



Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 6(8) pp. 215-219, August, 2017 Issue.  
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Full Length Research Paper

# Aphelinidae (Hymenoptera: Chalcidoidea) Parasitoids of Whiteflies (Hemiptera: Aleyrodidae) in Southern Coahuila, Mexico

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Accepted 14 August, 2017

In southern Coahuila, Mexico, six species of the genus *Encarsia* (*E. barracas*, *E. guajavae*, *E. inaron*, *E. luteola*, *E. macula*, *E. pergandiella*) and three species of the genus *Eretmocerus* (*E. jimenezi*, *E. joeballi*, *E. perseae*) were collected and determined, also six Aleyrodidae host species (*Aleuropleurocelus abnormis*, *Aleurothrixus floccosus*, *Paraleyrodes minei*, *Siphoninus phillyreae*, *Tetraleurodes mori*, *Trialeurodes vaporariorum*). Aleyrodidae nymphs were obtained from *Persea americana*, *Punica granatum*, *Citrus sinensis*, *Morus nigra*, *Lindleya mespiloides*, *Solanum tuberosum*, *Cucurbita pepo* and *Taraxacum officinale*. The percentage of parasitism ranged from 4% to 66% in the monthly samples. The most abundant species was *Eretmocerus sjoeballi* (73.72% of the total for Aphelinidae). Seven species of Aphelinidae are new records for the State of Coahuila: *Encarsia barracas*, *E. guajavae*, *E. inaron*, *E. luteola*, *E. macula*, *Eretmocerus jimenezi* and *Er. perseae*. New host-parasitoid associations found in Coahuila are: *Encarsia guajavae* in *S. phillyreae*, *E. macula* in *A. abnormis*, *E. pergandiella* in *Siphoninus phillyreae*; *Eretmocerus perseae* in *A. abnormis*, *Er. jimenezii* in *P. minei*, and *Er. joeballi* in *A. floccosus*.

**Keywords:** Aphelinidae, Aleyrodidae, hosts, parasitism.

## INTRODUCTION

Aphelinids are recognized by the following combination of characters: a body no greater than 1.5 mm in length, not strongly metallic, usually clear or slightly sclerotized; labial

and maxilarpalpi of one or two segments; antenna of female with five-eight segments, excluding radicle and anellus; funicle at most with four segments; antennal club of one to four segments; mandible usually with two teeth and a truncated part or with three teeth; mesoscutum with entire notaular lines, more or less straight and widely separated; anterior wing with long marginal vein, stigmal

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vein short, postmarginal vein generally absent or short; tarsal formula 5-5-5 or 4-4-4, rare 5-4-5; anterior tibia with cleft and curve spur; metasoma widely attached to the mesosoma; petiole transverse or broad; gaster usually of seven tergites, occasionally with eight; cerci slightly forward (*Coccobius* only); third valvula separate and articulated with the second valvifer. Male similar to the female, except mainly in the antennal and genital structure (Myartseva et al., 2012). This family includes species used in biological control programs, currently includes 40 genera and 1350 species placed in seven subfamilies: Aphelininae, Azotinae, Calesinae, Coccophaginae, Eriaphytinae, Eriaporinae and Eretmocerinae (Noyes, 2016). Most species are primary parasitoids of Hemiptera Sternorrhyncha (Coccidae, Aleyrodidae, Aphididae, Diaspididae), and others act as hyperparasitoids or primary parasitoids of lepidopteran, orthopteran and dipteran eggs, acting as solitary or gregarious parasitoids, endophagous or ectophagous koinobionts (Triplehorn and Johnson, 2005). In Mexico, Aphelinidae have been studied not enough so the fauna present and its ecological role are little known. The objectives of this research were to collect and determine the species of Aphelinidae, their hosts and host plants, and the percentage of natural parasitism in southern Coahuila, Mexico.

## MATERIAL AND METHODS

Aphelinids were collected in the municipalities of Saltillo, Parras and Matamoros, in the southern part of the State of Coahuila, from February 2012 to July 2013. These localities have from semi-dry to very dry climate. In each municipality, at least one collection per month was carried out on weeds, shrubs and trees located in parks, hotels, backyards, public gardens, roadsides and highways; moreover, collecting were done on crops, horticultural and ornamental plants and fruit trees. The underside of the leaves of as many plants was checked in order to locate pupae of white flies fourth in star.

When pupae of Aleyrodidae were located, leaves were cut and put into Petri dishes sealed with Kleen Pack®. All samples were tagged with their respective collection data (country, state, municipality, specific situation, date and collector) and transferred to the Laboratory of Insect and Mite Taxonomy of the Autonomous Agrarian University Antonio Narro, Campus Saltillo, where they were stored at room temperature and humidity. Subsequently, every eight days, until the end of one month, Petri dishes were opened to take the emerged adult parasitoids.

Adults of Aphelinidae and the pupae of Aleyrodidae were mounted on slides and cover slips, using Canada Balsam, following the techniques of Noyes (1982) and Martin (2004), respectively. Grissell & Schauf (1997) identification keys were used to determine the genera of Aphelinidae,

and Myartseva et al. (2012) keys for the species. The determination of genera and species of Aleyrodidae was carried out with the identification keys from Martin (1987).

In order to calculate the percentage of natural parasitism, each month 100 remains of pupae were taken at random and calculated by the ratio  $(A / B) * 100$ , where A was the number of emerged parasitoids and B the number of pupae.

## RESULTS AND DISCUSSION

Approximately 5,600 pupae of *Aleuropleurocelus abnormis* [listed as *Aleuropleurocelus Affacaudatus* by Sanchez et al. (2015), 460 of *Trialeurodes vaporariorum*, 1,200 of *Siphoninus phillyreae*, 2,600 of *Paraleyrodes minei*, 4,800 of *Tetraleurodes mori*, and 2,800 of *Aleurothrixus floccosus* were collected, with a total of 17,460 nymphs of Aleyrodidae. The numbers are approximate given the difficulties to accurately count the hosts. Of these, a total of 2,934 adults of Aphelinidae emerged (16.8% mean parasitism). Two subfamilies, six genera and six species of Aleyrodidae were the hosts of the aphelinids, being Aleyrodinae the subfamily more represented with five species from five genera. From the subfamily Aleurodicinae, only *Paraleyrodes minei* was recorded on *Persea americana*.

Table 1 shows the names of the species of Aphelinidae, hosts, host plants and municipalities.

We collected 2,474 specimens from three species of the genus *Eretmocerus*, that is 84.32% of the total obtained; *E. joeballi* was the most abundant species (2,163 specimens, 73.72% of the total of aphelinids) and emerged from nymphs of *Aleurothrixus floccosus*, *Tetraleurodes mori* and *Trialeurodes vaporariorum* on *Citrus sinensis*, *Lindleya mespiloides* and *Taraxacum officinale* leaves. *Eretmocerus perseae* was the second species in abundance, it emerged from nymphs of *Aleuropleurocelus abnormis* collected on *Persea americana* (296 specimens, 10.09%). From *Eretmocerus jimenezi*, only 15 adults (0.51%) were emerged from *Paraleyrodes minei* pupae on *Persea americana* leaves.

From the genus *Encarsia*, represented by six species, 460 adults were obtained (15.67% of the total). *Encarsia inaron* (128 individuals, 4.36%) and *E. macula* (126, 4.29%) were the most collected species in the genus. *E. inaron* emerged from *Siphoninus phillyreae* pupae on *Punica granatum* leaves, *E. macula* emerged from *Aleuropleurocelus abnormis* on *Persea americana* leaves. A few adults of *Encarsia pergandiella*, *E. luteola*, *E. guajavae* and *E. barracas* were obtained, the latter species emerged from *Trialeurodes vaporariorum* pupae on *Taraxacum officinale* leaves.

The percentage of natural parasitism, considering all species of Aphelinidae was from 4% (*Encarsia barracas*)

**Table 1.** Aphelinidae parasitoids of whiteflies in southern Coahuila, Mexico. February 2012 to July 2013.

Aphelinidae	Hosts	Plants	Municipalities
Genus <i>Encarsia</i>			
* <i>barracas</i>	<i>Trialeurodes vaporariorum</i>	<i>Taraxacum officinale</i>	Saltillo
* <i>guajavae</i>	<i>Siphoninus phillyreae</i>	<i>Punica granatum</i>	Matamoros
	<i>Tetraleurodes mori</i>	<i>Morus nigra</i>	Saltillo
* <i>inaron</i>	<i>Siphoninus phillyreae</i>	<i>Punica granatum</i>	Matamoros
* <i>luteola</i>	<i>Trialeurodes vaporariorum</i>	<i>Solanum tuberosum</i>	Saltillo
		<i>Cucurbita pepo</i>	Saltillo
		<i>Taraxacum officinale</i>	Saltillo
* <i>macula</i>	<i>Aleuropleurocelus abnormis</i>	<i>Persea americana</i>	Matamoros, Parras
<i>pergandiella</i>	<i>Siphoninus phillyreae</i>	<i>Punica granatum</i>	Matamoros
	<i>Tetraleurodes mori</i>	<i>Morus nigra</i>	Matamoros
	<i>Trialeurodes vaporariorum</i>	<i>Solanum tuberosum</i>	Saltillo
		<i>Cucurbita pepo</i>	Saltillo
		<i>Taraxacum officinale</i>	Saltillo
Genus <i>Eretmocerus</i>			
* <i>jimenezi</i>	<i>Paraleyrodes minei</i>	<i>Persea americana</i>	Matamoros, Parras
<i>joeballi</i>	<i>Aleurothrixus floccosus</i>	<i>Citrus sinensis</i>	Matamoros
	<i>Tetraleurodes mori</i>	<i>Lindleya mespiloides</i>	Saltillo
	<i>Trialeurodes vaporariorum</i>	<i>Taraxacum officinale</i>	Saltillo
* <i>persea</i>	<i>Aleuropleurocelus abnormis</i>	<i>Persea americana</i>	Matamoros, Parras

\*New records for the State of Coahuila.

to 66% (*Encarsia macula*) in the monthly samples. The levels of parasitism in the monthly samples were: *Encarsia barracas* from 0 to 10, *E. luteola* and *E. pergandiella* from 11 to 20, *E. guajavae* from 21 to 30, *E. inaron* and *Eretmocerus sjoeballi* from 31 to 40, *Eretmocerus perseae* and *Er. jimenezi* from 41 to 50, and *E. macula* from 61 to 70.

### Aphelinidae

*Encarsia pergandiella* is widely distributed in the Nearctic Region. In Mexico it was recorded before parasitizing

*Bemisia tabaci*, *Tetraleurodes mori*, *Trialeurodes* sp. and *Trialeurodes vaporariorum*. This species has also been recorded from *Aleyrodes* sp., *Aleurodicus dispersus*, *Aleuroglandulus subtilis*, *Aleuroplatus coronata*, *A. elemerae*, *Aleurothrixus floccosus*, *Aleurotrachelus socialis*, *A. trachoides*, *Dialeurodes citri*, *D. kirkaldyi*, *Pealius azuleae*, *Trialeurodes abutiloneus*, *T. floridensis*, *T. packardi* and *T. variabilis* in other countries (Myartseva et al., 2012). In this research, *E. pergandiella* was obtained from *Tetraleurodes mori*, *Trialeurodes vaporariorum* and *Siphoninus phillyreae*.

*Encarsia macula* is distributed in Florida, USA, Honduras and Mexico. Its known hosts are *Tetraleurodes* sp. And *Trialeurodes vaporariorum* (Myartseva et al., 2012). In this work, it was obtained from *Aleuropleurocelus abnormis*.

*Encarsialuteola* is difficult to distinguish from *E. formosa*; both share many hosts and are widely distributed in the New World (Polaszek et al., 1992). This species was found previously in *Aleurocanthus* sp., *Aleurocybotus occiduus*, *Aleyrodes* sp., *Bemisia tabaci*, *Dialeurodes* sp., *Dialeurodicus* sp., *Tetraleurodes acaciae*, *Tetraleurodes* sp., *Trialeurodes abutiloneus*, *T. fernaldi*, *T. packardi*, *T. vaporariorum*, *T. variabilis*, *Trialeurodes* sp., *VasDavidius* [= *Aleurocybotus*] *indicus* (Myartseva et al., 2012). In this research emerged from *T. vaporariorum*.

*Encarsia inaron* was introduced into California, USA, to control *Siphoninus phillyreae* (Gould et al., 1992). This species was not intentionally introduced to Mexico but it was obtained from *Aleurocanthus woglumi* in *Citrus aurantifolia* (Myartseva et al., 2012).

*Encarsia guajavae* was found before from *Tetraleurodes mori* and *Tetraleurodes* sp. (Myartseva et al., 2012). In this work emerged from *Tetraleurodes mori* and *Siphoninus phillyreae*.

*Encarsia barracas* was collected previously in Las Barracas (Los Cabos), Baja California Sur, Mexico (Myartseva et al., 2013). In this research emerged from *Trialeurodes vaporariorum*.

*Eretmoceru perseae* was obtained before from *Tetraleurodes perseae* on avocado *Persea americana* and on lemon *Citrus limon*. In Mexico, this species was misidentified as *Eretmoceru portoricensis* found in *Trialeurodes perseae* (Myartseva et al., 2012). In this work emerged from *Aleuropleurocelus abnormis*.

*Eretmoceru jimenezi* was found previously from *Aleurothrixus floccosus* and *Tetraleurodes* sp. In this work emerged from *Paraleyrodes minei*.

*Eretmoceru sjoeballi* had already been reported in Saltillo, Coahuila, from *Tetraleurodes* sp. on *Morus* sp. This species is distributed in USA (California) and Mexico (Coahuila, Tamaulipas), its known hosts were *Bemisia tabaci* and *Tetraleurodes* sp. (Myartseva et al., 2012). In this work emerged from *Aleurothrixus floccosus* and *Tetraleurodes mori*.

*Encarsia macula*, *E. luteola*, *E. inaron*, *E. guajavae*, *E. barracas*, *Eretmoceru perseae*, *E. jimenezi* and *E. sjoeballi* are new records for the State of Coahuila. Prior to this work, six species of Aphelinidae had been reported for Coahuila: *Eretmoceru longiterebrus*, *E. antennator*, *Encarsia mahoniae*, *E. narroi*, *E. perniciosi* and *E. pergandiella*, so the list for Coahuila increased to 15 species.

## Aleyrodidae

*Paraleyrodes minei* is distributed in the Neotropical, Nearctic, Palearctic, Ethiopian and Oriental regions. It was described from citrus in Syria; all species of *Paraleyrodes* are native to the Neotropical region, with *P. minei* clearly mobile (Martin 2004).

The genus *Aleuropleurocelus* was named by Drews and Sampson to separate species of the New World with pupae black, one slightly elevated vasiform orifice and the dorsal surface deflected (Drews and Sampson 1956). *Aleuropleurocelus abnormis* is present in southern Coahuila (Sánchez-Flores et al., 2015, 2016).

*Siphoninus phillyreae* is a pest of many ornamental and fruit crops such as citrus. It causes serious damage to pears and apple trees in Europe; in California, USA, is found in pomegranate, ash, pear, apple, medlar and citrus trees (Bellows et al., 1990).

*Aleurothrixus floccosus* is native to the Neotropical region, and it is widely distributed in the Neotropical, Nearctic, Palearctic, Ethiopian and Oriental regions. Known as the woolly whitefly, it was described from Jamaican material; it has been spreading, causing economic problems in various parts of the world; it is possible that there are several breeds in this species (Martin, 2005).

*Tetraleurodes mori* is recorded in the Neotropical and Nearctic regions (USA, Mexico and Central America), it is very common and widely distributed. The group of pores on each side of the IV abdominal segment is an important character to recognize it (Martin, 2005).

*Trialeurodes vaporariorum* is cosmopolitan although less common in the Oriental region, it is usually found in cold temperate regions; in greenhouses causes significant economic damages (Martin, 2005).

So, 10 species of Aleyrodidae are known from the State of Coahuila: *Aleuropleurocelus abnormis*, *Aleurothrixus floccosus*, *Bemisia afer*, *B. tabaci*, *Paraleyrodes minei*, *Siphoninus phillyreae*, *Tetraleurodes acaciae*, *T. mori*, *Trialeurodes floridensis* and *T. vaporariorum*. More species are expected to be collected in other areas of Coahuila.

## CONCLUSIONS

At the moment, the Aphelinidae fauna (nine species, including seven new records) is the known diversity of these family attacking whiteflies in southern Coahuila, a dry area. Six new host-parasitoid associations were found for Coahuila. Aphelinids parasitized six species of Aleyrodidae in varied percentages (4-66%) which helps to explain why whiteflies are not considered pests on creole avocados and other crops in the studied area.

## ACKNOWLEDGMENTS

To the Parasitology Department of the Autonomous Agrarian University Antonio Narro and to CONACYT by the support for the present work.

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