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Conopidae larvae (Diptera: Conopidae) as endoparasitoids of Aculeata

Carlos Henrique Marchiori *

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

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Abstract

Conopid larvae are internal parasitoids, most are parasitoids of Hymenoptera, particularly those of the Aculeata group, wasps and bees and orthopterans. Adult females are aggressive when attacking their hosts in flight to lay their eggs. The abdomen of the females is modified, it is like a can opener with which they can separate the segments of the abdomen of their victims to insert an egg. The subfamily Stylogastrinae, including the genus *Stylogaster*, is somewhat different. The egg is shaped like a harpoon, capable of piercing the host's integument. Some species of *Stylogaster* are mutualistic with army ants. The most important economic and ecological impact caused by Conopidae is probably its harmful effect on pollinating populations of Hymenoptera, especially bumblebees. Conopidae therefore significantly regulates highly infected insect populations and provides substantial selective forces, reducing the colonies' ability to produce sex in late summer. This review aims to verify the biological characteristics of the Conopidae Family. In order to achieve the main objective, a qualitative method was used based on research and analysis of theoretical books, theses banks, university dissertations, national and international scientific articles, scientific journals, documents and digital platforms. The verification of the mini review of the Conopidae Family was carried out from 1961 to 2022.

Keyword: Egg; *Stylogaster*; Larvae; Female; Ant; Bumblebees

1 Introduction

Conopidae is a family of small dipterans relatively little studied worldwide, with species that resemble solitary wasps. is formed by dipterans with parasitoid habit when immature and nectarivorous. A family (Conopidae) of flies whose species have a club-shaped abdomen and an elongated sucking proboscis. About 800 species have already been described, distributed over 46 genera, and occurring in all zoogeographical regions (Figures 1, 2, 3A and 3B) [1,2,3,4].

* Corresponding author: Carlos Henrique Marchiori
Department of Biological Science, Instituto Federal Goiano, Goias, Brazil.

Source: ID 183883527 © Dreamstime.com

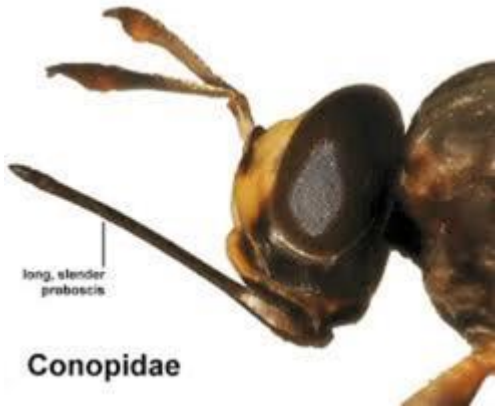
Figure 1 Spiny bushy fly of the adorable fly of the conopidae family sleeping in the morning, nailed on a dry red-green gray background illuminated with flashes

Source: ID 226539488 © Sarah2 | Dreamstime.com

Figure 2 *Physiocephaly rufipes* on silk head mimic devon uk. it's a stubborn fly

Source: ID 93142450 © Azhar Suratman | Dreamstime.com

Figure 3A Densely driven fly & x28; *Physocephala sp* & x29; a wasp statement with black background

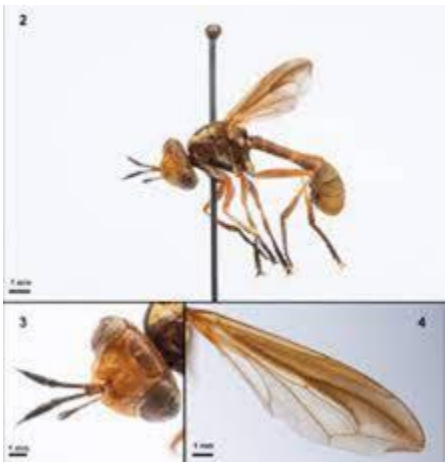


Source: file:///C:/Users/USUARIO/Downloads/23_Brachycera%20(1).pdf

Figure 3B Proboscis long, slender

1.1 Description

Most conopids are black and white or black and yellow and often resemble wasps or flies of the family Syrphidae. The resemblance to wasps is considered a case of Batesian mimicry. They measure 3 to 20 mm, (most 5 to 15 mm). They have wide heads. Some species lack ocelli. The antennae have three segments, the third has an edge. The proboscis is long and thin and often jointed. The external genitalia are conspicuous in both sexes (Figures 4, 5, 6, 7, 8A and 8B) [5,6,7,8].

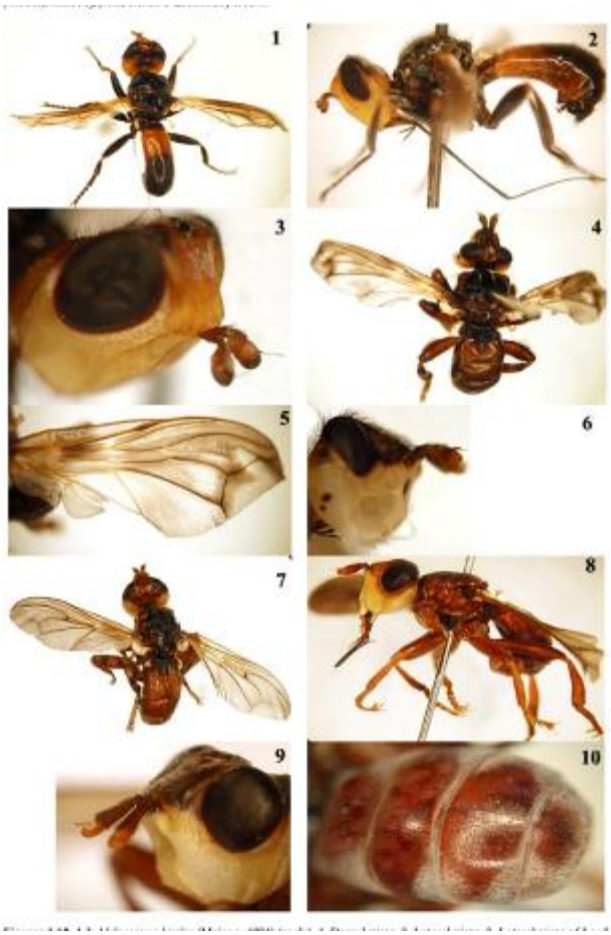


Source: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-34532020000100615

Figure 4 fig2-4 *Physoconops gracilis* (Williston, 1885). 2) lateral view, male; 3) head and antenna details, male, and 4) wing, male

Source: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-34532020000100615

Figure 5 fig. 9-13 *Physoconops tentenvilu* sp. nov. 9) lateral view, male; 10) lateral view, female; 11) wing, female; 12) head, antenna and thorax details, female, and 13) frontal view of head, male



Source: https://www.semanticscholar.org/paper/Contribution-to-the-knowledge-of-thick-headed-flies-Khaghaninia-Kazerani/d93aec79e51d533e10936cd907bae4a8c8c80cef

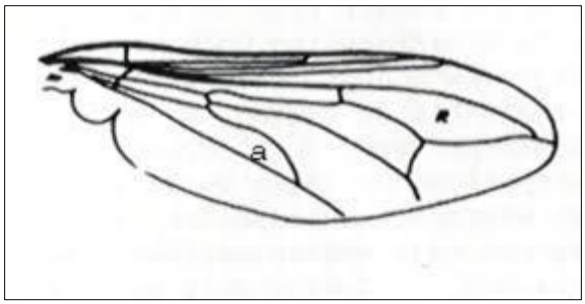
Figure 6 figs 1-10. 1-3: *Melanosoma bicolor* (Meigen, 1824) (male), 1. Dorsal view, 2. Lateral view, 3. Lateral view of head; 4-6: *Myopa buccata* (Linnaeus, 1758) (male), 4. Dorsal view, 5. Wing, 6. Lateral view of head; 7-10: *Myopa dorsalis* Fabricius, 1794 (male), 7. Dorsal view, 8. lateral view, 9. Lateral view of head, 10. Dorsal view of abdomen

Source: https://www.semanticscholar.org/paper/Contribution-to-the-knowledge-of-thick-headed-flies-Khaghaninia-Kazerani/d93aec79e51d533e10936cd907bae4a8c8c80cef

Figure 7 figs, 11-18. 11-14: *Myopa morio* Meigen, 1804, (male), 11. Dorsal view, 12. Lateral view of head, 13. Lateral view, 14. Wing; 15-18: *Myopa pellucida* (Robineau-Desvoidy, 1830), (male), 15. Dorsal view, 16. Lateral view of head, 17. Lateral view, 18. Wing

Source: https://www.semanticscholar.org/paper/Contribution-to-the-knowledge-of-thick-headed-flies-Khaghaninia-Kazerani/d93aec79e51d533e10936cd907bae4a8c8c80cef

Figure 8A figs. 36-47. 36-40: *Thecophora melanopa* Rondani, 1857, (female), 36. dorsal view, 37. lateral view, 38. Lateral view of theca, 39. head lateral view, 40. Wing. 41-45: *Zodion cinereum* (Fabricius, 1794), 41. dorsal view (male), 42. Lateral view (Female), 43. Head lateral view, 44. Lateral view of theca. 45. Wing; 46-47: *Sicus* sp. (male), 46. Dorsolateral view, 47. Dorsal view of abdomen



Source: https://home.hccnet.nl/mp.van.veen/conopidae/

Figure 8B Wing of Conopidae with cell R and anal cell a marked

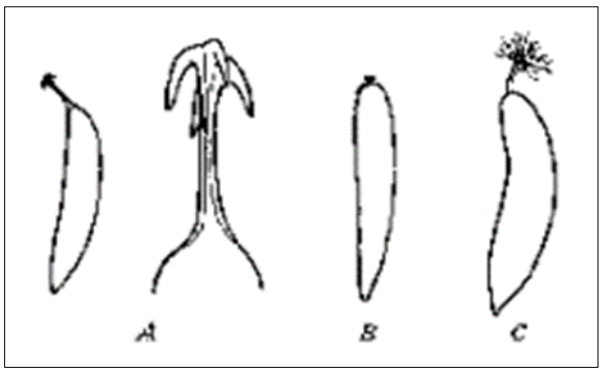
1.2 Biology

They are often found on flowers sipping nectar. They also lie in wait for their victims, usually hymenopterans that visit flowers (Figure 9).

Source: https://www.flickr.com/photos/treebeard/29012349165

Figure 9 Conopidae (Thick-Headed Flies) – Field Guide to the Insects of Tasmania

Conopid larvae are internal parasitoids, most are parasitoids of Hymenoptera, particularly those of the Aculeata group, wasps and bees and orthopterans. Adult females are aggressive when attacking their hosts in flight to lay their eggs.



Source: https://faculty.ucr.edu/~legneref/immature/gif/conop1.ima.htm

Figure 10 The eggs of *Myopa buccata* L., 1758, (Fig. 184A), *Dalmannia punctata* (Fabricius, 1794) . (Fig. 184B) *Physocephala flavipes* L., 1758 (Fig. 184C)

The abdomen of the females is modified, it is like a can opener with which they can separate the segments of the abdomen of their victims to insert an egg. The subfamily Stylogastrinae, including the genus *Stylogaster*, is somewhat different. The egg is shaped like a harpoon, capable of piercing the host's integument. Some species of *Stylogaster* are

mutualistic with army ants. The most important economic and ecological impact caused by Conopidae is probably its harmful effect on pollinating populations of Hymenoptera, especially bumblebees. Conopidae therefore significantly regulates highly infected insect populations and provides substantial selective forces, reducing the colonies' ability to produce sex in late summer (Figures 10, 11, 12, 13, 14, 15 and 16) [9,10,11,12].

Source: https://www.scielo.br/j/rbent/a/cxbqp6qb9mCPgg9BTT9Vx5w/abstract/?lang=en

Figure 11 A. Cocoon soon after pupation of *Physocephala* sp. lodged inside the bee's abdominal cavity (dissected in this micrograph). B. Cocoon opened by newly-emerged fly

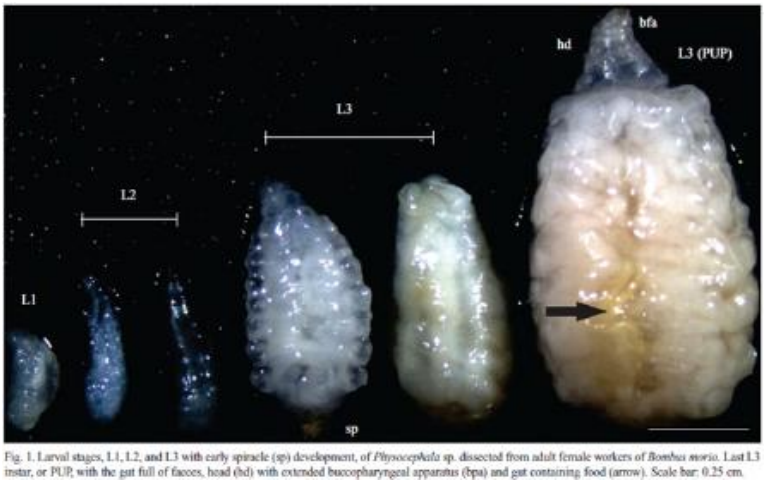
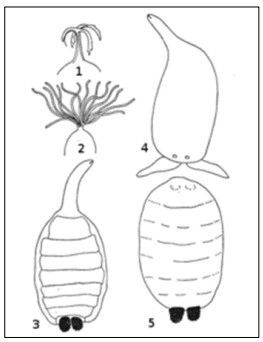


Fig. 1. Larval stages, L1, L2, and L3 with early spiracle (sp) development, of *Physocephala* sp. dissected from adult female workers of *Bombus morio*. Last L3 instar, or PUP, with the gut full of faeces, head (hd) with extended buccopharyngeal apparatus (bpa) and gut containing food (arrow). Scale bar: 0.25 cm.

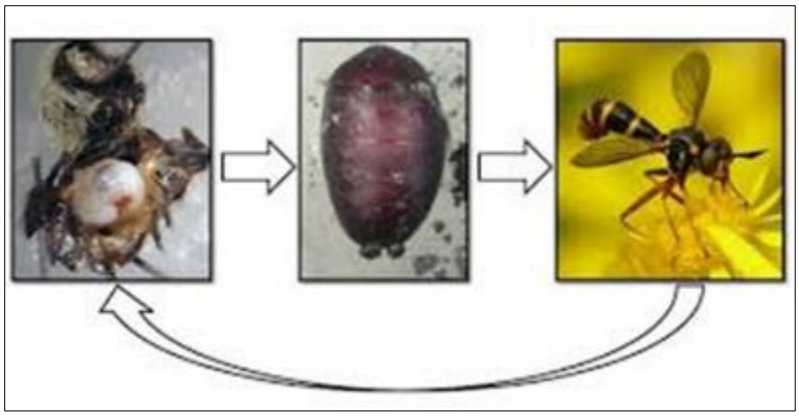
https://www.scielo.br/j/rbent/a/cxbqp6qb9mCPgg9BTT9Vx5w/?lang=en&format=pdf

Figure 12 Larval stages, L1, L2, and L3 with early spiracle (sp) development, of *Physocephala* sp. dissected from adult female workers of *Bombus morio* (Swederus, 1787). Last L3 instar, or PUP, with the gut full of faeces, head (hd) with extended buccopharyngeal apparatus (bpa) and gut containing food (arrow)



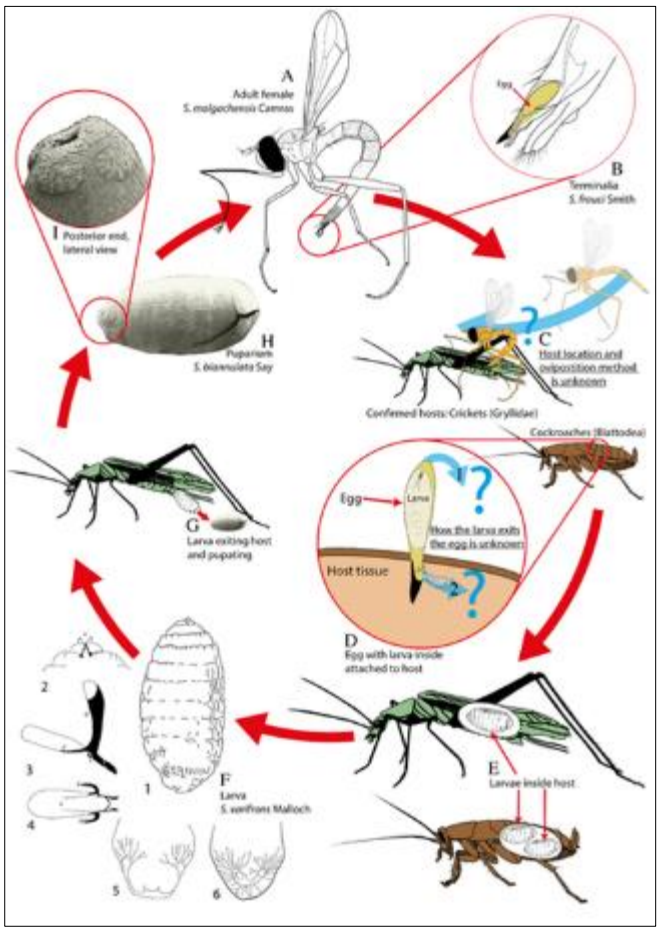
Source: https://fr.wikipedia.org/wiki/Fichier:Immature_stages_of_Conopidae,_Meijere,_1904.png

Figure 13 Immature stages of a Conopidae, 1: *Sicus*, micropylar structure of eggs; 2: *Physocephala*, idem; 3: *Physocephala,* third larval instar; 4: *Zodion*, ditto; 5: *Physocephala*, pupa



Source: Photo Credits (Left to Right): R. Malfi, R. Malfi, Jaco Visser

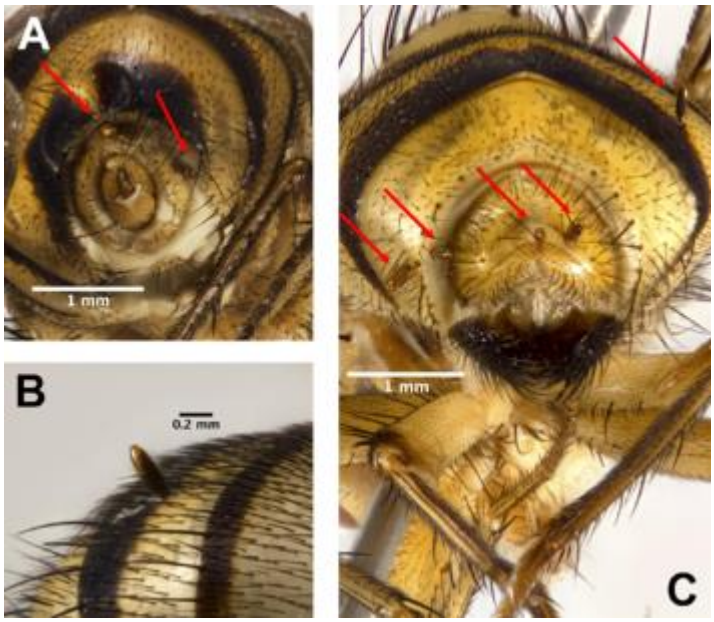
Figure 14 Conopid fly life cycle. Left to right: (1) Late instar larva inside dissected bee abdomen, (2) Conopid pupa extracted from abdomen, (3) Adult conopid fly (*Conops* spp.)



Source: Modified from Smith (1967), Smith and Cunningham-Van Someren (1985), Kotrba (1997) and Woodley and Judd (1998) Etzler et al. (2020)

Figure 15 Lifecycle of *Stylogaster*. A. Adult female of *Stylogaster malgachensis* sp. nov.; notice the bent abdomen which the females flick when hovering in flight; B. Close-up of terminalia from *Stylogaster frauci* Smith, 1979. Egg lodged in terminal chamber with anti-micropylar end protruding; C. Host location and ovipostition method unknown (Confirmed hosts: Crickets (Gryllidae) and cockroaches (Blattodea); D. Egg attached to host. Anti-micropylar end is inside the host, extrusible sac and spines keeping the egg from falling off (2). How the larva exits the egg is unknown, the two proposed ways are illustrated (1 and 2); E. Larvae developing inside hosts; F. Illustration of *Stylogaster larva*, *V varifrons Malloch*. 1 Whole larva in left lateral view. 2 Ventral view of anterior end showing antennae and mouthparts. 3

Cephalopharyngeal skeleton in lateral view and 4 dorsal view. 5 Posterior end of larva showing network of tracheoles in ventral view and 6 dorsal view; G. Larva exiting host from the end of the abdomen and pupating; H. SEM of puparium, *Stylogaster biannulata* (Say, 1823) and close-up of I. posterior end, lateral view. The method of oviposition (C) and how the larva exits from the egg and enters the host (D) are still unknown, shown by blue arrows and question marks (?). Compiled from literature and based on (A, C) S. malgachensis, (B, D) *Stylogaster frauci* Smith, 1979 (E, F, G) *Stylogaster varifrons* Malloch, 1930 and (G, H, I) *S. biannulata*, as all life stages from a single species were not available



Source: https://www.researchgate.net/figure/Stylogaster-eggs-found-on-Tricyclea-spp-A-Tricyclea-fasciata-Maquart-Fly-T-2_fig3_342580494

Figure 16 *Stylogaster* eggs found on *Tricyclea* spp. A*. Tricyclea fasciata (Maquart*), "Fly T", 2 eggs, posterior view; B. *Tricyclea* sp. A, "Fly J", egg on tergite 5; C. *Tricyclea sp. A,* "Fly J", 5 eggs, posterior view

Source: https://pt.frwiki.wiki/wiki/Conopidae

Figure 16 Zodion mating

2 Taxonomy

Conopidae is included among the Schizophora dipterans, but their exact relationships and morphology have not yet been resolved. In the Conopidae family, five subfamilies are recognized: Conopinae, Dalmanninae, Myopinae, Zodioninae and Stylogastrinae.

Source: Sample ID: CNC Diptera 1719 and https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=293384

Figure 17 Subfamily Conopinae

Source: https://bugguide.net/node/view/956958/bgimage

Figure 18 Subfamily Myopinae

Source: https://bugguide.net/node/view/137839/bgimage

Figure 19 Subfamily Stylogastrinae

Some genera: *Conops, Dalmannia, Physocephala, Stylogaster, Myopa* and *Physoconops* (Figures 20, 21, 22, 23, 24 and 25).

Source: http://insecta.pro/taxonomy/893925

Figure 20 Genus *Conops*

Source: http://naturetheplacewhereyoulive.blogspot.com/2019/06/conopidae-dalmannia-sp.html

Figure 21 Genus *Dalmannia*

Source: https://www.flickr.com/photos/andresmoline/11371298863/

Figure 22 Genus *Physocephala*

Source: https://commons.wikimedia.org/wiki/Category:*Stylogaster*

Figure 23 Genus *Stylogaster*

Source: https://www.researchgate.net/figure/Myopa-clausa-a-hilltopping-species-of-Conopidae-found-on-Mount-Rigaud-Quebec-High_fig4_44800945

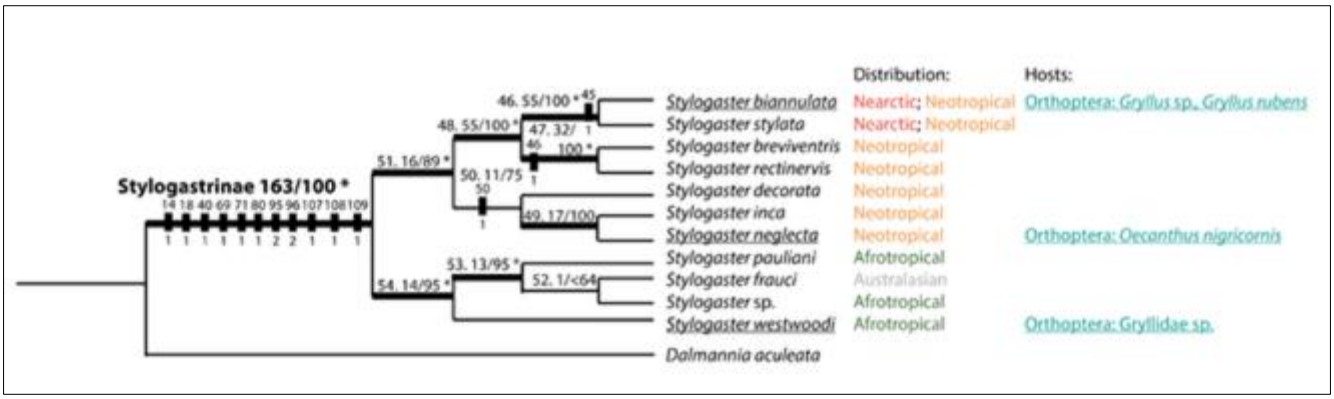
Figure 24 Genus *Myopa*

Source: https://en.wikipedia.org/wiki/Physoconops

Figure 25 Genus *Physoconops*

However, Stylogastrinae are different from other conopids in terms of their biology, in addition to having a number of distinct morphological characteristics, leading some authors to recognize them as a different family, Stylogastridae.

Overall, the systematics of conopids is still controversial. A classification based on molecular analysis, which suggested the group (Conopidade + Lauxanioidea) as sister to all Schizophora. However, most authors consider conopids more closely related to Tephritoidea (Figure 26) [13,14,15,16,17,18].



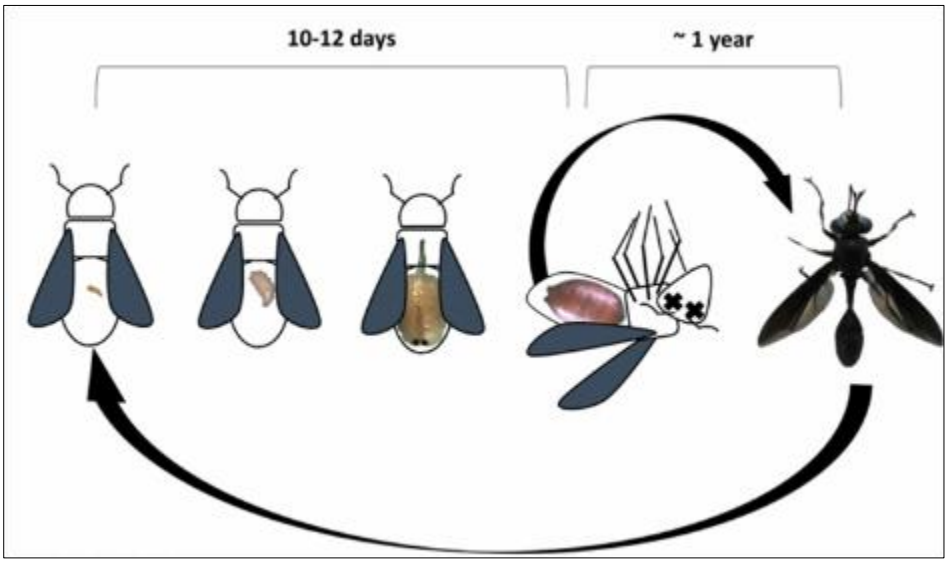
Source: Stuke J. A revision of Afrotropical species of *Stylogaster* Macquart (Diptera: Conopidae), with descriptions of twenty-one new species and an identification key. African Invertebrates. 2012; 53 (1): 267-354

Figure 26 Phylogenetic tree modified from Gibson et al. (2012). Most-parsimonious cladogram generated from combined molecular and morphological data, see Gibson et al. (2012) for details. Host and biogeographical information added. *Stylogaster* with confirmed hosts underlined. Biogeographical information from Stuke (2017) and host

2.1 Study 1

Conopid flies, as a family, utilize a variety of host organisms, with bees and wasps being the most commonly used. At least four genera of conopid flies use bees as hosts over a wide geographic range (North America, Europe, and Asia) [20,21].

How do conopid flies and bumblebees interact? An adult female conopid fly will attack a foraging bee in flight and lay a single egg in the abdominal cavity of the bee. The egg hatches an endoparasitic larva, which feeds on the host bee's hemolymph in the first instars. In later instars, the larva consumes the bee's intestinal tissue, resulting in the death of the host bee about 10 to 12 days after the egg is laid. Not long after the bee dies, the larva will pupa within its host's body. The fly hibernates as a pupa and emerges as an adult the following spring (Figure 27) [20,21].

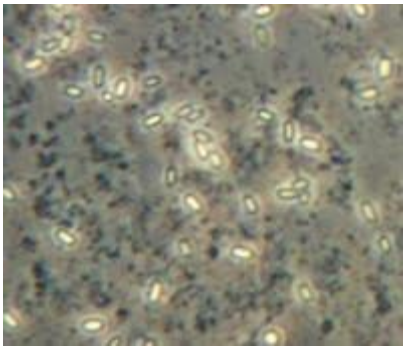


Source: Image credit: Amber Slatosky

Figure 27 The conopid fly life cycle is about 1 year long, with a conopid spending months of its life as a pupa inside of the exoskeleton of its deceased host. This is different than the strategy employed by many other parasitoids, in which time within the host is minimized

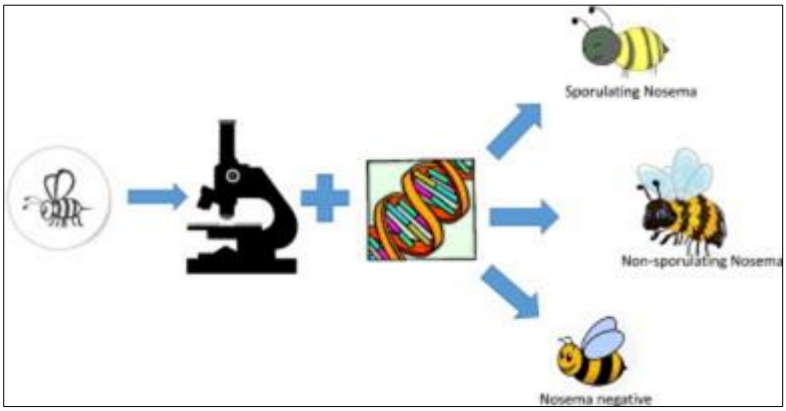
Nosema bombi Fantham & A. Porter 1914 (Microsporidia: Fungi) is an obligate intracellular parasite that can cause systemic infections in bees. As this organism is not predictably common, the fitness effects of *Nosema* infections have been somewhat difficult to establish. Studies have shown that *Nosema* can:

- Inhibit colony formation.
- Inhibit colony growth, and
- Reduce worker survival (Figures 28 and 29) [20,21].



Source: Credit: Rosemary Malfi

Figure 28 *Nosema bombi* Fantham & A. Porter 1914 (Microsporidia: Fungi) Photo: *Nosema bombi* spores at 40x using phase contrast microscopy



Source:
https://www.google.com/search?q=Rhopalomyia+solidaginis&oq=Rhopalomyia+solidaginis&aqs=chrome..69i57j46i19i512j69i60l3.1416j0j7&sourceid=chrome&ie=UTF-8

Figure 29 PCR reveals high prevalence of non/low sporulating *Nosema bombi* (Microsporidia) infections in bumble bees (*Bombus*) in Northern Arizona [20,21].

2.2 Study 2

The knowledge of the fauna of this family has been seriously affected by the numerous gaps in knowledge, mainly due to the low collection effort, especially in the Neotropical Region. Thus, faunal inventories are important tools to highlight such gaps and point out areas where there may be new distribution data or even the occurrence of new species, contributing to the increase of knowledge about this little studied group.

2.2.1 Conopinae

Physocephala aurifrons (Walker, 1849). Type locality: unknown. Distribution: Mexico, Trinidad, Peru, Brazil [MS (Maracaju) to BA], Paraguay (Figure 30) [23,24,25].

Source: http://insecta.pro/taxonomy/330017

Figure 30 *Physocephala aurifrons* (Walker, 1849)

Physocephala bicolor Kröber, 1915. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju)].

Physocephala unicolor Kröber, 1915. Type locality: Paraguay, La Cordillera, San Bernardino. Distribution: Brazil [MS (Maracaju)], Paraguay, Argentina.

Physoconops abruptus Kröber, 1915. Type locality: Argentina, Mendoza. Distribution: Brazil [MS (Maracaju), SC], Paraguay, Argentina.

Physoconops apicalis Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Peru, Brazil [MS (Maracaju), SC].

Physoconops gilmorei Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju), GO], Paraguay.

Physoconops guianicus Curran, 1934. Type locality: Guyana, Bartica, Kartabo. Distribution: Colombia, Guyana, Venezuela, Peru, Brazil [MS (Maracaju), GO].

Physoconops infuscatus Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju) to SP, SC].

Physoconops nitens Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju), SC].

Physoconops ornatifrons Krober, 1915. Type locality: Peru. Distribution: Venezuela, Peru, Brazil [MS (Maracaju) to SC].

Physoconops shannoni Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju)].

Physoconops travassosi Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju), GO, RJ, SP].

Tropidomyia alexanderi Camras, 1955. Type locality: Brazil, Mato Grosso do Sul, Maracaju. Distribution: Brazil [MS (Maracaju), GO, SP], Paraguay.

2.2.2 Stylogastrinae

Stylogaster rectinervis Aldrich, 1930. Type locality: Guyana, Bartica, Kartabo. Distribution: Costa Rica, Colombia, Ecuador, Peru, Guyana, Brazil [AP, RR, AM, PA, RO, TO, MG, RJ, SP, MS (Maracaju), SC].

Stylogaster stylata (Fabricius, 1805). Type locality: “America Meridionalis”. Distribution: Colombia, Ecuador, Brazil [PA, RJ, MS (Porto Murtinho), SC, RS], Paraguay, Argentina (Figure 31).

Source: https://www.researchgate.net/figure/fig1_263925573

Figure 31 *Stylogaster stylata* (Fabricius, 1805)

With regard to the studies of neotropical conopids, the main gap is also supported:

- The need for collections throughout the region, to supply the lack of knowledge of the fauna of this family.
- Breakdowns of this knowledge, such as taxonomy, phylogeny, inventories, identification keys.
- The scarcity of specialists working with the group, especially in South America, should also be pointed out as an important gap and, as a result of this fact, many collections in Brazil and other countries have valuable material that has not yet been identified.
- Increased knowledge of the diversity of conopids and their representativeness in different regions.
- Development of biogeographic studies, with a broad focus or of some genres, which still do not exist. Such studies will be able to point out the regions and environments where the greatest collection effort should be concentrated [23,24,25].

2.3 Study 3

The bees collected belonged to seven of the ten species of *Bombus* present in the country: *Bombus pauloensis* Friese, 1912, *Bombus opifex* Smith, 1879, *Bombus bellicosus* Smith,1879, *Bombus brasiliensis* Lepeletier, 1836, *Bombus dahlbomi* Guérin-Méneville, 1835, *Bombus terrestris* L. 1758, and *Bombus ruderatus* (Fabrício, 1775) (Hymrnoptera: Apidae) know conopid larvae found, identified as such based on morphological characters, in 86 drones of four native species *B. pauloensis, B. opifex, B. bellicosus*, and *B. brasiliensis*, both in males and in worker females. it was possible to identify specific, through molecular techniques, 18 specimens of the 89 larvae obtained, reporting compatibility in all cases of *Physocephala nervosa* Krober, 1915 (Figures 32 and 33).

Source: Graciela Alcantara. ID Registry: 54196 and

Figure 32 *Bombus pauloensis* Friese, 1912

Source: © Photographer UGCA195886_01 and https://www.discoverlife.org/20/q?search=Bombus+opifex

Figure 33 *Bombus opifex* Smith, 1879 Female front

The presence of this species in South America had only been recorded in the provinces of Mendoza, Buenos Aires and Entre Ríos. To estimate the prevalence of each host species, and due to the impossibility of specifically identifying all the larvae obtained, the total number of samples as a single group of Conopidae sensu lato. *Bombus pauloensis* (n = 1,906) had the lowest percentage of cases per season (mean: 4.6%; range: 1.8%, 16.8%) and its presence was recorded in all seasons except one (2013-2014) (Figures 34 and 35) [26,27,28].

Source: Photo 66441186, (c) Gabriel Paladino Ibáñez, all rights reserved, uploaded by Gabriel Paladino Ibáñez

Figure 34 *Bombus brasiliensis* Lepeletier, 1836

Source: https://apoidea.myspecies.info/taxonomy/term/15801

Figure 35 *Bombus bellicosus* Smith,1879

Within *B. bellicosus* (n = 164) conopids were detected in two seasons, with prevalences of 7% (temp. 2015-2016) and 13.6% (temp. 2011-2012), with a mean of 10.3%. *Bombus brasiliensis* (n = 6) and *B. opifex* (n = 16) were found in higher percentages (16.67% and 31.25% respectively), but only in one season (2014-2015 and 2011-2012, respectively). In all cases, one larva per host, except in two individuals of *B. bellicosus* and one of *B. pauloensis*, which harbored two larvae each. I don't know how they found parasitoids in B*. terrestris* (n = 796), *B. ruderatus* (n = 8) or *B. dahlbomii* (n = 1) (Figures 36 and 37).

Source: https://www.usgs.gov/media/images/bombus-dahlbomii-back2-chile

Figure 36 *Bombus dahlbomi* Guérin-Méneville, 1835

Source: https://en.wikipedia.org/wiki/Bombus_terrestris

Figure 37 *Bombus terrestris* L. 1758

Source: https://www.bwars.com/bee/apidae/bombus-ruderatus

Figure 38 *Bombus ruderatus* (Fabrício, 1775)

Although the parasitoid-host complex Diptera-Hymenoptera has been occasionally recorded in other regions of the world, current knowledge of Diptera hosted by *Bombus* spp. in Southamerica it is scarce, limited to isolated records of conopids, tachinids (Tachinidae) and phorids (Phoridae) (Figure 39) [26,27,28].

Source: https://ru.frwiki.wiki/wiki/Physocephala

Figure 39 Genus *Physocephala*

2.4 Study 4

First documented the association of *Calodexia* van der Wulp, 1891 and *Androeuryops* Beneway, 1961 (Tachinidae) and *Stylogaster* Macquart (Conopidae) with army ant attacks (Formicidae: Ecitoninae), noting their presence in front of swarm attacks where they chased runaway insects (acting as parasites on crickets and cockroaches) (Figure 40).

Source: Photo 6368673, (c) Pete Woodall, some rights reserved (CC BY-NC), uploaded by Pete Woodall and

Figure 40 *Calodexia* van der Wulp, 1891

Thousands of these flies can be found accompanying the attacks. Other fly families like Calliphoridae, Phoridae and Sarcophagidae have also been documented. *Calodexia* are reported to be parasitoid on both cockroaches and crickets, and seem to ignore all other arthropods. On the other hand, *Stylogaster*s were never bred, but observing their behavior hypothesizes that they are it also parasites on cockroaches and possibly other arthropods.

I was alerted to the presence of the army ants by the sound of dry litter crackling under the fugitive insects and their pursuers. The army ant species I observed probably belongs to the genus *Labido*. I saw very large numbers (hundreds) of *Calodexia* flies, mostly females, perching on the vegetation, the vast majority of which was right in front of the swarm attack, where they quickly changed position to avoid contact with the ants. I have noticed several mating attempts between *Calodexia* and two specimens were already mating. *Stylogaster*, both male and female, were also very common in front of the attack, hovering and changing positions suddenly movements.

Source: https://es-la.facebook.com/photo/?fbid=10152314363487273&set=a.10150335073072273

Figure 41 Genus *Stylogasters*

The females had a very elongated abdomen and the oviscape curved forward. I don't have noticed any mating attempts in this case. Whenever an arthropod fled from the ants, it was immediately followed and checked by both tachinids and conopids, but, as previously reported, only cockroaches and/or crickets were persecuted, while others were quickly ignored.

At one point, a cricket tried to escape and instantly half a dozen *Calodexia* females surrounded him and chased him under the litter. I have seen many similar attempts, whose oviposition success I cannot confirm, also with cockroaches. The females attacking cockroaches, but ignoring the crickets and other arthropods. The females also chased the cockroaches under the litter [29,30,31,32].

3 Conclusion

Therefore, contributing to the knowledge of expanding this family, while diagnosing possible native natural enemies, mainly parasites, is vital to avoid possible environmental impacts of classical biological control, such as migration or even extinction of native species.

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