



Study of Diptera species of medical, sanitary, veterinary, and economic importance in Brazil: Bibliographic summary

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Abstract

The aim of this study is to describe the species of Diptera of medical, sanitary, and veterinary importance in Brazil: Bibliographic summary. The mini review consists of a bibliographic summary about the Diptera (Order: Diptera). The research was carried out in studies related to the theme with an emphasis on quantitative and conceptual aspects of Family, Subfamilies, Genera and Species (taxonomic groups). A literature search was carried out containing articles published from 2000 to 2021. The mini review was prepared in Goiânia, Goiás, from July to August 2021, through the Online Scientific Library (SciELO) and internet.

Keywords: Arthropods; Insecta; Flies; SciELO; Mini review

1. Introduction

The order Diptera, which comprises flies, mosquitoes, and the like, is one of the most diverse groups of insects, both ecologically and in terms of species richness. Diptera are distributed on all continents, including Antarctica, and have successfully colonized virtually any type of habitat, especially in aquatic environments, in which the larval stage occurs. Diptera larvae can occupy coastal marine areas and estuaries, lakes of all depths, rivers and streams of all sizes and speeds, stagnant waters, thermal waters, oil wells and phytohelms. It can be said that the only unexplored habitat by Diptera (Figure 1) is the open sea [1].

Larvae of most groups are free-living, actively swimming or crawling in their habitat (e.g., Culicidae and Simuliidae), while others may live buried in sediment or under rocks (e.g., Tabanidae and Tipulidae), in submerged wood or macrophytes (e.g., many Chironomidae and Tipulidae), in tubes formed by salivary secretion, associated with rock, plants and debris (Chironomidae), or rarely as parasitoids (e.g., Sciomyzidae larvae, which parasitize freshwater molluscs) [1].

The 60,000 described species of Cyclorrhapha (Muscomorpha) are characterized by an unusual diversity in larval life-history traits, which range from saprophagy over phytophagy to parasitism and predation [2].

The Cyclorrhapha is composed of those flies where the adult escapes from the pupal case through a circular opening in the anterior end. These flies are characterized by the possession of three-segmented antennae where the last segment bears an arista or style. The suborder Cyclorrhapha (Muscomorpha) has historically represented one of three suborders of the Diptera, along with the Nematocera and Brachycera. Recently, it has been proposed that the Brachycera and Cyclorrhapha be combined in an infraorder called the Muscomorpha (Figure 2) [2, 3, 4, 5].

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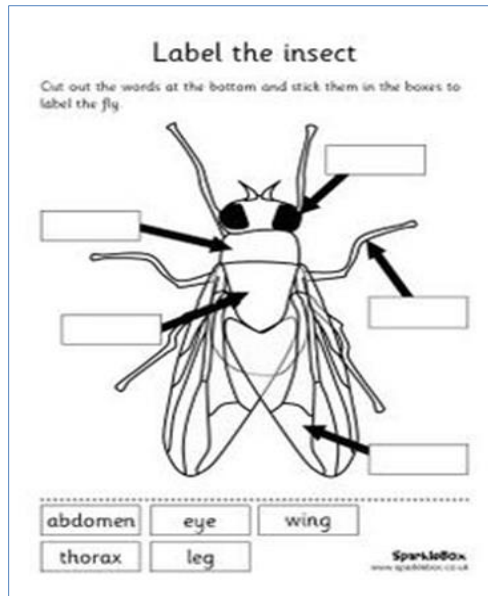


Figure 1 Specimen of Diptera; (Source: <https://br.pinterest.com/med725/classroom-insects/>)

Ordem	Subordem (= infra-ordem)	Seção	Subseção	Superfamília	Família
Diptera	Muscomorpha (= Cyclorrhapha)	Aschiza (sem sutura frontal)	Acalypratae (sem calípteras)	Syrphoidea	Syrphidae
				Tephritoidea	Tephritidae Piophilidae Chloropidae
				Carnoidea	
				Ephydroidea	Drosophilidae
				Hippoboscoidea	Glossinidae Hippoboscidae Strebliidae Nycteribiidae
		Schizophora (com sutura frontal)	Calypratae (com calípteras)	Muscoidea	Anthomyidae Muscidae
					Oestroidea

Figure 2 Classification of the Muscomorpha Suborder (Cyclorrhapha) citing only the Families of Medical-Veterinary interest. Diptera order: adults have a pair of functional wings and a pair of vestigial wings that are the dumbbells or rockers. Suborder Nematocera: they are dipterous that present antennas formed by more than six articles. Suborder Brachycera: they are the dipterous that present the antennas with three segments, the last being ringed. Suborder Muscomorpha or Cyclorrhapha have antennas formed by three segments, with the edge resting on the last one. Schizophora Division: Muscoid dipterans that have a ptilineal suture belong to this division. This suture is the scar left by the retraction of the frontal or ptilineal ampoule, existing in the fly's head during its exit from the pupae. (Circular opening = Cyclorrhapha). Calyprate section: they have the calíptera, which is a fold of the wing, which covers the rocker arm: dipterous that have been called Calyprata and those that do not have Acalyprata (Source: Neves. David Pereira. Parasitologia Humana).

The Schizophora are a section of true flies containing 78 families, which are collectively referred to as muscoids, although technically the term "muscoid" should be limited to flies in the superfamily Muscoidea; this is an example of informal, historical usage persisting in the vernacular. The section is divided into two subsections, the Acalypratae and Calypratae, which are commonly referred to as acalyprate muscoids and calyprate muscoids, respectively (Figures 3, 4 and 5) [2, 3, 4, 5].

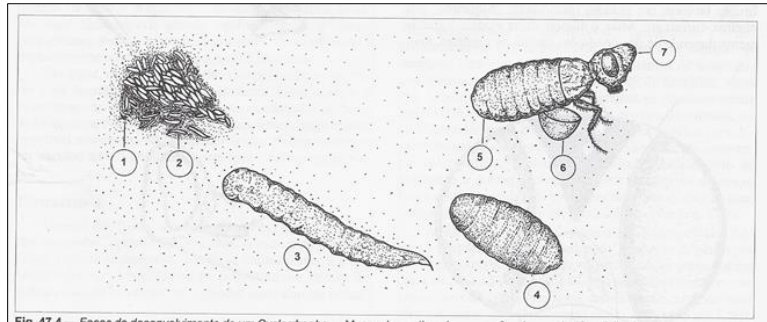


Figure 3 *Musca domestica* L. 1758 (Diptera: Muscidae): 1 egg, 2 first-stage larvae, third-instar larvae, 4 pupa, 5 adult emerging from the pupae, 6 pupary spherical structure displaced, 7 ptilineal or frontal ampoule distended by the hemolymph to displace the spherical structure of the puparium; (Source: Neves. DP. Parasitologia Humana)



Figure 4 The flies belong to the order Diptera, characterized by the presence of only two pairs of wings used in the flight itself. In the taxonomic classification of the group, the Schizophora division is characterized by the presence of ptilinal suture, which is a scar left due to the pumping and distension of the ptilineum (membranous region of the frontal area of the fly's head) through the pumping of hemolymph (insect blood). This forces the opening of the pupae (where the larva metamorphoses) allowing the winged adult to exit. After emergence, the Ptilineum retracts leaving a U-shaped scar that characterizes Schizophora; (Source: <https://shkola.of.by/familia-muscidae-mosca-domstica-musca-domestica.html>)

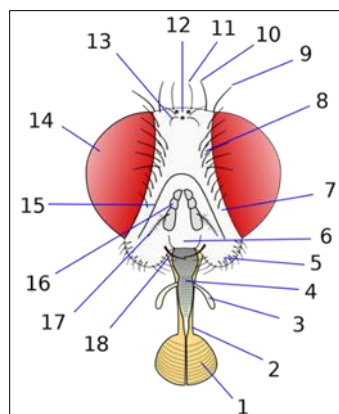


Figure 5 Head morphology of muscoid flies sensu lato (Diptera: Muscomorpha); 1: labellum; 2: lower lip (labium); 3: maxillary palp; 4: upper lip (labrum); 5: subgenal area; 6: clypeus; 7: front-orbital area; 8: front-orbital bristles; 9: outer vertical bristle; 10: inner vertical bristle; 11: postocellar bristles; 12: ocelli; 13: ocellar bristles; 14: compound eye; 15: Frontal suture or ptilinal suture; 16: antenna; 17: arista; 18: vibrissa; (Source: <https://identify.us.com/idmybug/flies/index.html>)



Figure 6 The suborder Cyclorrhapha: eggs, larva, pupa and adult; (Source: https://entnemdept.ufl.edu/creatures/urban/flies/house_fly.htm)

The development cycle of flies goes through 4 phases: egg, larva, pupa and adult. The insect lays about 2,000 eggs during its lifetime, which lasts about 30 days. After ovulation, eggs are deposited. They are white in color and about 1.2 mm long. After 1 day, the larvae hatch from the eggs. Eggs are always deposited close to nutrients, such as decaying organic material, for example, to feed the larvae. Afterwards, the insects go through the pupa stage and in a few days, they are ready to become adults, living for about 2 weeks (Figure 6) [2, 3, 4, 5].

Objective

The aim of this study is to describe the species of Diptera of medical, sanitary, and veterinary importance in Brazil: Bibliographic summary.

2. Methods

The methodology used in this study was that of Marchiori (2021) [6]. The collection was built from articles from 2000 to 2021 with the themes: Classification, study of the main Genus and Species and Families.

3. Studies performed

3.1. Study 1

3.1.1. Popular name: Horn fly



Figure 7 *Haematobia irritans* (Linnaeus, 1758) (Diptera: Muscidae)

Scientific name: *Haematobia irritans* (Linnaeus, 1758) (Diptera: Muscidae) (Figure 7). This insect has become a serious problem in cattle breeding in the country. Until recently this insect did not exist in Brazil. Currently, its incidence is very high in the country. The main characteristic of this insect is that thousands land on a bovine that even finds it difficult to feed due to the discomfort caused by the endless stings of these insects. With difficulty in feeding, the animal quickly loses weight, causing serious damage if appropriate measures are not taken. This insect can also transmit a filaria that causes ulcerative lesions on the animal's skin.

3.1.2. Popular name: House fly

Scientific name: *Musca domestica* L. 1758 (Diptera: Muscidae) (Figure 8). It is the most important species, as in addition to being extremely well adapted to the environment, it is quite uncomfortable and can transmit more than a hundred pathogenic organisms (viruses, bacteria, protozoa, helminths) to humans and domestic animals.



Figure 8 *Musca domestica* L. (Diptera: Muscidae); (Source: <https://stock.adobe.com/sk/search/images>)

The females place the eggs in breeding places by locating them through the organs of smell in the antennae and positioning themselves in such a way that the eggs are placed in the most humid and shaded places. Within 24 hours, the first-stage larvae hatch, passing through two other stages, lasting from five to eight days, but during winter, larval development can last for several weeks.

In the first stage, it measures about 2 mm in length and in the third from 10 to 14 mm. The larvae are light in color and actively move around. They feed on solubilized substances and mainly on bacteria that improve the development of this insect. They feed constantly, digesting a wide variety of animal and vegetable substances, especially sugary ones.

Before ingesting the food, they deposit a drop of saliva on it to dissolve it and then suck it. Adult flies live for about 30 days. This insect is attracted by different odors and can fly around 1,000 to 3,000 m in 24 hours. Flies are transmitters of diseases to humans. After landing on feces, wounds, and dead animals, they can land on human food and contaminate it, depositing on it the bacteria contained in its saliva, feet, and bristles of its body.

3.1.3. Popular name: Flies or banana fly

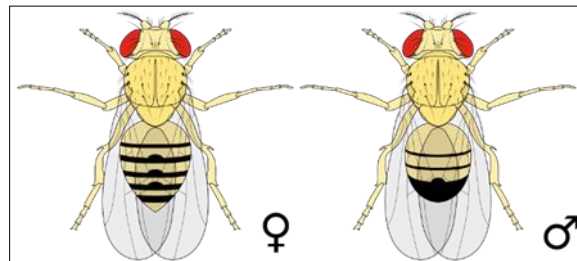


Figure 9 *Drosophila melanogaster* Meigen, 1830. (Diptera; Drosophilidae);

(Source: https://pt.m.wikipedia.org/wiki/Ficheiro:Biologia_Illustration_Animals_Insects_Drosophila_melanogaster.sv)

Scientific name: *Drosophila melanogaster* 1830. (Diptera; Drosophilidae) (Figure 9). This insect also known as vinegar fly, banana fly, or fruit fly has characteristics such as: being yellowish, having relatively long ventral receptacle, medium

long spiral testicles, larvae do not jump, sexual combs present in the males. Native to tropical and subtropical regions of the Old World, some of which are now widely distributed.

The development of this insect, including fertilization and zygote formation, takes place within the egg membranes. It undergoes complete metamorphosis: egg, larva, pupa, and imago. The duration of its development varies according to the temperature. Its food is mainly based on fungi and bacteria, from which it takes the sugars needed for its food. Females need a lot of sugars and yeasts to produce eggs and larvae also feed on liquids and yeasts as well as adults (Figure 9) [7].

3.2. Study 2

The objective of the present study was to analyze the type of substrate utilized by and the influence of altitude variation on synanthropic flies.

Between August 2003 and July 2004, a total of 2946 flies were collected, of which 1255 were from the altitude of 740 meters and 1691 from the altitude of 1000 meters. The flies did not present any preference between the traps placed at the altitudes of 740 meters and 1000 meters ($F=0.16$; $P=0.6949$) (Figure 10).



Figure 10 General appearance of the trap (improvised or homemade) for collecting flies

The altitude of 1000 meters presented greater richness of species (13 species collected) and abundance of flies (57.4% of the flies collected), in comparison with the altitude of 740 meters. At 740 meters the most frequently found species was *Oxysarcodexia thornax* (Walker, 1849) (Diptera: Sarcophagidae), accounting for 42.4% of the individuals collected. At 1000 meters, the most frequently found species was *Peckia chrysostoma* (Wiedemann, 1830) (Diptera: Sarcophagidae), accounting for 27.6% [8].

3.3. Study 3

The aim of this study was to quantify populations of *Haematobia irritans* (Linnaeus, 1758) (Diptera: Muscidae) and its parasitoids that develop in fecal masses of Nelore cattle.

Considering a total of 352 fecal masses of Nelore cattle collected, 281 (79.8%) presented dipteran pupae and 71 (20.2%) did not present pupae. In 145 (43.7%) of the fecal masses collected, pupae of *H. irritans* were obtained. Of the total of 4,193 collected pupae belonging to the Muscidae family, only 588 (14%) were *H. irritans*. Of the horn fly pupae obtained, 395 (67.2%) produced adults, 134 (22.8%) did not emerge as adults or parasitoids and 59 (10%) were parasitized (Figure 11).



Figure 11 *Haematobia irritans* (Linnaeus, 1758) (Diptera: Muscidae); (Source: <https://www.semanticscholar.org/paper/Molecular-Characterization-of-the-Horn-Fly-irritans>)

Other species of dipteran observed in the fecal masses were: 1,369 pupae of *Brontaea debilis* (Williston, 1896). (Muscidae), 516 pupae of *Brontaea quadristigma* (Thomson, 1869) (Diptera: Muscidae) 101 pupae of *Cyrtoneurina paraescita* Couri, 1995 (Muscidae), 963 pupae of *Sarcophagula* sp. (Sarcophagidae) and 656 pupae of *Palaeseopsis pusio* (Schiner) (Sepsidae) [9].

3.4. Study 4

The purpose of this work was to identify the species of Diptera present in bovine feces that had been exposed to different periods time in a pasture in Itumbiara, Southeastern Goiás.

Among the Diptera, *Palaeseopsis* spp. (Sepsidae) were the most abundant, comprising 50.3% of sampled insects, followed by *Sarcophagula occidua* (Fabricius, 1794) (Diptera: Sarcophagidae) (Figure 12) with 39.1%. The collected flies were more abundant in feces of 72h and 144h of exposure (16.6% and 13.6%, respectively). The results show that the flies were more abundant (52.4%) in fresh fecal pats with highest levels of humidity (24, 48, 72, 96 and 120 hours of exposure).



Figure 12 *Sarcophagula occidua* (Fabricius, 1794) (Diptera: Sarcophagidae); (Source: Cook Islands Biodiversity)

The collected flies showed the following preferences for fecal pats: *Brontaea quadristigma* (Thomson, 1869) (Diptera: Muscidae) preferred feces exposed 48, 168, 216 and 240 hours; *B. debilis* for 24 and 168 hours; *Cyrtoneurina paraescita* Couri, 1995 (Diptera: Muscidae) preferred 168, 192 and 240 hour-feces; *Ravinia belfort* (Prado & Fonseca, 1932) (Diptera: Sarcophagidae) preferred 120 and 168 hour-feces; *S. occidua* 48, 72, 120 and 216 hour-feces; *Archiseopsis scabra* (Loew, 1861) (Diptera; Sepsidae) preferred 192 and 216 hour-feces; *Palaeseopsis* spp. (Diptera; Sepsidae) showed its preference for 96, 144, 168, 216 and 240-hour-feces and Sphaeroceridae (Diptera: Sphaeroceridae) for 24 and 192 hours of exposure in the field ($X^2= 1085,8$; $GL=56$, $P<0,0001$) [10].

3.5. Study 5

This study had the objective of determining the species flies present in buffalo dung, collected in the municipality of Itumbiara, GO, from May 2003 to June 2004.

The fly pupae were obtained by the flotation method. They were individually placed in gelatin capsules until the emergence of the flies. The frequency, percentage and species of flies collected were: *Archiseopsis scabra* (Loew, 1861) (Diptera; Sepsidae) (Figure 13) with 310 specimens (9.0%), *Brontaea quadristigma* (Thomson, 1869) (Diptera: Muscidae) with 138 specimens (4.0%), of *Brontaea debilis* (Williston, 1896) (Diptera: Muscidae) with 127 specimens (3.7%), *Cyrtoneurina paraescita* Couri, 1995 (Diptera: Muscidae) with 19 specimens (0.5%), *Palaeosepsis* spp. (Diptera: Sepsidae) with 1948 specimens (56.0%) and *Sarcophagula occidua* (Fabricius, 1794) (Diptera: Sarcophagidae) with 931 specimens (26.8%).



Figure 13 *Archiseopsis* (Diptera: Sepsidae); (Source: <https://sepsidnet.biodiversity.online/species/Sepsidae>)

The frequency, percentage and species of flies collected were: 628 fly pupae were collected in bovine feces, belonging to 4 families and 10 species. The most frequent species were: *A. scabra* with 40 (6.5%), *B. debilis* with specimens 56 (8.9%), *B. quadristigma* with specimens 49 (7.8%), *C. paraescita* with specimens 151 (24.0%), *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) with specimens 51 (8.1%), *Musca domestica* L. 1758 (Diptera: Muscidae) with specimens 10 (1.6%), *Oxysarcodexy thornax* (Walker, 1849) (Diptera: Sarcophagidae) with specimen 70 (11.2%), *Palaeosepsis* sp. with specimens 107 (17.0%) and *Ravinia belfort* (Prado & Fonseca, 1932) (Diptera: Sarcophagidae) [11].

3.6. Study 6

The objective of this study was to determine the species of dipterous medical and veterinary importance in southern Goiás.

In the present study were obtained 4080 dipterous belonging to six families. The most frequent was the family Sarcophagidae with 41.6%, followed by Sepsidae family with 40.2%.

The species *Palaeosepsis* spp. (Diptera: Sepsidae) was the most abundant with 36.6% of the individuals collected, then the species *Sarcophagula occidua* (Fabricius, 1794) (Diptera: Sarcophagidae) with 22.8%. Both species were collected from cattle feces, probably due to the greater number of substrates listed for performing the work. Species *Chrysomya* were collected in bovine liver in Uberlândia, Minas Gerais, and Rio de Janeiro-RJ, respectively, represent 100% of Calliphoridae collected.

Despite the *Musca domestica* L. 1758 (Diptera: Muscidae) was not the most abundant Diptera but is the species of greatest health concern because of its synanthropic character, its abundance in the urban districts ability to develop into various types of substrates, their high reproductive power and be identified as veiculadora of pathogens to humans and animals. In this study *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae) was the species of greatest economic importance Figures (14 and 15) [12].



Figure 14 Adult: *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae)



Figure 15 Figure contaminated with eggs and larvae; (Source: Informativo da Sociedade Entomológica do Brasil 4)

3.7. Study 7

3.7.1. Fruit fly (*Anastrepha* spp.)

Crops Affected: Acerola, Plum, Guava, Mango, Peach and Grape

Group of flies that cause great damage in papaya, citrus, apple, passion fruit, nectarine, loquat, pear, acerola and plum.

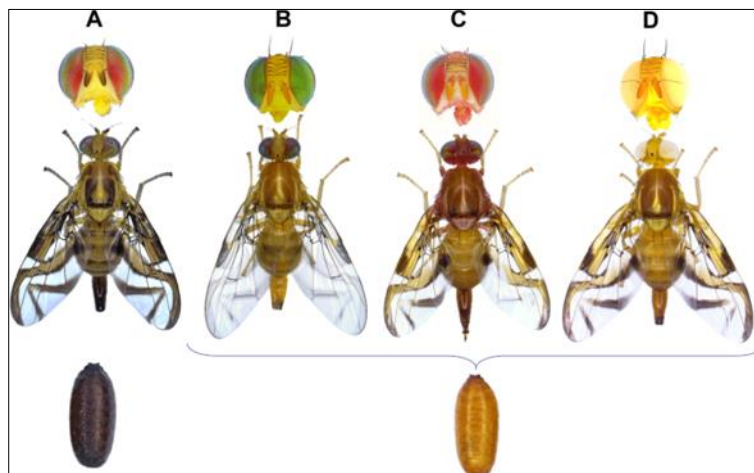


Figure 16 Phenotype of wild type and mutant individuals of *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera, Tephritidae); (<https://bmcbgenomdata.biomedcentral.com/articles/10.1186/s12863-020-00932-5>)

Damage - Fruits attacked by flies present very characteristic symptoms, with the appearance of a dark colored halo with approximately 2 cm in diameter around the place where the laying was made. When the larvae hatch, this halo turns brownish due to the rotting of the bark. It is exactly there, on these destroyed tissues that certain fungi develop. The

pest preferentially attacks fruits exposed to the sun. As they have a longer ovipositor, the species *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera, Tephritidae) and *Anastrepha obliqua* (Macquart, 1835) (Diptera, Tephritidae) attack green and ripe fruits indistinctly. Due to the “host succession”, flies of the *Anastrepha* genus will transfer from several fruit trees, which are harvested during the summer, to early varieties of other crops. The species of this genus occur in all Brazilian regions (Figure 16).

For monitoring species of this genus, McPhail traps or traps made of plastic packaging containing food attractants are used. This trap also catches flies of the species *Ceratitis capitata* Wiedemann 1824 (Diptera: Tephritidae). As food attractant, 5% hydrolyzed protein, 10% cane molasses, fruit juices, brown sugar, wine vinegar and torula can be used, with sugarcane molasses being considered more efficient. It is also possible to mix the protein with molasses, in the proportion of 2.5 and 5% respectively, to improve the attractive efficiency. The evaluation and change of attraction must be carried out every 10 or 15 days. To avoid rapid decomposition, the attractant can be stabilized with Borax (pH between 8.5 and 9.0) (Figures 17 and 18) [13].



Figure 17 McPhail trap; (Source: <https://www.indiamart.com/proddetail/mcphail-trap-22473045891.html>)



Figure 18 *Ceratitis capitata* Wiedemann, 1824 (Diptera: Tephritidae); (Source: https://twitter.com/andrea_acurio/status/1184700277502435328)

3.8. Study 8

The main objective of this work is to know the diversity of fruit flies associated with the guava crop, in an orchard located in a semiarid region of Brazil, and to evaluate the dominance, constancy and frequency of these tephritid species.

During the two years of collection, a total of 10,775 fruit flies were captured, being 8,875 *Ceratitis capitata* (Wiedemann, 1824) (2,639 males and 6,236 females) and 1,900 *Anastrepha* spp. (497 males and 1,403 females), represented by *Anastrepha zenildae* Zucchi, *Anastrepha sororcula* Zucchi, *Anastrepha obliqua* (Macquart) and *Anastrepha dissimilis* Stone. From the guava fruits randomly collected in the orchard, emerged *C. capitata* (44 specimens), *A. zenildae* (28 specimens) and *A. sororcula* (12 specimens).

There was a greater number of captures and frequency of *C. capitata*, *A. zenildae* and *A. sororcula*, with emphasis on the former, while *A. obliqua* and *A. dissimilis* were obtained in lower number and frequency. *Ceratitis capitata*, *A. zenildae* and *A. sororcula* were also obtained directly from fruits collected in the orchard, confirming that these species use guava as their host in this region.

In general, it was found that *C. capitata* was the only dominant species in the orchard and was considered constant, despite having been an accessory in 2009. *Anastrepha zenildae* and *A. sororcula* were considered constant, *A. obliqua* was an accessory and accidental *A. dissimilis*.

In this study, the Simpson index was considered high (0.69) and indicated that the probability of two randomly chosen and independent individuals belonging to the same species was 69%. In relation to the Shannon-Wiener index, the low value (0.59) evidenced the low diversity of the studied community, and as for the evenness index (modified Hill), the low value (0.56) indicated that the distribution the frequencies between the collected species was not uniform. obtained were similar due to the high frequency and dominance of *A. fraterculus*, a species that represented 77% of the collected specimens. The faunal indexes obtained in the present study were also like those of the studies mentioned above; however, *C. capitata* was frequent and dominant (Figure 19) [14].

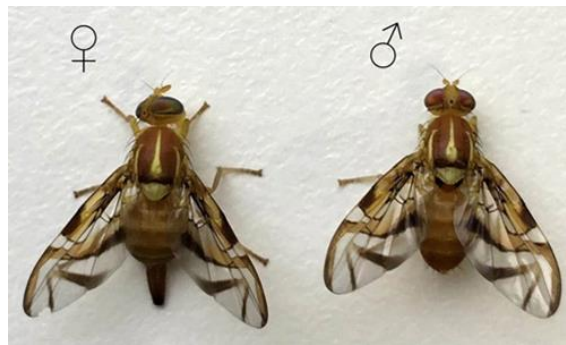


Figure 19 Female and male of *Anastrepha*; (Source: https://entnemdept.ufl.edu/creatures/fruit/tropical/south_american_fruit_fly.htm)

3.9. Study 9

Given the above this article aims to report the occurrence of *Stomoxys calcitrans* L. 1758 (Diptera: Muscidae) (Figures 20 and 21) in cattle dung in pastures.

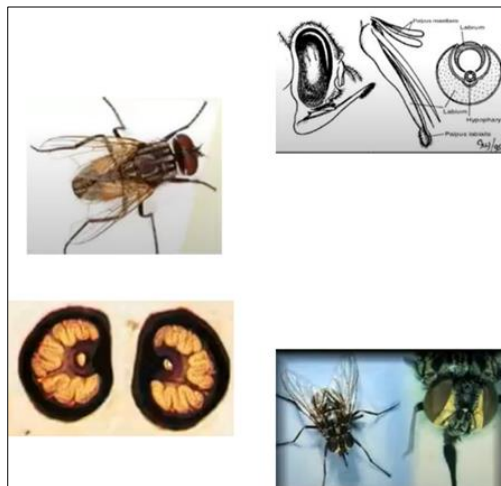


Figure 20 Gray chest with black stripes - short palps - Wing with slightly pronounced elbow - Arista pectinate - Preference for horses and dogs (non-specific) - Importance: pain and irritation from the bite. - Transmission of diseases such as *Trypanosoma*. - Intermediate host of Habronema and Raillietina- Anemia. Fly deposits digestive enzymes under food, eats and often regurgitates to eat again. - Importance: foretic transport of microorganisms (bacteria, viruses, protozoa and helminth eggs, carrier of Dermatobia); (Source: <https://www.passeidireto.com/arquivo/88159599/moscas-parasitologia-4>)

A total of 628 dipterans pupae were obtained from bovine feces, from which 8 specimens of *S. calcitrans* emerged from 8 pupae in bovine feces collected in pastures. This species is found preferentially in feces put in stables, corrals, and

other places. The pastures were approximately 500, 100 and 10 meters from the stables and corrals. The feces were in places that the animals did not have access to. The presence of ewes near the stables was noted only once during the study. The percentage of individuals collected was 1.3% (8/628) (Figure 20) [15].



Figure 21 Eggs of *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) glued to the abdomen of a carrier fly

When the *Dermatobia* female is ready to oviposit, she captures another insect - usually a fly - and glues her eggs to the captured insect's abdomen.

4. Conclusion

The flies included in the infra-order Muscomorpha have medical and veterinary importance, since they may produce myiasis and act in carrying pathogens to man and animals). They have been found to carry more than 100 species of disease-causing organisms such as bacteria, protozoa and helminths.

Compliance with ethical standards

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