

Research Article

## Associated Chalcidoidea (Hymenoptera) with the cotton mealybug *Phenacoccus solenopsis* (Hemiptera: Pseudococcidae) in the southwestern Iran

Ebrahim Tamoli Torfi<sup>1</sup>, Arash Rasekh<sup>1\*</sup>, Seyed Abbas Moravvej<sup>1</sup>, Mohammad Saeed Mossadegh<sup>1</sup> and Ali Rajabpoor<sup>2</sup>

1. Department of Plant Protection, College of Agriculture, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

2. Department of Plant Protection, Faculty of Agriculture, Agricultural Sciences and Natural Resources University of Khuzestan, Mollasani, Ahvaz, Iran.

**Abstract:** Eleven species of Chalcidoidea (Hymenoptera) belonging to Aphelinidae, Encyrtidae, Eriaporidae and Signiphoridae associated with the cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) were collected and identified during 2017-2018 from Khuzestan province in the southwestern Iran. *Prochiloneurus rex* (Girault) (Encyrtidae) is new record for the fauna of Iran. Meanwhile, biological associations of *Bothriothorax serratellus* (Dalman), *Leptomastix dactylopii* Howard and *L. mayri* Özdikmen (Encyrtidae) as parasitoids and *Marietta picta* (André), *P. rex* and *Chartocerus kurdjumovi* (Nikolskaya) (Signiphoridae) as hyperparasitoids of *Ph. solenopsis* were new.

**Keywords:** *Phenacoccus solenopsis*, Chalcidoidea, parasitoids, Khuzestan province, southwestern Iran

### Introduction

The cotton mealybug, *Phenacoccus solenopsis* Tinsley, 1898 (Hemiptera: Pseudococcidae) is a phytophagous insect with large populations causing serious damage to numerous plants including economically important hosts such as cotton *Gossypium hirsutum* L., sugarcane *Saccharum officinarum* L. and tomato *Solanum lycopersicum* L. (Hodgson *et al.*, 2008; Wang *et al.*, 2010; Mossadegh *et al.*, 2015; Seyfollahi *et al.*, 2016). This pest and its damage have been reported from the New World, Afrotropical, Australia, Oriental, and the Middle East (Wei *et al.*, 2017) including Iran. It was firstly recorded

from Hormozgan province in the southern on Chinese hibiscus shrubs, *Hibiscus rosa-sinensis* L. (Moghadam and Bagheri, 2010). Its report was followed by Bushehr, Khuzestan, Fars, Kerman, Yazd and Kohgiluyeh-va-Boyerahmad provinces, respectively on various hosts such as Chinese hibiscus, okra and potato (Mossadegh *et al.*, 2015).

As a dispersing key pest and an increasing threat to horticultural and ornamental plants in particular, control measures must be taken to prevent economic damage. As with other mealybugs, chemical control of cotton mealybug is difficult especially due to protection created by producing waxy materials around the body and the encapsulated eggs, as well as overlapping generations (Grasswitz and Burts, 1995). Further, excessive and long-term use of pesticides against mealybugs including cotton mealybug causes resistance

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\*Corresponding authors, e-mail: a.rasekh@scu.ac.ir

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to insecticides and their repercussion (Kaur and Virk, 2011). Therefore, utilization of other control options is required such as biological control by natural enemies as predators or parasitoids, which has attracted considerable attention since the outbreak of this mealybug. Several natural enemies as well as other associates (e.g. hyperparasitoids and parasitoids of predators) have been documented for the cotton mealybug (Nagrare *et al.*, 2011; Suoshe *et al.*, 2013). Ladybirds (Coccinellidae) and *Aenasius arizonensis* (Girault) (Hym.: Encyrtidae) have been reported as the most effective enemies (Mossadegh *et al.*, 2015). Cotton mealybug was reported in 2009 on the Chinese hibiscus shrubs from different cities of Khuzestan province and currently is known to have 219 host plants belonging to 70 families. This mealybug can lead to irreparable damage to horticultural, crop and vegetable products such as citrus, sugarcane, corn, tomato, okra and eggplant (Mossadegh *et al.*, 2015).

Due to the lack of comprehensive study on the parasitic wasps associated with cotton mealybug, this investigation was conducted to collect and identify Hymenoptera including parasitoid, hyperparasitoid, and ladybirds' parasitoid on cotton mealybug from Khuzestan province of Iran.

## Materials and Methods

During 2017-2018, samplings were obtained from Chinese hibiscus shrubs, *Hibiscus rosa-sinensis* infested with cotton mealybug in Ahvaz (31°19'N, 48°42'E, Altitude: 18 m), Abadan (30°21'N, 48°16'E, Altitude: 3 m), Bawi (Mollasani: 31°35'N, 48°53'E) and Baghe-Malek (31°31'N, 49°53'E) in Khuzestan province in the southwestern Iran by cutting off the infested leaves which were then placed in a ventilated container and transferred to the laboratory, where they were maintained for four weeks at room condition (temperature: 25 ± 5 °C, relative humidity: 45-60%) for further inspection.

The containers were visited daily, during which the wasps emerging in each container were recorded and stored in 75% ethanol for identification. The specimens were identified by relevant references e. g., Timberlake (1919), Mercet (1929), Ferrière (1956), Hayat (1986, 1998, 2006, 2009a, 2009b), Noyes and Hayat (1994), Noyes (2000) and Çalışkan *et al.* (2016). The specimens were photographed under a stereomicroscope equipped with a Coolpix S10 digital camera (Nikon, Tokyo, Japan) attached to a binocular microscope. The material is deposited at the Insect Collection of Department of Plant Protection, College of Agriculture, Shahid Chamran University of Ahvaz.

For each species, the following parts are presented: the material examined in this study, reference(s) used for morphology and diagnosis, inland and world distribution and know host species from Iran.

## Results

Eleven species of wasps which were all chalcid (superfamily Chalcidoidea) were collected and determined belonging to four families as Aphelinidae, Encyrtidae, Eriaporidae and Signiphoridae with 8, 1, 1 and 1 species, respectively. Taxa are listed alphabetically.

### Aphelinidae

*Marietta picta* (André, 1878) (Fig. 1-A)

**Material examined:** Abadan: 2 ♀♀, 1 ♂, 2018.iii.8. Ahvaz: 2 ♀♀, 2018.x.12; 1 ♀, 2018.x.19. Baghe-Malek: 2 ♀♀, 2 ♂♂, 2018.x.4.

**Morphology and Diagnosis:** see Hayat (1986 and 1998).

**Distribution in Iran:** Fars (Lotfalizadeh and Ahmadi, 2001; Hesami and Fallahzadeh, 2004; Fallahzadeh *et al.*, 2008, 2011), Khorasan-Jonubi (Lotfalizadeh *et al.*, 2019), East Azarbaijan (Jafari *et al.*, 2015), Hamadan (Rajabi Mazaher and Sadeghi, 2006), Kerman (Yazdani and Mehrnejad, 1993; Jalaieian *et al.*, 2011), Tehran (Talebi *et al.*, 2008), Zanjan (Keyhanian *et al.*, 1995)

and Khuzestan provinces (Baniameri, 1996; this study).

**Distribution outside Iran:** throughout Palaearctic including Iraq (Hayat, 1986), Nearctic, Neotropical and Oriental (Noyes, 2019).

**Hosts:** Parasitoids of *A. arizonensis* and *P. aegyptiacus* (Encyrtidae), and hyperparasitoid of *Ph. solenopsis* (this study). In Iran, the following hosts have been reported: *Agonoscena cisti* (Paton) (Hemiptera: Psyllidae) (Yazdani and Mehrnejad, 1993), *Anophococcus abaii* (Danzig, 1990) (Lotfalizadeh et al., 2019), *Planococcus vovae* (Nasonov) (Lotfalizadeh and Ahmadi, 2001; Talebi et al., 2008), *P. ficus* (Signoret) (Fallahzadeh et al., 2008, 2011), and also it is hyperparasitoid of *Pseudococcus comstocki* (Kuwana) (Jafari et al., 2015), *Euphyllura olivina* Costa (Keyhanian et al., 1995) (Hemiptera: Aphalaridae), *Psyllopsis repens* Loginova (Rajabi Mazaher and Sadeghi, 2006) (Hemiptera: Psyllidae), and *Anagyrus* sp. (Baniameri, 1996). Noyes (2019) lists at least 46 species of Hemiptera as primary hosts and 17 species of Hymenoptera as parasitoid hosts for this wasp.

#### Encyrtidae

***Aenasius arizonensis* (Girault, 1915) (Fig. 1-B)**

**Material examined:** Abadan: 18 ♂♂, 27 ♀♀, 2018.iii.8. Ahvaz: 1 ♂, 2018.iii.23; 1 ♂, 3 ♀♀, 2018.iii.30; 2 ♀♀, 2018.iv.6; 1 ♀, 2018.iv.16; 1 ♂, 3 ♀♀, 2018.iv.20; 1 ♂, 4 ♀♀, 2018.iv.27; 8 ♂♂, 3 ♀♀, 2018.v.4; 16 ♂♂, 23 ♀♀, 2018.v.11; 30 ♂♂, 57 ♀♀, 2018.v.18; 26 ♂♂, 81 ♀♀, 2018.v.25; 44 ♂♂, 29 ♀♀, 2018.vi.1; 38 ♂♂, 24 ♀♀, 2018.vi.8; 44 ♂♂, 57 ♀♀, 2018.vi.15; 7 ♂♂, 22 ♀♀, 2018.vi.22; 3 ♂♂, 15 ♀♀, 2018.vi.29; 6 ♂♂, 6 ♀♀, 2018.vii.6; 7 ♂♂, 13 ♀♀, 2018.vii.13; 10 ♂♂, 14 ♀♀, 2018.vii.20; 18 ♂♂, 27 ♀♀, 2018.vii.27; 21 ♂♂, 14 ♀♀, 2018.viii.3; 23 ♂♂, 32 ♀♀, 2018.viii.10; 28 ♂♂, 32 ♀♀, 2018.viii.17; 38 ♂♂, 44 ♀♀, 2018.viii.24; 82 ♂♂, 102 ♀♀, 2018.viii.31; 67 ♂♂, 79 ♀♀, 2018.ix.7; 157 ♂♂, 139 ♀♀, 2018.ix.14; 174 ♂♂, 160 ♀♀, 2018.ix.21; 89 ♂♂, 109 ♀♀, 2018.ix.28; 61 ♂♂, 80 ♀♀, 2018.x.5; 21 ♂♂, 40 ♀♀, 2018.x.12; 1 ♂, 1 ♀, 2018.x.19; 1 ♂, 2018.xi.9; 4 ♀♀, 2018.xi.16. Baghe-Malek: 3 ♂♂, 7 ♀♀, 2018.x.4. Bawi

(Mollasani): 21 ♂♂, 28 ♀♀, 2017.iv.30; 29 ♂♂, 25 ♀♀, 2017.v.25; 14 ♂♂, 13 ♀♀, 2018.iv.25; 31 ♂♂, 24 ♀♀, 2018.v.8.

**Morphology and Diagnosis:** see Hayat (2009a).

**Distribution in Iran:** Hormozgan, Bushahr, Fars, Kerman, Kohgiluyeh-va-Boyerahmad, and Khuzestan provinces (Fallahzadeh et al., 2014, 2016; Mossadegh et al., 2015; this study).

**Distribution outside Iran:** USA, Oriental (Noyes, 2019) and the Middle East (Abdul-Rassoul, 2018; Spodek et al., 2018).

**Hosts:** *Ph. solenopsis* in this study, in Iran (Fallahzadeh et al., 2014, 2016; Mossadegh et al., 2015), and from extralimital (Noyes, 2019). The host recorded in India includes *Pseudococcus longispinus* (Targioni-Tozzetti) (Nalini and Manickavasagam, 2011).

***Anagyrus aligarhensis* Agarwal and Alam, 1959 (Fig. 1-C)**

**Material examined:** Ahvaz: 1 ♀, 2018.ix.14; 1 ♀, 2018.ix.21.

**Morphology and Diagnosis:** see Çalışkan et al (2016).

**Distribution in Iran:** Tehran (Noyes and Hayat, 1994), Fars (Hesami and Fallahzadeh, 2004, 2005), and Khuzestan provinces (Asadeh and Mossadegh, 1991, 1993; Novin et al., 2000; Mossadegh et al., 2015; this study).

**Distribution outside Iran:** Old World and USA (Çalışkan et al., 2016).

**Hosts:** *Ph. solenopsis* (this study). The hosts recorded in Iran include *Nipaeococcus viridis* (Asadeh and Mossadegh, 1991, 1993; Noyes and Hayat, 1994; Novin et al., 2000; Hesami and Fallahzadeh, 2004, 2005), and *Ph. solenopsis* (Mossadegh et al., 2015). Noyes (2019) lists one coccinellid and 16 pseudococcid species as hosts for this wasp.

***Bothriothorax serratellus* (Dalman, 1820) (Fig. 1-D)**

**Material examined:** Ahvaz: 2 ♂♂, 2018.x.5.

**Morphology and Diagnosis:** see Ferrière (1956).

**Distribution in Iran:** Khuzestan province (this study).

**Distribution outside Iran:** Europe, Armenia, Mongolia, Russia, Tajikistan and Turkey (Noyes, 2019).

**Hosts:** Hyperparasitoid of *Ph. solenopsis* (this study), and *Syrphus albostrigatus* (Noyes, 2019).

***Homalotylus flaminus* (Dalman, 1820)** (Fig. 1-E)

**Material examined:** Ahvaz: 5 ♀♀, 2 ♂♂, 2018.x.5; 14 ♀♀, 5 ♂♂, 2018.x.12. Baghe-Malek: 3 ♀♀, 2 ♂♂, 2018.x.4.

**Morphology and Diagnosis:** see Timberlake (1919).

**Distribution in Iran:** Fars (Fallahzadeh *et al.*, 2006a) and Khuzestan provinces (Moravvej *et al.*, 2018; this study).

**Distribution outside Iran:** Nearly cosmopolitan (Noyes, 2019).

**Hosts:** Larvae of Coccinellidae (this study). In Iran, *Nephus bipunctatus* (Coccinellidae) (Fallahzadeh *et al.*, 2006a) is known as its host. Noyes (2019) lists 1, at least 62, 2 and 3 host species of Chrysomelidae, Coccinellidae, Coccidae, and Pseudococcidae, respectively for this wasp.

***Leptomastix dactylopii* Howard, 1885** (Fig. 1-F)

**Material examined:** Ahvaz: 1♀, 2018.ix.7; 1♀, 2018.ix.14.

**Morphology and Diagnosis:** see Noyes and Hayat (1994) and Noyes (2000).

**Distribution in Iran:** Fars (Fallahzadeh and Japoshvili, 2010; Fallahzadeh *et al.*, 2011), Kermanshah (Jalilvand *et al.*, 2014) and Khuzestan provinces (this study).

**Distribution outside Iran:** Nearly cosmopolitan (Noyes, 2019).

**Hosts:** *Ph. solenopsis* (this study). *Planococcus ficus* (Fallahzadeh and Japoshvili, 2010; Fallahzadeh *et al.*, 2011), and *Phenacoccus* sp. (Jalilvand *et al.*, 2014) are known Iranian hosts. Noyes (2019) lists one and 48 host species of Diaspididae and Pseudococcidae, respectively for this wasp.

***Leptomastix mayri* Özdikmen, 2011** (Fig. 1-G)

**Material examined:** Ahvaz: 1♀, 2018.vi.22; 1♀, 2018.vii.6.

**Diagnosis:** see Noyes and Hayat (1994).

**Distribution in Iran:** Fars (Fallahzadeh *et al.*, 2006b), Kermanshah (Jalilvand *et al.*, 2014) and Khuzestan (this study) provinces.

**Distribution outside Iran:** Palaearctic and Oriental (Fallahzadeh and Japoshvili, 2017).

**Hosts:** Three pseudococcids, viz. *Ph. solenopsis* (this study), *Peliococcus kimmericus* (Fallahzadeh *et al.*, 2006b), and *Chorizococcus* sp. (Jalilvand *et al.*, 2014) are hosts recorded in Iran for this wasp.

***Prochiloneurus aegyptiacus* (Mercet, 1929)** (Fig. 1-H)

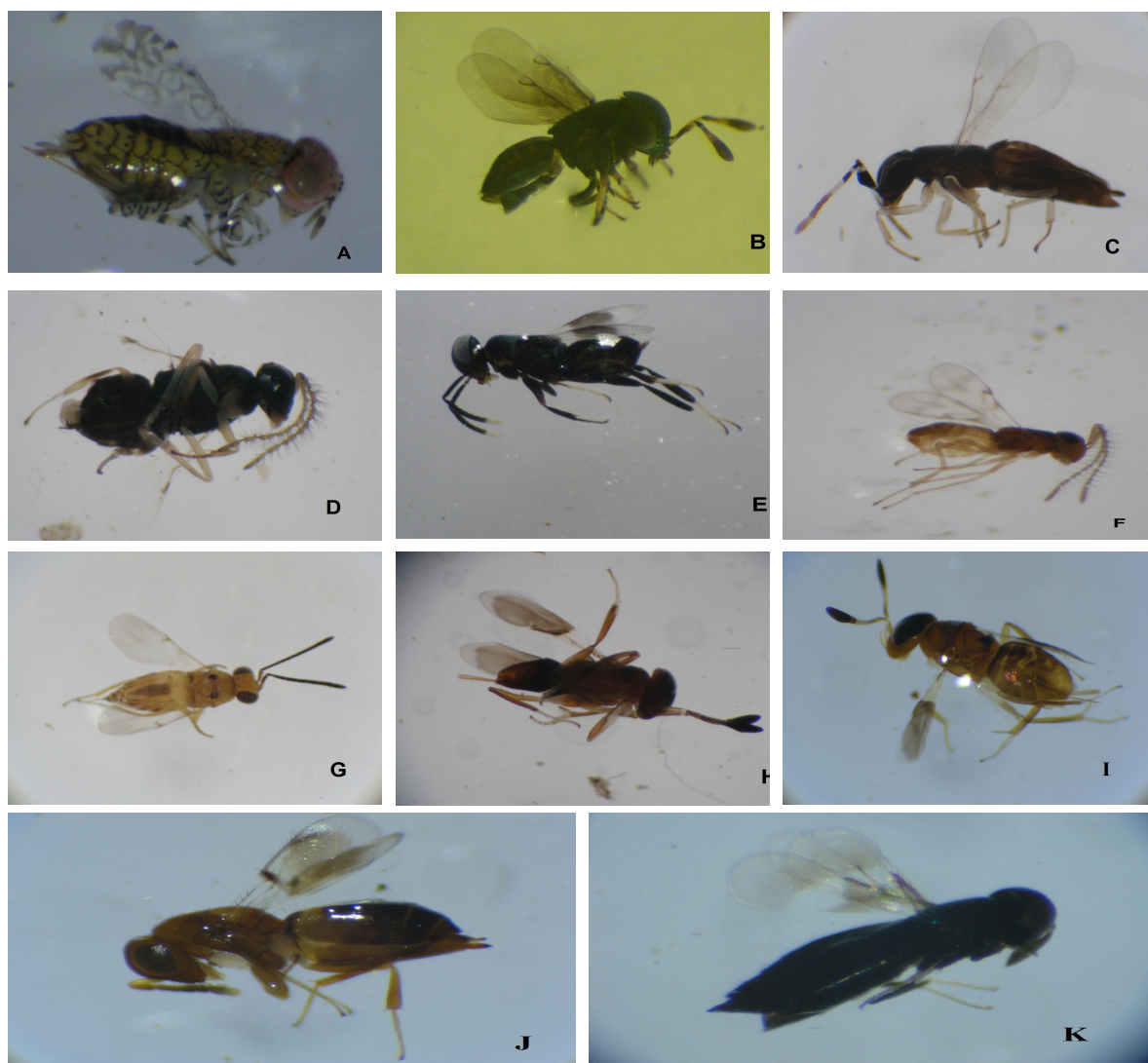
**Material examined:** Abadan: 15 ♀♀, 6 ♂♂, 2018.iii.8. Ahvaz: 3 ♀♀, 1 ♂, 2018.v.11; 1♀, 1♂, 2018.v.18; 35 ♀♀, 14 ♂♂, 2018.v.25; 50 ♀♀, 16 ♂♂, 2018.vi.1; 51 ♀♀, 10 ♂♂, 2018.vi.8; 34 ♀♀, 20 ♂♂, 2018.vi.15; 10 ♀♀, 5 ♂♂, 2018.vi.22; 10 ♀♀, 1 ♂, 2018.vi.29; 5 ♀♀, 1 ♂, 2018.vii.6; 5 ♀♀, 1 ♂, 2018.vii.13; 5 ♀♀, 2018.vii.20; 3 ♀♀, 1 ♂, 2018.vii.27; 5 ♀♀, 1 ♂, 2018.viii.3; 8 ♀♀, 2 ♂♂, 2018.viii.10; 27 ♀♀, 9 ♂♂, 2018.viii.17; 20 ♀♀, 7 ♂♂, 2018.viii.24; 75 ♀♀, 7 ♂♂, 2018.viii.31; 108 ♀♀, 21 ♂♂, 2018.ix.7; 203 ♀♀, 55 ♂♂, 2018.ix.14; 306 ♀♀, 30 ♂♂, 2018.ix.21; 202 ♀♀, 40 ♂♂, 2018.ix.28; 97 ♀♀, 40 ♂♂, 2018.x.5; 42 ♀♀, 10 ♂♂, 2018.x.12. Baghe-Malek: 8 ♀♀, 3 ♂♂, 2018.x.4. Bawi (Mollasani): 9 ♀♀, 4 ♂♂, 2017.iv.30; 13 ♀♀, 7 ♂♂, 2017.v.25; 4 ♀♀, 1 ♂, 2018.iv.25; 6 ♀♀, 4 ♂♂, 2018.v.8.

**Morphology and Diagnosis:** see Mercet (1929).

**Distribution in Iran:** Tehran (OILB, 1971), Fars (Hesami and Fallahzadeh, 2004; Fallahzadeh *et al.*, 2007), Hormozgan (Fallahzadeh *et al.*, 2016) and Khuzestan provinces (Alizadeh *et al.*, 2013; this study).

**Distribution outside Iran:** Cosmopolitan excluding Australia and South America (Noyes, 2019).

**Hosts:** Parasitoids of *A. arizonensis* and *Anagyrus* sp., and hyperparasitoid of *Ph. solenopsis* (this study). *Anagyrus* spp. (Hesami and Fallahzadeh, 2004), *Nephus hiekei* (Coleoptera: Coccinellidae), *Homalotylus turkmenicus* (Fallahzadeh *et al.*, 2016), and hyperparasitoid of *Maconellicoccus hirsutus* (Fallahzadeh *et al.*, 2007), from Iran. *Homalotylus quaylei* (OILB, 1971), as well, Noyes (2019) listed 3, 2 and at least 21 host species of Coccinellidae, Coccidae, and Pseudococcidae, respectively for this wasp.



**Figure 1** A. *Marietta picta* (Female); B. *Aenasius arizonensis* (Female); C. *Anagyrus aligarhensis* (Female); D. *Bothriothorax serratellus* (Male); E. *Homalotylus flaminius* (Female); F. *Leptomastix dactylopii* (Female); G. *Leptomastix mayri* (Female); H. *Prochiloneurus aegyptiacus* (Female); I. *Prochiloneurus rex* (Female); J. *Promuscidea unfasciiventris* (Female); K. *Chartocerus kurdjumovi* (Female).

***Prochiloneurus rex* (Girault, 1920) (Fig. 1-I)**

**Material examined:** Ahvaz: 2 ♀♀, 2 ♂♂, 2018.viii.17; 4 ♀♀, 2 ♂♂, 2018.viii.24; 2 ♀♀, 1 ♂♂, 2018.viii.31; 5 ♀♀, 2 ♂♂, 2018.ix.7; 7 ♀♀, 2 ♂♂, 2018.ix.14; 2 ♀♀, 1 ♂, 2018.ix.21; 4 ♀♀, 1 ♂, 2018.ix.28.

**Morphology and Diagnosis:** see Hayat (2006), however, some specimens studied here differ

from the extralimital material by the absence of basal infuscation in forewing.

**Distribution in Iran:** Khuzestan province (this study).

**Distribution outside Iran:** India, Philippines and Puerto Rico (Noyes, 2019).

**Hosts:** Parasitoid of *A. arizonensis* and hyperparasitoid of *Ph. solenopsis* in Iran (this

study) and *Planococcus citri* and *Pseudococcus citri* (Noyes, 2019).

#### Eriaporidae

***Promuscidea unfasciativentris* Girault, 1917** (Fig. 1-J)

**Material examined:** Ahvaz; 3 ♀♀, 1 ♂, 2018.ix.7; 13 ♀♀, 6 ♂♂, 2018.ix.14; 28 ♀♀, 6 ♂♂, 2018.ix.21; 19 ♀♀, 13 ♂♂, 2018.ix.28; 123 ♀♀, 30 ♂♂, 2018.x.5; 61 ♀♀, 18 ♂♂, 2018.x.12; 3 ♀♀, 2018.x.19.

**Morphology and Diagnosis:** see Hayat (1998).

**Distribution in Iran:** Hormozgan, Fars and Khuzestan provinces (Mossadegh *et al.*, 2015; this study).

**Distribution outside Iran:** Afrotropical and Oriental (Noyes, 2019).

**Hosts:** Parasitoids of *A. arizonensis* and *Anagyrus* sp. (this study). In Iran it is known as parasitoid of Encyrtidae (Mossadegh *et al.*, 2015). Noyes (2019) lists at least 17 species of Hemiptera and at least eight chalcidoids as hosts for this wasp.

#### Signiphoridae

***Chartocerus kurdjumovi* (Nikolskaya, 1950)** (Fig. 1-K)

**Material examined:** Ahvaz: 1 ♀, 2018.vi.29; 4 ♀♀, 1 ♂, 2018.vii.20; 5 ♀♀, 2018.vii.27; 1 ♀, 2018.viii.3; 4 ♀♀, 2 ♂♂, 2018.8.10; 7 ♀♀, 1 ♂, 2018.8.17; 2 ♀♀, 2018.8.24; 5 ♀♀, 3 ♂♂, 2018.8.31; 6 ♀♀, 2 ♂♂, 2018.ix.7; 4 ♀♀, 2018.ix.14; 17 ♀♀, 4 ♂♂, 2018.ix.21; 46 ♀♀, 8 ♂♂, 2018.ix.28; 52 ♀♀, 14 ♂♂, 2018.x.5; 50 ♀♀, 12 ♂♂, 2018.x.12. Bawi (Mollasani): 3 ♀♀, 2 ♂♂, 2017.iv.30; 8 ♀♀, 3 ♂♂, 2017.v.25; 4 ♀♀, 2 ♂♂, 2018.v.8.

**Morphology and Diagnosis:** see Hayat (2009b).

**Distribution in Iran:** Fars (Fallahzadeh *et al.*, 2008), Khuzestan (Asadeh and Mossadegh, 1991, 1993; Novin, 2000; Alizadeh *et al.*, 2013), and East Azarbaijan provinces (Jafari *et al.*, 2015).

**Distribution outside Iran:** Europe and India (Noyes, 2019).

**Hosts:** Parasitoid of *A. arizonensis*, and hyperparasitoid of *Ph. solenopsis* (this study).

In Iran, it is known as parasitoid of *Planococcus ficus* (Fallahzadeh *et al.*, 2008), hyperparasitoid of *Nipaecoccus viridis* (Asadeh and Mossadegh, 1991, 1993; Novin, 2000), and parasitoid or hyperparasitoid of *Pseudococcus comstocki* (Kuwana) (Jafari *et al.*, 2015). Noyes (2019) lists one and at least 13 species of Diptera and Hemiptera, respectively as hosts for this wasp.

#### Discussion

In this study, *Prochiloneurus rex* is recorded for the first time from Iran and three species, viz. *Bothriothorax serratellus*, *Leptomastix dactylopii* and *L. mayri* are reported as new provincial records from Khuzestan. *Marietta picta*, *P. rex*, and *C. kurdjumovi* as hyperparasitoid and *B. serratellus*, *L. dactylopii*, and *L. mayri* are also documented as parasitoids of *Ph. solenopsis*. Similar to this research, several species of natural enemies have been previously reported from the cotton mealybugs (e. g. Mossadegh *et al.*, 2015; Çalışkan *et al.*, 2016) (Table 1); however, it is expected that more species associated with cotton mealybugs will be identified in the future.

Among cotton mealybug's parasitoids, *A. arizonensis* is assumed to be the most important species (Mossadegh *et al.*, 2015), which has been reported as the factor of up to 100% parasitism of *Ph. solenopsis* in Israel (Spodek *et al.*, 2018). Nevertheless, the rates of parasitism are sometimes diminished by hyperparasitoid wasps like *M. picta*, *Prochiloneurus* spp., and *C. kurdjumovi*.

Effort to create an effective biological control program of *Ph. solenopsis* must be accompanied by accurate identification of natural enemies (e.g. parasitoid and predator, etc.) of the pest and the accompanying insects (e. g. hyperparasitoid and parasitoid). It is hoped that this study will make a significant contribution to the development of the biological control program of this serious pest in southwestern Iran and other regions with similar climate.

**Table 1** Insects associated with cotton mealybug *Phenacoccus solenopsis*.

Order	Family	Scientific name	Role
Coleoptera	Coccinellidae	<i>Chilocorus bipustulatus</i> (L.), <i>Clistothethus arcuatus</i> Rossi, <i>Coccinella septempunctata</i> (L.), <i>Cryptolaemus montrouzieri</i> Mulsant, <i>Exochomus nigripennis</i> (Erichson), <i>Hyperaspis polita</i> Weise, <i>H. vinciguerrae</i> (Capara), <i>Nephus arcuatus</i> Kapur, <i>N. includes</i> Kirsch, <i>Nephus</i> near <i>fenestratus</i> , <i>N. nigricans</i> Weise, <i>N. hiekei</i> Fursch, <i>Scymnus pallipes</i> Mulsant, <i>S. argutus</i> Mulsant, <i>S. apetzi</i> Mulsant, <i>S. flavicollis</i> (Redtenbacher), <i>S. levaillanti</i> Mulsant, <i>S. syriacus</i> (Marseul)	Predator
Diptera	Cecidomyiidae	<i>Dicrodiplosis manihoti</i> Harris	Predator
Hemiptera	Anthocoridae	<i>Anthocoris</i> sp.	Predator
Hymenoptera	Aphelinidae	<i>Marietta picta</i> (André, 1878) (this study)	Hyperparasitoid
	Eriaporidae	<i>Promuscidea un fasciiventris</i> Girault, 1917 (this study)	Hyperparasitoid
	Encyrtidae	<i>Aenasius arizonensis</i> (Girault) (= <i>bambawalei</i> Hayat) (this study), <i>Anagyrus agraensis</i> Sarawat, <i>A. aligarhensis</i> Agarwal and Alam (= <i>diversicornis</i> Mercet) (this study), <i>A. dactylopii</i> (Howard), <i>A. near kamali</i> , <i>A. mirzai</i> Agarwal and Alam, <i>A. osmoi</i> Guerrieri and Ghahri, <i>Homalotylus flaminus</i> (Dalman, 1820) (this study), <i>Leptomastix dactylopii</i> Howard, 1885 (this study), <i>L. mayri</i> Özdikmen, 2011 (this study)	Parasitoid
		<i>Bothriothorax serratellus</i> (Dalman, 1820) (this study), <i>Prochiloneurus aegyptiacus</i> (Mercet, 1929) (this study), <i>P. rex</i> (Girault, 1920) (this study)	Hyperparasitoid
	Signiphoridae	<i>Chartocerus kurdjumovi</i> (Nikolskaya, 1950) (this study)	Hyperparasitoid
Neuroptera	Chrysopidae	<i>Chrysoperla carnea</i> (Stephens)	Predator

References: Mossadegh et al. (2015), Guerrieri and Ghahri (2018), this study.

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## زنبورهای بالاخانواده Chalcidoidea (Hymenoptera)، مرتبط با شپشک آردآلود پنبه *Phenacoccus solenopsis* در جنوب غربی ایران

ابراهیم تامولی طرفی<sup>۱</sup>، آرش راسخ<sup>۱\*</sup>، سیدعباس مروج<sup>۱</sup>، محمدسعید مصدق<sup>۱</sup> و علی رجب پور<sup>۲</sup>

۱- گروه گیاه پزشکی، دانشکده کشاورزی، دانشگاه شهید چمران اهواز، اهواز، ایران.

۲- گروه گیاه پزشکی، دانشکده کشاورزی، دانشگاه علوم کشاورزی و منابع طبیعی خوزستان، ملاتانی، اهواز، ایران.

پست الکترونیکی نویسندگان مسئول مکاتبه: a.rasekh@scu.ac.ir

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**چکیده:** یازده گونه زنبور از بالاخانواده Chalcidoidea (Hymenoptera) متعلق به خانواده‌های Aphelinidae، Encyrtidae، Eriaporidae و Signiphoridae مرتبط با شپشک آردآلود پنبه *Phenacoccus solenopsis* (Hemiptera, Pseudococcidae) طی سال‌های ۲۰۱۷ و ۲۰۱۸ میلادی از استان خوزستان واقع در جنوب غربی ایران، جمع‌آوری و شناسایی شدند. زنبور *Prochiloneurus rex* (Encyrtidae) گزارش جدیدی از فون ایران است. همچنین ارتباطات زیستی گونه‌های *Bothriothorax* (Encyrtidae) *L. mayri* و *Leptomastix dactylopii serratellus* (Encyrtidae) به‌عنوان پارازیتوئید و گونه‌های *Marietta picta* (Aphelinidae)، *P. rex* و *Chartocerus kurdjumovi* (Signiphoridae) به‌عنوان هیپرپارازیتوئید شپشک آردآلود پنبه *Phenacoccus solenopsis*، جدید بودند.

**واژگان کلیدی:** شپشک آردآلود پنبه، Chalcidoidea، پارازیتوئیدها، استان خوزستان، جنوب غربی ایران