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(REVIEW ARTICLE)

Parasitic behavior of the larvae of the Conopidae family (Diptera: Conopidae)

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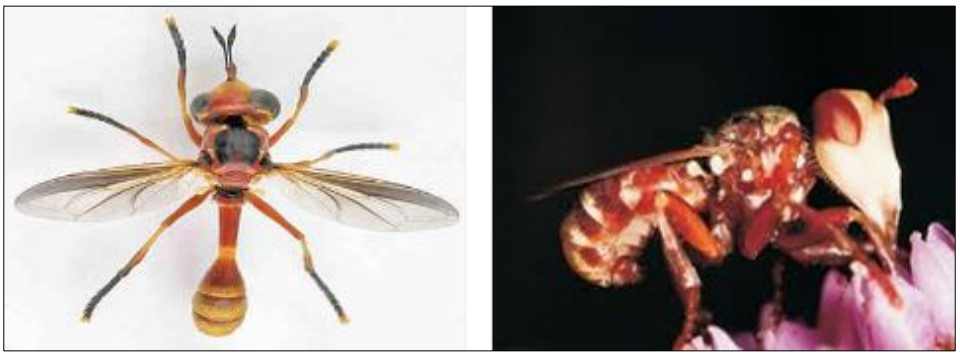
Abstract

Known larvae are parasitoids, most are parasitoids of Hymenoptera, particularly those of the Aculeata group, wasps and bees. Adult females are aggressive when they attack their hosts in flight to lay their eggs. The female abdomen 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 Stylogastrinae subfamily, including the *Stylogaster* genus, is somewhat different. The egg is harpoon-shaped, capable of piercing the host's integument. Some species of *Stylogaster* are mutualistic with warrior ants. To know the parasitic behavior of the larvae of the Conopidae Family (Diptera: Conopidae). In this study, quantitative and conceptual aspects were used. To this end, a bibliographic survey of Conopidae was carried out in the years 1974 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: Hymenoptera; Bees; Wasps; Mutualism; Ants

1. Introduction

The Conopidae are a family of brachycephalic diptera. They are distributed worldwide except at the poles and many islands in the Pacific. The family contains about 800 species in 52 genera (Figure 1) [1].



Source: https://bugguide.net/node/view/880209

Figure 1 Specimens of Conopidae Diptera

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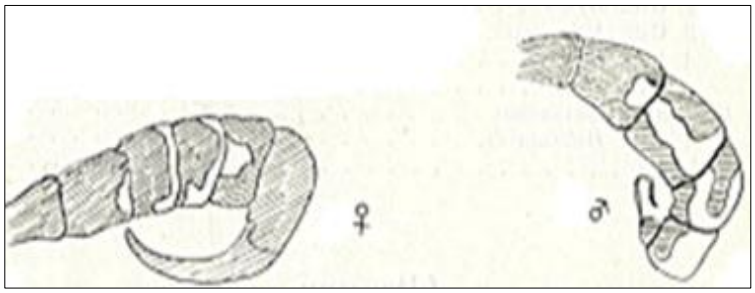
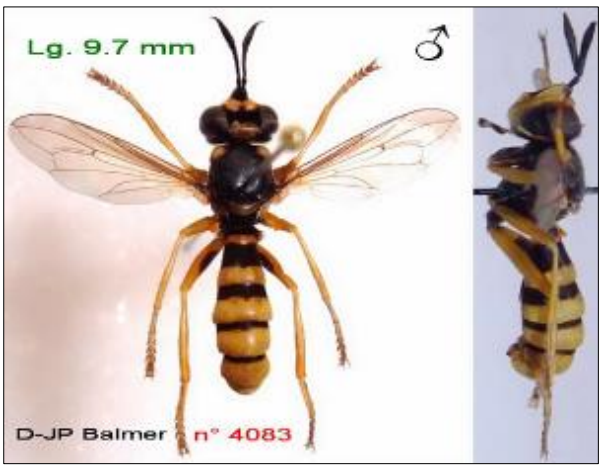
Most of the conópidos are black and white or black and yellow and often resemble wasps or flies of the family Syrphidae. The resemblance to wasps is considered a case of Batesian mimicry. They measure 3 to 20 mm, (most of 5 to 15 mm). They have a broad head. Some species lack ocelli. The antennas have three segments, the third has an edge. The proboscis is long and thin and often articulated to the nectarivorous feeding habit, feeding on flowers of plants of the Apiaceae, Asteraceae and Lamiaceae families. The external genitalia are conspicuous in both sexes (Figures 2, 3, 4, 5, 6 and 7) [1, 2, 3]



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

Figure 2 Abdomen of *Dalmannia*, left male, right female

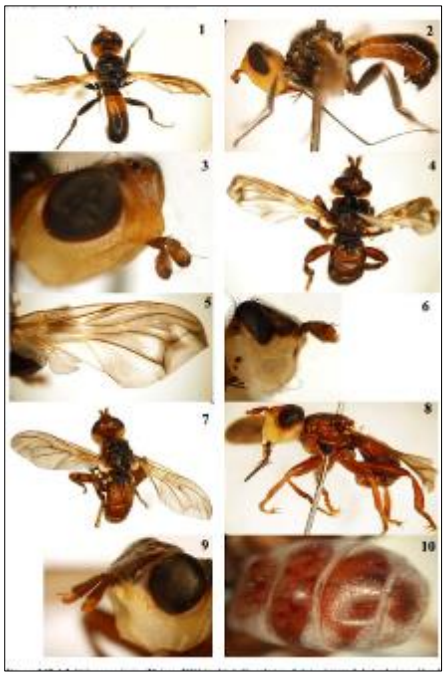


Source: https://www.flickr.com/photos/d-jp-balmer/6949067207

Figure 3 Male of Conopidae (Diptera)

Source: https://alchetron.com/Conopidae

Figure 4 Female of Conopidae (Diptera)



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

Figure 5 Fig. 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/1

Figure 6 Fig. 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

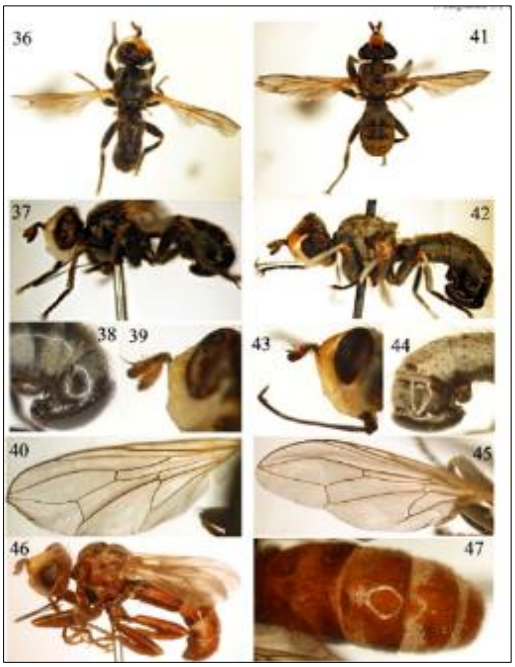


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Figure 7 Figs. 36-47. 36-40: *Thecophora melanopa* Rondani, 1857, (female), 36. Dorsal view, 37. Lateral view, 38. Lateral view of theca, 39. Head lateral view, 40. Wing. 41-45: *Zodion cinereum* (Fabricius, 1794), 41. Dorsal view (male), 42. Lateral 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

They are often found on flowers sipping nectar. They are also on the lookout for their victims, usually Hymenoptera visiting flowers (Figures 8 and 9) [1, 2, 3]

Source: https://commons.wikimedia.org/wiki/File:Conopidae_-_Conops_quadrifasciatus_ (female).jpg

Figure 8 Conopidae visiting flowers

Source: https://www.mindenpictures.com/search?s=conopidae

Figure 9 Copulation two Conopidae

Known larvae are parasitoids, most are parasitoids of Hymenoptera, particularly those of the Aculeata group, wasps and bees. Adult females are aggressive when they attack their hosts in flight to lay their eggs. The female abdomen 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 Stylogastrinae subfamily, including the *Stylogaster* genus, is somewhat different. The egg is harpoon-shaped, capable of piercing the host's integument. Some species of *Stylogaster* are mutualistic with warrior ants [4, 5, 6].

The larvae are endoparasites of other insects, being considered minor pests in beekeeping, except for the Stylogastrinae, which oviposit on Orthoptera, Blattaria and Diptera Calyptratae. They are less important as pollinators, but in general the biology is little known, with few works focused on the species that parasitize Hymenoptera (Figures 10, 11, 12, 13 and 14) [6,7]

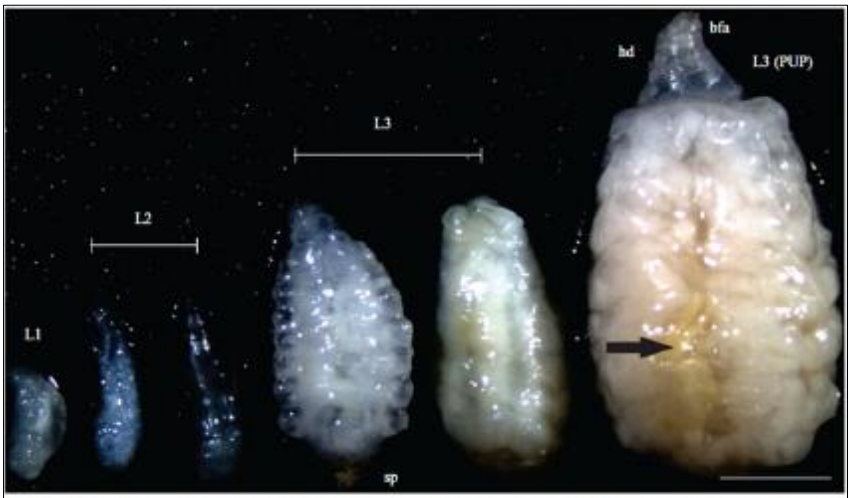
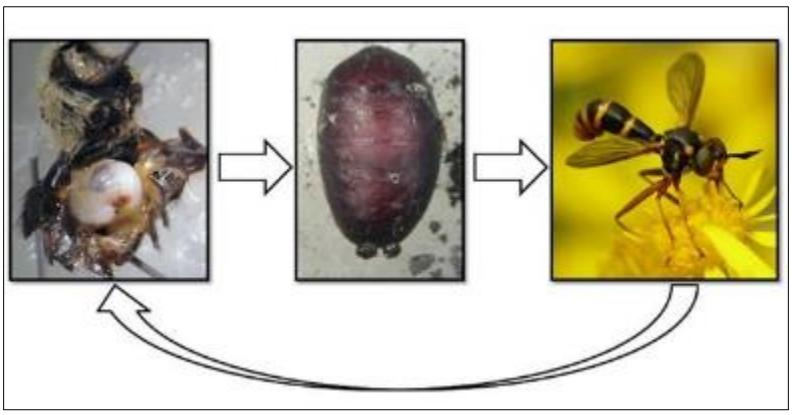


Fig. 1. Larval stages, L1, L2, and L3 with early spiracle (sp) development, of *Physocephala* sp. dissected from adult female workers of *Bombus morio*. Last L3 instar, or PUP, with the gut full of faeces, head (hd) with extended buccopharyngeal apparatus (bpa) and gut containing food (arrow). Scale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

Source: https://write-paper-for-me.online/?rt=x0eNuGGg&utm_keyword=1452bb3f4b46d4fa641798aab8eb9661&utm_source=current&utm_

Figure 10 Larval stages, L1, L2 and 13 (The larvae are endoparasites of other insects) and pupa



Source: Photo Credits (Left to Right): R. Malfi, R. Malfi, Jaco Visser and https://sites.google.com/site/rmalfiresearch/research/parasitism/Parasites

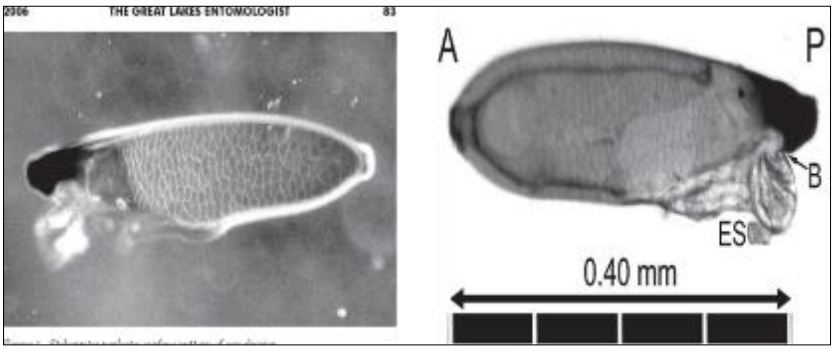
Figure 11 Conopid fly life cycle. Left to Right: (1) Late instar larva inside dissected bee abdomen, (2) Conopid pupa extracted from abdomen, (3) Adult conopid fly (*Conops* spp.). An adult female conopid fly will assail a foraging bumblebee in flight, and oviposit a single egg into the abdominal cavity of the bee. The egg hatches an endoparasitic larva, which feeds on the host bee's hemolymph (analogous to blood) in early instars. In later instars, the larva consumes the gut tissue of the bee, resulting in the host bee's death about 10-12 days after the egg was oviposited. Not long after the bee's death, the larva will pupate within the body of its host. The fly overwinters as a pupa and emerges as an adult the following spring

Source: https://link.springer.com/article/10.1007/s00114-019-1634-9

Figure 12 Dipterans of the genus *Physocephala* (Diptera: Conopidae) are parasitoids that attack adult bees during their field activities, and the parasitoid larvae develop inside the host abdomen their host, the solitary bee species *Centris analis* (Apidae: Centridini)

Source: https://www.tandfonline.com/doi/abs/10.1080/00305316.2021.1943558?journalCode=toin20

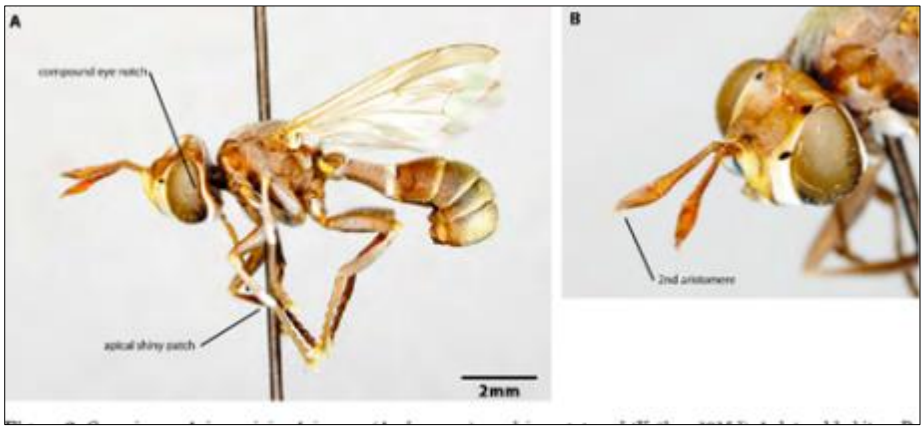
Figure 13 Eggs, larvae, pupa and adult (Biology and seasonal incidence of *Physocephala* (Diptera: Conopidae) on carpenter bees (Hymenoptera: Apidae)



Source: https://www.semanticscholar.org/paper/The-Egg-of-Stylogaster-Neglecta-Williston-(Diptera%3A-Taber-aloney/23bbf8a287974ab09887a73a7d8a8c296651830c/figure/3

Figure 14 *Stylogaster neglecta* Williston, 1883; surface pattern of egg chorion. *S. neglecta*: egg; A = Anterior end, P = Posterior end, ES = Extrusible Sac, B = Barb

Some genera: Conops, Dalmannia, Physocephala, Stylogaster, Myopa, and Physoconops (Figure 15) [7, 8].



Source: https://www.semanticscholar.org/paper/Phylogeny-and-taxonomic-revision-of-all-genera-of-Gibson-Skevington/d0cb2f4f4519cca9ed77c0dbb4190bab193445eb

Figure 15 Conopinae – Asiconopini – *Asiconops (Aegloconops) quadripunctatus* (Kröber, 1915d). A, lateral habitus; B, head

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 (Figure 16) (Table 1) [8,9]

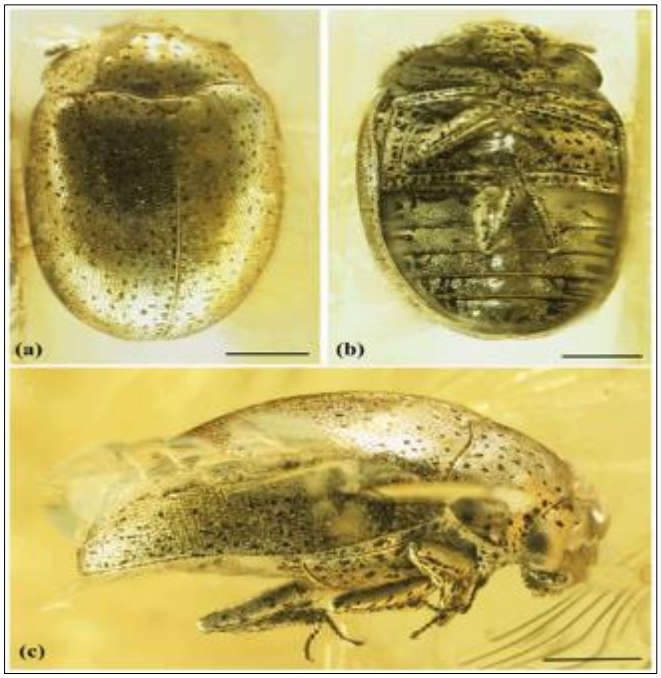


Figure 16 The first *Stylogaster* Macquart, 1835 (Diptera: Conopidae) fossil, from Oligo-Miocene Dominican amber, and some phylogenetic and biogeographic considerations

Table 1 Past tribal classifications for genera of Conopidae

Zimina, 1960	Camras, 1965	Papavero, 1971
Conopidae of USSR Conopinae Brachyceraeini *Brachyceraea* *Neobrachyceraea* Conopini *Abrachyglossum* *Conops* *Brachyglossum* (now *Leopoldius*) *Physocephala* Tropidomyiini *Tropidomyia* Myopinae Myopini *Melanosoma* *Myopa* *Occemyia* (now *Thecophora*) Sicini *Sicus* *Carbonosicus* Zodionini *Zodion* Dalmanniini *Dalmannia*	Nearctic Conopidae Conopinae Conopini *Conops* (1 subgenus) *Physoconops* (3 subgenera) Physocephalini *Physocephala* Myopinae *Myopa* *Robertsonomyia* *Thecophora* *Zodion* Dalmanniinae *Dalmannia* Stylogasterinae *Stylogaster*	Neotropical Conopidae Conopinae Conopini *Conops* (5 subgenera) *Mallachoconops* *Physoconops* (3 subgenera) Physocephalini *Physocephala* Tropidomyiini *Tropidomyia* Myopinae *Myopa* *Neozodion* *Robertsonomyia* *Scatoccemyia* *Thecophora* *Zodion* Dalmanniinae *Baruerizodion* *Parazodion* Stylogasterinae *Stylogaster*
Smith, 1980	**Chvála & Smith, 1988**	**Camras, 2000, 2001**
Afrotropical Conopidae Conopinae Conopini *Anticonops* *Archiconops* *Caenoconops* *Conops* (2 subgenera) *Dacops* *Euconops* Physocephalini *Physocephala* *Physoconops* *Pleurocerinella* *Pseudophysocephala* *Tropidomyia* Myopinae *Paramyopa* *Pseudoconops* *Thecophora* *Zodion* Stylogasterinae *Stylogaster*	Palaearctic Conopidae Conopinae Brachyceraeini *Brachyceraea* *Neobrachyceraea* Conopini *Abrachyglossum* *Archiconops* *Conops* (2 subgenera) *Leopoldius* *Macroconops* *Neobrachyglossum* *Physocephala* *Siniconops* Pleurocerinellini *Pleurocerinella* Tropidomyiini *Tropidomyia* Myopinae Myopini *Melanosoma* *Myopa* *Myopotta* *Thecophora* Sicini *Carbonosicus* *Sicus* Zodionini *Zodion* Dalmanniinae *Dalmannia*	Afrotropical Conopinae Conopinae Conopini *Anticonops* *Caenoconops* *Conops* (3 subgenera) *Euconops* *Physoconops* Physocephalini *Dacops* *Physocephala* *Pleurocerinella* *Pseudophysocephala* *Tropidomyia*

Source: https://www.semanticscholar.org/paper/Phylogeny-and-taxonomic-revision-of-all-genera-of-Gibson-Skevington/d0cb2f4f4519cca9ed77c0dbb4190bab193445eb/figure/0

The main gap is also based on the need for collections throughout the region, to supply the lack of knowledge of the fauna of this family, followed by the dismemberment of this knowledge, such as taxonomy, phylogeny, inventories and identification keys [8, 9].

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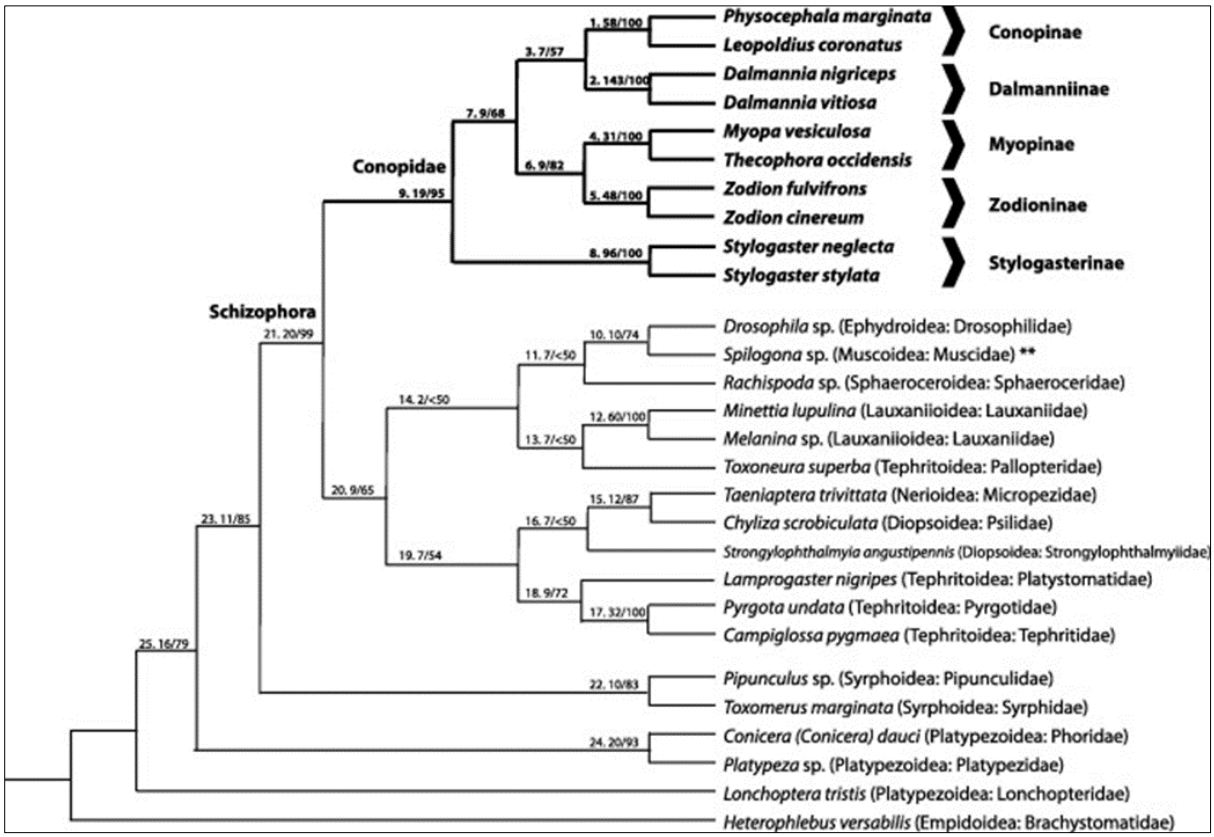


Source: https://www.sciencedirect.com/science/article/abs/pii/S1055790310001399

Figure 17 The first attempt to phylogenetically place Conopidae using molecular characters, as well as the largest molecular analysis of relationships within Schizophora (Diptera) to date, is presented. Twenty-eight taxa from 11 acalyptrate families and seven acalyptrate superfamilies are represented. Nearly 12,800 bp of sequence data from 10 genes representing both mitochondrial

Objective

To know the parasitic behavior of the larvae of the Conopidae Family (Diptera: Conopidae).

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [10].

3. Studies conducted and selected

3.1. Study 1

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.

List of Conopidae from the State of Mato Grosso do Sul, Brazil (Figure 18):

3.1.1. Conopinae

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

Figure 18 Species of Conopinae

- *Physocephala aurifrons* (Walker, 1849). Type locality: unknown. Distribution: Mexico, Trinidad, Peru, Brazil [MS (Maracaju) to BA], Paraguay.
- *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 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.

3.1.2. 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.

Fifteen species in four genera were recorded for the State of Mato Grosso do Sul. The municipality of Maracaju was the only municipality with recorded occurrences, with only one exception: *Stylogaster stylata* in Porto Murtinho (Figure 19).

Source: https://commons.wikimedia.org/wiki/File:Stylogaster_stylata_(Macquart_-_1838).jpg

Figure 19 *Stylogaster stylata* (Macquart, 1838)

The increase in knowledge of the diversity of conopids and their representativeness in different regions will also enable the development of biogeographic studies, with a broad focus or of some genera, 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 [11,12,13,14,15,16,17,18,19,20].

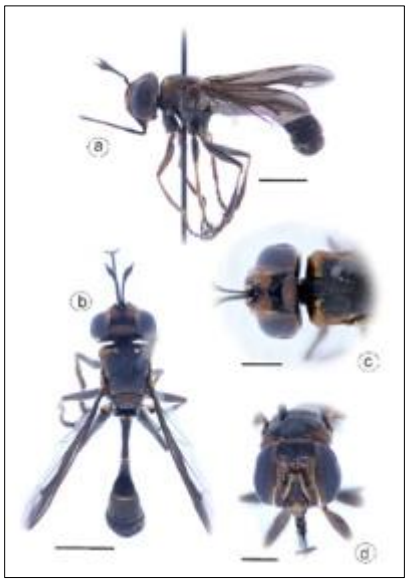
3.2. Study 2

This work shows an association between *Centris analis* (Fabricius, 1804) (Hymenoptera: Apidae: Centridini) and the parasitoid *Physocephala* ssp. (Diptera: Conopidae). The objective is to identify behaviors related to extra deposition in these females parasitized by flies of the genus *Physocephala* (Figures 20, 21, 22 and 23)

Source: https://www.youtube.com/watch?v=VmgqKQTAnz0

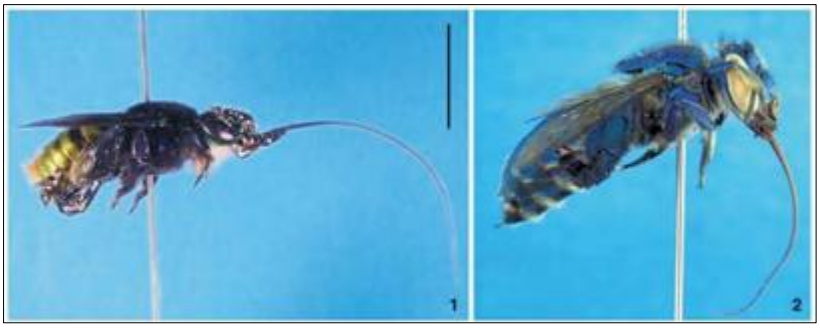
Figure 20 *Centris analis* (Fabricius, 1804) (Hymenoptera: Apidae: Centridini)

During the study, 26 females were previously marked and 138 nests were obtained. Of these females, 11 were found dead inside empty trap-nests, along with nine males also found dead in the nests. The insects were taken to the laboratory, from which 20 parasitoides after a period of 19 to 53 days. The parasitoids belonged to eight species: *Physocephala soror* Kröber, 1915 (n=2), *Physocephala bipunctata* Macquart, 1849 (n=1), *Physocephala inhabilis* (Walker, 1849) (n=5), *Physocephala rufithorax* Kröber, 1891 (n=5), *Physocephala cayennensis* Macquart, 1843 (n = 2), *Physocephala aurifrons* Walker (n = 1), *Physocephala bennetti* Camras, 1966 (n = 1), *Physocephala spheniformis* Camras, 1957 (n = 3).



Source: https://www.redalyc.org/journal/3220/322063447007/html/

Figure 21 *Physocephala inhabilis* (Walker, 1849) male. a, habitus in lateral view; b, habitus in dorsal view; c, head and thorax in dorsal view; d, head in front view



Source: https://www.scielo.br/j/rbzool/a/XJLs6QymkfYJdH7BWRTtt4j/?lang=en#

Figure 22 *Physocephala bipunctata* Macquart, 1884

Source: https://www.scielo.br/j/rbent/a/cxbqp6qb9mCPgg9BTT9Vx5w/?lang=en#ModalFiga07fig02

Figure 23 *Physocephala* (Larval development of *Physocephala* (Diptera, Conopidae) in the bumble bee *Bombus morio* (Swederus, 1787) (Hymenoptera, Apidae)

The 11 females of *C. analis* parasitized built 37 nests with brood cells and 42 nests that were just closed (empty), without brood cells. All nests with brood cells received an extra oil deposition at the closing of the last cell partition, similar to the oil deposition at the closing of the nests [21].

3.3. Study 3

In a work summarizing the studies carried out in Brazil using the trap-nest technique to attract solitary bees that nest in preexisting cavities, the actors suggested that among the species occupying the trap-nests, some of them could be indicated for breeding programs. Controlled pollination. Among these species, those of the genus *Centris* stand out, especially the species *Centris analis* Fabricius, 1804), *Centris tarsata* (Smith, 1874) and *Centris vittata* Lepeletier, 1841) (Hymenoptera: Apidae: Centridini), mainly because they are relatively constant and abundant in most studies carried out with trap-nests in Brazil. This abundance is an important characteristic when seeking to identify potential species that can be worked on in order to properly manage them in controlled pollination programs (Figures 24, 25, 26).

Source: https://www.biolib.cz/en/image/id161242/

Figure 24 *Centris analis* (Fabricius, 1804), *Centris tarsata* (Smith, 1874) and *Centris vittata* Lepeletier, 1841) (Hymenoptera: Apidae: Centridini)

Source: Rosemeri Orchids, 2 Feb. from 2020

Figure 25 The trap-nest technique to attract solitary bees. *Stingless* bees, called *Centris analis* (Fabricius, 1804) bees, are tame bees that pollinate flowers such as acerola, passion fruit, and guava, among others

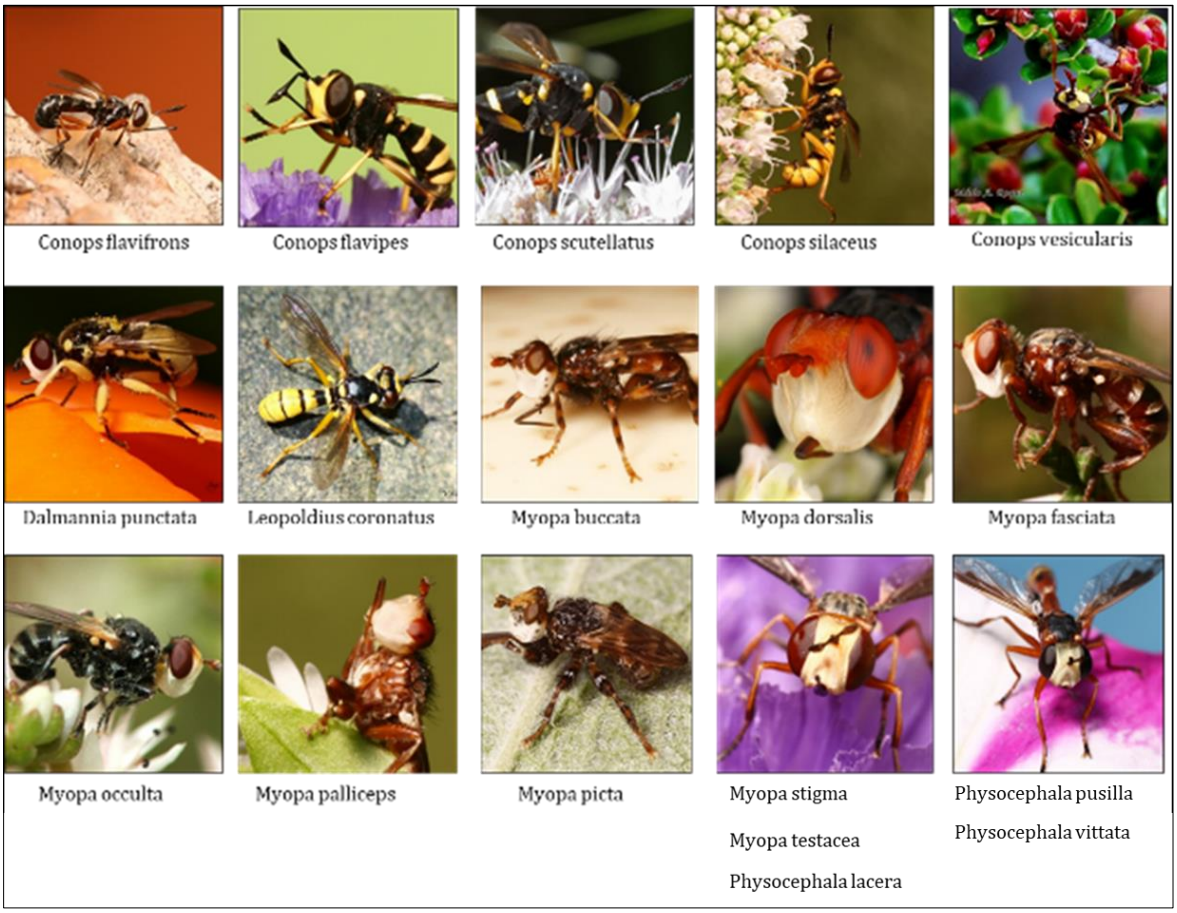
Source: Photos: Carolina Hirotsu & Diego Moure Oliveira. The seven females who showed these behaviors described as unusual

Figure 26 Closures (or plugs) of *Centris analis* (Fabricius, 1804) nests: (A) commonly observed closure; (BC) closures in which extra oil deposition by parasitized female occurred; (D) Empty trap-nest with just the plug built in. Scale bars = 1 cm

The information available so far showed that species of *Centris* would be good pollinators in acerola *(Malpighia emarginata* DC) (Malpighiaceae) and murici (*Byrsonima* spp.) (Malpighiaceae) crops, which are abundant in northeastern Brazil, where they visit the flowers to collect oil and pollen. Other information indicated species of *Centris* as pollinators of cashew (*Anacardium occidentale* L.) (Anacardiaceae), guava (*Psidium guajava* L.) and tamarind (*Tamarindus indica* L.) (Fabaceae). More recent information reinforcing the association of *C. analis* with *M. emarginata* emphasize the importance and the possibility of using this bee species in pollination programs for the production of acerola *C. analis* is a species that has a wide geographic distribution occurring from Mexico until Brazil (Figure 27).

Source: https://link.springer.com/article/10.1007/s00114-019-1634-9

Figure 27 *Centris* female analyzed after presenting activities different from those considered as standard, during the nesting period, containing a conopideo larva (Diptera: Conopidae) inside her abdomen (eggs and larvae)



Source:https://naturdata.com/especies-portugal/taxon/0@1-animalia: arthropoda:insecta:diptera:conopidae/

Sicus ferrugineus

Figure 28 Specimens of Conopidae Family

Other species of the subgenus *Heterocentris, C. analis n*ests in preexisting cavities and, therefore, accepts artificial cavities called trap-nests to establish their nests. This species uses plant material and an oily substance to coat the cavity and build the back wall and operculum of the cells, which are provisioned with pollen and nectar. The brood cells are arranged linearly and are usually followed by a vestibular cell, that is, by an empty space between the closing of the last brood cell and the closing wall of the nest. In completed nests occupying 5.8cm long and 0.6cm diameter trap nests, females can build one to four brood cells. Females emerge from the first cells built and males emerge from cells closest to the nest entrance.

The period from egg to adult was affected by climatic conditions and ranged from 36 to 85 days for males and from 37 to 88 days for females. The mortality of the immature stages can be caused by attacks by the kleptoparasitic bees *Coelioxys* sp. (Hymenoptera: Megachilidae) and *Mesocheira bicolor* (Fabricius, 1804) (Hymenoptera: Apidae), by attacks by the wasp *Leucospis cayennensis* Westwood, 1839 (Hymenoptera: Leucospidae), by the dipteran *Anthrax* (Diptera: Bombyliidae) and Conopidae (Diptera) by climatic conditions r other factors [22, 23, 24, 25, 26, 27, 28].

Conopidae family genera; 24 species were found.

4. Conclusion

The increase in knowledge of the diversity of conopids and their representativeness in different regions will also enable the development of biogeographic studies, with a broad focus or of some genera, 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.

References

[1] Kröber O. Contributions to the knowledge of conopids. Annals and Magazines of the Natural History. 1939; 11(4): 1-38.

[2] Camras S. The Conopidae of Madagascar (Diptera). Memoirs of the Scientific Institute of Madagascar Series E. 1962; 8:1-18.

[3] Smith KGV. The larva of *Thecophora occidensis*, with comments upon the biology of Conopidae (Diptera). Journal of Zoology. 1966; 149(3): 2-263.

[4] Camras S, Parrillo PP. Review of the New World *Stylogaster* (Diptera Conopidae). Annals of the Entomological Society of America. 1985; 78: 111-126.

[5] Couri MS, Pont A. Eggs of *Stylogaster* Macquart (Diptera, Conopidae) on Madagascan muscids (Diptera, Muscidae). Proceedings of the California Academy of Sciences. 2006; 57: 473-478.

[6] Rocha LSG, Mello-Patiu CA. *Stylogaster* Macquart 1835 (Diptera: Conopidae): from Northeastern Brazil new records and two new species. Zootaxa. 2012; 3590: 23-36.

[7] McAlpine JF. Phylogeny of the Muscomorpha. 3th ed. Ottawa: Research Branch Agriculture Canada. 1989.

[8] McAlpine JF, Peterson BV, Shewell GE, Teskey HJ, Vockeroth JR, Wood DM. 2th ed. Ottawa: Manual of Nearctic Diptera. Research Branch Agriculture Canada. 1987.

[9] Marchiori CH. Biology and feeding behavior of ceratopogonid adult (Diptera: Ceratopogonidae). International Journal of Frontiers in Science and Technology Research. 2021; 1(2): 007–024.

[10] Gomes LS, Mello-Patiu RCA. Checklist of Conopidae (Insecta, Diptera) from Mato Grosso do Sul State, Brazil. Iheringia, Série Zoologia. 2017; 107: e2017144.

[11] Camras S. A review of the New World flies of the genus *Conops* and *Allies* (Diptera: Conopidae). Proceedings of the United States National Museum. 1955; 105: 155-187.

[12] Camras S. A review of the New World *Physocephala* (Diptera: Conopidae). Annals of the Entomological Society of America. 1957; 50: 213-218.

[13] Smith KGV, Peterson BV. Conopidae. 2th ed. Ottawa: Research Branch Agriculture Canada. 1987; 1-657.

[14] Gibson JF, Skevington JH. Biodiversity of Argentine arthropods 4th ed. Buenos Aires: Argentine Entomological Society. 2014.

[15] Gibson JF, Skevington JH, Kelso S. Placement of Conopidae within Schizophora based on mtDNA and nrDNA gene regions. Molecular Phylogenetics and Evolution. 2010; 56: 91-103.

[16] Han HY, Ro KE. Molecular phylogeny of the superfamily Tephritoidea (Insecta: Diptera): New evidence from the mitochondrial 12S, 16S and COII genes. Molecular Phylogenetics and Evolution. 2004; 34: 416-430.

[17] Korneyev VA. Phylogenetic relationships among the families of the Superfamily Tephritoidea. Phylogeny and evolution of behavior. Boca Raton, CRC Press. 1999.

[18] Papavero N. Family Conopidae. 1th ed. São Paulo, Department of Zoology, Department of Agriculture. 1971.

[19] Smith K. Further data on the oviposition by the genus *Stylogaster* Macquart (Diptera: Conopidae, Stylogasterinae) upon adult calyptrate Diptera associated with ants and animal dung. Proceedings of the Royal Entomological Society of London, Series A General Entomology. 1969; 44: 35-37.

[20] Couto RM, Camillo E. Oil deposition by females of *Centris analis* (Fabricius) (Hymenoptera: Apidae: Centridini) parasitized by *Physocephala* spp. (Diptera: Conopidae). EntomoBrasilis. 2014; 7(2): 81-85.

[21] Garófalo CA, Martins CF, Alves-dos-Santos I. The brazilian solitary bee species caught in trap nests. 1th ed. Fortaleza: Imprensa Universitária. 2004.

[22] Garófalo CA, Martins CF, Aguiar CML, Del LMA, Alves-dos-Santos I. Solitary bees and perspectives for their use in pollination in Brazil. 1th ed. São Paulo: EDUSP Publisher. 2012.

[23] Gazola AL, Garófalo CA. Parasitic behavior of *Leucospis cayennensis* Westwood (Hymenoptera: Leucospidae) and rates of parasitism in populations of *Centris (Heterocentris) analis* (Fabricius) (Hymenoptera: Apidae: Centridini). Journal of the Kansas Entomological Society. 2003; 76: 131-142.

[24] Martins CGM, Lorenzon MCA, Baptista JL. Efficiency of pollination types in acerola. Caatinga. 1999; 12:55-59.

[25] Magalhães LMF, Oliveira D, Ohashi OS. Effect of pollination on acerola fruit set in the Amazon. Brazilian Fruit Growing Magazine. 1999; 21: 95-97.

[26] Melo CG, De Alves EU, Lorezon MC, Baptista JL. Malpighia labra L. Sweet Message pollinators. 1997; 42:14-17.

[27] Hirotsu CM. Selection of nesting cavities, progeny size per nest, sex ratio and mortality of immatures and adults of Centris (Heterocentris) analis (Fabricius, 1804) (Hymenoptera, Apidae, Centridini) [Master's Dissertation]. Ribeirão Preto: University of São Paulo. 2013.