

Banana fly (Insecta: Diptera: Drosophilidae).

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Drosophilidae which have a mycophagous habit, many flies use the fructifications of macroscopic fungi as the main resource for oviposition and feeding their larvae. However, these are not the only ways in which these structures are used: males of some species of *Zygothrica* Wiedemann 1830 use fungi as combat arenas for dominance over territory and females, and even present polymorphisms related to this behavior (Figure 1) [1-3].

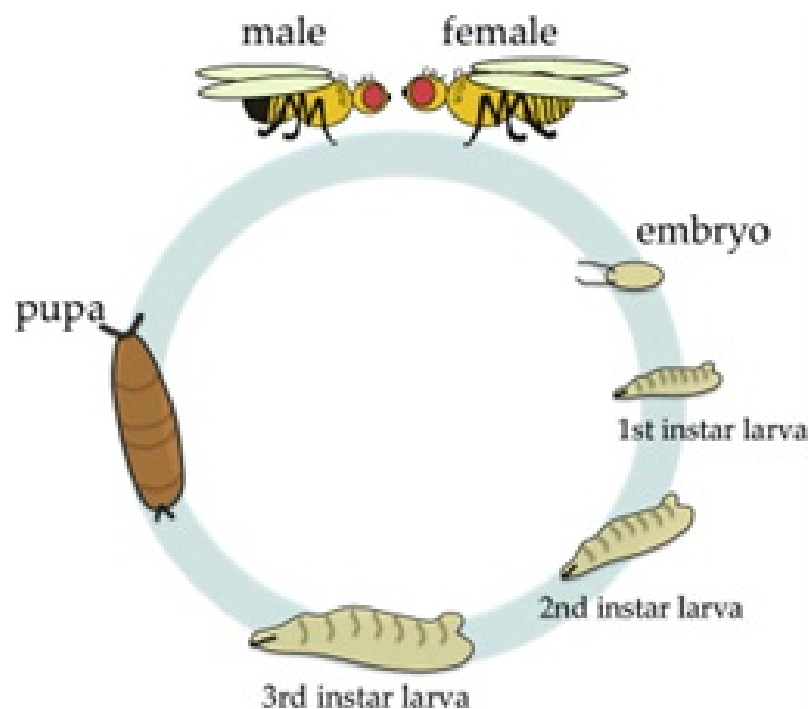


Figure 1. *Drosophila Melanogaster* (Meigem, 1830) life cycle. The entire life cycle lasts approximately 10 days at 25°C. Flies complete embryonic development as eggs before hatching as first instar larvae. The larvae eat, grow, and molt through three instar stages before pupariating. Flies undergo metamorphosis during the pupal stage and adult structures are formed. Upon completing metamorphosis, an adult fly hatch. Source: https://www.researchgate.net/figure/Drosophila-melanogaster-life-cycle-The-entire-life-cycle-lasts-approximately-10-days-at_fig2_323467189.

For this genus, only a part of the species seems to use fungi as resources for oviposition and feeding, therefore, the use

of the term mycophilia is suggested. However, there are species whose larvae are found in nephric pads under the third maxilliped of crabs, eggs of spiders, dragonflies, Hemiptera, foamy secretions of frogs, leafhopper nymphs, and secretions from mammalian eyes. For a long time, it was believed that yeast and bacteria were the only source of nutrients for the larvae of these flies [4-7].

Exhibit predatory behavior of aquatic larvae of mosquitoes, a commensal of crabs, spiders, bees, parasitic from lepidopteran caterpillars, and even cannibalism, in the case of larvae that are found in an overpopulated resource. Yeast is considered a diffuse mutualism, as yeasts are not dispersed by wind, and depend on other insects, such as drosophiles, for their dispersal to other environments. Acting as vectors, drosophiles transport yeast to the outside of their bodies and eliminate them through defecation and regurgitation [8-11].

1. *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae).

The genus *Zaprionus* (Coquillett, 1902) is made up of 56 species, and *Z. indianus* seems to be the only species spreading out around the globe, mainly due to international fruit trading. This Drosophilidae is probably from Africa, where it was registered in fruits of 74 plant species. The first record of the occurrence of this fly in the American continent refers to samples observed in persimmon fruit in Santa Isabel, São Paulo. Its polyphagy and relatively fast development in hot weather environments have contributed to its setting and dispersion. The fig production recorded a loss of 50% in the state of São Paulo due to this fly (Figures 2-3) [12-15].



Figure 2. *Zaprionus indianus* Gupta, 1970 (Diptera: Drosophilidae). Sources: Photo#1312217 and <https://bugguide.net/node/view/1312217>.



Figure 3. Fig infested with *Zaprionus indianus* larvae Gupta, 1970. Source: https://www.researchgate.net/figure/Figo-infestado-com-larvas-de-Zaprionus-indianus_fig1_267833234.

Drosophila suzukii (Matsumura, 1931).

The main damage caused by *D. suzukii* is caused by the larvae feeding inside the fruits. However, the insertion of the ovipositor by the female opens entry points for infestations secondary, such as filamentous fungi, yeasts, and bacteria. Furthermore, the attack of this pest depreciates the quality of the fruits, reducing the useful life of the product in the post-harvest period [15-16].

Monitoring is generally carried out using traps (McPhail) with attractive baits, the same system used for Drosophilidae. The bait that was most attractive to *D. suzukii* was the combination of apple cider vinegar and red wine, in a 40:60 ratio. The control method most used in places where this pest occurs is chemical control. Organophosphates, pyrethroids, and spinosad showed good results in control by contact and residual power on *D. suzukii*, on cherry, raspberry, blueberry, strawberry, and grapevine. Neonicotinoids and systemic organophosphates have ovicidal action and the ability to control larvae inside the fruits. The use of the insecticide Malathion in low doses appears to be efficient in controlling this pest [15-17].

The difficulty in finding egg and larvae parasitoids that control this pest can be explained by the fact that *D. suzukii* is capable of ovipositing inside intact and healthy fruits, making it difficult for biological control agents to attack. *Ganaspis xanthophoda* (Ashmead, 1896) (Hymenoptera, Figitidae) and *Asobara japonica* Belokobylskij, 1998 (Hymenoptera, Braconidae), *Leptopilina japonica* Novković & Kimura (Hymenoptera, Figitidae) and *Pachycrepoideus vindemmiae* (Rondani, 1875) (Hymenoptera, Pteromalidae) [18-20].

The recent occurrence of *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae), also known as spotted-wing *Drosophila*, causing damage to small fruit crops (blackberries, raspberries, blueberries, and strawberries) and native fruits, has made it one of the main phytosanitary threats to these crops. The species, which is native to the Asian continent, quickly expanded throughout North America and Europe and, more recently, through Brazil (Figure 4) [20-23].



Figure 4. Male *Drosophila suzukii* (Matsumura, 1931). Sources: Photo by John Davis and https://www.researchgate.net/figure/Male-Drosophila-suzukii-Matsumura-1931-photo-by-John-Davis-source_fig1_291791689.

Among the species of insects belonging to the Drosophilidae family, *D. suzukii* is the only one in which the females have a serrated-type ovipositor apparatus, which allows them to lay eggs inside the fruits, causing damage to intact fruits with thin skins. In strawberry plants, the losses are even more pronounced, as in addition to the damage resulting from the oviposition of *D. suzukii*, they allow the infestation of the fig fly *Z. indianus* (Figure 5) [20-23].



Figure 5. Cherry fruit damaged by *Drosophila suzukii* (Matsumura, 1931) larvae feeding. Source: <https://biblioteca.inia.cl/bitstream/handle/20.500.14001/67178/Informativo%20INIA%20N%C2%B0%2072?sequence=1&isAllowed=y>.

To avoid economic damage and reduce the population rates of these insect pests, chemical control has been the most used management method worldwide, carried out mainly with phosphorus insecticides, pyrethroids, and spinosyns. In addition to chemical control, other measures are essential for adequate pest management, including:

1- Reduction in the harvest interval, minimizing the supply of ripe fruits, more susceptible to pest attack, in addition to eliminating spoiled fruits from the cultivation area.

- 2- Destruction of discarded fruits, either by burying them in the ground at a minimum depth of 20cm from the surface, macerating them and distributing them on a surface for direct exposure to the sun, or even exposing them inside plastic bags and, subsequently leaving them in the sun for three days.
- 3- Elimination of old leaves from strawberry plants to improve aeration, light penetration and decrease humidity between plants, since *D. suzukii* prefers sheltered and humid areas.
- 4- Use of screens (exclusion net with 0.80mm to 0.98mm mesh), such as in semi-hydroponic strawberry cultivation, to prevent or reduce the entry of the pest into the cultivation.
- 5-Elimination of old leaves from strawberry plants, improving aeration, and light penetration, and reducing plant humidity, since *D. suzukii* prefers sheltered and humid areas.
- 6- Use of the entomopathogenic fungus *Beauveria bassiana* (Bals.) Vuil., 1912 (Hypocreales: Cordycipitaceae) to control adults when there is an increase in adult capture levels in monitoring traps.
- 7- There is potential for biological control using parasitoids. Parasitoids are natural enemies responsible for controlling the pest species, killing the host before its emergence occurs [23-37].

References

- [1] Barraclough DA. An illustrated identification key to the Acalyprate fly families (Diptera: Schizophora) occurring in southern Africa. *Annals of the Natal Museum*. 1995; 36: 97–133.
- [2] Lachaise D, Tsacas L. Breeding-sites. In: tropical African Drosophilids. In: Ashburner M, Carson HL, Thompson JRJN, eds. *The genetics and biology of Drosophila*. 3rd ed. London: Academic Press. 1983. p. 221-332.
- [3] Mendes M, et al. The use of the trophic resource by exotic and native species Drosophilidae: fruit colonization on the plant. *Drosophila Information Service*. 2019; 102: 18-20.
- [4] Brito RR. Drosophilidae (Insecta, Diptera) in the Amazon Brazilian [Internet]. Belém: Course Completion Work; Federal University of Pará; @2021 [cited 2024 Mar 27]. Available from https://bdm.ufpa.br:8443/jspui/bitstream/prefix/4342/1/TCC_DrosophilidaeInsectaDiptera.pdf.
- [5] Bächli G. TaxoDros: The database on taxonomy of Drosophilidae. [Internet]. Zurich: Zoological Museum of the University of Zurich; @2022 [cited 2024 Jan 04]. Available from <https://www.zm.uzh.ch/de.html>.
- [6] Poppe JC. Uncovering the fauna of the Pampa Biome in Rio Grande do Sul: Inventory of the Drosophilidae (Insecta, Diptera) fauna [Internet]. Rio Grande do Sul: University Federal of Rio Grande do Sul; @2013 [cited 2024 Jan 04]. Available from <https://lume.ufrgs.br/bitstream/handle/10183/143555/000885586.pdf?sequence=1&isAllowed=y>.
- [7] Fernandes DRR, Lara RIN, Perioto NW. Drosophilidae and Their Parasitic Hymenoptera in a *Coffea arabica* L. CRO. *Coffee Science*. 2009; 4(2): 110-113.

- [8] Mata RA, Mcgeoch DA, Tidon MR. *Drosophilids* (Insecta, Diptera) as tools for conservation biology. *Natureza & Conservação*. 2010; 8: 60–65.
- [9] Santos JPJ. Description of new neotropical species of *Hirtodrosophila* and *Mycodrosophila* (Diptera, Drosophilidae) based on morphological and molecular data [Internet]. Santa Maria: Universidade de Santa Maria; @2013 [cited 2024 Jan 04]. Available from https://repositorio.ufsm.br/bitstream/handle/1/22392/DIS_PPGBA_2013_SANTOS_JO%C3%83O.pdf?sequence=4&isAllowed=y.
- [10] Başpınar H, et al. Seasonal abundance and diversity of the family Drosophilidae (Diptera) and records of some other Diptera in orchards in Aydın Province (Türkiye). *Turkish Journal of Entomology*. 2022; 46(3): 289-298.
- [11] Santos RA. Larval development substrates of Drosophilidae (Diptera) in the forest reserve of the USP Biosciences Institute [Internet]. São Paulo: Master's dissertation at the University of São Paulo; @2019 [cited 2024 Jan 04]. Available from <https://teses.usp.br/teses/disponiveis/41/41131/tde-02082019-084917/publico/DissertacaoAugustoRampasso.pdf>.
- [12] Mendes M, Valer F, Viera J, Blauth M, Gottschalk M. Diversity of Drosophilidae (Insecta, Diptera) in the Restinga forest of southern Brazil. *Brazilian Journal of Entomology*. 2017; 6: 248-246.
- [13] Valer FB, Bernardi E, Mendes MF, Blauth M, Gottschalk M. Diversity and associations between Drosophilidae (Diptera) species and Basidiomycetes in a Neotropical Forest. *Annals of the Brazilian Academy of Sciences*. 2016; 88: 705-718.
- [14] Carvalho DA, et al. The use of the fruit *Diospyros inconstans* as a resource for oviposition of Drosophilidae (Insecta, Diptera) [Internet]. Pelotas: XXVII Congress of Scientific Initiation; @2018 [cited 2024 Jan 04]. Available from <https://www.prp.unicamp.br/pibic/congressos/xxviicongresso/index.php>.
- [15] Tidon R, Almeida JMD. Family Drosophilidae. *Zootaxa*. 2006; 4122: 1-719.
- [16] Markow TA, O'Grady P. Reproductive ecology of *Drosophila*. *Functional Ecology*. 2008; 22: 747–759.
- [17] Deus PHM, Roque F. High abundance of exotic drosophilids in a gallery forest of the Brazilian savanna. *Drosophila Information Service*. 2016; 99: 44–47.
- [18] Chaves NB, Tidon R. Biogeographical aspects of drosophilids (Diptera, Drosophilidae) of the Brazilian Savanna. *Brazilian Journal of Entomology*. 2008; 52: 340-348.
- [19] Bøhn T, Sandlund OT, Amundsen PA, Primicerio R. Rapidly changing life history during invasion. *Okios*. 2004; 106: 138–150.
- [20] Commar LS, et al. A taxonomic and evolutionary analysis of *Zaprionus indianus*. *Genetics and Molecular Biology*. 2012; 35: 395–406.
- [21] Santos JF, et al. Colonization Northeast Region of Brazil by the drosophilid flies *Drosophila malerkotliana* and

Zaprionus indianus, a new potential insect pest for Brazilian Fruitculture. *Drosophila* Information Service. 2003; 86: 92–95.

[22] Van Der L, et al. First records of *Zaprionus indianus* (Diptera: Drosophilidae), a pest species on commercial fruits from Panama and the United States of America. *Florida Entomologist*. 2006; 89: 402–404.

[23] Schlesener DCH, Wollmann J, Nunes AM, Lamb J, Gottschalk MS, Garcia FRM. *Drosophila suzukii*: a new pest for the Brazilian fruit production. *Biological*. 2015; 77(1): 45-51.

[24] Rohde C. Invasive species of the family Drosophilidae (Diptera, Insecta) in environments of the Caatinga of Pernambuco. *Annals of the Pernambuco Academy of Agricultural Science*. 2010; 7: 227-240.

[25] Sene FM, Val FC. Occurrence of *Drosophila malerkotliana* Parshad and Paika, 1963, in South America. *Science and Culture*. 1977; 29: 716.

[26] Rocha CS, Martins MB. Diversity of Drosophilidae (Diptera), with emphasis on *Drosophila (Sophophora)*, in Amazonian Forest Areas [Internet]. Belém: Scientific Initiation Seminar at the Goeldi Museum; @2006 [cited 2024 Jan 04]. Available from <https://repositorio.museu-goeldi.br/handle/mgoeldi/2351>.

[27] Santos RS. II Regional Research Congress of the State of Acre and [Internet]. Rio Branco: II Regional Research Congress of the State of Acre and XXV UFAC Scientific Initiation Seminar; @2016 [cited 2024 Jan 02]. Available from <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/163681/1/26371.pdf>.