

(REVIEW ARTICLE)



## Research of the family Mesembrinellidae (Insecta: Diptera)

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### Abstract

Adult Mesembrinellidae feeds on decomposed organic matter; their mouthparts are adapted to collect soft or semi-liquid food, including microorganisms. It is known that this family is attractive for feces, and animal substrates. They are potential bioindicators of environmental quality, with some species already evaluated for such use in certain forest environments, and can help to solve ecological problems and diagnose the causes of environmental changes, being an inexpensive way to indicate the conditions of an environment. Muscomorpha is supported by the presence of posterior spiracles, both immature forms, not the last abdominal segment. This infraorder shelters the so-called Muscoid Diptera, insects that are among the groups of greatest economic and medical-veterinary importance. The objective of this work is to verify the biological characteristics of the family Mesembrinellidae (Insecta: Diptera). In terms of the type of research source, we worked with scientific articles published in national and international journals. This modality of production, in addition to being commonly the most valued in the set of bibliographic production, is the most easily accessed. Access to articles was through virtual libraries such as SCIELO, ResearchGate, Hall, USP, UNB, CAPES, and LILACS.

**Keywords:** Forensic Entomology; Synanthropy; Microorganisms; Predator

## 1. Introduction

### 1.1. Suborder Brachycera

Brachycera is a suborder of insects of the order Diptera, which includes species known generically by the common name of flies. Most species feed on detritus or are predators, including several hematophagous species. This group is distinguished from mosquitoes (suborder Nematocera) by its short antennae, with few segments [1,2].

### 1.2. Infraorder Muscomorpha

Muscomorpha is an infraorder of Diptera of the suborder Brachycera that includes a large and diverse number of insects. The group includes most of the species belonging to the Brachycera group, and, consequently, most of the known flies, including houseflies, fruit flies, and blowflies. In this group, the antennae are short, usually tri-segmented, with a dorsal ridge [1,2,3].

### 1.3. Cyclorrhapha section

Cyclorrhapha is a circumscription name historically used to designate an infraorder of Brachycera, one of the two suborders into which the order Diptera, the flies, is traditionally divided, which included those species whose pupae emerge from the puparium exuvia through a circular orifice [1,2,3].

The insects and other arthropods associated with these criminals are studied by Forensic Entomology, which serves as tools to help, for example, in the investigation of cases of violent death. Due to their necrophagous and saprophagous

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habits, flies contribute to the solution of crimes, being able to inform how, where, when, and why the crime was committed.

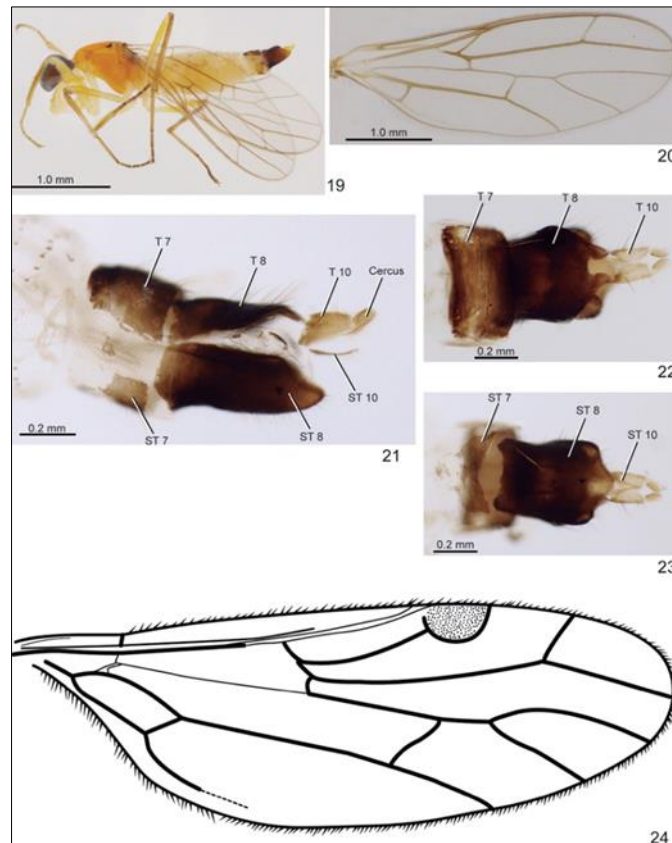
Muscomorpha is supported by the presence of posterior spiracles, both immature forms, not the last abdominal segment. This infraorder shelters the so-called Muscoid Diptera, insects that are among the groups of greatest economic and medical-veterinary importance (Figure 1) [4,5,6].



Source: file:///C:/Users/Lenovo/Downloads/56695-Article%20Text-165865-177735-10-20190826.pdf

**Figure 1** *Mesembrinella vogelsangi* (Mello, 1967)

#### 1.4. Description



Source: <https://zookeys.pensoft.net/article/11503/list/1/>

**Figure 2** *Metachela spinulosa* sp. nov., paratype female 19 Habitus, lateral view 20 Wing 21 Segments 6-11, lateral view 22 Tergite 7 until cercus, dorsal view 23 Segments 7-11, ventral view 24 *Metachela circumdata* Collin (1933), wing modified from Collin (1933)

Species of the Mesembrinellidae family can be considered jungle green flies. They are attracted to decaying fruits as well as animal remains. They are large flies, about 2 to 3 cm in length, and generally have a blue or metallic green abdomen. The shiny brown thorax can be smooth or with clearly evident light stripes. The family has about 15 species recorded for the Amazon. All species are restricted to the forest environment and their presence is a good indicator of ecosystem integrity (Figure 2) [4,5,6].

Head, general appearance orange color with abundant silver pollinia. The width of the forehead in its narrowest portion is 0.27 m in relation to the width of the head. Head, general appearance orange color with abundant silver pollinia. The posterior mesonotum seen from behind, presents five longitudinal brown bands and six longitudinal bands with silver pollinia. Chestnut scutellum with pubescence of the same color but lighter.

Abdomen, tergites I and II orange and front half of III dark orange with black bristles, all others glossy dark brown with black bristles. marginals three times larger than decumbent normals; wing hyaline, veins brown to orange on the basal part. Orange costal vein with black bristles. Legs, coxa, trochanter, and femur are dark orange in color, the rest of the segments brown, and the hair is black and gold. Femur I with a row of bristles on the dorsal face, one on the postero-dorsal face, and one on the postero-ventral face [7,8,9].

### 1.5. Biology

Adult Mesembrinellidae feeds on decomposed organic matter; their mouthparts are adapted to collect soft or semi-liquid food, including microorganisms. It is known that this family is attractive for feces, and animal substrates. Females produce a single large egg at a time, in decomposition, in addition to being observed in tree and flower sap. As for the feeding and development of immatures, little is known. Larvae and pupae of some species have already been collected from rat carcasses and pig carcasses but in very low abundance Mesembrinellidae females have adenotrophic viviparous habit, that is, the egg has all the necessary nutrients, and also pseudoplacental, where the female nourishes the immatures in the uterus until practically the end of the larval stage.

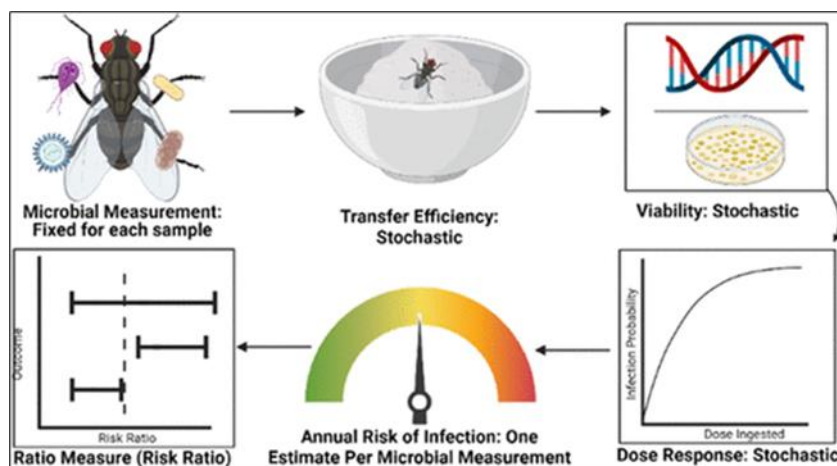
With this, a macro larva is placed in the pre-pupal stage and practically does not feed. This is a unique reproductive habit, which occurs in only two other groups of dipterans, both hematophagous. As for copulation behavior, life cycle, and developmental stages, there is no information. Mesembrinellidae has no affinity with anthropized environments. Thus, they are recorded only in forest environments that do not have a large flow of people or the presence of garbage and logging. When collected in regions of edges and ecotones, they are always in low abundance (Figure 3) [10,11].



Source: <https://www.thoughtco.com/insect-larval-forms-1968484>

**Figure 3** Vermiform larvae are maggot-like, with elongated bodies but no legs. They may or may not have well-developed head capsules

They are, therefore, potential bioindicators of environmental quality, with some species already evaluated for such use in certain forest environments, it can help to solve ecological problems and diagnose the causes of environmental changes, being an inexpensive way to indicate the conditions of an environment such as *Mesembrinella bellardiana* Aldrich, 1922, *Mesembrinella bicolor* (Fabricius, 1805) and among the collected groups (Figures 4).



Source: <https://pubs.acs.org/doi/10.1021/acs.est.2c06864>

**Figure 4** Index of synanthropy: Quantitative microbial risk assessment (QMRA): Pathogen-specific dose–response models offer an alternative approach that considers how these additional factors influence transmission. Such an approach offers the potential for a more nuanced understanding of the interactions between interventions, fecal contamination in the environment, and children’s health outcomes compared to epidemiological methods

The Mesembrinellidae family is considered a bioindicator of well-preserved areas. Although a small number of specimens were found, 12 individuals distributed in three species, the presence of this group can already be considered relevant information for the environmental quality of the area [12,13].

### 1.6. Classification

**Subfamilies:** Laneellinae, Mesembrinellinae and Souzalopesiellinae.

**Genus:** *Eumesembrinella* Townsend, 1931, *Henriquella* Bonatto and Marinoni, 2005, *Huascaromusca* Mello, 1967, *Laneella* Townsend, 1931, *Mesembrinella* Giglio-Tos, 1893, *Thompsoniella* Guimarães, 1977 and *Souzalopesiella* Guimarães [16,17].

**Some Species:** *Eumesembrinella randa* (Walker, 1849), *Mesembrinella patriciae* sp. nov, *Mesembrinella umbrosa* Aldrich, 1922, *Mesembrinella facialis* (Aldrich, 1922), *Souzalopesiella facialis* Aldrich, 1922, *Mesembrinella batesi* Aldrich 1922 and *Mesembrinella bellardiana* Aldrich, 1922 were identified [14,15]

### Objective

The objective of this work is to verify the biological characteristics of the family Mesembrinellidae.

## 2. Methods

In terms of the type of research source, we worked with scientific articles published in national and international journals. This modality of production, in addition to being commonly the most valued in the set of bibliographic production, is the most easily accessed. Access to articles was through virtual libraries such as SCIELO, ResearchGate, Hall, USP, UNB, CAPES and LILACS.

## 3. Selected Papers

### 3.1. Study 1

Thus, this study aims to survey the Diptera fauna of forensic interest present in the Pedra Branca State Park (Rio de Janeiro - RJ) attracted by baits of organic material of animal origin.

To capture insects, we used traps made from 2L PET bottles. As baits, 200g of sardines, 200g of beef muscle, 200g of beef liver, and 200g of human feces.

A total of 96 specimens were collected in this first moment of the study. Of this total, Mesembrinellidae was the most abundant group, with 40.63% (n = 39), followed by Calliphoridae with 35.42% (n = 34), Muscidae, with 19.79% (n = 19) and Neriidae 4.17% (n = 4). With regard to diversity, Mesembrinellidae and Calliphoridae had the highest number of species represented, a total of four for each, while Muscidae (two) and Neriidae (one) were the least diverse. In Calliphoridae species of *Chloroprocta idioidea* (Robineau-Desvoidy, 1830) (4%) and *Chrysomya albiceps* (Wiedemann, 1819), (4%) were the least abundant with only one representative, *Hemilucilia segmentaria* (Fabricius, 1805) (52%) and *Hemilucilia semidiaphana* (Rondani, 1850) (40%) were the most abundant.

In Muscidae, we obtained two genera, *Cyrtoneurina* Giglio-Tos (89.5%) is the most abundant, and *Morellia* Robineau-Desvoidy (10.5%) is the least abundant. The strong presence of Mesembrinellidae is an indication of good environmental quality since this group is associated with well-preserved forests [18,19,20]

### 3.2. Study 2

The superfamily Oestroidea is a Miocene fly belonging to a new species: *Mesembrinella caenozoica* Cerretti et al., 2017. A study of "the first unambiguous fossil of Oestroidea based on a male fly perfectly preserved in amber from the Dominican Republic," according to the study authors. The Oestroidea superfamily includes about 15,000 species, including this fly fossilized in amber from the Miocene (between 23 and 5 million years ago), belonging to a new species: *M. caenozoica*. The specimen is part of the collection of the American Museum of Natural History in New York.

"The Mesembrinellidae family is estimated to be approximately 39 million years old, substantially older than the fossil *M. caenozoica*. The new species of fly was generally included in the Cenozoic (from 66 million years ago to the present), as indicated by the epithet "Caenozoic".

The specimen, a medium-sized fly, about 8.5 millimeters long, was identified by digital dissection with CT scanners, a non-invasive technique. The results provide new insights into the timing and rate of steroid diversification and highlight the rapid radiation of some of the most diverse and ecologically important families of flies [21,22,23].

### 3.3. Study 3

To carry out a rapid ecological assessment of the diversity of blowflies in an area with irrelevant anthropic activity, in the Tumucumaque Mountains National Park (Parna Tumucumaque). Forty-two (42) traps (PET) were installed, and distributed in 21 sampling points, 100m apart, on an existing trail in the Park.

Three hundred and twenty-five (325) species, three of Calliphoridae belonging to the subfamilies Chysomyinae and Luciliinae; and two, from Mesembrinellidae, belonging to the subfamily Mesembrinellinae. Of these, 176 are of the species *Chloroprocta idioidea* Robineau-Desvoidy, 1830, that is, more than 50% of the individuals collected. No species was distinguished that preferred higher or soil sites. More individuals were collected at higher heights (n=166) than at ground level (n=159). Among the individuals collected, 62.9% were females while 37.1% were males.

The species were collected throughout the stratification gradient established during the work, both male and females, namely: 10.3m, 10.4m, 11.1m, 11.3m, 15.4m, 12.3m, 12.4m, 12.6m, 13.3m, 13.5m, 14.3m, 19,5 m. *Mesembrinella batesi* Aldrich, 1922, and *Eumesebinella randa* Walker, 1849, are species commonly found in environments free of pests and anthropic interference. The Mesembrinellidae are good environmental indicators for these traits. [24,25,26].

### 3.4. Study 4

The objective of this study was to study the synanthropic behavior of Diptera Calliphoridae and Mesembrinellidae (Diptera) in the State of Rio Janeiro with a view to providing subsidies for the implementation of public policies and environmental conservation, in addition to assisting in legal medical studies using Forensic Entomology.

A total of 2826 dipterans were collected during the autumn and winter seasons, represented by 19 species of the Calliphoridae (89.24%) and Mesembrinellidae (10.76%) families. In the forest environment, the most representative species of Calliphoridae were: *Lucilia eximia* (Wiedemann, 1819) (61.95%) and *Hemilucilia segmentaria* (Fabricius, 1805) (Diptera: Calliphoridae) (14.81%); while the most representative species of Mesembrinellidae were *Laneella nigripes* Guimarães, 1977 (7.60%) and *Mesembrinella bellardiana* Aldrich, 1922 (4.39%).

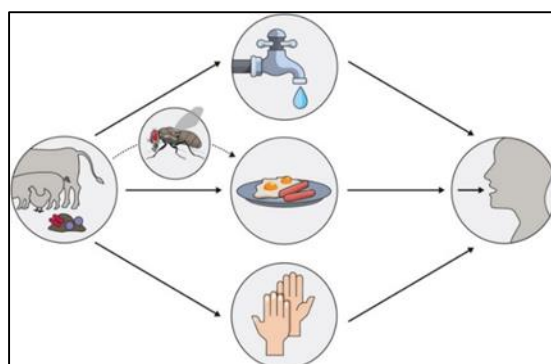
In the urban environment, the two most representative species were *H. segmentaria* (55.73%) and *L. eximia* (26.56%). In the rural environment, the two most representative species were *L. eximia* (62.86%) and *Cochliomyia hominivorax* (Coquerel, 1858) (Diptera: Calliphoridae) (16.43%). All species of Mesembrinellidae were exclusively synanthropic,



with a Synanthropy Index (S.I.= +100), as well as two calliphorid species: *Hemilucilia benoisti* Séguy, 1925 (Calliphoridae) and *Paralucilia nigrofacialis* (Mello, 1969).

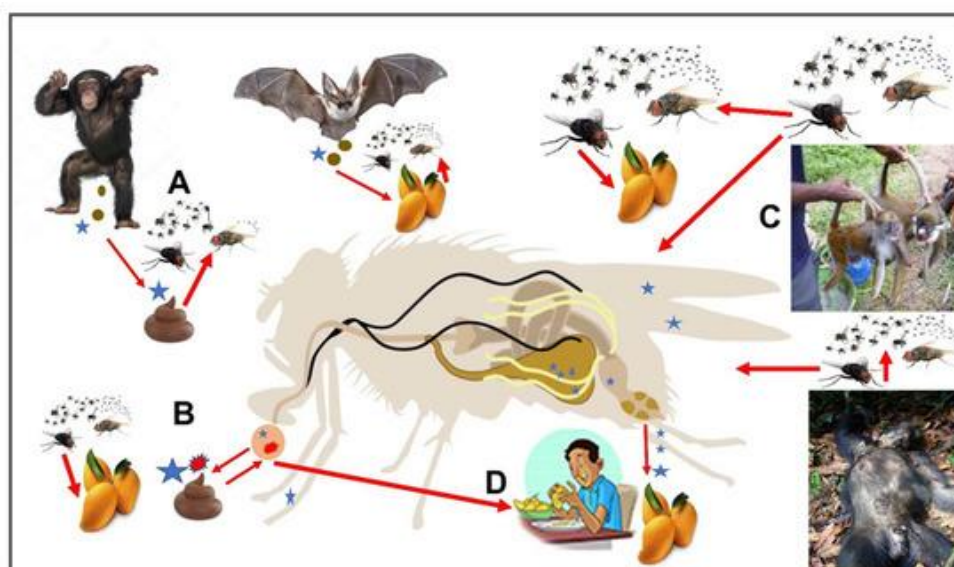
The species that showed the greatest synanthropic were: *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) (S.I.=87.17), followed by *Chrysomya albiceps* (Wiedmann, 1819) (Diptera: Calliphoridae) (S.I.=75) [27,28,29].

**Synanthropy** is the ability of certain species to take advantage of the anthropic environment; obtaining shelter, water, and nutritional or reproductive substrate, whereas the human-modified environment consists of humans, species domestic, and synanthropic species.



Source: <https://www.sciencedirect.com/science/article/pii/S1477893918300371>

**Figure 5** Synanthropy: Pathways of fecal-oral transmission. Pathogens from feces can be transmitted to humans or animals through drinking water, food, or hands (smear infection). Flies can enhance the contamination of food, as no direct contact with food and feces is necessary



Source: <https://www.mdpi.com/2075-4450/13/9/776>

**Figure 6** Finally, a schematic diagram shows the involvement of synanthropic flies as transmission agents of diverse pathogens and their role in an epidemiological model. The fly image is the courtesy of Dana Nayduch and is modified from Nayduch and Burrus, [29], 2017, while the dead chimpanzee photo is the courtesy of Jennifer Jaffee and the Tai Chimpanzee Project. A more detailed explanation is provided for the various subfigures (A–D). Drawing of mango eater by Sahil Upalekar

**Synanthropy Indexes:** In this index, the preferred region of the analyzed species and its feeding and reproductive behavior are considered. The formula used to determine the index is  $IS=(2a+b-2c)/2$  (Nuorteva, 1963). This index considers the analyzed species' preferred region and its feeding and reproductive behavior. The result of this index

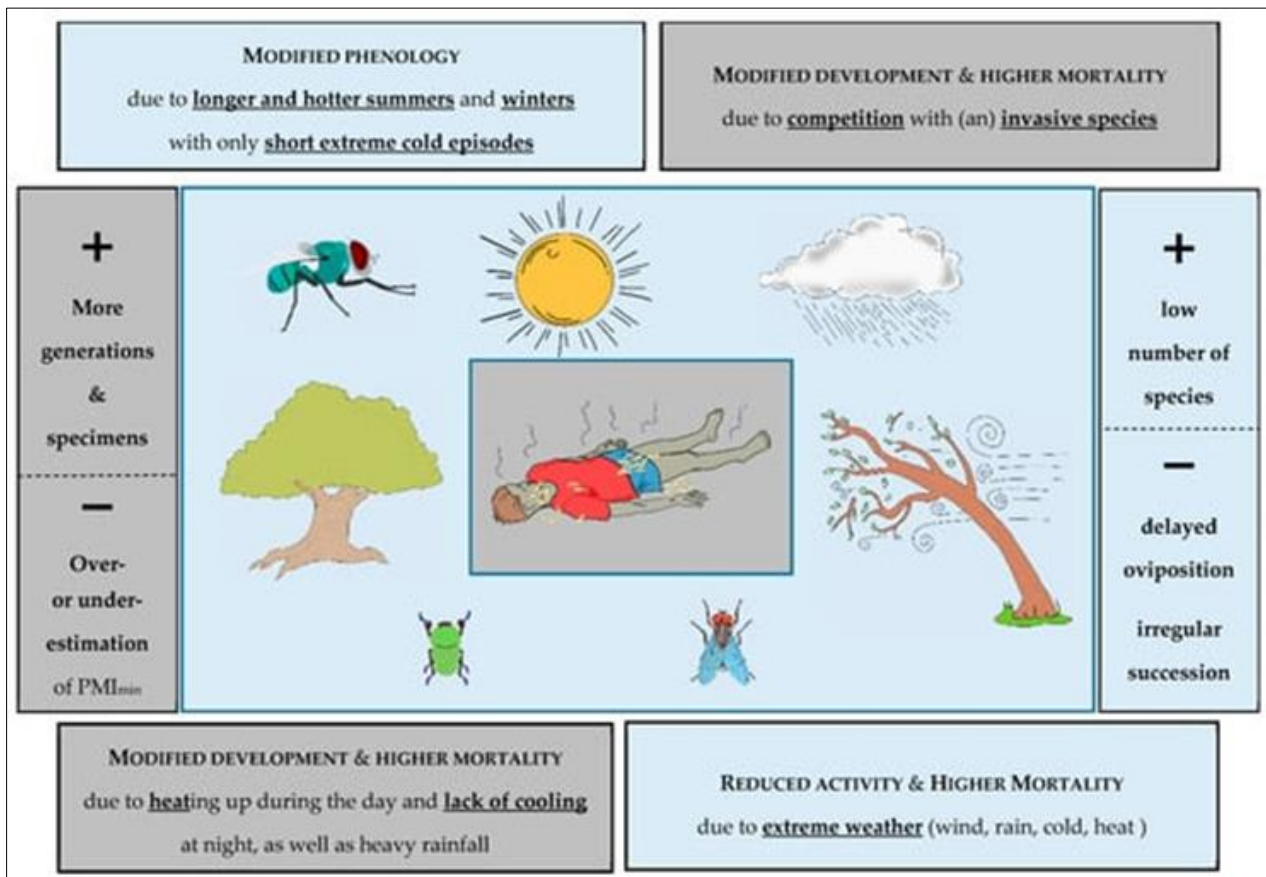
varies from + 100 to -100, where the highest value indicates the highest degree of synanthropic and negative values reflect the aversion species to the urbanized environment (Table 1) (Figure 5).

**Table 1** The degree of synanthropy following this index can vary from +100 to -100 and is linearly distributed

Synanthropy Indexes	Limit Values	Classification
High preference for densely populated areas High preference for inhabited areas preference for inhabited areas	+100 a +90 +90 a +65 +65 a +20	Synanthropic
Independence by inhabited areas	+20 a 0	Hemissinanthropics
Preference for uninhabited areas	0 a -40 -40 a -100	Asynanthropic

Sources: The table model is taken from the doctoral thesis in animal biology: Identification, synanthropic and microbiological analysis 2013. 234 and <https://pt.wikipedia.org/wiki/Sinantropia> and Nuorteva formula (1963)

Forensic Entomology can provide invaluable aid in death cases where human remains are colonized by insects and in the overall investigation. His main role is identifying the arthropods associated with such cases and analyzing entomological data for interpreting insect evidence. A Forensic Entomology may collect adults, eggs, and larvae; identify the type of arthropod present; and use that information to assess the time since death (Figure 7).



Sources: Insects 2021, 12(4), 324; <https://doi.org/10.3390/insects12040324> and <https://www.mdpi.com/2075-4450/12/4/324>

**Figure 7** Global warming as a driver of insect decline and its possible impact (+ and -) on the necrophagous fauna and Forensic Entomology (grey background: juvenile stages, light blue: adult stages)

### 3.5. Study 5

Knowledge of dipterans in the Amazon is still fragmentary, and the catalogs published for the Neotropical region mention few records for the region. species richness and relative abundance in open areas, subject to anthropic alterations, and in adjacent forests of Fazenda Tanguro, state of Mato Grosso.

The capture of flies was carried out using an entomological net and traps for collecting saprophagous dipterans of several families, containing 50 g of bovine lung with 24 hours of decomposition [30,31].

A total of 11,313 dipterans were captured, of which 92% belong to the Sarcophagidae family; 7.89%, to the Calliphoridae family; and 0.10% to the Mesembrinellidae family. Seven species of Calliphoridae were obtained, with *Chloroprocta idioidea* (Robineau-Desvoidy, 1830) (Calliphoridae) being the most representative, with 547 specimens (61%); followed by the species *Chrysomya albiceps* (Wiedmann, 1819) (Calliphoridae), with 262 specimens (29%). The other two exotic calliphorid species, *Chrysomya megacephala* (Fabricius, 1794) (Calliphoridae) and *Chrysomya putoria* (Wiedemann, 1830) (Calliphoridae), were also collected.

Among 14 species of Sarcophagidae, the most abundant were: *Peckia lambens* (Wiedemann, 1830) (Diptera: Sarcophagidae), with 9,980 individuals obtained (96%) of the total number of sarcophagids. The second most abundant species was *Peckia collusor* (Curran e Walley, 1934) (Sarcophagidae), with 341 specimens captured (3%). Despite the collection of only seven specimens of Mesembrinellidae, three species of this family were recorded.

Comparing abundance values for the Calliphoridae family in forests and open areas, 64% of specimens were collected in forest areas and 36% in open areas. The opposite was observed for the Sarcophagidae family, in which 64% of the total was captured in open areas and the remainder in forest areas. In terms of richness patterns, the forest areas had a total of 19 species of Diptera from the three analyzed families; and the open areas had 21 species [32,33,34].

### 3.6. Study 6

Mesembrinellidae, with approximately 50 described species, was treated for a long time as a subfamily of Calliphoridae. Flies in this family are commonly stout, with metallic abdomens and brown thoraxes. Females produce a single large egg at a time, which hatches into a larva inside the uterus, where it is fed.

They are usually found in well-preserved forests. The objective of the present work was to carry out the first record of Calliphoridae, Muscidae, Sarcophagidae, and Mesembrinellidae from the Santa Lucia Ecological Station (Espírito Santo).

The sampled area has the typical phytosociology of the Atlantic Forest but presents advanced stages of ecological succession as well as points of anthropic impact. Subsequent super wet with sundry. To capture insects, two Van Someren-Rydon traps, using sardines as bait, were placed on the Tapinoã and Rio trails, remaining there for 120 hours; a Malaise trap was placed on the Indaiá-açu trail, remaining there for 120 hours. Collections with entomological nets were performed daily by two team members, totaling 40 hours.

A total of 1,253 specimens of Diptera were collected, with Calliphoridae standing out with 864 individuals, representing about 69% of the total obtained, followed by Muscidae (n=75; 5.9%), Sarcophagidae (n=60; 4.7%) and Mesembrinellidae (n=12; 0.9%), in addition to 242 individuals belonging to seven other families (225 of which are Fanniidae).

Among the Mesembrinellidae were identified, respectively, *Mesembrinella bellardiana* Aldrich, 1922, *Mesembrinella peregrina* Aldrich, 1922, and *Laneela nigripes* Guimarães, 1977. Among the collected groups, the Mesembrinellidae family is considered a bioindicator of well-preserved areas. Although a small number of specimens were found, 12 individuals distributed in three species, the presence of this group can already be considered relevant information for the environmental quality of the area [35,36].

### 3.7. Study 7

They are divided into five subfamilies: Mesembrinellinae, Calliphorinae, Rhiniinae, Toxotarsinae, Chysomyinae, and Mesembrinellinae is closely linked to the wild environment and is considered to be a synanthropic, i.e., not adapted to human-made alterations. They comprise a small group of exclusively Neotropical Diptera containing genera and species in which the females do not lay eggs but instead present a modification of the main oviduct, which increases in volume, allowing a single egg produced in the ovary to be launched into the oviduct.



Knowledge of the biodiversity of the Tinguá Biological Reserve may contribute to phylogenetic and biogeographical studies, as well as help in forest management, environmental management, and species preservation, by detecting areas with high biodiversity indices and providing information to underpin conservation policies.

Evaluate the distribution of Mesembrinellinae in three distinct sites in the Tinguá Biological Reserve from June 2006 through March 2007. Six black homemade traps were distributed as described by Ferreira (1978) and Linhares (1981), containing 400 grams of sardines defrosted in the refrigerator 24 hours prior to exposure. The collections were carried out monthly, from June 2006 to March 2007.

During the period of this study, 7663 Calliphoridae were collected, 2824 of which belonged to the subfamily Mesembrinellinae, distributed among *Laneela nigripes* (Guimarães, 1977) (1197), *Mesembrinella bellardiana* Aldrich, 1922 (4), *Mesembrinella peregrina* Aldrich, 1922 (1252), *Mesembrinella semihyalina* Mello, 1967 (260), *Mesembrinella bicolor* (Fabricius, 1805) (35), (Wiedemann, 1830) (32), *Huascaromusca purpurata* (Aldrich, 1922) (2), *Eumesebrinella pauciseta* Aldrich 1922 (41) and *Eumesebrinella quadrilineata* (Fabricius, 1805) (1) [37].

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#### 4. Conclusion

Thus, the two leave the group to finish Family Mesembrinellidae are, therefore, potential bioindicators of environmental quality, with some species already evaluated for such use in certain forest environments, it can help to solve ecological problems and diagnose the causes of environmental changes, being an inexpensive way to indicate the conditions of an environment.

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