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Description of the Diapriidae Family (Insecta: Hymenoptera)

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Abstract

Diapriidae are commonly found in moist and shady habitats, where they can be very diverse; despite their abundance, little is known about their biology. The basal diapriids, Belytinae and Ambositrinae are probably parasitoids of larvae or pupae of Mycetophilidae and Sciaridae (Diptera). Diapriinae are mostly Diptera parasitoids (Brachycera and Cyclorrhapha), some species parasitize staphylinid and scarab (Coleoptera) larvae others are associated with ants (Formicidae). Some species of Diapriidae were used in biological control programs for dipterans. The purpose of this article is to obtain a description of the Family Diapriidae (Insecta: Hymenoptera). To this end, a bibliographic survey of Diapriidae was carried out from 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: Parasitoid; *Trichopria;* Ants; Flies; Control

1. Introduction

1.1. Characteristics

Diapriidae is cosmopolitan, with 2080 described species and distributed in 194 genera. Most Diapriidae measure between two and four mm in length, have a smooth and shiny integument; monolithic antennae with up to 15 anthenomers, inserted in the center of the face over a projecting projection; are winged, with front wing without stigma and sometimes with slightly thickened marginal vein, with 1-3 closed cells; posterior wing with submarginal vein reaching the humuli; petiolate metasome and ovipositor almost completely retracted (Figures 1, 2, 3, 4, 5, 6, 7A and 7B) [1,2,3].

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Figure 1 Female and male of Diapriidae Family (sexual dimorphism); (Source: https://www.researchgate.net/publication/267152740_Life_History_Host_Choice_and_Behavioral_Plasticity_of_Trichopria_Nigra_Hymenoptera_Diapriidae_a_Parasitoid_of_Higher_Diptera/link/54592d9b0cf2cf516483cc14/download)

Figure 2 49, 50, female, head, dorsal view. 51, female, head, frontal view; 52, mesosoma and petiole, dorsal view; 53, female, lateral view; 54, male, antenna, proximal part; 55, female, antenna; 56, venation. Scale bars: 49–52, 54– 56, 200 µm; 53, 1.0 mm; (Source: https://www.zin.ru/journals/zsr/content/2019/zr_2019_28_1_Chemyreva.pdf)

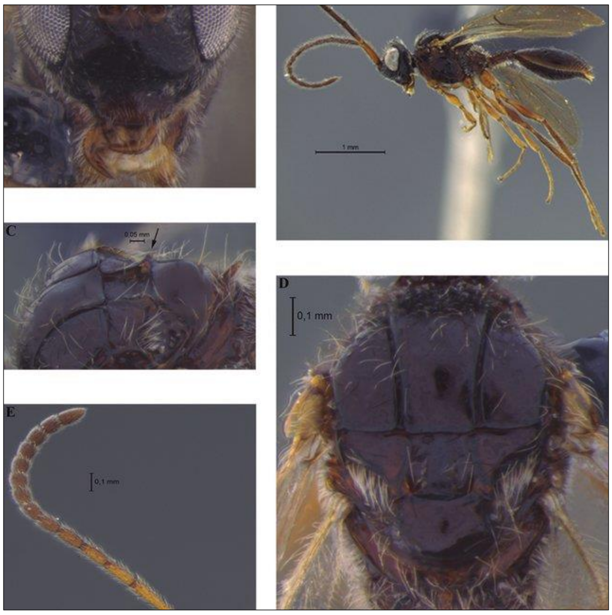

Figure 3 *Lyteba* sp. (Hymenoptera, Diapriidae, Belytinae) from Parque Estadual de Intervales, SP (Biota project 2000-2002): (A) head of male, frontal view; (B) habitus of male, lateral view; (C) part of mesosoma, dorsolateral view (arrow indicates the tooth in the scutellar bridge); (D) mesosoma of male, dorsal view; (E) female antenna; (Source: https://www.researchgate.net/figure/Lyteba-sp-Hymenoptera-Diapriidae-Belytinae-from-Parque-Estadual-de-Intervales-SP_fig8_315945986)

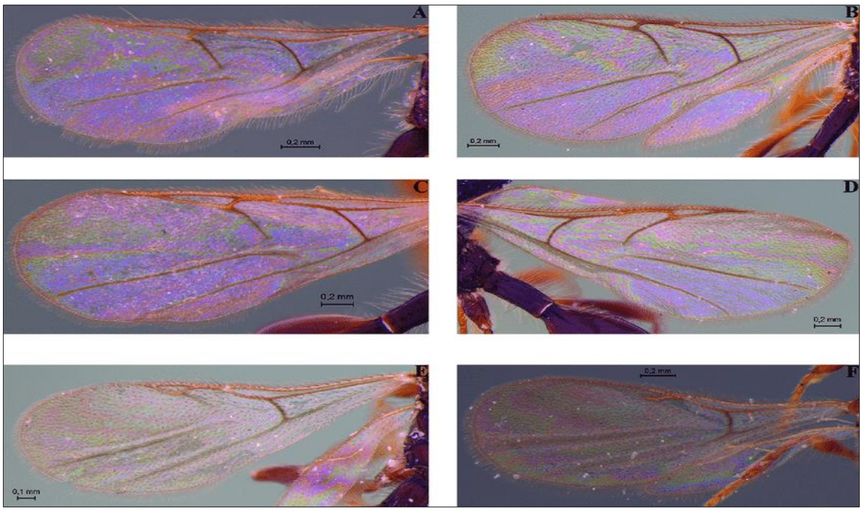

Figure 4 Forewing of six *Belytinae* spp. (Hymenoptera, Diapriidae) from the Biota project (2000-2002): (A) female forewing of *Scorpioteleia* collected in Parque Estadual Serra do Mar, SP; (B) female forewing of *Cinetus* collected in strain *Rugendas,* SC; (C) female forewing of *Scorpioteleia* collected in Parque Estadual de Intervales, SP; (D) female forewing of *Cinetus* collected in Parque Estadual de Intervales, SP; (E) female of *Belyta* collected in Estação Ecológica Pau Brasil, BA; (F) male forewing of *Belyta* collected in Reserva Biológica do Tinguá, RJ; (Source: https://www.researchgate.net/figure/Forewing-of-six-Belytinae-spp-Hymenoptera-Diapriidae-from-the-Biota-project_fig9_315945986)

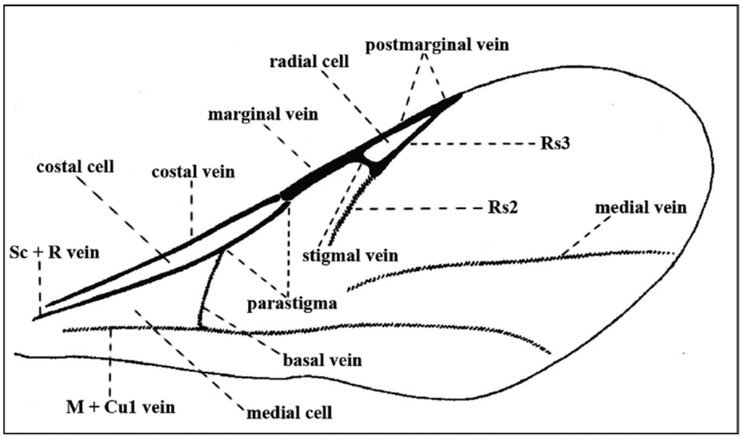

Figure 5 Venational scheme for the Belytinae forewing; (Source: https://www.researchgate.net/figure/Venational-scheme-for-the-Belytinae-forewing-modified-from-Nixon-1957_fig2_315945986)

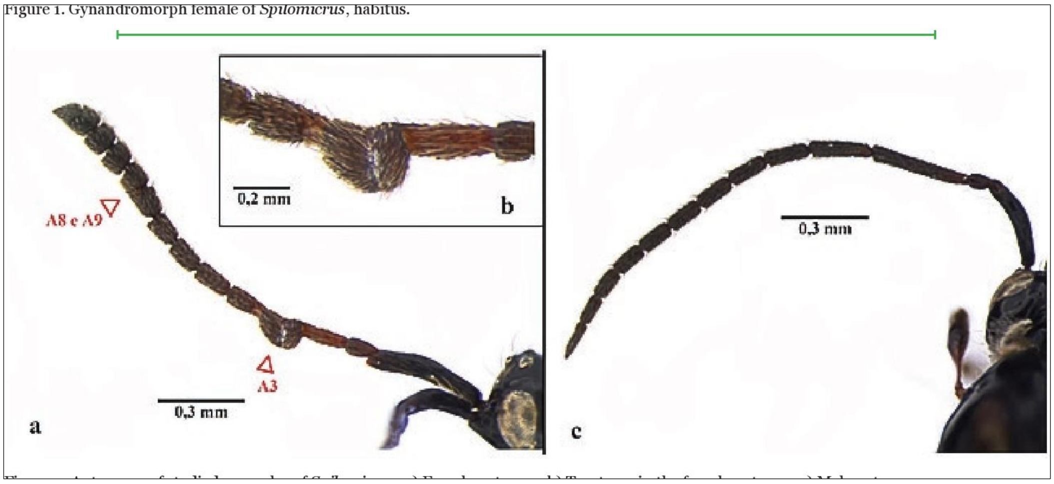

Figure 6 The occurrence of antennae with female and male characteristics in a female of *Spilomicrus* sp. (Hymenoptera, Diaprioidea, Diapriidae); (Source: https://www.semanticscholar.org/paper/A-Gynandromorph-and-Teratological-Case-in-sp.-Com%C3%A9rio-Perioto/8c54ff9ad5040fcc531f96d73b736414ba0f1969)

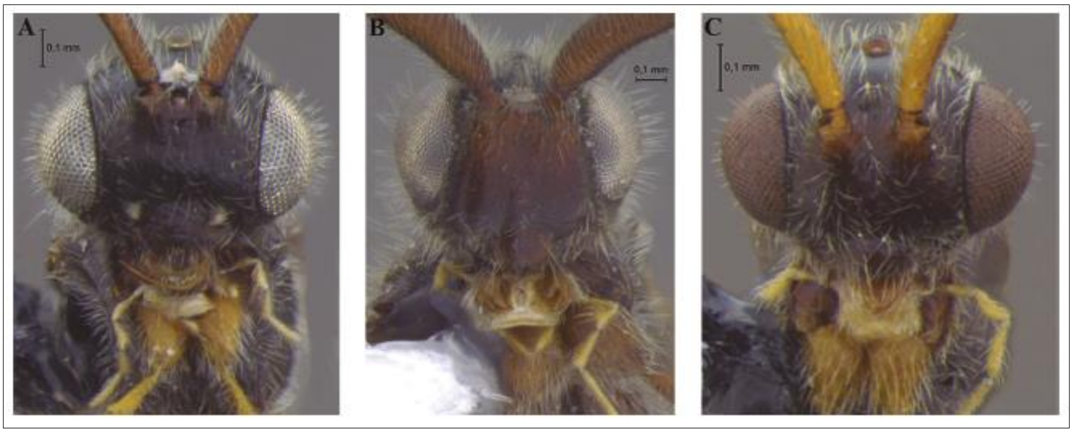

Figure 7A Head in frontal view of three different Belytinae (Hymenoptera, Diapriidae): (A) female of *Aclista* collected in Parque Estadual de Intervales, SP; (B) female of *Belyta* collected in Reserva Biológica do Tinguá, RJ; (C) female of *Cinetus* collected in strain Rugendas, SC; (Source: https://www.scielo.br/j/paz/a/thwKfpPbTj9ZPpmjrNt7ZcN/?lang=en#ModalFigf12)

1.2. Biology

Diapriidae are commonly found in moist and shady habitats, where they can be very diverse; despite its abundance, little is known about its biology. The basal diapriids, Belytinae and Ambositrinae are probably parasitoids of larvae or pupae of Mycetophilidae and Sciaridae (Diptera). Diapriinae are mostly Diptera parasitoids (Brachycera and Cyclorrhapha), some species parasitize staphylinid and scarab (Coleoptera) larvae others are associated with Formicidae or with dipterans associated with ants. Some species of Diapriidae were used in biological control programs for dipterans [4,5,6,7].

1.3. Host

Ceratitis capitata (Wiedemann, 1824) (Diptera: Tephritidae), *Hippelates* Gnats (Diptera: Chloropidae) species, *Mangifera indica* (L.) (Anacardiaceae) and *Psidium guajava* L. (Myrtaceae) and *Coptera* Say (Diapriidae) species were recorded as parasitoids of pupae of Muscidae, Drosophilidae and Lonchaeidae (Diptera). Some members of Diapriidae are solitary; many, such as *Trichopria nigra* (Nees, 1834) are gregarious endoparasitoids (Figure 7B) [7,8,9].

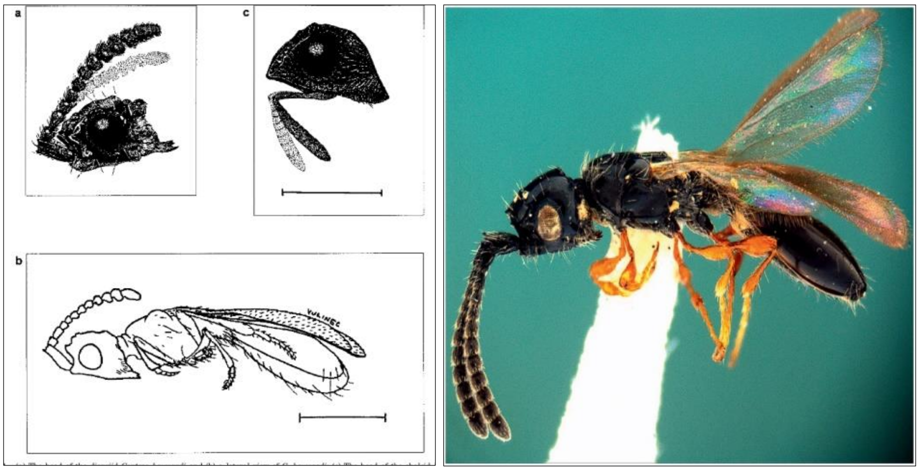

Figure 7B The head of the diapriid *Coptera haywardi* Loiácono, 1981 and (b) a lateral view of *C. haywardi*; (c) The head of the chalcid *Dirhinus himalayanus* Westwood, 1836. All lines represent 1 mm. The apparent convergence in the hypognathus morphology of the heads may be due to similar adaptations for digging in soil to locate the pupae of flies; (Source: https://www.semanticscholar.org/paper/The-Bionomics-ofCoptera-Haywardi(Ogloblin)-and-of-Sivinski-Vulinec/87748d5239093013763d18461dd80dfcb68a8e29/figure/0)

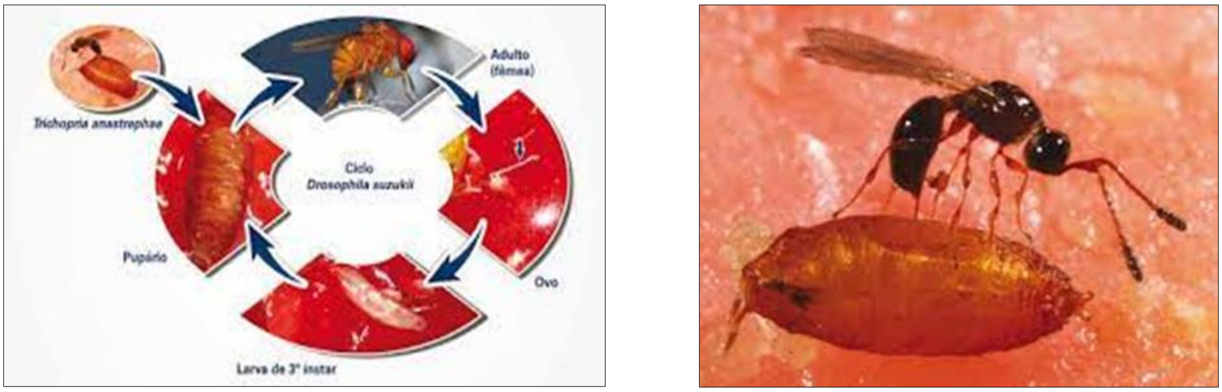

Figure 7C Biological cycle of *Drosophila suzukii* (Matsumura, 1931) demonstrating the phase of development of the pest in which *Trichopria anastrephae* Lima, 1940 parasitism occurs; (Source: https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1076698/1/DoriCultivarHF.pdf)

In Brazil reported Coptera haywardi Loiácono, 1981, parasitizing fruit flies on Eugenia uniflora L. (Myrtaceae) in Seropédica Rio de Janeiro reported species of Diapriidae parasitizing fruit flies associated with peach fruit Prunus persica L. (Rosaceae) in Presidente Prudente, São Paulo; Trichopria anastrephae Lima, 1940, has been recorded in the states of Rio de Janeiro, Minas Gerais, Goiás, and Santa Catarina parasitizing fruit flies and species of Trichopria have been reported in the states from Goiás, Minas Gerais, Rio Grande do Sul and São Paulo parasitizing scavenger flies associated with bovine feces (Figure 7C) [10,11,12].

1.4. Life cycle stages

1.4.1. Egg

Eggs were dissected from *Trichopria columbiana* (Ashmead, 1893) ovaries to determine their pre-oviposition morphology. *Trichopria columbiana* eggs, which are hymenopteriform (wasp-like) in shape, were 0.19 mm long and 0.06 mm wide. The chorion (outer membrane) is smooth and thin. As the chorion is transparent, the developing embryo is clearly visible. The second inner membrane, which is likely to be hydropic eggs take up nutrients and water from the host's hemolymph for continued development and typically expand in size eggs were removed from the host 72 hours post-oviposition. These eggs were much larger than those dissected from the female parasitoid; they measured 0.57 mm in length by 0.28 mm in width (Figures 8, 9, 10, 11 and 12) [13,14,15].

Figure 8 Egg of *Columbian Trichopria* (Ashmead, 1893); (Source: Byron Coon, Argosy University)

1.5. Larvae

There are three instars; the first instar is 0.49 mm long and 0.14 mm wide. At this stage, the body is segmented and the mandibles are large and sclerotized (hardened). The end of the abdomen has a two-lobed appendage with several teeth on each lobe. This instar moves freely in the hemolymph of the host and is believed to obtain oxygen by diffusion [13,14,15].

The second instar is 0.92 mm long and 0.31 mm wide, and the third instar is 1.50 mm long and 0.52 mm wide. Both the second and third instars are similar in appearance and are grub-like. The abdominal appendage and large mandibles present on the first instar are absent. The abdominal appendage and large mandibles present on the first instar are absent. The head of the later instars has indistinct mouthparts that are not differentiated from the body. The second and third instars obtain oxygen from the host by attaching to the host tracheal system [13,14,15].

Figure 9 First instar larva of *Trichopria columbiana* (Ashmead, 1893); (Source: Byron Coon, Argosy University)

Figure 10 Second or third instar larva of *Trichopria columbiana* (Ashmead, 1893); (Source: Byron Coon, Argosy University)

1.6. Pupae

The pupae are enclosed in a thin case which is believed to be the last larval exuvium (cast skin). The case is transparent, and the developing adult is visible inside with the red eyes particularly noticeable. Also visible are many small globules, which are believed to be the meconium (fecal material) released by the last instar before pupation [13,14,15].

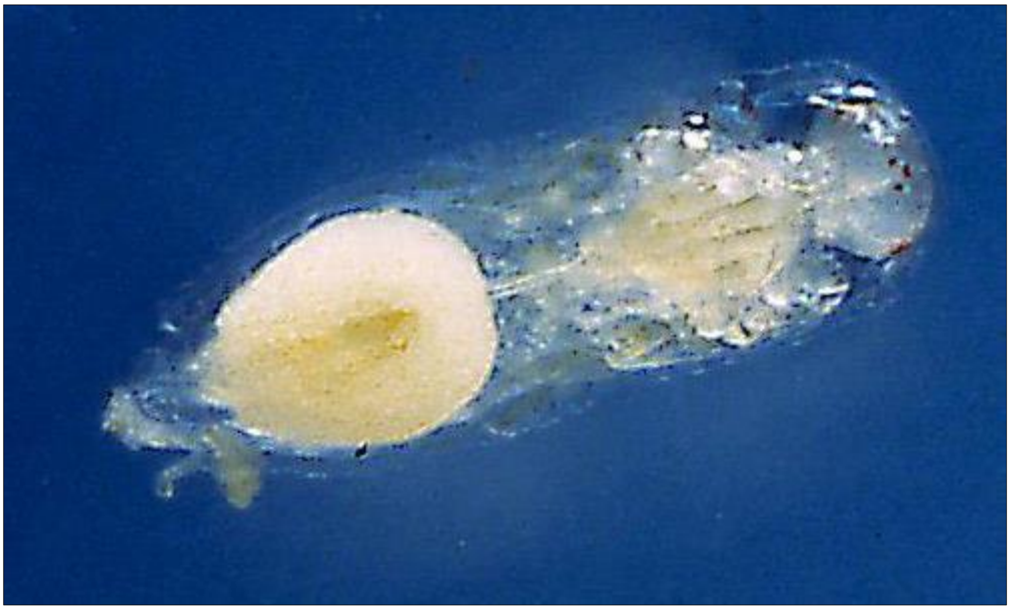

Figure 11 Pupa of *Trichopria Columbiana* (Ashmead, 1983); (Source: Byron Coon, Argosy University)

1.7. Adult

The body is shiny and black in color with the base of the antennae and the legs reddish yellow. The head is round and narrows behind the eyes. The thorax narrows anteriorly forming a round neck. The abdomen is oval-shaped. The wings are strongly fringed and clear with pale yellow veins [13,14,15].

Adults of *Trichopria columbiana* (Ashmead 1893); male (A) with filiform or thread-like antennae and female (B) with slightly clavate or club-like antennae. Male and female *T. columbiana* can be distinguished easily by the shape of the antennae. The antennae of females (B) have 12 segments and are slightly clavate, or club-like. In contrast, the antennae of males have 13 segments and are filiform, or thread-like [16,17,18,19].

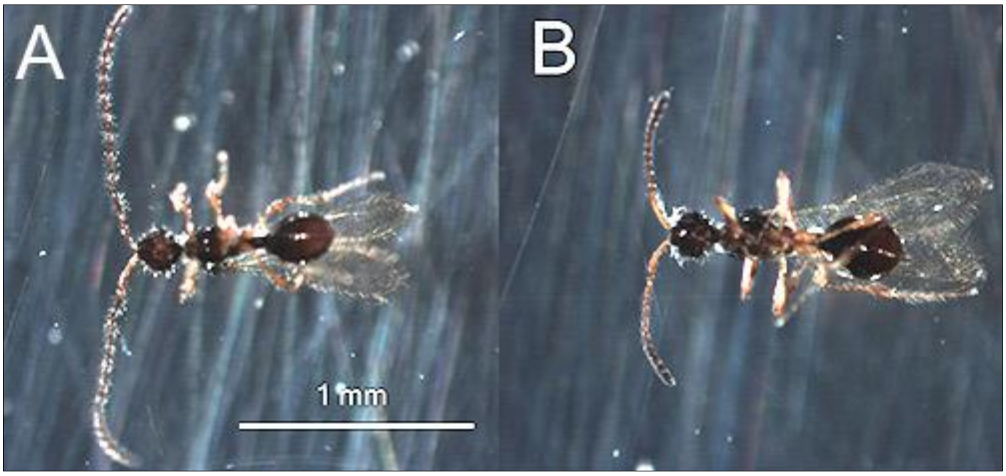

Figure 12 Adults of *Trichopria columbiana* (Ashmead, 1893); male (A) with filiform or thread-like antennae and female (B) with slightly clavate or club-like antennae; (Source: Nathan Harms, US Army Engineer Research and Development Center)

1.8. Life cycle

Diptera). Some members of Diapriidae are solitary; many, such as *Trichopria nigra* Nees, 1834, are gregarious endoparasitoids. The female inserts her antennae into the water first, presumably to detect chemical cues of plant damage or the host insect. When given a choice of hydrilla with *Hydrellia* (Diptera: Ephydridae) pupae and hydrilla with

Hydrellia larvae, 96% of parasitoids selected the hydrilla with *Hydrellia* pupae. Therefore, a suitable host in the appropriate life stage is located using chemoreception. The adult female wasp swims underwater by trapping a bubble of air under her wings, which she uses to breathe. After locating a suitable host, the female inserts her ovipositor into the thorax of the fly, which is close to the cuticle of the puparium. The female parasitoid prefers to lay her eggs in early- to intermediate-stage pupae (Figures 13A and 13B) [20,21,22].

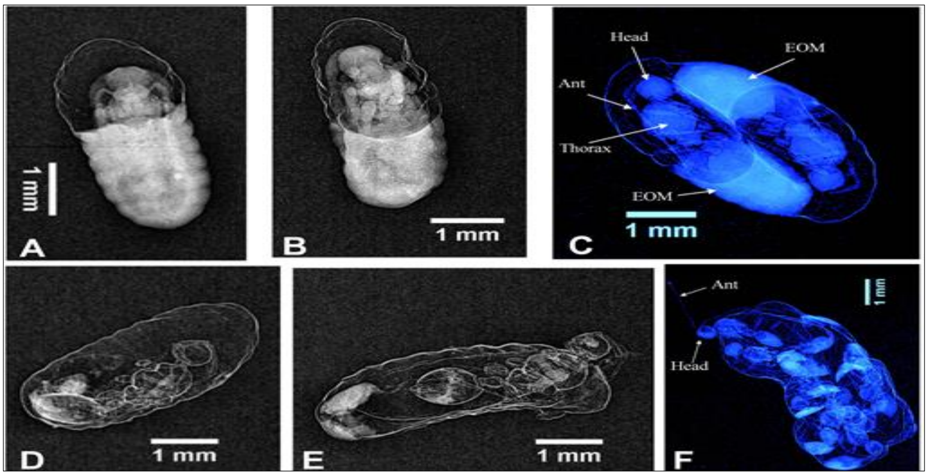

Figure 13A *Szelenyiopria talitae* Loiácono et Margaría, 2013, pre-pupal and pupal phases of development within *Acromyrmex* larvae. (A) Early melanization of *S. talitae* pre-pupae, observed through the translucent host integument. White arrows mark the early melanization of the parasitoid pupal cuticle; (B) Four parasitized host larvae showing increasing levels of melanization from left to right; 1st host with six gregarious parasitoids before melanization had initiated; 2nd with 4 parasitoids at the start of the melanization process; 3rd and 4th with four parasitoids per host at a more advanced stage of parasitoid development; (C) A completely melanized solitary parasitoid pupa and a non-parasitized larva; (D) X-ray microscopy showing two parasitoids at the pre-pupal phase prior to complete melanization; (E) Two parasitoids at a slightly more advanced stage of pre-pupal development coinciding with increased melanization of the parasitoid integument; (F) Example of X-ray image of a control (non-parasitized) larva. Scale bar: 1 mm; (Source: https://www.scirp.org/journal/paperinformation.aspx?paperid=110792)

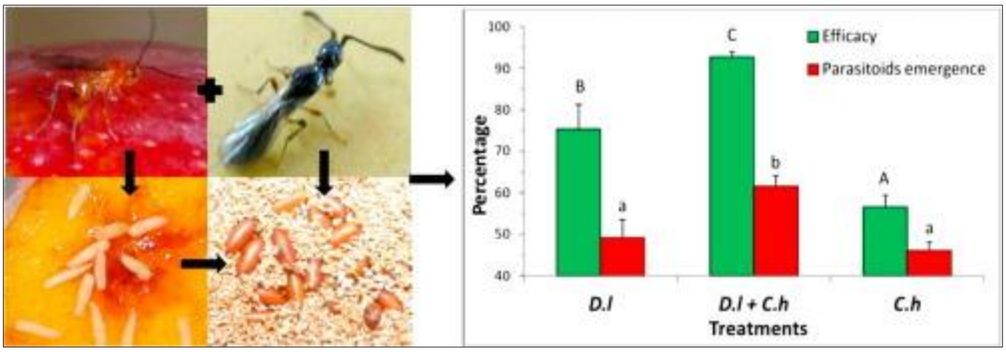

Figure 13B larval-prepupal koinobiont endoparasitoid, and the diapriid *Coptera haywardi* Loiácono, 1981, a native idiobiont pupal endoparasitoid; (Source: https://www.sciencedirect.com/science/article/abs/pii/S1049964416300044)

1.9. Taxonomic and Phylogeny

The subfamilies, Diapriinae (117 genera / 1281 species), Belytinae (56 / 700) and Ambositrinae (21 / 99) have reports of occurrence for the Neotropical Region, where they are 78 genera were reported, of which 30 reported occurrences in Brazil. Diapriines, the largest subfamily of Diapriidae, are cosmopolitan with 1281 species in 117 genera. For the Neotropical region, 264 species were reported, in 78 genera, of which 30 occur in Brazil. The number of species of the Neotropical yet to be described is difficult to estimate and is much greater than the number of described species (Figures 14, 15,16 and 17) [22,23,24].

Figure 14 *Lyteba* sp. (Hymenoptera, Diapriidae, Belytinae) from Intervales State Park, SP (Biota project 2000-2002): (A) head of male, frontal view; (B) habitus of male, lateral view; (C) part of mesosoma, dorsolateral view (arrow indicates the tooth in the scutellar bridge); (D) mesosoma of male, dorsal view; (E) female antenna; (Source: https://www.scielo.br/j/paz/a/thwKfpPbTj9ZPpmjrNt7ZcN/?lang=en#ModalFigf3)

Figure 15 Ambositrinae: parasitoids of Mycetophilidae and Sciaridae (Diptera); (Source: https://sites.google.com/site/hymenopteramzsp/mzusp/pesquisa-1)

Diapriinae species are characterized by morphological reductions, especially in the venation and structure of the wings and antennas, which does not occur in Ambositrinae and Belytinae, more basal. Spilomicrini have eleven antenomers in both sexes and Psilinae and Diapriini, 10 anthenomers in females and 12 in males. Diapriinae males have filiform antennae with hairiness and bristles long and the second modified flagelomer; their females have nailed flagellum or apically thickened; in both sexes the anterior wing has reduced venation and, in some species, open radial cell or even without venation. The Psilini, more basal, has the largest T2 while in Spilomicrini and Diapriini T2 is often fused with T3, originating a sintergo [25,26].

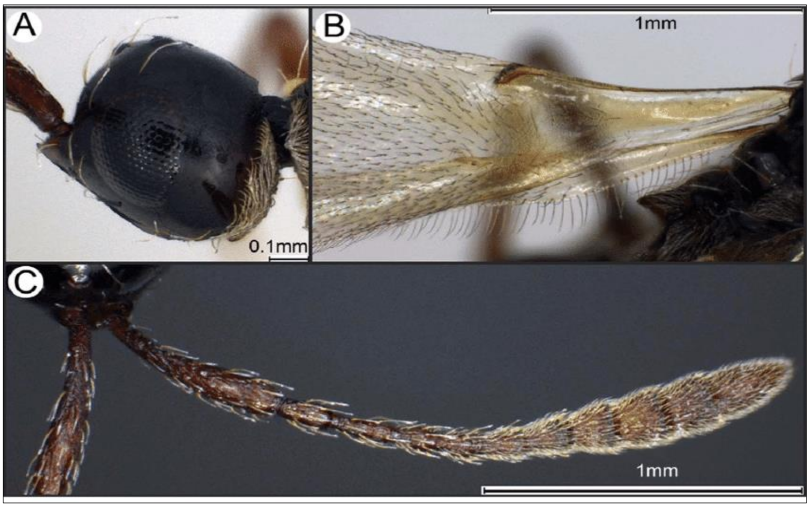

Figure 16 Female. A. Head in lateral view; B. Fore wing; C. Antenna (Diapriinae); (Source: https://www.researchgate.net/figure/Szelenyiopria-talitae-sp-nov-Female-A-Head-in-lateral-view-B-Fore-wing-C-Antenna_fig2_290054967)

The main Psilini synapomorphies are: retention of macrotergite 2 of the metasome, exposed and sclerotized labrum sinapomorphies shared with the Belytinae) and long submarginal vein, which does not reach the anterior margin of the wing; you Spilomicrinae, basal tribe, present notaulices, submarginal and marginal veins fused, reaching the basal third of the forewing and T2 and T3 fused; the Diapriini, derived tribe, do not present notaulices, short submarginal vein, which approaches from the anterior margin of the fore wing, antennas with 12 to 14 anthenomers and T2 and T3 cast (Figure 17) [27,28].

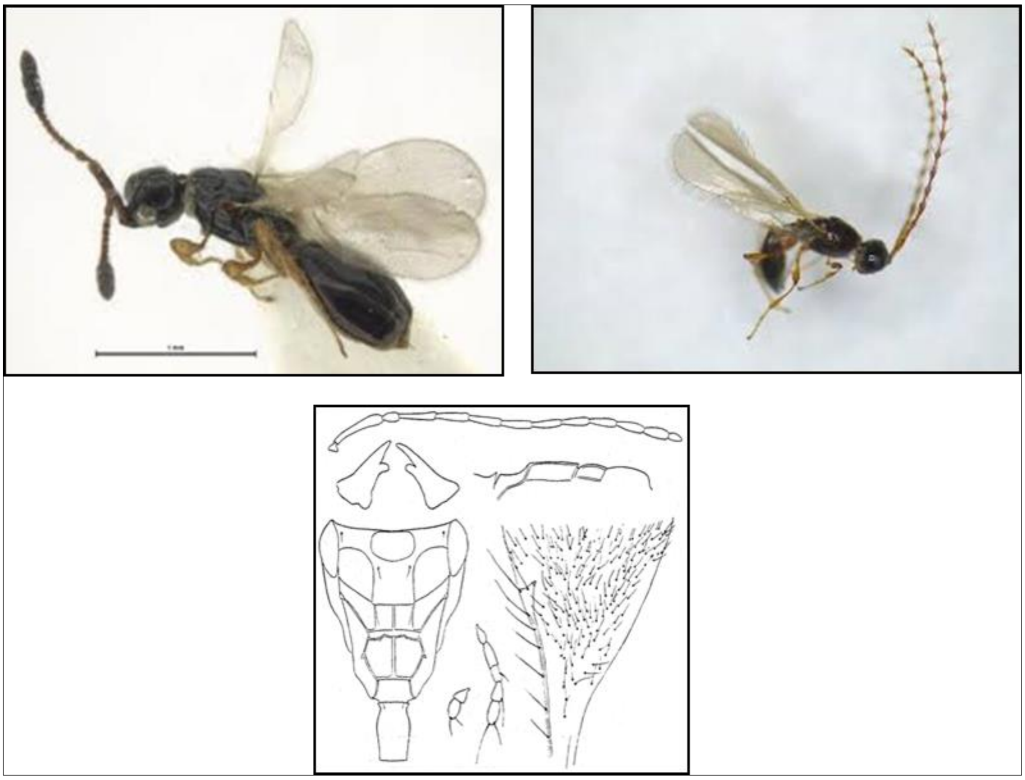

Figure 17 Adults of Diapriinae; (Source: http://www.waspweb.org/Diaprioidea/Diapriidae/Diapriinae/index.htm)

Diapriini is the tribe with the largest number of species and the most diversified and apomorphic among the Diapriinae. It is the only tribe that includes myrmecophyll species, some of them with very adapted morphology are primarily parasitoids primaries, solitary or gregarious, of several Diptera; several species were created to from beetles and some species are aquatic [27,28].

Diapriinae is a group with potential to be used in biology studies of conservation, as it has a large number of species that develop in the more diverse environments and are easily collected by different methods of sampling. Diapriinae species are mainly hosted by Diptera Orthorrhapha (Tabanidae, Stratiomyidae and Syrphidae) and Cyclorrapha (Muscidae, Anthomyiidae, Tachinidae, Calliphoridae, Sarcophagidae, Chloropidae and Tephritidae); some of its species parasitize Staphylinidae and Sphecidae (Coleoptera) while others are associated with ants; other few species are associated with termites (Dyctioptera: Termitoidea) in the Old World (Figure 18) [27,28].

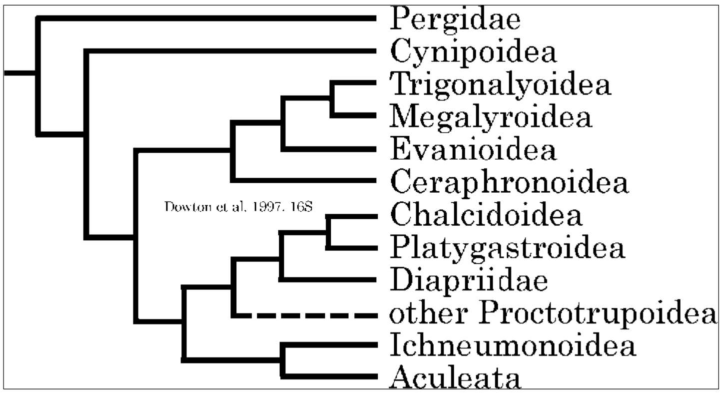

Figure 18 The higher phylogeny and classification is presented. Molecular and morphological cladistic and pre-cladistic studies are summarized. A superfamily-level classification of the Hymenoptera is offered to reflect recent advances in our understanding of the phylogenetic relationships of the Hymenoptera. It differs from most recent classifications in the recognition of the Diaprioidea, to include Diapriidae, Monomachidae, and Maamingidae; (Source: https://www.semanticscholar.org/paper/Phylogeny-and-Classification-of-Hymenoptera-Sharkey/9dca1eeac422818788b385b381e9fb17310dd478)

Objective

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

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [29].

3. Studies conducted and selected

3.1. Study 1

3.1.1. Natural enemy

Biology. Endoparasitoids mainly from Diptera. Data by subfamily:

Diapriinae: parasitoids of several Diptera families, also parasitize Coleoptera and Formicidae larvae (Figure 20).

3.1.2. Host: Kayapo Ant

(*Acromyrmex subterraneus* Forel, 1893 (Hymenoptera: Formicidae).

Affected Cultures

All cultures with occurrence of the biological target. They are leaf-cutting ants whose anthills are small and generally have few compartments (pots). Workers vary widely in size, but are generally much smaller than sauvas.

Commonly, individual variations in the proportion of trunk and head spines are found in specimens belonging to the same colony. The taxonomic characterization based on the proportion of the shape of the trunk spines, the type of integumentary sculpture and the disposition of the tubercles in the gaster are signs that are easily visualized in the maximum workers.

Damage

The damage caused by leaf-cutting ants is considerable. They attack almost all crops, cutting leaves and tender branches, and can completely destroy plants (Figure 19) [30].

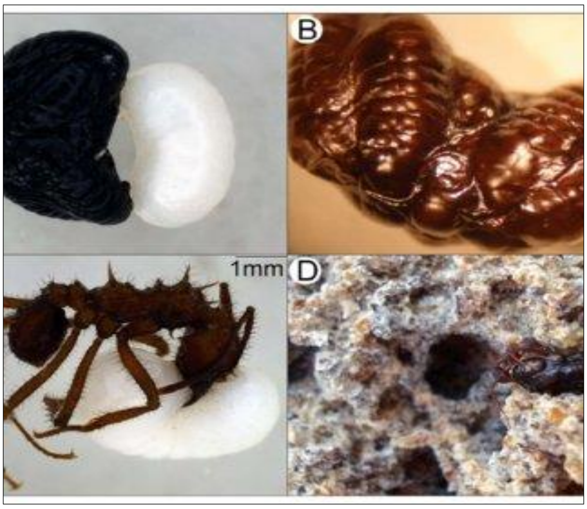

Figure 19 *Acromyrmex subterraneus* Forel, 1893 (Hymenoptera: Formicidae). A. Healthy larva and parasitized larva; B. Ant larvae showing gregarious parasitoidism; C. Ant worker taking care of a healthy larva; D. Ant worker taking care of a larva attacked; (Source: https://www.mindat.org/taxon-2790.html)

3.2. Study 2

In this work we proposed to investigate the preference and hosts of *Tricopria* sp. in samples of bovine dung.

At site 1, the highest percentage of parasitism occurred in *Sarcophagula occidua* (Fabricius, 1794) pupae with 3.40% and in site 2, in Sphaeroceridae pupae with 17.3%. The total percentage of parasitism at site 1 was 1.32% and at site 2 it was 1.50%. There were statistically significant differences regarding the preference of the parasitoid *Trichopria* sp. by their hosts. At site 1, *Trichopria* sp. had a preference for *S. occidua* pupae ($F=5.04$; $P<0.001$) and, in location 2, for *S. occidua* and Sphaeroceridae pupae ($X^2=29.63$; GL=16; $p=26.30$) at the level of 5% significance. Diapriidae are mainly gregarious endoparasitoids of Diptera pupae, but in our work, *Trichopria* sp. (Diapriidae) was shown to be a solitary parasitoid (Figure 20).

Figure 20 Specimens of *Trichopria* parasitoids of Diptera; (Source: http://www.waspweb.org/Diaprioidea/Diapriidae/Diapriinae/Trichopria/index.htm)

Trichopria sp. it is cited in the literature as an important parasitoid of *Haematobia irritans* L. 1758 (Diptera: Muscidae) in Mississippi, Missouri and Texas (USA) from some Sarcophagidae, Sepsidae, Muscidae and Calliphoridae, from *Stomoxys calcitrans* L., 1758 and *Musca domestica* L., 1758 (Diptera: Muscidae) in the USA and Hungary from *Fannia canicularis* (L., 1758).

Trichopria sp. has also been found in pupae of *Fannia femoralis* (Stein, 1791) (Diptera: Fanniidae) in chicken manure and cattle in Southern California (USA), from *Chrysomya putoria* (Wiedemann, 1819) (Diptera: Calliphoridae) in chicken feces in the State from São Paulo, from *Ravinia derelecta* (Walker, 1853), Northeast Mississippi, from *Gymnodia arcuata* (Stein., 1898), *Orthellia caesarion* (Meigen, 1826), *Paregle cinerella* (Fallen, 1825) (Diptera: Muscidae) and *Sepsis neocynipsea* Melander, 1827 (Diptera: Sepsidae) in Midwestern Texas pupae of *Anastrepha* sp. in São Carlos, SP, in pupae of *Synthesiomyia nudiseta* (Wulp, 1833) (Muscidae), *Chrysomya albiceps* (Wiedeman, 1819) and *Phaenicia eximia* (Wiedemann, 1819) (Calliphoridae) in rat carcass in São Carlos, SP and in pupae of *Mesembrina meridiana* (L., 1758) in London (England) [31].

3.3. Study 3

In this work, it is registered, for the first time, the occurrence of *Trichopria anastrephae* Lima 1940, in the State of Rio Grande of Sul.

A total of 54 guava fruits were collected, 89% of which were infested with fruit fly larvae, with an infestation rate of 7.76 (±5.03) puparia/fruit. Pupal viability was 55.30% (±34.79). 189 specimens of *Anastrepha* were obtained, all of the species *Anastrepha fraterculus* (Wiedemann, 1830). From the puparia obtained, 52 specimens of parasitoids emerged, namely *Doryctobracon areolatus* (Szepligeti, 1911) (Braconidae), *Opius bellus* Gahan, 1930, (Braconidae), *Aganaspis pelleranoi* (Bréthes, 1924) (Figitidae) and *Trichopria anastrephae* Lima, 1940. *Trichopria anastrephae* in this work, was obtained from *A. fraterculus* pupae in guava *(*Figure 21) [32].

Figure 21 *Trichopria anastrephae* Lima,1940 is a parasitoid of the invasive fruit fly spotted-wing drosophila, *Drosophila suzukii* (Matsumura, 1931), a serious pest of fruit crops. A new study shows that some insecticides are less damaging to the survival and parasitism abilities of parasitoids of spotted-wing drosophila. The use of these lower-toxicity insecticides could help conserve these parasitoids that provide natural biological control of this invasive pest species; (Source: Photo credit: Daniele Cristine Hoffmann Schlesener, Ph.D.)

In Brazil, there are few published works on the geographic distribution of parasitoids. Thus, these results increase knowledge of the distribution of *T. anastrephae* [32].

3.4. Study 4

The spotted drosophila, *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) has great economic importance for fruit production, mainly for the small fruits sector. Damage is caused by females through perforation on the surface of the fruits to perform oviposition (punctures) and by the larvae that consume the fruit pulp.

The recent introduction in Brazil, the exploration of natural and applied biological control is little evidenced. In recent studies carried out with blackberry (*Rubus* sp.) and strawberry *Fragaria ananassa* (Weston) fruits infested with *D. suzukii,* individuals of the pupal endoparasitoid *Trichopria anastrephae* Lima, 1940 (Hymenoptera: Diapriidae) were found. Individuals of *T. anastrephae* are considered microhymenopterans, as they have on average 2 to 4 mm in length.

In addition, they are black in color, and are characterized by marked sexual dimorphism, where males present long antennae and females have shorter and clubbed antennae. Likewise, females have a larger and ovipositor abdomen, which they introduce into the host's pupae and deposit their eggs (Figures 22 and 23).

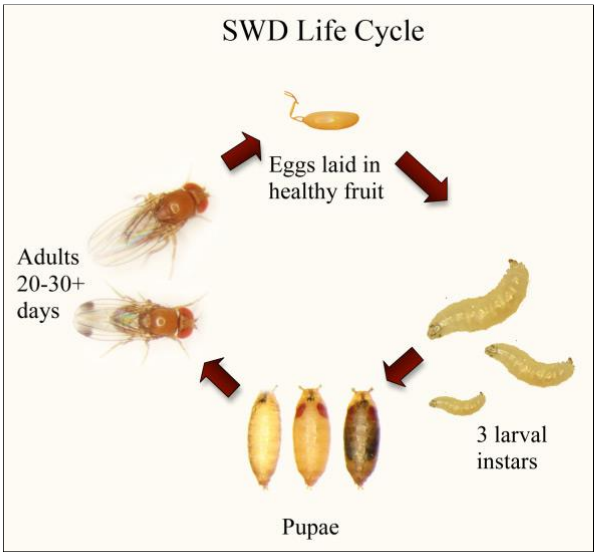

Figure 22 *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) life cycle; (Source: https://probodelt.com/reports/information-of-pests/drosophila-suzukii/?lang=en)

Native natural enemies are being increasingly studied as, exotic species may not adapt to the environment and, moreover, also can compete with other species, generating an ecological imbalance. However, for the use of native parasitoids in biological control programs, preliminary studies on the biological aspects of the studied insect are necessary, in order to be able to develop techniques for its mass. Because of this, the goal.

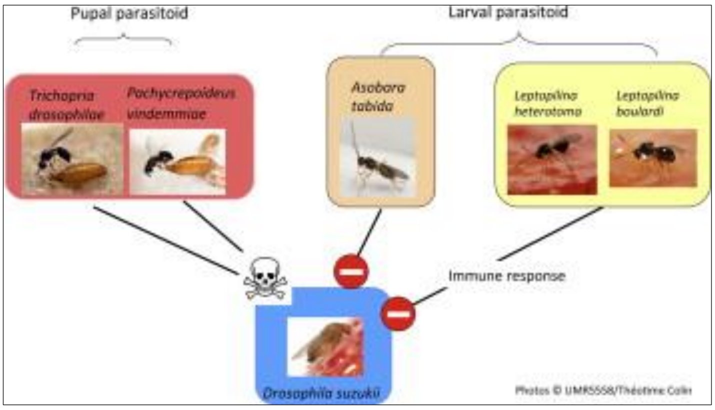

Figure 23 Life cycle of *Trichopria anastrephae* Lima, 1940 in *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae); (Source: https://www.sciencedirect.com/science/article/abs/pii/S1049964412001090)

This work was to determine the ideal pupae density for the parasitism of *T. anastrephae* on *D. suzukii*.

Twenty puparia of *D. suzukii* is the adequate amount to be offered for the parasitism by female *T. anastrephae* for the creation of the insect in the laboratory.

Regarding the number of offspring, there was an increase in emerged insects according to the number of puparia offered. However, the percentage of parasitism decreased with the increase in the number of pupae offered. In addition, *T. anastrephae* provided a percentage of parasitism ideal for the multiplication of the species in the laboratory (62.8%) [33,34,35].

3.5. Study 5

Trichopria drosophilae Perkins, 1910, as a parastoid of *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) (Figures 24, 25 and 26).

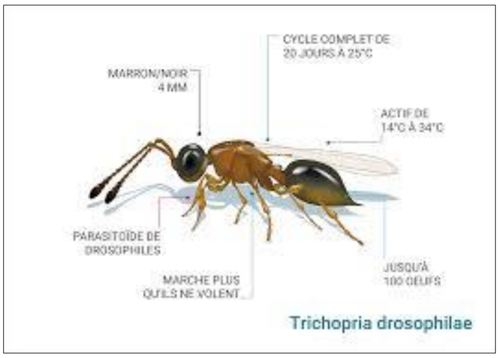

Figure 24 *Trichopria drosophilae* Perkins, 1910; (Source: https://www.insectesutiles.fr/insectes-utiles/34-trichopria-drosophilae.html)

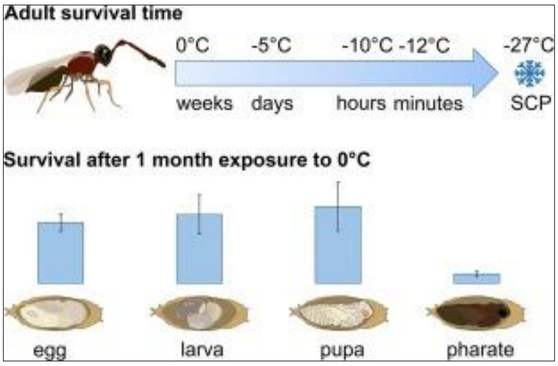

Figure 25 Adult parasitoids could tolerate several days of exposure to sub-zero temperatures and could reproduce afterwards, whereas sub-adult stages could survive longer periods under these conditions. The provision of honey and water enhanced the survival of adults and long-term acclimation led to longer survival in all stages. The semi-field experiment supported the results of the laboratory tests. Based on these results we suggest that in Central Europe, *Trichopria drosophilae* Perkins, 1910 survives winters mainly in developing stages but adults are likely able to tolerate short periods of low spring temperatures; (Source: https://www.sciencedirect.com/science/article/abs/pii/S0022191020302316)

Figure 26 *Trichopria drosophilae* Perkins, 1910, a natural enemy of spotted wing drosophila

Trichopria drosophilae is another pupae parasitoid that has been observed on *D. suzukii* in Spain, Italy and the United States, being very abundant in the south of France as a parasitoid of other drosophilae that attack the fruit. In tests performed in the laboratory, this parasitoid showed effective results to control the population in different fruits (strawberry, blueberry, cherry and raspberry) with an efficiency of infestation from 57% to 91%.

The parasitisms obtained in this field trial went up to 60%. In Catalonia, in 2014, they found parasitism by this species 16% in a commercial cherry field and almost 40% in an experimental plot of raspberries and strawberries. [36,37,38].

4. Conclusion

An organism varies through different host genotypes from the same population. And in the absence of the evolution of this organism, this variation can quickly select the attack reduction, since the ability of the organism to attack and exploit the association with the host decreases with the reduction geographic and also with distance phylogenetics of the host for which the organism is adapted.

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