International Journal of Life Science Research Archive

ISSN: 0799-6640 (Online)

Journal homepage: https://sciresjournals.com/ijlsra/

(REVIEW ARTICLE)

Check for updates

The characteristics of the families Anisopodidae and Mycetophilidae (Insecta: Diptera)

Carlos Henrique Marchiori *

Department of Biological Science, Instituto Federal Goiano, Goias, Brazil.

International Journal of Life Science Research Archive, 2023, 05(02), 096–108

Publication history: Received on 05 November 2023; revised on 19 December 2023; accepted on 22 December 2023

Article DOI: https://doi.org/10.53771/ijlsra.2023.5.2.0106

Abstract

The Anisopodidae is a cosmopolitan family of Diptera belonging to the mosquito group. The larvae live and feed on all types of decomposing material such as excrement, manure, vegetables, or dead wood. Adults are found mainly in summer in forests, meadows, and gardens, they are regularly seen on windows, both indoors and outdoors, which is why they have been called "window mosquitoes" or "wood mosquitoes". Mycetophilidae in Brazil, this insect mainly damages ornamental plants and causes great damage. Also, in seedlings of different crops, such as citrus, tobacco, strawberry, and others. Many sites on the internet say that adults do not harm plants, but this is a mistake. Fungus gnats' mosquitoes can cause great damage but in an indirect way. These little mosquitoes can carry harmful pathogens, that is, they can carry and spread diseases to your plants. The larvae can feed on the roots, and leaves and can even be found inside the stem, this is especially bad for young plants, such as seedlings, which have only a few delicate roots. Therefore, when you see two plants withering or turning yellow, this could be caused by fungus gnats (without roots the plant cannot absorb water or nutrients). The most common insect causing damage to greenhouses and indoor plants. The objective of the manuscript is to characterize the Anisopodidae and Mycetophilidae families. The bibliographic review methodology consists of a review of existing bibliographic material that concerns the subject to be studied. This is one of the main steps for any research and includes the selection of different sources of information, which can be collected in theoretical books; Banks of theses and dissertations from universities; Scientific articles; Scientific magazines; Documents; Websites; A bibliographic research methodology includes a set of phases that cover questions such as 1-Observation; Inquiry; Interpretation; Reflection; Analysis.

Keywords: Bibionomorpha; Damage; Fungus gnats; Larvae; Mosquitoes

1 Introduction

1.1 Family Anisopodidae

Currently, the Bibionomorpha comprise eleven families Anisopodidae, Pachyneuridae, Bibionidae, Cecidomyiidae, Sciaridae, Diadocidiidae, Ditomyiidae, Keroplatidae, Bolitophilidae, Lygistorrhinidae and Mycetophilidae, whose larvae often feed on plant roots and fungal hyphae (mycelia) or sporophores, being important in the process of decomposition of organic matter in forests, mainly wood and leaves. The adults, in turn, are free-living, measuring 2 to 10 mm in length, often found in dark places, humid forests, tunnels, and tree hollows, working to disperse fungal spores and plant pollen. Species in this group are known from all continents except Antarctica (Figure 1) [1-2].

* Corresponding author: Carlos Henrique Marchiori

Copyright © 2023 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution Liscense 4.0.

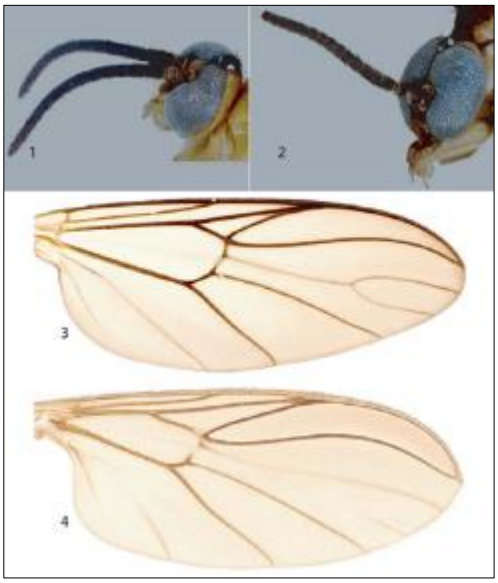
Sources: Photo: Michel Bertrand (France [60350] and https://www.galerie-insecte.org/galerie/Sylvicola_fenestralis.html

Figure 1 *Sylvicola fenestralis* (Scopoli, 1763)

Representatives of many genera are captured with puçás or various types of insect collection traps, such as light traps, Moericke, Malaise, pitfall, and Shannon. In the latter, fermented fruits are often used as bait. Decaying wood and fungi can be collected and kept in the laboratory until adults emerge. The Neotropical fauna is still little known. A recent project to study the biodiversity of Diptera in the Atlantic Forest has already described more than 80 species never described before by science, but there are still more than 1000 species to be described. The Amazon has still been little studied for many of these groups, except in some areas, and it is quite reasonable to expect that more than 100 new species of Mycetophilidae alone will be collected [1-2]

1.1.1 Description

These flies are slender, with small to medium body sizes, varying from 2 to 12 mm. The head is small, and rounded, with three ocelli, with big dichoptic eyes in males and females. The antenna always has 14 flagellomeres, in most cases with slightly elongated flagellomeres. The thorax is convex, and the wing membrane has color patterns as in *Sylvicola*. The male terminalia has the cercus prominent, which is also developed in females (Figure 2) [3].



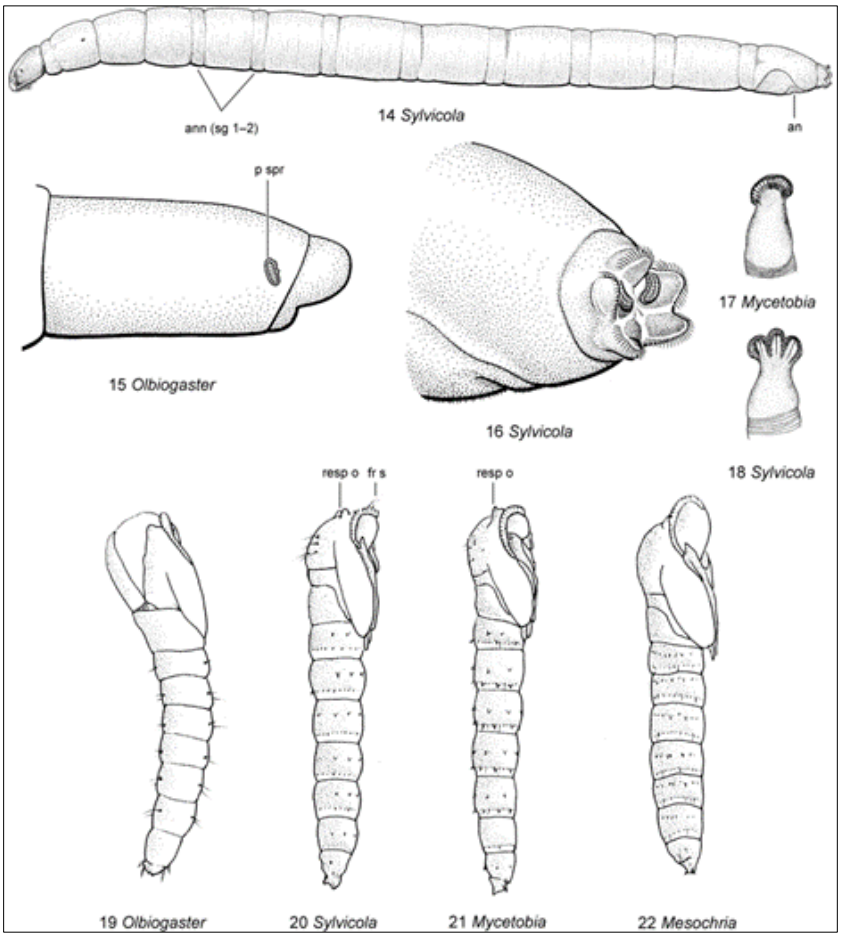
Source: https://www.semanticscholar.org/paper/New-Mesochria-species-(Diptera%3A-Anisopodidae)-from-Thompson/196d5fd739906b7936a8f2c658ce446682fe12d6/figure/0

Figure 2 figs. 1–2. Heads of male *Mesochria* Enderlein, 1910. 1. *Mesochria vulgaris* Thompson, 2006. 2. *Mesochria schlingeri* sp. nov. dorso later oblique view

1.1.2 Biology and Ecology

The Anisopodidae is a cosmopolitan family of Diptera belonging to the mosquito group. The larvae live and feed on all types of decomposing material such as excrement, manure, vegetables, or dead wood. Adults are found mainly in summer in forests, meadows, and gardens, they are regularly seen on windows, both indoors and outdoors, which is why they have been called “window mosquitoes” or “wood mosquitoes” [4-5].

Males form swarms to attract females for mating. Due to its appearance in swarms, studies have been carried out on the species *Sylvicola punctatus* (Fabricius, 1787) to control it using a fungus *Tolypocladium cylindrosporum* Gams, 1971(Hypocreales: Ophiocordycipitaceae) that attacks its larvae (Figure 3) [4-6].



Source: https://www.researchgate.net/figure/22-Larvae-and-pupae-of-Anisopodidae-14-larval-habitus-of-Sylvicola-punctatus-F_fig2_324080984

Figure 3 figs.14-22. Larvae and pupae of Anisopodidae: (14) larval habitus of *Sylvicola punctatus* (Fabricius, 1787), lateral view (non-Afrotropical); (15) larval posterior segment of *Olbiogaster africanus* Edwards 1915, lateral view; (16) same, *S. punctatus* , posterolateral view; (17) larval prothoracic spiracle of *Mycetobia* sp., lateral view; (18) same, *Sylvicola* sp.; (19) pupal habitus of *O. africanus*, lateral view; (20) same, *Sylvicola* sp.; (21) same, *Mycetobia* sp.; (22) same, *Mesochria medicorum* Edwards, 1928. Figs 14-16 (Peterson 1981, figs 19, 21, 22), Figs 17-22 (after Keilin & Tate 1940, figs 49, 14, 81, 41, 61, 84, respectively

The larvae of the Anisopodidae are saprophagous, being found in areas with moist decomposing and fermenting plant matter. Larvae have been found in rotting potatoes, decaying leaves and roots, sewage, tree exudates, rotting wood, and tree holes. Larvae and pupae. The larvae are aquatic, or terrestrial; saprophagous, or coprophagous, or consuming stored produce (sometimes in honeycombs, cider, and wine); eucephalic. The pupae without a puparium (Figures 4A-4B) [4-8].

A B

Source: Image: Stephen Moore

Figure 4A Wood gnat (Anisopodidae) larva. Non-retractile head. Moore wood gnat (Anisopodidae) larva. Tail with 5 lobes. **Figure 4B** Wood gnat (Anisopodidae) larva. Tail with 5 lobes

1.1.3 Classification

Ten genders are accepted in the family today. Of these, 3 should be in Costa Rica and *Neomesochria* Amorim & Tozoni (1994)*, Olbiogaster* Osten-Sacken, 1886*,* and *Sylvicola Harris*, 1780. *Sylvicola* has 2 confirmed species in Costa Rica. Two species of *Olbiogaster*, are known in Costa Rica and another 4 in neighboring areas. Two species of *Neomesochria* were described in the Neotropical region, both from Costa Rica. *Carreraia* Corrêa, 1947, *Lobogaster* Philippi, 1865, *Mesochria* Enderlein, 1910 and *Mycetibia* sp.

Species Iberian Peninsula: *Sylvicola cinctus* (Fabricius, 1787), *Sylvicola fenestralis, Sylvicola fuscatus* (Fabricius, 1775), (Scopoli, 1763) *Sylvicola punctatus* (Fabricius, 1787) and *Sylvicola zetterstedti* (Edwards, 1923).

he Neotropical and New Caledonian*: Mycetobia neocaledonica* Baylac & Matile, 1988, *Mycetobia scutelaris* Baylac & Matile, 1988, *Mycetobia antillea* Grimaldi, 1991, *Mycetobia cryptambra* Grimaldi, 1991*, Mycetobia limanda* Stone, 1966, and *Mycetobia stonei* Lane & d'Andretta, 1958.

Anisopodidae Spain, Galicia Subfamilia Mycetobyiinae: *Mycetobia gemella* Mamaev, 1968, *Mycetobia obscura* Mamaev, 1968, *Mycetobia pallipes* Meigen, 1818.

Mycetobia larvae are saprophagous and can be found in moist decomposed wood of fallen trees, rotting plant organic matter, fermented sap, sap exudations, under bark, holes of decomposed trees, and rotten roots.

Spain, Portugal, and Andorra: *Sylvicola cinctus* (Fabricius, 1787) a new record for Madeira: Chao, laurel forest, *Sylvicola fenestralis* (Scopoli, 1763) older records exist for this species from Spain Portugal, and Açores, *Sylvicola fuscatus* (Fabricius, 1775) Spain and Antiga, *Sylvicola oceanus* (Frey, 1949) this very distinctive endemic species and *Sylvicola punctatus* (Fabricius, 1787) Spain and Antigua.

Catalog of Anisopodidae of Colombia: Family Anisopodidae Knab, 1912. Subfamily Anisopodinae Knab, 1912. Genus *Olbiogaster*. Distribution: Colombia (Bolivar, Cauca, Meta). Genus *Sylvicola* Harris, 1776. *Sylvicola fasciatus* Roeder, 1886. Distribution: Colombia (Antioquia, Andes-Páramo de Santa Rita). Subfamily Mycetobyiinae Winnertz, 1863. Genus *Mycetobia* Meigen, 1818*. Mycetobia stonei* Lane & d'Andretta, 1958. Distribution: Colombia (Cauca, Bolivar, Risaralda) [18-19].

Objective

The objective of the manuscript is to characterize the Anisopodidae and Mycetophilidae families.

2 Methods

The bibliographic review methodology consists of a review of existing bibliographic material that concerns the subject to be studied. This is one of the main steps for any research and includes the selection of different sources of information, which can be collected in theoretical books; Banks of theses and dissertations from universities; Scientific articles;

Scientific magazines; Documents; Websites; A bibliographic research methodology includes a set of phases that cover questions such as 1-Observation; Inquiry; Interpretation; Reflection; Analysis.

3 Study Selection

3.1 Study 1

The present work aims to determine the diversity of Diptera families, as well as determine seasonality, abundance, frequency, dominance, constancy, and evenness, in addition to relating them to climatic factors precipitation, temperature, and relative humidity in points unique in the Inhamum Ecological Reserve – REI, municipality of Caxias MA.

Sampling was carried out using Malaise-type flight interception traps and suspended, for 15 consecutive days, between June 2017 and May 2018.

Ninety-five thousand nine hundred and forty-five specimens were identified, grouped into 53 families, the most abundant were Cecidomyiidae Newman, Phoridae Curtis, Tabanidae Latreille, Ceratopogonidae Newman, Chloropidae Rondani, Dolichopodidae Latreille, Milichiidae Schiner, Sarcophagidae Macquart, Drosophilidae Rondani, Sciaridae Billberg, Periscelididae Oldenberg, Somatiidae Hendel, Mydidae Latreille, Anisopodidae Knab, Curtonotidae Duda, Syringogastridae Prado and Simuliidae Newman were the families with the lowest abundance.

Anisopodidae, Curtonotidae, Empididae Latreille, Periscelididae, Platypezidae Latreille, Simuliidae, Somatiidae, and Syringogastridae were exclusive to the rainy season; Mydidae and Mythicomiidae Melander exclusive to the dry season. The families with the greatest diversity and evenness were Asilidae Latreille, Dolichopodidae Latreille, and Clusiidae Handlirsch; while those with the lowest indices were Anisopodidae, Curtonotidae, Simuliidae, and Syringogastridae. In the rainy season, there was a greater abundance of individuals, most likely influenced by precipitation [17].

3.1.1 Sylvicola fenestralis (Scopoli, 1763)

The window tree is a species of nematocerous dipterous insect in the family Anisopodidae. This harmless dipteran with a reddish-brown body 4.5-5.5 mm long and 6-10 mm wingspan resembles a small Tipulidae or Trichoceridae. The chest has three dark longitudinal lines. The wings are decorated with dark spots and veins. Similar species can only be distinguished by examining the genitalia.

Ecology: It can be observed in Europe almost all year round in the vicinity of human habitations, where it is attracted to light and where it lands on windows hence its name, and can enter the interior. The larva lives in decaying organic plant matter compost and garbage [19].

4 Family Mycetophilidae

The Bibionomorpha are an infraorder of the suborder Nematocera. One of its constituent families, the Anisopodidae, is the presumed sister taxon to the entire suborder Brachycera. Several of the remaining families in the infraorder (those shown without common names) are former subfamilies of the Mycetophilidae, which has been recently subdivided. The family Axymyiidae has recently been removed from the Bibionomorpha to its own infraorder Axymyiomorpha [20].

The Bibionomorpha are saprophagous or fungivores as larvae with the Cecidomyiidae being predominantly gall-formers. Some sciarids are common indoor pests, developing large populations in potting soil that has become moldy from overwatering. The larvae of the Bibionidae sometimes migrate in large, snake-like masses to minimize dehydration while seeking a new feeding site [20-21].

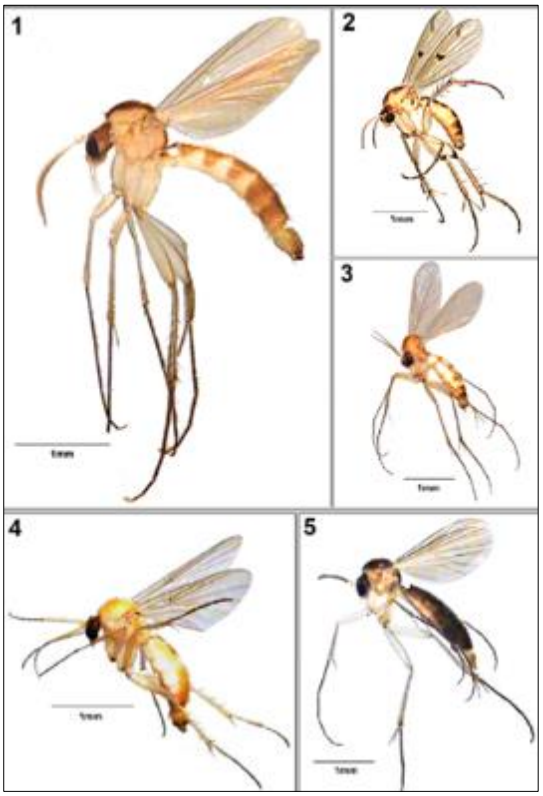
Brachycera is a suborder of insects of the order Diptera, which includes species known generically by the common name of flies. Most species feed on detritus or are predators, including several hematophagous species. This group is distinguished from the mosquito's suborder Nematocera by its short antennae, with few segments. The antennae are formed by three segments (the articles), the last of which ends in a long bristle, the arista, or in a multi-segmented article. As with most groups in Mycetophiliformia, little is known about their biology in general, but their larvae are often found in sporophores of fleshy fungi [20-22]. Mycetophilidae it is the second most numerous and diverse family of Bibionomorpha with 180 living genera and about 4,500 described species from all biogeographical regions. Although there is no consensus on the phylogenetic relationships within Mycetophilidae, the monophyly of the group is supported by morphological (Figure 5) [20-22].

Source: https://pt.dreamstime.com/foto-de-stock-micrografia-da-larva-do-mosquito-ampliada-na-%C3%A1gua-da-lagoa-image81665846 and file:///C:/Users/Lenovo/Downloads/Sevcik_2010_Diptera_fungi_LQ-1.pdf

Figure 5 Closed cocoons of fly larvae of the Mycetophilidae family

4.1 Description

Mosquitoes belong to the weevils, they have, as the name suggests, only one pair of wings, or two wings, the rear pair of wings being replaced by (transformed into) two swing clubs or club-shaped balance organs. Only a few species sting or bite. Mosquitoes can only be distinguished from flies by looking at the antennae, which should have more than 4 joints and be of the filamentous type, where the joints are the same size. (difficult to see, may require magnification). Mosquitoes often have slightly more pointed and longer wings, longer legs and a slightly slimmer body than flies. But the external appearance of some mosquitoes can be very similar to a fly, as with the Dung mosquitoes and the Knotten. All mosquitoes undergo a complete metamorphosis (Figure 6) [20-23].



Source: https://www.semanticscholar.org/paper/First-records-of-the-fungus-gnats-(Diptera%3A-reared-Barzegar-Zamani/262697d60be9acb6ba65481f99bfcfadd2c742ae/figure/0

Figure 6 figs. 1-5 Lateral habitus of the adult fungus gnats: 1-*Allodia ornaticollis* (Meigen, 1818); 2-*Mycetophila strigatoides* (Lundrock, 1927); 3-*Rymosia pseudocretensis* Burghele-Balacesco, 1967; 4-*Sciophila eryngii* Chandler, 1994; 5-*Synplasta gracilis* (Winnertz, 1863)

They have dot eyes. the palps are very short or absent, while the antennae are relatively long and usually filamentous (the joints may be flattened). The legs are long, especially the rear ones, and he hips (coxae) are extra-large. Often the hips are as "big" as the chest area. All legs have a stiff spur at the far end. The wings are usually glassy or yellowish but may have dark transverse bands. Most species are brown, yellow in color, but some are black and there are also a few that are more colorful. The fungus gnats look like simple mosquitoes. They begin to appear on your plants, in small numbers, and often go unnoticed, but when you least expect it, an infestation appears on your plants. The problem with this pest is not just the adults, the larvae that hatch from the eggs laid in the ground by them also harm the plants [20-23].

4.2 Biology, Ecology, Life cycle, Habitat, Damage and Control

Gnats are somewhat like biting mosquitoes, but a good look is missing the long, straight suction proboscis that biting mosquitoes have. Most of the fungus gnats have a large swollen chest area, the head is small and is attached far down the front of the chest so that the fungus gnat looks hunchbacked. The head is covered by large, faceted eyes, which do not meet (butt together) at the top of the head (Figures 7-8).

Sources: Credit: D. Cappaert, Bugwood.org and https://extension.unh.edu/resource/fungus-gnats-fact-sheet

Figure 7 *Bradysia* sp. Larva

Sources: Credit: Alan T. Eaton and https://extension.unh.edu/resource/fungus-gnats-fact-sheet

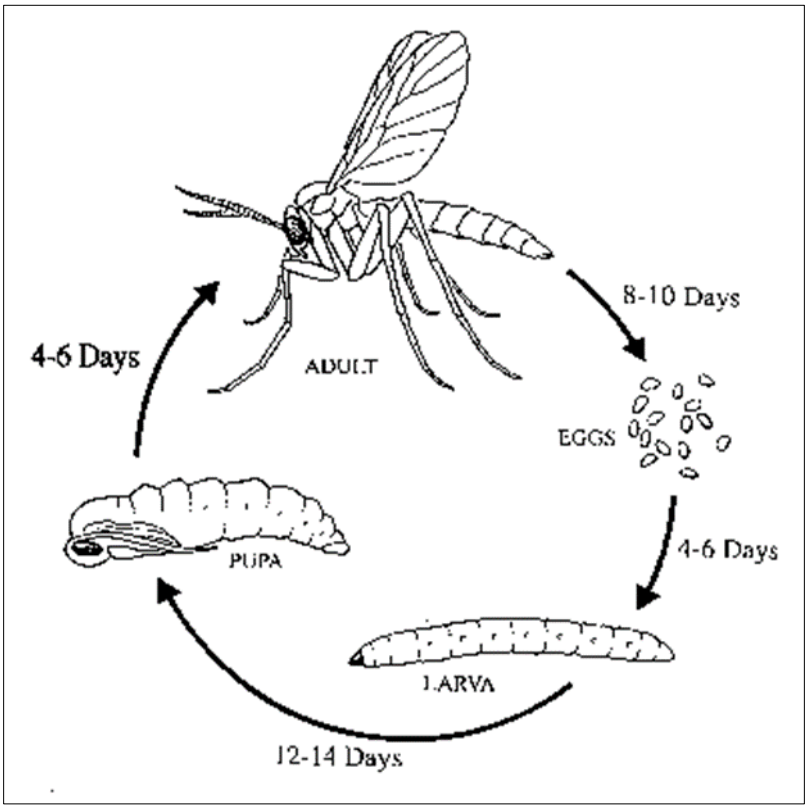
Figure 8 Split-open *Euphorbia pulcherrima* (Willd. Ex Klotzsch, 1834) (Euphorbiaceae) stems with several fungus gnat larvae inside

Fortunately, there are a variety of options for protecting yourself and your plants from this insect safely and effectively. See how to identify, control, and prevent fungus gnats' infestations in your plants. This insect, also known as the fungus

mosquito, is a very small mosquito, approximately 3 mm long, with long antennae and legs and is often mistaken for a mosquito. Despite the similarity, they are harmless to us humans.

Adult fungus gnats are tiny and grayish black in color. Its size varies from about 1.5 to 3 mm. Their legs are long, and the antennae are segmented, larger than their heads. They have dark, translucent wings that fold over their backs when at rest. The larvae of this insect can be up to 6 mm long and have a small, black head and a thin, white, or transparent body.

Knowing the life cycle of this insect is very important for you to know how to control this pest. At a temperature between 18 and 25 ºC, in 3 to 4 weeks the life cycle is completed. Reproduction indoors, that is, with plants indoors, can occur throughout the year. Adults are very short-lived. Females have a lifespan of 7 to 10 days, during which they lay around 250 to 300 eggs (Figure 9).



Sources: Credit: University of Massachusetts Amherst and http://www.organicgardeninfo.com/fungus-gnat.html

Figure 9 Life cycle of the fungus gnat

These eggs take about 5 to 6 days to hatch, and the larvae come out of it. These larvae feed on fungi, algae, decaying organic matter, and plant roots. It is important to say that they are on the surface of the soil, keep this information that will be very useful for us as a control method. After the larvae feed for approximately 14 days, they choose to pupate near the surface and after another 5 to 6 days' hatch into adult mosquitoes.

Mycetophilidae in Brazil, this insect mainly damages ornamental plants and causes great damage. Also, in seedlings of different crops, such as citrus, tobacco, strawberry, and others. Many sites on the internet say that adults do not harm plants, but this is a mistake. Fungus gnat's mosquitoes can cause great damage but in an indirect way. These little mosquitoes can carry harmful pathogens, that is, they can carry and spread diseases to your plants.

The larvae can feed on the roots, and leaves and can even be found inside the stem, this is especially bad for young plants, such as seedlings, which have only a few delicate roots. Therefore, when you see two plants withering or turning yellow, this could be caused by fungus gnats (without roots the plant cannot absorb water or nutrients). The most common insect causing damage to greenhouses and indoor plants. Below you see a nutritional problem in the *Cannabis sativa* L. (Cannabaceae) leaf caused by a fungus gnats' infestation. The prevention of these insects is directly related to irrigation and the soil, that is, it is necessary to control the humidity well so that the pest does not establish itself.

Most of the fungus fly's life cycle is spent as a larva and pupa, which are stages that take place on land. Therefore, reducing moisture and organic debris in the soil reduces problems with this pest. Let the soil dry out between waterings, especially the top surface, which is where fungus flies hang out. Another common method abroad, which is still new in Brazil, is the use of "Mosquito dunks". Generally, mosquito dunks are used to prevent mosquito larvae from populating fountains, pet waterers, fishponds, and other small bodies of water, but you can water your plants with this product (Figure 10).

Source: https://bugguide.net/node/view/398215/bgpage

Figure 10 Damage with fungus gnat

Because it is a better product used to fight this pest, we will talk about this method later, hold your curiosity for a bit. In addition to these practices mentioned, EMBRAPA (Brazilian Agricultural Research Company) recommends some others for prevention:

1-Increased ventilation and lighting; 2-Eliminate algae, slime, and fungus. Algaecide and fungicide products can also be used in the soil and in the material used in the production of seedlings; Do not use partially decomposed organic matter, that is, the organic compound when used as a substrate, must be completely decomposed; 4-Disinfest the general purpose material in the nursery; 5-Do not allow a layer of algae to form on the substrate; 6-Use a layer of sand (1 cm) on the substrate; 7. How to get rid of fungus gnats.

There are dozens of videos and websites on the internet with dubious practices to control fungus gnats, but in this article, I want to talk about two that are proven to be effective against this pest, which is the use of "mosquito dunks" and yellow sticky baits. Yes, this work. So, forget about those dubious methods that are said to be out there like ground cinnamon, potato slices in the soil, hydrogen peroxide, or diatomaceous earth.

Use of mosquito dunks to control fungus gnats The product consists of a dry pellet containing bacteria called *Bacillus thuringiensis* subsp. *israelensis*. These beneficial bacteria infect and kills the larvae of flying insects, including mosquitoes, fruit flies, and fungus gnats. For the control of adult mosquitoes, in addition to yellow sticky baits, plants can be used. It sounds like a lie, but some carnivorous plants are like true stickers for the fungus mosquito, such as those of the genus *Pinguicula* L. (Lentibulariaceae) L., *Drosera* L. (Droseraceae) and *Drosophyllum* Link (Droseraceae).

I recommend that you only use plants if the infestation is not high because even then, plants are not as efficient and malleable as sticky baits. Plants of the genus *Pinguicula* Plants of the genus *Drosera*. In this article, I showed you that fungus gnats (fungal mosquitoes) can cause direct and indirect damage to your plants. The indirect ones are related to the diseases they spread and to the nutritional deficiencies caused by the larvae eating the roots of the plants.

This insect spends most of its life cycle in the soil, so you need to be very careful with the land. Always use quality, well-drained soil, especially for your seedlings. Follow the recommendations for prevention and if your plants are already infested, buy the yellow bait immediately and use the product based on *Bacillus thuringiensis* subsp. *Israelensis* (Ben-Dov).

Around a dozen mycetophilid species are unique among flies in displaying bioluminescence. In some species, this is restricted to the larval stage, but in others this feature is retained by the pupae and adults. The ability to produce their own light may be used by some predatory larvae as a lure for potential prey, although it also obviously makes them more susceptible to predation or parasitism. These are not mycetophilids *sensu stricto*, but belong to the family Keroplatidae.

In the most recent classifications, the slime molds are divided into seven subfamilies: Sciophilinae, Gnoristinae, Mycomyiinae, Leiinae, Manotinae, Allactoneurinae and Mycetophilinae, of which only Allactoneurinae does not have Neotropical representatives. In some cases, a group such as a tribe of Gnoristinae and Metanepsiinae is treated as an independent subfamily, but this would certainly leave the Gnoristinae paraphyletic. Mycetophilidae in the Neotropical Region includes approximately 54 genera and 1,145 species.

In Brazil, 39 genera and approximately 360 species are known, in most of the South and Southeast regions of the country. At least half of the Mycetophilidae genera must have records in Mato Grosso do Sul [23-42].

5 Selected studies

5.1 Study 1

5.1.1 Mycetophilidae in Mato Grosso do Sul-Brazil.

Subfamily Sciophilinae. Genus *Cluzobra* Edwards, 1940. **Distribution:** Brazil (Mato Grosso do Sul and São Paulo).

Subfamily Gnoristinae. Genus *Dziedzickia* Johannsen, 1909. **Distribution:** Brazil (Pernambuco, Alagoas, Sergipe, Mato Grosso do Sul, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Santa Catarina). Argentina (Misiones), Brazil (Paraíba, Pernambuco, Mato Grosso do Sul, Minas Gerais, Rio de Janeiro, São Paulo and Santa Catarina).

Subfamily Mycomyiinae. Genus *Mycomya* Rondani, 1856. **Specie:** *Mycomya clavata* (Lynch, 1892). Distribution: Argentina (Salta), Brazil (Mato Grosso do Sul). **Genus** *Neoempheria* Osten-Sacken, 1878. **Specie** *Neoempheria pereirai* Edwards, 1940. **Distribution:** Brazil (Mato Grosso do Sul). States of São Paulo and Mato Grosso do Sul, in Brazil, and the provinces of Salta and Tucumán, in Argentina.

Subfamily Leiinae. Genus *Leia* Meigen, 1818. *Leia fuscicornis* Edwards, 1941. Distribuição: Brasil (Mato Grosso do Sul). **Genus** *Leia salobrensis* Edwards, 1941. **Distribution:** Brasil (Mato Grosso do Sul). *Leia incompleta* Edwards, 1933 (preocc. Curran, 1928). **Distribuição:** Brasil (Mato Grosso do Sul), Bolívia (Mapiri).

Genus Tetragoneura Winnertz, 1846. **Specie:** *Tetragoneura readfuscicornis* Edwards, 1941. **Distribution:** Brazil (Mato Grosso do Sul). **Specie:** *Tetragoneura salobrensis* Edwards, 1941. **Distribution:** Brazil (Mato Grosso do Sul). Specie: *Tetragoneura stonei* Lane, 1958. **Distribution**: Brazil (Mato Grosso do Sul) and Bolivia (Mapiri). *Tetragoneura flavicauda* Edwards, 1941. **Distribution:** Brazil (Mato Grosso do Sul), Ecuador (Napo).

Subfamily Mycetophilinae. *Epicypta* Winnertz, 1863. **Specie:** *Epicypta forattinii* Lane, 1960. **Distribution:** Brazil (Mato Grosso do Sul). **Species:** *Epicypta anambesi* lane, 1960. *Epicypta punctulata* (Lane, 1947). **Distribution:** Brazil (Mato Grande do Sul). *Epicypta planiventris* (Enderlein, 1910). **Distribution**: Brazil (Mato Grosso do Sul, Santa Catarina).

Genus *Neallodia* Edwards, 1932. **Specie:** *Neallodia brevicornis* (Enderlein, 1910). **Distribution:** Brazil (Mato Grosso do Sul, Santa) [42].

5.2 Study 2

The aim of this study was to evaluate the virulence of entomopathogenic nematodes against larvae *Bradysia mabiusi* (Lane, 1959), under laboratory conditions.

The nematode *Heterorhabditis indica* Poinar et al. 1992, IBCB-n05 caused 100% insect mortality. However, this value did not differ significantly from the results obtained with *Heterorhabditis* sp. IBCB-n10 and *Steinernema carpocapsae* (Nematoda, Steinernematidae) Alves, Alves, Quadro, 2009 CCA, with 96%, 83%, respectively ($F = 16.5$; $P = 0.848$). The nematode *Steinernema glaser* (Glaser and Fox, 1930), CCA was little virulent for fungus fly larvae, with 16.5% mortality, significantly differing from the other nematodes ($P< 0.001$), but not from the control ($P = 0.848$). Sciarid larvae killed by heterorhabditids showed a very characteristic symptom, with a reddish color resulting from their colonization by bacteria of the *Photorhabdus* Boemare et al. 1993.

In the experiment carried out in Holambra, the nematode at dosages of 5.7 and 22.6 JI/cm2 (equivalent to 5.7 x 108 and 2.26 x 109 JI/ha, respectively) provided, respectively, 67 and 80% of mortality corrected after 24 hours of application. However, there was no significant difference between these treatments in terms of actual mortality ($F = 24.8$; $P< 0.540$), with both differing from the control ($P< 0.001$).

At 15 days after the application, the corrected mortality did not exceed 6% (lowest dose), with no significant difference between the treatments in terms of actual mortality (F = 0.02; P = 0.97). In the test carried out at the Experimental Center, the nematode *H. indica* IBCB-n05, at dosages of 10 and 50 IJ/cm2 (equivalent to 1 x 109 and 5 x 109 IJ/ha, respectively), provided 69% and 97% mortality corrected larvae after 24 hours of application, respectively, with no significant difference between these treatments in terms of actual mortality (F = 28.6; P = 0.11), with both differing from the control (P< 0.001). At 15 days of application, the corrected mortality did not exceed 15% (highest dose), with no significant difference between treatments in terms of mortality real (F = 0.18; P = 0.83).

In general, the nematode H. indica IBCB-n05 presents I have the same performance in persistence tests carried out at Interplant and at Centro Experimental, in the evaluations made 24 hours and 15 days after application. Based on the first test evaluation carried out at Interplant, I could recommend give a dosage of 22.6 JI/cm2, equivalent to 2.26 x 109 JI/ha, as it resulted in 80% mortality of insects [43].

5.3 Study 3

5.3.1 Fungus gnats

Affected Crops: All cultures with occurrence of the biological target.

Fungus gnats are different species of dipterans from the families Sciaridae, Keroplatidae, Mycetophilidae and some smaller ones. Among the sciarids, the larvae of species of the fungus flies in general, feed on the root system of plants in protected cultivations and may cause direct and indirect damage through the transmission of phytopathogens. These species are considered important pests in mushroom crops and seedling nurseries, attacking citrus, tobacco, ornamentals and several other plants of economic importance.

Damage: The larvae of this insect feed on fungi, algae and decaying organic matter, living in damp and dark environments. However, when established, the larvae start to feed on the roots of the plants, with tunnels in the thickest roots, causing damage of great importance, mainly, in small seedlings in the germination phase, and the death of the plants in cases of infestations. heavy. In addition, indirect damage to plants can also be caused by larvae and adults acting as vectors of phytopathogenic fungi.

Control: Use of biological control using the nematode *Steinernema feltiae* Filipjev, 1934. The humid and shaded environment prevailing in seedling propagation areas favors the nematode, which attacks both the larva and the pupa of the insect, providing control levels of up to 90%. Biological products based on the mite *Stratiolaelaps scimitus* (Womersley, 1956) (Acari: Laelapidae) can also be used to control young fungus fly larvae [44-45].

6 Conclusion

The Mycetophilidae family is predominant in the cultivation of fungus mushrooms and is captured in a greater number of individuals. As an alternative control for mushroom cultivation insects, especially *Pleurotus*, light traps can be used, as well as the arrangement of adhesive tapes, inside the cultivation environment, suitable for capturing insects. Representatives of family Anisopodidae many genera are captured with puçás or various types of insect collection traps, such as light traps, Moericke, Malaise, pitfall, and Shannon. In the latter, fermented fruits are often used as bait. Decaying wood and fungi can be collected and kept in the laboratory until adults emerge. The Neotropical fauna is still little known.

References

[1] Oliveira S. About mosquitoes [Internet]. São Paulo: University of São Paulo; @ 2019 [cited 2023 Oct 15]. Available from http://formatempoeespaco.blogspot.com/2010/09/sobre-mosquitos.html.

[2] Oliveira SS, Falaschi RL, Urso-Guimarães MV, Amorim DS. Checklist of the Bibionomorpha (Diptera) of the State of Mato Grosso do Sul, Brazil. Iheringia, Série Zoologia. 2017; 107: e2017127.

[3] Amorim DS. Anisopodidae. 1st ed. San José: National Institute of Biodiversity Costa Rica. 1997.

[4] Sánchez O, Rodrígue AA. Scientific advice for the execution of the action plan for the detection and control of the Asian hornet in the Principality of Asturias. 1st ed. Oviedo: University of Oviedo. 2022.

[5] Bisby FA, Roskov YR, Orrell TM, Nicolson D, Cleaning L, Bailly N, Kirk PM, Bourgoin T, Baillargeon G, Ouvrard D. Species 2000 & ITIS Catalog of Life: 2011 Annual Checklist. 1st. ed. Ginkuhà: Species 2000. 2012.

[6] Navarrete-Carballo JC. Diversity of seven families of nematoceran Diptera (Insecta: Diptera) from the Puuc State Biocultural Reserve, Yucatán [Ph.D. dissertation]. Mérida: Management of Tropical Natural Resources, Autonomous University of Yucatán; 2017.

[7] Borkent A, et al. Remarkable fly (Diptera) diversity in a patch of Costa Rican cloud forest: Why inventory is a vital science. Zootaxa. 2018; 4402(1): 053–090.

[8] Falaschi RL, Oliveira SS, Lamas CJE. Catalogue of Anisopodidae (Diptera, Bibionomorpha) types housed in the collection of the Museu de Zoologia da Universidade de São Paulo, Brazil. Revista Brasileira de Entomologia. 2016; 60: 24–29.

[9] Brown BV, et al. A comprehensive inventory of true flies (Diptera) at a tropical site. Communications Biology. 2018; 1: 21.

[10] Carles-Tolrá M. Mycetobiinae, a new subfamily of Diptera for Galicia, and new captures of Ragadinae (Diptera: Anisopodidae, Empididae) (Spain, Galicia). Entomoloxic Archives. 2023; 26:187-189.

[11] Kurina O, Süda I. *Mycetobia obscura* Mamaev, 1968-The first records of Mycetobiinae (Diptera, Anisopodidae) from the Baltic States. Check List. 2021; 17(6): 1509-1514.

[12] Carles-Tolrá M, Hjorth-Andersen. Catalog of the Diptera of Spain, Portugal, and Andorra (Insecta). 1st ed. Catalog of the Diptera of Spain, Portugal, and Andorra (Insecta) Monographs. Zaragoza: Aragonese Entomological Society. 2002.

[13] Evenhuis NL, Pape T. Systema Dipterorum [Internet]. Honolulu: Bishop Museum; @2021 [cited 2023 Oct 15]. Available from http://diptera.org.

[14] Amorim DS, Falaschi RL, Oliveira SS. Family Anisopodidae. Zootaxa. 2016; 4122(1): 15–19.

[15] Thompson FC. New *Mesochria* species (Diptera: Anisopodidae) from Fiji, with notes on the classification of the family. Bishop Museum Occasional Papers. 2006; 86: 11–21.

[16] Michelsen V. Wood gnats of the genus *Sylvicola* (Diptera, Anisopodidae): taxonomic status, family assignment, and review of nominal species described by J.C. Fabricius. Journal of Entomology, 1999; 142: 69–75.

[17] Silva Neto CQ. Diversity OF Diptera (Insecta) - in a single point - in the Inhamum Ecological Reserve, Municipality of Caxias, State of Maranhão, Brazil [Internet]. Caxias: Universidade Estadual do Maranhão; @ 2018 [Cited 2023 Oct 15]. Available from https://sis.sig.uema.br/sigaa/public/programa/noticias_desc.jsf?lc=pt_BR&id=939&noticia=8807621.

[18] Amorim DS, Falaschi RL, Oliveira SS. Family Anisopodidae. Zootaxa. 2016; 4122(1): 015–019.

[19] Dvorak L, Andrade R. New records of window-gnats from Portugal (Diptera: Anisopodidae). Bulletin of the Aragonese Entomological Society. 2016; 58: 231–232.

[20] Bei-Bienko GY, Steyskal GC. Keys to the Insects of the European Part of the USSR. Diptera and Siphonaptera, Part I. 5st ed. New Delhi: Amerind Publishing Co. 1988.

[21] Gilberto. Fungus gnats: How to identify and 2 super effective control methods [internet]. Goiânia: Ask the agronomist; @ 2023 [cited 2023 Aug 26]. Available from https://pergunteaoagronomo.com.br/fungus-gnats/.

[22] Amorim DS, Yeates D. Pesky gnats: ridding dipteran classification of the Nematocera. Study Dipterologica. 2006: 13(1/2): 3-9.

[23] Hackman W, Laštovka P, Matile L, Väisänen R. Family Mycetophilidae (Fungivoridae). In: Soós A, Papp L, eds. Catalogue of Palaearctic Diptera, Ceratopogonidae-Mycetophilidae. 1st ed. Amsterdam: Elsevier; 1988; p. 220–327.

[24] Yakovlev EB. Palearctic Diptera associated with fungi and Myxomycetes. 1st ed. Petrozavodsk: Karelian Research Center, Russian Academy of Sciences, Forest Research Institute. 1994.

[25] Matile L. Family Mycetophylidae [internet] Sidney: Australasian/Oceanian Diptera Catalog — Web Version. Mycetophilidae; @1999 [cited 2023 Aug 26]. Available from https://en.wikipedia.org/wiki/Mycetophilidae.

[26] Bertone MA, Courtney GW, Wiegmann BM. Phylogenetics and temporal diversification of the earliest true flies (Insecta: Diptera) based on multiple nuclear genes. Systematic Entomology. 2008; 33(4): 668-687.

[27] Hutson AM, Ackland DM, Kidd LN. Mycetophilidae (Bolitophilinae, Ditiomyiinae, Diadocidiinae, Keroplatinae, Sciophilinae and Manotinae). Diptera, Nematocera. Handbooks for Identification of British Insects. 1980; 9: 1–109.

[28] Pape T, Blagoderov V, Mostovski MB. Order Diptera Linnaeus, 1758. Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa. 2011; 3148: 222-229.

[29] Chandler PJ, Gatt P. Fungus gnats (Diptera, Bolitophilidae, Keroplatidae, and Mycetophilidae) from the Maltese Islands. Studia Dipterologica. 2000; 7: 69–81.

[30] Chandler PJ, Báez M. Catalog of the Diptera of Spain, Portugal and Andorra (Insecta). 8th ed. Zaragoza: Monographs Aragonese Entomological Society; 2002. p. 59–64.

[31] Chandler P, Blasco-Zumeta J. The fungus gnats (Diptera, Bolitophilidae, Keroplatidae, and Mycetophilidae) of the Monegros Region (Zaragoza, Spain) and five other new European species of *Pyratula* Edwards and *Sciophila* Meigen. Zapater. 2001: 9: 1–24.

[32] Chandler PJ, Bechev DN, Caspers N. The fungus gnats (Diptera: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae, and Mycetophilidae) of Greece, its islands, and Cyprus. Studia Dipterologica. 2005; 12: 255–314.

[33] Rindal E, Soli GE, Bachmann L. Molecular phylogeny of the fungus gnat family Mycetophilidae (Diptera, Mycetophiliformia). Systematic Entomology. 2009: 34: 524-532.

[34] Chandler PJ. The fungus gnats (Diptera: Bolitophilidae, Keroplatidae, Mycetophilidae) of Sardinia, with the description of six new species. Research on the terrestrial arthropods of Sardinia (Italy). Zootaxa. 2009; 2318: 450–506.

[35] Oliveira SS, Amorim DS. Catalog of Neotropical Diptera. Mycetophilidae. Neotropical Diptera. 2014; 25: 1-87.

[36] Brown BV. Handbook of Central American Diptera. 1st ed. Ottawa: NRC Research Press. 2009.

[37] Oliveira SS. Dziedzickia Johannsen and Schnusea Edwards (Diptera, Mycetophilidae): Neotropical species diversity and phylogenetic analysis [Internet]. Ribeirão Preto: Master's Dissertation. University of Sao Paulo; @ 2009 [cited 2023 Aug 26]. Available from https://www.scielo.br/j/isz/a/Mg9h6nXrSMjkQQsXbDn4sCb/.

[38] Amorim DS. A phylogenetic analysis of the basal groups of Bibionomorpha, with a critical reanalysis of the wing vein homology. Brazilian Journal of Biology. 1993; 52(3): 379-399.

[39] Amorim DS, Oliveira SS. Types of Neotropical Mycetophilidae (Diptera) at the Natural History Museum collection. Zootaxa. 2013; 3726: 1-119.

[40] Amorim DS, Oliveira SS, Balbi MIPA. First Neotropical species of genus *Azana* (Diptera: Mycetophilidae: Sciophilinae). Zootaxa. 2008; 1937: 67-68.

[41] Amorim DS, Rindal E. A phylogenetic study of the Mycetophiliformia, with the creation of the subfamilies Heterotrichinae, Ohakuneinae, and Chiletrichinae for the Rangomaramidae (Diptera, Bibionomorpha). Zootaxa. 2007; 1535: 1-92.

[42] Sivinski JM. Phototropism, bioluminescence and the Diptera. Florida Entomologist. 1998; 81(3): 282–292.

[43] Oliveira SS. Checklist of the Bibionomorpha (Diptera) of the State of Mato Grosso do Sul, Brazil. Iheringia, Zoology Series. 2017; 107: e2017127.

[44] Milk LG. Virulence of entomopathogenic nematodes (Nematoda: Rhabditida) against fungi fly larvae *Bradysia Mabiusi* (Lane, 1959) and persistence of *Heterorhabditis indica* poinar et al. 1992 on organic substrates. Archive of the Biological Institute. 2007; 74(4): 337-342.

[45] Fungus flies [Internet]. Goiânia Agro link; @ 2021 [cited 2023 Aug 27]. Available from https://www.agrolink.com.br/problemas/moscas-dos-fungos_3122.html.