

(REVIEW ARTICLE)



## Bionomic of the Dolichopodidae Family (Insecta: Diptera)

Carlos Henrique Marchiori \*

*Instituto Federal Goiano, Biology, Parasitology, Goiânia, Goiás, Brazil.*

Open Access Research Journal of Biology and Pharmacy, 2022, 04(01), 048–059

Publication history: Received on 03 January 2022; revised on 05 February 2022; accepted on 07 February 2022

Article DOI: <https://doi.org/10.53022/oarjbp.2022.4.1.0026>

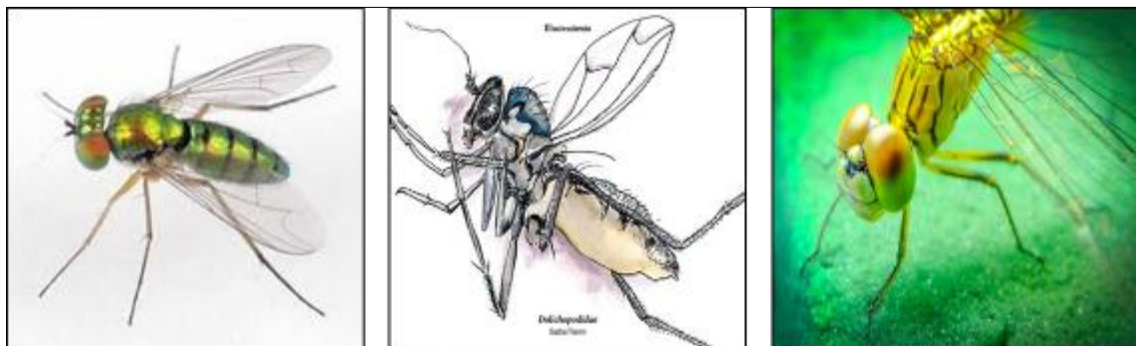
### Abstract

Although Dolichopodidae is a family with many species, little is known about the diversity of species associated with agricultural environments and how their abundances are distributed in different habitats. To date, only one unidentified species of *Condylostylus* has been recorded in association with agricultural systems and presents high abundance in areas with vegetable crops, when compared to agroforestry systems. The purpose of this article is to obtain description of the Dolichopodidae Family (Insecta: Diptera). In this article, the bionomy of the Dolichopodidae Family will be studied. To this end, a bibliographic survey of Dolichopodidae was carried out in the years 1940 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events, Doctoral Thesis and Master's Dissertation were considered. Data were also obtained from platforms such as: Academia.edu, Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic, Science and ERIC.

**Keywords:** Predator; *Orthoceratium lacustre*; Coleopteran; Larvae; Biological control

### 1. Introduction

One of the ways to assess the functionality of management practices, with regard to the natural biological control of pests in an agricultural landscape, is to know the fauna of predators present there, among which the group of flies can be highlighted Dolichopodidae (Figure 1) [1,2,3].

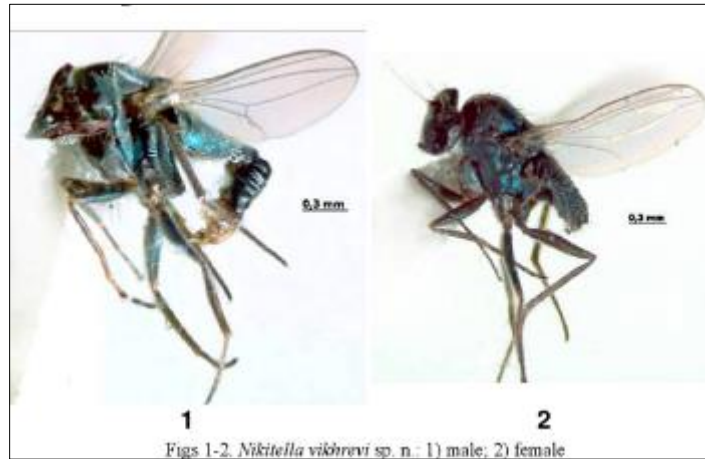


**Figure 1** Specimens of Dolichopodidae Family; (Source: <https://pxhere.com/pt/photo/499107>)

In general, most species prey on small soft-bodied invertebrates. However, this information is limited for neotropical species, with a lack of knowledge about their eating habits and functionality in ecosystems. Present complete metamorphosis during development, that is, they develop from an egg, they pass through the larval and pupae stages

\* Corresponding author: Carlos Henrique Marchiori  
Instituto Federal Goiano, Biology, Parasitology, Goiânia, Goiás, Brazil.

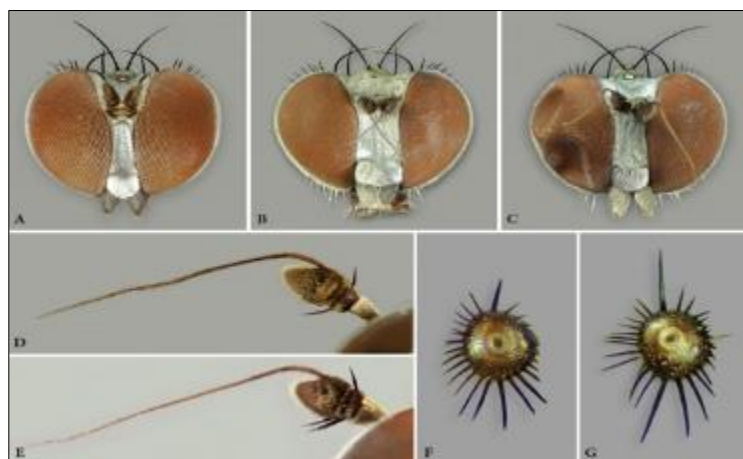
before becoming adults. Larvae are predominantly predators and some are phytophagous. It has been reported as an important natural enemy of aphids in wheat (Figures 2, 3, 4, 5, 6, and 7) [4,5,6].



**Figure 2** *Nikitella vikhrevi* sp. n.: 1) male; 2) female; (Source: <https://www.semanticscholar.org/paper/THREE-NEW-GENERA-OF-MEDETERINAE->)



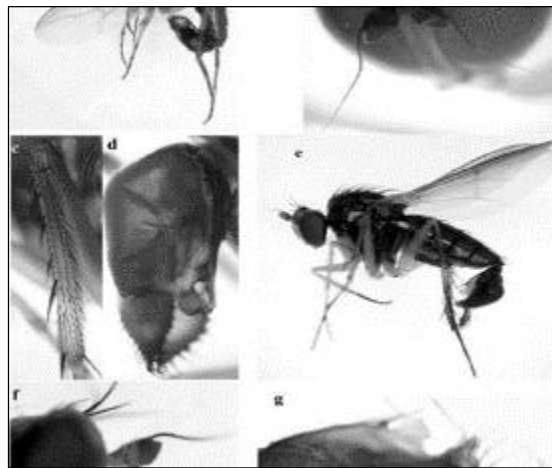
**Figure 3** Two male long-legged flies showing examples of specialized body features used in courtship: flags on the front legs (left) and modified antennae (right); (Source: <https://ohioline.osu.edu/factsheet/ent-69>)



**Figure 4** *Orthoceratium lacustre* (Scopoli, 1763) head: A face (male) B face (female) D antenna (male) F pedicel, posterior view (male). *Orthoceratium sabulosum* (Becker, 1907), head: C face (male) E antenna (male) G pedicel, posterior view (male); (Source: Pollet M, Stark A. The quest for the identity of *Orthoceratium lacustre* (Scopoli, 1763) reveals centuries of misidentifications (Diptera, Dolichopodidae). ZooKeys. 2018; 782: 49-79.)



**Figure 5** *Orthoceratium lacustre* (Scopoli, 1763), male: A femur I (posteroventral view) B tarsomere I 5, with left tarsus on the left and right tarsus on the right hand side (dorsal view). *Orthoceratium sabulosum* (Becker, 1907), male: C femur I (posteroventral view); (Source: [https://www.researchgate.net/figure/Orthoceratium-lacustre-male-A-femur-I-posteroventral-view-B-tarsomere-I-5-with-left\\_fig5\\_327059400](https://www.researchgate.net/figure/Orthoceratium-lacustre-male-A-femur-I-posteroventral-view-B-tarsomere-I-5-with-left_fig5_327059400))



**Figure 6** *Hercostomus apollo* (Loew, 1869) (male): a) habitus, lateral view; b) head, laterodorsal view; c) hypopygium of male, lateral view; d) mid tibia. *Poecilobothrus principalis* (Loew, 1861) (male): e) habitus, lateral view; f) head, lateral view; g) hypopygium of male, lateral view; (Source: [https://www.researchgate.net/figure/Hercostomus-apollo-Loew-1869-male-a-habitus-lateral-view-b-head\\_fig2\\_270276007](https://www.researchgate.net/figure/Hercostomus-apollo-Loew-1869-male-a-habitus-lateral-view-b-head_fig2_270276007))



**Figure 7** *Orthoceratium lacustre* (Scopoli, 1763), wing and halter: A male B female. *Orthoceratium sabulosum* (Becker, 1907): C-wing (male). Veins R 4 + 5, M 1, CuA 1 and dm-cu indicated; (Source: [https://www.researchgate.net/figure/Orthoceratium-lacustre-wing-and-halter-A-male-B-female-Orthoceratium-sabulosum-C-wing\\_fig4\\_327059400](https://www.researchgate.net/figure/Orthoceratium-lacustre-wing-and-halter-A-male-B-female-Orthoceratium-sabulosum-C-wing_fig4_327059400))

There are no truly aquatic larvae, but many are amphibious, inhabiting wetlands such as mudflats and the banks of lakes and rivers. There are species that live on marine coasts and mangroves. They can also be collected from tree holes and other phytotelmata. Larvae are cylindrical, much like vermin and other Brachicera larvae. The exception is the Thrypticus larva, a miner of marginal plants (Figures 8A, 8B, 9 and 10) [7,8,9,10].



A

**Figure 8A** Long legged fly (Dolichopodidae) larva



B

**Figure 8B** Long legged fly (Dolichopodidae) larva. Fleshy lobes at the end of the abdomen; (Source: Image: Stephen Moore)



**Figure 9** Pupa of Dolichopodidae; (Source: <https://ohioline.osu.edu/factsheet/ent-69>)



**Figure 10** A mating pair of long-legged flies (left) and another male (right) attempting to court the same female by waving his ornated front legs for her; (Source: <https://ohioline.osu.edu/factsheet/ent-69>)

### 1.1. Biological cycle

Biological cycle – egg, larva, pupa and adult.

Adult – from 2 to 10 mm in length; thin body, green, blue or metallic copper color; large eyes, edged antennae a pair of membranous, transparent wings with few ribs and reflections

metallic; long legs move with agility.

Larva - sharp and milky legs.

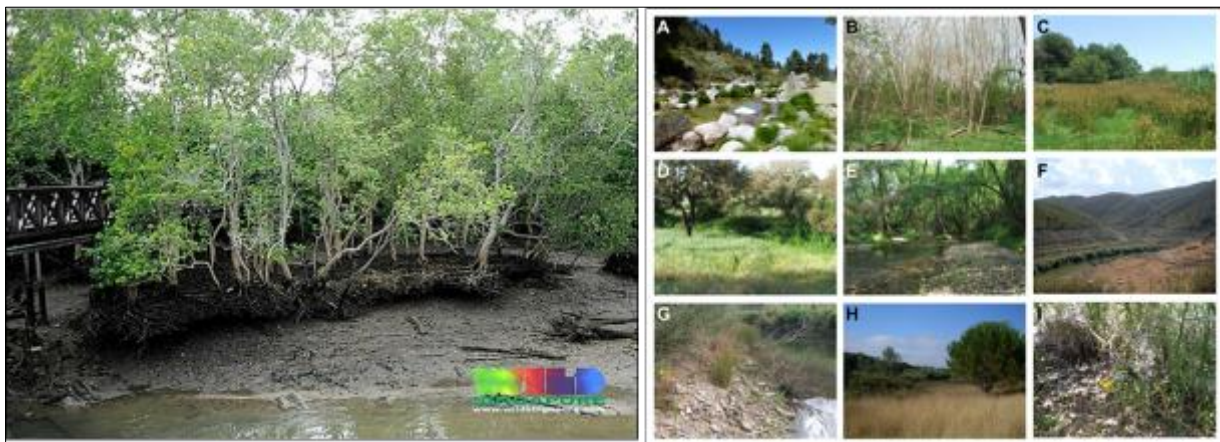
Importance – the adult is a predator of aphids, thrips, whitefly nymphs and adults, mites, fly adults and larvae, small beetles larvae and small moth caterpillars (Figure 11) [11,12].





**Figure 11** Biological cycle; (Source: <https://wiki.nus.edu.sg/display/TAX/Hercostomus+meieri>)

Aquatic species have been described, but many are semi-aquatic and live in or near water margins. A small number of species develop on the shores of saline inland bodies of water or the intertidal zone of sea shores. An example of a species that develop close to water is *Poecilobothrus nobilitatus* (Linnaeus, 1767) they can be found congregating around lakes and ponds (Figure 12) [13,14].



**Figure 12** Mudflats in mangroves of Sungei Buloh. Selected Portuguese habitats of dolichopodid species. A. 4 km SSW of Manteigas, Serra da Estrela, river Zêzere, May 2014, *Orthoceratium sabulosum* (Becker, 1907); B. Mouriscas, Tejo river, March 2011 (*Medetera feminina*); C. Salreu, Ria de Aveiro, June 2010 *Dolichopus andalusiacus* Strobl, 1899, *Chrysotus gramineus* (Fallén, 1823.); D. Santa Luzia, April 2011, *Medetera ambigua* (Zetterstedt, 1843); E. Santa Margarida da Coutada, March 2011, *Syntormon pallipes* (Fabricius, 1794)); F. São Marcos da Serra, Ribeira de Odelouca, September 2010, *Acropsilus niger* (Loew, 1869), *Hercostomus verbekei* Pollet, 1993, *Sybistroma dufourii* Macquart, 1838); G. detail of same location; H. Tornada, Paul de Tornada, July 2010 (*Poecilobothrus bigoti* Mik, 1883, *Poecilobothrus mainis* (Loew, 1861); I. detail of same location, with yellow pan trap; (Source: Taken from wild Singapore by Ria Tan (In Dipterological surveys in Portugal unveil 200 species of long-legged flies, with over 170 new to the country (Diptera: Dolichopodidae)

Other groups are found on trunks of trees damaged by bark beetles. Adults often are seen in a characteristic predatory posture standing high on their legs on the ground or on vegetation, tree trunks or rocks, and some species walk about on the surface of still water [14,15]. Dolichopodids belong to one of the groups of insects with the most species in the order Diptera, with 7,358 species distributed in 268 genera worldwide (Figure 13) [15].



**Figure 13** Greater diversity and abundance of dolichopods are recorded in warm, humid habitats, although they are found in all environments from forests to agricultural fields. Most species are generalist predators of small insects and other soft-bodied invertebrates, including some pest species such as whitefly, thrips, and mites; (Source: <https://www.flickr.com/photos/myobservatory/37754187145/in/photostream/>)



**Figure 14** The semaphore fly *Poecilobothrus nobilitatus* (Linnaeus, 1767) resting on the surface of a pond; (Source: <https://www.discoverwildlife.com/animal-facts/insects-invertebrates/semaphore-fly/>)

Although Dolichopodidae is a family with many species, little is known about the diversity of species associated with agricultural environments and how their abundances are distributed in different habitats. To date, only one unidentified species of *Condylostylus* has been recorded in association with agricultural systems and presents high abundance in areas with vegetable crops, when compared to agroforestry systems (Figure 15) [15,16].



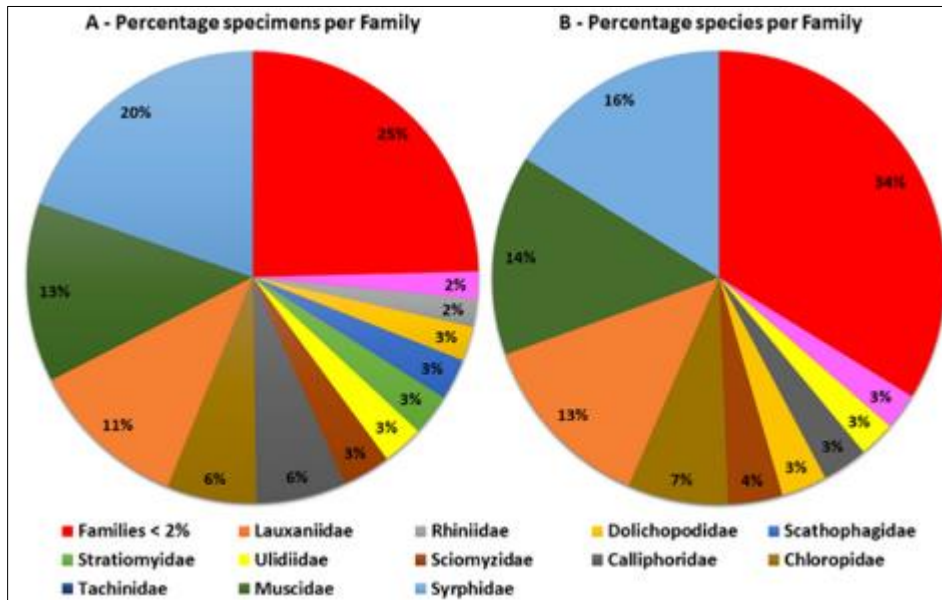
**Figure 15** The metallic long-legged fly is fast and friendly, choosing annoying insects for a meal instead of human food scraps; (Source: <https://www.insectidentification.org/insect-description.php?identification=Long-legged-Fly>)

## 1.2. Taxonomy

Classe: Insecta, Orden: Diptera, Suborden Brachycera, Infraorden: Asilomorpha, Superfamilia: Empidoidea

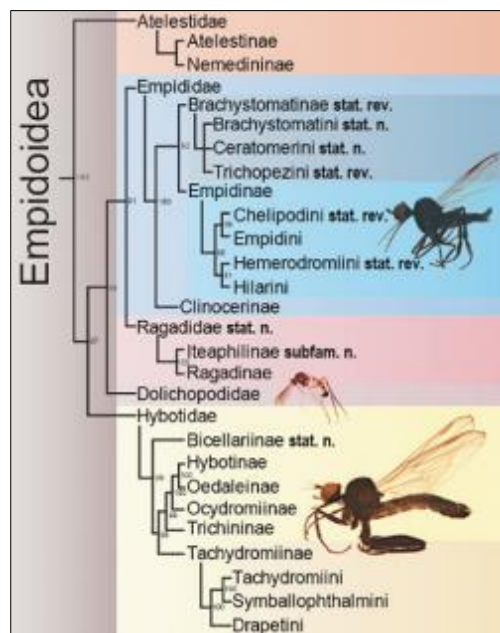
### 1.2.1. Familia: Dolichopodidae

Subfamilias: Achalcinae, Antyxinae, Babindellinae, Diaphorinae, Dolichopodinae, Eniliniinae, Hydrophorinae, Kowmunginae<sup>1</sup>, Medeterinae, Neurigoninae, Peloroepodinae, Plagioneurinae, Rhapsiinae, Sciapodinae, Stolidosomatinae, Sympycninae and Xanthochlorinae (Figura 16) [16,17].



**Figure 16** Distribution of specimens (A) and species (B), in percentage, per Diptera family present in the dataset. Families representing less than 2% of specimens were lumped together; (Source: <https://bdj.pensoft.net/article/49985/element/2/5482518/>)

## 1.3. Phylogenetic



**Figure 17** New internal classification of Empidoidea; numbers at nodes represent support as posterior probabilities in percentage based on the Bayesian analysis; (Source: <https://onlinelibrary.wiley.com/doi/full/10.1111/syen.12297>)



Based on the most recent phylogenetic studies, the relationship between Dolichopodidae and other members of Empidoidea is as follows. The placement of Dolichopodidae is emphasized in bold formatting (Figure 17) [18].

### Objective

The purpose of this article is to obtain description of the Dolichopodidae Family (Insecta: Diptera).

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## 2. Material

The method used to prepare this mini review was Marchiori 2021 methodology [19].

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## 3. Studies conducted and selected

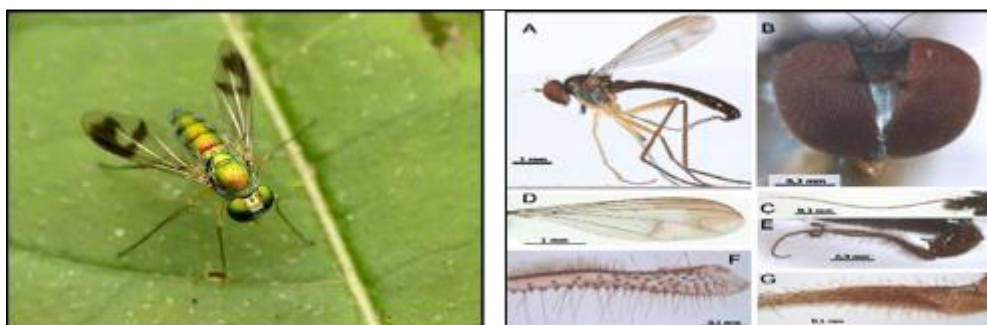
### 3.1. Study 1

The aim of this study is to present a key to the New World genera, the latter being the most complete and adequate to the neotropical fauna so far.

Only five species of Dolichopodidae are registered for the State of Mato Grosso do Sul, accounting for four genera of distinct subfamilies. This number is obviously an underestimate of the expected diversity for this region, given the small number of taxonomic studies with the group in the area. However, it is possible to suppose the presence of species (Figure 18), described for the state of Mato Grosso (Chapada dos Guimarães):



**Figure 18** Mato Grosso (Chapada dos Guimarães) Brazil; (Source: <https://viagemeturismo.abril.com.br/cidades/chapada-dos-guimaraes/>)



**Figure 19** *Condylostylus* spp., males. A–F. *Condylostylus* sp. nov. A. Habitus. B. Head. C. Antenna. D. Wing. E. Hypopygium, left lateral view. F. Cercus, basal part. G. *Condylostylus* sp. (paratype), cercus, basal part; (Source: <https://www.gbif.org/pt/species/1610262/treatments>)



*Condylostylus bisinuatus* Van Duzee, 1931, *Condylostylus gracilis* (Aldrich, 1904) (both Sciapodinae), *Tachytrechus albopilosus* (Van Duzee, 1931) and *Tachytrechus fuscipennis* (Van Duzee, 1931) (both Dolichopodinae). Species with distribution between areas that comprise Mato Grosso do Sul certainly also occur in this state. Dolicopods registry for the State of Mato Grosso do Sul (Figure 19).

### 3.1.1. Subfamilies

#### Diaphorinae

*Chrysotus brasiliensis* Van Duzee, 1933. Type locality: Brazil, Mato Grosso do Sul, Corumbá. Distribution: Brazil. Male holotype in AMNH.

#### Dolichopodinae

*Pelastoneurus brasiliensis* Van Duzee, 1931. Type locality: Brazil, Mato Grosso do Sul, Corumbá. Distribution: Brazil and Paraguay. Male holotype, allotype and paratypes in AMNH.

*Pelastoneurus ochreifacies* Van Duzee, 1931. Type locality: Brazil, Mato Grosso do Sul, Corumbá. Distribution: Brazil. Male holotype and allotype in AMNH.

#### Medeterinae

*Thrypticusromus* Bickel & Hernández, 2004. Type locality: Brazil, Mato Grosso do Sul, Corumbá. Distribution: Argentina and Brazil. Male holotype and paratypes in the USNM.

#### Sciapodinae

*Condylosty lusflagellatus* Becker, 1922. Type locality: Peru, Mischagua. Distribution: Peru and Brazil (registration for Maracajú, Mato Grosso do Sul: Milward-de-Azevedo, 1980). Male holotype in SMTD (Figure 20) [20, 21,22, 23,24,25].



**Figure 20** Specimen of *Tachytrechus*; (Source: <https://www.gbif.org/pt/species/1610262/treatments>)

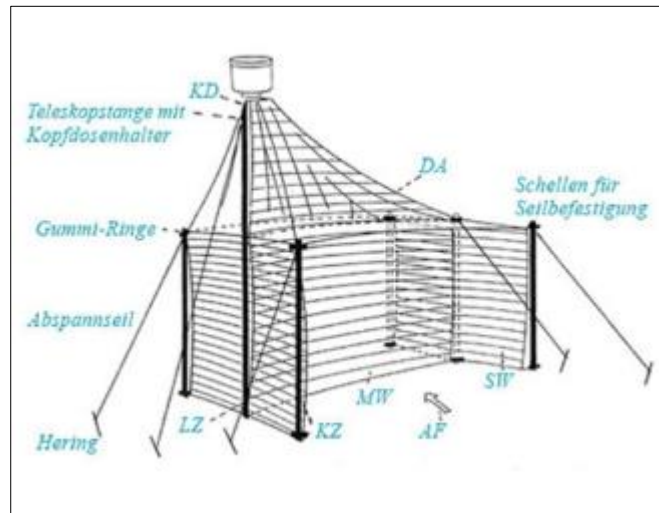
## 3.2. Study 2

An alternative to mitigate these effects would be the adoption of ecologically-based production systems, with sustainable practices that include increasing the planned plant diversity in the agricultural landscape and without the use of synthetic chemical pesticides. Ecologically-based production systems aim precisely to integrate high primary productivity, allied to the conservation of local biodiversity. For this, it is important to know the associated species and try to understand how their abundance is distributed in different habitats.

Dolicopodidade belong to one of the groups of insects with more species in the order Diptera, with 7,358 species distributed in 268 genera worldwide (Figure 21).

In Brazil, 30 genera and 192 species were registered, with geographic distribution occurring mainly in the states of Acre, Amazonas, Amapá, Pará, Roraima and Tocantins (northern region); Bahia, Maranhão, Paraíba, Pernambuco and Sergipe (northeast region); Goiás, Mato Grosso and Mato Grosso do Sul (central-west region); Espírito Santo, Minas Gerais, Rio

de Janeiro and São Paulo (southeast region); Paraná, Rio Grande do Sul and Santa Catarina (southern region) [25,26,27,28,29,30].

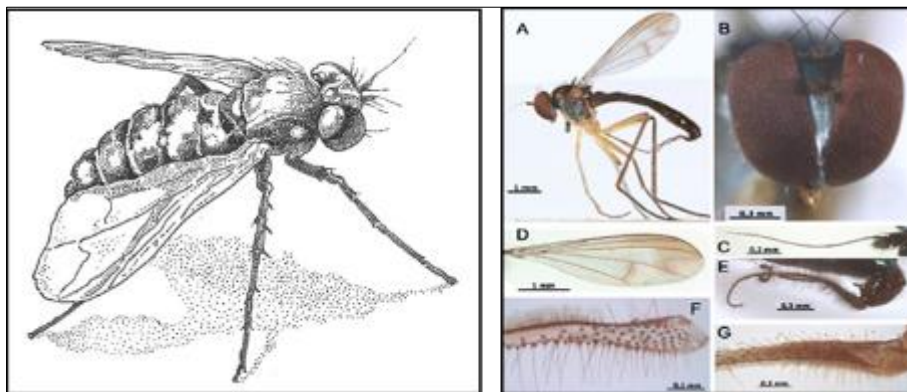


**Figure 21** Malaise trap; (Source: [https://www.ecotech.de/en/product/malaise\\_trap\\_following\\_townes\\_design](https://www.ecotech.de/en/product/malaise_trap_following_townes_design))

### 3.3. Study 3

In this work, we test the hypothesis that more open and disturbed habitats, such as vegetables, may harbor greater abundance and dominance of Dolichopodidae.

Collection sites: Fallow, Agroforest and Native Vegetation. Malaise trap. A total of 4,472 individuals were collected, which were later grouped into 17 genera and 70 species. *Chrysotus* (23 spp., 2,323 individuals) and *Condylostylus* (16 spp., 1,247 individuals) were the most abundant genera with the highest number of species (Figure 22).



**Figure 22** *Condylostylus* spp., males. A–F. *Condylostylus* sp. nov. A. Habitus. B. Head. C. Antenna. D. Wing. E. Hypopygium, left lateral view. F. Cercus, basal part. G. *Condylostylus* sp. (paratype), cercus, basal part; (Source: © Grichanov, Igor Ya.)

The average abundance of Dolichopodidae flies was higher in vegetable habitats ( $21.78 \pm 10.66$ ), followed by fallow ( $15.60 \pm 6.65$ ), agroforestry ( $3.68 \pm 1.76$ ) and native vegetation ( $1.56 \pm 0.64$ ) (KW-H(3.280) = 46.24; df = 3.280;  $P < 0.0001$ ). Species abundance distribution data were also evaluated by habitat and all fitted to the log normal distribution model with a large number of species with intermediate abundance and few dominant and rare species.

Habitats with vegetable cultivation harbored a greater number of species and local diversity ( $\alpha$ ), with a gradual reduction towards more forested environments of native vegetation. On the other hand, it was verified the dominance of some species and low evenness of abundance, when compared to the other habitats. Habitats with vegetable cultivation sheltered a greater number of species and local diversity ( $\alpha$ ), with a gradual reduction towards more

forested environments of native vegetation. On the other hand, it was verified the dominance of some species and low evenness of abundance, when compared to the other habitats [25,27,28,29,30].

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#### 4. Conclusion

In general, most species of Dolichopodidae are prey on small soft-bodied invertebrates. However, this information is limited for neotropical species, with a lack of knowledge about their eating habits and functionality in ecosystems. Present complete metamorphosis during development, that is, they develop from an egg, they pass through the larval and pupae stages before becoming adults.

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