35) [17].

Figure 34. *Euxesta stigmatias* Loew, 1868 attacking carrots

Source: https://www.embrapa.br/en/hortalicas/cenoura/doencas2

Figure 35. *Euxesta stigmatias* Loew, 1868 attacking carrots

Source: https://www.noticiasdejardim.com/legumes/cenouras/controle-de-moscas-cenouras/

3.4. Study 4

Cob fly, *Euxesta* spp. (Diptera, Ottidae)

The adult, five millimeters long, is dark in color and has colorless wings with dark spots. Oviposition is carried out on the stigma-styles and the hatching of the larvae takes place two to three days after laying. Despite being considered a secondary pest, currently, there has been an increase in the incidence of larvae on the ears, especially in sweet corn or corn with softer grains [18].

The larvae, once reaching the milky grains, penetrate inside where they complete larval development. Often the larvae penetrate the seed embryo, feeding entirely on the grain, leaving only the outer membrane. Two species occur in maize, *Euxesta eluta* Loew, 1868 and *Euxesta mazorca* Steyskal, 1974. These species can be separated by the intensity of the stripes on the wing which is complete in *E. eluta* (Figures 36-37) [18].

Figure 36. *Euxesta eluta* Loew, 1868

Source: https://specialtycropindustry.com/battling-silk-flies-in-south-florida-sweet-corn/

Figure 37. Damage caused to ears by *Euxesta* spp.

Sources: Photo Sinval Lopes

The control of the ear fly, one of the worst pests of this species, which attacks the sweet corn crop, gained an innovative technique (2021). Researchers from Embrapa Maize and Sorghum are using an innovative process of ecological control, which uses MacPhail traps in the fields to attract adult females of the insect, preventing their reproduction. This commercial trap model is already successfully used for monitoring fruit flies (2021) [18].

Traps that use food attractants to capture insects in a sweet corn field. The attractive feed is a hydrolyzed corn protein. The ear fly is usually associated with a bacterium that, when present in canned corn, can give the finished product an unpleasant smell, which makes it useless for consumption, causing economic losses for both the farmer and the agroindustry (Figure 38) [18].

Figure 38. Mcphail trap (detail)

Source: Photo Ademilson Rocha

4. Conclusion

Despite being considered a secondary pest, there has currently been an increase in the incidence of larvae in ears, especially in sweet corn or the type of corn with softer grains, which is the most important factor to attract the pest for the plant is the reproductive phase, attracting for oviposition and development.

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