

THE DISTRIBUTION, HOST PLANTS AND NATURAL ENEMIES OF WHITE PEACH SCALE, *PSEUDAULACASPIS PENTAGONA* (TARGIONI-TOZZETTI) (HEMIPTERA: DIASPIDIDAE), IN ANKARA PROVINCE

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ABSTRACT: The distribution, host plants, and natural enemies of the white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Hemiptera: Diaspididae), were investigated in 25 districts of Ankara Province, Turkey, during 2013-2015. Thirteen districts were infested with harmful white peach scale; infestation was most common in parks, roadsides, private and institution gardens in centrum and old silkroad parts of Ankara. Twenty-two host plant species were found in these 13 districts, five of which (*Aesculus carnea*, *Hibiscus* sp., *Paulownia tomentosa*, *Rhus thyphina* and *Salix babylonica*) had not previously been recorded as host plants in Turkey. Some host plant species, including *Catalpa bignonioides*, *Cornus alba*, *Fraxinus americana*, *F. excelsior*, *Forsythia intermedia*, *Morus alba*, *M. nigra* and *Sophora japonica*, were found to be very highly infested. Five species of predators and three species of parasitoids were associated with white peach scale. *Orius minutus* L., *Chrysoperla pallida* (Henry et al.) are new record as predator of *P. pentagona* in World and *Epitetracnemus comis* Noyes & Ren Hui are first time record in Turkey.

KEY WORDS: *Rhus thyphina*, *Salix babylonica*, *Epitetracnemus comis*, *Chrysoperla pallida*, *Orius minutus*

The white peach scale (WPS), *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Hemiptera: Diaspididae) is covered by a waxy scale that is oval to circular in shape and a creamy-white to reddish-orange in color female. By contrast, adult males are tiny, yellow, two-winged insects. Immature males are also covered with a scale, but this is elongate and snowy white.

WPS is Oriental species and widely distributed all over the world (Garcia et al., 2016). In 1886, this species was seriously pest of mulberry trees and a menace to the silk industry and neighboring countries (Rosen, 1990). After years their spreading towards the north has been observed in central Europe and Mediterranean basin (Bodenheimer, 1953; Kozstarab & Kozár, 1988; Hanks & Denno, 1994; Şişman & Ülgentürk, 2010; Kaydan et al., 2013). It is polyphagous species that infests mulberry, beside of various kinds of deciduous fruit trees, ornamental and wild plants (Ben-Dov et al., 2015). It develops 2-5 generations per year up hanging climatic and geographic conditions (Kosztarab, 1990; Park & Kim, 1990; Branscome, 2012).

WPS is a pest of economic importance for mulberry, peach trees and woody ornamentals. In USA, crop losses from WPS, plus control costs were only \$94000, but on the untreated peach trees the yield loss was valued at \$480000 (Kosztarab, 1990). In Hawaii, it is only known as a crop pest in papaya (*Carica*

papaya); WPS poses a serious quarantine problem here, as they move into the papaya fruit in heavily infested trees (Neumann et al., 2010).

WPS is also attacked by several natural enemies (Collins & Whitcomb, 1975). Some parasites have since provided good control of WPS under most conditions (Collins & Whitcomb, 1975).

WPS is one of the most widely distributed insect species on fruit trees in Turkey (Kozár et al., 1979) and is considered the primary pest for peach trees in the Black Sea region (Kıroğlu, 1981) and the East Mediterranean region (Erkiliç & Uygun, 1997). In Turkey, it has two generations per year in mountainous areas, and three generations per year in coastal areas (Kıroğlu, 1981; Erkiliç & Uygun, 1997). WPS infests fruit plants such as almond, apricot, cherry, kiwi, medlar, mulberry, peach, plum, walnut and ornamental trees in Turkey (Zeki et al., 2004; Ülgentürk et al., 2009; Kaydan et al., 2013).

In recent years, WPS has also become a pest of great importance for mulberry trees (*Morus* spp.) in Ankara, due to the increased number of mulberry. This study aims to find out the size and spread of this insect and also determine the possibility of using biological control elements within integrated control program in Ankara province.

MATERIALS AND METHODS

Surveys were conducted to determine the distribution, host plants, and natural enemies of WPS in 17 districts and eight areas of Centrum of Ankara in the Spring–Autumn period of 2013–2015 (Fig. 1). Sampling areas were randomly selected, and infested twigs and/or branches were collected and placed in labelled plastic bags. The samples were then taken to the laboratory and examined under a stereomicroscope. Some WPS females were placed in 70% ethyl alcohol for identification, while others were put into plastic jars to rear their natural enemies. Adult predators of WPS that were found feeding with WPS on the same plant were collected directly by hand, while immature stages were reared on the WPS in climate room. The identification of host plants was made by the Landscape Department of Faculty of Agriculture, University of Ankara, Turkey.

RESULTS AND DISCUSSION

In total, 23 host plant species of WPS were found in 13 districts of Ankara province in 2013–2015. 7 of them were fruit trees (*Juglans regia*, *Morus alba*, *M. nigra*, *Prunus avium*, *P. persica*, *Vitis vinifera*, *Ficus carica*), while 16 were woody ornamental trees (*Aesculus carnea*, *Catalpa bignonioides*, *Cornus alba*, *Forsythia intermedia*, *Fraxinus americana*, *F. excelsior*, *Hibiscus syriacus*, *Koelreuteria paniculata*, *Paulownia tomentosa*, *Rhus thyphina* var. *laciniata*, *Ribes aureum*, *Robinia pseudoacacia*, *Salix babylonica*, *Sophora japonica*, *Syringa vulgaris*, and *Tilia tomentosa*) and one ornamental species *Pelargonium peltatum* (Table 1). WPS was determined to very high level infestation in centrum of Ankara and some districts, especially Ayaş, Beypazarı, Nallıhan on old silkroad with *C. bignonioides*, *Cornus* spp., *Forsythia intermedia*, *Fraxinus* spp., *M. alba*, *M. nigra*, and *S. japonica*, being most common. While *P. peltatum*, *R. thyphina* var. *laciniata*, *S. babylonica*, *Ficus carica* and *V. vinifera* were found rare host plant with high infestation. Interestingly, *Fraxinus americana*, *F. excelsior*, *Hibiscus* sp., *P. peltatum*, *V. vinifera*, *Paulownia tomentosa*, *A. carnea*, *R. thyphina* var. *laciniata* and *S. babylonica* are found for the first time as host

plants of WSP in Ankara and last four of them are recorded for the first time in Turkey.

In Ankara, *Crataegus oxyacantha*, *C. bignonioides*, *F. intermedia*, *K. paniculata*, *M. alba*, *M. nigra* var. *pendula*, *R. aureum*, *S. japonica*, *S. vulgaris* have been recorded by previous researchers as host of WSP (Çobanoğlu & Düzgüneş 1986; Ülgentürk & Toros, 1996; Ülgentürk & Toros, 2000; Zeki et al., 2004). In Aegean, Black Sea, Central Anatolia, Marmara and Mediterranean regions of Turkey, many fruit and ornamental plant species like *Actinia chinensis*, *A. deliciosa*, *Aesculus* sp., *Ailanthus altissima*, *Buxus sempervirens*, *Prunus avium*, *P. amygdalus*, *P. laurocerasus*, *Pelarganium* sp., *Ribes aureum*, *Robinia pseudoacacia*, *Tamarix* sp., *Sophora japonica*, *Syringia*, *vulgaris* and *V. vinifera* were found as host plants of WPS (Çanakçıoğlu, 1977; Kiroğlu, 1981; Erkilic & Uygun, 1995; Ülgentürk & Çanakçıoğlu, 2004; Ülgentürk et al., 2009). *P. pentagona* is a cosmopolitan and polyphagous scale insect, and its wide range host spectrum points its adaptation and survival capacity.

In these study 5 species are found as predators of WSP; *Orius minutus* L. (Hemiptera: Anthocoridae), *Chilocorus bipustulatus* L., *Brumus quadripustulatus* L. (Coleoptera: Coccinellidae), *Cybocephalus* sp. (Coleoptera: Cybocephalidae) and *Chrysoperla pallida* (Henry et al.) (Neuroptera: Chrysopidae). The most common predator is *C. bipustulatus* followed by *Cybocephalus* sp. whereas the other predators are in few numbers. *C. bipustulatus* and *Cybocephalus* sp. are well known general predators on WPS and other scale insects in Turkey and all the world (Soylu & Ürel, 1977; Kiroğlu, 1981; Koztarab & Kozar 1988; Erkilic & Uygun, 1995; Erler & Tunç, 2001; Ülgentürk & Toros, 2001). In spring, *C. bipustulatus* had controlled successfully of population of WSP but this success was not permanently in peach orchards of Black Sea region (Kiroğlu, 1981). The other general predators are *Chrysoperla pallidus* and *Orius minutus* are detected first time on WPS in Turkey and the world. Both predators prey mites, thrips, whiteflies, aphids, many other soft-bodied arthropods and their immature stages (Soylu & Ürel, 1977; Hagen et al., 1999; Efe et al., 2015). Graora & Spasić (2008) were recorded first time *Chrysopa carnea* Stephens and *Deraeocoris ruber* Linnaeus feeding *P. pentagona*. We think omnivorous characters of these predators are limited to control of WPS populations in Ankara.

As parasitoid of white peach scale, 3 species namely *Aphytis proclia* (Walker), *Encarsia berlesei* (Howard) (Hymenoptera: Aphelinidae) and *Epitetracnemus comis* Noyes & Ren Hui (Hymenoptera: Encyrtidae) were found in Ankara. *E. berlesei* and *A. proclia* are common respectively while *E. comis* is few number in Ankara. This parasitoid is recorded for the first time in Turkey. *E. berlesei* is thelytokous, endophagous parasitoids, reproducing young female and both immature stages of WPS (Bennassy, 1958; Habibian & Assadi, 1989; Pedata et al., 1995). *E. berlesei* was introduced to Italy from Japan and U.S.A. for the control of heavy infestation of WPS on mulberry trees that use silk production. Releasing of *E. berlesei* was complete success in Italy and parasitoid distributed all over the areas in Europe (Rosen, 1990). *E. berlesei* was the most abundant parasitoid of WPS in Italian orchards (Goranna & Viggiani, 1997). According Bodenheimer (1958), few number of *E. berlesei* from Florida was introduced to control WSP on mulberry trees that used silk production in Bursa by director of Silk research Institute in in year 1930. Releasing was limited success in the beginning. Although *E. berlesi* was most common parasitoid of WPS in Antalya (Erler & Tunç, 2001), surprisingly it was insufficient to control WPS on peach in Black sea region (Kiroğlu, 1981) and in Mediteranean, Turkey (Erkilic & Uygun, 1995).

Gürkan (1982) reported *E. (Praspaltella) berlesei* and *Aphytis diaspidis* Howard were parasited 57.4% of *P. pentagona* of population in Marmara region.

General ectoparasitoid, *A. proclia* was recorded in the previous work in Ankara (Ülğentürk & Toros, 2001). Benassy (1961) was conducted ectoparasitoids like *Aphytis* were highly dependent on climatic influences. Endoparasitoid species like *Encarsia* more dependent their host than climatic conditions. Graora & Spasić (2008) were reported *E. berlesei* and *A. proclia* were found to be the most important regulators of *P. pentagona* population density with parasitism mounting to 60, even 64% in Serbia.

As a result of this study, among the 25 areas in Ankara, only 13 of them were infected with *P. pentagona*, 22 plant species has been found infected with armored insect. 4 of them are recorded for the first time in Turkey. In the affected areas with *P. pentagona*, 5 predators and 3 parasites were recorded. 2 predators and 1 parasite were not recorded in Turkey before. In a future study there is hope to see the relationship between *E. berlesei* and the WPS, and the extent of its ability to control this pest.

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Table 1. Host plants of white peach scale (*Pseudaulacaspis pentagona*) in Ankara Province.

District	Host plant	Location / date
Altındağ	<i>Cornus alba</i> , <i>C. alba</i> , <i>Fraxinus americana</i> <i>Forsythia intermedia</i> , <i>Juglans regia</i> , <i>Morus alba</i> , <i>M. nigra</i> , <i>Prunus avium</i> , <i>Sophora japonica</i> , <i>Syringa vulgaris</i>	Altın Park, 25.08.2013
	<i>M. nigra</i> var. <i>pendula</i>	Gençlik Park, 16.08.2014
	<i>M. alba</i> var. <i>pendula</i> , <i>Paulownia tomentosa</i>	Ankara Railway Station Garden, 16.08.2014
	<i>M. nigra</i>	Hasköy, 03.06.2015
	<i>S. japonica</i>	Aydınlık Evler, 03.06.2015
	Åyaş	<i>M. alba</i>
Beypazarı	<i>Ficus carica</i> , <i>M. alba</i> , <i>Salix babylonica</i> , <i>S. japonica</i>	Centrum, 21.09.2015
Cayırhan	<i>Paulownia tomentosa</i> , <i>M. alba</i>	Cumhuriyet Park, 21.9.2015
Çankaya	<i>Aesculus x carnea</i> , <i>Catalpa bignonioides</i> , <i>C. alba</i> , <i>F. excelsior</i> , <i>F. intermedia</i> , <i>J. regia</i> , <i>Koelreuteria paniculata</i> , <i>M. alba</i> , <i>M. nigra</i> , <i>Robinia pseudoacacia</i> , <i>S. japonica</i> , <i>Tilia tomentosa</i>	Dikmen Park 1, 2 Etap, 27.09.2013
	<i>M. alba</i>	Birlik quarter, 28.09.2014
	<i>M. alba</i>	Oran quarter, 28.10.2014
	<i>F. americana</i> , <i>S. japonica</i> , <i>Koelreuteria paniculata</i> , <i>M. nigra</i> , <i>Prunus persica</i>	Kurtuluş Park, 25.09.2013
	<i>M. alba</i> , <i>P. tomentosa</i>	Tandoğan, 01.10.2013
	<i>M. alba</i>	Ahlâtlıbel, 28.09.2015
	<i>M. alba</i>	Ulus Kale, 03.08.2014
	<i>M. alba</i> , <i>M. nigra</i>	Botanik Park, 20.04.2013
	<i>M. nigra</i>	Seğmenler Park, 20.04.2015
	<i>S. japonica</i>	İncek, 20.4.2015
	<i>M. alba</i> , <i>M. nigra</i>	Hoşdere, 20.04.2015
Çubuk	<i>S. japonica</i>	Esenboğa Airport Road , 30.06.2015
Gölbaşı	<i>M. alba</i>	Centrum
	<i>M. alba</i>	Hacıhasan village, 17.04.2013
	<i>F. excelsior</i>	Eymir Forest, 13.03.2014
Keçiören	<i>J. regia</i> , <i>M. alba</i> , <i>M. nigra</i>	İncirli Basınevler Park, 12.06.2013
	<i>C. bignonioides</i> , <i>C. alba</i> , <i>F. excelsior</i> , <i>F. intermedia</i> , <i>Hibiscus syriacus</i> , <i>M. alba</i> , <i>M. nigra</i>	Faculty of Agriculture /Campus, 23.05.2015
	<i>Fraxinus excelsior</i>	Ankara University Campus
	<i>M. alba</i>	General Directorate of Meteorology /garden
	<i>S. japonica</i>	Keçiören Casino Park, 18.05.2015
	<i>S. japonica</i>	Sanatoryum Hastanesi Bahçesi, 06.06.2015
Mamak	<i>F. intermedia</i> , <i>M. nigra</i> , <i>S. japonica</i> , <i>S. vulgaris</i>	Ankara Üniversitesi Dikimevi- Campus, 25.09.2013
	<i>R. pseudoacacia</i>	Samsun Highway, 15.09.2014
Nallıhan	<i>C. bignonioides</i> , <i>F. intermedia</i> , <i>M. nigra</i> , <i>M. alba</i> , <i>Prunus persica</i> , <i>Vitis vinifera</i>	Centrum and road, 21.09.2015
Polatlı	<i>M. alba</i> , <i>R. pseudoacacia</i> , <i>S. japonica</i>	Centrum, 20.09.2014

Pursaklar	<i>C. bignonioides</i> , <i>M. alba</i>	Bağla quarter, 15.05.2013
Yenimahalle	<i>M. alba</i> , <i>S. japonica</i> , <i>S. vulgaris</i>	TAGEM / garden, 10.07.2013
	<i>C. bignonioides</i> , <i>C. alba</i> , <i>F. intermedia</i> , <i>F. americana</i> , <i>M. alba</i> , <i>M. nigra</i> , <i>J. regia</i>	Demetevler Cemre Park, 12.06.2013
	<i>C. bignonioides</i> , <i>Ribes aureum</i>	Ministry of Agriculture Logistics Facilities / garden, 15.11.2013

Table 2. Predators of white peach scale (*Pseudaulacaspis pentagona*) in Ankara Province.

Predator	Host plant Date / location
<i>Chilocorus bipustulatus</i> L.	<i>Morus alba</i> , 26.08.2014, Altınpark; <i>M. alba</i> var. <i>pendula</i> , <i>M. alba</i> , <i>Morus alba</i> , 12.04.2013, Oran <i>Aesculus hippocastanum</i> , <i>Catalpa bignonioides</i> , <i>Cornus alba</i> , <i>Fraxinus americana</i> , <i>M. alba</i> , <i>M. alba</i> var. <i>pendula</i> , <i>Morus nigra</i> , <i>Robinia pseudoacacia</i> , <i>S. japonica</i> , 27.09.2015, Dikmen 1, 2 etap; <i>C. bignonioides</i> , <i>Fraxinus excelsior</i> , <i>M. alba</i> , <i>Morus nigra</i> var. <i>pendula</i> , 23.05.2015, Ankara University Campus, Tandoğan; <i>M. alba</i> , <i>C. bignonioides</i> , 17.05.2015, Faculty of Agriculture Campus; <i>S. japonica</i> 25.09.2014, Ankara University Dikimevi Campus; <i>C. bignonioides</i> , <i>F. americana</i> , <i>M. alba</i> , 10.08.2014, Cemre park; <i>C. bignonioides</i> , 15.11.2015, Campus of Agriculture, Yenimahalle
<i>Brumus quadripustulatus</i> L.	<i>M. alba</i> , 15.11.2015, Campus of Agriculture, Yenimahalle
<i>Cybocephus</i> sp.	<i>M. alba</i> , 26.08.2014, Altınpark; <i>Morus alba</i> , 12.04.2013, Oran; <i>M. alba</i> , 12.07.2014, Seymenler park; <i>M. alba</i> , <i>S. japonica</i> , 23.05.2015, Ankara University Campus, Tandoğan; <i>Forsythia intermedia</i> , <i>F. excelsior</i> , 17.05.2015, Faculty of Agriculture Campus; <i>C. bignonioides</i> , <i>M. alba</i> , 21.09.2015, Centrum: <i>M. alba</i> , Cemre park Demetevler, Ankara, 21.10.2015
<i>Orius minutus</i> L.	<i>F. excelsa</i> , 20.07.2015; <i>F. excelsa</i> , 22.09.2015; Altınpark, <i>M. alba</i> , <i>Salix babylonica</i> , 21.09.2015, Beypazarı
<i>Chrysoperla pallida</i> (Henry et al.)	<i>M. alba</i> , 21.09.2015, Botanik park

Table 3. Parazitoits of white peach scale (*Pseudaulacaspis pentagona*) in Ankara province.

Parazitoit	Host plant Location / Date
<i>Aphytis proclia</i> (Walker)	<i>M. alba</i> , Ayaş, 24.03.2013; <i>M. alba</i> , Ayaş, 13.05.2013; <i>M. alba</i> , Bağlar, 11.06.2013; <i>M. alba</i> , Cemre park Demetevler, Ankara, 21.10.2015
<i>Encarsia berlesei</i> (Howard)	<i>M. alba</i> , Altınpark, 22.05.2013; <i>M. alba</i> , Bağlar, 20.05.2013; <i>M. alba</i> , Ayaş, 13.05.2013; <i>M. alba</i> , Botanik park, 10.05.2013; <i>M. alba</i> , Gölbaşı, 03.04.2013
<i>Epitetracnemus comis</i> Noyes & Ren Hui	<i>M. alba</i> , Beypazarı (centrum), 21.09.2015; <i>M. alba</i> , Cemre park Demetevler, Ankara, 21.10.2015