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New additions and invasive aphids for Turkey's aphidofauna (Hemiptera: Aphidoidea)

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Abstract: This study was carried out in order to determine aphid species in the Inner Western Anatolian Subregion of Turkey. Nineteen aphid species are reported as new to the Turkish aphid fauna. These species are *Aphis eryngiglomerata* Bozhko, 1963; *Aphis glareosae* Bozhko, 1959; *Capitophorus eniwanus* Miyazaki, 1971; *Chaitophorus indicus* A.K. Ghosh, M.R. Ghosh & D.N. Raychaudhuri, 1970; *Chaitophorus ramicola* (Börner, 1949); *Cinara indica* Verma, 1970; *Cinara juniperensis* (Gillette & Palmer, 1925); *Cinara oxycedri* Binazzi, 1996; *Cinara setosa* (Börner, 1950); *Eulachnus thunbergii* Wilson, 1919; *Hyadaphis passerinii* (Del Guercio, 1911); *Mindarus kinseyi* Voegtlin, 1995; *Myzus padellus* Hille Ris Lambers & Rogerson, 1946; *Phylloxera quercina* (Ferrari, 1872); *Rhopalosiphum rufulum* Richards, 1960; *Schizaphis dubia* Huculak, 1968; *Schizolachnus orientalis* (Takahashi, 1924); *Tiliaphis shinjii* Higuchi, 1972; and *Tuberculatus borealis* (Krzywiec, 1971). Among these, 5 species are invasive to the Turkish aphidofauna. It is not surprising that new records and invasive species would be added to the Turkish aphid fauna due to Turkey's special floristic composition and various geographical and climatic features.

Key words: Aphid, Anatolia, invasive, new records, Turkey

1. Introduction

Aphidoidea is a large superfamily containing over 4500 aphid species worldwide (Remaudiere and Remaudiere, 1997; Blackman and Eastop, 2012). The Aphidoidea fauna of Turkey is one of the most diverse and fascinating in the Eurasian region, and studies about Turkey's aphid fauna have been conducted since the beginning of the 20th century. Initial studies pertaining to Turkish aphid fauna were revised by Çanakçıoğlu (1975), who listed 258 aphid species in the book *Aphidoidea of Turkey*. Following these studies, recent additions to the aphidofauna of Turkey were summarized by Remaudiere et al. (2006), Görür et al. (2012), and Şenol et al. (2014). A total of about 500 species in 141 genera and 3 families have been presented for the Turkish aphidofauna.

In addition to faunistic studies, researchers have realized that during the last 2 decades some species have changed their native habitats due to fluctuations in the biotic and abiotic conditions that influence them. These species are referred to as invasive (Liu et al., 2010). Aphids are considered an important invasive species group due to their small size, high fecundity, short development time, cyclical parthenogenetic reproduction, host preferences, and close participation with their host plants (Mondor and Addicott, 2007). Moreover, increased global trade and

recent climatic changes have resulted in the introduction and establishment of invasive aphid species into the different regions of the world as well as into Turkey. Turkey is in the Mediterranean Basin of the Palearctic region; only 2.4% of Turkey aphid fauna is native to Turkey (Akyıldırım et al., 2013). The aphid species that are considered invasive to the Turkish fauna originated from the Nearctic, Neotropic, Oriental, and Ethiopian regions. The objectives of this study are to give information about new records and invasive aphid species for the Turkish aphid fauna.

2. Materials and methods

This study was conducted in the Inner Western Anatolian Subregion (Kütahya, Afyonkarahisar, and Uşak provinces) of Turkey from April 2012 to July 2013. Samples (indicating each separate collection from different colonies, whether from the same host plant or different host plants) were processed in a laboratory according to the methods of Martin (1983). Processed samples were identified following Blackman and Eastop (2006, 2012) and Quednau (1999, 2003), and their taxonomic statuses were checked in accordance with recently evaluated sources and literature (Favret, 2013; Nafria, 2013). Identified samples were deposited in the Biology Department of Niğde University. Worldwide distribution, simple biology, and host plants

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were taken mainly from the previous literature for each newly recorded species. Origins of the invasive species were given as a result of evaluation of all current published studies related to the Turkish aphid fauna and other publications about world aphid fauna. Distinguishing features of each determined species are supplied.

3. Results

The evaluation of derived data showed that 19 species are new records for Turkey's aphid fauna. Distinguishing features and general information of each recorded species are presented in alphabetical order as follows. Invasive species are marked with asterisks.

Aphis eryngiglomerata Bozhko

Distinguishing features: No supracaudal process. ANT PT/BASE 1.7–7.1. Cauda much longer than its basal width. SIPH without polygonal reticulation. Well-developed marginal tubercles (MTu) present on ABD TERG 2–4 as well as 1 and 7. Hairs on legs all short (Blackman and Eastop, 2012).

Material examined: Two samples were collected on bases of branches of *Eryngium* sp. from Afyonkarahisar (between Hocalar and Sandıklı) (09.X.2012) and Kütahya (between Gediz and Simav) (07.X.2012).

Distribution: Widely distributed on *Eryngium* spp. in East Europe (Holman, 2009; Blackman and Eastop, 2012).

Aphis glareosae Bozhko

Distinguishing features: Eyes multifaceted. Hind tarsi similar in length to other tarsi. Head without spicules. ANT tubercles absent, ANT less than $0.9 \times$ BL, usually without rhinaria on III, ANT PT/BASE 0.9–2.5. Hairs on ANT III minute, the longest $0.3\text{--}0.4 \times$ BD III. Spiracular apertures reniform. SIPH imbricated, pale or dark, without a subapical annular incision. Stridulatory apparatus absent. Cauda helmet-shaped, triangular or finger-shaped, at least $0.8 \times$ as long as its basal width, with 7–15 hairs, MTu present on at least some of ABD TERG 2–6 as well as 1 and 7; MTu on ABD TERG 2–4 is $0.25\text{--}0.33$ the distance between them. Dorsum invariably with extensive dark sclerotization (Blackman and Eastop, 2012).

Material examined: Three samples were collected on *Euphorbia* sp. from Kütahya - Dumlupınar/Çalköy (28.VII.2012), Uşak - Sivaslı (23.IV.2013), and Uşak - Banaz (23.IV.2013). Blackish apterae individuals generally fed on the sprout.

Distribution: Widely distributed on *Euphorbia* spp. in East Europe (Holman, 2009; Blackman and Eastop, 2012).

Capitophorus eniwanus Miyazaki

Distinguishing features: ANT PT/BASE more than 0.7. SIPH present and $2.2\text{--}2.5 \times$ cauda, and only moderately swollen on distal part. Head cuticle mostly either smooth, wrinkled, corrugated, or papillate; without spicules, or with spicules only either anteroventrally or

posteriorly. Dorsal hairs, or at least those on head and ABD TERG 8, long, thick, and capitate, and arising from tuberculate bases. R IV + V rostrate; R IV + V $1.2\text{--}1.7 \times$ HT II (Blackman and Eastop, 2012).

Material examined: One sample (4 adult apterous individuals) was collected on *Polygonum* sp. from Kütahya - Tavşanlı (27.VII.2012). Pale greenish apterae individuals generally fed on the undersides of leaves.

Distribution: Japan, Russia, Siberia, Tajikistan (Holman, 2009; Blackman and Eastop, 2012).

**Chaitophorus indicus* Ghosh, Ghosh & Raychaudhuri

Distinguishing features: Body not aleyrodiform, not broadest anteriorly, without wax glands or with wax glands on ABD TERG 7, abdominal tergum pale, with long, pointed or spine-like spinal, pleural, and marginal hairs interspersed with smaller hairs, some of which are much smaller ($0.25 \times$ length of longest), ABD 2–6 with accessory hairs finer and less numerous, ABD TERG 1–7 with weak squamous or nodulose ornamentation. Head of immature alata without a pair of frontal horns. Antennae 5- or 6-segmented, longest hairs on ANT III $1.7\text{--}2.5 \times$ basal diameter of segment, ANT PT/BASE 2.7–3.4. Eyes multifaceted. Cauda with a constriction delimiting an apical knob. SIPH in form of small truncate cones or short cylinders (usually at least $0.5 \times$ basal width), with reticulate sculpturing at least distally. First tarsal segments usually with 7 hairs, empodial hairs enlarged and flattened, with expanded apices (Blackman and Eastop, 2012).

Material examined: Five samples were collected on *Populus* sp. from Afyon - Bolvadin (04.V.2012), Kütahya - Çavdarhisar (24.VII.2012), Kütahya - Tavşanlı (27.VII.2012), Kütahya - Domaniç (27.VII.2012), and Kütahya - Dumlupınar (28.VII.2012). Greenish apterae individuals generally fed on upper sides of leaves.

Distribution: It is an Oriental species (Chackrabarti, 1972) recorded from India and Pakistan (Holman, 2009; Blackman and Eastop, 2012).

Chaitophorus ramicola (Börner)

Distinguishing features: Abdominal tergum sclerotic, pale or pigmented, ABD TERG 1 separate, 2–6 fused or separate, ABD TERG 2 separate from 3, and ABD TERG 3–6 often with separate or only partially fused bands. Tergum usually dark, either completely or with a paler spinal region. Dorsal body hairs variable, usually with pointed apices. Cauda bluntly conical, often with an indentation or constriction partially delimiting a tongue-shaped or rounded apical part, but with the width at the constriction not usually less than $0.8 \times$ the maximum diameter of the apical part. ANT III with 2–30 hairs, but if 4 or fewer, then the longest are 30–100 μm , ANT BASE VI with 2, or rarely 3, hairs. Hind tibia without a basal swollen part bearing scent plaques. R IV + V $1.0\text{--}1.3 \times$ HT II (Blackman and Eastop, 2012).

Material examined: One sample (6 adult apterous individuals) was collected on *Salix* sp. from Afyonkarahisar - Dinar (05.X.2012). Dark greenish apterae individuals generally fed on the underside of leaves as a small colony.

Distribution: North, Central, and East Europe; Iran; and Kazakhstan (Holman, 2009; Blackman and Eastop, 2012).

****Cinara indica* Verma**

Distinguishing features: BL more than 3.0 mm. Antenna 6-segmented, ANT PT/BASE less than 1, longest hairs on ANT III maximally more than 2× basal diameter of segment. SIPH are broad hairy cones, SIPH cones large and dark with numerous hairs. R V acutely pointed, dagger-shaped, usually twice or more as long as its basal width. Dorsal hairs normal, pointed. Dorsal length of HT I shorter than basal width. Aptera with HT II 4× or more HT I. ANT III with fewer than 30 hairs of very variable length, often less than 2× basal diameter of segment (Blackman and Eastop, 2012).

Material examined: One sample (3 adult apterous individuals) was collected on *Cedrus* sp. from Afyon - Sultandağı (23.VIII.2012). Brownish black and large apterae individuals fed on the trunk and were heavily attended by ants.

Distribution: It is an Oriental species recorded from India (Holman, 2009; Blackman and Eastop, 2012).

****Cinara juniperensis* (Gillette & Palmer)**

Distinguishing features: SIPH in form of large pores on broad, often pigmented, hairy cones. SIPH base if with more than 70 hairs then many of these are longer than diameter of siphuncular pore. Greatest diameter of SIPH cone at least 0.28 mm, more than R IV + V. Rostrum much shorter than body. Hairs less fine and numerous, more erect and usually longer. Hairs on ANT III mostly more than 2× diameter of segment at midpoint and/or hairs on dorsal side of hind tibia mostly more than 1.5× width of tibia at midpoint. HT I with dorsal length a little more than or at least equal to (1.0–1.2×), basal width PT with 4–5 subapical hairs. HT II more than 0.25 mm long. ANT BASE VI 0.14 mm or more (Blackman and Eastop, 2012).

Material examined: One sample (2 adult apterous individuals) was collected on *Juniperus* sp. from Kütahya - Gediz (Şaphane junction) (24.IV.2013). Brownish apterae individuals generally fed on twigs.

Distribution: It is a Nearctic species (Gillette and Palmer, 1925), recorded from the United States (Colorado, Oregon) (Blackman and Eastop, 2012).

***Cinara (Cupressobium) oxycedri* Binazzi**

Distinguishing features: BL often less than 2.7 mm (range 2.1–3.4 mm). ANT V 0.7–0.9× ANT VI (incl. PT). ANT BASE VI without a constriction. ANT III without secondary rhinaria. Hairs on ANT III mostly more than 2× diameter of segment at midpoint and/or hairs on dorsal

side of hind tibia mostly more than 1.5× width of tibia at midpoint, ANT III 0.29–0.40 mm long, 1.25–1.7× longer than ANT VI (incl. PT). PT usually with 3 subapical hairs. SIPH in form of large pores on broad, often pigmented, hairy cones. ANT III less than 1.2× longer than maximum diameter of SIPH base. If SIPH base has more than 70 hairs, then many of these are longer than diameter of siphuncular pore. Rostrum much shorter than body, R IV 0.15–0.18 mm long and bearing 4–6 accessory hairs. R IV + V 0.83–0.99× HT II. Length of sclerotized part of stylet groove less than 1.25 mm, and less than 0.34× BL. Hairs less fine and numerous, more erect and usually longer. Longest dorsal tibial hairs 1.5–2.7× width of tibia at midpoint. Longest dorsal tibial hairs 1.9–2.7× width of tibia at midpoint. HT I with dorsal length distinctly shorter (0.5–0.9×) than basal width. Hind tibiae uniformly brown, except sometimes for a slightly lighter region on the basal half. ABD TERG 2 with spinopleural sclerites (Blackman and Eastop, 2012).

Material examined: One sample (3 adult apterous individuals) was collected on *Juniperus* sp. from Kütahya - Gediz/Dörtdeğirmen village (26.IV.2013). Pale brownish apterae individuals fed among leaves.

Distribution: Corsica, Italy, Spain (Blackman and Eastop, 2012; Nafria, 2013).

***Cinara setosa* (Börner)**

Distinguishing features: Dorsal abdomen with or without sclerites, but these are rarely fused between segments or with SIPH cones. ABD TERG 5 with 3–44 hairs between SIPH cones, the longest 5–140 µm. HT I (measured along ventral side) 0.07–0.17 mm long and less than 0.5× HT II. R IV less than 0.25 mm long, bearing 4–12 accessory hairs and less than 0.6× HT II, which is 0.27–0.41 mm. Longest hairs on ANT III 25–100 µm, on hind tibia 40–130 µm. ANT V 1.6–2.0× ANT VI (including PT). Genital plate with 26–35 hairs (Blackman and Eastop, 2012).

Material examined: One sample (2 adult apterous individuals) was collected on *Pinus* sp. from Kütahya - Tavşanlı/Göbel Thermal (25.VIII.2012). Brownish large apterae individuals generally fed on the base of the immature cones and were attended by ants.

Distribution: Austria and Italy (Holman, 2009; Blackman and Eastop, 2012).

***Eulachnus thunbergii* (Wilson)**

Distinguishing features: Adults without chitinous ovipositor. Eyes multifaceted. BL usually more than 1.3 mm. Rostrum less than 1.5× BL. Head and prothorax separate, antenna 6-segmented, ANT III more than 0.25 mm long and bearing hairs 20–130 µm long, ANT PT/BASE less than 1. SIPH as small pores without associated hairs. Hairs on ABD TERG 1–6 arising from dark sclerites or sclerites (small rounded sclerites). Hairs on ABD

TERG 1–7 usually longer than or as long as the minimal width of their basal sclerites. ABD TERG 1–3 with longest hairs 25–145 µm long. Hair-bearing sclerites on ABD TERG 1–5 in 2 irregular transverse rows on each tergite, the anterior row having more sclerites than the posterior row. Fore femur dusky or dark and very thick, its length less than 3.5× its maximum width (Blackman and Eastop, 2012).

Material examined: Six samples were collected on *Pinus* sp. from Afyon - Çay (4 samples) (15.IV.2013), Kütahya - Pazarlar (24.IV.2013), and Kütahya - Murat Mountain (26.IV.2013). Blackish apterae individuals generally fed on the needles in series.

Distribution: Widely distributed in East and Southeast Asia (China, India, Japan, Korea, Russia, Siberia, Philippines, and Taiwan), and in Australia (Holman, 2009; Blackman and Eastop, 2012).

Hyadaphis passerinii (del Guercio)

Distinguishing features: ANT PT/BASE more than 0.5. No wax gland plates. Eyes multifaceted. SIPH present (sometimes very small). SIPH 0.19–0.46 mm long and 0.85–1.2× cauda, usually with a distinct flange, SIPH without subapical polygonal reticulation, SIPH slightly to markedly swollen in middle or on distal part, the swollen section being at least 0.3 of the total length. Cauda finger-like and 1.25–2.0× its basal width in dorsal view and more than 0.12× BL. Prosternum with a dark, clearly defined trapezoid sclerite. Prosternal sclerite 2.7–3.6× wider than long. R IV + V 0.083–0.122 mm long (Blackman and Eastop, 2012).

Material examined: Two samples were collected on *Lonicera* sp. from Uşak - Karahallı (13.VI.2012) and Kütahya - Old Gediz (25.IV.2013). Small dull greenish apterae individuals fed on the undersides of leaves.

Distribution: Distributed particularly in South Europe, the Mediterranean, the Middle East, Pakistan, and India, and introduced into Africa, Australia, New Zealand, and South and North America (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

****Mindarus kinseyi*** Voegtlin

Distinguishing features: BL 1.3–7.8 mm. Eyes reduced, usually to only 3 facets (triommatidia). Aptera with head and prothorax fused dorsally, and antennae longer than rostrum. Aptera with 1–2 pairs of wax pore plates on all of ABD TERG 1–7, and usually with 3 pairs on ABD TERG 6. Prothorax of aptera with a pair of marginal wax pore plates, and such plates also often present at least on ABD TERG 2–7, with additional submarginal pairs often at least on ABD TERG 6 and 7. Adult apterae with 5- or 6-segmented antennae, at least 0.2 of body length, ANT PT/BASE less than 1.0. ANT III of alata with 8–23 rhinaria. SIPH either absent or present as pores without pigmented conical bases. Hairs on antennae and legs

short. R IV almost always with a pair of accessory hairs, rarely with 0–1 on apterae (Blackman and Eastop, 2012).

Material examined: One sample (about 4 small adult apterous and 2 alatae individuals taken from colony) was collected on *Abies* sp. from Uşak - Sivaslı (16.V.2013). White-greenish apterae individuals fed on the tips of the needles, and alatae individuals fed between needles.

Distribution: It is a Nearctic species (Voegtlin, 1995) distributed in eastern Canada and California (Quednau, 2010; Blackman and Eastop, 2012).

Myzus* (*Prunomyzus*) *padellus Hille Ris Lambers & Rogerson

Distinguishing features: Head capsule with spiculose (sometimes delicate) or nodulose ornamentation. Antennal tubercles at least partially developed without a finger-like projection. ANT PT/BASE more than 0.8, ANT III always without secondary rhinaria. If antennal tubercles are well developed, then the inner faces are usually gibbous in dorsal view or bear projections; ANT I with inner side scabrous or smooth but not protuberant. SIPH and antennal segments pale or dark but not contrastingly 2-toned, SIPH tubular, black, without hairs, heavily imbricated. Cauda rounded, triangular or finger-like, sometimes with a constriction but not distinctly knobbed. Anal plate entire. Marginal tubercles present or absent, if present usually smaller and on fewer segments. Mesosternum without spinal processes. Tergum either pale or dark. Longest hairs on ABD TERG 1–6 more than 20 µm long, with pointed apices, 0.8× or more basal diameter of ANT III. Hairs on ANT III with blunt or pointed apices. Spring generations curling, rolling, twisting, or blistering leaves, but not in closed galls (Blackman and Eastop, 2012).

Material examined: Three samples were collected on *Prunus* sp. from Uşak - Hocalar/Yeşilhisar village (23.IV.2013), Kütahya - Old Gediz (25.IV.2013), and Kütahya - Oysu village (26.IV.2013). Blackish apterae individuals heavily colonized and fed on the undersides of leaves.

Distribution: Distributed in Europe, Georgia, across Russia to east Siberia and Korea (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

Phylloxera quercina (Ferrari) (= *spinulosa* Targioni Tozzetti)

Distinguishing features: BL 0.9–1.5 mm. Free-living on stems and leaves. Stellate processes if present also in adult stage and with knob-like secondary projections. Dorsal processes evident, usually widened at extreme base, mostly longer than their basal widths; their apical hairs usually have expanded or capitate apices. Longest dorsal processes have attenuated, cylindrical apices and are more than 3× longer than their basal diameters. Longest dorsal processes on thorax tapering, without a constriction, narrow distally; if cylindrical on distal part then much narrower near apex than at base. Spicules on dorsal processes larger and not

arranged in spiral rows. All thoracic tergites and ABD TERG 1 with pleural as well as marginal processes. Dorsal cuticle with nodulose ornamentation. Spiracles present on ABD TERG 1–5 (Blackman and Eastop, 2012).

Material examined: Three samples were collected on *Quercus* sp. from Kütahya - Murat Mountain (26.VIII.2012), Kütahya - Gediz (near Uşak) (27.VIII.2012), and Uşak - Karahallı (28.VIII.2012). Yellowish apterae individuals fed on the undersides of leaves.

Distribution: Distributed in Mediterranean countries (Israel, Italy, Portugal) and Slovenia (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

****Rhopalosiphum rufulum* Richards**

Distinguishing features: Antennal tubercles undeveloped or weakly developed, ANT PT/BASE less than 2.0 in fundatrix and less than 2.5 in subsequent generations. Antenna of alata with oval or circular secondary rhinaria. Cauda tongue- or finger-shaped, clearly longer than its basal width; sometimes less than 1.4× longer. Cauda and anal plate dusky to dark. SIPH of aptera dark or, if only dark at apex, then short (less than 0.25 mm). SIPH slightly swollen or cylindrical on at least basal 0.7 of length, narrowing only towards apex, and with a well-developed apical flange. Marginal tubercles on ABD TERG 7 placed posterodorsally of spiracle, and usually smaller at base than the spiracular opening. Tibiae mainly pale or dusky, sometimes dark at apices (Blackman and Eastop, 2012).

Material examined: One sample (3 adult apterous individuals) was collected on *Crataegus* sp. from Kütahya - Dumlupınar (28.VII.2012). Greenish apterae individuals fed on the undersides of leaves.

Distribution: It is a Nearctic species (Hidalgo et al., 2012) distributed in Canada and Europe (Denmark, England, Germany, Netherlands, former Czechoslovakia) (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

***Schizaphis dubia* Huculak**

Distinguishing features: SIPH cylindrical or tapering, sometimes with or without a slight subapical constriction, but usually with a small flange. SIPH dusky, only dark at apices 0.6–2.5× cauda and 0.12–0.18× BL and 1.4–2.0× cauda. Cauda pale or dusky. Dorsal cuticle not coarsely rugose. ABD TERG 1 and 7 without marginal tubercles (MTu), or rarely only on ABD TERG 7 (Blackman and Eastop, 2012).

Material examined: One sample (2 adult apterous individuals) was collected on *Bromus* sp. from Afyonkarahisar - Sultandağı (14.IV.2013). Greenish apterae individuals fed on upper sides of leaves.

Distribution: Distributed in northern Europe (Finland, Poland, Sweden) (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

***Schizolachnus orientalis* (Takahashi)**

Distinguishing features: BL usually more than 1.3 mm, eyes multifaceted. Adults without chitinous ovipositor. Head and prothorax separate, and antenna of at least 4 segments, ANT PT/BASE less than 1. SIPH as large pores on usually pigmented hair-bearing cones. Rostrum less than 1.5× BL; R V with long tip, more than 46 µm long and more than 0.45× R IV. Hairs on ventral side of hind femur long, not peg-like. Hind legs long but less than 2× BL, with at least basal fifth of femur pale. Hind tibia pale, bearing mainly long (less than 20× longer than its width at midpoint) finely pointed hairs. Dorsal abdominal hairs also long and fine, not arising from sclerites (Blackman and Eastop, 2012).

Material examined: Six samples were collected on *Pinus* sp. from Kütahya - Akpınar village (27.VII.2012), Afyonkarahisar - Sandıklı (09.X.2012), Uşak - Banaz (23.IV.2013), Kütahya - Gediz (2 samples) (26.IV.2013), and Kütahya - Murat Mountain (26.IV.2013). Yellowish brown and dirty-white wax-covered meal apterae individuals fed in rows along needles.

Distribution: Distributed in China, India, Japan, Taiwan (Holman, 2009; Blackman and Eastop, 2012).

***Tiliaphis shinjii* Higuchi**

Distinguishing features: BL less than 4 mm, SIPH pale as truncate cones, hardly longer than their basal width. Cauda knobbed, anal plate bilobed (all viviparae alate). Base of forewing infuscated, forewing with a zigzag black band joining distal ends of media, Cu1a and Cu1b. Costal margin of forewing heavily pigmented and RS present. Secondary rhinaria on ANT III transversely elongate, with rims not ciliated. R IV + V and SIPH both longer than HT II. ANT III with 8–16 secondary rhinaria. Hind femur mainly pale. ABD TERG 1–7 with or without dark markings. Mesothoracic dorsal lobes each with a longitudinal dark stripe (Blackman and Eastop, 2012).

Material examined: Two samples were collected on *Tilia* sp. from Kütahya - Şaphane (25.VII.2012) and Afyonkarahisar - Sinanpaşa (10.VII.2012). Greenish apterae individuals fed on the undersides of leaves; their colony was mixed with *Eucallipterus tiliae*.

Distribution: Distributed in Japan, Korea, and eastern Siberia (Holman, 2009; Blackman and Eastop, 2012).

***Tuberculatus (Tuberculoides) borealis* (Krzywiac)**

Distinguishing features: Frontal hairs mostly shorter than and hairs on ANT III less than 0.5× basal diameter of ANT III. Dorsal abdomen with more than 1 pair of spinal processes, usually separated basally, which may be conical or finger-like, or merely low hair-bearing bases that in a few species are only slightly raised above the surface. Marginal hairs also often on processes. Dorsal hairs of immature specimens and embryos without spicules.

Spinal hairs on at least ABD TERG 2–3 of embryos only half as long as marginal hairs on same segments or shorter. Embryos with spinal hairs on ABD TERG 1–6 all about 5–8 µm long, thin, with blunt apices; marginal hairs 15–45 µm long, with those on at least ABD TERG 2–3 not overlapping those of next tergite. First tarsal segments with 5–7 ventral hairs. Forewings not maculate, except in 1 specimen that has dark marginal processes. Tibiae pale or variably pigmented but without a well-defined jet-black basal spot. ABD TERG 1–4 each with a pair of pale spinal processes. R IV + V 0.08–0.12 mm, 0.80–1.05× HT II, with 2 pairs of lateral accessory hairs (and 3–5 ventral ones) (Blackman and Eastop, 2012).

Material examined One sample (3 adult apterae individuals) was collected on *Quercus* sp. from Uşak - Eşme (15.V.2013). Greenish apterae individuals generally fed on the undersides of leaves.

Distribution: Distributed in Europe (England, Belgium, Denmark, western Russia), east to Iran, and introduced to North America (Holman, 2009; Blackman and Eastop, 2012; Nafria, 2013).

Among these defined species, 5 species are considered as invasive to Turkey's aphid fauna. It was shown that the origins of these determined invasive species are Nearctic and Oriental.

4. Discussion

Recent studies conducted on Turkey's aphid fauna have shown that there is a high probability of determining new additions due to the characteristic features of Turkey. In

accordance with these properties, Görür et al. (2012) listed 480 species, and then Şenol et al. (2014) added 10 new entries for Turkey's aphid fauna. Nineteen species were determined as new records for the Turkish Aphidoidea fauna within the samples collected from the Inner Western Anatolian Subregion of Turkey. With these new records, the number of species known in Turkey's aphidofauna was increased to about 510. In addition, increased global trade and recent climatic changes have resulted in the introduction and establishment of invasive aphid species into different regions of the world, including Turkey. Aphids can be introduced and adapt to new areas easily due to their small size and ability to reproduce both sexually and asexually (with parthenogenesis) (Coeur d'Acier et al., 2010). Akyıldırım et al. (2013) analyzed the zoogeographical composition of Turkey's fauna and listed 41 invasive species, which indicated that about 8% of Turkey's aphid fauna are invasive. With the results of the present study, the number of invasive species has increased to 46. As Turkey is geographically and climatologically heterogeneous and agriculturally diverse and rich, 31% of Turkish flora is endemic (Davis, 2008) and the aphid fauna in some regions has not been studied yet, it would not be surprising to determine more new records and invasive species for Turkey's aphid fauna.

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