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The new association records on ants (Hymenoptera: Formicidae) and aphids (Hemiptera: Aphididae) in the Central Province of Çanakkale

Çanakkale il merkezinde yaprakbitleri (Hemiptera: Aphididae) ile karınca (Hymenoptera: Formicidae) türlerinin yeni ilişki kayıtları

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ABSTRACT

Aphid and ant species have a mutualistic or an obligately mutualistic association in nature conditions. Many ant species protect soft-bodied aphids with a low level of defense against their natural enemies. This study was conducted to determine the associations between aphid and ant species from 2014 to 2015 in the Center of Çanakkale Province and 12 ant species belonging to 8 genera in Dolichoderinae, Formicinae and Myrmicinae subfamilies of Formicidae associated with 16 aphid species were determined. The most encountered ant species associated with different aphids were *Lasius alienus* (Foerster, 1850), *Plagiolepis pygmaea* (Latreille, 1798), *Camponotus aethiops* Latreille, 1798 and *Plagiolepis taurica* Santsci, 1920. The most encountered aphid species associated with different ant species, were; *Aphis fabae* Scopoli, 1763, *Aphis gossypii* Glover, 1877 and *Aphis craccivora* Koch, 1854. Moreover, *Camponotus samius* Forel, 1889, *Camponotus sanctus* Forel, 1904, *Crematogaster ionia* Forel, 1911 and *Pheidole* cf. *pallidula* (Nylander, 1849) associations with aphids were determined for the first time in Turkey. Furthermore, *Aphis nerii* Boyer de Fonscolombe, 1841, *Aphis punicae* Passerini, 1863, *Aphis umbrella* (Börner, 1950), *Chaitophorus leucomelas* Koch, 1854, *Chromaphis juglandicola* (Kaltenbach, 1843), *Panaphis juglandis* (Goeze, 1778), *Prociphilus fraxini* (Fabricius, 1777) and their associations with different ant species were determined for the first time in Turkey. Consequently, the recent studies indicated that aphid-ant associations should be further detailed investigated locally.

INTRODUCTION

Mutualism is generally described as an interaction between two species beneficial to each other (Begon et al. 1999, Boucher et al. 1982, Krohne 1998). The best known example of mutualism should be the interaction between ants and honeydew producing insects such as aphids, scales, mealy bugs and whiteflies belonging to the suborder Sternorrhyncha in the order Hemiptera (Styrsky and Eubanks 2007). In the ant-aphid associations,

both partners may obtain benefits from each other. Ants gain a vital source of nutritions and in return provide protection for aphids against their natural enemies (Stadler and Dixon 2005, Völkl et al. 2007). Consequently, these interactions have usually adverse effect on species diversity and abundance of natural enemies of pests such as aphids, scales, mealy bugs and whiteflies.

Although aphid and ant fauna of Turkey were represented by about 554, and 363 taxa respectively (Görür et al. 2017, Karaman et al. 2017) studies on the interactions of both organisms are still very limited. There are only three studies on the mutualistic interactions between ants and aphids in different locations and habitats across Turkey. The first study, conducted by Özdemir et al. (2008) on wild plants in Ankara Province, identified 16 ant species associated with 19 aphid species. Besides, Akyıldırım et al. (2014) reported the interactions between 15 ant and 48 aphid species in Artvin, Rize and Trabzon Provinces. Finally, 13 ant species associated with 45 aphid species were identified in Samsun Province, located in the Black Sea Region of Turkey (Akyürek et al. 2016). These studies conducted in different geographical regions of Turkey are of great importance for a better understanding of the interaction between ants and aphids. Therefore, it is very important to conduct local studies to investigate the interaction of ants and aphids and to reveal the rich diversity in Turkey.

There are few studies investigating ant species in different areas in Çanakkale (Aktaç and Karaman 2012, Aras and Aktaç 1992, Aras and Aktaç 1994). These studies were conducted to determine the faunal and taxonomic characteristics of ants and report ant species from different areas in Çanakkale, but there is no record of the associations between aphids and ants. Determination of the partnership between aphids and ants on different host plants is highly significant for biological control studies using the natural enemies against these pests. The ants feeding on honeydew secreted from the anus of aphids has reduced the success rate of biological control agents such as predator coccinellids, syrphids, chrysopids and parasitoids in cultivated areas. Accordingly, the aim of the study is to determine the interactions between ants and aphids on different host plants in Central Province of Çanakkale, Turkey.

MATERIALS AND METHODS

Aphid and ant specimens which has been found on the same host plant were collected in the Central Province of Çanakkale, located in the Southern Marmara region of Turkey between 2014 and 2015. To determine the associations between aphid and ant species, the live aphid and ant specimens were aperiodically collected from herbaceous plants, shrubs and trees in cultivated, uncultivated and urban areas during spring and summer. Both aphid and ant species were separately put in an Eppendorf tube containing 70% alcohol by using a 00 number soft brush and then were brought to the laboratory for identification.

To identify aphid species, both apterous and alate aphids were sufficiently collected. The method by Hille Ris Lambers (1950) was followed for collection and preparation of aphids. The identification of aphids was conducted according to Blackman and Eastop (2006, 2017), Bodenheimer and Swirski (1957), Heie (1986) and Kök et al. (2016). Host plants of aphids were checked according to Holman (2009).

Collected ant species were identified by the second author using CNA (Collection of Nihat AKTAÇ), collection of Biology Department of Trakya University and identification keys for ants of Turkey and its neighbors.

Current taxonomic statutes of aphid species were checked according to Favret (2017) and ant species according to Bolton's Catalogue (2017). All aphid and ant specimens identified in the study were collected by the first author in the Central Province of Çanakkale, Turkey. The aphid specimens were identified by the first and third authors. The voucher specimens of aphid and ant species are deposited in the Department of Plant Protection, Agricultural Faculty, Çanakkale Onsekiz Mart University and Trakya University, respectively.

The taxonomic status, host aphid species, host plants of aphids and locality coordinates, locality, collected altitude and collection dates of the determined ant and aphid species are given below.

RESULTS

Family Formicidae

Subfamily Dolichoderinae

Tapinoma erraticum (Latreille, 1798)

Material examined: *Brachycaudus cardui* (Linnaeus, 1758), [*Cirsium arvense* (L.) Scop. (Asteraceae)], 40°05'29.6" N 26°23'12.5" E, Çanakkale-Kepez, 19 m, 25.iv.2014; *Aphis craccivora* Koch, 1854, [*Robinia pseudoacacia* L. (Fabaceae)], 40°06›41.0» N 26°25›00.4» E, Çanakkale-Terzioğlu Campus, 80 m, 06.vi.2015.

Aphids associated with *T. erraticum* in Turkey: Unknown aphid species (Özdemir et al. 2008).

Subfamily Formicinae

Camponotus aethiops Latreille, 1798

Material examined: *Aphis umbrella* (Börner, 1950), [*Malva* sp. (Malvaceae)], 40°05'35.7" N 26°23'25.3" E, Çanakkale-Kepez, 19 m, 25.iv.2014; *Aphis fabae* Scopoli, 1763, [*Vicia faba* L. (Fabaceae)], 40°05'38.7" N 26°23'25.6" E, Çanakkale-Kepez, 21 m, 25.IV.2014; *Hyalopterus pruni* (Geoffroy, 1762), [*Typha* sp. (Typhaceae)], 40°06'32.0" N 26°24'45.1" E, Çanakkale-Terzioğlu Campus, 38 m, 23.V.2014.

Aphids associated with *C. aethiops* in Turkey: *Aphis brotericola* Mier Durante, 1978; *A. fabae*; *A. salviae* Walker, 1852; *Brachycaudus cardui*; *B. helicrysi* (Kaltenbach, 1843); *Lachnus roboris* (Linnaeus, 1758); *Thelaxes suberi* (Del Guercio, 1911) (Akyürek et al. 2016, Özdemir et al. 2008).

Camponotus samius Forel, 1889

Material examined: *Cinara pini* (Linnaeus, 1758), [*Pinus* sp. (Pinaceae)], 40°06'37.7" N 26°24'37.1" E, Çanakkale-Kepez, 36 m, 14.v.2014.

Aphids associated with *C. samius* in Turkey: First record of *C. samius* with an aphid species in Turkey.

Camponotus sanctus Forel, 1904

Material examined: *Myzus cerasi* (Fabricius, 1775), [*Prunus avium* L. (Rosaceae)], 40°13'56.1" N 26°32'25.4" E, Çanakkale-Yapıldak Village, 8 m, 06.vi.2015.

Aphids associated with *C. sanctus* in Turkey: First record of *C. sanctus* with an aphid species in Turkey.

Formica cunicularia Latreille, 1798

Material examined: *Aphis fabae*, [*Cirsium arvense*], 40°05'23.2" N 26°23'05.7" E, Çanakkale-Kepez, 16 m, 30.v.2014; *A. fabae*, [*Robinia pseudoacacia*], 40°06'41.0" N 26°25'00.4" E, Çanakkale-Terzioğlu Campus, 80 m, 06.vi.2015.

Aphids associated with *F. cunicularia* in Turkey: *Aphis brotericola*; *A. craccivora*; *A. fabae*; *A. nasturtii* Kaltenbach, 1843; *A. solanella* Theobald, 1814; *A. spiraecola* Patch, 1914; *Macrosiphum rosae* (Linnaeus, 1758); *Sipha maydis* Passerini, 1860 (Akyürek et al. 2016, Özdemir et al. 2008).

Lasius alienus (Foerster, 1850)

Material examined: *Aphis gossypii* Glover, 1877, [*Malva* sp. (Malvaceae)], 40°06'38.9" N 26°24'43.9" E, Çanakkale-Terzioğlu Campus, 30 m, 23.v.2014; [*Abelmoschus esculentus* (L.) Moench (Malvaceae)], 40°13'56.1" N 26°32'25.4" E, Çanakkale-Yapıldak Village, 58 m, 06.vi.2015; *A. punicae* Passerini, 1863, [*Punica granatum* L. (Lythraceae)], 40°09'02.9" N 26°24'29.6" E, Çanakkale-City center, 9 m, 01.vi.2014; *A. fabae*, [*Phaseolus vulgaris* L. (Fabaceae)], 40°05'57.5" N 26°22'03.4" E, Çanakkale-Kepez, 6 m, 05.vi.2015; *A. craccivora*, [*R. pseudoacacia*], 40°06'41.0" N 26°25'00.4" E, Çanakkale-Terzioğlu Campus, 80 m, 06.vi.2015; *Chaitophorus leucomelas* Koch, 1854, [*Populus* sp. (Salicaceae)], 40°08'24.1" N 26°24'04.3" E, Çanakkale-City center, 7 m, 10.vi.2015; *Pterochloroides persicae* (Cholodkovsky, 1899), [*Prunus* sp. (Rosaceae)], 40°09'02.2" N 26°24'36.7" E, Çanakkale-City center, 10 m, 17.vi.2015.

Aphids associated with *L. alienus* in Turkey: *Aphis fabae*; *A. galliiscabri* Schrank, 1801; *A. gossypii*; *A. molluginis* (Börner, 1950); *A. nasturtii*; *A. pomi* De Geer, 1773; *A. pseudocardui* Theobald, 1915; *A. solanella*; *A. urticata* J. F. Gmelin, 1790; *A. verbasci* Schrank, 1801; *Brachycaudus cardui*; *B. tragopogonis* (Kaltenbach, 1843); *Capitophorus hippophaes* (Walker, 1852); *Chaitophorus kapuri* Hille Ris Lambers, 1966; *Dysaphis foeniculus* (Theobald, 1923); *Dysaphis pyri* (Boyer de Fonscolombe, 1841); *Myzus cerasi*; *Neobetulaphis pusilla* Basu, 1964; *Sipha maydis*; *Toxoptera aurantii* Boyer de Fonscolombe, 1841 (Akyıldırım et al. 2014, Akyürek et al. 2016, Özdemir et al. 2008).

Plagiolepis pygmaea (Latreille, 1798)

Material examined: *A. gossypii*, [*Malva* sp.], Çanakkale-Terzioğlu Campus, 40°06'38.9" N 26°24'43.9" E, 30 m, 23.v.2014; *Prociphilus fraxini* (Fabricius, 1777), [*Fraxinus excelsior* L. (Oleaceae)], 40°06'41.6" N 26°25'01.4" E, Çanakkale-Terzioğlu Campus, 82 m, 13.v.2015; *Chromaphis juglandicola* (Kaltenbach, 1843) and *Panaphis juglandis* (Goeze, 1778), [*Juglans regia* L. (Juglandaceae)], 40°06'38.1" N 26°24'23.6" E, Çanakkale-Kepez, 14 m, 31.v.2015.

Aphids associated with *P. pygmaea* in Turkey: *Aphis fabae*; *A. gerardianae* Mordvilko, 1929; *A. gossypii*; *A. spiraecola*; *Brachycaudus cardui* (Akyürek et al. 2016).

Plagiolepis taurica Santsci, 1920

Material examined: *Aphis fabae* and *Brachycaudus helichrysi* (Kaltenbach, 1843), [*Cirsium arvense*], 40°05'29.6" N 26°23'12.5" E, Çanakkale-Kepez, 17 m, 25.iv.2014; *A. gossypii*, [*Abelmoschus esculentus*], 40°13'56.1" N 26°32›25.4» E, Çanakkale-Yapıldak Village, 58 m, 06.vi.2015.

Aphids associated with *P. taurica* in Turkey: *Staegeriella necopinata* Börner, 1939 and one unknown species (Özdemir et al. 2008).

Subfamily Myrmicinae

Crematogaster ionia Forel, 1911

Material examined: *Aphis nerii* Boyer de Fonscolombe, 1841, [*Nerium* sp. (Apocynaceae)], 40°09'59.9" N 26°24'39.5" E, Çanakkale-City center, 50 m, 17.vi.2015.

Aphids associated with *C. ionia* in Turkey: First record of *C. ionia* with an aphid species in Turkey.

Crematogaster sordidula (Nylander, 1849)

Material examined: *Cinara pini,* [*Pinus* sp.], 40°06'37.7" N 26°24'37.1" E, Çanakkale-Kepez, 36 m, 14.v.2014; *A. fabae*, [*Spartium junceum* L. (Fabaceae)], 40°06'43.1" N 26°25'16.0" E, Çanakkale-Terzioğlu Campus, 130 m, 23.v.2014.

Aphids associated with *C. sordidula* in Turkey: Unknown aphid species, *Brachycaudus cardui* (Özdemir et al. 2008).

Pheidole cf. pallidula (Nylander, 1849)

Material examined: *Hyalopterus pruni*, [*Typha* sp. (Typhaceae)], 40°06'32.0" N 26°24'45.1" E, Çanakkale-Terzioğlu Campus, 38 m, 23.v.2014.

Aphids associated with *P.* cf. *pallidula* in Turkey: First record of *P.* cf. *pallidula* with an aphid species in Turkey.

Tetramorium caespitum (Linnaeus, 1758)

Material examined: *Aphis gossypii*, [*Abelmoschus esculentus*], 40°13'56.1" N 26°32'25.4" E, *Çanakkale*-Yapıldak Village, 58 m, 06.vi.2015; *A. craccivora*, [*Portulaca oleracea* L. (Portulacaceae)], 40°13'56.1" N 26°32'25.4" E, *Çanakkale*-Yapıldak Village, 8 m, 06.vi.2015.

Aphids associated with *T. caespitum* in Turkey: *A. fabae*; *A. farinose* Gmelin, 1790; *A. gossypii*; *A. salviae*; *A. spiraecola*;

Table 1. The list of aphid species and their ant partners in the Central Province of Çanakkale from 2014 to 2015

Aphids (Hemiptera: Aphididae)	**Ants (Hymenoptera: Formicidae)**
Aphis craccivora	*Lasius alienus* *Tapinoma erraticum* *Tetramorium caespitum*
Aphis fabae	*Camponotus aethiops* *Crematogaster sordidula* *Formica cunicularia* *Lasius alienus* *Plagiolepis taurica*
Aphis gossypii	*Lasius alienus* *Plagiolepis pygmaea* *Plagiolepis taurica* *Tetramorium caespitum*
Aphis nerii	*Crematogaster ionia*
Aphis punicae	*Lasius alienus*
Aphis umbrella	*Camponotus aethiops*
Brachycaudus cardui	*Tapinoma erraticum*
Brachycaudus helichrysi	*Plagiolepis taurica*
Chaitophorus leucomelas	*Lasius alienus*
Chromaphis juglandicola	*Plagiolepis pygmaea*
Cinara pini	*Camponotus samius* *Crematogaster sordidula*
Hyalopterus pruni	*Camponotus aethiops* *Pheidole* cf. *pallidula*
Myzus cerasi	*Camponotus sanctus*
Panaphis juglandis	*Plagiolepis pygmaea*
Prociphilus fraxini	*Plagiolepis pygmaea*
Pterochloroides persicae	*Lasius alienus*

Brachycaudus cardui; Macrosiphoniella sanborni (Gillette, 1908); *Myzus lythri* (Schrank, 1801) (Akyıldırım et al. 2014, Akyürek et al. 2016).

Also, the list of aphid species and their ant partners in the Central Province of Çanakkale were given Table 1.

DISCUSSION

This study was performed to determine aphid and their ant partners in the Central Province of Çanakkale, located in Southern Marmara region of Turkey. Thus, 12 ant species belonging to 8 genera in 3 subfamilies of Formicidae and 16 aphid species belonging to 10 genera in family of Aphididae were determined for the purpose of the study. Of these ant species, 7 species are member of Formicinae, 4 species of Myrmicinae and one species of Dolichoderinae subfamily. *Lasius alienus*, *Plagiolepis pygmaea*, *Camponotus aethiops* and *P. taurica* were the most encountered ant species associated with aphid species, respectively. *L. alienus* associated with 6 aphid species, *P. pygmaea* with 4 aphid species, *C. aethiops* and *P. taurica* with 3 aphid species were sampled. The other determined ant species, *Tapinoma erraticum*, *Formica cunicularia*, *Crematogaster sordidula*, *Tetramorium caespitum* with 2 aphid species and *C. samius*, *C. sanctus*, *C. ionia*, *Pheidole* cf. *pallidula* associated with only one aphid species were sampled. As for aphids, *Aphis fabae*, *A. gossypii* and *A. craccivora* were the most frequently visited by ant species compared to the other aphid species. *A. fabae* with 5 species, *A. gossypii* with 4 species and *A. craccivora* with 3 species were sampled from many different host plants. In the present study, *A. nerii*, *A. punicae*, *A. umbrella*, *Chaitophorus leucomelas*, *Chromaphis juglandicola*, *Panaphis juglandis*, *Prociphilus fraxini* and different ant species associated with them were determined for the first time in Turkey. Moreover, *Camponotus samius*, *C. sanctus*, *Crematogaster ionia* and *Pheidole* cf. *pallidula* were identified as new mutualistic partners of aphid species.

So far, 90 aphid and 31 ant species associated with each other were determined from Ankara, Artvin, Rize, Trabzon and Samsun Provinces of Turkey. With the results of our study, the number of aphids related to ant species has increased to 97 aphid and 35 ant species. There are very few studies conducted to investigate ant species in all the districts of Turkey. The first investigation related to aphid-ant associations in Turkey was conducted by Özdemir et al. (2008). They reported 16 ant species associated with 19 aphid species on wild plants in Ankara Province. In their study, *C. aethiops*, *C. piceus*, *C. sordidula, Formica glauca* Ruzsky, and *Lasius paralienus* Seifert were the most encountered ant species associated with different aphid species in Ankara. Likewise, *C. aethiops* was one of the most common ant species associated with aphids in this study. Moreover, aphid species belonging to *Aphis* genus were the most visited species by ant species in both studies. In addition, they emphasized the importance of aphid-ant associations for biological control studies. In the second study, Akyıldırım et al. (2014) determined 15 ant species associated with 48 aphid species in Artvin, Rize and Trabzon Provinces of Turkey. They reported that *F. cinereofusca* Karawaiew, 1929, *L. turcicus* Santschi, 1921, *L. emarginatus* (Olivier, 1792) were the most encountered ant species associated with aphids and *A. fabae*, *A. gossypii*, *A. spiraecola, Brachycaudus cardui*, *Cinara pilicornis* (Hartig, 1841), *Toxoptera aurantii* were the most visited species by ant species in these provinces. In their and the present study, *A. fabae* and *A. gossypii* were the most visited aphid species by ants. Besides, these aphid species were visited by *L. alienus* in both studies carried out in different localities of Turkey. The third study related to aphid-ant interactions in Turkey was conducted by Akyürek et al. (2016) in Samsun Province. As a result of this study, they reported 13 ant species associated with 45 different aphid species. *L. alienus*, *L. brunneus* (Latreille, 1798), *L. turcicus* Santschi, 1921, *F. cunicularia* and *F. rufibarbis* Fabricius, 1793 were presented as the most tending ant species. In addition, the most visited aphid species by ants in this study were *A. fabae* and *B. cardui*.

The number of interrelated aphid and ant of Iran located in the same biogeographical region as in Turkey are represented by about 80 and 55 species, respectively (Latibari et al. 2017, Mirzamohamadi et al. 2015, Mortazavi et al. 2015, Mossadegh et al. 2016, Shiran et al. 2013). The aphid and ant fauna of Turkey are represented by about 554 and 363 species, respectively (Görür et al. 2017, Karaman et al. 2017). Considering the aphid and ant fauna of Turkey, the number of aphid-ant associations is very limited because of the fact that very few related recent studies were conducted in Turkey. Consequently, the results of the present and other recent studies indicated that associations between aphid and ant species are not known well and should be further investigated locally.

ÖZET

Yaprakbitleri ve karıncalar doğada mutualistik ya da zorunlu mutualistik bir ilişkiye sahiptir. Birçok karınca türü yumuşak vücutlu ve zayıf bir savunmaya sahip yaprakbitlerini doğal düşmanlarına karşı korumaktadır. Çanakkale il merkezinde 2014 ve 2015 yılları arasında yaprakbitleri ve karıncalar arasındaki ilişkileri belirlemek için yürütülen bu çalışmanın sonucunda Formicidae familyasının Dolichoderinae, Formicinae ve Myrmicinae altfamilyaları içerisinde bulunan 8 cinse ait, 12 karınca

türünün 16 farklı yaprakbiti ile ilişkisi tespit edilmiştir. Farklı yaprakbitleri ile ilişkili en fazla karşılaşılan karınca türleri *Lasius alienus* (Foerster, 1850), *Plagiolepis pygmaea* (Latreille, 1798), *Camponotus aethiops* Latreille, 1798 ve *Plagiolepis taurica* Santsci, 1920'dir. Farklı karınca türleri ile ilişkili en fazla karşılaşılan yaprakbitleri ise *Aphis fabae* Scopoli, 1763, *Aphis gossypii* Glover, 1877 ve *Aphis craccivora* Koch, 1854'dir. Ayrıca *Camponotus samius* Forel, 1889, *Camponotus sanctus* Forel, 1904, *Crematogaster ionia* Forel, 1911 ve *Pheidole* cf. *pallidula* (Nylander, 1849) karınca türlerinin yaprakbitleri ile ilişkili olduğu Türkiye'de ilk kez bu çalışma ile belirlenmiştir. Bunlara ilave olarak belirlenen yaprakbitlerinden *Aphis nerii* Boyer de Fonscolombe, 1841, *Aphis punicae* Passerini, 1863, *Aphis umbrella* (Börner, 1950), *Chaitophorus leucomelas* Koch, 1854, *Chromaphis juglandicola* (Kaltenbach, 1843), *Panaphis juglandis* (Goeze, 1778), *Prociphilus fraxini* (Fabricius, 1777)'nin ise karıncalar ile işbirliği içinde olduğu Türkiye'de ilk kez tespit edilmiştir. Sonuç olarak son çalışmalar yaprakbitleri ve karıncalar arasındaki ilişkilerin bölgesel olarak daha detaylı araştırılması gerektiğini göstermektedir.

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