J. Entomol. Res. Soc., 16(3): 01-10, 2014 *ISSN:1302-0250*

Survey of Natural Enemies of Mealybug Species (Hemiptera, Pseudococcidae) in Kermanshah Province, Western Iran to Inform Biological Control Research

Khatereh JALILVAND[1] Masomeh SHIRAZI[1] Majid FALLAHZADEH [2]*
Hassan Ali VAHEDI[1] Mohammad Amin SAMIH[3] Naser MOEINI NAGHADEH[1]

[1]Department of Plant Protection, College of Agriculture, Razi University, Kermanshah, IRAN
[2]Department of Entomology, Jahrom Branch, Islamic Azad University, Jahrom, IRAN,
[3]Department of Plant Protection, College of Agriculture, Vali-e-Asr University, Rafsanjan, IRAN
*e-mail: mfalahm@yahoo.com

ABSTRACT

A field survey for natural enemies of mealybugs (Hemiptera, Pseudococcidae) in Kermanshah province, Iran was conducted during years 2009-2010. Five primary, two primary/secondary, one secondary parasitoid species, and twelve predator species were collected on five species of Pseudococcidae. The coccinellids *Diomus rubidus* Motsch 1837, *Nephus biflammulatus* (Motschulsky 1837) and *Nephus ulbrichi* Fürsch 1977 are new records for Iran. In addition, two encyrtid species, including *Homalotylus turkmenicus* Myartseva and *Homalotylus eytelweinii* (Ratzeburg) were reared on coccinellid larvae that have been associated with mealybugs colonies. Available ecological and biological information as well as geographical distribution for each species are also included.

Key words: Mealybug, Parasitoids, Hyperparasitoid, Predators, Kermanshah, Iran.

INTRODUCTION

Mealybugs (Hemiptera, Pseudococcidae) comprise one of the largest and most abundant families of Coccoidea with over 2200 species known throughout the world (Ben-Dov *et al*., 2012). Mealybugs are the most universally important insect pest (Ben-Dov, 1994). Their feeding may cause leaf yellowing, defoliation, reduced plant growth and in some cases death of plants. Hundreds of natural enemies contribute to mealybug control (Bartlett, 1978; Noyes and Hayat, 1994). Several species of chalcidoid wasps (Hymenoptera, Chalcidoidea) and coccinellid beetles (Coleoptera, Coccinellidae) have been used or are used today for biological control of various mealybug crop pests in some parts of the world (Noyes and Hayat, 1994; Ben-Dov, 1994; Ben-Dov *et al*., 2012). For example, *Cryptolaemus montrouzieri* Mulsant was introduced into Iran from Spain fifty years ago for the control of *Pseudococcus viburni* (Signoret), a severe pest of *Thea sinensis* (Theaceae) in northern parts of Iran (Chodjai, 1989). Information on the natural enemies associated with mealybugs is mainly limited to collection records (Fallahzadeh and Japoshvili, 2010, 2013). Kiriukhin (1947) provided an initial, but limited, list of mealybug species and their

natural enemies, since then, a lots of studies on mealybug and their natural enemies have made; such as: *Nipaecoccus viridis* (Newstead) (Asadeh and Mossadegh, 1993; Khalaf and Aberoumand, 1989; Novin *et al*., 2000), *Planococcus vovae* (Nasonov) (Lotfalizadeh and Ahmadi, 2000; Talebi *et al*., 2008), *Peliococcus kimmericus* (Kiritshenko) (Fallahzadeh *et al*., 2006a; b), *Maconellicoccus hirsutus* (Green) (Fallahzadeh *et al*., 2007); *Planococcus ficus* (Signoret) (Fallahzadeh *et al*., 2011) and *Phenacoccus solenopsis* Tinsley (Fallahzadeh *et al*., 2013; 2014). The aim of the current work was to conduct a survey to identify the important natural enemies of mealybug species occurring in Kermanshah province, Western Iran, giving a better basis for biological control program of these pests.

MATERIALS AND METHODS

Surveys for parasitoids of mealybugs were conducted on abandoned orchards and wild plants in various districts of Kermanshah province, Western Iran, between the years 2009 and 2010. Mealybugs were collected by using visual examination of different plant parts (e.g., fruit, leaves). In the laboratory, the number of mealybugs per sample was recorded and all mummified mealybugs were individually isolated in 5cm^3 glass vials with ventilated lids and held at room conditions (25 ±2ºC, 30- 40% RH, and 16 h L:8 h D) for 30 days. Parasitoid adults that emerged from mummified hosts were transferred to 70% ethyl alcohol and later slides mounted (by using the method described by Noyes, 1982) and identified (using the keys by Hayat, 1986; Noyes and Hayat, 1994). During field surveys, predators were collected using an aspirator, when observed, or by shaking the plant to dislodge and collect predators in a funnel below. In the laboratory, immature stages of the predators were reared to adult stages, on mealybugs which the predators were collected, to the adult stage for identification (using keys by Majerus, 1994; Harris, 1997). Voucher specimens of predators and parasitoids were deposited in the Plant Protection Department, College of Agriculture, Razi University, Kermanshah, Iran.

RESULTS AND DISCUSSION

Five primary parasitoid, two species that could be either primary or secondary parasitoids, one secondary parasitoid species, and twelve additional predator species were found associated with five species of Pseudococcidae as follows:

Primary Parasitoids:

Hymenoptera, Chalcidoidea, Encyrtidae

Anagyrus pseudococci (Girault, 1915)

Material examined: 24♀♀, 12♂♂, Agriculture College (N: 34° 19’ 32/44”: E: 47° 05’ 56/86”) ex *Planococcus vovae* on *Hesperocyparis arizonica* (Greene) Bartel (Cupressaceae), 24.06.2009; 3♀♀, 1♂, Agriculture College (N: 34° 19’ 40/94”: E: 47° 06’ 08/61”) ex *P. vovae* on *H. arizonica*, 15.08.2009; 5♀♀, Biston Road (N: 34° 22’ 26/49”: E: 47° 25’ 33/55”) ex *Trabutina crassispinosa* on *Tamarix* L. (Tamaricaceae) 12.09.2009; 5♀♀, Agriculture College (N: 34° 19’ 32/44”: E: 47° 05’ 56/86”) ex *P. vovae* on *H. arizonica*, 05.03.2010; 1♂, Kohestan Park (N: 34° 23’ 44/84”: E: 47° 07’ 34/60”) ex *P. vovae* on *H. arizonica*, 18.03.2010; 4♀♀, Agriculture College (N: 34° 19’ 40/94”: E: 47° 06’ 09/61”) ex *P. vovae* on *H. arizonica*, 25.04.2010.

Note: The genus *Anagyrus* Howard, 1896 has nine species in Iran (Fallahzadeh and Japoshvili, 2010; 2013). *Anagyrus pseudococci* is widely distributed in the Iran and it is a common primary parasitoid of *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) on *Ficus carica* L. (Moraceae) (Chodjai, 1968; 1976; 1989), *P. citri* on *Vitis vinifera* L. (Vitaceae) (OILB, 1971), *Nipaecoccus viridis* (Newstead) (Hemiptera, Pseudococcidae) on *Citrus* (Khalaf and Aberoumand, 1986), *Planococcus vovae* (Nasonov) on cypress tree (Cupressaceae) (Xu and Lotfalizadeh, 2000; Lotfalizadeh and Ahmadi, 2000; Talebi *et al*., 2008); *N. viridis* on *Citrus* (Rutaceae) (Hesami and Fallahzadeh, 2004; 2005) and *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) on *M. alba* L. (Moraceae) (Fallahzadeh and Hesami, 2004; Fallahzadeh *et al*., 2007).

Coccidoxenoides perminutus Girault, 1915

Material examined: 18♀♀, Agriculture College (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *Planococcus vovae* on *Hesperocyparis arizonica*, 24.06.2009.

Note: *Coccidoxenoides perminutus* has been reported as primary parasitoid from several armored scale insects (Hemiptera: Diaspididae) and mealybugs species (Hemiptera: Pseudococcidae) (Noyes, 2012). This species has been reported from Iran by Talebi *et al*. (2008) and Lotfalizadeh (2010) as a primary parasitoid of *P. vovae* on cypress tree (Cupressaceae).

Leptomastidea abnormis (Girault, 1915)

Material examined: 1♀, Biston Road (N: 34° 28' 07/96": E: 47° 25' 26/41") ex *Planococcus vovae* on *Cupressus arizonica*, 22.07.2009.

Note: The parasitoid is solitary and has been reported from Europe, Middle East, East Palearctic, Afro-tropical, Australian, Nearctic, Neotropical and North Africa as primary parasitoid of two soft scale insect species (Coccidae) and 25 Pseudococcidae species (Noyes, 2012). *L. histrio* were recorded from *Peliococcus kimmericus* (Kiritshenko) on grape in Fars province, Iran (Fallahzadeh and Japoshvili, 2010).

Leptomastix dactylopii Howard, 1885

Material examined: 4♀♀, 2♂♂, Songhor Road (N: 34° 22' 26/46": E: 47° 25' 33/55") ex *Phenacoccus* sp. on *Euphorbia helioscopia* L. (Euphorbiaceae), 27.08.2009; 1♀, Biston Road (N: 34° 29' 26/36": E: 47° 65' 53/15") ex *Phenacoccus* sp. on *E. helioscopia*, 21.09.2009.

Note: *Leptomastix dactylopii* has been reported from more than 30 different pseudococcid species (Noyes, 2012) up to know. It is best known as a parasitoid of *P. citri* (Tingle and Copeland, 1989; Mani, 1994), although it has been reared from *P. ficus* (Daane *et al*., 2008; Fallahzadeh and Japoshvili, 2010; Fallahzadeh *et al*., 2011).

Leptomastix histrio Mayr, 1876

Material examined: 7♀♀, Agriculture College (N: 34° 19' 30/24": E: 47° 05' 55/71") ex *Chorizococcus* sp. on *Lactuca serriola* L. (Asteraceae), 22.08.2009; 2♀♀, 2♂♂, Agriculture College (N: 34° 19' 30/24": E: 47° 05' 55/71") ex *Chorizococcus* sp. on *L. serriola*, 06.09.2009; 1♀, Songhor Road (N: 34° 28' 07/19": E: 47° 25' 26/41") ex *Chorizococcus* sp. on *Populus trichocarpa* Torr. and A. Gray ex Hook. (Salicaceae), 21.09.2009.

Note: Fallahzadeh *et al*. (2006b) have reported this species as primary parasitoid of *Peliococcus kimmericus* (Kiritshenko) (Hemiptera: Pseudococcidae) on *Lactuca serriola* L. (Asteraceae).

Hyperparasitoids:

Hymenoptera, Chalcidoidea, Aphelinidae

***Marietta picta* (Andre, 1878)**

Material examined: 7♀♀, 3♂♂, Agriculture College (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *Planococcus vovae* on *Hesperocyparis arizonica,* 24.06.2009; 6♀♀, 1♂, Biston Road (N: 34° 23' 44/84": E: 47° 07' 34/60") ex *Phenacoccus* sp. on *Euphorbia helioscopia,* 21 September 2009; 1♀, Kohestan Park (N: 34° 24' 76/49": E: 47° 15' 53/55") ex *P. vovae* on *H. arizonica,* 18.03.2010.

Note: *Marietta picta* is known throughout the Palaearctic region and has also been reported from some parts of Oriental, Neotropical, and Nearctic regions (Hayat, 1986; 1997). This species was previously recorded as a hyperparasitoid of encyrtids attacking pink hibiscus mealybug, *Maconellicoccus hirsutus*, in Fars Province (Fallahzadeh *et al*., 2007).

Hymenoptera, Chalcidoidea, Pteromalidae

***Pachyneuron muscarum* (L. ,1758)**

Material examined: 7♀♀, Biston Road (N: 34° 22' 26/49": E: 47° 25' 33/55") ex *Trabutina crassispinosa* on *Tamarix* L. 12.09.2009.

Note: The genus *Pachyneuron* Walker includes both primary and secondary parasitoids (Viggiani, 1997). *Pachyneuron muscarum* is best known as a hyperparasitoid (Kfir and Rosen, 1981), but has been associated with numerous mealybug and scale species as a primary parasitoid (Fallahzadeh *et al*., 2011).

Hymenoptera, Chalcidoidea, Signiphoridae

***Chartocerus kurdjumovi* (Nikol'skaya, 1950)**

Material examined: 55♀♀, 2♂♂, Agriculture College (N: 34° 19' 30/24": E: 47° 05' 55/71") ex *Planococcus vovae* on *H. arizonica,* 24.06.2009; 5♀♀, Biston Road (N: 34° 23' 53/74": E: 47° 26' 42/22") ex *P. vovae* on *H. arizonica,* 22.07.2009; 1♀, Agriculture College (N; 34° 19' 47/16": E: 47° 06' 58/70") ex *Chorizococcus* sp. on *Lactuca serriola*, 15.08.2009; 6♀♀, Agriculture College (N: 34° 19' 49/81": E: 47° 06' 59/79") ex *Chorizococcus* sp. on *L. serriola,* 06.09.2009.

Note: *Chartocerus kurdjumovi* is a known mealybug parasitoid, including *P. citri* (Noyes, 2012). This species was previously recorded as a hyperparasitoid of *Anagyrus* spp. attacking pink hibiscus mealybug in Fars Province (Fallahzadeh *et al*., 2007). It has also been reported as a secondary parasitoid of both *Anagyrus* and *Leptomastix* species (Fallahzadeh *et al*., 2011; Noyes, 2012).

Predators:

Coleoptera, Coccinellidae

***Coccinula elegantula* (Weise, 1890)**

Material examined: 13♀♀, 8♂♂, Agriculture College (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *Planococcus vovae* on *Cupressus arizonica,* 05.04.2010.

Note: So far as its biology is known in Iran, it has been previously reported in the Southeast of Iran (Kerman Province) as a psyllophagous coccinellid on common

pistachio psylla, *Agonoscena pistaciae* Burkhadt and Lauterer (Hemiptera: Psyllidae) (Mehrnejad, 2010).

Diomus rubidus Motsch, 1837

Material examined: 4♀♀, 12♂♂, Agriculture College (N: 34° 19' 46/55": E: 47° 06' 59/81") ex *Planococcus vovae* on *H. arizonica,* 05.04.2010; 12♂♂ Kohestan Park (N: 34° 23' 48/03": E: 47° 07' 35/61") ex *P. vovae* on *H. arizonica,* 20.06.2010.

Note: *Diomus rubidus* is widespread from Central Asia to the Mediterranean Region (Canepari, 2009) that has been recorded only on *Antonina graminis* (Maskell) among mealybugs species (Gerson *et al*., 1975; Ben-Dov *et al*., 2012). This is a new record for the fauna of Iran and *Planococcus vovae* (Hemiptera, Coccoidea, Pseudococcidae) is a new prey record for this coccinellid.

Exochomus nigromaculatus (Goeze, 1777)

Material examined: 7♀♀, 16♂♂, Biston Road (N: 34° 22' 26/49": E: 47° 25' 33/55") ex *Phenacoccus* sp. on *Euphorbia helioscopia,* 21.09.2010.

Note: The species is widely distributed in south and central Europe, Africa and Asia. It has been recorded as a predator of the mealybug *Ferrisia virgata* (Cockerell) (Ben-Dov *et al*., 2012) and *Trabutina crassispinosa* Borchsenius (Kaydan *et al*., 2012).

Exochomus undulatus Weise, 1878

Material examined: 24♀♀, 18♂♂, Agriculture College (N: 34° 19' 46/55": E: 47° 06' 59/81") ex *Planococcus vovae* on *H. arizonica,* 25.03.2009; 10♀♀, Agriculture College (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *P. vovae* on *H. arizonica,* 28.08.2010.

Note: In Iran, *E. undulates* is known to be a generalist aphidophagous ladybird, and preying on multiple aphid species (Ansari Pour *et al*., 2011) but aphidophagous species take other prey when aphids are rare (Mehrnejad, 2010)

Hyperaspis polita Weise, 1885

Material examined: 15♂♂, Songhor Road (N: 34° 28' 07/19": E: 47° 25' 26/41") ex *Trabutina crassispinosa* on *Tamarix*, 27.08.2009; 6♂♂, Biston Road (N: 34° 22' 26/49": E: 47° 25' 33/55") ex *Phenacoccus* sp. on *Euphorbia helioscopia,* 21.09.2009.

Note: *Hyperaspis polita* is widely distributed in Lebanon and the coastal areas of the Eastern Mediterranean region, Turkey, Iran to Pakistan and dry regions in South Western Asia (Yazdani, 1990; Raimundo and van Harten, 2000; Raimundo *et al*., 2006). It has been recorded as a predator of the mealybug *Nipaecoccus viridis* (Newstead) (Asadeh and Mossadegh, 1993; Novin *et al*., 2000; Hesami and Fallahzadeh, 2004), *Planococcus vovae* (Nasonov) (Lotfalizadeh and Ahmadi, 2000), *Maconellicoccus hirsutus* (Green) (Fallahzadeh and Hesami, 2004), *Planococcus ficus* (Signoret) (Fallahzadeh *et al*., 2011) and *Phenacoccus solenopsis* (Fallahzadeh *et al*., 2013).

Nephus biflammulatus (Motschulsky, 1837)

Material examined: 11♀♀, 3♂♂, Agriculture College (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *Planococcus vovae* on *H. arizonica,* 23.08.2009.

Note: *Nephus biflammulatus* is a species of ladybird native to Caucasus (Fürsch, 1965). This is a new record for the fauna of Iran. Still, there are no published records

on *N. biflammulatus* as predator of any mealybug species, and this is the first record of *N. biflammulatus* attacking *P. vovae*.

Nephus bipunctatus (Kugelann, 1794)

Material examined: 9♀♀, 4♂♂, Biston Road (N: 34° 22' 26/49": E: 47° 25' 33/55") ex *Phenacoccus* sp. on *Euphorbia helioscopia,* 21.09.2009.

Note: *Nephus bipunctatus* is a common and widely distributed coccinellid species in Iran. A wide prey range has been reported for this species but in Iran it is mostly a predator of mealybug species including *Planococcus vovae* (Lotfalizadeh and Ahmadi, 2000); *Peliococcus kimmericus* (Fallahzadeh *et al*., 2006a); *Chorizococcus viticola* Kaydan and Kozár (Fallahzadeh *et al*., 2010) and *Planococcus ficus* (Fallahzadeh *et al*., 2011).

Nephus ulbrichi Fursch, 1977

Material examined: 13♀♀, 12♂♂, Kohestan Park (N: 34° 23' 44/84": E: 47° 07' 34/60") ex *Planococcus vovae* on *H. arizonica,* 18.03.2010.

Note: This species was hitherto known only from Spain, Greece and Turkey (Fürsch and Uygun, 1980). This is a new record for the fauna of Iran and *Planococcus vovae* is a new prey record for this coccinellid.

Oenopia conglobata (L., 1758)

Material examined: 16♀♀, 4♂♂, Tagh Bostan (N: 34° 23' 11/56": E: 47° 07' 53/34") ex *Planococcus ficus* on *Platanus orientalis* L. (Plantanaceae)*,* 22.07.2010.

Note: *Oenopia conglobata* is a species native to Asia, Europe and Africa that has been recorded as a predator of *Matsucoccus feytaudi* Ducasse (Hemiptera, Matsucoccidae) (Covassi *et al*., 1991). In Iran, it is generally reported as a psyllophagous coccinellid (Mehrnejad, 2010).

The majority of the Coccinellidae, also known as ladybird-beetles or ladybugs, are predatory and among their prey are many important pests of agricultural crops, especially belonging to the superfamilies Aphidoidea (aphids), Coccoidea (scale insects), Psylloidea (jumping plantlice) and Aleyrodoidea (whiteflies) (Raimundo *et al*., 2008). Members of the coccinellid are questionably one of the most useful groups in biological control, whereas several species of them are used in biological control programs of scale insect species (Majerus, 1994), particularly on the mealybugs (Ben-Dov *et al*., 2012). In our survey, each species was directly observed feeding on eggs, nymphs, and adults of mentioned mealybug species. More work is needed to document the effectiveness of the lady beetles, as mealybug predators.

Two encyrtid species (*Homalotylus turkmenicus* Myartseva and *H. eytelweinii* (Ratzeburg)) were reared from coccinellid larvae and they reduced the effectiveness of these predators. Several species of *Homalotylus* Mayr were previously reported from Iran (e.g., Lotfalizadeh and Ahmadi, 2000; Japoshvili and Noyes, 2005; Fallahzadeh *et al*., 2006a; Talebi *et al*., 2008; Fallahzadeh and Japoshvili, 2010).

Diptera, Cecidomyiidae

***Dicrodiplosis manihoti* Harris, 1981**

Material examined: 3♀♀, Agriculture College (N: 34° 19' 30/24": E: 47° 05' 55/71") ex *Chorizococcus* sp. on *Lactuca serriola,* 22.08.2009; 2♂♂, Agriculture college (N: 34° 19' 32/44": E: 47° 05' 56/86") ex *Planococcus vovae* on *H. arizonica,* 23.08.2009; 14♂♂ Agriculture College (N: 34° 19' 30/24": E: 47° 05' 55/71") ex *Chorizococcus* sp. on *L. serriola,* 06.09.2009; 6♀♀, 20♂♂, Sarab Nilofar (N: 34° 24' 30/14" : E: 46° 51' 06/58") ex *P. vovae* on *H. arizonica,* 6.6.2010; 5♀♀, Agriculture College (N: 34° 19' 34/03": E: 47° 05' 51/08") ex *P. vovae* on *Asparagus officinalis* L. (Liliaceae), 15.09.2010.

Note: The family Cecidomyiidae is biologically diverse and widespread (Harris and Harten, 2006). Many cecidomyiid species are important mealybug predators (Harris, 1997). In this survey, larvae of *Dicrodiplosis manihoti* were observed feeding on egg masses of mentioned mealybug species.

Neuroptera, Chrysopidae

***Chrysoperla sillemi* Esben-Petresen, 1935**

Material examined: 1♀, 7♂♂, Biston Road (N: 34° 22' 26/49": E: 47° 25' 33/55") ex *Phenacoccus* sp. on *Euphorbia helioscopia,* 21.09.2009.

Neuroptera, Hemerobiidae

***Wesmaelius* sp.**

Material examined: 6♀♀, Kohestan Park (N: 34° 23' 44/84": E: 47° 07' 33/65") ex *Planococcus vovae* on *H. arizonica,* 18.03.2010; 1♀, Sarab Nilofar (N: 34° 24' 30/52": E: 46° 55' 06/53") ex *P. vovae* on *H. arizonica,* 6.06.2010.

Note: Insects belonging to families Chrysopidae (green lacewings) and Hemerobiidae (brown lacewings) of the order Neuroptera are well-known predators of small arthropods, including scale insects that inhabit plant surfaces (Miller *et al*., 2006). First instar larvae of green lacewing, *Chrysoperla carnea* (Stephens) were shown to suppress *Nipaecoccus viridis* (Newstead) (Hemiptera, Pseudococcidae) on citrus in southern Iran (Zakerin *et al*., 2009). Lacewing larvae are effective predators of smaller mealybugs. They may have a difficulties feeding on eggs in the mealybug ovisac where waxy secretions provide some protection from the predator. Larger mealybugs excrete an ostiolar fluid that can act as a defensive mechanism. Native brown and green lacewing species are often overlooked while *C. carnea* has received more attention (Daane *et al*., 2012). Larvae of *Chrysoperla sillemi* and *Wesmaelius* sp. were observed feeding on nymphs and adults of mentioned mealybug species. Still, there are no published records on *Chrysoperla sillemi* as a biological control agent, and this is the first record of *Chrysoperla sillemi* attacking on mealybug.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. Chris Hodgson (Department of Biodiversity and Biological Systematics, The National Museum of Wales, Cathay's Park, Cardiff), Dr. J.

Noyes (Natural History Museum, London), Dr. A. Polaszek (Natural History Museum, London), Dr. M. Doğanlar (Mustafa Kemal University, Turkey), Dr. H. Fürsch (Kormoran University, Germany) and Dr. A. N. Mirmoayedi (Razi University, Kermanshah, Iran) for invaluable help with the project. The research was supported by Razi University, Kermanshah, Iran

REFERENCES

Ansari Pour, A., Vafaei-Shoushtari, R., Shakarami, J., 2011, Study of faun ladybirds (Col., Coccinellidae) in Khorramabad district. *Journal of Entomological Research*, 3(2): 103-117.

Asadeh, G. A., Mossadegh, M. S., 1993, Important natural enemies of mealybugs (*Pseudococcus* spp.) in the Khuzestan province Iran. *Scientific Journal of Agriculture Shahid Chamran University,* 16(1, 2): 46-52.

Bartlett, B. R., 1978, *Pseudococcidae*. *In*: Clausen, C. P., (Ed.). Introduced Parasites and Predators of Arthropod Pests and Weeds: a World Review. Agricultural Research Service, United States Department of Agriculture, Washington, D.C., 137-170.

Ben-Dov, Y., 1994, *A Systematic Catalogue of the Mealybugs of the World (Insecta: Homoptera: Coccoidea: Pseudococcidae and Putoidae) with Data on Geographical Distribution, Host Plants, Biology and Economic Importance*. Intercept Ltd., Andover, U.K., 686.

Ben-Dov, Y., Miller, D. R., Gibson, G. A. H., 2012, ScaleNet. Available on: http://www.sel.barc.usda.gov/scalenet/scalenet.htm (12.10.2012).

Canepari, C., 2009, New data on some Coccinellidae (Coleoptera) from the Mediterranean Region, *Zootaxa*, 2318: 394-399.

Chodjai, M., 1968, Résultats de l'étude faunistique des Hyménoptères parasites (Terebrants) en Iran et l'importance de leur utilisation dans la lutte biologique. *Proceedings of the first Iranian Plant Protection Congress*, 13-18 September 1968 Karaj, Tehran University, Iran, 25-35.

Chodjai, M., 1976, *Entomology (Ontogeny and Biology)*. Tehran University Publishing, Iran, 2: 207.

Chodjai, M., 1989, *Entomology (Ethology, Social Life and Natural Enemies) (Biological Control)*, Second Edition, Tehran University Publishing, Iran, 3: 406.

Covassi, M., Binazzi, A., Toccafondi, P., 1991, Studies on the entomophagous predators of *Matsucoccus* Cock. in Italy I. Faunistical and ecological notes on species found in pine stands of Liguria and Tuscany. *Redia*, 74(2): 575-597.

Daane, K. M., Cooper, M. L., Triapitsyn, S.V., Walton, V. M., Yokota, G. Y., Haviland, D. R., Bentley, W. J., Godfrey, K. E., Wunderlich, L. R., 2008, California vineyard managers and researchers seek sustainable solutions for mealybugs, a changing pest complex. *California Agriculture*, 62: 167-176.

Daane , K. M., Almeida, R. P. P., Bell, V. A., Walker, J. T. S., Botton, M., Fallahzadeh, M., Mani, M., Miano, J. L., Sforza, R., Walton, V. M., Zaviezo, T., 2012, *Biology and Management of Mealybugs in Vineyards. In*: Bostanian, N. J., Vincent, C., Isaacs, R. (Eds.). Arthropod Management in Vineyards: Pests, Approaches, and Future Directions. Springer, Dordrecht, Heidelberg, New York and London, 271-307.

Fallahzadeh, M., Hesami, S., 2004, Study of the natural enemies of *Maconellicoccus hirsutus* (Homoptera: Pseudococcidae) in Jahrom region of Fars province. *Proceeding of the 16th Plant Protection Congress of Iran*, Tabriz 28 August-1 September 2004 Tabriz, University of Tabriz, Iran, 47.

Fallahzadeh, M., Japoshvili, G., 2010, Checklist of Iranian Encyrtids (Hymenoptera: Chalcidoidea) with descriptions of new species. *Journal of Insect Science,* 10(68): 1-24.

Fallahzadeh, M., Japoshvili, G., 2013, Corrections to the List of Encyrtidae (Hymenoptera: Chalcidoidea) from Iran. *Journal of the Entomological Research Society*, 15(2): 117-121.

Fallahzadeh, M., Kaydan, M. B., Kozár, F., 2010, Description of a new species of *Chorizococcus* (Hemiptera: Coccoidea: Pseudococcidae) infesting *Vitis vinifera* in Iran. *Türkiye Entomoloji Dergisi*, 34(2): 157-163

Fallahzadeh, M., Shojaei, M., Ostovan, H., Kamali. K., 2006a, The first report of two parasitoid wasps on the larvae of *Nephus bipunctatus* (Col.: Coccinellidae) from Iran. *Journal of Entomological Society of Iran,* 26(1): 95-96.

Fallahzadeh, M., Shojaei, M., Ostovan, H., Kamali. K., 2006b, The first report of four parasitoid wasps on *Peliococcus kimmericus* (Hem.: Pseudococcidae) from Iran. J*ournal of Entomological Society of Iran,* 26(1): 97-98.

Fallahzadeh, M., Shojaei, M., Ostovan, H., Kamali. K., 2007, Study of the parasitoids and hyperparasitoids of *Maconellicoccus hirsutus* (Hem., Pseudococcidae) in Fars province, *Journal of Agricultural Sciences, Islamic Azad University*, 13(3): 593-609.

Fallahzadeh, M., Japoshvili, G., Saghaei, N., Daane, K. M., 2011, Natural enemies of *Planococcus ficus* (Hemiptera: Pseudococcidae) in Fars province vineyards, Iran. *BioControl Science and Technology*, 4: 427- 433.

Fallahzadeh, M., Japoshvili, G., Abdimaleki, R., Saghaei, N., 2014, New records of Tetracneminae (Hymenoptera, Chalcidoidea, Encyrtidae) from Iran. *Turkish Journal of Zoology*, 38: 515-518.

Fürsch, H., 1965, Die palaearktischen Arten der *Scymnus-bipunctatus*-Grappe und die europaischen Vertreter der Untergattung *Sidis* (Col. Cocc.). *Mitteilungen Der Muenchener Entomologischen Gesellschaft*, 55: 178-213.

Fürsch, H., Uygun, N., 1980, Neue Scymnini aus der Türkei (Coleoptera: Coccinellidae). *Sonderdruck aus dem Nachrichtenblatt der Bayerischen Entomologen*, 29(3): 189-202.

Gerson, U., Mescheloff, E., Dubitzki, E., 1975, The introduction of *Neodusmetia sangwani* (Rao) (Hymenoptera: Encyrtidae) into Israel for the control of the Rhodes-grass scale, *Antonina graminis* (Maskell) (Homoptera: Pseudococcidae). *Journal of Applied Ecology*, 12: 767-779.

Harris, K. M., 1997, *Cecidomyiidae and other Diptera*. *In*: Ben-Dov, Y., Hodgson, C. J. (Eds.). Soft Scale Insects - Their Biology, Natural Enemies and Control, Amsterdam, Elsevier, 7(B): 61-68.

Harris K. M., Harten, A., 2006, Records of predaceous Cecidomyiidae (Diptera) on mealybugs (Homoptera: Pseudococcidae) in Yemen*. Fauna of Arabia*, 21: 351-356.

Hayat, M., 1986, Notes on some species of *Marietta* (Hymenoptera: Aphelinidae), with a key to world species. *Colemania*, 2: 1-18.

Hayat, M., 1997, *Aphelinidae*. *In*: Ben-Dov, Y., Hodgson, C. J. (Eds.). Soft Scale Insects - Their Biology, Natural Enemies and Control. Amsterdam, Elsevier, 7(B): 111-145.

Hesami, S., Fallahzadeh, M., 2004, Study of the natural enemies of the citrus mealybug *Nipaecoccus viridis* (Homoptera: Pseudococcidae) in Jahrom region of Fars province. *Proceeding of the 16th Plant Protection Congress of Iran*, Tabriz 28 August-1 September 2004 Tabriz, University of Tabriz, Iran, 50.

Hesami, S., Fallahzadeh, M., 2005, Recorded species of mealybug parasitoids of the genus *Anagyrus* (Hymenoptra; Encyrtidae) from Fars province of Iran. *Caspian Journal of Environmental Sciences*, 3(1): 63-68.

Japoshvili, G. O., Noyes, J. S., 2005, New record of Encyrtidae (Hymenoptera: Chalcidoidea). *Caucasian Entomological Bulletin*, 1(2): 159-160.

Kaydan, M. B., Atlihan, R., Uygun, N., Senal, D., 2012, Coccinellid (Coleoptera: Coccinellidae) species feeding on Coccoids (Hemiptera: Coccoidea) in Van Lake Basin, Turkey. *Türkiye Biyolojik Mücadele Derneği*, 3(1): 37-46.

Kfir, R., Rosen, D., 1981, Biology of the hyperparasite *Pachyneuron concolor* (Hymenoptera: Pteromalidae) reared on *Microterys flavus* in soft brown scale. *Journal of the Entomological Society of Southern Africa*, 44: 151-164.

Khalaf, J., Aberoomand, G., 1989, Preliminary research on the biology and biological control of mealybug in Fars Province of Iran. *Applied Entomology and Phytopathology*, 56(1-2): 93-99.

Kiriukhin, G., 1947, Les cochenilles farineuses et leurs parasites en Iran (sousfamille: Pseudococcinae). *Ministère de l'Agriculture, Entomologie et Phytopathologie Appliquées*, 4: 1-17.

Lotfalizadeh, H., 2010, Some new data and corrections on Iranian encyrtid wasps (Hymenoptera: Chalcidoidea, Encyrtidae) fauna. *Biharean Biologist,* 4(2): 173-178.

Lotfalizadeh, H., Ahmadi, A. A., 2000, Natural enemies of cypress tree mealybug, *Planococcus vovae* (Nasonov), and their parasitoids in Shiraz, Iran. *Iran Agricultural Research,* 19(2): 145-154.

Majerus, M. E. N., 1994, Ladybirds, London, UK, Hopper Collins, 320.

Mani, M., 1994, Effectiveness of the exotic encyrtid parasitoid, *Leptomastix dactylopii* How., in the control of mealybug, *Planococcus citri* (Risso), in guava orchards. *Journal of Entomological Research*, 18: 351-355.

Mehrnejad, R., 2010, Potential Biological Control Agents of the Common Pistachio Psylla, *Agonoscena pistaciae*, a review, *Entomofauna*, 31(21): 317-340.

Miller, G. L., Oswald, J. D., Miller, D. R., 2004, Lacewings and scale insects: A review of predator/prey associations between the Neuropterida and Coccoidea *Annals of the Entomological Society of America,* 97: 1103-1125.

Novin, M., Mossadegh, M. S., Karami Nejad, M., Ghasemi Nejad, M., 2000, Natural enemy of Nipaecoccus viridis in the North of Khuzestan. *Proceedings of the 14th Iranian Plant Protection Congress*, Isfahan, 5-8 September 2000 Isfahan, Isfahan University of Technology, Iran, 264.

Noyes, J. S., 1982, Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). *Journal of Natural History*, 16: 315-334.

Noyes, J. S., 2012, Universal Chalcidoidea Database. World Wide Web electronic publication. Available on: www.nhm.ac.uk/entomology/chalcidoids/index.html (12.10. 2012).

Noyes, J. S., Hayat, M., 1994, *Oriental mealybug parasitoids of the Anagyrini (Hymenoptera: Encyrtidae)*. CAB International, Wallingford, U.K., 8: 554.

OILB, 1971, *Liste d'identification des entomophages*. OILB, Genève, 8: 1-64.

Raimundo, A. A. C., van Harten, A., 2000, An annotated checklist of Coccinellidae (Insecta: Coleoptera) of Yemen. *Fauna of Arabia*, 18: 211-243.

Raimundo, A. C., Fürsch, H., van Harten, A., 2008, *Order Coleoptera, family Coccinellidae*. *In*: van Harten, A., (Ed.). Arthropod Fauna of the UAE. Volume 1. Dar Al Ummah Printing, Adu Dhabi, UAE, 217-239.

Talebi, A. A., Ameri, A., Fathipour, Y., Rakhshani, E., 2008, Natural enemies of Cypress tree mealybug, *Planococcus vovae* (Nasonov) (Hem., Pseudococcidae), and their parasitoids in Tehran, Iran. *Journal of Agricultural Science and Technology,* 10(2): 123-133.

Tingle, C. C. D., Copland, M. J. W., 1989, Progeny production and adult longevity of the mealybug parasitoids *Anagyrus pseudococci*, *Leptomastix dactylopii*, and *Leptomastidea abnormis* (Hym.: Encyrtidae) in relations to temperature. *Entomophaga*, 34: 111-120.

Viggiani, G., 1997, *Eulophidae, Pteromalidae, Eupelmidae and Signiphoridae*. *In*: Ben-Dov, Y., Hodgson, C. J. (Eds.). Soft Scale Insects - Their Biology, Natural Enemies and Control, Amsterdam, Elsevier, 7(B): 147-158.

Xu, Z., Lotfalizadeh, H., 2000, Notes on eight species of Encyrtidae (Hymenoptera: Chalcidoidea) from Iran with a description of one new species. *Entomotaxonomia*, 22(1): 61-64.

Yazdani, A., 1990, The coccinellids (Col.; Coccinellidae) Fauna of Fars province. M. Sc. Thesis, Shiraz University, 145 pp.

Zakerin, A., Zibaiee, K., Fallahzadeh, M., 2009, To study the biological control of *Nipaecoccus viridis* (Hem., Pseudococcidae) by *Chrysoperla carnea* (Neu., Chrysopidae) in citrus orchards of Jahrom, Fars province-Iran. *Plant Protection Journal, Islamic Azad University, Shiraz Branch,* (Iran) 1(2): 126-139.

Received: January 3, 2013 *Accepted: August 29, 2014*