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(REVIEW ARTICLE)

Species of Diptera Muscomorpha of medical and veterinary importance in Brazil: Collections

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Abstract

The aim of this study is to describe the species of Diptera Muscomorpha of medical and veterinary importance in Brazil: Mini Review. The mini review consists of a bibliographic summary about the Diptera Muscomorpha. 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: Insecta; Miíases; Bibliographic Summary; Flies; Vectores

1. Introduction

It is estimated that 150,000 species of Diptera, classified in about 10,000 genera, from 188 families, have been escribed and that half of the species have larvae with aquatic habits. In fact, a small proportion of the families in the order are strictly aquatic (Culicidae, Chaoboridae, Blephariceridae, Dixidae, Canacidae, Simuliidae, among others), and about half of the other families have a variable representation of species occupying this environment. Chironomidae and Ceratopogonidae, for example, are mostly aquatic; Muscidae and Sarcophagidae, in turn, have a very low proportion of aquatic species [1].

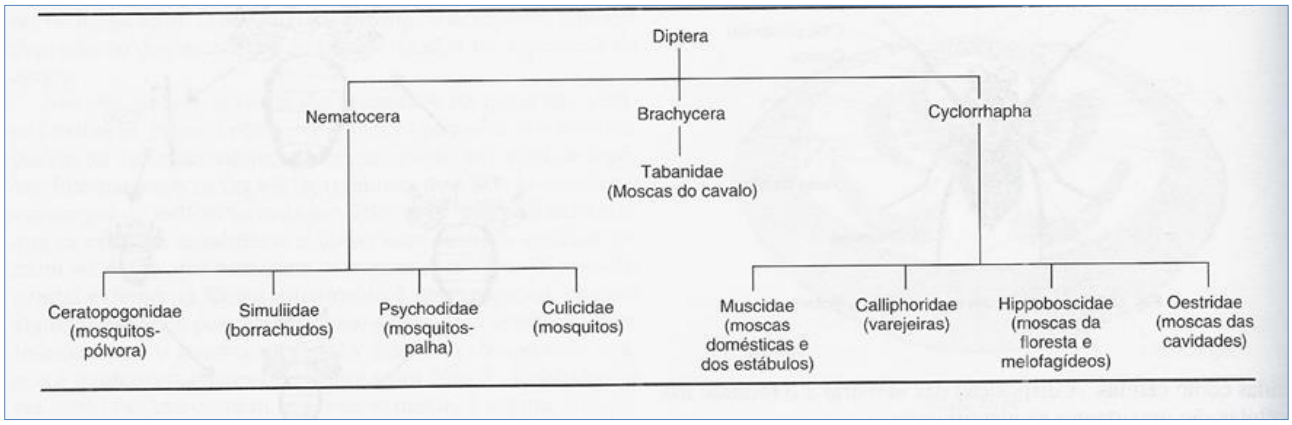

Figure 1 Classification of the Muscomorpha Suborder (Cyclorrhapha) citing only the Families of Medical-Veterinary interest; (Source: Neves DP. Parasitologia Humana. 10.ed. São Paulo: Atheneu, 2000)

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The Cyclorrhapha contains many adult flies that are free-living and many of the flies that are true parasites of vertebrates as larval stages. Within this group are the filth flies (Muscidae), the flesh flies (Sarcophagidae), the blow flies (Calliphoridae), and the tse-tse (Glossinidae). Some of these flies are parasitic as larvae causing myiasis that mybe obligatory or which can be facultative. One last group of these flies, the Cuteribridae, causes significant disease in cats through the migration of the large bot-like larval stage that is usually found in the rodents or lagomorphs (Figure 1) [2, 3, 4].

The Calliphoridae (Family) flies are of great importance in different areas. In the medical-veterinary area, some species are related to the occurrence of myiasis in humans and animals. These species, in the Neotropical region, belong to the genera *Cochliomyia* Towsend, *Compsomyiosps* Towsend, *Lucilia* Robineau Desvoidy (including *Phaenicia* Robineau-Desvoidy), *Calliphora* Robineau-Desvoidy and *Chrysomya* Robineau-Desvoidy [3, 4, 5, 6]. Among the species mentioned, *Cochliomyia hominivorax* (Coquerel, 1858)) causes primary myiasis, a larval infestation caused by Diptera species that have larvae that develop in the body of living vertebrates. The other species of the above genera are related to the occurrence of secondary myiasis, an infestation produced by species that have larvae that develop in decaying organic matter or in necrotic tissues of live animals (Figure 2) [3, 4, 5, 6].

In addition, calliphorids can act as passive vectors of pathogenic microorganisms to humans and between animals Larvae and adults meet these microorganisms, found in secretions, excretions and infected tissues of animals, and can become contaminated, transporting the microorganisms by a few days [3, 4, 5, 6].

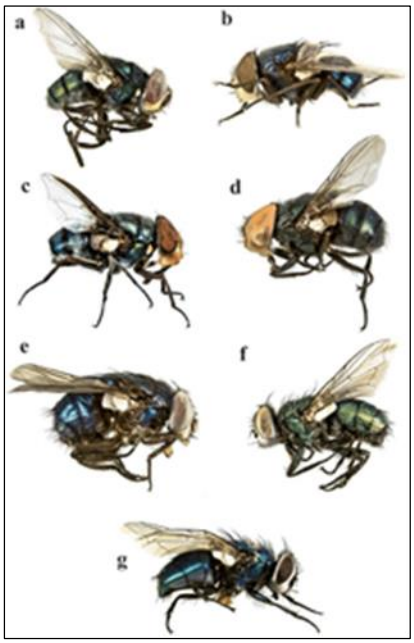


Figure 2 Flies of family Calliphoridae: a. *Chrysomya albiceps*; b. *Chrysomya bezziana*; c. *Chrysomya marginalis*; d. *Chrysomya megacephala*; e. *Hemipyrellia pulchra*; f. *Lucilia cuprina*; g. *Lucilia sericata*; (Source: https://www.researchgate.net/figure/Flies-of-family-Calliphoridae-a-Chrysomya-albiceps-b-Chrysomya-bezziana-c-Chrysomya_fig1_341997482)

Muscidae (Family) are a large family of Diptera, with about 4,500 described species and occurring in all biogeographic regions. Of these, 843 species are recognized in the Neotropical Region. Adults can be recognized by the absence of the vertical series of setae in the grouper, by the presence of calliptras, females with less than 7 pairs of spiracles (6 in most genders) in the abdomen and males without the pair of accessory glands of the reproductive system [7].

The eggs are elongated oval with two dorsal longitudinal folds, along which the chorion breaks when the larvae hatch. The larvae are sub-cylindrical or slightly flattened, tapering anteriorly, with cuticular thickening and spikes. Adults can be predators, hematophagous, saprophagous or scavengers. The larvae occupy extremely varied habitats, such as mammal dung and decaying meat, decaying plant and animal organic matter, wood, fungi, nests, and mammal burrows, among others. Species with saprophagous and coprophagous larvae can be beneficial, contributing to the recycling of organic waste, while carnivorous larvae can feed on synanthropic species larvae, playing the role of regulators of these populations [7].

Many species are associated with humans and domestic animals. They have great economic importance and considerable medical importance, mainly as mechanical vectors of causative agents of various diseases. Some species are also the cause of mandatory or facultative myiasis [7].

The Sarcophagidae (Family) have about 2,600 described species. Most species are ovoviviparous, eliminating first instar larvae, which immediately start feeding on the carcass (Figure 3).

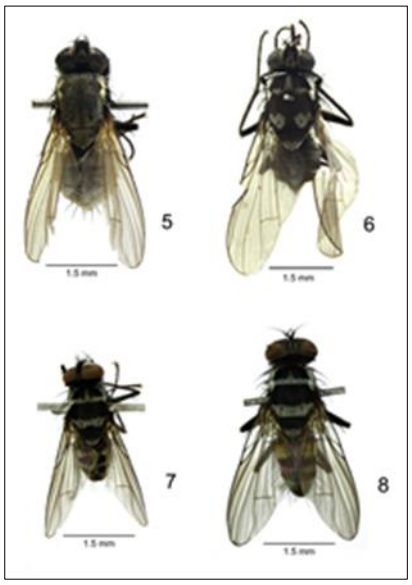


Figure 3 Dorsal habitus of *Limnophora* species: 5. *Limnophora parallelifrons* Emden. 6. *Limnophora perfidodes* Emden. 7. *Limnophora simulans* Stein. 8. *Limnophora translucida* Stein; (Source: https://zenodo.org/record/242397#.YSp9n45KjIU)

This development strategy differs from that of calliphorids, which are oviparous and require additional time for eggs to hatch, in addition to laying eggs in specific locations on the carcass. We believe that the difference in the strategies of the two families can give the Sarcophagidae a pioneering spirit in the colonization of corpses, which highlights its forensic importance (Figure 4) [8].

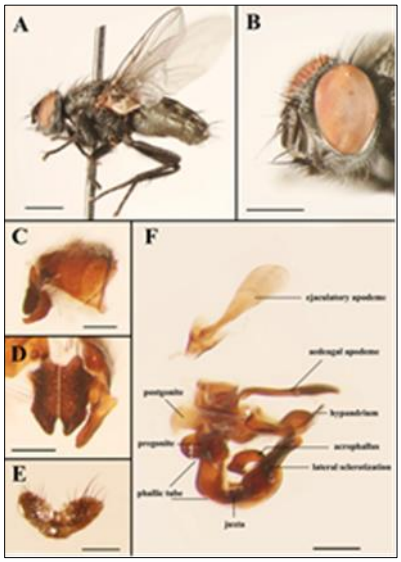


Figure 4 Light micrographs of the male *Agria affinis* (Fallén). A Habitus, lateral view B Head, anterolateral view C *Terminalia epandrium, Terminalia surstylus* and cercus, lateral view D Surstylus and cerci, dorsal view E Sternite 5, ventral view F Genitalia, lateral view. Scale bars: A= 2.00 mm, B= 1.00 mm, C–F= 0.25 mm; (Source: https://zookeys.pensoft.net/article/3263/)

2. Methods

The methodology used in this study was that of Marchiori (2021) [9]. The collection was built from articles from 2000 to 2021 with the themes: Classification, study of the main Genus and Species, Families and also the Myiasis.

3. Studies performed

3.1. Study 1

The aim of this study was to identify enterobacteria, associated with *Musca domestica* Linnaeus, 1758 (Diptera: Muscidae) and *Chrysomya megacephala* (Fabricius, 1754) (Diptera: Calliphoridae), captured at the Rio de Janeiro Zoo, RJ. The results show that *Proteus mirabilis* was the most frequent species in *C. megacephala* both in the body surface and in the intestinal contents. In *M. domestica* lots there was a high frequency of *Citrobacter* sp. on the surface of the body and of *P. mirabilis* on the intestinal contents. *Morganella* sp., *Klebesiella* sp., *Pseudomanas* sp. and *Enterobacter* sp. were also frequent on the body surface and in the gut contents of *C. megacephala* and *M. domestica.* Of the 25 batches of *C. megacephala* analyzed, the presence of *Salmonella agona* was observed in only two batches (8%) from body surface washing and one batch (4%) from the intestinal contents (Figures 5 and 6).

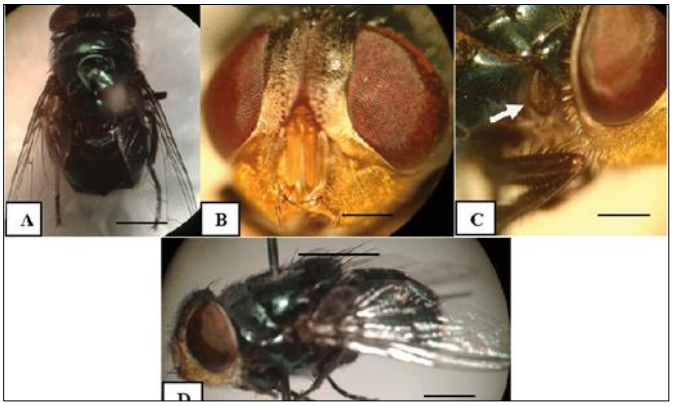


Figure 5 *Chrysomya megacephala* (Fabricius, 1754) (Diptera: Calliphoridae). In (A) dorsal view; (B) parafrontal and antenna; (C) anterior spiracle (arrow); (D) adult side view; (Source: https://www.researchgate.net/figure/Figura-4-Chrysomya-megacephala-Em-A-vista-dorsal-B-parafrontalia-e-antena-C_fig4_275657733)

Figure 6 *Musca domestica* Linnaeus, 1758 (Diptera: Muscidae); (Source: https://free3d.com/pt/3d-model/musca-domestica-black-house-fly-614.html)

In batches from the surface of the body and intestine of *M. domestica*, no strains of *Salmonella* were found. Several authors incriminate *M. domestica* as a transmitter of *Salmonella enteritidis* and *Typhimurium*, *Shigella* sp., *Vibrio* sp. and *Staphylococcus* sp. *P. mirabilis* was isolated in almost all the flocks studied, and this fact may explain the low frequency of *Salmonella.* The search for *Escherichia coli*, in intestine content, was positive for eight analyzed batches (32%) of *C. megacepala*, and in only two (10%) of *M. domestica*, but no enteropathogenic *E. coli* was found [10].

3.2. Study 2

The myiasis fly (whose scientific name is *Cochliomyia hominivorax* (Coquerel, 1858) (Diptera: Calliphoridae), in warm-blooded animals and even in man, presents a periodic obligatory parasitism, which is produced by its larvae, which are commonly known as bicheira. Extremely high or low temperatures, as well as prolonged rains or droughts act negatively on the development of myiasis in cattle. In the South Region, low winter temperatures are noted as one of the most important factors in reducing parasitism by *C. hominivorax* (Figure 7) [11].

Figure 7 *Cochliomyia hominivorax* (Coquerel, 1858) (Diptera: Calliphoridae)

3.3. Sudy 3

This work aimed to identify the species and factors involved in the occurrence of myiasis (Figure 8) in patients treated in public hospitals in the city of Recife, as part of the project to identify cyclorrhaph dipterans in the State of Pernambuco.

During 35 months of study, 24 myiasis diagnoses were made, of which 19 patients were treated at the HGV, 04 at the HCM, and 01 at the HR. Studies on the occurrence of human myiasis are scarce, with emphasis on the pioneer epidemiological study carried out in hospitals in Brisbane, where 14 cases were registered in 36 months of study. In all diagnosed cases, larvae and adults were identified as *Cochliomyia Hominivorax* (Coquerel, 1858) (Diptera, Calliphoridae). According to their biology, *C. hominivorax* larvae are classified as biontophagous or obligatory, as they are capable of invading and developing in recent wounds or in natural openings, causing rapid and intense tissue destruction (Figure 8).

Figure 8 Myiasis: maggot infestation: *Cochliomyia Hominivorax* (Coquerel, 1858) (Diptera, Calliphoridae); (Source: https://www.nursingtimes.net/clinical-archive/tissue-viability/myiasis-maggot-infestation-01-04-2003/)

Diagnosed myiasis were classified as cutaneous, oral, anal, auricular, and ocular. There are several factors that predispose the occurrence of human myiasis. In all cases analyzed in this study, myiasis settled in pre-existing wounds or in natural openings with exudation and/or foul odor, and the predisposing factors observed were: grazes of varied

nature (10/24) (41.7%); lesions of unidentified origin (05/24) (20.8%); diseases of the circulatory system (03/24) (12.5%); neoplasms (02/24) (8.3%); conjunctivitis, otitis, abscess, dermatitis and surgical wound (01/24) (4.2%). This is the first report of the occurrence of human myiasis in Pernambuco with the involvement of *C. hominivorax* [12].

3.4. Study 4

In order to contribute to the knowledge of the bioecology of *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) in the state of Paraná, an experiment was carried out with the following objectives: a) to evaluate the monthly frequency of *D. hominis* larvae in Holstein Black and White cattle and distribution of these ectoparasites on the body surface of animals throughout the year; and b) to estimate the seasonality of the main vector families of *D. hominis* in the city of Palotina, Paraná (Figures 9, 10 and 11).

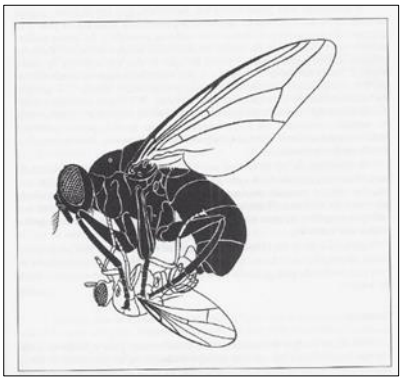


Figure 9 *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae). Performing fly posture; (Source: Guimarães et al. 2001)

The climatic fluctuations verified during the work are within the favorable limits for the development of the free life stages of *D. hominis.* As for the seasonality of *D. hominis* larvae in cattle, there were infestations throughout the experimental period, with 346 "berne" nodules being counted. The population peaks of *D. hominis* larvae in cattle occurred when the mean temperature, in ascent, reached 24°C, and the population decreased with a temperature below 18°C. The maximum peak of infestation by larvae was observed in December. Represents a relative frequency of 33.00% of the total of larvae collected in the analyzed period.

Figure 10 Lateral view of an adult human bot fly, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae). Photograph by Lyle J. Buss, University of Florida; (Source: https://entnemdept.ufl.edu/creatures/misc/flies/human_bot_fly.htm)

In addition to temperature, it is observed that precipitation also influenced the population of larvae in the host. As larvae (L3) that find moist soil are more likely to pup and hatch, and the pupal period varies from 33 to 49 days (Figure11).

Figure 11 Berne (Larvae) *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae); (Source: http://www.ufrgs.br/para-site/siteantigo/Imagensatlas/Athropoda/Dermatobia%20hominis.htm)

After analyzing the frequencies of berne nodules on each side (right/left) of the animal, it was demonstrated that there was a significant difference ($p>0.001$) in the parasitic infestation. The intensity was greater on the left side of the animal, in which a total of 240 nodules were found, which represents a relative frequency of 69.36%. This result can be explained by the fact that the cattle usually rest in the right side-sternal decubitus to facilitate rumination [13].

3.5. Study 5

Figure 12 Left to right 1st, 2nd, early 3rd, and late 3rd instar larva of the human bot fly, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae). Photograph by Francisco M. Marty, M.D. and Kristen R. Whiteside, B.S., Brigham and Women's Hospital, Boston, MA

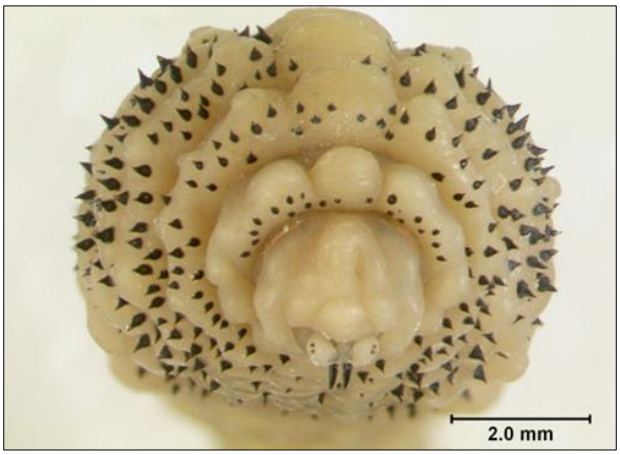


Figure 13 Third instar larva of the human bot fly, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae). frontal view. Photograph by Lyle J. Buss, University of Florida; (Source: https://entnemdept.ufl.edu/creatures/misc/flies/human_bot_fly.htm)

Synanthropic dipterans fly with a metallic abdomen (1) whose larval cycle develops in the skin of some animals, constituting an ectoparasitosis: the "berne". Berne is a myiasis, a parasitosis caused by dipteran larvae; secondary bacterial infections can occur. *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) oviposes in another insect (phoretic insect, preferably hematophagous), which transports the eggs, allowing the larvae to exit when they are on the skin of warm-blooded animals (mammals and birds), where, in the epidermis, develops a single larva (2) per lesion. The larval stage lasts from 35 to 45 days (may last 2 to 3 months) and causes inflammation and swelling in the host's skin - a lesion with a small hole similar to a boil (Figures 12, 13, 14 and 15).

Larva removal is based on preventing the larva from breathing and carrying out surgical removal; then, apply iodine-formed ether and cover the lesion. The use of tetanus vaccine is indicated [14].

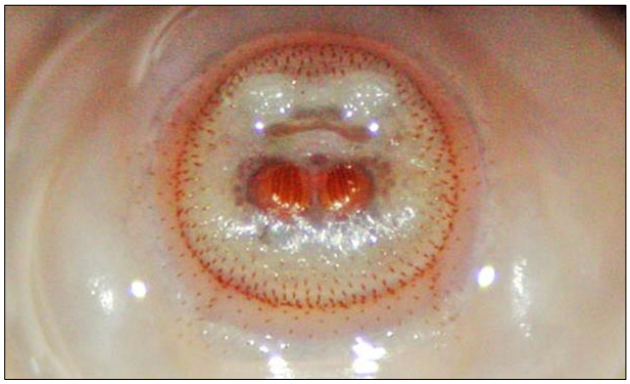


Figure 14 Posterior spiracles of the larva of the human bot fly, *Dermatobia hominis* (Linnaeus Jr.). Photograph by C. Roxanne Connelly, University of Florida; (Source: https://entnemdept.ufl.edu/creatures/misc/flies/human_bot_fly.htm)

Figure 15 Side view of posterior spiracles of the larva of the human bot fly, *Dermatobia hominis* (Linnaeus Jr. 1781) (Diptera: Cuterebridae**)**). Photograph by C. Roxanne Connelly, University of Florida; Source: https://entnemdept.ufl.edu/creatures/misc/flies/human_bot_fly.htm

3.6. Study 6

This study aimed to evaluate the frequency of parasitism of *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) larvae in cattle at slaughter age. Of the evaluated cattle, 37.63% of the animals had *Dermatobia* nodules (Figure 16 and 17) among which; 10.45% of the animals had more than five nodules of warble when presenting for slaughter, 27.17% had between one and five nodules and 62.37% had no nodules. During the evaluation, incidentally, it can be observed that, in most cases, the animals with the highest number of larvae were those with a low body score.

In this work, it was observed that animals coming from regions with lower monthly averages of temperature had smaller amounts of vermin nodules, namely, animals coming from Cipotânea (80.49%), Diogo de Vasconcelos (78.26%),

Mariana (77 0.36%), Lagoa Dourada (73.64%) and Ouro Preto (73.24%). In this work, the index was 37.63%, below that observed by other authors, which can be explained by the altitude and the milder temperature.

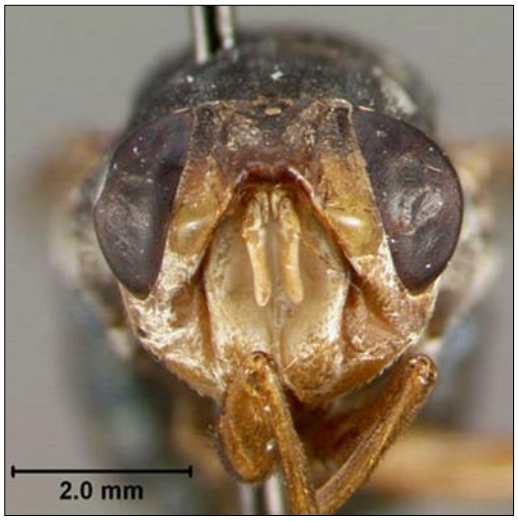


Figure 16 Frontal view of an adult human bot fly, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) Photograph by Lyle J. Buss, University of Florida; (Source: https://entnemdept.ufl.edu/creatures/misc/flies/human_bot_fly.htm)

Figura 17 Raised lesion on the skin caused by the presence of a larva of the human bot fly, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae); (Source: Photograph by Francisco M. Marty, M.D. and Kristen R. Whiteside, B.S., Brigham and Women's Hospital, Boston, MA)

The percentage of animals that had more than five nodules represented only 10.45% of the animals, while animals with one to five nodules checked before slaughter represented 21.17% of the animals. It was observed that the animals raised for fattening were among those in which the presence of *D. hominis* larvae was not observed, whereas those animals from dairy production are those with the highest number of larvae [15].

3.7. Study 7

Myiasis occurs more often in domesticated animals than in humans. However, when it occurs, it generates a lot of anxiety and discomfort. The deposition of fly eggs in wounds or holes in the body with subsequent hatching, originating larvae that feed on human tissue, is the basis of this disease. Read our review and update yourself on the topic. Among the flies most identified as related to myiasis, *Dermatobia hominis* (Linnaeus Jr., 1781) (Diptera: Cuterebridae) is endemic to tropical Mexico, South America and Central America, while *Cordylobia anthropophaga* (Blanchard, 1872) (Diptera: Calliphoridae) is endemic to sub-Saharan Africa.

3.7.1. Other species also described as responsible for myiasis in humans are:

Cochliomyia hominivorax (Coquerel, 1858) (Diptera, Calliphoridae) (America)
Chrysomyia bezziana (Villeneuve, 1914) (Diptera, Calliphoridae) (Africa, Australia, Asia)

Hipoderma bovis (De Geer, 1776) (Diptera: Hypodermatidae) (infested cattle)
Gasterophilus intestinalis (De Geer, 1776) (*Diptera*: Gasterophilidae) (infested horses)
Oestrus ovis L. 1761 (Diptera: Oestridae) (sheep fly)
Myiasis occurs more often in domesticated animals than in humans. However, when it occurs, it generates a lot of anxiety and discomfort. The deposition of fly eggs in wounds or holes in the body with subsequent hatching, originating larvae that feed on human tissue, is the basis of this disease. Read our review and update yourself on the topic. Infestation can occur due to the deposit of flies' eggs in the body of hematophagous insects, which start to serve as vectors to spread the infestation; deposit of eggs directly on the intact skin, in holes in the hair follicles or in a preexisting skin lesion; or, still, females can lay their eggs on the ground or in damp clothes hanging to dry, later infecting humans.

Myiasis can be classified as primary or secondary

3.7.2. Primary or furunculoid (berne)

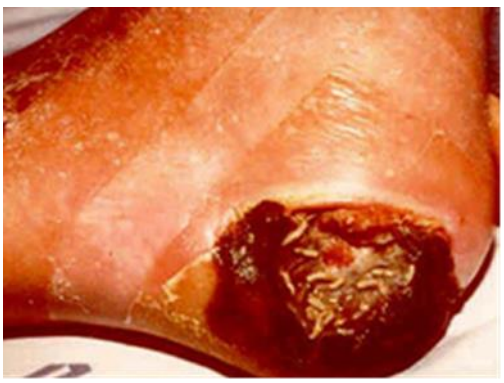
In which the larvae of the *D. hominis* fly (berneira fly) feed on living tissue. There are usually one or more nodular lesions measuring 1 to 3 cm, which have a central hole through which the larvae come out to breathe. Serous secretion can come out of it. The orifice is often painful and may resemble a boil. Direct Health Protocol].

3.7.3. Secondary (crown)

These cases are related to *C. hominivorax* larvae (bottle fly), *Callitroga macellaria* (Fabricius, 1775) (Diptera: Calliphoridae) or species of the genus *Lucilia*, which feed on healthy tissue, or more rarely on necrotic tissue of the skin or mucous membranes. Secondary myiasis can be cutaneous or cavitary. In the cutaneous form, the larvae are seen moving on the surface of the ulceration in the skin, amid the purulent secretion. In the cavity form, the larvae are found in infected natural cavities and holes (16 A, B and C) It can affect the eyes, nose, intestine, mouth, ear, among other places. Some species of fly have a greater predilection for specific locations, such as Oestrus ovis, which causes ophthalmomyiasis [16].

16 Figure A The ulceration in the skin, amid the purulent secretion

Source: http://proencaderma.com.br/arquivos-tipo-atlas/miIase_furunculoide_-_berne.html



16 Figure B The surface of the ulceration in the skin, amid the purulent secretion

Source: http://stanford.edu/group/parasites/ParaSites2001/myiasis

Figure 1C In the cutaneous form, the larvae are seen moving on the surface

Source: https://www.slideshare.net/zumaamza/myiasis-a-parasitic-disease

4. Conclusion

Dipterans are of great medical and health interest and their occurrence, distribution and predominance in metropolitan areas are factors of great importance in Public Health. The main species, in terms of pathogen transmission, are synanthropic flies that have adapted to environmental conditions modified by man.

Compliance with ethical standards

Acknowledgments

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