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Beneficial mite fauna of Hevsel Gardens-Diyarbakır

Hevsel Bahçelerinin (Diyarbakır) faydalı akar faunası

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ABSTRACT

This study was conducted to determine beneficial mite species of Hevsel Gardens in Diyarbakir province in 2018-2019. These historical gardens, which have been cultivated continuously for thousands of years, are listed on UNESCO World Heritage List. Survey studies were carried out periodically every 15 days from April to November with the random sampling method. In the study, samples were taken from 66 plants species consisting of fruit trees, vegetables, and weeds. As a result of the study, 15 predator mite species from families Tydeidae, Cheyletidae, Stigmaeidae, Triophtyidae, Raphignathidae, Iolinidae, and Phytoseiidae were identified on 33 plants species. Among these families, 7 from Phytoseiidae, 3 from Iolinidae, and one species from other families were determined. *Phytoseius finitimus* (Ribaga, 1904) (Mesostigmata: Phytoseiidae) was the dominant species with 37.5%. The highest number of mite species were found on *Rubus* sp. with 7 species. In the study, more beneficial mites were found in regions where agricultural activity is less. Predator mites were mostly found on fruit trees, and less frequently on vegetables and fragrant plants. Poplar and mulberry trees have a high population in Hevsel Gardens. Although many samples were taken from these two plants during the surveys, only *P. finitimus* was found. With this two-year study, it has been revealed that Hevsel Gardens, which are important for the world, are rich in beneficial mites. Important predator species used in the world for biological control against harmful mites and insects have been identified. With study, beneficial species that create new records for the region were determined.

INTRODUCTION

Hevsel Gardens is a unique delta land with an average area of 7.000 da, lying near to the historical Diyarbakir Walls (Figure 1). Despite the fact that Diyarbakir is the main grain production there has been a rise in the production of various fruits and vegetables in recent years. In Hevsel Gardens, the Tigris River passes in the middle, most vegetables are grown and especially the leaves of the city meet a significant part of the edible vegetables. There are various fruit trees in the area, but there is no economic production. No study on beneficial mite fauna has been carried out in the area with a special ecology so far. Although mites are millimeters, they are very important creatures for nature. About 50.000 species of these creatures have been described so far, and most of them are beneficial, but there are also important species that cause serious damage to agricultural products. They are highly effective against beneficial mites, pests,

and mites. Therefore, identifying and revealing beneficial mites is extremely important in terms of pest control. This study is aimed to reveal the beneficial mite fauna of Hevsel Gardens in the World Heritage List and to contribute to the mite fauna of Turkey. In the provinces of the region, as a few studies have been conducted to determine the mite fauna (Ayata 2015, Bolu 2002, Çıkman et al. 1996, Geçer and Denizhan 2015, Kaplan and Yücel 2014, Karaca et al. 2007, Yaman et al. 2017), but no such study has been carried out in the area in question. In addition, the research was mostly aimed at determining the pest species. This study is important in terms of being the first in the historical Hevsel Gardens and revealing beneficial species.

Figure 1. Hevsel Gardens

MATERIALS AND METHODS

Cultivated plants, weeds and trees, and plants growing naturally in non-agricultural areas were the main material of the study.

Field studies

As of April, field surveys were started, and samples were taken periodically every 15 days until the end of November, with random sampling. For this purpose, the leaves, flowers, fruits, and twigs of the cultivated plants in the gardens and the other plants in the dense population were sampled. The number of samples taken was determined according to the total number of plants in the area. While taking samples from trees, samples were taken from four sides of the tree to represent the whole tree. Vegetables and weeds were sampled from the lower, middle, and upper parts of the plant. The samples, together with the comprehensive label number, were first taken into a paper bag and then into a small polyethylene bag and after being tied up, they were placed in ice containers and brought to Directorate of Diyarbakir Plant Protection Research Institute, Entomology Laboratory.

Laboratory studies

The upper and lower surfaces of the leaves were examined with a stereoscopic binocular microscope, and any mites observed were taken into 70% ethanol with a brush. Berlese Funnel was used to remove mites found on plant parts such as flowers, short branches, and fruit. According to the size of the leaves, 30-60 leaves were placed in the Berlese Funnels. To prevent the mites from escaping, liquid petroleum jelly was applied to the upper part of the Berlese Funnel and kept under 100-watt light for 24-48 hours (depending on the drying condition of the leaves). Accordingly, the mites escaping from the light fell into the glass tubes containing 70% ethyl alcohol at the bottom of the funnel.

Slide preparation

The preparation of slides was done according to Düzgüneş (1980). To see the diagnostic characteristics of the mites in the preparation phase, the mites were kept on the hot plate at 50 °C in Syracuse containers until their color was cleared by checking every 15 minutes in an average of 5 ml of lactophenol solution. Then, 3-5 drops of acid fuchsin dye were added to the mites and left for 1-3 hours. The mites were taken from the Syracus cups with the help of a pointed preparation needle, then placed on a slide with a drop of Hoyer on it. A dorso-ventral position was carefully placed on the slide with the help of the preparation needle under the Leica S8 APO Stereo Microscope, and after it was brought to the appropriate position for diagnosis, a coverslip was placed on it. The preparations were then kept in an oven at 50 °C for one week. Finally, the coverslip was fixed with transparent nail polish and the preparations were sent to the subject specialist for diagnosis after sorting.

RESULTS

To reveal the beneficial mite species of Hevsel Gardens; 65 plants consisting of vegetables, fruit trees, weeds, and other groups found in the area were sampled for two years (Table 1). As a result of the surveys, 15 species of beneficial mites were determined on 33 plants (Table 2). These species are given in the table below.

As can be seen from the table, a total of 15 predatory mite species were determined from the families Tydeidae, Cheyletidae, Stigmaeidae, Triophtyidae, Raphignathidae, Iolinidae, and Phytoseiidae.

Beneficial mites determined in Hevsel Gardens

Family: Phytoseiidae

Species: *Phytoseius finitimus* (Ribaga, 1904)

Economic importance: It is an important predator, it is common and dense in Turkey (Figure 2).

Table 1. Plant species sampled in Hevsel Gardens in 2018-2019

Plants			
1.	*Malus domestica Borkh*	2.	*Cucumis sativus L.*
3.	*Vitis vinifera L.*	4.	*Cucumis melo var. Flexuosus L.*
5.	*Prunus avium L.*	6.	*Lycopersicon lycopersicum L.*
7.	*Cydonia oblonga Miller*	8.	*Solanum melongena L.*
9.	*Diospyros kaki L.*	10.	*Capsicum annuum L.*
11.	*Pyrus sp.*	12.	*Eruca vesicaria Miller*
13.	*Rubus fructicocus L.*	14.	*Lactuca sativa L.*
15.	*Punica granatum L.*	16.	*Lepidium sativum L.*
17.	*Prunus cerasus L.*	18.	*Petroselinum crispum Miller*
19.	*Prunus armeniaca L.*	20.	*Ocimum basilicum L.*
21.	*Prunus persica L.*	22.	*Spinacia oleracea L.*
23.	*Pyrus communis L.*	24.	*Allium sativum L.*
25.	*Prunus amygdalus L.*	26.	*Allium ampeloprasum L.*
27.	*Ficus carica L.*	28.	*Allium cepa L.*
29.	*Citrullus lanatus (Thunb.) Matsum.&Nakai*	30.	*Cucurbita pepo L.*
31.	*Juglans regia L.*	32.	*Phaseolus vulgaris L.*
33.	*Morus alba L.*	34.	*Cucurbita sp.*
35.	*Fragaria sp.*	36.	*Cucurbita sp.*
37.	*Sorghum halepense L.*	38.	*Abelmoschus esculentus L.*
39.	*Chenopodium album L.*	40.	*Cucurbita sp.*
41.	*Amaranthus retroflexus L.*	42.	*Abelmoschus esculentus L.*
43.	*Xanthium strumarium L.*	44.	*Beta vulgaris var. cicla L.*
45.	*Solanum nigrum L.*	46.	*Brassica sp.*
47.	*Portulaca oleracea L.*	48.	*Mentha piperita L.*
49.	*Populus alba L.*	50.	*Brassica sp.*
51.	*Rhus coriaria L.*	52.	*Mentha pulegium L.*
53.	*Fraxinus excelsior L.*	54.	*Lamium alba-album L.*
55.	*Pinus sp.*	56.	*Medicago sativa L.*
57.	*Platanus sp.*	58.	*Verbascum thapsus L.*
59.	*Salix alba L.*	60.	*Euphorbia cyparissias L.*
61.	*Maclura pomifera (Rafinesque)*	62.	*Echinops sp.*
63.	*Elaeagnus angustifolia L.*	64.	*Centaurea sp.*
65.	*Laurus nobilis L.*	66.	*Alcea sp.*

Table 2. Beneficial mite species determined in Hevsel Gardens in 2018-2019

Order	Family	Species
Prostigmata	Tydeidae	*Tydeus californicus* (Banks)
	Cheyletidae	*Acaropsis sollers* (Kuzin)
	Stigmaeidae	*Zetzellia mali Ewing*
	Triophtyidae	*Triophtydeus triophthalmus* (Oudemans)
	Raphignathidae	*Raphignathus gracilis* (Rack)
	Iolinidae	*Neopronematus neglectus* (Kuznetzov)
		Pronematus sextoni (Baker)
		Pronematus sp.
Mesostigmata	Phytoseiidae	*Typhlodromus recki* (Wainstein)
		Phytoseius finitimus (Ribaga)
		Euseius finlandicus (Oudemans)
		Amblyseius andersoni (Chant)
		Typhlodromus pyri (Scheuten)
		Neoseiulus barkeri (Hughes)
		Proprioseiopsis messor (Wainstein)

Figure 2. Dorsal view of *Phytoseius finitimus*

Distribution: It was recorded for the first time in Italy. It is quite common in the Mediterranean region. It has been most commonly reported in Greece and Israel. Iran, Israel, Italy, Morocco, Portugal, Spain, Egypt, France, Greece, Tunisia, and the USA (Demite et al. 2014). Phytoseius finitimus is especially abundant in vineyard areas of the Mediterranean Region. In the researches in Turkey; Adana, Adapazarı, Amasya, Ankara, Antalya, Aydın, Bolu, Burdur, Bursa, Çanakkale, Edirne, Erzincan, Erzurum, Giresun, Gümüşhane, Hakkari, Mersin, Isparta, İstanbul, İzmir, Kastamonu, Konya, Muğla, Niğde, it has been reported that it is widely seen in the future such as Rize, Tekirdağ, Tokat and it is quite effective (Akçakoyunluoğlu 2017, Faraji et al. 2011, Göven et al. 2002, 2009, Kasap et al. 2013). The plants on which it was determined in this study are given in Table 3.

Table 3. Plants on which *Phytoseius finitimus* is found

Sample	Host
1	*Malus domestica*
2	*Morus sp.*
3	*Rubus fructicocus*
4	*Ficus carica*
5	*Petroselinum crispum*
6	*Portulaca oleracea*
7	*Amaranthus retroflexus*
8	*Cydonia oblonga*
9	*Pyrus sp.*
10	*Populus alba*
11	*Mentha pulegium*
12	*Prunus avium*
13	*Punica granatum*
14	*Prunus armeniaca*
15	*Rhus coriaria*
16	*Vitis vinifera*
17	*Juglans sp.*
18	*Mentha piperita*
19	*Spinacia oleracea*
20	*Capsicum annuum*
21	*Pyrus sp.*
22	*Lamium sp.*
23	*Xanthium sp.*
24	*Platanus sp.*
25	*Eruca vesicaria*
26	*Laurus nobilis*

Species: *Euseius finlandicus* (Oudemans, 1915)

Economic importance: Euseius finlandicus is an economically important species (Figure 3). It is known to play an important role in the natural control of mites such as red spiders, Eriophids, and others. This species is a general predator feeding on specific pollen (McMurtry and Croft 1997).

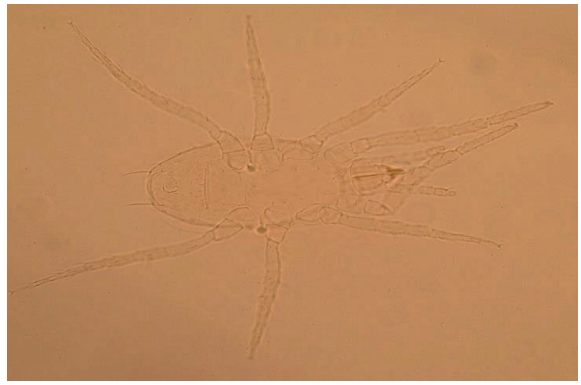

Figure 3. Dorsal view of *Euseius finlandicus*

Distribution: It has been found in many countries such as Austria, Canada, England, Finland, France, Georgia, Germany, Greece, Hungary, Iran, Italy, Poland and United States (Demite et al. 2014). Adana, Amasya, Antalya, Ankara, Bitlis, Ordu, Erzurum, Hakkari, Tokat, Samsun and Kahramanmaraş in Turkey (Alaoğlu 1996, Çobanoğlu 1993, Çobanoğlu and Kumral 2014, Faraji et al. 2011, Göven et al. 2009, İnal 2005, İncekulak and Ecevit 2002, Kasap and Çobanoğlu 2007, 2009, Kumral and Kovancı 2007, Özşişli and Çobanoğlu 2011, Yanar and Ecevit 2005, Yanar and Erdoğan 2013).

Euseius finlandicus has also been detected in trees in previous studies. It was found in the study from April to November. It has been detected in both fruits and vegetables but is more commonly found on fruit trees (Table 4).

Table 4. Plants on which *Euseius finlandicus* is found

Sample	Host
1	*Prunus avium*
2	*Punica granatum*
3	*Malus domestica*
4	*Malus domestica*
5	*Cydonia oblonga*
6	*Morus sp.*
7	*Pyrus sp*
8	*Capsicum annuum*
9	*Mentha piperita*
10	*Cydonia oblonga*

Species: *Typhlodromus pyri* (Scheuten, 1857)

Economic importance: The predator is a species; it is an important predator of *Panonychus ulmi* (Koch) (Prostigmata: Tetranychidae) (Gerson et al. 2003).

Distribution: Netherlands, France, England, Belgium, Sweden, Denmark, Russia, Moldavia, Azerbaijan, America and Turkey (Chant and Yoshida-Shaul 1986, Çobanoğlu 1993). Tokat, İstanbul, Ordu, Bursa, İzmir, Manisa, and Ankara in Turkey (Akyol 2019, Göven et al. 2009, Kumral 2005, Kumral and Çobanoğlu 2015, Yeşilayer 2009, Yeşilayer and Çobanoğlu 2011, Yanar and Ecevit 2005).

As can be seen from Table 5, T. recki has been found on 15 plants.

Table 5. Plants on which *Typhlodromus pyri* is found

Sample	Host
1	*Morus sp.*
2	*Punica granatum*
3	*Pyrus sp.*
4	*Prunus persica*
5	*Cydonia oblonga*
6	*Mentha piperita*
7	*Rosa sp.*
8	*Malus domestica*
9	*Platanus sp.*
10	*Ficus carica*
11	*Populus alba*
12	*Vitis vinifera*
13	*Rubus fructicocus*
14	*Juglans sp.*
15	*Amaranthus retroflexus*

Species: *Typhlodromus* (*Anthoseius*) *recki* (Wainstein, 1958)

Economic importance: *Typhlodromus recki*, is a predatory species commonly found in Turkey (Figure 4).

Figure 4. Dorsal view of *Typhlodromus recki*

Distribution: Turkey, Iran, Algeria, Tunisia, Russia, Moldova, Italy, Caucasus Region, Armenia, Lebanon, Azerbaijan, Georgia, Greece, Croatia, Israel and Kazakhstan (Kreiter et al. 2000, Moraes et al. 1986, Rahmani et al. 2010). In Turkey, Ankara, Amasya, Burdur, Bursa, Edirne, Erzurum, Gümüşhane, İçel, Isparta, İstanbul, Adapazarı, Amasya, İzmir, Kars, Kastamonu, Konya, Muğla, Nevşehir, Niğde, Tekirdağ, Tokat and Zonguldak (Akçakoyunluoğlu 2017, Bayram and Çobanoğlu 2007, Çobanoğlu 1989, 1991, 2004, Faraji et al. 2011, Kumral 2005, Madanlar 1992, Swirski and Amitai 1982, Şekeroğlu 1984).

As can be seen from Table 6, *T. recki* has been found on more than ten plants, and these plants are mostly fruit trees.

Table 6. Plants in which *Typhlodromus recki* has been detected

Sample	Host
1	*Prunus persica*
2	*Prunus armeniaca*
3	*Punica granatum*
4	*Morus sp.*
5	*Mentha pulegium*
6	*Rubus fructicocus*
7	*Ficus carica*
8	*Malus domestica*
9	*Vitis vinifera*
10	*Capsicum annuum*
11	*Amaranthus retroflexus*

Species: *Amblyseius andersoni* (Chant, 1957)

Economic importance: This species; *Phythonemus pallidus* (Banks) (Prostigmata: Tarsenomidae), is a predator that can be used to control mites such as *T. urticae* and *Aculops lycopersici* (Massee) (Prostigmata: Eriophyidae). It gives good results in a low pest population (Figure 5). This predator also feeds on small arthropods and pollen and is active at lower temperatures than other predators (Anonymous 2020). This species generally prefers Gal mites (Eriophyidae) as prey (Dicke et al. 1988).

Distribution: Italy, Poland, Serbia, England, France, Germany, Greece, Hungary, Ukraine and America. This species is mostly found in the west of Turkey. Samsun, Tokat, Erzurum, Adana, Adapazarı, Antalya, Bartın, Bolu, Bursa, Edirne, Giresun, Hatay, İstanbul, Kırklareli, Rize, Sakarya, Tekirdağ, Tokat, Trabzon, Kahramanmaraş and Çanakkale (Akçakoyunluoğlu 2017, Akyazı and Ecevit 2003, Demite et al. 2014, Döker et al. 2020, Faraji et al. 2011, İnal 2005, Kasap et al. 2013, Özşişli and Çobanoğlu 2011, Yanar and Erdoğan 2013, Yanar and Ecevit 2005).

A.andersoni has been found on 7 plants (Table 7).

Figure 5. Dorsal view of *Amblyseius andersoni*

Table 7. Plants in which *Amblyseius andersoni* has been detected

Sample	Host
1	*Vitis vinifera*
2	*Pyrus sp.*
3	*Rubus fructicocus*
4	*Populus alba*
5	*Mentha pulegium*
6	*Fraxinus excelsior*
7	*Xanthium sp.*

Species: *Proprioseiopsis messor* (Wainstein, 1960)

Economic importance: It is an important predator, feeding on harmful mites as well as thrips (Anonymous 2020).

Distribution: Argentina, Brazil, China, Egypt, England, Finland, France, Georgia, Germany, Greece, Iran, Israel, Italy, Japan, Netherlands, Norway, Portugal, Russia, South Africa, South Korea, Spain, Sweden, Ukraine and America. Antalya, Şanlıurfa, Aydın, Samsun, İzmir, Çanakkale, Ankara and Bursa in Turkey (Çakmak et al. 2003, Çıkman et al. 1996, Çobanoğlu 1989, Çobanoğlu and Kumral 2014, Demite et al. 2014, İnal 2005, Kasap et al. 2013, Kılıç et al. 2012, Kumral and Çobanoğlu 2015).

Species: *Neoseiulus barkeri* (Hughes, 1948)

Economic importance: It is an important predator species (Figure 6). In this study, it was found on *Amaranthus retroflexus* plant.

Distribution: Argentina, Brazil, China, Egypt, England, Finland, France, Georgia, Germany, Greece, Iran, Israel, Italy, Japan, Netherlands, Norway, Portugal, Russia, South Africa, South Korea, Spain, Sweden, Ukraine and America. Antalya, Şanlıurfa, Aydın, Samsun, İzmir, Çanakkale, Ankara and Bursa in Turkey (Kumral and Çobanoğlu 2015, Çobanoğlu and Kumral 2014, Demite et al. 2014, Kasap et al. 2013, Kılıç et al. 2012, İnal 2005, Çakmak et al. 2003, Çıkman et al. 1996, Çobanoğlu 1989).

Figure 6. Adult of *Neoseiulus barkeri*

Family: Cheyletidae

Species: *Acaropsis sollers* (Kuzin, in Rohdendorf, 1940)

Economic importance: It is an important predator of economic importance (Figure 7).

Distribution: Greece, India, America, China, Russia, Turkmenistan (Eliopoulas and Papadoulis 2001, Gupta and Chatierjee 2004, Volgin 1989). İzmir and Edirne in Turkey (Çobanoğlu 1996, Madanlar and Kısmalı 1991, Özer et al. 1989).

Figure 7. Dorsal view of *Acaropsis sollers*

A. sollers has been found on 19 plants (Table 8).

Table 8.

Family: Stigmaeidae

Species: *Zetzellia mali* (Ewing, 1960)

Economic importance: It is an important agent in the biological control of pest mites and insects.

Distribution: Detected in most countries such as USA, Canada, France, Germany, Italy, England, Netherlands, Switzerland, Africa and Iran (González-Rodrigeuz 1965,

Table 8. Plants on which *Acaropsis sollers* was detected

Sample	Host
1	*Chenopodium album*
2	*Ficus carica*
3	*Beta vulgaris var. cicla*
4	*Portulaca oleracea*
5	*Solanum nigrum*
6	*Cydonia oblonga*
7	*Pyrus sp.*
8	*Juglans sp.*
9	*Capsicum annuum*
10	*Prunus armeniaca*
11	*Rubus fructicocus*
12	*Vitis vinifera*
13	*Rubus fructicocus*
14	*Malus domestica*
15	*Rosa damascena*
16	*Prunus armeniaca*
17	*Prunus persica*
18	*Platanus sp.*
19	*Pyrus communis*

Khanjani and Ueckermann 2002, Lindquist et al. 1996, Meyer 1969, Meyer and Ueckermann 1989, Yeşilayer and Çobanoğlu 2013). It is common available in Turkey. It has been recorded in both fruit and vegetables in Ankara, Bilecik, Bitlis, Samsun, Ordu and Van (Akyazı and Ecevit 2003, Akyol 2019, Çobanoğlu et al. 2003, Denizhan and Çobanoğlu 2008, 2009, Doğan 2007, Düzgüneş 1963, Kasap and Çobanoğlu 2007, Özkan et al. 1988, Sağlam and Çobanoğlu 2010, Soysal and Akyazı 2018). In this study, it was detected in apple, quince and blackberry (Table 9).

Table 9. Plants on which *Zetzellia mali* has been detected

Sample	Host
1	*Malus domestica*
2	*Rubus fructicocus*
3	*Cydonia oblonga*

Family: Raphignathidae

Species: *Raphignathus gracilis* (Rack, 1962)

Economic importance: Species of the genus *Raphignathus* are predators. They live under debris, soil, moss, lichen, storage product, house dust, bird's nest, and tree bark (Doğan and Erman 2019).

Distribution: United States, Germany, China, South Africa, Azerbaijan, Iran, Israel, Japan, Crimea, Egypt, Poland, New Zealand. Afyonkarahisar, Artvin, Denizli, Erzincan, Erzurum, Istanbul, Izmir, Kelkit Valley, and Kutahya in Turkey (Miroğlu 2020).

Family: Triophtyidae

Species: *Triophtydeus triophthalmus* (Oudemans, 1929)

Economic importance: There are different opinions about eating habits (Tempfli et al. 2015).

Distribution: Germany, Switzerland, Italy, and Hungary (Tempfli et al. 2015). It has been found in the Black Sea Region of Turkey and especially in the provinces of Ordu and Samsun.

Family: Tydeiade

Species: *Tydeus californicus* (Banks, 1904)

Economic importance: There are different opinions about eating habits.

Distribution: It is distributed all over the world. Adana, İstanbul, Çanakkale, Adana, Ankara, Bursa, Hatay, Kahramanmaraş and Mersin in Turkey (Da Silva et al. 2016, Düzgüneş 1963, İnak 2017, Kasap et al. 2014, Yeşilayer 2009).

Family: Iolinidae

Species: *Pronematus sextoni* (Baker, 1968)

Economic importance: A predator is a species.

Distribution: Moldova, Ukraine, India, Cuba, and South Africa. It was found for the first time in Turkey, in Ordu Province, on cucumber and beans. (Soysal 2017). In this study, P. sextoni, F. carica was found on July 10, 2018.

Species: *Neopronematus neglectus* (Kuznetzov, 1972)

A predator is a species. Neopronematus neglectus; Pyrus sp., R. fructicocus, and P. armeniaca found on plants. In Turkey, this species was recorded for the first time in tomatoes in Bursa (Çobanoğlu and Kumral 2014).

DISCUSSION

Mites in the Phytoseiidae family have been successfully used in biological control against many plant-feeding mites and important insects including thrips. (Kazak et al. 1989, Zhang and Rhode 2003). As in this study, a large number of species belonging to the aforementioned family have been identified in many studies conducted in Turkey (Faraji et al. 2011, İnak 2017, Öksüz 2019, Özcan 2019). *Phytoseius finitimus* (37.5%) was determined as the dominant predatory mite species in the study. This species is most commonly detected on *Rubus* sp. and *Malus* sp., and was encountered from May to November. Males of the species were found at a very low rate (2.3%). This species also is an efficient predator, has been frequently recorded in studies conducted in Turkey (Akçakoyunluoğlu 2017, Faraji et al. 2011, Göven et al. 2002, 2009, Kasap et al. 2013). This study is promising because previous research in the region has extensively detected spider mites and eriophyid mites, as well as pests such as aphids and thrips (Ayata 2015,

Bolu 2002, Çıkman et al. 1996, Geçer and Denizhan 2015, Kaplan 2014, Karaca et al. 2007, Yaman et al. 2017).

Acaropsis sollers, determined from the Cheyletidae family in the study, was the second dominant predator species. This mite has been found in the products in the warehouses in most of the studies conducted at home and abroad (Çobanoğlu 1996, Madanlar and Kısmalı 1991, Özer et al. 1989). However, in this study, 17 plants, mostly fruit trees, were found from April to November. This was important in terms of showing that the predatory species in question lived in different ecologies.

Members of the Iolinidae family have been found rare in Turkey in previous studies. In this study, 3 species were identified. All 3 species were rare in Turkey and reported for the first time in the Southeastern Anatolia Region. *Pronematus sextoni* determined from this family, *Eutetranychus orientalis* (Klein) (Prostigmata: Tetranychidae) has been reported to feed on (Dhooria 1982). This species has also been reported to be a predator of *Polyphagotarsonemus latus* (Banks) (Prostigmata: Tarsonemidae) (Singh 2017).

There are different opinions about *T. californicus*; some researchers have stated that it can be a predator or feed on phytophage or pollen. Kasap et al. (2014) stated that *T. californicus* is known to be neutral however, Yeşilayer (2009) reported that it forms a leathery layer under the leaves of its host plant. The aforementioned type was detected in the study, especially in the samples in the area where the pesticide was not applied. It was recorded for the first time in the region with this study.

The Stigmaeidae family has been identified as the *Z. mali*. Species of the *Zetzellia* genus have been reported to be predators of plant pest mites such as Eriophyidae, Tetranychidae, and Tenuipalpidae. (Gerson and Smiley 1990, Koç and Madanlar 1998). In the study, this species was mostly recorded in fruit trees. For the first time, its existence was revealed in the Southeastern Anatolia Region with this study.

Although the feeding behavior of the Triophtyidae family is not known exactly, it has been reported that they feed on the eggs of some insects and spider mites (Da Silva et al. 2014, Tempfli et al. 2015). In the study, *T. triophthalmus* determined from this family was reported especially in the Black Sea Region, its presence was detected for the first time in the Southeastern Anatolia Region with this study. There is not enough information about nutrition habits (Tempfli et al. 2015).

According to studies on the Raphignathidae family, most of them are predators. (Fan and Zhang 2005). Raphognathis gracilis, which was determined from this family in the study, was recorded in our country for the first time in Istanbul (Yeşilayer 2009). It was determined for the first time in the Southeastern Anatolia Region by this study.

Although most of the mites are beneficial, more harmful species were determined in the studies conducted in the Southeastern Anatolia Region (Ayata 2015, Bolu 2002, Geçer and Denizhan 2015, Kaplan 2014, 2020, Taşçıoğlu et al. 1969, Yaman et al. 2017). In this study, beneficial species were found. The determined species were mostly detected on fruit trees, and the highest number of species was recorded on *R. fructicocus* with seven species. This can be attributed to the fact that there is no economical fruit growing in the area. Therefore very little application of pesticides. Few species and individuals were found in vegetables and fragrant plants.

The rich fauna of Hevsel Gardens should be protected, for this, the farmers here should be informed and educated about beneficial mites. Inspections in the gardens should be carried out periodically, and the entry of environmental pollutants into the gardens should be prevented. As a result, this study formed the basis for the beneficial mite fauna of the region, common and rare beneficial species were found and revealed that Hevsel Gardens is rich in beneficial mites.

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ÖZET

Bu çalışma, 2018-2019 yıllarında Diyarbakır ili Hevsel Bahçeleri'nde bulunan faydalı akar türlerinin belirlenmesi amacıyla yapılmıştır. Binlerce yıldır kesintisiz olarak ekilen bu tarihi bahçeler, UNESCO Dünya Mirası Listesi'nde yer almaktadır. Sürvey çalışmaları tesadüfi örnekleme metodu ile nisan ayından kasım ayına kadar her 15 günde bir periyodik olarak yapılmıştır. Çalışmada meyve ağaçları, sebzeler ve yabancı otlardan oluşan 66 bitki türünden örnekler alınmıştır. Çalışma sonucunda 33 bitki türü üzerinde Tydeidae, Cheyletidae, Stigmaeidae, Triophtyidae, Raphignathidae, Iolinidae ve Phytoseiidae familyalarından 15 predatör akar türü tespit edilmiştir. Bu familyalardan

Phytoseiidae familyasından 7 tür, Iolinidae familyasından 3 tür ve diğer familyalardan bir tür tespit edilmiştir. *Phytoseius finitimus* (Ribaga, 1904) (Mesostigmata: Phytoseiidae) %37.5 oran ile baskın tür olmuştur. En fazla akar türü 7 tür ile *Rubus* sp.(böğürtlen)'de bulunmuştur. Araştırmada, tarımsal faaliyetin az yapıldığı bölgelerde daha fazla sayıda faydalı akar bulunmuştur. Predatör akarlar, daha çok meyve ağaçlarında bulunmuş bunun yanında sebze ve kokulu bitkilerde daha az oranda bulunmuştur. Hevsel Bahçeleri'nde kavak ve dut ağaçları yüksek bir popülasyona sahiptir. Bu iki bitkiden çok sayıda örnekleme yapılmasına rağmen sadece *P. finitimus* saptanmıştır. İki yıllık bu araştırma ile Dünya için önemli olan Hevsel Bahçeleri'nin faydalı akar yönüyle zengin olduğu ortaya çıkartılmıştır. Zararlı akar ve böceklere karşı biyolojik mücadelede dünyada kullanılan önemli avcı türler tespit edilmiştir. Çalışma ile bölge için yeni kayıt oluşturan faydalı türler belirlenmiştir.

Anahtar kelimeler: Diyarbakır, predatör, Phytoseiidae, *Phytoseius finitimus*

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