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Özgün makale (Original article)

Natural enemies of *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae) on vineyards in Diyarbakır, Mardin and Elazığ Provinces, Türkiye

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Diyarbakır, Mardin ve Elazığ İlleri üzüm bağlarında *Planococcus ficus* (Signoret)'un (Hemiptera: Pseudococcidae) doğal düşmanları

Öz: *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), Akdeniz bölgesi genelinde bağların önemli bir zararlısıdır. Bu çalışmada, Türkiye'de Diyarbakır, Mardin ve Elazığ illerindeki çeşitli lokalitelerde *P. ficus*'un yoğun populasyonlarına rastlanmış ve bağlarda ciddi zararlara yol açtığı belirlenmiştir. Zararlı ile ilişkili doğal düşmanları belirlemek amacıyla arazi sürveyleri gerçekleştirilmiştir. Çalışma sonucunda, Hymenoptera takımına bağlı Encyrtidae familyasına ait sekiz parazitoit türü, bir coccinellid parazitoiti ile Aphelinidae ve Eulophidae familyalarına ait üç hiperparazitoit türü tespit edilmiştir. Hiperparazitoitlerin, P. ficus'un birincil parazitoitlerini parazitlediği gözlenmiştir. Belirlenen en yaygın parazitoit türleri *Anagyrus dactylopii* (Howard) (%12,23), *Anagyrus pseudococci* (Girault) (%5,88) ve *Coccidoxenoides perminutus* (Girault) (%2,58) olmuştur. Ayrıca, hiperparazitoit *Marietta picta* (André)'nın farklı Planococcus parazitoit türleri üzerinde %15,76 oranında bulunduğu saptanmıştır. Bunun yanı sıra, yedi Coccinellidae, bir Chrysopidae, iki Hemerobiidae ve bir Cecidomyiidae türü olmak üzere çeşitli predatör böcek türleri de belirlenmiştir. Özellikle, *Gyranusoidea hecale* (Noyes & Hayat) (Encyrtidae) ve *Sympherobius domesticus* (Nakahara) (Hemerobiidae) türleri Türkiye'den ilk kez bu çalışma ile rapor edilmektedir.

Anahtar sözcükler: Parazitoit, Avcı, Biyolojik Mücadele, Unlubit, Türkiye

Abstract: *Planococcus ficus* (Signoret) (Hemiptera: Coccomorpha: Pseudococcidae) is a major pest of vineyards across the Mediterranean region. In the present study, intensive infestations of *P. ficus* were detected in several localities, causing serious damage to vineyards in the provinces of Diyarbakır, Mardin, and Elazığ in Türkiye. Surveys were conducted to identify the natural enemies associated with this pest. The study revealed the presence of eight parasitoid species belonging to the family Encyrtidae (Hymenoptera), one coccinellid parasitoid and three hyperparasitoid species within the families Aphelinidae and Eulophidae. Hyperparasitoids were observed to parasitise the primary parasitoids of *P. ficus*. The most common parasitoid species identified were *Anagyrus dactylopii* (Howard) (12.23%), *Anagyrus pseudococci* (Girault) (5.88%), and *Coccidoxenoides perminutus*

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(Girault) (2.58%). In addition, the hyperparasitoid *Marietta picta* (André) was found at a rate of 15.76% on different *Planococcus* parasitoid species. Several predatory insects were also identified, including seven species from Coccinellidae, one from Chrysopidae, two from Hemerobiidae, and one from Cecidomyiidae. Notably, *Gyranusoidea hecale* (Noyes & Hayat) (Encyrtidae) and *Sympherobius domesticus* (Nakahara) (Hemerobiidae) are reported here for the first time from Türkiye.

Keywords: Parasitoids, Predators, Biological Control, Mealybugs, Türkiye

Introduction

Viticulture is a globally significant and economically valuable agricultural activity, serving purposes ranging from fresh and dried fruit production to winemaking (Chervin et al. 2012). Worldwide, vineyards occupy approximately 7.1 million hectares with an estimated export value of 7.8 billion USD (FAOSTAT 2018). According to FAO data (Anonymous 2025), Türkiye ranks sixth in global grape production. Around 71% of the world's grape yield is used for wine, while 27% is consumed fresh and 2% is processed as dried fruit (Gupta et al. 2015). Viticulture is an important activity in Türkiye. Fifty percent of the grapes produced in Türkiye are used for table grapes, 38% for raisins, and 12% for wine and juice (Akşit 1981). When looking at the vineyard areas of provinces in Türkiye, Mardin ranks second, Diyarbakır sixth, and Elazığ tenth among the provinces where the study was conducted (Anonymous 2025).

The vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Coccomorpha: Pseudococcidae), is among the most destructive pests in major grape-producing regions such as Argentina, California, southern Europe, Mediterranean Africa, Mexico, and South Africa (Daane et al. 2004; Daane et al. 2012; Franco et al. 2009; García Morales et al. 2016; Mansour et al. 2017; Varikou et al. 2010; Walton 2003). It infests various parts of the grapevine, including roots, trunks, canes, leaves, and fruit (Haviland et al. 2005). The pest inflicts direct damage by feeding on plant sap, leading to leaf drop, dieback, and, in severe cases, plant death (Walton & Pringle 2004). Indirect damage occurs through honeydew secretion, which promotes sooty mould growth and reduces the marketability of table grapes (Wood 1963). Additionally, *P. ficus* acts as a vector of several grapevine viruses, including GLRaV-1, 3, 4, 5, and 9, *Grapevine virus A*, and *Grapevine virus B* (Tanne et al. 1989; Tsai et al. 2010; Daane et al. 2018).

Chemical control of *P. ficus* relies mainly on repeated applications of synthetic insecticides—particularly organophosphates and neonicotinoids—throughout the growing season (Walton et al. 2004, 2006; Daane et al. 2012). However, these substances often cause harmful effects on non-target organisms and pollinators (Mansour et al. 2018). Although systemic insecticides like spirotetramat have shown efficacy against *P. ficus* without affecting beneficial fauna (Brück et al. 2009; Mansour et al. 2018), chemical control remains inconsistent because mealybugs often inhabit concealed areas such as beneath bark or underground roots (Walton & Pringle 2004; Sharon et al. 2016).

Excessive reliance on pesticides can also diminish populations of natural enemies, thereby weakening the potential for biological control (Walton & Pringle 2004).

Consequently, Integrated Pest Management (IPM) approaches have been increasingly adopted worldwide. IPM combines biological, cultural, and chemical strategies while emphasising ecological balance (Mizell III & Short 2016). Natural enemies play a crucial role in suppressing *P. ficus* populations in vineyards across the Mediterranean, North America, and South Africa (Gutierrez et al. 2008; Walton & Pringle 2004). However, data on the biological control of *P. ficus* in Türkiye remain limited. Japoshvili et al. (2018) reported the parasitoid complex of *P. ficus* in Adana and Mersin provinces, identifying five primary, two facultative, and two secondary parasitoid species, including *Clausenia josefi* Rosen and *Chartocerus kurdjumovi* (Nikol'skaya) as new records for the Turkish fauna.

The present study aimed to identify the natural enemies of *P. ficus* in vineyards in Diyarbakır, Mardin, and Elazığ provinces, contributing to the understanding its biological control potential in Türkiye.

Materials and Methods

Field Survey

This research primarily focused on identifying predators and parasitoids associated with *Planococcus ficus* (Signoret) populations in the provinces of Diyarbakır, Mardin, and Elazığ, Türkiye, between 2022 and 2024. Surveys were conducted on 425 vineyards covering an area of 1527 Ha.. Parasitoids were obtained from 76 of the surveyed vineyards. Field surveys were conducted weekly throughout the grape production season. Infested plant parts, such as shoots, branches, and leaves, were pruned and collected into paper and polyethene bags, then transported to the laboratory in insulated containers to preserve sample integrity.

Identification

For identification, portions of the mealybug samples were stored in Eppendorf tubes containing 70% ethyl alcohol. The remaining material was transferred to specialised rearing jars and placed inside climate chambers maintained at 26 ± 1 °C, 50 ± 5% relative humidity, and a 16:8 h (light:dark) photoperiod to enable parasitoid emergence after host removal. Emerging parasitoids were collected in transparent 8-litre storage boxes, whose lids were covered with fine tulle mesh to prevent escape. Adult parasitoids were retrieved using aspirators directed toward a light source, phototaxis. The collected specimens were preserved in 70% ethanol at −20 °C for morphological identification. Samples were sent to Prof. Dr George Japoshvili (Agricultural University of Georgia) for confirmation. Species identification was performed using standard taxonomic keys (Trjapitzin 1989; Noyes & Hayat 1994; Nikolskaya & Yasnosh 1966).

Two complementary approaches were used to collect predatory insects. The first consisted of direct field observations, recording species feeding on *P. ficus* individuals. The second involved rearing immature predators in transparent containers with live *P. ficus* and supplemental food adulthood. All predator specimens were catalogued and deposited in the entomological collection of the Diyarbakır Plant Protection Research Institute.

Results

Field surveys conducted in the vineyards of Diyarbakır, Mardin, and Elazığ provinces revealed the presence of eight primary parasitoid species and one coccinellid parasitoid, all belonging to the family Encyrtidae (Hymenoptera) and associated with *Planococcus ficus*. Additionally, one hyperparasitoid species from the family Aphelinidae and two from the family Eulophidae were identified (Table 1).

Table 1. Primary and secondary parasitoids, as well as coccinellid parasitoids, parasitise individuals of *Planococcus ficus*

Order	Family	Species	Host association
HYMENOPTERA	*Encyrtidae*	*Anagyrus dactylopii (Howard)*	*Primary parasitoid*
		Anagyrus pseudococci (Girault)	*Primary parasitoid*
		Coccidoxenoides perminutus (Girault)	*Primary parasitoid*
		Prochiloneurus bolivari (Mercet)	*Primary parasitoid*
		Leptomastix dactylopii (Howard)	Primary parasitoid
		Leptomastidea bifasciata (Mayr)	Primary parasitoid
		Dusmetia fuscipennis (Noyes&Hayat)	Primary parasitoid
		*Gyranusoidea hecale** (Noyes&Hayat)	Primary parasitoid
		Homalotylus albiclavatus (Agarwal)	Primary parasitoid - coccinellids
	Aphelinidae	*Marietta picta* (Andre)	Secondary parasitoid
	Eulophidae	*Aprostocetus* sp. (Kostjukov)	Secondary parasitoid
		Cirrospilus sp. (Westvood)	Secondary parasitoid

*New record for the Turkish fauna

In the section of the study determining natural parasitism rates, 53% of the emerging parasitoids were identified as *Anagyrus* sp.; 30% as *Marietta picta*; 11% as *Coccidoxenoides perminutus*; 3% as *Aprostocetus* sp.; 2% as *Leptomastix dactylopii*; and 1% as *Leptomastidea bifasciata* (Table 1).

Among these species, *Gyranusoidea hecale* (Noyes & Hayat) was recovered from parasitised *P. ficus* individuals collected exclusively from the Hoşköy location in Elazığ Province (N 38°38′35″, E 39°23′28″) (Figure 1.). The hyperparasitoid *Marietta picta* (André), which negatively influences biological control by parasitising primary parasitoids, was found to be widespread in the surveyed

vineyards, with an infestation rate of 15.76%. This species is distributed across most of the Palaearctic region and parts of the Oriental, Neotropical, and Nearctic zones.

Figure 1. General wiew of *Gyranusoidea hecale* (Original)

Surveys targeting mealybugs in vineyard ecosystems also revealed a diverse complex of predatory species feeding on *P. ficus*. Seven species of Coccinellidae (Coleoptera) were recorded at different developmental stages. Additionally, one species from Reduviidae and another from Miridae (Hemiptera) were identified as mealybug predators. The study also documented one Chrysopidae and two Hemerobiidae species (Neuroptera), and a single member of the Cecidomyiidae family (Diptera) (Table 2).

Table 2. Predatory species feed on *Planococcus ficus*

Order	Family	Species	Host association
HEMIPTERA	Reduviidae	*Zelus renardi* (Kolenati)	Mealybug predator
	Miridae	*Deraeocoris punctulatus* (Fallen)	Mealybug predator
COLEOPTERA	Coccinellidae	*Exochomus nigromaculatus* (Goeze)	Mealybug predator
		Coccinella septempunctata (Linneaus)	Mealybug predator
		Hippodamia variegata (Goeze)	Mealybug predator
		Oenopia conglobata (Linneaus)	Mealybug predator
		Scymnus mediterraneus (Khnzorian)	Mealybug predator
		Nephus nigricans (Weise)	Mealybug predator
		Stethorus gilvifrons (Mulsant)	Mealybug predator
NEUROPTERA	Chrysopidae	*Chrysoperla carnea* (Stephens)	Mealybug predator
	Hemerobiidae	*Sympherobius pygmaeus* (Rambur)	Mealybug predator
		*Sympherobius domesticus** (Nakahara)	Mealybug predator
DIPTERA	Cecidomyiidae	*Dicrodiplosis manihoti* (Harris)	Mealybug predator

*New record for the Turkish fauna

Coccinellid beetles were particularly abundant in areas where *P. ficus* populations were dense. The collected species, including *Exochomus nigromaculatus* (Goeze), *Coccinella septempunctata* (Linnaeus), *Hippodamia variegata* (Goeze), *Oenopia conglobata* (Linnaeus), *Scymnus mediterraneus* (Khnzorian), *Nephus nigricans* (Weise), and *Stethorus gilvifrons* (Mulsant), were observed actively feeding on various developmental stages of *P. ficus*.

Neuropteran predators, well known for their voracious predatory behaviour, were represented by *Chrysoperla carnea* (Stephens), *Sympherobius pygmaeus* (Rambur), and *Sympherobius domesticus* (Nakahara). The latter species is newly recorded for the Turkish fauna in this study (Figure 2.).

Figure 2. General wiew of *Sympherobius domesticus* (Original)

Polyphagous hemipteran predators, such as *Zelus renardii* (Kolenati) and *Deraeocoris punctulatus* (Fallen), were also observed feeding on *P. ficus* individuals. Moreover, larvae of *Dicrodiplosis manihoti* (Harris) (Diptera: Cecidomyiidae) were observed preying on ovisacs and first-instar mealybug nymphs, highlighting their role as potential biocontrol agents.

Discussion

Anagyrus dactylopii is a widely recognised endoparasitoid and one of the most effective biological control agents of *P. ficus* worldwide. Previous studies have reported that natural parasitism by *A. dactylopii* can reach up to 70% on *P. ficus* (Amala et al. 2014; Mani et al. 2014). Additionally, the species has been observed parasitising *Maconellicoccus hirsutus* at approximately 30% in vineyard ecosystems (Pillai 2016). Walton and Pringle (2004) identified *A. dactylopii* as the primary parasitoid of *P. ficus* in South African vineyards. This parasitoid predominantly targets third-instar nymphs and unmated adult females, as reported by Cadée & Van Alphen (1997) and Amala et al. (2014).

Anagyrus pseudococci was originally described by Girault in 1915 as a parasitoid of the citrus mealybug (*P. citri*). Subsequent records documented its presence in Hawaii in 1932 (Tiberlake), Argentina in 1936 (Compere), Italy in 1952 (Domenichini), California in 1958 (Bartlett & Lloyd), and Cyprus and South Africa in 1963 (Wood) (Rosen & Rössler 1966). The species typically inhabits regions characterised by hot summers and mild winters, including the Mediterranean and Black Sea regions, as well as central Russia (Niyazau 1967).

Coccidoxenoides perminutus is an asexual, thelytokous parasitoid of *P. citri*, native to Australia and capable of parasitising all developmental stages of its host (Krishnamoorthy & Mani 1989). Its wide distribution has been confirmed in multiple studies, including India (Noyes & Hayat 1984), and its occurrence in Türkiye was reported by Kaydan et al. (2006).

Gyranusoidea hecale is a cosmopolitan species known to parasitise only members of the Pseudococcidae family. Its distribution is primarily confined to the Palearctic region (Xu et al. 2004). *M. picta* was first reported in Mexico approximately two decades ago as a hyperparasitoid of Encyrtidae species attacking the pink hibiscus mealybug (*M. hirsutus*) in Fars Province (Fallahzadeh et al. 2007). It targets parasitoids of insects belonging to the Aphididae, Psyllidae, and Triozidae families within the Coccoidea superfamily (Noyes 2019).

Leptomastix dactylopii Howard (Hymenoptera: Encyrtidae) is believed to have originated in Brazil (Compere 1939; Bartlett& Lloyd 1958), although it has also been documented in western India and various regions of the Americas (Blumberg et al. 2001). The species was subsequently recorded in Spain in 1948 (Gomez Clementre 1951), Uzbekistan in 1959 (Roxanova & Loseva 1963), Italy in 1974 (Viggiani 1975), and Sicily in 1979 (Barbagallo et al. 1982). Nagarkatti et al. (1992) also reported its successful establishment in India in 1983. *Leptomastidea bifasciata* (Mayr, 1876) was previously referred to under both *L. rubra* and *L. bifasciata*, but recent studies support its classification solely as *L. bifasciata* (Japoshvili et al. 2016). Records indicate its presence across Asia, Europe, and Khuzestan (Moravvej et al. 2018). The species is known to parasitise 21 Pseudococcidae species (Noyes 2017).

Prochiloneurus bolivari Mercet has been documented as a parasitoid of *P. ficus* in numerous countries, including Afghanistan, Algeria, Armenia, Azerbaijan, Bulgaria, Congo, Egypt, Finland, Former Czechoslovakia, France, Georgia, Hungary, Iran, Italy, Japan, Moldova, Mongolia, Nigeria, Poland, Romania, Russia, Slovakia, South Africa, Spain, the United Kingdom, Uzbekistan, and Former Yugoslavia (Noyes 2003; Fallahzadeh et al. 2008).*Dusmetia fuscipennis* was reported as a parasitoid of *Planococcus vovae* in Iran by Xu & Lotfalizadeh (2000) and Lotfalizadeh & Ahmadi (2000).

Species within the Coccinellidae family (Coleoptera) are recognised as highly effective predators of soft-bodied hemipterans (Majerus 1994). *Chrysoperla carnea* is a polyphagous predator widely distributed across diverse agroecosystems and greenhouse environments (Hassan 1974; Sundby 1966; Stark & Whitford 1987; Jokar & Zarabi 2012; Senior & McWen 2001). *Sympherobius domesticus* has been observed in Japan and South Korea, where it primarily feeds on the eggs of *Phenacoccus pergandei* and *Icerya purchasi* rather than aphids (Nakahara 1954; Kuwayama 1962). *S. pygmaeus* preys on *Planococcus citri* in Antalya citrus groves (Türkyılmaz 1984), and it has also been recorded feeding on *P. aceris*, *P. ficus*, and *P. vovae* (Kaydan et al. 2006).

Hemipteran predators are generally polyphagous. *Zelus renardii* is a generalist predator capable of consuming both pest and beneficial arthropods on various crops and fruit trees (Lozano et al. 2018). Its nymphs primarily feed on aphids and thrips, whereas adults capture a broader spectrum of arthropods (Pinzari et al. 2018). *Deraeocoris punctulatus*, another common hemipteran predator, is known to prey on woolly aphids and small insects and has also been reported as a predator of pear psyllids (Almatni et al. 2002; Almatni & Elabdulla 2003; Abu Faour 2002).

The Cecidomyiidae family includes numerous species, some of which are important predators of mealybugs (Harris 1997; Harris & Harten 2006). However, *Dicrodiplosis manihoti* is not considered a mealybug predator and has been reported

from Congo, Senegal, and Nigeria (Mansour 1985; Neuenschwander & Hammond 1988; Abbas 1998).

In summary, the parasitoid and predator complexes associated with *P. ficus* represent a highly diverse and ecologically important natural enemy community. Their wide distributions and varying host specificities emphasise their potential value in biological control programs. However, factors such as environmental conditions, host availability, and the presence of hyperparasitoids may influence their effectiveness. Strengthening regional monitoring and ecological assessments is therefore essential to maximise the reliability and long-term success of *P. ficus* management strategies.

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References

Abbas M. S. T., 1998. Mealybugs and their natural enemies in Sultanate of Oman. Egyptian Journal of Agricultural Research, 76(2).

Abu Faour M., 2002. Ecological and biological study of pear psylla on pear at southern Syria and its control. M.Sc. Thesis, Faculty of Agriculture, Damascus University. (In Arabic).

Akşit İ. 1981. Hititler. Türkiye'nin Tarih Hazineleri Orta Anadolu Uygarlığı, Sandoz Yayınları (2).

Almatni W. & J. Elabdulla, 2003. Preliminary survey of the predators of pear psylla, *Cacopsylla bidens* (Šulc) (Psyllidae: Hemiptera) in Sweida, Syria. *Arab Journal of Plant Protection,* 21(1): 46-48. (In Arabic).

Almatni W., M. Z. Mahmalji & H. Al Rouz, 2002. A preliminary study of some natural enemies of woolly apple aphid *Eriosoma lanigerum* (Hausmann) (Homoptera: Aphididae) in Sweida, Syria. *Damascus University Journal for the Agricultural Sciences*, 18(1): 117-129.

Amala U., C. Chinniah, I. S. Sawant, N. Muthukrishnan & C. Muthiah, 2014. Survey for grapevine mealybug incidence and their natural enemies in Tamil Nadu and Maharashtra. *Biopesticides International*, 10: 169-175.

Anonymous, 2025. Access: http://www.fao.org/faostat/en/#data/QC Visit date: October 2025.

Anonymous, 2025. Erişim: https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr Visit date: October 2025.

Barbagallo S., A. Longo & I. Patti, 1982. Preliminary results of integrated control in Eastern Sicily to control the citrus mealybug and citrus whitefly in Eastern Sicily. *Fruits*, 36(2): 115-121.

Bartlett B. R., 1978. Pseudococcidae. In: C.P. Clausen (ed.), Introduced Parasites and Predators of Arthropod Pests and Weeds: A World Review. USDA Agricultural Research Service, Agriculture Handbook 480, Washington DC, pp. 137-170.

Bartlett B. R. & D.C. Lloyd, 1958. Mealybugs attacking citrus in California – a survey of their natural enemies and the release of new parasites and predators. *Journal of Economic Entomology*, 51(1): 90-93.

Blumberg D., J. C. Franco, P. Suma, A. Russo & Z. Mendel, 2001. Parasitoid encapsulation in mealybugs (Hemiptera: Pseudococcidae) as affected by the host–parasitoid association and superparasitism. *Bollettino Di Zoologia Agraria E Di Bachicoltura*, 33: 385-395.

Cadée N. & J. J. van Alphen, 1997. Host selection and sex allocation in *Leptomastidea abnormis*, a parasitoid of the citrus mealybug *Planococcus citri*. *Entomologia Experimentalis et Applicata*, 83(3): 277-284.

Compere H., 1936. Notes on the classification of the Aphelinidae with descriptions of new species. *University of California Publications in Entomology*, 6: 277-322.

Compere H., 1939. Mealybugs and their insect enemies in South America. *University of California Publications in Entomology*, 7(356): 57-73.

Daane K. M., C. Vincent, R. Isaacs & C. Ioriatti, 2018. Entomological opportunities and challenges for sustainable viticulture in a global market. *Annual Review of Entomology*, 63(1): 193-214.

Daane K. M., R. D. Malakar-Kuenen & V. M. Walton, 2004. Temperature-dependent development of *Anagyrus pseudococci* (Hymenoptera: Encyrtidae) as a parasitoid of the vine mealybug, *Planococcus ficus*. *Biological Control*, 31(2): 123-132.

Daane K. M., R. P. Almeida, V. A. Bell, J. T. Walker, M. Botton, M. Fallahzadeh, M. Mani, J. L. Miano, R. Sforza, V. M. Walton & T. Zaviezo, 2012. Biology and management of mealybugs in vineyards. *Arthropod Management in Vineyards*, 271-307.

Domenichini G., 1952. Morfologia, variabilità dei caratteri e speciografia dell' *Anagyrus pseudococci* Gir. *Bollettino di zoologia agraria e bachicoltura*, 18(2-3): 117-181.

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

Fallahzadeh M., M. Shojai, H. Ostovan & K. Kamali, 2008. Natural enemies of *Planococcus ficus* in Fars province vineyards, Iran. Proceedings of the 18th Iranian Plant Protection Congress, Hamedan, p. 79.

Girault A. A., 1915. New chalcidoid Hymenoptera. *Annals of the Entomological Society of America*, 8(3): 279-284.

Gomez Clementre F., 1951. Experiments on the acclimatization of *Leptomastix dactylopii* a parasite of *Planococcus citri*. Biol. Patol. Veg. Agr., 18: 21-28.

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

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, 7B, pp. 61-68.

Japoshvili G., N. Dzneladze, G. Kirkitadze, B. Kiss & M.B. Kaydan, 2018. A new and dangerous pest for the Caucasus – *Drosophila suzukii*. *Annals of Agrarian Science*, 16(4): 464-465.

Japoshvili G., Y. Higashiura & S. Kamitani, 2016. A review of Japanese Encyrtidae with descriptions of new species. *Acta Entomologica Musei Nationalis Pragae*, 56(1): 345-401.

Kaydan M. B., N. Kilinçer, N. Uygun, G. Japoshvili & S. Gaimari, 2006. Parasitoids and predators of Pseudococcidae in Ankara, Türkiye. *Phytoparasitica*, 34: 331-337.

Krishnamoorthy A. & M. Mani, 1989. *Coccidoxenoides peregrinus*: a new parasitoid of *Planococcus citri* in India. *Current Science*, 58: 466-466.

Lotfalizadeh H., 2000. Lacewings parasitoids (Neuroptera: Chrysopidae) in Shiraz. *Journal of Entomological Society of Iran*, 19(1-2): 31-44.

Lozano B. R., M. B. Ruiz & M. Á. G. de Dios, 2018. The invasive species *Zelus renardii* in Spain. *Transactions of the American Entomological Society*, 144(3): 551-558.
Majerus M. E. N., 1994. Ladybirds. London: Harper Collins.
Mani M., C. Shivaraju & N. S. Kulkarni, 2014. The grape entomology. Springer, 202 pp.
Mansour R., K. Grissa-Lebdi, M. Khemakhem, I. Chaari, I. Trabelsi, A. Sabri & S. Marti, 2017. Pheromone-mediated mating disruption of *Planococcus ficus*. *Biologia*, 72(3): 333-341.
Mansour R., L. P. Belzunces, P. Suma, L. Zappalà, G. Mazzeo, K. Grissa-Lebdi, A. Russo & A. Biondi, 2018. Vine and citrus mealybug pest control based on synthetic chemicals. A review. *Agronomy for Sustainable Development*, 38(4): 37.
Mansour S. A., 1985. Laboratory toxicity of some insecticides to *Nipaecoccus* and *Dicrodiplosis* spp. *Journal of Agricultural Research* (Pakistan), 23(3): 193-196.
Moravvej S. A., H. Lotfalizadeh & P. Shishehbor, 2018. Encyrtidae of Khuzestan. *Journal of Insect Biodiversity and Systematics*, 4(1): 13-23.
Nagarkatti S., S. P. Singh, K. P. Jayanth & B. S. Bhummannavar, 1992. Introduction and establishment of *L. dactylopii* against *Planococcus* spp. in India. Indian *Journal of Plant Protection*, 20(1): 102-104.
Neuenschwander P. & W. N. O. Hammond, 1988. Natural enemy activity after release of *Epidinocarsis lopezi*. *Environmental Entomology*, 17(5): 894-902.
Nikolskaya M. N. & V. A. Yasnosh, 1966. Aphelinidae of Europe and Caucasus. AS USSR.
Niyazau O. P., 1967. *Anagyrus pseudococci* parasitoid of *Planococcus citri*. The Review of applied entomology, 61(4).
Noyes J. S. & M. Hayat, 1984. A review of the genera of Indo-Pacific Encyrtidae. *Bulletin of the British Museum* (Natural History), 48(3): 131-395.
Noyes J. S. & M. Hayat, 1994. Oriental mealybug parasitoids of the Anagyrini (Hymenoptera: Encyrtidae).CAB International, Wallingford, Oxon, UK, viii + 554 pp.
Noyes J. S., 2003. Universal Chalcidoidea Database. (Accessed 2012).
Noyes J. S., 2017. Universal Chalcidoidea Database. Natural History Museum, London. (Accessed September 2017).
Noyes J. S., 2019. Universal Chalcidoidea Database. (Accessed 22 September 2023).
Pillai K. G., 2016. Glasshouse, greenhouse and polyhouse crops. In: *Mealybugs and Their Management*, pp. 621-628.
Pinzari M., F. Cianferoni, S. Martellos & P. Dioli, 2018. *Zelus renardii* in Italy. *Fragmenta Entomologica*, 50(1): 31-35.
Rosen D. & Y. Rössler, 1966. Studies on an Israel strain of *Anagyrus pseudococci*. *Entomophaga*, 11(3): 269-277.
Roxanova A. A. & V. G. Loseva, 1963. The vine mealybug and its parasites. *Zashchita Rastenii*, 3: 53.
Tanne E., Y. Ben-Dov & B. Raccah, 1989. Transmission of corky-bark disease by *Planococcus ficus*. *Phytoparasitica*, 17: 55.
Trjapitzin V. A., 1989. Parasitic Hymenoptera of the fam. Encyrtidae of Palaearctics. *Opredeleteli po Faune SSSR, Izdavavaemiye Zoologicheskim Institutom Akademii Nauk SSSR*: 1-489.
Viggiani G., 1975. Reintroduction de *Leptomastix dactylopii*. *Fruits*, 30(4): 259-260.
Walton V. M. & K. L. Pringle, 2004. A survey of mealybugs and natural enemies in Western Cape vineyards. *South African Journal* of *Enology and Viticulture*, 25: 23-25.
Walton V. M., 2003. Development of an IPM system for *Planococcus ficus* in South Africa. PhD Thesis, Stellenbosch University.
Wood B. J., 1963. Natural enemies of citrus coccids and aphids in Cyprus. *Entomophaga*, 8(1): 67-82.

Xu Z. & H. Lotfalizadeh, 2000. Notes on Encyrtidae from Iran with one new species. *Entomotaxonomia*, 22(1): 61-64.

Xu Z. H., M. Tao & G. H. Chen, 2004. New records of Tetracneminae with two new species in China. *Insect Science*, 11(2): 143-148.