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RESEARCH ARTICLE

Phytoseiid species (Acari: Phytoseiidae) on walnut trees in Samsun Province, Turkey

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ABSTRACT: This research was conducted to determine the phytoseiid species on walnut trees in Samsun Province, Turkey in 2018. Most of the surveys were done in unsprayed orchards. A total of nine phytoseiid species were collected - *Euseius finlandicus*, *E. gallicus*, *E. stipulatus*, *Kampimodromus aberrans*, *Neoseiulella tiliarum*, *Phytoseius finitimus*, *Typhlodromus* (*Anthoseius*) *rapidus*, *Typhlodromus* (*Anthoseius*) sp. and *Amblyseius* (*andersoni*?) sp. *Euseius finlandicus* was the most abundant species, followed by *Phytoseius finitimus*. Mite density was twice as high on the lower surface as on the upper surface of leaves. These nine species represent a substantial local genetic resource with the potential to improve the efficacy of biological control programs.

Keywords: Acari, Mesostigmata, Phytoseiidae, walnut, Black Sea

INTRODUCTION

There are 21 known walnut species (Juglandaceae: *Juglans* spp.) worldwide. Of them, *Juglans regia* L. is the best known species and Turkey is one of countries to which it is native (Çelik et al., 2011). Turkey is also a leading walnut growing country, ranking fourth in world production after China, the USA and Iran (Martínez et al., 2010). Areas under walnut production have increased considerably in recent years in Turkey, including the Black Sea region.

Many insects and mites feed on walnut trees (Alaoğlu, 1984; Güçlü et al., 1995; Çevik, 1996; Strand, 2003; Kasap et al., 2008; Canıhoş et al., 2014; Khan et al., 2016). There are also predatory insects and mites in the walnut plantation ecosystem, especially where pesticide use is absent or minimal (Strand, 2003; Kasap et al., 2008, 2009; Kabíček, 2010; Kavianpour et al., 2016). It is essential to document these potential biological control agents because they can contribute to the reduction of pesticide use if strategically applied.

One of the important groups of biological control agents is the phytoseiid mites (Acari: Mesostigmata) (Moraes et al., 2004; Chant and McMurtry 2007; Papadoulis et al., 2009). *Phytoseius persimilis* Athias-Henriot, *Amblyseius swirskii* Athias-Henriot, *Neoseiulus californicus* (McGregor), *N. cucumeris* (Oudemans) and *N. fallacis* (Garman) are effective biological control agents of important pests in many field and greenhouse crops globally (McMurtry et al., 1970; Helle and Sabelis, 1985; Gerson et al., 2003). The successful application of these mites has helped raise the profile of biological control (Zhang, 2003). They also play an important role in preventing outbreaks of various phytophagous mites, especially tetranychid and eriophyoid mites, in natural habitats (Edland and Evans, 1998).

In Turkey, 105 phytoseiid species have been recorded from 21 genera in the subfamilies Amblyseiinae, Phytoseiinae and Typhlodrominae (Döker et al., 2017, 2018, 2019; Döker, 2019; İ. Döker, Adana, Turkey, December 2019, personal communication). Among them, some species, such as *P. persimilis, A. swirskii*, *Euseius stipulatus* (Athias-Henriot), *E. gallicus* Kreiter and Tixier, *N. californicus*, *N. cucumeris* and *Iphiseius degenerans* (Berlese), have been mass reared and released as biological control agents in different parts of the world (Düzgüneş, 1963; Şekeroğlu, 1984; Şekeroğlu and Kazak, 1993; Çobanoğlu, 1989, 1997; Cobanoğlu and Özman, 2002; Çakmak and Çobanoğlu, 2006; Faraji et al., 2011; Döker et al., 2014a,b, 2015a,b).

There have been no studies on phytoseiid mites in walnut orchards in Samsun Province which is in the central Black Sea region in northern Turkey. For that reason, this research was conducted to determine the species present and their abundances in representative orchards in each district.

MATERIALS AND METHODS

This study was conducted in 2018 in walnut orchards in Samsun Province, Turkey. Most of the surveys were done periodically in July, August and September in unsprayed orchards in villages of 17 provincial districts, namely Asarcık, Alaçam, Atakum, Ayvacık, Bafra, Canik, Çarşamba, Havza, İlkadım, Kavak, Ladik, Ondokuzmayıs, Salıpazarı, Tekkeköy, Yakakent, Terme and Vezirköprü (Fig. 1).

Surveys were conducted in 68 orchards, according to the methodologies of Lazarov and Grigorov (1961) and Erkam (1981). Fifty two orchards were unsprayed and 16 orchards were sprayed. The numbers of trees in orchards ranged from 5 to 300 and their ages ranged from 5 to 15 years. A total of 101 samplings were done. In each sampled orchard, a total of one hundred leaves were randomly collected from the lower, middle and upper thirds of the trees while the collector walked in a "Z" pattern. The leaves collected were placed in a labeled plastic bag and

kept in an ice-box until brought to the laboratory. They were then refrigerated until each sample was checked for mites with a stereomicroscope. All of the collected mites were mounted on slides with the use of Hoyer's medium. Additionally, one orchard was selected in each of 13 districts and samplings were done monthly for 3 months to determine the population density of phytoseiid mites. For that purpose, the active stages of phytoseiid mites were counted in a 4 cm^2 area on the upper and lower surfaces of 30 randomly selected leaves from each orchard. The identifications of the species were done by the second author, using the generic classifications of Chant and McMurtry (2007).

Figure 1. Districts of Samsun Province (Anonymous, 2019a), Turkey where phytoseiid mite species were surveyed in walnut orchards in 2018.

RESULTS

In this study, phytoseiid mites were collected from 61.40% of the 101 walnut leaf samplings. Nine phytoseiid species from 6 genera were identified from the total of 211 specimens collected. The genus represented by most species was *Euseius* (3), followed by *Typhlodromus* (2), with the remaining four genera each represented by one species (Table 1).

Table 1. Phytoseiid mites and their percentages in walnut orchards in Samsun Province, Turkey in 2018.

Species	%
Euseius finlandicus (Oudemans, 1915)	45.50
Phytoseius finitimus Ribaga, 1904	24.64
Euseius gallicus Kreiter and Tixier, 2009	11.37
Neoseiulella tiliarum (Oudemans, 1930)	7.58
Kampimodromus aberrans (Oudemans, 1930)	4.27
Ambyseius (andersoni?) sp.	2.84
Euseius stipulatus (Athias-Henriot, 1960)	2.37
Typhlodromus (*Anthoseius*) sp.	0.95
Typhlodromus (*Anthoseius*) *rapidus* Wainstein and Arutunjan, 1968	0.47

Euseius finlandicus was the most abundant species (45.50%), followed by *P. finitimus* (24.64%) and *E. gallicus* (11.37%); more than two thirds of all the specimens (70.14%) were from the two most abundant species. At the other end of the abundance scale, the least common species were *Typhlodromus* (*Anthoseius*) sp. (0.95%) and *T.* (*Anthoseius*) *rapidus* (0.47%).

The phytoseiid distribution on walnut leaves was also determined in this study. The total number of phytoseiids on the lower leaf surface (68.01%) was more than double the number on the upper leaf surface (31.98%). In Table 2, the mean phytoseiid densities on both leaf surfaces are shown.

Table 2. The mean numbers of phytoseiid mites on walnut leaf surfaces in Samsun Province, Turkey in 2018.

Month	Mean number of mites / 4 cm^2	
	Upper surface	Lower surface
July	0.111	0.233
August	0.097	0.228
September	0.151	0.312

Species:

***Amblyseius* (*andersoni*?) sp.**

Typhlodromus andersoni Chant, 1957

Amblyseius potentillae (Garman, 1958)

Material examined: A total of 6 *Amblyseius* specimens, all males, were collected - Samsun, Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 28.07.2018, 1♂; Ayvacık, Yenice (41°03'18.5"N 36°39'02.8"E), 14.09.2018, 1♂; Canik, Demirciler (41°14'17.7"N 36°15'18.9"E), 15.08.2018, 1♂; Kavak, Bahçelievler (41°04'23.8"N 36°02'43.3"E), 16.08.2018, 1♂; Ladik, Salur (40°59'54.4"N 35°53'20.3"E), 17.08.2018, 1♂; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 30.07.2018, 1♂.

Comments: As only males were collected, identification could not be accurately made to species level but the specimens might be *Amblyseius andersoni* (Chant, 1957) which is very common in the study area. *Amblyseius andersoni* has been recorded from more than 30 countries, including France, Greece, Italy, Syria and the USA (Tixier et al., 1998; Kabíček, 2010; Demite et al., 2014). In Turkey, it has been reported from different plants, including apple, persimmon and hazelnut, in different regions (Çobanoğlu, 1993, 2008; Ozman and Cobanoğlu, 2001; Akyazı and Ecevit, 2003; Bayram and Çobanoğlu, 2007; Ozsisli and Çobanoğlu, 2011; Yesilayer and Çobanoğlu, 2011; Kasap et al., 2013; Satar et al., 2013; Kumral and Çobanoğlu, 2015; Çobanoğlu and Kumral, 2016; Akyazı et al., 2017; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). As prey, this species prefers spider mites to eriophyoid mites (Dicke et al., 1988).

***Euseius finlandicus* (Oudemans, 1915)**

Seiulus finlandicus Oudemans, 1915

Typhlodromus pruni Oudemans, 1929

Typhlodromus finlandicus Oudemans, 1929

Amblyseius finlandicus Wainstein, 1962

Material examined: *Euseius finlandicus* was the most abundant species collected in this study. The number of females was much higher than the number of males (81♀♀ and 15♂♂) - Samsun, Atakum, Güzelyurt (41°24'19.6"N 36°10'00.9"E), 25.07.2018, 1♂, 2♀♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 25.07.2018, 3♀♀; Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 27.07.2018, 2♂♂; 17.08.2018, 2♀♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 28.07.2018, 1♀; 15.09.2018, 1♀; Ondokuzmayıs, Çetirlipınar (41°28'32.7"N 36°02'12.4"E), 30.07.2018, 1♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 5♀♀; 17.08.2018, 3♀♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 17.09.2018, 1♀; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 31.07.2018, 2♀♀; 17.09.2018, 3♀♀; Vezirköprü, Köprübaşı (41°03'11.9"N 35°30'57.8"E), 31.07.2018, 2♀♀, 1♂; Vezirköprü, Yeniçelik (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 3♀♀; Vezirköprü, Pazarcı (41°04'19.5"N 35°29'52.2"E), 31.07.2018, 2♀♀; Havza, Yenice (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 2♀♀; Ondokuzmayıs, Tepeköy (41°30'33.4"N 36°01'50.4"E), 31.07.2018, 1♂; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.08.2018, 1♀; 17.09.2018, 3♀♀; Canik, Demirciler (41°14'17.7"N 36°15'18.9"E), 15.08.2018, 1♀, 1♂; Alaçam, Alparslan (41°36'53.1"N 35°36'21.2"E), 17.08.2018, 1♂; Alaçam, Soğukçam (41°36'09.0"N 35°45'06.7"E), 17.08.2018, 5♀♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 1♀, 2♂♂; 13.09.2018, 1♀; Salıpazarı, Cevizli (41°03'19.4"N 36°54'46.8"E), 14.09.2018, 1♀; Salıpazarı, Kuşcuğaz (41°04'54.7"N 36°52'40.3"E), 14.09.2018, 2♀♀; Vezirköprü, Çakırtaş (41°08'09.1"N 35°29'02.2"E), 15.09.2018, 6♀♀, 3♂♂; Vezirköprü, Esentepe (41°06'47.9"N 35°09'02.3"E), 16.08.2018, 2♀♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 2♀♀; 16.08.2018, 1♀; 15.09.2018, 7♀♀; Havza, Şeyhli (41°07'45.2"N 36°52'53.0"E), 16.08.2018, 1♀; Havza, Ortaklar (41°01'39.5"N 35°33'45.0"E), 15.09.2018, 2♀♀, 1♂; Ladik, Ayvalı (41°06'47.9"N 35°09'02.3"E), 12.09.2018, 2♀♀; Vezirköprü, Meşeli (41°04'45.8"N 35°29'56.5"E), 15.09.2018, 1♀, 1♂; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 31.07.2018, 3♀♀; 17.08.2018, 1♀; 17.09.2018, 3♀♀; Bafra, Kozağzı (41°28'58.3"N 35°49'32.7"E), 17.09.2018, 3♀♀.

Comments: *Euseius finlandicus* is a common species on decidious trees (McMurtry and Croft, 1997). It has been reported from New Zealand, Hungary, Serbia, Italy, France, Japan and the USA (Collyer, 1980; Ripka et al., 2013; Demite et al., 2014). It has been collected from almost every region in Turkey and on different plants, including apple, citrus, grape, hazelnut, pear and walnut (Swirski and Amitai, 1982; Düzgüneş and Kılıç, 1983; Şekeroğlu, 1984; Ozman and Cobanoğlu, 2001; Çobanoğlu, 2004; İncekulak and Ecevit, 2002; Yanar and Ecevit, 2005; Kasap et al., 2008, 2009; Denizhan and Çobanoğlu, 2009; Ozsisli and Çobanoğlu, 2011; Yeşilayer and Çobanoğlu, 2011; Satar et al., 2013; Kumral and Çobanoğlu, 2015; Akyazı et al., 2016, 2017; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). This species is included in the type IV classification of McMutry and Croft (1997), which means that it is a specialized pollen feeder/generalist predator (McMurtry, 1983; McMurtry and Croft, 1997). It can feed on tetranychid, eriophyid, tyroglyphid and tarsonemid mites, pollen, fungal spores and hyphae, the eggs and larvae of insects, honeydew and plant liquids (Schausberger, 1992; Kostiainen and Hoy, 1994; Abdallah et al., 2001).

***Euseius gallicus* Kreiter and Tixier, 2009**

Material examined: The twenty four *E. gallicus* females found in this study were all on the lower leaf surface - Samsun, Kavak, Kayaköy (41°05'46.5"N 36°01'21.3"E), 28.07.2018, 1♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 1♀; Salıpazarı, Alan (41°03'47.7"N 36°47'09.5"E), 30.07.2018, 2♀♀; 18.08.2018, 1♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 1♀; Vezirköprü, Yenice (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 3♀♀; Vezirköprü, Pazarcı (41°04'19.5"N 35°29'52.2"E), 31.07.2018, 1♀; Alaçam, Soğukçam (41°36'09.0"N 35°45'06.7"E), 17.08.2018, 2♀♀; İlkadım, Kapaklı (41°16'12.9"N 36°11'22.3"E), 12.09.2018, 1♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 14.09.2018, 3♀♀; Alaçam, Geyikkoşan (41°37'12.6"N 35°36'28.7"E), 17.09.2018, 1♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.09.2018, 3♀♀; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.09.2018, 3♀♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 1♀.

Comments: *Euseius gallicus* was first found and identified in France from the leaves of large-leaved summer linden (*Tilia platyphyllos* Scopoli), sour cherry (*Prunus cerasus* L.), horse chestnut (*Aesculus hippocastanum* L.), laurustinus (*Viburnum tinus* L.) and grape (*Vitis vinifera* L.) in 2009 (Tixier et al., 2009). Later, it was found on *Tilia cordata* (Miller) in Belgium, *Lycium barbarum* L. in Germany, *Rosa* sp. cv. Red Naomi in Holland and *Ipomea* sp. in Trabzon, Turkey (Döker et al., 2014b), and on *Capsicum annuum* L., *Phaseolus vulgaris* L. and *Cucumis sativus* L. in Ordu, Turkey (Soysal and Akyazı, 2018). This study reports this species for the first time on walnut trees in Turkey. *Euseius* species are pollen feeding, type IV generalist predators (McMurtry and Croft, 1997). *Euseius gallicus* has shown potential as a biocontrol agent for western flower thrips and whiteflies on roses when *Typha* sp. (cattail) pollen is supplied as an additional food source (Wackers, 2013). It has been commercially produced since 2014 (Anonymous, 2019b).

***Euseius stipulatus* (Athias-Henriot, 1960)**

Amblyseius stipulatus Athias-Henriot, 1960

Amblyseius (*Amblyseius*) *stipulatus* Ueckermann and Loots, 1988

Material examined: Five females of this species were found on the undersurface of leaves, and only in August - Samsun, Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 17.08.2018, 1♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 2♀♀; Salıpazarı, Cevizli (41°03'19.4"N 36°54'46.8"E), 18.08.2018, 1♀.

Comments: *Euseius stipulatus* is a common predatory mite found mainly in southern Europe (Athias-Henriot, 1960; Mijuskovic and Tomasevic, 1975; Ragusa and Swirski, 1976; McMurtry, 1977; Ferragut et al., 1983). It has been reported from apple, citrus and vegetable orchards in Turkey (McMurtry, 1977; Çobanoğlu, 1989; Satar et al., 2013; Çobanoğlu and Güldali, 2017). This type IV pollen feeding generalist predator can feed on tetranychid mites (McMurtry, 1977; McMurtry and Croft, 1997), especially on *Panonyhus citri* McGregor in citrus orchards (Ferragut et al., 1992). It was introduced to Peru to control *P. citri* and it is now produced commercially for the control of that pest (Aguirre-Gil et al., 2013).

***Kampimodromus aberrans* (Oudemans, 1930)**

Typhlodromus aberrans Oudemans, 1930

Typhlodromus (*Typhlodromus*) *aberrans* Beglyarov, 1957

Amblyseius aberrans Athias-Henriot, 1958

Typhlodromus (*Amblyseius*) *aberrans* Chant, 1959

Paradromus aberrans Muma, 1961

Amblyseius (*Kampimodromus*) *aberrans* Pritchard and Baker, 1962

Amblyseius (*Amblyseius*) *aberrans* Tseng, 1976

Kampimodromus aberrans [sic] Kolodochka, 1978 and 1998

Kampimodromus (*Kampimodromus*) *aberrans* Karg, 1983

Kampimodromus aberrans Moraes et al., 2004

Material examined: Nine individuals of this species were collected, and only in Yakakent district - Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 27.07.2018, 2♀♀, 2♂♂; 17.08.2018, 5♀♀.

Comments: *Kampimodromus aberrans* has been collected from different plants, including *Corylus avellana* L., *Diospyrus kaki* L., *Fagus sylvatica* L., *Ficus carica* L., *Morus nigra* L., *Quercus cerris* L., *Malva* sp., *Rosa* sp. and *Sorbus* sp. in different countries (Ragusa and Tsolakis, 1994). It was later recorded on various plants, namely hazelnut, walnut, apple, pear, loquat and rose, in different parts of Turkey (Ozman-Sullivan, 2006; Kasap et al., 2008, 2009; Faraji et al., 2011; Ozsisli and Çobanoğlu, 2011; Yesilayer and Çobanoğlu, 2011; Satar et al., 2013). *Kampimodromus aberrans* is categorized as a generalist predator (Type III). This mite feeds readily on pollen and extracts liquid from leaves (McMurtry and Croft, 1997). It also feeds on tetranychid mites (Tixier et al., 1998; Kasap, 2005, 2019; Lorenzon et al., 2012; Duso et al., 2014; Akyazı et al., 2017; Soysal and Akyazı, 2018) and eriophyoid mites (Duso and de Lillo, 1996); it was observed feeding on *Phytoptus avellanae* Nalepa in hazelnut orchards in Samsun Province, Turkey (Ozman-Sullivan, 2006).

***Neoseiulella tiliarum* (Oudemans, 1930)**

Typhlodromus tiliarum Oudemans, 1930

Material examined: Sixteen individuals of this species were found - Samsun, Ladik, Ayvalı (41°24'19.6"N 36°10'00.9"E), 28.07.2018, 1♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 2♀♀; Vezirköprü, Esentepe (41°06'47.9"N 35°09'02.3"E), 16.08.2018, 2♀♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.08.2018, 1♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 17.08.2018, 1♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♀; Salıpazarı, Alan (41°03'47.7"N 36°47'09.5"E), 18.08.2018, 1♀; Terme, Söğütlü (41°13'22.0"N 36°51'45.7"E), 18.08.2018, 1♀; Ladik, Salur (40°59'54.4"N 35°53'20.3"E), 12.09.2018, 1♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 13.09.2018, 1♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 14.09.2018, 1♀; Havza, Ortaklar (41°01'39.5"N 35°33'45.0"E), 15.09.2018, 1♂; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 17.09.2018, 1♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 1♀.

Comments: *Neoseiulella tiliarum* was found on linden trees in Germany (Oudemans, 1930). Nesbitt (1951) recorded it on apple, linden and pear trees in Canada. More recently, it has been found in many countries, including Turkey, on different plants (Swirski and Amitai 1982; Düzgüneş and Kılıç, 1983; Denmark and Rather, 1996). It feeds on tetranychid and eriophyoid mites (Jeppson et al., 1975; Kozlowski and Kozlowska, 1991).

***Phytoseius finitimus* Ribaga, 1904**

Phytoseius (*Dubininellus*) *finitimus* Wainstein, 1959

Phytoseius finitimus Chant, 1959

Phytoseius (*Pennaseius*) *finitimus* Pritchard and Baker, 1962

Pennaseius finitimus Schuster and Pritchard, 1963

Phytoseius (*Phytoseius*) *finitimus* Denmark, 1966

Material examined: Fifty two individuals of this species were found, on the underside of the leaves - Samsun, Atakum, Güzelyurt (41°24'19.6"N 36°10'00.9"E), 25.07.2018, 1♀, 1♂; 17.09.2018, 2♀♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 25.07.2018, 1♀; Ondokuzmayıs, Çetirlipınar (41°28'32.7"N 36°02'12.4"E), 30.07.2018, 2♀♀; 17.09.2018, 2♀♀; Alaçam, Alparslan (41°36'53.1"N 35°36'21.2"E), 30.07.2018, 1♂;

17.09.2018, 2♀♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 1♀; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 31.07.2018, 1♂; Ondokuzmayıs, Erenköy (41°26'23.6"N 36°08'12.0"E), 31.07.2018, 1♀; Ondokuzmayıs, Tepeköy (41°30'33.4"N 36°01'50.4"E), 31.07.2018, 4♀♀; Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 17.08.2018, 4♀♀, 2♂♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 4♀♀; Ayvacık, Yenice (41°03'18.5"N 36°39'02.8"E), 18.08.2018, 1♂; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 4♀♀; Terme, Şeyhli (41°07'45.2"N 36°52'53.0"E), 18.08.2018, 2♀♀; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.08.2018, 6♀♀; 17.09.2018, 1♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.08.2018, 1♂; 17.09.2018, 3♀♀; Vezirköprü, Köprübaşı (41°03'11.9"N 35°30'57.8"E), 15.09.2018, 1♀; Alaçam, Geyikkoşan (41°37'12.6"N 35°36'28.7"E), 17.09.2018, 1♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 3♀♀.

Comments: This species is common in the USA, central and northern Europe, and Mediterranean countries (Peverieri et al., 2009; Miñarro and Kreiter, 2012). It has been reported from different plants in different parts of Turkey (Şekeroğlu, 1984; Faraji et al., 2011; Ozsisli and Çobanoğlu, 2011; Yeşilayer and Çobanoğlu, 2011; Kumral and Çobanoğlu, 2015; Akyazı et al., 2016; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). Öksüz (2019) collected this species from beans, cucumbers, eggplants and potatoes on the Çarşamba and Bafra plains of Samsun Province, Turkey. *Phytoseius finitimus* is a generalist predator that feeds on eriophyid and tetranychid mites, other small arthropods and pollen (Jeppson et al., 1975; Pappas et al., 2013).

***Typhlodromus* (*Anthoseius*) *rapidus* Wainstein and Arutunjan, 1968**

Typhlodromus (*Neoseiulus*) *rapidus* Arutunjan (1970)

Mumaseius rapidus Abbasova (1972)

Anthoseius (*Amblydromellus*) *rapidus* Arutunjan (1977)

Anthoseius rapidus Beglyarov (1981)

Amblydromella rapida Moraes et al. (1986)

Material examined: Only one specimen of this species was found - a female on the lower leaf surface - Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E) on 17.08.2018.

Comments: *Typhlodromus* (*Anthoseius*) *rapidus* was first found on apple and oak trees in Russia (Wainstein and Arutunjan, 1968). Later it was reported from *Betula* spp. and *Quercus* spp. in Latvia (Salmane and Petrova, 2002). It was first collected in Turkey by Çobanoğlu (1997) on *Coryllus* sp. in İzmit. In the current study, it was found on walnut trees in Turkey for the first time. The *Typhlodromus* species are included in the type III classification of McMutry and Croft (1997).

***Typhlodromus* (*Anthoseius*) sp.**

Material examined: Only two males of this unidentified *Typhlodromus* species were collected - Samsun, Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♂; Terme, Şeyhli (41°07'45.2"N 36°52'53.0"E), 18.08.2018, 1♂.

DISCUSSION

A total of nine phytoseiid species were recorded in this study. This relatively high number of phytoseiid species indicates that walnut orchards in the Black Sea region, particularly unsprayed orchards, provide suitable habitat for the establishment and maintenance of phytoseiid diversity. To date, there have been few studies on phytoseiid mites in walnut orchards in Turkey. This study represents the first in the Black Sea region on this subject. Kasap et al. (2008, 2009) recorded *E. finlandicus*, *K. aberrans*, *Paraseiulus soleiger* (Ribaga) and *Typhlodromus* (*Anthoseius*) *bagdasarjani* Wainstein and Arutunjan in walnut orchards in the Van Lake basin in eastern Turkey. Of them, *E. finlandicus* was common, especially in unsprayed orchards, and was observed feeding on harmful mites. Denizhan and Çobanoğlu (2009) investigated the eriophyoid mites and their predators in walnut orchards in Ankara Province of Turkey. In that study, *E. finlandicus* was observed feeding on eriophyoid mites. In another study on parks and green areas, Gökçe (2015) found *E. finlandicus* on walnut trees in Tekirdağ Province in northwestern Turkey. *Euseius finlandicus* was also found in *Amphitetranychus viennensis* (Zacher) colonies on walnut leaves in Iran (Rahmani et al., 2010). In another study in Iran on the distribution of phytoseiid mites, *E. finlandicus, E. amissibilis* Meshkov and *Euseius* sp. were observed feeding on the eriophyid mite, *Aceria erinea* (Nalepa), in walnut plantations (Hajizadeh and Mortazavi, 2015).

Kabíček (2010) studied the population densities of phytoseiid mites on walnut trees, especially uncultivated and unsprayed trees, in summer in the Central Bohemia region of the Czech Republic. In that study, 8 phytoseiid species were collected, namely *A. andersoni, E. finlandicus, Neoseiulella aceri* (Collyer), *N. tiliarum, Typhlodromus* (*T.*) *cotoneastri* Wainstein, *Typhlodromus* (*T.*) *pyri* Scheuten, *Paraseiulus triporus* (Chant and Yoshida-Shaul) and *Phytoseius turiacus* Wainstein and Kolodochka, and their mean combined density was 1.4 mites per leaflet. Of the eight species, *E. finlandicus* (34.8%) was the most abundant species, as in the current study. Another study was conducted in the Kashmir valley of India to determine the distribution and population densities of phytoseiid mites. The highest mean number of phytoseiids per leaf was recorded for *E. pruni* (=*E. finlandicus*) (5.3), followed by *Amblydromella* sp. (5.0) and *E. vignus* Rishi and Rather (4.0), and the lowest mean number was recorded for *Anystis baccarum* (L.) (1.5) (Rather et al., 2015). Sudo and Osakabe (2011) reported that many mite taxa commonly prefer to live on the lower leaf surfaces of wild vegetation. In the current study, the monthly mean phytoseiid numbers on the lower leaf surfaces were slightly more than twice the numbers on the upper leaf surfaces.

Some studies have demonstrated the efficacy of phytoseiid mites against spider mites in walnut plantations. In a study by Welter et al. (2011), *Galendromus occidentalis* (Nesbitt) was released to control *Tetranychus* spp. in walnut plantations in the King region of California. During the same study, *Amblyseius similoides* Buchellos and Pritchard and *Euseius* sp. were also observed in the plantations. The authors stated that *G. occidentalis* successfully controlled the spider mites. In another study, Mills et al. (2013) reported that the spider mite, *Tetranychus urticae* Koch, had become a secondary pest in walnut plantations in California and that *G. occidentalis* and *N. californicus* were effective predators. *Amblyseius similoides*, *E. stipulatus, E. quetzali* McMurtry, *E. tularensis* Congdon, *Metaseiulus* (*Metaseiulus*) *citri* (Garman and McGregor) and *Typhlodromus* (*Anthoseius*) *caudiglans* Schuster were also found in the plantations. In addition, Khan et al. (2016) reported that in walnut plantations in India, *T. urticae* could be controlled by *G. occidentalis*, if the pest population was not too high.

CONCLUSIONS

The high natural diversity of phytoseiid mites in the mostly unsprayed walnut orchards in Samsun Province in the Black Sea region of Turkey may include additional genetic diversity that could be usefully incorporated in IPM and organic control programs in tree crops, field crops and shadehouses.

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