

(REVIEW ARTICLE)



Importance of Sphaeroceridae family as accelerators of the putrefaction process, nutrient recycling and in its association with the cadaveric decomposition process (Insecta: Diptera)

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Abstract

The family is recognized for participating in the decomposition process of all kinds of organic material, being able to be polysaprophagous or specialists. They found each other in some of their life phases feeding on resources such as: fungi feces of various animal's carcasses of invertebrates and carcasses of vertebrates. Despite their diverse biology, their medical and economic importance is not relevant, being potential mechanical transmitters of pathogens. They are pests in cheese industries, reducing the sanitary standards of manufacturing. There are also reports of intestinal miasa and damage to the cultivation of mushrooms. Carrion-feeding species are useful post mortem interval indicators in Forensic Entomology. This mini review aims to verify the importance of Sphaeroceridae as accelerators of the putrefaction process, nutrient recycling and its association with the cadaveric decomposition process. To this end, a bibliographic survey of Sphaeroceridae was carried out in the years 1955 to 2021. Only complete articles published in scientific journals and expanded abstracts presented at national and international scientific events were considered. Data were also obtained from platforms such as: Academia.edu, Frontiers, Qeios, Pubmed, Biological Abstract, Publons, Dialnet, World, Wide Science, Springer, RefSee and Microsoft Academic.

Keywords: Miasa; Forensic Entomology; Acalyptrated flies; Cattle; Coastal environments

1. Introduction

The Sphaeroceridae are acalyptrated flies that are characterized by their small size, generally less than 5mm in length, a robust body that is black to brown in color, and, mainly, by the first tarsus of the hind legs that is shorter and thicker than the rest. They can be wingless, winged, or brachypterous. In winged species, venation is characteristic with two rib breaks and M and CuA1 veins often not fully developed (Figures 1, 2, 3, 4, 5, 6 and 7) [1,2,3].

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Figure 1 Specimens of Sphaeroceridae Source: <https://www.wikiwand.com/pt/Brachycera>



Figure 2 Habitat of the Sphaeroceridae Family Source: Photo by M. Tkoč (1, 2) and J. Roháček (others)



Source: <https://www.padil.gov.au/maf-border/pest/main/140636/32290>

Figure 3 Fourth and 5th veins not reaching wing margin and not pigmented much beyond the posterior cross vein; anal vein only slightly pigmented; anal cell absent

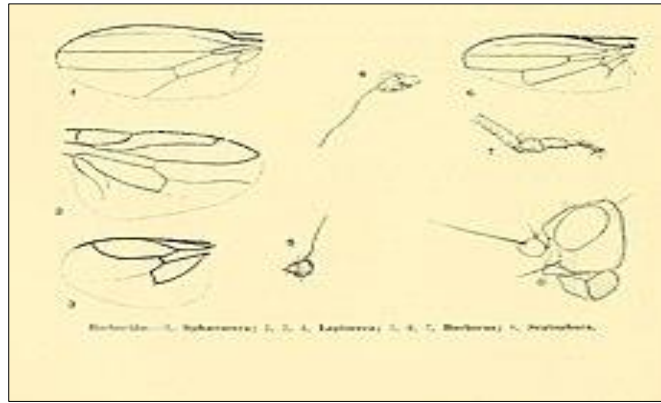


Figure 4 *Sphaeroceridae* morphological details Source: <https://www.wikizero.com/en/Sphaeroceridae>

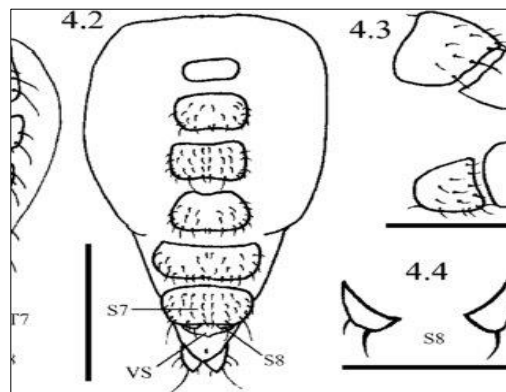
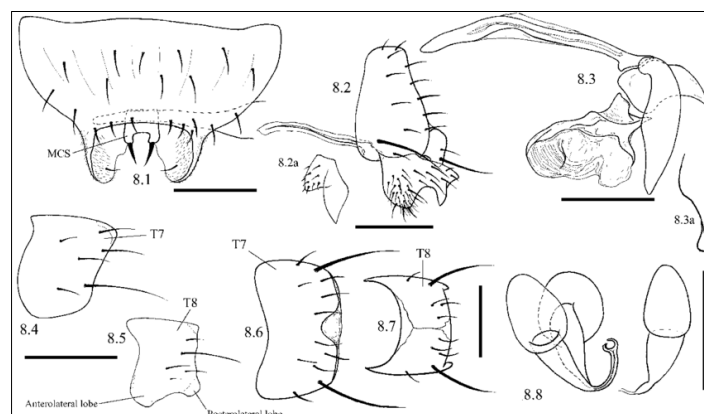


Figure 5 Female abdominal structures of *Chespiritos jamaicensis* sp. n. paratype. 4.1 -dorsal view of abdomen; 4.2 -ventral view of abdomen; 4.3 -lateral view of female terminalia; 4.4 -sternite 8; 4.5 -vaginal sclerite. Abbreviations: Hyp-hypoproct, S7 -sternite 7, S8 -sternite 8, T7 -tergite 7, T8 -tergite 8, VS -vaginal sclerite. Scale bars 0.50 mm (4.1-4.3), 0.125 mm (4.4 and 4.5 Source: https://www.researchgate.net/figure/45-Female-abdominal-structures-of-Chespiritos-jamaicensis-sp-n-paratype-41-dorsal_fig2_340804066



Source: https://www.researchgate.net/figure/45-Female-abdominal-structures-of-Chespiritos-jamaicensis-sp-n-paratype-41-dorsal_fig2_340804066

Figure 6 *Chespiritos jamaicensis* sp. n., male (holotype) and female abdominal structures. 8.1 -male S5, ventral; 8.2 -terminalia, lateral; 8.2a -surstylus, posterior; 8.3 -aedeagus and associated structures, lateral; 8.3a -postgonite, posterior; 8.4 -female T7, lateral; 8.5 -female T8, lateral; 8.6 -female T7, dorsal; 8.7 -female T8, dorsal; 8.8 -spermathecae. Abbreviations: MCS -medial connecting sclerite. Scale bars: 0.20 mm except spermathecae (0.10 mm)

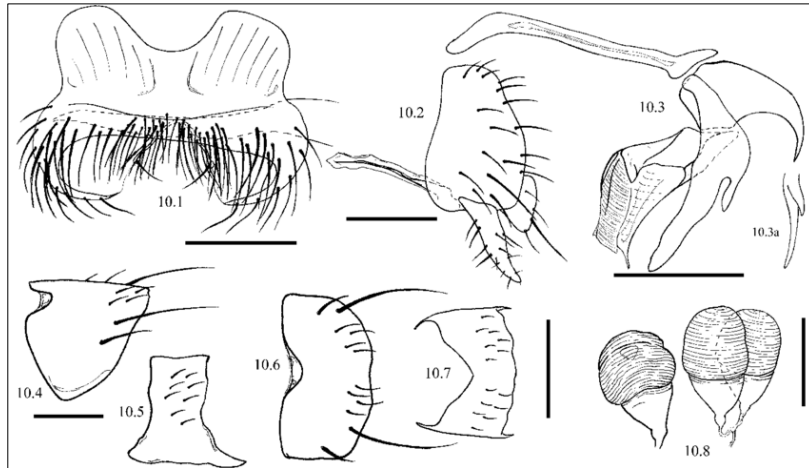


Figure 7 *Chespirtos ventrisetis* sp. n., male (holotype) and female abdominal structures. 10.1 -male S5, ventral; 10.2 - terminalia, lateral; 10.3 -aedeagus and associated structures, lateral; 10.3a -postgonite, posterior; 10.4 -female T7, lateral; 10.5 -female T8, lateral; 10.6 -female T7, dorsal; 10.7 -female T8, dorsal; 10.8 -spermathecae. Scale bars: 0.20 mm except spermathecae (0.10 mm) Source: https://www.researchgate.net/figure/45-Female-abdominal-structures-of-Chespirtos-jamaicensis-sp-n-paratype-41-dorsal_fig2_340804066

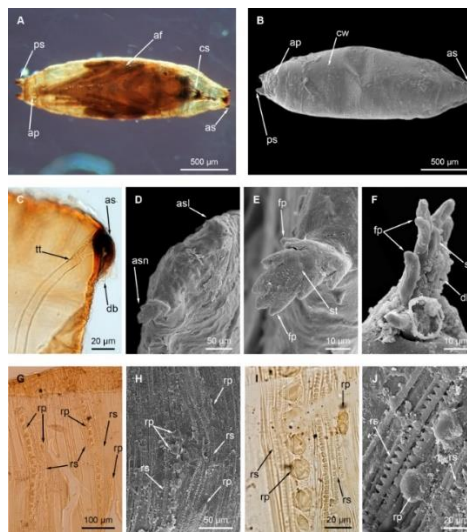


Figure 8 *Telomerina flavipes* (Meigen, 1830) (Diptera: Sphaeroceridae). The first known images of the puparium are provided, as well as its redescription and that of the cephalopharyngeal skeleton recovered from the puparium Source: Pradera C. 06-2013



Figure 9 *Phthitia empirica* (Hutton, 1901) puparium. Dorsal (a), ventral (b), and lateral (c) view (scale bar 500 µm) Source: Giordani, G, Vanin S. Description of the puparium and other notes on the morphological and molecular identification of *Phthitia empirica* (Diptera, Sphaeroceridae) collected from animal carcasses. Egyptian Journal of Forensic Sciences. 2020; 10: 13

They are cosmopolitan and present in a wide variety of terrestrial habitats, some of them linked to activities human while others highly specialized, developing in niches with extreme conditions such as deep layers of plant debris,

burrows, vertebrate nests, decomposing algae. We can also be found in coastal environments, sub-antarctic, caves pastagens, phytotelmas, turfeiras, touches and children invertebrates (Figures 8 and 9) [4,5,6].

The family is recognized for participating in the decomposition process of all kinds of organic material, being able to be polysaprophagous or specialists. They found each other in some of their life phases feeding on resources such as: fungi feces of various animals carcasses of invertebrates and carcasses of vertebrates. Despite their diverse biology, their medical and economic importance is not relevant, being potential mechanical transmitters of pathogens, they are pests in cheese industries, reducing the sanitary standards of manufacturing. There are also reports of intestinal miasa and damage to the cultivation of mushrooms. Carrion-feeding species are useful post mortem interval indicators in Forensic Entomology (Figure 10) [7,8,9].



Figure 10 *Limosina silvatica* (Meigen, 1830) Source: <https://en.wikipedia.org/wiki/Sphaeroceroidea>

Some species have phoretic associations with other arthropods, such as ants, kissuros and caranguejos and in high mountains with low temperatures; reaching a wide ecological tolerance, in addition, they play an important role in nature as accelerators of the process of putrefaction and recycling of nutrients; hence his association with the cadaveric decomposition process (Figure 11) [10,11].



Figure 11 *Coproica* (Diptera: Sphaeroceridae) in bovine feces Source: <https://www.biotaxa.org/Zootaxa/article/view/zootaxa.3953.1.1>

1.1. Taxonomy

Subfamily Tucminae Marshall, 19964

Subfamily Copromyzinae Stenhammar, 1855

Subfamily Sphaerocerinae Macquart, 1835

Subfamily Homalomitrinae Roháček & Marshall, 1998

Subfamily Limosininae Frey, 1921 (Figures 12 and 13).



Source: Photos by D. Gavryushin (Fig. 9), R. Ahlburg (Fig. 10), S. A. Marshall (Figs. 11, 12, 15) and D. K. B. Cheung (Figs. 13, 14, 16)

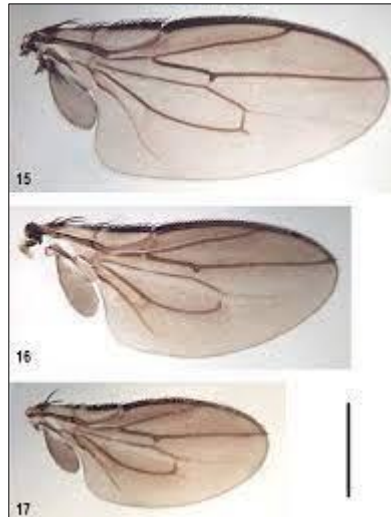
Figure 12 Sphaerocerinae (9–12) and Limosininae (13–26): 9 – *Ischiolepta pusilla* (Fallén, 1820), male (Russia, 1.7 mm); 10 – *Ischiolepta crenata* (Meigen, 1838), female (Denmark, 3.5 mm); 11 – *Lotobia* sp., male (Tanzania, 3 mm); 12 – *Parasphaerocera* sp., female (Costa Rica, 3 mm); 13 – *Anatalanta crozetensis* Enderlein, 1908, male (Crozet Archipelago, 4 mm); 14 – *Anomioptera picta* Schiner, 1868, female (Venezuela, 3 mm); 15 – *Aptilotella* sp., female (Costa Rica, 1.1 mm); 16 – *Archileptocera lutea* Marshall, 1998, male (Ecuador, 2.5 mm)



Source: Photos by D. K. B. Cheung (Figs 25, 26, 31, 32), S. A. Marshall (Figs. 27, 29) and D. Gavryushin (Figs. 28, 30)

Figure 13 Limosininae: 25 – *Myrmolimosina andersoni* Marshall, 2000, male (Mexico, 2.4 mm); 26 – *Phthitia selkirki* (Enderlein, 1938), male (Chile: Juan Fernández Is., 2.3 mm); 27 – *Poecilosomella angulata* (Thomson, 1869), male (Cuba, 2.9 mm); 28 – *Pseudocollinella humida* (Haliday, 1836), female (Russia, 2.4 mm); 29 – *Pterogramma* sp., sex unknown (Costa Rica, 1.5 mm); 30 – *Rachispoda lutosa* (Stenhammar, 1855), female (Russia, 3 mm); 31 – *Robustagramma disjunctum* Marshall & Cui, 2005, male (Costa Rica, 1.8 mm); 32 – *Sclerocoelus caribensis* Marshall, 1997, male (Costa Rica, 2.1 mm)

Worldwide, approximately 140 genera are reported, of which 14 are reported in Colombia: *Antrops* Enderlein, 1909; *Bitheca* Marshall, 1987; *Coproica* Rondani, 1861; *Homalomitra* Borgmeier, 1931; *Lepidosin* Marshall and Buck, 2007; *Leptocera* Olivier, 1813; *mini limousine* Rohacek, 1983; *Opalimosina* Roháček, 1983; *Palaeocoprini* Doubt, 1920; *Poecilosomella* Duda, 1925; *Pterogramma* Spuler, 1924; *Rachispoda* Liroy, 1864; *Robustagramma* Marshall and Cui, 2005; and *Spelobia* Spuler, 1924 (Figures 14 and 15) [12,13].



Source: Photo by Roháček J

Figure 14 *Spelobia manicata* (Richards, 1927), male wings. 15 – macropterous (Czech Republic: Třešť); 16 – submacropterous (Czech Republic: Hrubý Jeseník Mts. - Kouty nad Desnou); 17 - brachypterous (Czech Republic: Třešť - Desert). Scale: 0.5 mm



Source: Photo by Roháček J

Figure 15 Figs. 35–37. *Terrilimosina corrivalis* (Villeneuve, 1918), male wings. 35 – almost macropterous (Romania: Banat, Sfânta Elena – Kulhavá skála); 36 – usual brachypterous (Slovakia: Bukovské vrchy Mts.– Stučica res.); 37 – strongly brachypterous (Slovakia: Poľana Mts.– Hrončeký Grúň res.). Scale: 0.5 mm

Objective

This mini review aims to verify the importance of Sphaeroceridae Family as accelerators of the putrefaction process, nutrient recycling and its association with the cadaveric decomposition process.

2. Methods

The method used to prepare this mini review was Marchiori 2021 methodology [14].

3. Studies conducted and selected

3.1. Study 1

Flies of the genus *Leptocera* (Diptera, Sphaeroceridae) (Figures 16, 17 and 18).



Source: Pradera C. 06-2013

Figure 16 Pupae and fly of the genus *Leptocera*

A couple of months ago I found myself in a basement doing a rat extermination. There were no mice, but it was full of black flies about 3 millimeters long. The client complained that there were many, but he did not know where they came from. I was looking for a while. They were around a downspout. It didn't look like he lost. There were some cracks in the floor that looked like they could get out.



Source: Pradera C. 06-2013

Figure 17 Flies of the genus *Leptocera*

The client told me that 15 days earlier the basement had flooded when a downspout leaked residual water. I took a sample of flies. When I got home, I put them under the binocular loupe. This fly did not know her. I ripped the wings off one of the flies and started looking in books and then on the internet. It took me hours to get to the genus *Leptocera*, which belongs to the family Sphaeroceridae.

I have subsequently encountered this fly on two similar occasions on clients who had had sewage leaks. I was looking for information on what species could be the most common of this genus. It seems that it could be *Leptocera caenosa* (Rondani, 1880), according to the information I have found in the book 'Urban Insects and Arachnids. A Handbook of Urban Entomology' by William H Robinson. Luckily, this very interesting work can be consulted on the internet thanks to google. At the end there is a link to the book and also an image with the information it contains about the Sphaeroceridae family.



Source: Pradera C. 06-2013

Figure 18 Wing of *Leptocera* (top) and *Drosophila* (bottom)

This fly could be confused with species of the genus *Drosophila*. The truth is that through the binocular loupe they are very different. In photograph number 3 you can see a wing of *Leptocera* and another of *Drosophila*. If you look at photos 1 and 2, this fly is quite hairy. It has long bristles on its head and thorax. I have learned to identify it thanks to the fact that it has a more curved profile than other flies. Also, fold the wings in a different way.

A couple of weeks ago, I was lucky enough to come across a bunch of larvae and pupae. I was in a basement where I found a dead rat inside a feeder. The rats had made a gallery between the sewer and the cellar. When I opened the feeder, I found a lot of different insects. I took a sample. The flies that emerged from the pupae were *Leptocera* [15,16].

3.2. Study 2

This research is presented as a preliminary study of some ecological aspects of the genera present in the dry forest ecosystem tropical of the Colombian Caribbean Coast (Figures 19, 20, 21, 22, 23 and 24).

147 individuals belonging to six genera were collected, of which *Archiceroptera* Papp, 1977 and *Bromeloecia* Spuler, 1924 are new records for Colombia and the record of the genera *Coproica*, *Poecilosomella*, *Robustagramma* and *Spelobia* is expanded for the Colombian Caribbean Coast [17].



Source: <https://www.gbif.org/species/1589204>

Figure 19 *Archiceroptera* Papp, 1977

In relation to the hours of activity, it was observed that the 66.6% of the individuals were collected during the day and 33.3% at night. The human feces bait was the most effective attractant in the three environments (99.31%), followed by fish (0.68%) and without any specimen associated with fermented fruit. Regarding the sampled ecosystems, rural areas and forests recorded the highest number of individuals with 53% and 39% respectively, as opposed to urban

areas with 8%. For each of the ecosystems and genera, it was observed that the largest number of specimens corresponded to females with the 58.5% [17].



Source: <https://en.wikipedia.org/wiki/Coproica>

Figure 20 *Coproica* Rondani, 1861

Archiceroptera, is a complex of species mainly with a neotropical distribution with only two species described in Paraguay and Venezuela, which was present in the departments of Córdoba, Magdalena and Sucre, constituting the first record for the country. It was collected mainly in the forest ecosystem, at night and with feces human.

Bromeloecia, reported for the United States, Canada, Costa Rica, Mexico and Brazil, is primarily neotropical. In the present investigation, it constitutes the first record for Colombia, found in the departments of Córdoba in a rural ecosystem and Magdalena in a forest, both in daylight hours diurnal and attracted to human feces [18].



Source: <https://www.biotaxa.org/Zootaxa/article/view/zootaxa.4445.1.1>

Figure 21 *Bromeloecia* Spuler 1924

Coproica is widely distributed associated with urban environments and feces, especially from domestic animals. In Colombia, four species from the department of Antioquia are reported. This was the second most abundant genus, although it was collected in all ecosystems, during daytime and always attracted to human feces, its greatest abundance was in the forest. For this study, the registry is extended to the departments of Córdoba, Magdalena and Sucre [18].

Poecilosomella comprises about 30 species originating from the Old World that have been introduced to the New World. In Colombia there is a record of the Sierra San Lorenzo, Magdalena. For the Caribbean Coast it was the gender more abundant, mainly in rural ecosystem. In relation to the activity schedule, it appeared both during the day and at night and mainly with human feces as bait. It was collected in Magdalena and its distribution is extended to the departments of Cesar and Córdoba.



Source: <https://bugguide.net/node/view/780936>

Figure 22 *Poecilosomella* Duda, 1925

Robustagramma, a recently described genus of which there are not many data on its biology, it is distributed from the southeastern United States, Central America, East India and South America. In Colombia these authors recorded two species, both from the North of Santander. In the present study, the distribution is extended to the department of Córdoba, with a male collected in human feces, during daytime [18].



Source: <https://en.wikipedia.org/wiki/Robustagramma>

Figure 23 *Robustagramma* Marshall & Cui, 2005

Spelobia is a small genus, and with a majority presence in the Holarctic region, but it has spread throughout the Central American mountain range and from Venezuela to Ecuador, which has been associated with urban environments, however, many of them are from specific habitats. In Colombia it has records for the department of Santander (Marshall 1985), in addition, in the present study, it was found in the department of Magdalena, in an area rural, at night and attracted to human feces [18].



Source: <https://en.wikipedia.org/wiki/Spelobia>

Figure 24 *Spelobia* Roháček, 1983

3.3. Study 3

Only one species of Sphaeroceridae was recorded in the state of Mato Grosso do Sul (Brazil): *Neosphaerocera flavicoxa* (Malloch, 1925). This number certainly does not represent the diversity of sphaerocerid species in this region of Brazil. Another seven species are known in the Center-West region, six of which are in the state of Mato Grosso.

The remaining species reported in Brazil occur in states with greater tradition in entomological research, such as São Paulo, Rio de Janeiro, Paraná, Santa Catarina and Pará. For a better understanding of diversity of the Sphaeroceridae in Mato Grosso do Sul, further studies are needed, including collections directed to this group of flies, taking into account the biology and appropriate collection methods.

The knowledge of Sphaeroceridae from the Neotropical Region is also incipient, with many species to be described and it is possible to affirm that the number of species recorded in Mato Grosso do Sul is due to the little knowledge of the dipterofauna of the region (Figure 25).



Source: https://pt.wikipedia.org/wiki/Neoceroplatus_betaryiensis

Figure 25 Larva of *Neosphaerocera* Kim, 1972

List of species of Sphaeroceridae in the State of Mato Grosso do Sul (Brazil).

Neosphaerocera Kim, 1972

flavicoxa (Malloch, 1925). Type locality: Costa Rica, San Mateo, Higuito. Neotropical Distribution: Belize, Brazil, Colombia, Costa Rica, El Salvador, Ecuador, Guatemala, Guyana, Mexico (Chiapas), Panama, Paraguay and Venezuela.

Neosphaerocera youngheae Kim, 1972, synonymous with *N. flavicoxa*, has as type locality Mato Grosso do Sul, Maracaju [19,20,21,22,23].

3.4. Study 4

This paper report the first occurrence of the parasitoid *Pachycrepoideus vindemmiae* (Rondani, 1875) collected from the pupae of *Poecilosomella angulata* (Thomson, 1869).

These studies were conducted at the Faculdade de Agronomia settled in the city of Itumbiara, GO, Brazil. In the upper part the cans were coupled with nylon funnels, opened at the bottom, base pointing down and wrapped with plastic bags, so when removed would make possible the collection of flies and parasitoids. The following items were used as human feces bait placed inside the cans, over a layer of land [24].



Figure 26 Metal container traps.

Five traps were used and they were hanged in trees one meter from the ground, two meters apart from each other. The collected insects were taken to the laboratory, sacrificed with ethyl ether and kept in 70% alcohol for further identification. The content of the traps was placed in plastic containers having a layer of sand to be used as a substratum of larvae pupae. Therefore, this sand was sifted after being 15 days in the fields and from this sand was extracted the pupae which were individually placed in gelatine capsules (00 number) to obtain flies and /or the parasitoids (Figures 27 and 28).



Source: <https://bugguide.net/node/view/780936>

Figure 27 *Poecilosomella angulata* (Thomson, 1869)

During the period from March to October 2001, 40 specimes of *P. vindemmiae* were collected in 420 pupas of *P. angulata* showing 9.5% of parasitism. This is the first register *P. vindemmiae* in pupae *P. angulata* in world [24].



Source: http://waspweb.org/Chalcidoidea/Pteromalidae/Pteromalinae/Pachycrepoideus/Pachycrepoideus_vindemmiae.htm

Figure 28 *Pachycrepoideus vindemmiae* (Rondani, 1875) (Hymenoptera: Pteromalidae)

4. Conclusion

Sphaeroceridae is of great importance given its association with a wide variety of ecosystems there are no studies on its distribution, diversity and associations; hence, this research is proposed as a preliminary study of some ecological aspects of the genera present in the dry forest ecosystem tropical.

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