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(REVIEW ARTICLE)

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Study of the biology and ecology of the Muscidae Family (Insecta: Diptera): Collections

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Abstract

Adults can be predators, hematophagous and detritivores or feed on numerous types of exudates from plants or animals. They can be attracted to various substances including sugars, sweets, tears, and blood. Larvae appear in a variety of habitats, including decaying vegetation or animals, dry or moist soil, insect, or bird nests, fresh or stagnant water, and droppings. The objective of the mini review consists of bibliographical research on the muscoid dipterans of the Family Muscidae. The research was carried out in studies related to quantitative aspects of the Family and Species (taxonomic groups) and in conceptual. A literature search was carried out containing articles published from 1971 to 2021. The mini review was prepared in Goiânia, Goiás, from August to September 2021, through the Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Publons, Qeios, Portal of Scientific Journals in Health Sciences, https://goo.gl/gLTTTs and https://www.growkudos.com/register. Although some species are very common worldwide, such as the housefly and the stablefly due to their synanthropy, most species do not have this behavior, so they are restricted to some territorial areas, sometimes-small dimension.

Keywords: Predators; Hematophages; Detritivores; Synanthropy; Vectors

1. Introduction

Muscidae is a family of flies composed of almost 4000 species described in more than 100 genera. The apical segment of its antennae is plumose, and its basal portion is smooth (Figure 1) [1].

Muscidae is a family of species that are very common in Brazil. They are small to medium sized flies, with body length ranging from 2 to 8 mm, usually dark in color, but with some yellow, blue, or metallic-green species. They are easily recognized by the full-grown caliptera and the absence of full-grown bristles on the grouper. The preapical dorsal bristle on the posterior tibia is absent and the A1+CuA2 vein is incomplete, extending halfway from the base to the edge of the wing (Figure 2) [2, 3, 4].

Adults can be predators, hematophagous and detritivores or feed on numerous types of exudates from plants or animals. They can be attracted to various substances including sugars, sweets, tears, and blood. Larvae appear in a variety of habitats, including decaying vegetation or animals, dry or moist soil, insect, or bird nests, fresh or stagnant water and droppings. The housefly *Musca domestica* L. 1758 (Diptera: Muscidae) is probably the most important and best-known species of the family [3, 4].

This family is subdivided into two subfamilies, according to the appearance of the oral appliance:

Muscinae: flies with licking mouthparts; presents numerous species such as *Muscina stabulans* (Fallén, 1817) and *M. domestica*.

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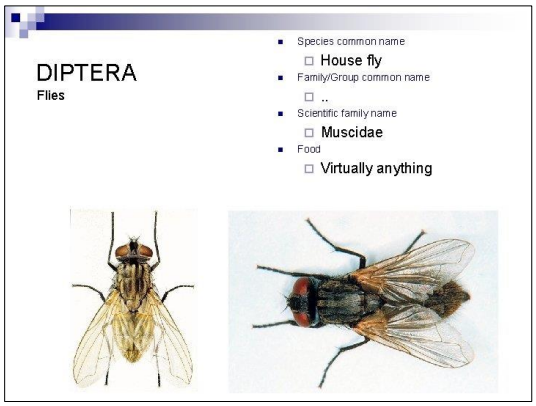

Figure 1 Specimen of Muscidae; (Source: https://slidetodoc.com/diptera-flies-ordinal-characteristics-1-mouthparts-often-piercingsucking/)

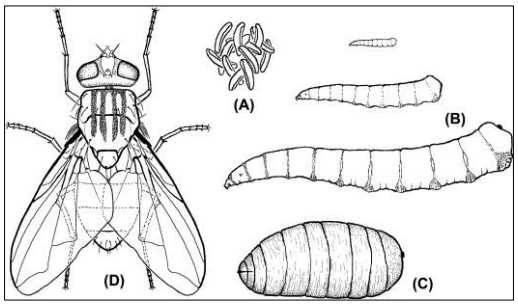

Figure 2 Characteristics of Muscidae A, B, C and D: eggs, larvae, pupae, and adult; (Source: https://www.sciencedirect.com/science/article/pii/B9780128140437000170)

Stomoxydinae: fly with biting-sucking mouthparts; in it we find the important species: *Stomoxys calcitrans* (Linnaeus, 1758) and *Haematobia irritans* (Linnaeus, 1758).

Some species of Diptera have great medical and veterinary importance, since can carry various pathogens that cause parasitic and infectious diseases to the man and domestic animals Among the anthropic activities that have caused harm to the environment and public health, by providing the conditions for the increase of the synanthropic fauna, are those related to basic sanitation, agriculture, and agribusiness [5, 6].

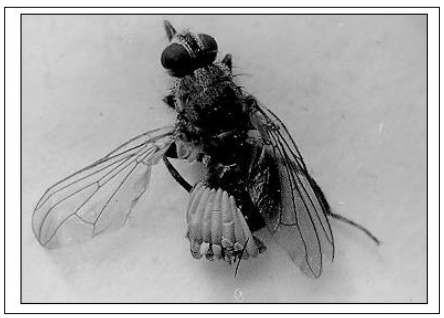

Figure 3 Muscidae as vectors; (Source: https://memorias.ioc.fiocruz.br/article)

Waste organics produced and/or accumulated in these activities (tons/month) when not properly treated, may contain a variety of pathogenic bioagents (viruses, bacteria, protozoa, fungi, and helminths) or their forms of transmission. As a result, the quality of organic waste management in human activities can act as a determinant of environmental health, contributing to the increased incidence of communicable diseases, both for contain the causal agents, as well as by providing the proliferation of numerous vectors (Figure 3) [5, 6].

1.1. Fly life cycle

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 4).

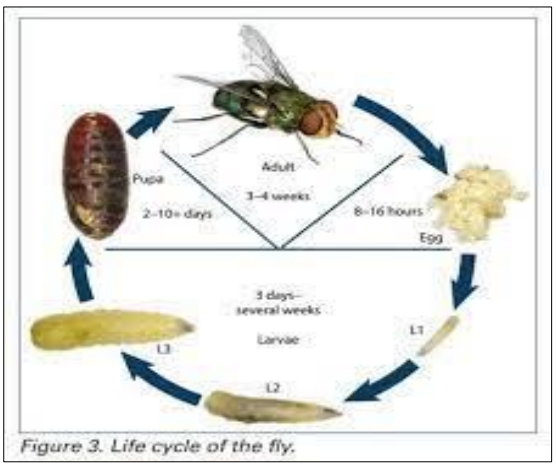

Figure 3. Life cycle of the fly.

Figure 4 Muscidae life cycle; (Source; chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl)

Objective

The objective of this bibliographical research was to report the studies related to the quantitative aspects and the conceptual aspects about the Family Muscidae.

2. Methods

The collection is about the muscoid dipteran of the Muscidae family (Diptera: Muscomorpha). The research was developed in studies related to the quantitative aspects of the Family and Species (taxonomic groups) and in conceptual aspects. Bibliographic research was carried out containing articles published from 1971 to 2021. The mini review was prepared in Goiânia, Goiás, from October to 2021, through the Online Scientific Library (Scielo), internet, ResearchGate, Academia.edu, Frontiers, Publons, Qeios, Portal of Scientific Journals in Health Sciences, https://goo.gl/gLTTTs and https://www.growkudos.com/register.

3. Searches carried out

3.1. Study 1

Biological transmission of eggs and larvae of the human bot fly *Dermatobia hominis* (Linnaeus Jr., 1781): by a female of the horn fly *Haematobia irritans* (Linnaeus, 1758) is reported for the first time in South America. Seventeen females of H. irritans were collected near the municipality of Morada Nova (19ºS, 45ºW) in the Três Marias, region of northwestern Minas Gerais.

The viability of recently eclosed larvae was demonstrated by host-seeking behavior consisting of vibratory movements and projection of the anterior part of the body in response to stimulation with heat and CO2. Four larvae were used for experimental inoculation of a rabbit *Oryctolagus cuniculus* (L., 1758*)* (Lagomorpha: Leporidae) where they completed their larval development. These observations of the emergence of *D. hominis* larvae transported by *H. irritans* suggest that the latter species could be an efficient biological vector of the human bot fly. The importance of this report lies in the fact that H. irritans had never been implicated in the transportation of eggs of *D. hominis* (Figure 5) [7].

Figure 5 *Haematobia irritans* (L.) (Diptera: Muscidae) as Vector of *Dermatobia hominis* (L. jr.) (Diptera: Cuterebridae) in Minas Gerais, Brazil; (Source: https://memorias.ioc.fiocruz.br/article)

3.2. Study 2

3.2.1. Housefly

The housefly is an insect that easily adapts to urban centers. It is a nuisance insect, which surrounds places with exposed food and debris to lay its eggs and nourish itself. Upon landing, it can leave various microorganisms on food surfaces such as parasites, bacteria and viruses, for example.

Flies are approximately 30 days old. They can fly up to 3000 meters in 24 hours. Insects must be controlled because they transmit diseases to humans. Microorganisms can be found in your body or saliva.

Size: From 5 to 8 mm in length Color: gray Kingdom: Animalia, Order: Diptera, Classe: Insect, Species: *Musca domestica,* Family: Muscidae, Phylum: Arthropod.

Diet: Excrement, waste and decaying organic matter.

Habitat: They are attracted to humid and warm environments.

Impact: Some diseases that flies transmit are dysentery, diarrhea, conjunctivitis, cholera and typhoid fever.

Prevention: Removal of food sources, standing water and soft fruits. If there is food exposed, place a fan, which prevents the fly from landing on the food. It is also important to pack and dispose of garbage daily (Figure 6) [8].

Figure 6 *Musca domestica; (*Source: https://www.freeimages.com/pt/premium/dirty-common-housefly-eating-musca-domestica-isolated-on-white-1405380)

3.3. Study 3

The objective of this work was to evaluate the behavior of *Musca domestica* L. 1758, in relation to the use of these transparent plastic bags with water associated with the effect of light.

A greater collection of houseflies was obtained with the BL lamps ((BL (ultraviolet black light and BLB ultraviolet blue-black light) differing statistically in the treatment with a plastic bag containing water. Regarding the transparent plastic

bag containing water placed in the mouth of the pipe before the light, it proved to be repellent, collecting an average of 31.9% of the total of released flies, differing significantly from the treatment without a plastic bag.

In the present experiment, it was observed that when two BL lamps were aligned in opposite directions in the light tester, the collection of flies was greater than when there were two BLB lamps in opposite directions or a BL lamp aligned with a BLB.

In the field experiment, it was observed that the control differed from all treatments, with the largest number of flies being collected (35.2%). Treatment with a transparent plastic bag containing only air presented an intermediate value (18.6%), also differing from the others. The plastic bags containing colored water did not differ from each other, but the yellow color differed from the other treatments. On the other hand, the transparent plastic bag containing water had the lowest collection values (5.9%), differing significantly from most treatments, except for the transparent plastic bags containing green and red water (Figure 7].

Figure 7 Houseflies often feed on rotting and decaying organic matter, including human and animal faces. When a housefly feasts on a food source infected with bacteria, viruses, or parasites they accumulate the pathogens within their esophagus or digestive system; (Source: https://www.rentokil.co.id/en/my-pest-control-quick-tips/how-does-housefly-spread-diseases/)

In experiments in a closed environment with boxes, containing Moscaffin inside, the transparent plastic bag with yellow water, after two hours of release, captured 10.2% of the flies and 35.7% after 24 h. The witness collected 23.8% and 43.5%, respectively. Of the colors, yellow was the most attractive color for flies. The fly repulsion efficiency was 18.1% in the yellow water treatment against 56.6% in the treatment with a transparent plastic bag with water. This demonstrates that the plastic bag containing yellow water was the most attractive color. Many dead flies were found, after 24 hours, inside the box where the plastic bag containing yellow water was placed, with values close to those of the control, due to the insecticide in Moscafim.

In the experiment-using mirror, it was observed that after 2 h the collection was 14.9% and after 24 h, 21.1% of the released flies. The repelling efficiency of insects was 68.9%, showing an intermediate efficiency between the yellow color and the red and green colors. In the witness it was observed 28.9 and 68%, respectively. The efficiency of the transparent plastic bag with water was 89%, constituting the greatest repulsion effect observed in the experiment [9].

3.4. Study 4

Given the above this article aims to report the occurrence of *Stomoxys calcitrans* L. 1758, in cattle dung in pastures.

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 (Figure 8).

Figure 8 Both male and female stable flies bite humans and animals and draw blood. The bite from the creatures, which are only active during the day, is extremely painful. In some instances, they torment pets so much that the animals' milk yield and fattening capacity can be significantly reduced. However, the stable fly is not just a nuisance – it can also cause problems in terms of health and hygiene as it can transmit pathogens, such as *Escherichia coli, Salmonella*, *Listeria* and *Borrelia* when it draws blood; (Source: https://detia-degesch.de/pest/stable-fly/?lang=en)

The percentage of individuals collected was 1.3% (8/628) low due to its high degree of synanthropy. *Stomoxys calcitrans* have most animals and humans as hosts, and their bite is painful. Food remains and vinasse, a byproduct of the sugarcane industry, attract and stimulate posture, as well as can be formed in straw and harvest residues, which remain for some time in the field, especially if these materials are fermented or moistened with urine and animal feces. *Stomoxys calcitrans* is a fly that belongs to the muscidae family, which is distributed worldwide. It is responsible for transmitting various diseases to domestic animals [10].

3.5. Study 5

It is necessary to study the epidemiology and damage that this fly (*Haematobia irritans* L. 1758) causes in different physiographic regions of Brazil.

It was observed that the use of insecticide in cows in the treated group kept the animals free from the horn fly during the entire experimental period. The infestation in the control group cows, without the use of insecticide, did not exceed the average of 80 flies/animal, in any of the counts made during the four experimental years. The annual means of infestation found were 44, 20, 31 and 24 flies/cow, respectively, for the first, second, third and fourth year.

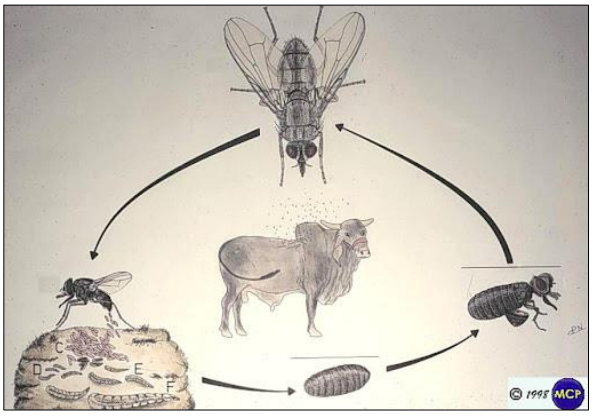

Figure 9 *Haematobia irritans L. 1758*. In ideal warm, humid weather, the entire cycle from egg to egg requires 2 weeks or less but may require a month or longer in dryer, cooler weather; (Source: http://www.icb.usp.br/~marcelcp/Haematobia.htm)

Although the experimental period corresponds to the rainy season, the horn fly counts were higher when the rainfall sum (14 days before counting) was lower. It was also found that about 83% of the cows in the control group had few flies, while 17% had more. At the April 1, 1992, count, for example, of 60 cows, 50 had up to 75 flies, six had between 100 and 150, and the remaining four cows had 225, 400, 475 and 675 flies, respectively.

It was also found that about 83% of the cows in the control group had few flies, while 17% had more. At the April 1, 1992, count (Fig. 2), for example, of 60 cows, 50 had up to 75 flies, six had between 100 and 150, and the remaining four cows had 225, 400, 475 and 675 flies, respectively.

The level of horn fly infestation is influenced by the breed and coat color and within the same breed each animal has different susceptibility to the fly. Thus, cows with a greater number of flies, at the beginning of the study, remained with greater infestation throughout the experimental period (Figure 9).

A tendency for cows treated with insecticides, as well as their offspring, to gain more weight than animals in the control group, although these differences were not statistically significant (P>0.05). The differences in average weight gain were 7, 1, 2 and 3 kg for cows and 3, 2, 1 and 2 kg for weaned calves, in the first, second, third and fourth year, respectively. The use of insecticide increased in relation to the untreated group 4.8%, 15.7%, 25.9% and 12% the percentage of pregnancy, respectively, for the first, second, third and fourth year [11].

3.6. Study 6

3.6.1. Horn flies

The horn fly is responsible for most of the economic loss caused to cattle. It feeds on blood and has a lancing and sucking mouth part that generates a very painful bite. It primarily lives on the cow's back and underbelly. Horn flies only leave the cow to lay eggs in freshly deposited manure. They are smaller than the other nuisance flies and unable to travel long distances.

3.6.2. Face flies

The face fly is a pasture fly those feeds on the mucus secretions around the eyes and nasal cavities. They have an abrasive sponging mouthpart that irritates the eye and surrounding skin, causing tearing. The face fly soaks in tears and other eye secretions and is a known transmitter of *Moraxella bovis* (Hauduroy et al., 1937) Murray, 1948 (Moraxellaceae), which is the causative agent for bovine pink eye. They are only on the animal to feed and will spend most of their time resting on vegetation, fencing and buildings, otherwise leaving to lay their eggs in fresh manure.

3.6.3. House flies

The house fly is very common and can be responsible for spreading disease and general animal discomfort and irritation. They have a sucking mouthpart that feeds on liquids or soft material, which they regurgitate their saliva onto to soften the material. They can live in vegetation, barns, and wooded areas, and lay their eggs in both manure and composted material.

3.6.4. Stable flies

The stable fly is a biting fly which is commonly found in barn lots or feedlot settings, however they can also be a nuisance to pasture cattle. They bite with a mouth part that has a piercing needle-like structure, which penetrates the hides of cattle and horses. They will lay their eggs in both manure and composted material (Figure 10) [12].

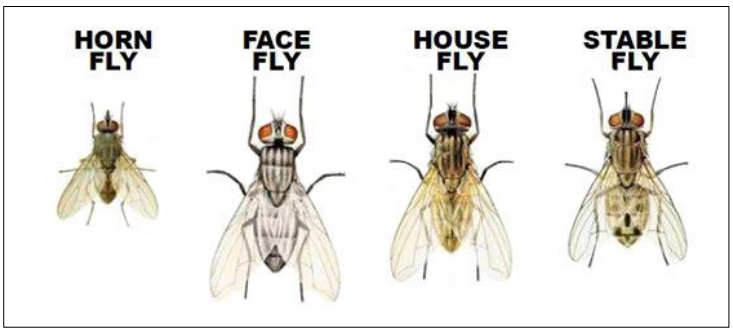

Figure 10 Fly characteristics and differences; (Source; https://www.crystalyx.com/blog/feed-through-fly-control-options-and-the-new-mineral-lyx-gfr/)

3.7. Study 7

Muscina stabulans (Fallén 1817) (Diptera: Muscidae) a common eusinanthropic fly in farms and orchards, may be associated with human dwellings. In addition, it can play a role in the control of some Diptera species because of its predatory habits on their larvae.

The objective of this study was to establish a thermal constant for a population of *M. stabulans*.

Thermal constant was obtained from the equation K = D (T-Tb), where K = constant thermal, D = development time (hours), T = temperature in which the insect grew and Tb = basic temperature of the insect.

Average larval development times decreased with increasing temperature. This was inversely proportional to increase in temperature, except at 31°C when development time was longer than at 26°C. The data obtained at 26ºC. When analyzed the thermal constant at 28ºC, obtaining an average of 12.9 to 14 days. The total development time, in our study (12.8 days). Thermal requirements were estimated by determining the thermal constant K and expressed in degree-days. The regression analysis, which showed Tb = 4.4°C and K = 35.3 GD.

The habits of the false stable fly are like those of the house fly, and immature and adult forms of these species frequently coexist. The fly sometimes is abundant in confined-animal housing, especially in poultry houses where it breeds in accumulate manure (Figure 11) [13].

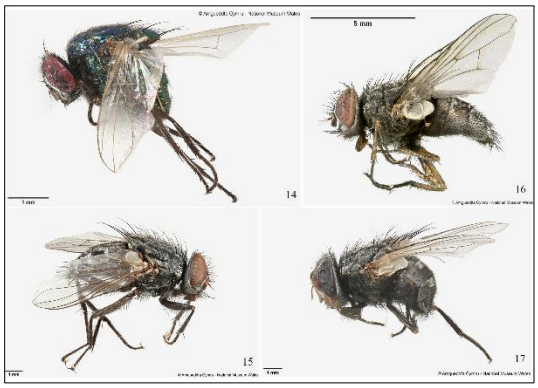

Figure 11 *Muscina stabulans* Fallén, 1817; (Source: http://treatment.plazi.org/id/)

4. Conclusion

The risk to public health, especially blocks containing day care centers, schools, hospitals, demarcating the blocks, streets, and squares with the greatest polluting activity by human and domestic animal excreta and secretions, sources of waste and organic effluents exposed to open air, aiming to the implementation of a continuous sanitation and sanitation system, integrating the action of the various sectors of society in these areas.

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