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(REVIEW ARTICLE)

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Study of the bioecology of *Chrysomya* (Robineau-Desvoidy, 1830) (Diptera: Calliphoridae): Collections

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Abstract

The *Chrysomya* primary importance to the field of medico legal Forensic Entomology is due to the genus' predictable life cycle length, allowing researchers to accurately estimate a postmortem interval. The aim of this study was to carry out a bibliographical summary on the blowflies of the genus *Chrysomya* (Insecta: Calliphoridae) with emphasis on the species: *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae), *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae) and *Chrysomya putoria* (Wiedemann, 1830). The mini review consists of bibliographical research on the muscoid dipterans (Muscomorpha) (Order: Diptera). The research was carried out in studies related to quantitative aspects of the Family and Species (taxonomic groups) and in conceptual aspects such as origin, geographic distribution, biology, life cycle, as a secondary vector of enterobacteria, for causing secondary myiasis and importance in Forensic Emtomology. 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) and internet. This is a family of blowflies of great ecological and medical-sanitary importance, as they are decomposers of organic matter, with their larvae usually developing in decayed material of animal origin, decomposing it and quickly consuming the carcasses, thus removing possible sources of diseases and recycling nutrients.

Keywords: Flies; Diptera; Muscomorpha; Calliphoridae; Vectors

1. Introduction

Among the dipterans, there are several relevant groups for carrying out research that have an impact on today's society, with a family of very important dipterans, the Calliphoridae. This is a family of blowflies of great ecological and medical-sanitary importance, as they are decomposers of organic matter, with their larvae usually developing in decayed material of animal origin, decomposing it and quickly consuming the carcasses, thus removing possible sources of diseases and recycling nutrients, being also common in pits containing human feces, being this contact with putrefying organic matter that makes them mechanical vectors of pathogens (Figure 1) [1, 2, 3, 4].

Chrysomya is a genus of Old-World blowflies belonging to the family Calliphoridae. The genus *Chrysomya* contains several species, including *Chrysomya rufifacies* (Macquart, 1843) and *Chrysomya megacephala* (Fabricius 1794). The *Chrysomya* primary importance to the field of medico legal forensic entomology is due to the genus' predictable life cycle length, allowing researchers to accurately estimate a postmortem interval. Adult *Chrysomya* are typically metallic colored with thick bristles on the meron and feathery edge [3, 4].

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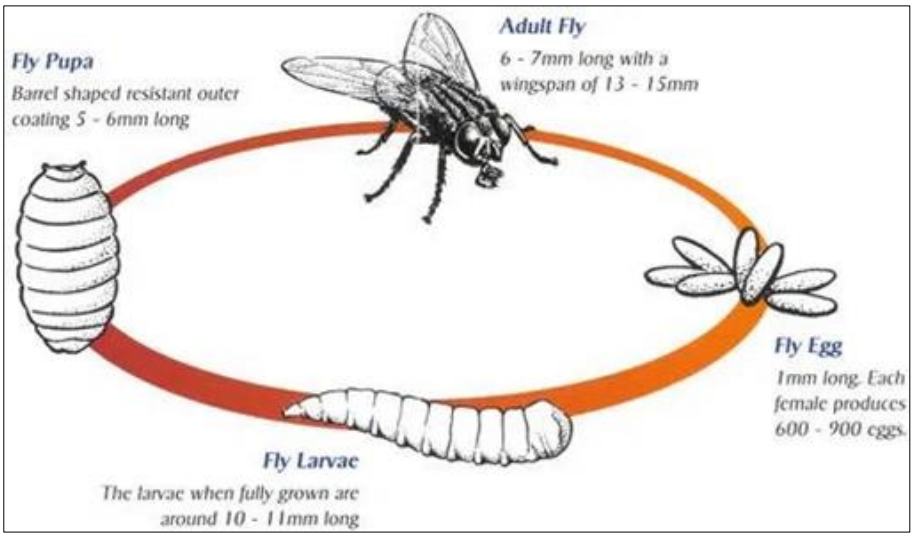

Figure 1 Calliphoridae life cycle; (Source: https://www.fliesonly.com/how-long-do-flies-live/)

They are seen in large numbers, in the urban centers of several cities in southeastern Brazil, in products exhibited at open markets. They are raised in large numbers in dumps around cities, pigsties, slaughterhouses, septic tanks. They can be of great epidemiological importance in the transmission of enteric diseases, poliomyelitis, and intestinal parasites (Figure 2) [1, 2, 3, 4].

Figure 2 *Chrysomya putoria* (Wiedemann, 1830) (Diptera: Calliphoridae) (A) dominating the surface of a human feces and (B) uncooked market stall meat. The rings demonstrate vomit drops and fly feces; (Source: https://www.researchgate.net/figure/Chrysomya-putoria-dominating-the-surface-of-A-human-feces-and-B-uncooked-market-stall_fig10_232976049)

The genus *Chrysomya* (Robineau-Desvoidy 1830) (Diptera: Calliphoridae) characterized by metallic-looking adults, is of forensic interest because of the abundance with which it is found, both in adult and immature forms, feeding on cadavers. *Chrysomya megacephala* and *Chrysomya putoria* (Wiedemann 1830) (Diptera: Calliphoridae) are two species accidentally introduced into Brazil and found breeding in bodies in Paraíba, Pernambuco, Rio de Janeiro, and São Paulo (Figure 3) [5, 6, 7, 8].

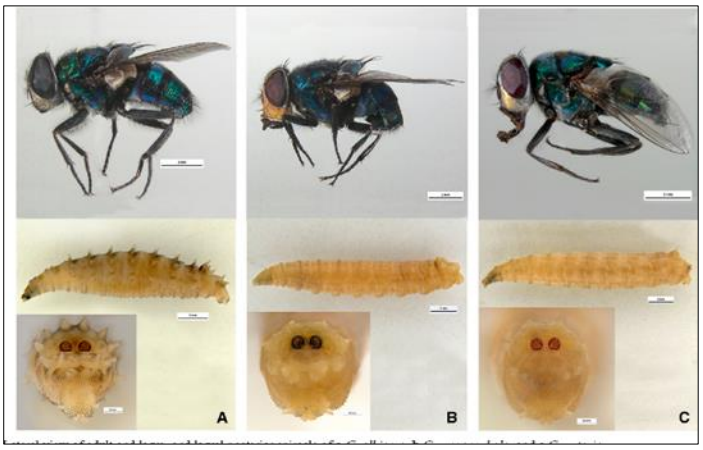

Figure 3 Lateral view of adult and larva, and larval posterior spiracle of (a) *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae), (b) *Chrysomya megacephala* (Fabricius 1794), and (c) *Chrysomya putoria* (Wiedemann, 1830) (Diptera: Calliphoridae)); (Source: emanticscholar.org/paper/Developmental-rates-of-immatures-of-three-Chrysomya-Rezende-Alonso/)

Forensic Entomology consists of the study of insects and other arthropods associated with forensic procedures with the main purpose of gathering information and traces that can help an investigative process (Figure 4) [7, 8].

Figure 4 Insects and other arthropods found at a forensic scene are considered to represent relevant evidence regarding the time and place of death, a possible antemortem or postmortem treatment of the victim, the geographical origin of narcotic substances and drugs. However, to derive firm conclusions from entomological evidence, it is critical to understand the different aspects of the insect biology of the whole area under consideration. Moreover, most forensic investigators are not specially trained in basic Entomology procedures, which can result in limitations when trying to achieve an accurate expert report. The present work illustrates the utility and necessity of such entomological studies and the expert training that is required using actual forensic cases; (Source: https://www.mdpi.com/2075-4450/12/5/429/htm)

Objective

The aim of this study was to carry out a bibliographical summary on the blowflies of the genus *Chrysomya* (Insecta: Calliphoridae) with emphasis on the species: *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae), *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae) and *Chrysomya putoria* (Wiedemann, 1830). This is a family of blowflies of great ecological and medical-sanitary importance, as they are decomposers of organic matter, with their larvae usually developing in decayed material of animal origin, decomposing it, and quickly consuming the carcasses, thus removing possible sources of diseases and recycling nutrients.

2. Methods

The mini review consists of bibliographical research on the muscoid dipterans (Muscomorpha) (Order: Diptera). The research was carried out in studies related to quantitative aspects of the Family and Species (taxonomic groups) and in conceptual aspects such as: origin, geographic distribution, biology, life cycle, as a secondary vector of enterobacteria, for causing secondary myiasis and importance in Forensic Entomology. 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) and internet.

3. Studies performed

3.1. Study 1

The objective of the present communication was to determine the species of parasitoids associated with specimens of *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae) collected on bovine kidney baits, in Itumbiara, State of Goiás (Figure 5).

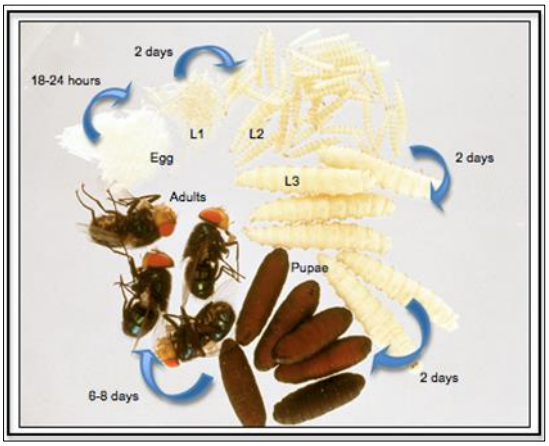

Figure 5 *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae); (Source: http://click-wardhana.blogspot.com/)

From March to October 2002, 122 specimens of parasites were collected from 70 *C. megacephala* pupae. The total percentage of parasitism was 18.6%. The parasitoids collected belong to three species: *Brachymeria podagrica* (Fabricius, 1789) (Hymenoptera: Chalcididae) with 8.6%, *Nasonia vitripennis* (Walker, 1775) (Hymenoptera: Pteromalidae) with 8.6% and *Pachycrepoideus vindemmiae* (Rondani, 1885) (Hymenoptera: Pteromalidae) with 1.4% of the individuals collected [9].

3.2. Study 2

The present study aimed to know the relative abundance and seasonality of species of the genus *Chrysomya* in the sub-region of Nhecolândia, Pantanal Sul-Mato-Grossense.

During the three years of study, 159,086 specimens of Calliphoridae were captured, 31.87% belonging to the genus *Chrysomya* and 68.11% to other species, including: *Chloroprocta idioidea* Robineau - Desvoidy, 1830, *Cochliomyia hominivorax* (Coquerel, 1858), *Cochliomyia macellaria* (Fabricius, 1775), *Lucilia cuprina* (Wiedmann, 1830) and *Lucilia eximia* (Wiedmann, 1819). Other families were also sampled during this period, such as Fanniidae, Muscidae, Sarcophagidae, Syrphidae and Ropalomeridae.

Chrysomya albiceps (30.86%) was the most abundant species of the genus, followed by *C. megacephala* and *C. putoria*, with respective abundances of 0.67 and 0.34%. Considering only *Chrysomya* specimens, *C. albiceps* represented 96.80% of the individuals captured (Figure 6).

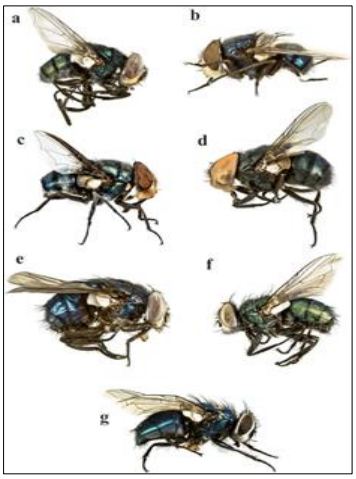

Figure 6 Flies of family Calliphoridae: a. *Chrysomya albiceps* (Wiedemann, 1819); b. *Chrysomya bezziana* (Villeneuve, 1914); c. *Chrysomya marginalis* (Wiedemann, 1830); d. *Chrysomya megacephala*, (Fabricius, 1794); e. *Hemipyrellia pulchra* (Wiedemann 1830); f. *Lucilia cuprina* (Wiedemann 1830); g. *Lucilia sericata* (Meigen, 1826); (Source: https://www.researchgate.net/figure/Flies-of-family-Calliphoridae-a-Chrysomya-albiceps-b-Chrysomya-bezziana-c-Chrysomya)

The three species observed in the region were more abundant at average temperatures above 20 °C and relative humidity between 70% and 80%. *Chrysomya* species present well-defined seasonality, with population peaks, in Brazil, occurring in months with an average temperature above 18 °C. Low correlations ($r<0.25$) were observed between population data and climatic parameters, indicating that the seasonality of *Chrysomya* species is not determined by a single climatic variable, but probably by associations between such variables. It is noteworthy that other factors can influence captures and their results in terms of species abundance. Thus, captures are influenced not only by the total monthly rainfall, but also by the distribution of rainfall in the period [10].

3.3. Study 3

Therefore, the present study aimed to evaluate the post-embryonic development rate of *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae) in artificial diets, prepared with different animal tissues (liver, rumen and bovine muscle or chicken heart).

When developing artificial diets in the laboratory, one must always consider, in addition to the nutritional aspects important for the development of the insect, the characteristics that govern the physical, chemical, and biological requirements during feeding.

The consistency of the diets was established with a balance between the percentages of water present and the characteristics of each tissue. Diets D1 and D2 showed pasty characteristics, although D2 was more consistent, probably because the liver does not have the same amount of muscle fibers as the bovine muscle. D3 and D4 had a mousse texture and, thus, the less rigid consistency did not make feeding difficult for the larvae.

The diets from D1 to D4 did not restrict the larval development of *C. albiceps* until the transformation into pupae, with most specimens. The diets from D1 to D4 did not restrict the larval development of *C. albiceps* until the transformation into pupae.

The high weight gain of specimens fed D1 and D2 diets in relation to the others may have resulted from the addition of bovine liver and muscle, respectively, which contain animal protein of high nutritional value, supplementing the proteins already present in powdered milk. However, the high amount of carbohydrates, proteins, vitamins, and hormones in the liver, in addition to its action as a filter of impurities and various toxins transported through the blood or transformed into by-products, may have accelerated the rate of development and affected the assimilation of more nutrients. Important for the development of the insect, reducing pupal survival (50%).

Bovine muscle, added to the D2 diet, does not have the same disadvantages mentioned above. However, the high amount of fatty tissue that permeates the meat made it difficult to obtain a good degree of homogenization of the diet, hindering

its use in bioassays, especially in entomotoxicology, which requires a standard and uniform substrate for the addition of drugs or other substances to be tested.

D4 diet showed adequate pupal survival (close to 70%) and a good degree of homogenization. However, it is important to consider that chicken hearts from non-hormone fed birds are not easily available on the market, in addition to having a higher cost (Figure 7).

Figure 7 The egg masses were sterilized with 2% glutaraldehyde, a sterilizing liquid, used for hospital material. This agent acts quickly and effectively on Gram-positive and -negative bacteria, mycobacteria, fungi, and virus; (Source: https://bioone.org/journals/journal-of-insect-science/volume-14/issue-160/ieu022/Sterilization-of-Chrysomya-putoria-Insecta--Diptera--Calliphoridae-Eggs)

In diet D5 without addition of animal tissue, 100% mortality of immatures was recorded after 144h of development, when they were in the beginning of the third larval instar, although a portion of the specimens died in the first and second larval instars. Diet D3 was more efficient and very similar to the control group in two important parameters, pupal survival and emergence interval, the latter being one of the most efficient in the evaluation of artificial diets.

However, about other factors, an increase of 36h was observed in the time it took the larvae to reach the end of the third stage between the diet (156h) and the control (120h), in addition to a reduction in weight, on average 19 mg in the first group [11].

3.4. Study 4

Understanding the routes of diarrhea-pathogen transmission is critically important since it may suggest new opportunities for the control of these life-threatening diseases.

A total of 4,572 flies were collected from 62 pit latrines during July and November (median=7.00 flies/latrine/day, interquartile range, IQR=0.0–25.25). We found 13% (n=8) of latrines sampled produced 85% of the total flies (n=3689). 60% (n=37) produced less than 10 flies. Of the 4,034 flies collected from 31 latrines in July, 94.72% were *Chrysomya putoria* (Wiedemann, 1818), 5.21% *Musca* spp., 0.05%; and 0.02% *Sacrophaga* spp. Of the two morphologically similar species of adult *Chrysomya*, *C. putoria* (Figure 8) was the dominant species in both the wet season (99.2%, 891/898) and dry season (99.1%, 1173/1183). Since nearly all flies collected were *C. putoria* we refer, for simplicity, only to this species hereafter. Overall, 80.9% of the *C. putoria* were females, with a greater proportion of females emerging from latrines in the dry season (91.5%) than wet season (74.5%, χ^2=6.017, p=0.0142) and captured in fish-baited traps in the wet season (91.7%) compared with the dry season (77.1%, χ^2=12.44, p<0.001).

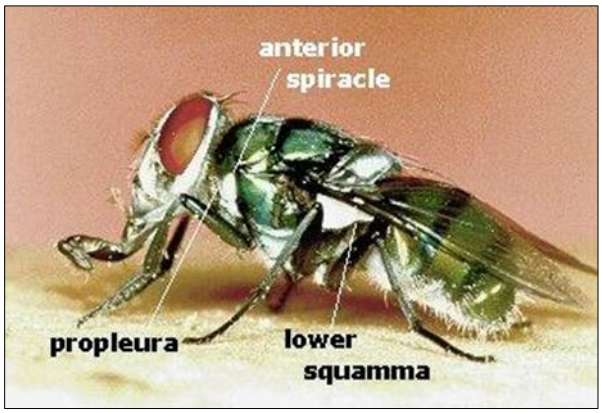

Figure 8 *Chrysomya putoria* (Wiedemann, 1830) (Diptera: Calliphoridae); (Source: http://docplayer.com.br/179354725-Bmp-introducao-a-parasitologia-veterinaria-dipteros-brachycera-alda-maria)

The larvae of *Chrysomya* spp collected in pit latrines were all *C. putoria*. None of the samples included larvae of *Chrysomya albiceps* (Wiedemann, 1819), which are highly distinctive due to their fleshy processes. The percentage of Psychodidae compared to *C. putoria* was 7.75% (30/387) in the wet season and 61.47% (461/750) in the dry season. These flies were found mainly in different latrines from *C. putoria*, preferring latrines with relatively clear water compared to the more solid contents [12].

3.5. Study 5

Therefore, this study aimed to know the abundance and population fluctuation of the genus *Chrysomya* during the stages of decomposition of the *Sus scrofa* (Linnaeus, 1758) carcass in a fragment of Atlantic Forest in the Northeast region of Brazil.

A total of 1299 flies belonging to four species of the Calliphoridae family were identified: 689 *Chrysomya albiceps* (Wiedemann, 1819), eight *Chrysomya putoria* (Wiedemann, 1830), 101 *Chrysomya megacephala* (Fabricius, 1794) and 501 of *Cochliomyia macellaria* (Fabricius, 1775).

Studies on the calliphorid fauna in various ecosystems have shown the predominance of the *Chrysomya* genus, including in this study. This genus includes species introduced in Brazil accidentally in the 70s, from the rubbish of African ships and which quickly dispersed across the continent from southeastern Brazil, reaching the anthropized areas, settling and settling becoming abundant in or near urban centers.

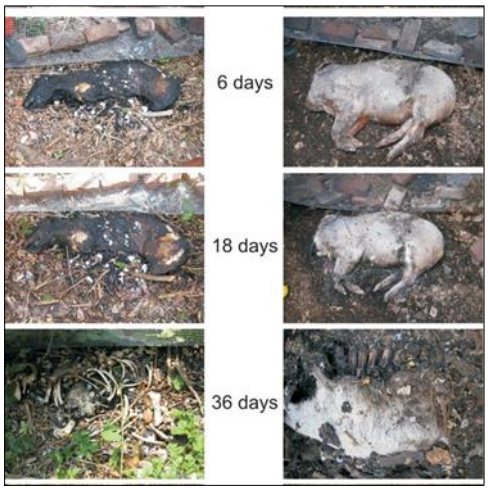

Figure 9 *Chrysomya* during the stages of decomposition of the Sus scrofa carcass in a fragment of Atlantic Forest; (Source: https://www.researchgate.net/figure/Experiment-performed-during-the-summer-stages-of-decomposition-of-the-burnt-left-and_)

C. megacephala had a low relative frequency (12.65%) and was considered not to dominant and with a constancy of 55.55%. The species *C. putoria* had a low relative frequency (1%) and constancy (33.33%) (Figure 9).

The dominance for this study was calculated to be 25%. This parameter classified the species into dominant, when the frequency values were above 25% and non-dominant, when the values found were less than 25%. Thus, *C. albiceps* presents values of relative frequency 86.34% and constancy 77.7%, being the species with the highest dominance.

The decaying carcass of this study represented a micro-habitat with food resource temporary, exploited by a wide variety of organisms, from bacteria to large predators, making it interesting for the study of calliphorids, especially the genus *Chrysomya* [13, 14, 15, 16].

3.6. Study 6

The present study aimed to determine the main species of *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae) parasitoids in the city of Rio de Janeiro for use in future biological control programs (Figure 10).

Figure 10 Parasitoids of *Chrysomya megacephala*, (Fabricius, 1794) (Diptera: Calliphoridae); (Source: https://www.researchgate.net/figure/Emerged-adults-parasitoids_fig3_288271803)

Three species of natural enemies of *C. megacephala* that stood out during the year of collection were found: *Tachinaephagus zealan*dicus (Ashmead, 1904) (Hymenoptera: Encyrtidae), *Pachycrepoideus vindemmiae* (Rondani, 1875) (Hymenoptera: Pteromalidae) and *Nasonia vitripennis* (Walker, 1836) (Hymenoptera: Pteromalidae). These three species have a cosmopolitan distribution, having already been reported in Brazilian aviaries, occurring in association with other species as well [13, 14, 15, 16].

3.7. Study 7

The importance of *Chrysomya albiceps* (Wiedemann, 1819) (Diptera: Calliphoridae) for domestic animals and its association with *Cochliomyia hominivorax* (Coquerel, 1858) (Diptera: Calliphoridae) is discussed here.

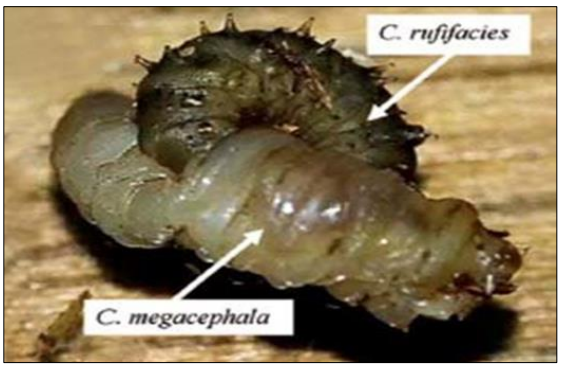

Figure 11 *Chrysomya rufifacies* larva preying on the other *Chrysomya megacephala* serving its sclerotized spines. *Chrysomya rufifacies* larvae preying on another *Chrysomya megacephala* larva using sclerotized thorns; (Source: Fuente: Shiao & Yeh, 2008)

Chrysomya albiceps is a fly that develops on carcasses and optionally can cause secondary myiasis. Second instar larvae were removed from an existing lesion in a Merino sheep in Botucatu. Among the wool, around the lesion, first instar larvae were found. Also, inside the lesion, a third instar larva was obtained. The larvae were kept in the laboratory and adult insects were obtained from them, with 50 couples formed and kept in cages for eight generations (Figure 11).

From each generation, 100 adults were sacrificed and examined morphologically, with their characters confronting those of *Chrysomya rufifacies* (Macquart, 1843) (Diptera: Calliphoridae). The third instar larva gave rise to *C. hominivorax* and the others to *C. albiceps*. It was found that *C. albiceps*, in addition to being able to damage integral tissue, is also a possible predator of *C. hominivorax* larvae [17].

3.8. Study 8

In that order, the forewings are functional, and the hindwings are modified, known as rockers or dumbbells, which have a tapered part called the pedicel and a dilation at the end known as the capitis. These modified wings aid in the insect's balance during flight.

A feature that helps identify flies are the large compound eyes on the head, which in turn is detached from the body. The mouthpiece can be either a sucker or a chopper type. The urbanization process favored the reproduction of flies found in garbage, food scraps and other perfect places to get food, shelter and reproduce. They can feed on feces, sputum, pus, animal, and vegetable products that are decomposing, as well as sugar and fruits. Thus, flies are seen as urban pests, capable of transmitting diseases, serving as hosts for pathogens and should be avoided. Some of these diseases are: typhus, dysentery (housefly); conjunctivitis (eye-licking fly). There are also flies that cause worms in animals such as blowflies (Figure 12) and crab flies (parasites).

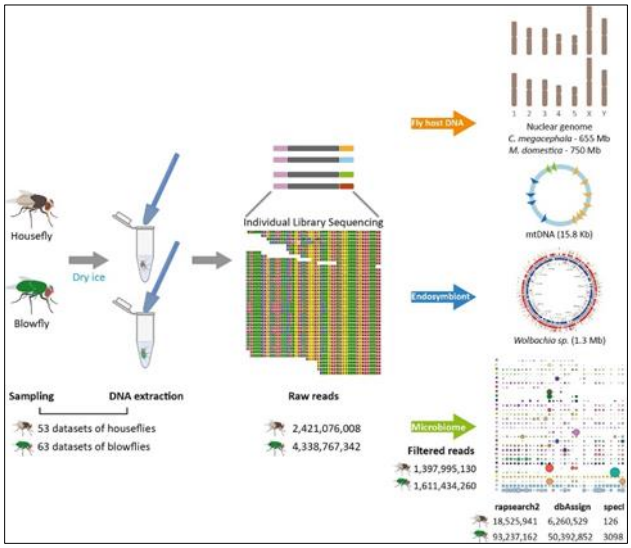

Figure 12 Blowflies and houseflies are mechanical vectors inhabiting synanthropic environments around the world. They feed and breed in fecal and decaying organic matter, but the microbiome they harbor and transport is largely uncharacterized. The environmental sequencing approach presented here detected a stochastic distribution of human pathogens, such as *Helicobacter pylori*, thereby demonstrating the potential of flies as proxies for environmental and public health surveillance; (Source: https://www.nature.com/articles/s41598-017-16353-x)

In horses, the horn fly and horseflies are transmitters of horse-chair. As a behavioral characteristic, they are more active during the day than at night, when they rest. We can identify the presence or passage of flies in a place through dark spots from their feces or light spots resulting from the saliva produced by the insect that throws on the food to facilitate its ingestion

But as incredible as it may seem, they are not only harmful to humans, but some species are also used for experiments, mainly in genetics. In agriculture, they can be used as agents for the biological control of weeds and for pest control. Furthermore, many species have an important ecological role and act as pollinating agents [18].

3.9. Study 9

The present study aimed to identify Caliphoridae species and to know the succession of this fauna along the stages of decomposition of a swine carcass in a gallery forest area of the Inhamum Ecological Reserve, municipality of Caxias, Maranhão.

A total of 4,221 adult Calliphoridae specimens were collected, belonging to nine species of five genera: *Chloroprocta idioidea* (Robineau-Desvoidy, 1830) (83), *Chrysomya albiceps* (Wiedemann, 1819) (561), *Chrysomya megacephala*, (Fabricius, 1794) (383), *Chrysomya rufifacies* (Macquart, 1843) (21), *Cochliomyia macellaria* (Fabricius, 1775), (3,142), *Hemilucilia benoisti* Séguy, 1925 (02), *Hemilucilia segmentaria* (Fabricius, 1805) (07), *Hemilucilia* Townsend 1875 ((01), *Lucilia eximia* (Wiedemann, 1819) (21). Four stages of decomposition of the swine carcass were verified: fresh, swelling, deterioration and dry, with duration of 1, 2, 4 and 5 days, respectively.

During the fresh stage no Calliphoridae species was collected; in the swelling occurred the species *C. albliceps, C. megacephala, C. rufifacies, C. idioidea, C. macellaria* and *L. eximia*; in the deterioration stage, the nine species were collected; in the dry stage, *C. albiceps, C. megacephala, C. rufifacies* and *C. macellaria* were collected. The species *C. rufifacies, H. benoisti* and *H. townsendi* are new records for the gallery forest area in the Inhamum Ecological Reserve (Figure 13) [19].

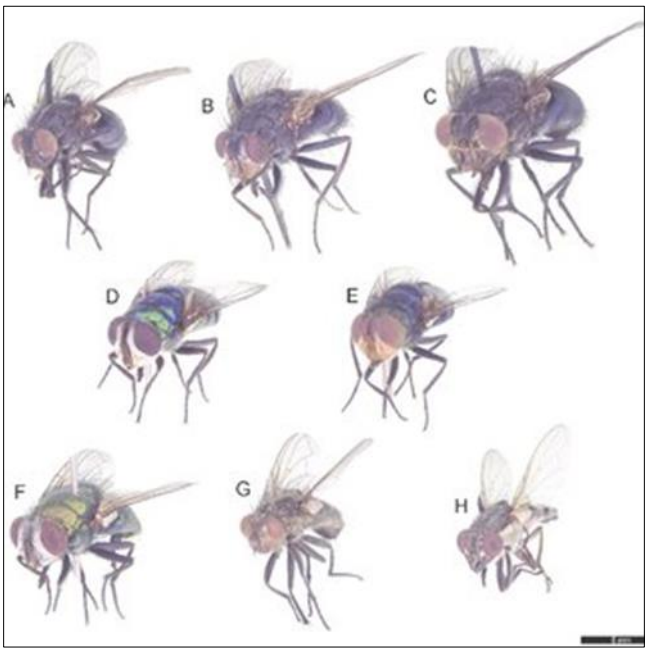

Figure 13 Habitus in antero-lateral view of madeiran blowflies: (A) *Calliphora loewi* Enderlein, 1903 (B) *Calliphora vicina* (Robineau-Desvoidy, 1830 (C) *Calliphora vomitoria* (Meigen, 1826) (D) *Chrysomya albiceps* Wiedemann 1819 (E) *Chrysomya megacephala* (Fabricius, 1794) (F) *Lucilia sericata* (Meigen, 1826) (G) *Pollenia rudis* (Fabricius, 1794) (H) *Stomorhina lunata* Fabricius, 1805; (Source: https://www.researchgate.net/figure/Habitus-in-antero-lateral-view-of-Madeiran-blowflies-A-Calliphora-loewi-B-Calliphora_fig2_310604991)

3.10. Study 10

Evaluate the degree of synanthropy of Calliphoridae species in the Municipality of São José/SC and analyze the influence of abiotic factors on the seasonality and abundance of these species.

Consider that synanthropic flies are those that maintain ecological relationships with man and his environment, and these relationships may be mandatory or optional.

From November 2013 to October 2014 4,569 calliphorids were captured in the three areas. Twelve species were identified. Comparing the three study sites, the rural area had the highest abundance of calliphorids, while the urban area had the lowest number of flies captured during the twelve months of collection. The calculation of the analysis of variance did not confirm this difference in species abundance between the collection sites ($F= 5.9295$; $gl= 11$; $p= 0.0001$).

Of the 1069 calliphorids captured in the urban area, the most abundant species was *Lucilia eximia* (Wiedemann, 1819), representing 50.9% of the individuals collected. In rural and forest areas, the most frequent species was *Chrysomya megacephala* (Fabricius, 1794), representing 64.9% of the 1920 calliphorids captured in the rural environment and 51.6% of the 1580 calliphorids collected in the forest area (Figure 14).

The species that 38 showed a high degree of synanthropy was *L. eximia* (+ 46.67). The species that showed independence for the areas inhabited by man were: *C. albiceps* Wiedemann 1819 (+ 13.02), *C. meg*acephala (+ 15.22) and *Lucilia cuprina* (Wiedemann, 1830), with the synanthropy index calculated at +1.39. The species *Paralucilia nigrofacialis* (Mello, 1969) (-1.66), *Hemilucilia segmentaria* (Fabricius, 1805) (- 2.75), *Laminaria nigripes* Agardh, 1868 (-4.87), *Mesembrinella bellardiana* Aldrich. 1922 (-6.58) and *Hemilucilia semidiaphana* (Rondani, 1850) (-11.37) showed preference for uninhabited areas. *L. nigripes* and *Mesembrinella bellardiana* Aldrich, 1922 were found only in the forest environment and were specific to natural areas. *Chrysomya putoria* (Wiedemann, 1830), *Sarconesia chlorogaster* (Wiedemann, 1830) and *Huascaromusca aneiventris* (Wiedemann, 1830) were collected in low numbers (n=3, n=1 and n=1, respectively), and cannot be related to human-created conditions [20].

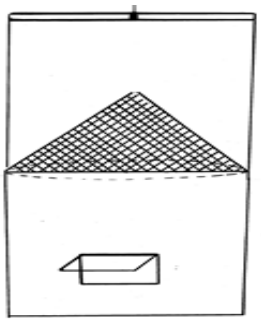

Figure 14 PET plastic bottle trap

3.11. Study 11

Many studies on ecological interactions, such as competition, predation, and migration among calliphorids, have been carried out. That's because, about 35 years ago, four species of flies of the genus *Chrysomya*, restricted to the Old World, were introduced into the New World. *Chrysomya megacephala* (Fabricius 1794) *Chrysomya rufifacies* (Macquart, 1843), *Chrysomya albiceps* (Wiedemann, 1819) and *Chrysomya putoria* (Wiedemann, 1818) were introduced when *Angolan refugees* (1961-1974) came to Brazil with their domestic animals. These species spread rapidly in South America, causing changes in the local fauna of dipterans, probably due to frequent interspecific interactions between species, such as predatory behavior in *C. albiceps* [21, 22, 23, 24, 25, 26].

Chrysomya albiceps Wiedemann 1819. Distribution: Africa, Southern Europe, Middle East, South Asia, Madagascar, Canary Islands, Central and South America. This species it is almost cosmopolitan and continues to occupy new areas. The predatory behavior of *C. albiceps* larvae is a widely studied topic. Preferably, *C. albiceps* consumes carcasses, but when the resource becomes scarce, it changes its behavior, becoming a facultative predator of other dipteran larvae. Studies have shown that in the presence of several species, *C. albiceps* preferentially attacks *Cochliomyi*a *macellaria* (Fabricius, 1775). In the veterinary field, *C. albiceps* is related to the occurrence of myiasis. considers this species harmful in Africa. In the Neotropical region, it is the only species of the genus *Chrysomya* that has been reported to cause myiasis. The first case was reported because it obtained L3 larvae from a calf lesion [27, 28, 29, 30, 31, 32].

Chrysomya megacephala (Fabricius 1794). This species is native to the Eastern and Australasia regions and has been found on the west coast of Africa and Central and South America. It reached North America and settled in Los Angeles. This great preference for inhabited areas has serious consequences in the medical-sanitary area, mainly as mechanical vectors of pathogenic microorganisms. Bacteria (*Morganella* sp., *Klebesiella* sp., *Pseudomonas* sp., *Enterobacter* sp. and *Salmonella agona*), helminth eggs and larvae (*Ascaris* sp., *Oxiurids*, *Toxascaris* sp., *Toxacara* sp., *Trichuris* sp., *Capillaria* sp. and *Necator americanus*) and polio virus were found associated with the body surface or in the intestinal contents of this species (Figure 15) [33, 34, 35].

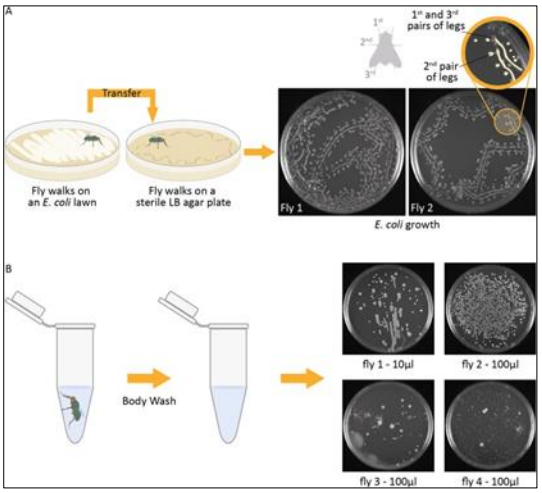

Figure 15 Blowflies and houseflies are mechanical vectors inhabiting synanthropic environments around the world. They feed and breed in fecal and decaying organic matter, but the microbiome they harbor, and transport is largely uncharacterized. The environmental sequencing approach presented here detected a stochastic distribution of human pathogens, such as *Helicobacter pylori*, thereby demonstrating the potential of flies as proxies for environmental and public health surveillance; (Source: https://www.nature.com/articles/s41598-017-16353-x)

Chrysomya putoria (Wiedemann, 1830). This species is native to Africa and is currently found in Madagascar and South America. It is considered one of the main vectors of microorganisms, as it occurs in large quantities and because it visits and grows in human feces (Figure 16) [36, 37, 38].

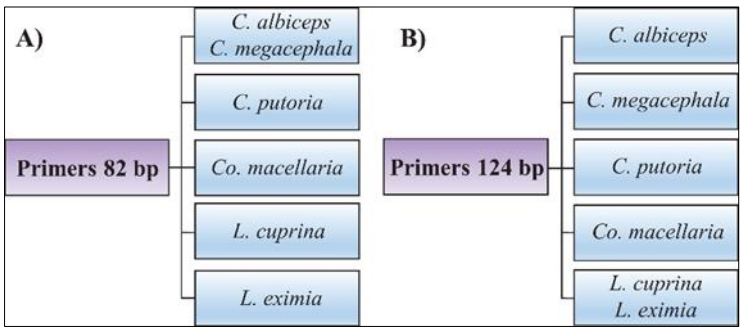

Figure 16 Flowchart showing species identification of blowflies using each of the proposed HRM primers, (A) 82 bp amplicon and (B) 124 bp amplicon; (Source: https://peerj.com/articles/9680/)

4. Conclusion

Chrysomya is a genus of Old-World blowflies belonging to the family Calliphoridae. Chrysomya's primary importance to the field of medical legal Forensic Entomology is due to the genus' predictable life cycle length, allowing researchers to accurately estimate a postmortem interval. The flies of the genus *Chrysomya* (Diptera: Calliphoridae) are of great medical and sanitary importance as they are producers of secondary myiasis and transmitters of pathogenic microorganisms to humans and domestic animals.

Compliance with ethical standards

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