



Study of the importance of the Chalcididae Family in agriculture (Insecta: Hymenoptera)

Carlos Henrique Marchiori *

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

Open Access Research Journal of Multidisciplinary Studies, 2022, 03(02), 001–031

Publication history: Received on 12 February 2022; revised on 24 March 2022; accepted on 26 March 2022

Article DOI: <https://doi.org/10.53022/oarjms.2022.3.2.0037>

Abstract

Chalcidids of economic importance are associated with palm trees in Tropical America, since about 19 species of the family are associated with palm trees, a remarkable number. The parasitoids of this family are phytophagous insects, which are mainly Lepidoptera and Hispinae beetles, which attack the leaves of palm trees. The objective of this mini review is to describe the economic importance of the Chalcididae Family. With emphasis on conceptual and taxonomic aspects was carried out in the years 1979 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events. Data were also obtained from platforms such as: Scielo Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSeek, Microsoft Academic and Science.

Keywords: *Brachymeria podagrica*; *Conura*; Phytophagous; Biocontrol; Parasitoid

1 Introduction

The muscular legs of the *Lasiochalcidia igiliensis* (Masi, 1916) species serve to keep the jaws of Myrmeleontidae larvae open. They are robust wasps, usually black with yellow, red, or white markings; they are rarely bright metallic colors with heavily wrought surfaces. They usually measure between 2 and 7-mm. Robust body, small head with eyes and ocelli present while they deposit an egg in them (Figures 1, 2, 3, 4, 5 and 6) [1,2,3].



Figure 1 *Lasiochalcidia igiliensis* (Masi, 1916); (Source: https://www.reddit.com/r/NatureIsFuckingLit/comments/9ida47/chalcidid_wasp/)

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



Figure 2 Specimens of Chalcididae Family; (Source: <https://bugguide.net/node/view/1344970>)

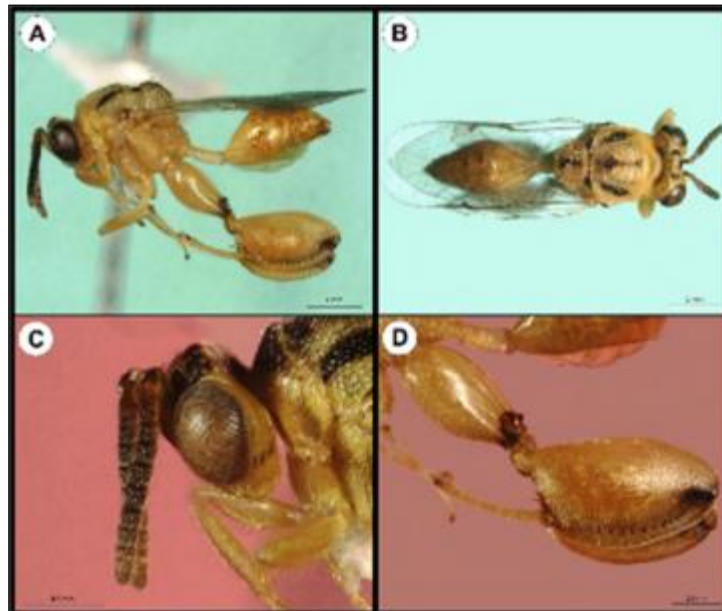


Figure 3 Figure 1. Specimens of *Conura morley* (Ashmead, 1904) collected in Campo Grande, MS, Brazil. A. Habitus, lateral view. B. Habitus, dorsal view. C. Head, lateral view. D. Hind leg, posterior view; (Source: [https://www.semanticscholar.org/paper/First-record-of-Conura-morleyi-\(Ashmead%2C-1904\)-sp.-Tibcherani-Aranda/1c1834dc4f711abda631ae20ae1ee34d14f781b6/figure/0](https://www.semanticscholar.org/paper/First-record-of-Conura-morleyi-(Ashmead%2C-1904)-sp.-Tibcherani-Aranda/1c1834dc4f711abda631ae20ae1ee34d14f781b6/figure/0))

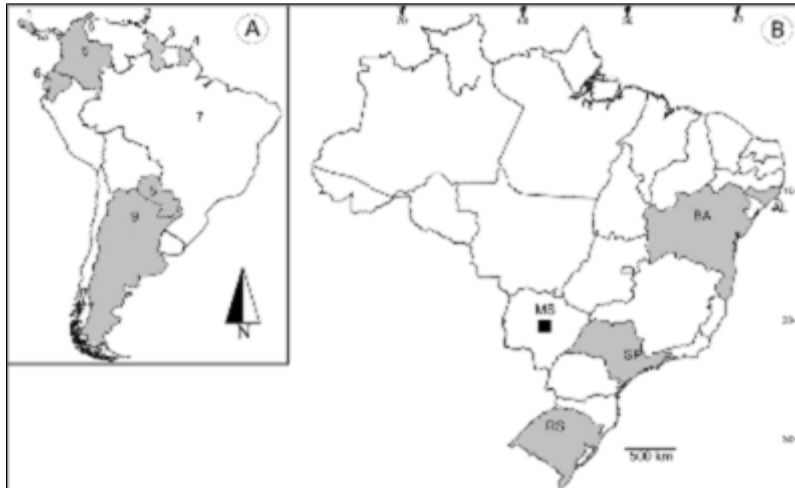


Figure 4 Geographic distribution of *Conura* sp. in South America (A); and Brazil (B). Square: new record from Brazil. Countries: 1: Costa Rica; 2: Trinidad & Tobago; 3: Guyana; 4: French Guiana; 5: Colombia; 6: Ecuador; 7: Brazil (AL: Alagoas, BA: Bahia, SP: São Paulo, RS, Rio Grande do Sul, MS: Mato Grosso do Sul); 8: Paraguay; 9: Argentina; (Source: [https://www.semanticscholar.org/paper/First-record-of-Conura-morleyi-\(Ashmead%2C-1904\)-sp.-Tibcherani-Aranda/1c1834dc4f711abda631ae20ae1ee34d14f781b6/figure/1](https://www.semanticscholar.org/paper/First-record-of-Conura-morleyi-(Ashmead%2C-1904)-sp.-Tibcherani-Aranda/1c1834dc4f711abda631ae20ae1ee34d14f781b6/figure/1))

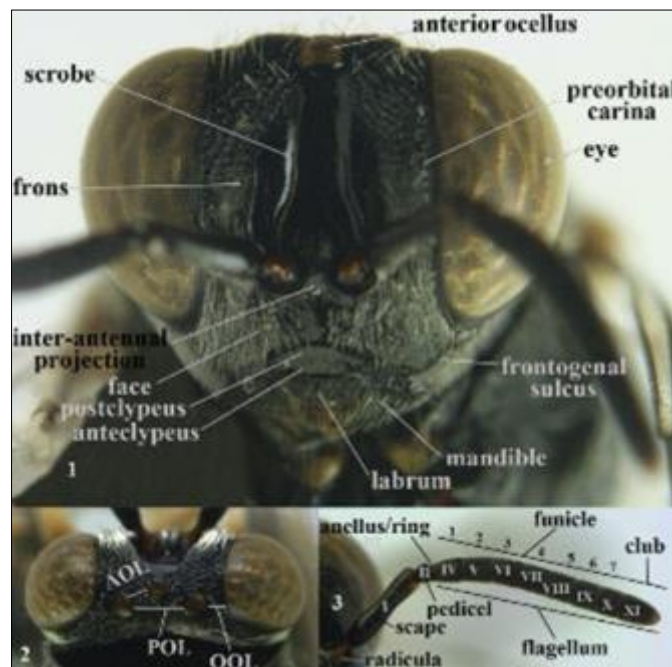


Figure 5 Nomenclature of head (anterior, dorsal) and antenna, *Brachymeria lasus* (Walker, 1841), female, Vietnam. In Roman ciphers the antennal segments and in Arabic ciphers the funicular segments; (Source: <https://zookeys.pensoft.net/article/8177/>)



Figure 6 Nomenclature of head (side), mesoscutum and wings, *Brachymeria lasus* (Walker, 1841), female, Vietnam; (Source: <https://zookeys.pensoft.net/article/8177/>)

The chalcidids (Chalcididae) are a family of Apocrite hymenoptera of the superfamily Chalcidoidea, of moderate size, composed mainly of parasitoids and a few hyperparasitoids (those that parasitize other parasites). The most frequent hosts or prey are Lepidoptera (butterflies and moths) and Diptera (flies, mosquitoes and others) but some species attack members of Hymenoptera (bees, wasps or ants) and Coleoptera (beetles). Chalcididae is a family of larval or pupal parasitoid wasps (Figures 7A and 7B [4,5,6]).

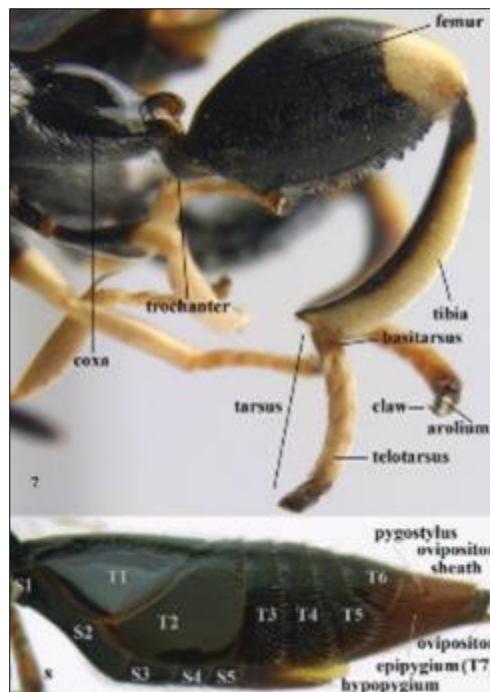


Figure 7A Nomenclature of hind leg of *Brachymeria lasus* (Walker, 1841), female, Vietnam and metasoma (lateral) of *Sthulapada vietnamensis* sp. n., holotype; (Source: <https://zookeys.pensoft.net/article/8177/>)



Figure 7B Female chalcid wasp is a parasitoid in the family Chalcididae, vintage line drawing or engraving illustration; (Source: <https://www.shutterstock.com/pt/search/chalcididae>)

While the majority of the species of Chalcididae are primary solitary endoparasitoids, some are secondary parasitoids or gregarious parasitoids. Chalcidids attack a wide range of hosts (Figures 8 and 9) [5,6].



Figure 8 (A, B) *Philornis puparia* sp. nov. enclosed in a cocoon with nest debris collected from a wild nest of an unknown bird species in mainland Ecuador. (C) *Philornis downsi* Dodge & Aitken, 1968 puparium in a wild nest partially covered in cocoon. (D) *P. downsi* puparium harvested from a society finch nest in captivity. (E) *Conura annulifera* (Walker, 1864) parasitizing *P. downsi* puparium covered in nesting material. (F) *C. annulifera* parasitizing *P. downsi* puparium cleared of nesting material; (Source: Photos: A, B: G. A. Brito Vera; C, D, E: M. Bulgarella; F: R. Boulton)



Figure 9 Chalcid wasp parasitizing a larva; (Source: <https://alchetron.com/Chalcid-wasp>)

Chalcidids of economic importance are associated with palm trees in Tropical America, since about 19 species of the family are associated with palm trees, a remarkable number. The parasitoids of this family are phytophagous insects, which are mainly Lepidoptera and Hispinae beetles, which attack the leaves of palm trees (Figures 10, 11, 12, 13, 14, 15,16, 17, 18 and 19) [7,8,9,10].

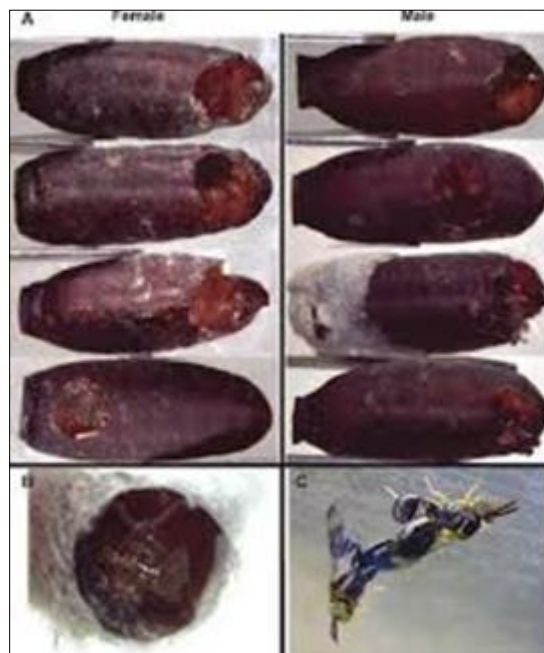


Figure 10 (A) Exit holes in *Philornis downsi* Dodge & Aitken, 1968, puparia that yielded female and male *Conura annulifera* (Walker, 1864) (B) Exuvium shed by a *C. annulifera* wasp after emergence from a *P. downsi* puparium. (C) Male and female *C. annulifera* in copula; (Source: Photos: A, B: M. Bulgarella, C: P. Lahuatte)



Figure 11 Puparium of *Philornis* sp. and the adult wasp found in its interior; (Source: https://www.researchgate.net/figure/Puparium-of-Philornis-sp-and-the-adult-wasp-found-in-its-interior_fig5_6924415)

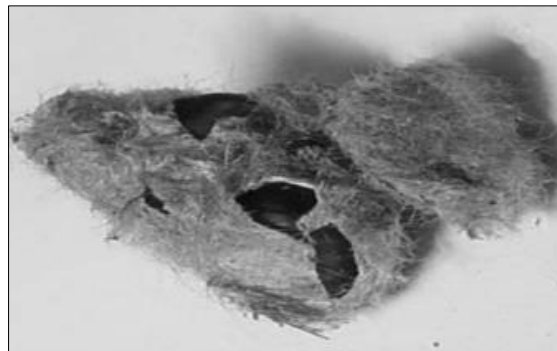


Figure 12 Puparia of *Philornis* sp. found in nest of *Thalurania glaucopis* (Gmelin, 1788) (Classe: Aves: Apodiformes: Trochilidae) Hummingbird; (Source: https://www.researchgate.net/figure/Puparia-of-Philornis-sp-found-in-nest-of-Thalurania-glaucopis_fig4_6924415)



Figure 13 (A) *Conura annulifera* (Walker, 1864) egg that was laid on exterior of a *Philornis downsi* Davies et al,1990 (Diptera: Muscidae) pupa (arrow). (B) Close up of same. (C) *C. annulifera* larva removed from exterior of a *P. downsi* pupa within the puparium; (Source: Photos: G. E. Heimpel)



Figure 14 *Conura annulifera* (Walker, 1864) (Chalcididae): dried specimen; (Source: https://www.researchgate.net/figure/Conura-annulifera-Walker-1864-Chalcididae-dried-specimen_fig3_6924415)

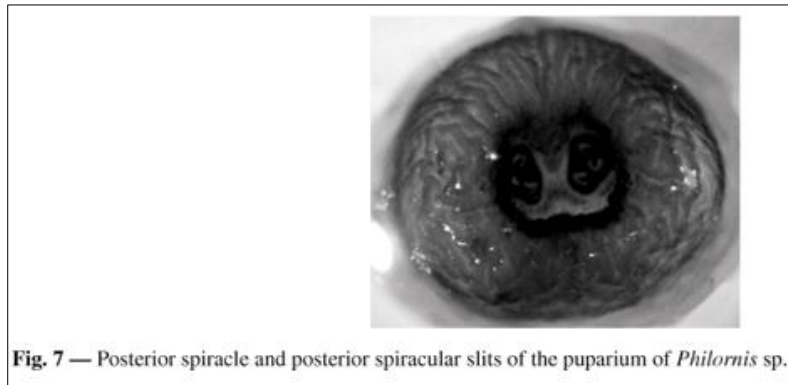


Fig. 7 — Posterior spiracle and posterior spiracular slits of the puparium of *Philornis* sp.

Figure 15 Posterior spiracle and posterior spiracular slits of puparium of *Philornis* sp. (Diptera: Muscidae); (Source: <https://www.scielo.br/j/bjb/a/trh3CLSgJJxCRjHjTThKxds/?lang=en#>)



Fig. 1 — Nestlings of *Thalurania glaucopsis* Gmelin, 1788 infested by *Philornis* sp larvae.

Figure 16 Nestlings of *Thalurania glaucopsis* (Gmelin,1788) (Classe: Aves: Apodiformes: Trochilidae) Hummingbird, *Philornis* sp. larvae (Diptera: Muscidae); (Source: <https://www.scielo.br/j/bjb/a/trh3CLSgJJxCRjHjTThKxds/?lang=en#ModalFigfig01>)

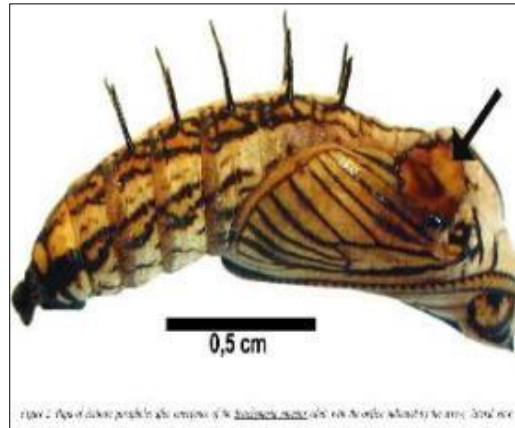


Figure 17 Pupa of *Sctinote parapehes* Jordan, 1913 (Lepidoptera: Nymphalidae) after emergence of the *Brachymeria mnestor* (Walker, 1841) (Chalcididae) adult, with the orifice by the arrow, latera view; (Source: <https://www.scielo.br/j/bn/a/H94ZdmHMzFCR7wdvD5CSqWy/?lang=en#>)



Figure 18 *Brachymeria mnestor* (Walker, 1841) (Chalcididae); (Source: <https://www.scielo.br/j/bn/a/H94ZdmHMzFCR7wdvD5CSqWy/?lang=en#>)



Figure 19 Detail of the exit orifice of the parasitoid *Brachymeria annulata* (Fabricius, 1793) (Hymenoptera: Chalcididae) in pupae of *Erinnyis ello* (Linné, 1758) (Lepidoptera: Sphingidae); (Source: Photo: Rodrigo Souza Santos)

The family appears to be polyphyletic, meaning that they lack a common ancestor. However, it is possible that each of the subfamilies is monophyletic and some may need to be raised to family status in the near future. As the family is currently defined there are 85 genera with more than 1455 species. They are predominantly from tropical regions. Subfamilies: Chalcidinae, Dirhininae, Epitraninae, Haltichellinae and Smicromorphine (Figure 20) [11,12,13].

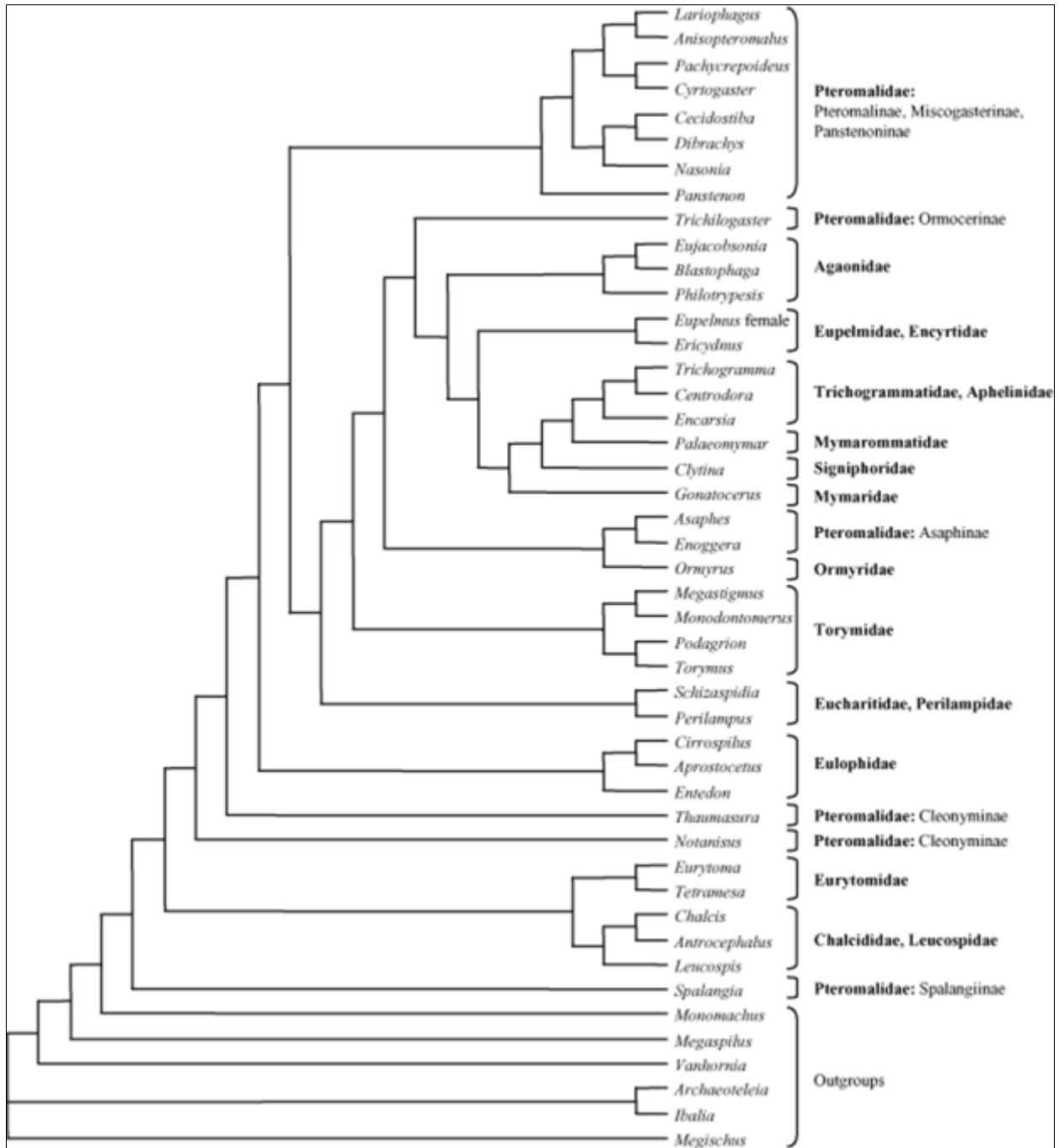


Figure 20 Phylogenetic implications of the mesosomal skeleton in Chalcidoidea (Hymenoptera, Apocrita) – tree searches in a jungle of homoplasy; (Source: <https://www.mapress.com/zootaxa/2007f/zt01668p548.pdf>)

Haltichellinae: this subfamily is of distribution cosmopolitan and is characterized by presenting the apex of the posterior tibia blunt, usually with two apical spurs; the lower part of the posterior femur bears dense and small denticles. In the Neotropics, three tribes and nine genera are reported as follows: Haltichellini: with five genera *Hockeria*, *Inthrocephalus*, *Haltichella*, *Aspirrhina* and equation Hybothoracini: with three genera: *Psilochalcis*, *Notaspidium* and *Halsteadium* and Zavoyini: with one gender *Zavoya* (Figure 21) [12,13,14].

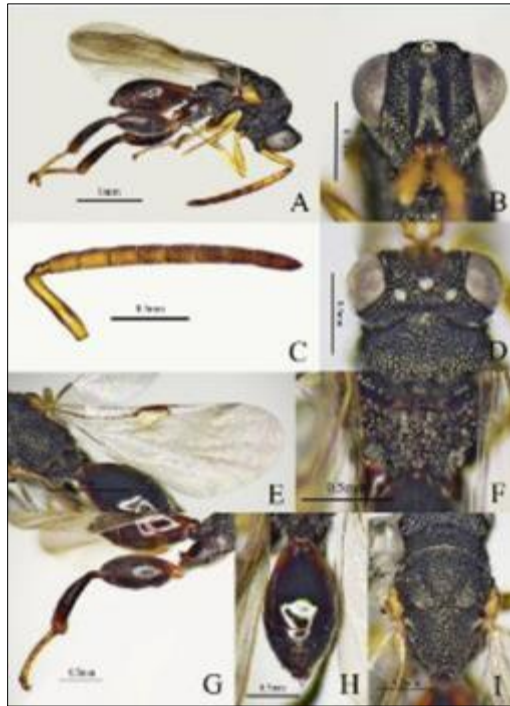


Figure 21 *Haltichella bomiana* sp. nov. (holotype male) A habitus, lateral view B head, front view C Antenna D head and part of mesosoma, dorsal view E Forewing F Propodeum G hind leg H metasoma I mesosoma, dorsal view; (Source: <https://www.mapress.com/zootaxa/2007f/zt01668p548.pdf>)

Chalcidinae: It is characterized by presenting the insertion of the antenna in the anterior part of the face lower; the forewing has a short marginal vein and the developed postmarginal vein. In the Neotropics Chalcidinae contains four tribes and 12 genera as follows: Brachymeriini: with two genera *Brachymeria* and *Caenobrachymeria*, Chalcidini: with six genera: *Chalcis*, *Melanosmicra*, *Stenosmicra*, *Conura*, *Corumbichalcis* and *Pilismicra* (Figure 22) [12,13,14,15].

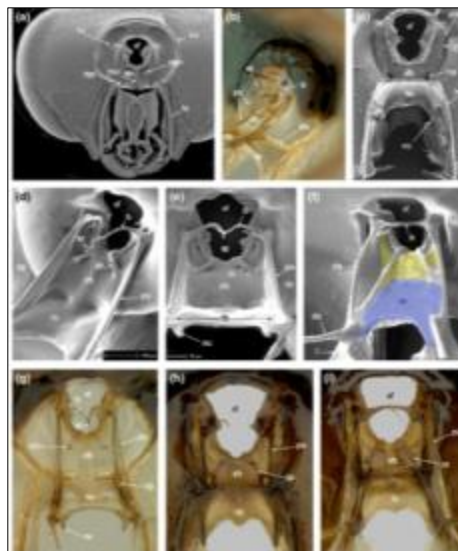


Figure 22 Tentorial complex for Chalcidinae. (a, b, d, e, g) *Conura decides* Ashmead, 1886) (Chalcididae). (c, f, h, i) *Chalcis myrifex* (Sulzer, 1776). (a, c, h) subforaminal and hypostomal bridges posterior view; (b, d-g, i) Tentorium anterior and anterolateral views; (Source: <https://zookeys.pensoft.net/article/52059/>)

Dirhininae: this subfamily has a cosmopolitan distribution and is characterized by presenting in the dorsal head and in each eye a projection to horn way; the dorsal part of the petiole shows striations and the specimens exhibit metallic colorations. In the Neotropics, the genus *Dirhinus* is reported (Figure 23) [12,13,14].



Figure 23 *Dirhinus maasai* Delvare, 2018. Holotype in National Museums of Kenya, Nairobi (NMKE). Type locality: Rift Valley Province, Olorgesailie National Monument, 1.57930°S 36.44566°E, 982 m, Kenya; (Source: http://www.waspweb.org/chalcidoidea/chalcididae/Dirhininae/Dirhinus/Dirhinus_maasaii.htm)

Epitraninae: This subfamily is restricted to the African continent, Southeast Asia, and Australia. I know characterized by presenting the insertion of the antenna on the back of the underside and the base of the clypeus has a projection on the mouth. The species that have been reported in the Neotropics Apparently they were introduced from some countries Paleotropics (Africa and Asia). This subfamily contains one genus *Epitranus* (Figure 24) [12,13,14].

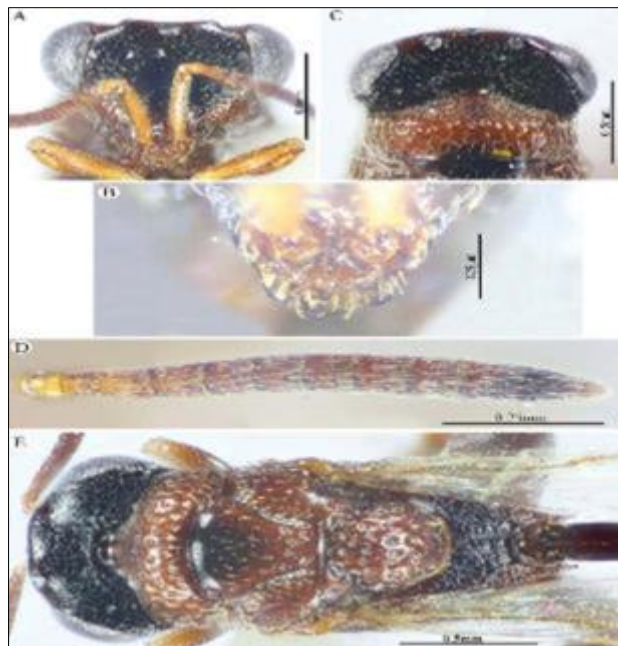


Figure 24 Epitraninae: *Epitranus subinops* Soliman & Gadallah, sp. Nov. (holotype female) A head (frontal view) B lower part of face showing frontal lobe (frontal view) C head and pronotum (dorsal view) D antennal pedicel and flagellum E head and mesosoma (dorsal view); (Source: <https://zookeys.pensoft.net/article/52059/>)

Members of this tribe are the most common and diverse in the Neotropics and several species have been bred for their economic importance in controlling crop pests. Cratocentrini: with a single genus Neotropical *Acanthochalcis*. Phasgonophorini: with three genera: *Trigonura*, *Stypiura* and *Parastypiura* (Figures 25 and 26) [12,13,14].



Figure 25 Cratocentrini Tribe; (Source: <https://www.waspweb.org/Chalcidoidea/Chalcididae/Cratocentrinae/index.htm>)



Figure 26 Phasgonophorini Tribe; (Source: <http://www.waspweb.org/chalcidoidea/Chalcididae/Chalcidinae/Phasgonophorini/index.htm>)

1.1 Objective

The objective of this mini review is to describe the importance of the Chalcididae Family in agriculture (Insecta: Hymenoptera).

2 Methods

The method used to prepare this mini review was Marchiori 2021 methodology [15].

3 Studies conducted and selected

3.1 Study 1

Members of the genus *Dirhinus* have been reared numerous times from tephritid puparia. The species of this genus burrow through the substrate to locate puparia. Oviposition is through the puparial wall onto the host pupa. *Dirhinus giffardii* (Silvestri 1914) from Africa to Hawaii, where it was propagated, released, and became established on medfly, *Ceratitis capitata* Later (1971), this species was introduced as a biological control agent in Bolivia against medfly (Figure 27A) [16].



Figure 27A *Dirhinus giffardii* (Silvestri, 1914); (Source: <https://www.biodiversity4all.org/taxa/121516-Chalcididae>)

The species of *Dirhinus* can be readily recognized by the fact that the antennae are inserted in a deep concavity formed by two ridges extending out from the face. In dorsal view, these appear as two horn-like protruberances. Species in the genus *Conura* are also occasionally reared from fruit-infesting tephritids, but only rarely [16].

3.2 Study 2

Many chalcid wasps are hyperparasites on the gall-forming cynipid wasps (see below) and some on other cynipids which do not form the galls, but live in the gall formed by other cynipids (these are called 'inquilines') (Figures 27B and 27C).



Figure 27B Chalcid wasp (*Torymus* sp.), a parasitoid of *Andricus kollari* (Hartig, 1843) (Hymenoptera: Cynipidae) which causes the marble galls on oak trees; (Source: <https://www.earthlife.net/insects/parasit.html>)



Figure 27C Cynipid wasps (Hymenoptera: Cynipidae); (Source: <https://bugguide.net/node/view/1495207>)

It is amazing to think about the fact that when these small wasps are laying their eggs, they lay them through the walls of the gall, which may contain many cells (that they cannot see) with a variety of occupants and yet – like *Sirex gigas* Linnaeus, 1758 they never lay in the wrong host or in some larvae that has already been laid in by another member of the same species (Figure 28).



Figure 28 *Sirex gigas* = *Urocerus gigas* (Linnaeus, 1758) (: Hymenoptera: Siricidae). English: Giant Woodwasp, life cycle: larvae (right), pupa (bottom left), adult male (top right), adult females (left); (Source: <https://www.alamy.com/sirex-gigas--urocerus-gigas-linnaeus-1758-english-giant-woodwasp-life-cycle-larvae-right-pupa-bottom-left-adult-male-top-right-adult-females-left-1849-published-1850-341-sawflywing-image211466278.html>)

Another amazing member of superfamily Chalcidoidea is *Caraphractus cintus* L., 1758 ((Hymenoptera: Mymaridae), one of the Fairy Flies (Mymaridae). *Caraphractus* is a parasite of the eggs of diving beetles (Dytiscidae) and both the males and females swim readily under water. This is hardly surprising, as one of the characteristics of this family is that their wings are very narrow near the body – so that they look more like oars with hairy ends than conventional insect wings [17].

3.3 Study 3

The objective of this study was to verify the hosts of parasitoid Dipterous (flies) *Brachymeria podagratica* (Fabricius 1787) (Hymenoptera: Chalcididae) (Fabricius) in the south Goiás and west Minas Gerais, Brazil.

From March 2001 December 2014, 2430 pupae of Diptera and 395 specimens of *B. podagratica* were collected. The total parasitism rate observed was 16.2%. Probably due to the availability of resources, to the density of hosts and to the searching capacity of the parasitoids. The species *B. podagratica* occurs almost everywhere in the world and lives associated with synanthropic and other Diptera flies emerging from their pupae.



Figure 29 Specimens of *Brachymeria podagratica* (Fabricius 1787) (Hymenoptera: Chalcididae); (Source: <https://bdj.pensoft.net/article/6900/>)

This species occurred as a dipterous parasitoid, developed in rats carcasses in areas of tropical wood in the State of Goiás, Brazil. Its preferred host was *Patonella intermutans* (Walker, 1861) (Sarcophagidae) from where parasitoid pupae emerged, predominating female.

Chrysomya albiceps (Wiedemann, 1819) (Diptera: Calliphoridae) was the fly that had a higher percentage of parasitism, 50.4%. Probably, the prevalence of parasitism may be influenced by variations in the quality, availability of food resources and the type of methodology used.

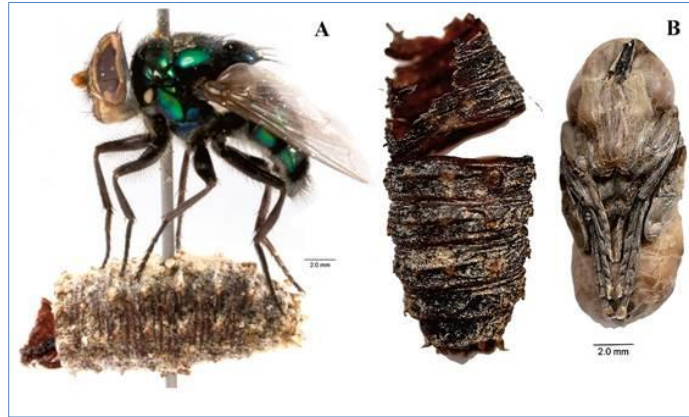


Figure 30 *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) A adult; B pupa (Source: <https://www.scielo.br/j/aa/a/cvPhCDqT8RwyRgkq9p93CYx/abstract/?lang=en>)

In relation to the hosts collected, the species *C. albiceps* and *Chrysomya megacephala* (Fabricius, 1794) (Diptera: Calliphoridae) medical-veterinary. *Chrysomya albiceps* is of major medical and sanitary interest, because it is responsible for secondary myiasis and is a vector for pathogenic microorganisms.

Chrysomya megacephala is often found associated with the modified human environment with creating their larvae into an animal decomposing organic matter. This is of great interest Diptera medical sanitation and their occurrence, distribution and prevalence in metropolitan areas are very important factors. Have been observed in human bodies and pets. Adults can be attracted by substances in the fermentation process, decomposing, blood and wounds.

3.4 Study 4

The aim of this study is to describe the parasitism of *Brachymeria annulata* (Fabricius, 1793) (Hymenoptera: Chalcididae) in pupae of *Talides hispa* Evans, 1955 (Lepidoptera: Hesperidae) in Panama. The pupae presented dark colorations, as well as evident signs of parasitism. These were removed from the plants and placed in fine mesh cages, awaiting the emergence of adult parasitoids. After a month, we observed another larva feeding on one of the *H. iatispatha* plants with the same characteristics.



Figure 31 Adult specimen of *Brachymeria annulata* (Fabricius, 1793, in lateral habit; (Source: https://www.researchgate.net/figure/Figura-1-Especime-adulto-de-Brachymeria-annulata-Hymenoptera-Chalcididae-em-habito_fig1_318085662)

We waited 10 days for the larva to pupate, we removed it from the plant and placed it in a fine mesh cage to prevent it from being parasitized and to obtain the adult form of *Talides hispa* Evans, 1955 (Lepidoptera: Hesperiiidae).



Figure 32 *Talides hispa* Evans, 1955 (Lepidoptera: Hesperiiidae); (Source: <https://www.flickr.com/photos/grandma-shirley/5468652567/>)

Six circular holes were observed in one of the pupae of *T. hispa* and 11 adult wasps emerging from it; while in the second pup they observed five circular holes from which 17 adult wasps emerged, all belonging to the species *B. annulata*. The number of holes present in the pupae, with respect to the number of parasitoid wasps that emerged from each pupa, indicate that the first wasps make the opening of the holes and later, the following ones take advantage of these holes to hatch [19].

3.5 Study 5

In this study, new occurrences of genera and species of Chalcididae are recorded for the fauna of the State of Espírito Santo and the composition of the fauna is compared with that of other regions.

A total of 149 species of Chalcididae belonging to 11 genera were obtained. Of this total, 37 species were related to names of previously described species, which are listed below, along with their geographic distributions and new occurrences. At least 48 species found are not described (Figures 33, 34, 35, 36, 37, 38A, 38B, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49 and 50) [20,21,22,23,24,25,26].

4 List of Species of Chalcididae of Espírito Santo

4.1 Brachymerinae

Brachymeria (Brachymeria) aeca Burks, 1960 (Figure 42)

4.1.1 Distribution

Neartic and Neotropical (Brazil: Espírito Santo).



Figure 33 *Brachymeria (Brachymeria) aeca* Burks, 1960; (Source: <https://eol.org/pt-BR/pages/849379>)

4.2 *Brachymeria (Brachymeria) annulata* (Fabricius, 1793)

4.2.1 Distribution

Widely distributed in the Neotropical region. In Brazil it is registered in the states: São Paulo, Goiás and Espírito Santo.



Figure 34 *Brachymeria (Brachymeria) annulata* (Fabricius, 1793); (Source: https://www.researchgate.net/figure/Figure-1-Especime-adulto-de-Brachymeria-annulata-Hymenoptera-Chalcididae-em-habito_fig1_318085662)

Brachymeria (Brachymeria) cabira (Walker, 1838)

Distribution: Ecuador (Galapagos), Brazil (Roraima, Federal District, Espírito Santo, São Paulo), Bolivia and Argentina.

Brachymeria (Brachymeria) compact (Walker, 1862)

Distribution: Mexico and Brazil (Espírito Santo).

Brachymeria (Brachymeria) flaviscapus (Girault, 1911)

Distribution: Brazil (Espírito Santo) and Paraguay.

Brachymeria (Brachymeria) koehleri Blanchard, 1935

Distribution: Venezuela, Brazil and Argentina. In Brazil, it occurs in the states of Espírito Santo and Rio de Janeiro (Tavares et al. 2006).

Brachymeria (Brachymeria) mnestor (Walker, 1841)

Distribution: Nearctic and Neotropical. In Brazil it is registered for the states of Amazonas, Espírito Santo, Rio de Janeiro (Gil-Santana & Tavares 2006, Tavares et al. 2006) and São Paulo.

Brachymeria (Brachymeria) nigriritibialis Tavares & Navarro-Tavares, 2006

Distribution: Brazil (Espírito Santo and Rio de Janeiro).

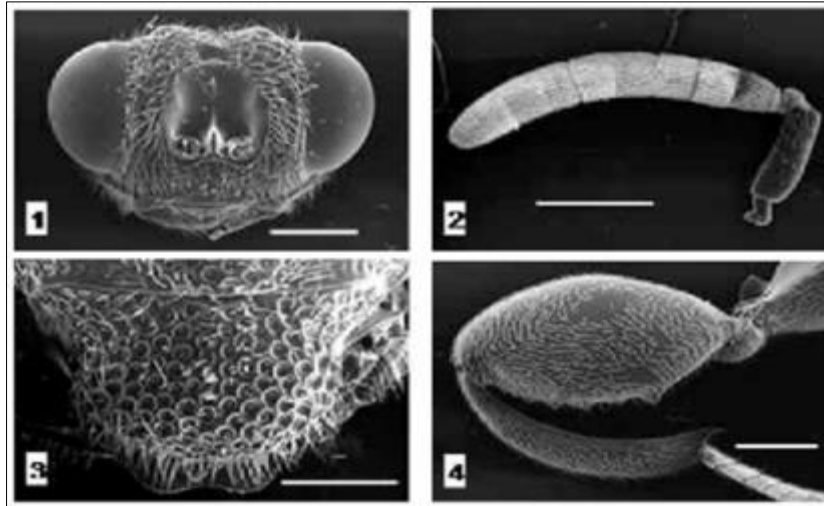


Figure 35 *Brachymeria (Brachymeria) nigrifemoralis* Tavares & Navarro-Tavares, 2006. Female. 1. Front head. 2. Side antenna. 3. Scutellum. 4. Metafemur and tibia. Scale=0.5mm; (Source: https://www.researchgate.net/figure/FIGURES-1-4-Brachymeria-nigrifemoralis-sp-n-female-1-Head-frontal-2-Antenna_fig1_291608973)

4.3 *Brachymeria (Brachymeria) pandora* (Crawford, 1914)

4.3.1 Distribution

Venezuela, Guyana and Brazil [Goiás (Marchiori et al. 2003), Espírito Santo, Rio de Janeiro (Gil-Santana & Tavares 2005).

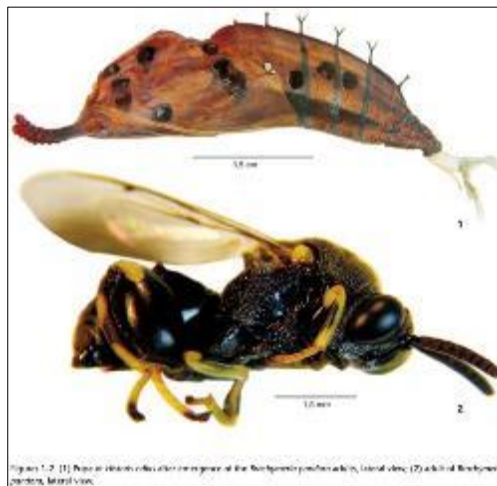


Figure 36 *Brachymeria (Brachymeria) pandora* (Crawford, 1914); (Source: <https://enciclovida.mx/especies/93437-brachymeria-brachymeria-pandora>)

4.3.2 *Brachymeria (Brachymeria) parvula* (Walker, 1834)

Distribution: United States, Mexico, Colombia (Arias & Delvare 2003) and Brazil (Espírito Santo).

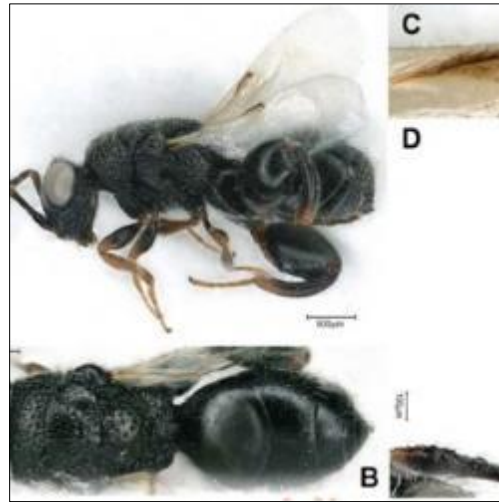


Figure 37 *Brachymeria (Brachymeria) parvula* (Walker, 1834). A. Mesosoma in dorsal view and round scutellum, B. Hind leg; C. Female gaster; (Source: https://www.researchgate.net/figure/Brachymeria-parvula-A-Mesosoma-in-dorsal-view-and-round-scutellum-B-Hind-leg-C_fig4_320244084)

4.4 *Brachymeria (Brachymeria) podagrica* (Fabricius, 1787)

4.4.1 Distribution

This species appears to be distributed throughout tropical and temperate regions of the world. In the Neotropical region, it occurs in Mexico, Cuba, Jamaica, Haiti, Venezuela and Brazil [Goiás, Minas Gerais (Marchiori et al. 2002), Espírito Santo].



A



B

Figure 38A *Brachymeria (Brachymeria) podagrica* (Fabricius, 1787): 21 – 28. 21 – 24, *B. podagrica*, ♀. 21, antenna excluding scape. 22, mesosoma in dorsal view. 23, metasoma in dorsal view. 24, metafemur. 25 – 28, *Brachymeria amenocles* (Walker, 1846), ♀. 25, antenna excluding scape. 26, mesosoma in dorsal view. 27, metasoma in dorsal view. 28, metafemur. ♀. 21, antenna excluding scape. 22, mesosoma in dorsal view. 23, metasoma in dorsal view. 24, metafemur. 25 – 28, *B. amenocles*, ♀. 25, antenna excluding scape. 26, mesosoma in dorsal view. 27, metasoma in dorsal view. 28, metafemur. **Figure 38B** Adult *Brachymeria (Brachymeria) podagrica* (Fabricius, 1787) Side view; (Source: <https://tb.plazi.org/GgServer/html/03B1879CFFDA557EFF54482678530606>)

4.5 *Brachymeria (Pseudobrachymeria) annulipes* (Costa Lima, 1919)

4.5.1 Distribution

Brazil (Maranhão, Espírito Santo).

4.6 *Brachymeria (Pseudobrachymeria) pedalis* (Cresson, 1872)

4.6.1 Distribution

United States, Mexico and Brazil (Espírito Santo).



Figure 39 *Brachymeria (Pseudobrachymeria) pedalis* (Cresson, 1872); (Source: <https://eol.org/pages/849749>)

4.7 *Brachymeria (Pseudobrachymeria) subconica*, Boucek, 1992

4.7.1 Distribution

Neartic and Neotropical regions. In Brazil, it occurs in the states of Pará, Minas Gerais and Espírito Santo.

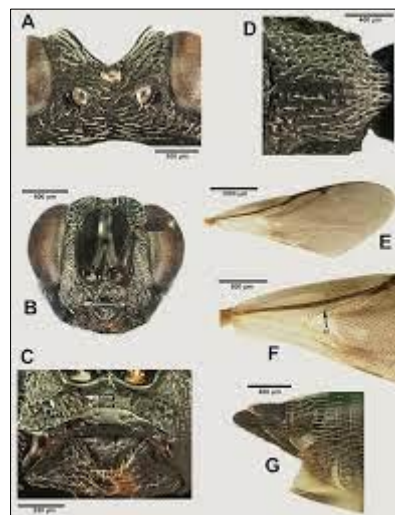


Figure 40 ♀ A, head in front view. B, head in anterolateral view. C, lower face in front view. D, pedicel and base of flagellum *Brachymeria subrugosa* Blanchard, 1942. E, clava in apicolateral view. Abbreviations: atrc, adtorular carina; stsw subtorular swelling; (Source: © Gérard D, Baur HH, George E, Dave DC, Martinez R, Knutie, Sarah A)

4.8 *Brachymeria (Pseudobrachymeria) vesparum*, 1992

4.8.1 *Distribution*

Brazil (Pará, Espírito Santo) and Argentina.

4.9 ***Stypiura condalus* (Walker, 1841)**

4.9.1 *Distribution*

Brazil (Pará, Espírito Santo).



Figure 41 *Stypiura condalus* (Walker, 1841); (Source: <https://eol.org/pages/64605>)

4.10 Chalcidinae

Conura (Keratosmicra) dema (Burks, 1940)

4.10.1 *Distribution*

Mexico and Brazil (Espírito Santo).



Figure 42 *Conura (Keratosmicra) dema* (Burks, 1940); (Source: <https://bugguide.net/node/view/1304200>)

4.11 ***Conura (Conura) maculata* (Fabricius, 1787)**

4.11.1 *Distribution*

Neartic and Neotropical. In Brazil it is registered for the states of Amazonas, Espírito Santo, Rio de Janeiro and São Paulo.



Figure 43 Specimens of *Conura (Conura) maculata* (Fabricius, 1787) from Corrientes, Argentina. A. Female lateral view. B. Male lateral view. C. Head, frontal view. D. Thorax, dorsal view; (Source: [https://www.semanticscholar.org/paper/First-record-of-Conura-\(Conura\)-maculata-1787\)-1904-Gervazoni-Arbino/2a1090600d9b90990750a17c8be0656947ed2e01/figure/0](https://www.semanticscholar.org/paper/First-record-of-Conura-(Conura)-maculata-1787)-1904-Gervazoni-Arbino/2a1090600d9b90990750a17c8be0656947ed2e01/figure/0))

4.12 *Conura (Conura) nigrifrons* (Cameron, 1884)

4.12.1 Distribution

Neartic and Neotropical. In Brazil it is registered for the states of Espírito Santo and São Paulo.



Figure 44 *Conura (Conura) nigrifrons* (Cameron, 1884); (Source: <https://bugguide.net/node/view/15307>)

4.13 *Conura (Spilochalcis) femorata* (Fabricius, 1775)

4.13.1 Distribution

Neartic and Neotropical. In Brazil it is registered for the states of Amazonas, Pernambuco, Espírito Santo and São Paulo.



Figure 45 Female of *Brachymeria femorata* (Panzer, 1801); body length 8mm. Ryc. 3. *B. femorata*; (Source: Photo B. Wiśniowski)

4.14 *Conura (Spilochalcis) masus* (Walker, 1841)

4.14.1 Distribution

From Cuba and Guatemala to Peru, Bolivia and Brazil, where it is recorded for the states of Amazonas, Espírito Santo and São Paulo.

4.15 *Conura (Spilochalcis) minuta* Delvare, 1992

4.15.1 Distribution

Brazil (Paraíba, Espírito Santo).

4.16 *Melanosmicra flavicollis* (Cameron, 1904)

4.16.1 Distribution

Neartic and Neotropical. In Brazil it is only registered for the state of Espírito Santo.

4.17 *Melanosmicra gracilis* (Kirby, 1889)

4.17.1 Distribution

Brazil (Espírito Santo, Rio de Janeiro).



Figure 46 *Melanosmicra gracilis* (Kirby, 1889): Male, Bronte, NSW. (1) Head and part of thorax. (2) Right wing; (Source: https://www.researchgate.net/figure/Figures-1-2-Microepicausta-gracilis-Hendel-male-Bronte-NSW-1-Head-and-part-of_fig1_333730382)

4.18 *Melanosmicra immaculata* Ashmead, 1904

4.18.1 Distribution

Brazil (Mato Grosso, Espírito Santo).



Figure 47 *Melanosmicra immaculata* Ashmead, 1904; (Source: https://v3.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=758568)

5 Dirhininae

5.1 *Dirhinus anthracia* Walker, 1846

5.1.1 Distribution

Oriental, Afrotropical, Afrotropicate, Neotropical, Neoguinean, Australotropical and Australotemperate. In the Neotropical region it is recorded only for Brazil (Espírito Santo).



Figure 48 *Dirhinus anthracia* Walker, 1846; (Source: <https://www.biodiversity4all.org/taxa/662555-Dirhinus-anthracia>)

6 Epitraninae

6.1 *Epitranus clavatus* (Fabricius, 1804)

6.1.1 Distribution

Neartic, Oriental, Afrotropical and Neotropical. In Brazil it is registered for the states of Espírito Santo, Rio de Janeiro and São Paulo.



Figure 49 *Epitranus clavatus* (Fabricius, 1804); (Source: <http://www.waspweb.org/Chalcidoidea/Chalcididae/Epitraninae/Epitranus/index.htm>)

7 Haltichellinae

7.1 *Aspirhina dubitator* (Walker, 1862)

7.1.1 *Distribution*

Brazil (Roraima, Amazonas, Pará, Mato Grosso, Espírito Santo).

7.2 *Aspirhina retractor* (Walker, 1862)

7.2.1 *Distribution*

Brazil (Pará, Espírito Santo) and Argentina.

7.3 *Halsteadium petiolatum*, 1992

7.3.1 *Distribution*

Guatemala, Costa Rica, Colombia, Trinidad and Tobago, and Brazil (Espírito Santo).

7.4 *Haltichella hydara* (Walker, 1842)

7.4.1 *Distribution*

Venezuela (Arias & Delvare 2003) and Brazil (Espírito Santo).



Figure 50 *Haltichella*; (Source: <https://en.wikipedia.org/wiki/Haltichella>)

7.5 *Haltichella ornaticornis* Cameron, 1884

7.5.1 *Distribution*

Neartic and Neotropical. In Brazil it is recorded for the states of Goiás (Marchiori et al. 2003) and Espírito Santo.

7.6 *Notaspidium acutum* Halstead, 1991

7.6.1 *Distribution*

Colombia, Brazil (Amazonas, Mato Grosso, Espírito Santo) and Ecuador.

7.7 *Notaspidium burdicki* Halstead, 1991

7.7.1 *Distribution*

Brazil (Mato Grosso, Espírito Santo, Rio de Janeiro).

7.8 *Notaspidium giganteum* Halstead, 1991

7.8.1 *Distribution*

Neotropical. In Brazil it is registered for the states: Espírito Santo and São Paulo.

7.9 *Zavoya Cooperi*, 1992

7.9.1 *Distribution*

Costa Rica, Panama, Colombia, Venezuela (Arias & Delvare 2003), Trinidad & Tobago and Brazil (Bahia, Minas Gerais, Espírito Santo) [20,21,22,23,24,25,26].

6 Study 6

The present research aims to record the parasitoid species of the genus *Conura* as a natural biological control agent in oil palm cultivation in northern Brazil.

Parasitized or non-parasitized pupae were collected in commercial oil palm plantations where they were individualized in transparent plastic pots until the emergence of the moth adults and/or parasitoids [27].

The parasitoid species of the genus *Conura* emerged from immatures of the lepidopterans *Opsiphanes invirae* (Hubner, 1818) (Lepidoptera: Nymphalidae) and *Brassolis sophorae* (Linnaeus, 1758) (Lepidoptera: Nymphalidae) and the beetle *Hispoleptis* sp. (Coleoptera: Chrysomelidae) in commercial oil palm plantations were *Conura maculata* (Fab.,1787) (Hymenoptera: Chalcididae) and *Conura immaculata* Cresson, 1865 (Hymenoptera: Chalcididae) (Figures 51, 52A, S2B, 53, 54, 55 and 56) [27].



Figure 51 *Conura* emerged from immatures of the lepidopterans; (Source: <https://www.flickr.com/photos/colinhutton/6718209645>)



Figure 52A Immature of *Opsiphanes invirae* (Hubner, 1818) (Lepidoptera: Nymphalidae 6). **Figure 52B** Adult of *O. invirae*; (Source: <https://twitter.com/insetoland/status/1290716668864466944>)



Figure 53 Stages of *Brassolis sophorae* (Linnaeus, 1758) (Lepidoptera: Nymphalidae); (Source: <https://arteejardimfranca.com/2016/03/30/conhecendo-o-terrivel-mandruva/>)



Figure 54 beetle *Hispoleptis* sp. (Coleoptera: Chrysomelidae); (Source: https://www.zin.ru/animalia/coleoptera/pdf/santiago-blay_2004.pdf)



Figure 55 First record of *Conura (Conura) maculata* (Fabricius, 1787) (Hymenoptera, Chalcididae) parasitizing *Opsiphanes invirae amplificatus* Stichel, 1904 (Lepidoptera, Nymphalidae) in the province of Corrientes, Argentina; (Source: [https://www.semanticscholar.org/paper/First-record-of-Conura-\(Conura\)-maculata-1787\)-1904-Gervazoni-Arbino/2a1090600d9b90990750a17c8be0656947ed2e01](https://www.semanticscholar.org/paper/First-record-of-Conura-(Conura)-maculata-1787)-1904-Gervazoni-Arbino/2a1090600d9b90990750a17c8be0656947ed2e01))



Figure 56 *Conura* (Hymenoptera; Chalcididae); (Source: <https://inaturalist.ca/taxa/250160-Conura>)

7 Hyperparasitoid

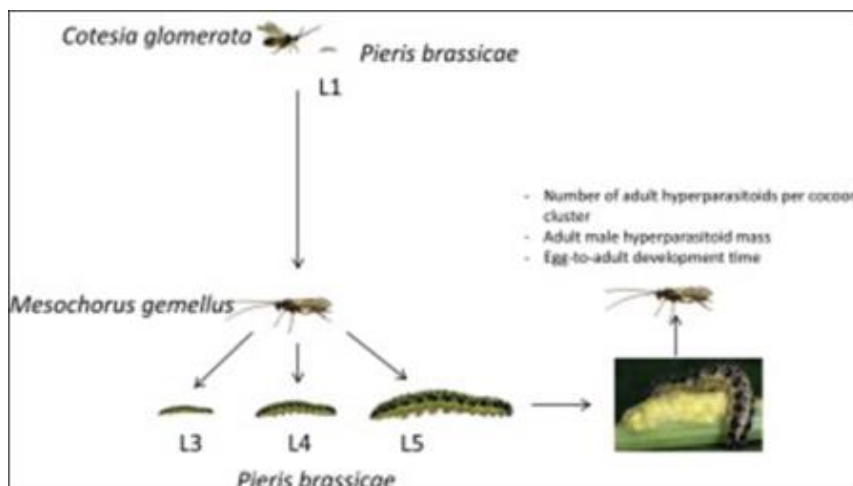


Figure 57 Development of a solitary koinobiont hyperparasitoid in different instars of its primary and secondary hosts; (Source: <https://www.sciencedirect.com/science/article/abs/pii/S002219101630138X>)

The hyperparasitoid *Conura comescens* Delvare, 1992 (Hymenoptera: Chalcididae) was collected from pupae of *Cotesia* sp. (Hymenoptera: Braconidae) from the enemy of *O. invirae*. Unidentified individuals at the species level of this genus *Conura* were found in immatures in the genus *Brassolis* (Lepdoptera: Nymphalidae). In the state of Alagoas, individuals of *Conura morleyi* Ashmead, 1904 (Hymenoptera: Chalcididae) were collected parasitizing pupae of *Brassolis sophorae* (Linnaeus, 1758) (Lepidoptera: Nymphalidae) and *Brassolis astyra* Godart, 1821 (Lepidoptera: Brassolidae) in coconut trees [27].



Figure 58 Hyperparasitoid *Conura* (Hymenoptera: Chalcididae) in Ichneumonidae cocoon in Espírito Santo; (Source: <https://www.insetologia.com.br/2017/09/hiperparasitoide-conura-em-casulo-de.html>)

8 Conclusion

The chalcidids (Chalcididae) are a family of Apocrite hymenoptera of the superfamily Chalcidoidea, of moderate size, composed mainly of parasitoids and a few hyperparasitoids (those that parasitize other parasites). The most frequent hosts or prey are Lepidoptera (butterflies and moths) and Diptera (flies, mosquitoes and others) but some species attack members of Hymenoptera (bees, wasps or ants) and Coleoptera (beetles). Chalcididae is a family of larval or pupal parasitoid wasps.

References

- [1] Wijesekara GA. Phylogeny of Chalcididae (Insecta: Hymenoptera) and its congruence with contemporary hierarchical classification. American Entomological Institute. 1997; 29(3):1-61.
- [2] Morrone JJ. Biogeographical regions under track and cladistic scrutiny. Journal of Biogeography. 2002; 29:149-152.
- [3] Bouyek Z. Oriental chalcid wasps of the genus *Epitranus*. Journal of Natural History. 1982; 16: 577-622.
- [4] Passamani M, Mendes SL Chiarello AG. Non-volant mammals of the Estação Biológica de Santa Lúcia and adjacent areas of Santa Teresa, Espírito Santo, Brasil. Boletim do Museu de Biologia Mello Leitão. 2000; 11: 201-214.
- [5] Cowan DP. The function of enlarged hind legs in oviposition and aggression by *Chalcis canadensis* (Hymenoptera: Chalcididae). The Great Lakes Entomology. 1979; 12: 133-136.
- [6] Azevedo CO, Kawada R, Tavares MT, Periotto NW. Perfil da Fauna de himenópteros parasitoides (Insecta, Hymenoptera) em uma área de Mata Atlântica do Parque Estadual da Fonte Grande, Vitória, ES, Brasil. Revista Brasileira de Entomologia. 2002; 46(2):133-137.
- [7] Costa C, Ide S, Simonka CE. Insetos imaturos: metamorfose e identificação. Ribeirão Preto: Editora Holos. 2006.
- [8] Halstead JA. New species of *Notaspidium* (Dalla Torre) from the Nearctic and Neotropical regions. The Pan-Pacific Entomologist. 1991; 67(4): 229-242.
- [9] Hanson PE, Gauld ID. Hymenoptera of the Region Neotropical. The American Entomological Institute. 2006; 77: 333-341.

- [10] Bouyek Z. Oriental chalcid wasps of the genus *Epitranus*. *Journal of Natural History*, 1982; 16:577-622.
- [11] De Santis EL. *Catalog of the Brazilian Hymenoptera of the parasitic series; including Bethyloidea*. 1st ed. Curitiba: Universidade Federal do Paraná. 1980.
- [12] Perieto NW, Lara RRI, Santos JCC, Silva TC. Himenópteros parasitoides (Insecta, Hymenoptera) coletados em cultura de soja *Glycine max* Merrill (Fabaceae), no município de Nuporanga, SP, Brasil. *Revista Brasileira de Entomologia*. 2002; 46(2): 165-168.
- [13] Souza L, Braga SMP, Campos MJO. Himenópteros parasitoides (Insecta; Hymenoptera) em área agrícola de Rio Claro, SP, Brasil. *Arquivo do Instituto Biológico*. 2006; 73(4): 465-469.
- [14] Arias DC, Delvare G. List of the genera and species of the family Chalcididae (Hymenoptera: Chalcidoidea) of the Neotropical region. *Colombian Biota*. 2003; 4(2):123-145.
- [15] Azevedo CO, Santos ES. Perfil da fauna de himenópteros parasitoides (Insecta, Hymenoptera) em uma área de Mata Atlântica da Reserva Biológica de Duas Bocas, Cariacica, ES, Brasil. *Boletim do Museu de Biologia Mello Leitão* 2000; 12: 117-126.
- [16] Boucek Z, Delvare G. The identities of species described or classified under *Chalcis*. *Memoirs of the American Entomological Institute*. 1992; 53(1-4): 11-48.
- [17] 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.
- [18] El-Husseini MM, Agamy EA, Saafan MH, El-Khalek WM. On the biology of *Dirhinus giffardii* (Silvestri) (Hymenoptera: Chalcididae) parasitizing pupae of the peach fruit fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) in Egypt. *The Egyptian Journal of Biological Pest Control*. 2008; 18(2): 391-396.
- [19] Santos-Murgas A, Gutiérrez-Lanzas J, Idalfredo Lanuza-4 IL. Record of parasitism of *Brachymeria Annulata* (Hymenoptera: Chalcididae) in pupae of *Talides hispa* Evans (Lepidoptera: Hesperidae) in Panama. *Poeyana Cuban Journal of Zoology*. 2021 512: 1-3.
- [20] Marchiori CH. *Brachymeria podagrica* (Hymenoptera: Chalcididae) (Fabricius) collected in Brazil. *Qeios*;2019; 4: 1-5.
- [21] Peruquetti RC. Comportamento de oposição e tempo de desenvolvimento de *Brachymeria villosa* (Oliver) (Hymenoptera, Chalcididae) *Revista Brasileira de Zoologia*. 2001; 18(3): 695-697.
- [22] Tavares MT, Araújo BC. Espécies de Chalcididae (Hymenoptera, Insecta) do Estado do Espírito Santo, Brasil. *Biota Neotropica*. 2007; 7(2): 1-8.
- [23] Tavares MT, Navaro-Tavares AB, Almeida GSS. The species of Chalcididae (Hymenoptera) parasitoids of *Parides ascanius* (Cramer), an endangered Papilionidae (Lepidoptera) from restingas of Southeastern Brazil. *Zootaxa*. 2006; 1197: 55-63.
- [24] Gil-Santana HR, Tavares MT. *Brachymeria pandora* (Crawford) (Hymenoptera, Chalcididae): a new parasitoid of *Historis odius* (Fabricius) (Lepidoptera, Nymphalidae). *Revista Brasileira de Zoologia*. 2005; 22(4): 1211-1212.
- [25] Delvare G. List of genera and species of the Chalcididae family (Hymenoptera: Chalcidoidea) of the region. Neotropical. *Colombian Biota*. 1992; 4(2):123-145.
- [26] Arias DC, Delvare G. List of genera and species of the Chalcididae family (Hymenoptera: Chalcidoidea) of the Neotropical region. *Colombian Biota*. 2003; 4(2): 123-145.
- [27] Sakazaki AY, Ribeiro RC, Tinôco RS, Lemos WP, Zanuncio JC. Registro de espécies de *Conura* spp., parasitoides e hiperparasitoides em insetos praga em cultivos da palma do óleo na região Amazônica. *Viçosa: Agropecuária Sustentável*. 2011; 3: 1-3.