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Scale insect (Hemiptera: Sternorryncha: Coccomorpha) species on medicinal and aromatic plants in Adana (Turkey)

Adana (Türkiye)'da tıbbi ve aromatik bitkilerdeki Kabuklubit (Hemiptera: Sternorryncha: Coccomorpha) türleri

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ABSTRACT

Medicinal and aromatic plants are used primarily in the medicine, food and cosmetic industries. Scale insect species belonging to Coccomorpha (Hemiptera: Sternorryncha) feed on medicinal and aromatic plants, reducing the yield and commercial value of these crops. This study aimed to determine the scale insect species on these plants in Adana Province between 2015 and 2017. Scale insect samples were collected from leaves, trunks, brunches and fruits of 28 medicinal and aromatic plant species examined and identified in the laboratory. In the study, a total of 16 species were identified from the families of Coccidae (5 species), Diaspididae (7 species), Monophlebidae (1 species) and Pseudococcidae (3 species) belonging to this infraorder.

INTRODUCTION

Turkey is one of the leading countries in the production of medicinal and aromatic plants (MAP) because of its unique geographic location, climate and soil characteristics, agricultural potential, large surface area, having rich plant diversity. Medicinal and aromatic plants are being used in alternative or complementary medicinal science, which has become more widespread in recent years worldwide. Besides food and medicine industries, MAPs are used in many fields, such as the beverage, perfume and cosmetic industries (Baydar 2016, Yücer and Altıntaş 2012). In Turkey, about 20 species of MAPs are cultivated on an area of 1.3 million decares. Among these plants, poppy, cumin, anise, thyme and rose (oil) are cultivated the most. Turkey is one of the leading countries in thyme production and ranks first in world thyme exports. In addition, approximately 90% of the world's dry bay leaf production and 50% of the world's rose oil demand comes from Turkey. Turkey is an important supplier for MAPs such as thyme and laurel, as well as capers and cumin. It is reported that medicinal and aromatic plant exports amounted to 280 million dollars in 2015 (Öztürk et al. 2014, Temel et al. 2018). One of the wide usage areas of MAPs is to be used as organic plant protection products in the control of pest insect and mite species (Aydın and Mammadov 2017, Bakkali et al. 2008, Isman 2006, Isman et al. 2008, Kim et al. 2015, Lengai et al. 2020, Topuz and Madanlar 2006, Ujvary 1999). In recent years, natural products of botanical origin instead of synthetic ones have been increased worldwide and in Turkey (Arnason et al. 2012, Karaca et al. 2017, Misra 2014). Due to the enhancement

in the consumption of natural products, the world market volume of MAPs shows a rapid increase. With the increase in demand for these plants, which were previously collected from nature, studies on the production of MAPs have also been accelerated (Şekeroğlu and Gezici 2020). In order to evaluate sustainable production and market potential as competently, medical and aromatic plants must be of the required quantity and quality. One of the important issues affecting yield and quality in MAPS are the pests feeding on these plants (Abro et al. 2016, Marimuthu et al. 2018, Simova-Tosia et al. 1997). Sarma et al. (2008), reported that there are 40-45 main pest species in MAPs and they may cause 50-60% damage. Pests reduce the yield as well as the commercial value of crops, causing damages, such as stubbornness, shortening between nodes, colour change in flower and body, decrease in number and diameter of flowers, loss of absorption, leaf curling, leaf deformation and spillage in MAPs. They reduce the medicinal value of these plants by impairing their quality, and also have negative effects on secondary metabolites in plant parts used as drugs (Abo-Zaed Amal et al. 2019, Milek and Simala 2010, Taşkın 2015, Verma 2006). A group of pest species in MAPs is species related to scale insects (Hemiptera: Sternorryncha: Coccomorpha). Scale insects are important pest groups that settle on the trunk, branch, leaf, fruit, flower and even roots and feed by sucking the plant sap. As a result, effecting in plant development, early leaf fall, fumagine formation, deterioration in fruit quality, shape and colour disorders are observed. High pest populations can cause the host plant to die back completely (Kaydan et al. 2007, Kosztarab 1996, Yaşar 1990). Some species can transmit plant virus diseases (Cabaleiro and Segura 2006). Species belonging to this infraorder have a wide number of hosts. They can cause significant damages and economic losses especially in fruit, vineyard and forest trees, park and ornamental plants (Kozstarab and Kozár 1988). Worldwide, the presence of 8.194 species belonging to 50 families were reported, while Diaspididae, Pseudococcidae and Coccidae are the three largest families of Coccomorpha (Garcia Morales et al. 2016). In Turkey, 359 species belonging to 18 families has been identified (Kaydan et al. 2013a). It is reported that species of Coccomorpha cause damage by feeding on the reproductive and vegetative organs of medicinal and aromatic plants and symptoms of sooty mold (Abo-Zaed Amal et al. 2019, Conti 2003, Kondo et al. 2018). Upto now, scale insect species on many plant species in different geographic areas of Turkey were investigated (Çalışkan Keçe and Ulusoy 2017, Çalışkan et al. 2017, Develioğlu et al. 2018, Karsavuran et al. 2001, Karsavuran et al. 2004, Kaydan et al. 2005, Kaydan et al. 2013b, Kaymak and Yaşar 2017, Ülgentürk and Toros 1996, 1999, Ülgentürk et al. 2008, Yaşar 1990, Yaşar and Küçükçakal 2013). It is known that there are limited number of studies to reveal the scale insect fauna in medicinal and aromatic plants, whose importance, use and production is increasing in Turkey. The previously recorded pest species are the ones from the general faunistic studies. The present study was undertaken to record the scale insect species associated with various medicinal and aromatic plants in Adana province.

MATERIALS AND METHODS

Study sites

The studies were conducted in Karaisalı and Sarıçam districts located at Adana province, Turkey. Species were collected from MAPs by non-periodical surveys in 2015 to 2017. Infected plant materials were gathered from Ali Nihat Gökyiğit Botanical Garden in Sarıçam (37° 3'2.53'N; 35° 21'15.49'E, 109 m above sea level) and experimental field of Çukurova University, Karaisalı Vocational School (37° 15'12.96'N; 35° 4'7.28'E, 235 m above sea level) and around the district.

Sampling and laboratory processing of specimens

In total 208 samples were collected from plants by visual check of which 178 species from Sarıçam and 30 species from Karaisalı. Each infected sample was put into a plastic bag, labeled and taken to the laboratory. Scale insect samples on plants were put into Eppendorf tubes with 70% alcohol for further examination. Samples were prepared under the light microscope by using the slide-mounting method described by Kosztarab and Kozár (1988). The collection data (host plants, host locality, collection date) are recorded. Previously recorded distribution and host-plant data were taken from Kaydan et al. (2013a) and Garcia Morales et al. (2016). All the species were identified by the second author.

RESULTS AND DISCUSSION

Totally 16 Coccomorpha species belonging to Coccidae (5), Diaspididae (7), Monophlebidae (1) and Pseudococcidae (3) families were identified. These species were; *Anapulvinaria pistaciae* (Bodenheimer), *Ceroplastes floridensis* Comstock, *C. rusci* (Linnaeus), *Coccus hesperidum* Linnaeus, *Parthenolecanium corni* (Bouché) (Coccidae), *Aonidiella aurantii* (Maskell), *Aonidia lauri* (Bouché), *Aspidiotus nerii* (Bouché), *Epidiaspis leperii* (Signoret), *Lepidosaphes pistaciae* Archangelskaya, *Melonaspis inopinata* (Leonardi), *Parlatoria oleae* (Colvée) (Diaspididae), *Icerya purchasi* Maskell (Monophlebidae), *Phenacoccus madeirensis* Green, *P. solenopsis* Tinsley, *Planococcus citri* (Risso) (Pseudococcidae). Locality, collection date and host plants for the determined species are given below.

Family: Coccidae

Anapulvinaria pistaciae (Bodenheimer, 1926)

Material examined: 2 ♀♀, Karaisalı, ex *Pistacia lentiscus* L. (Anacardiaceae), 20.XII.2015, Coll: N.Z. Elekcioğlu.

Anapulvinaria pistaciae has Palaearctic distribution (Garcia Morales et al. 2016). It was recorded in Ankara, Isparta, Gaziantep and Urfa in Turkey on *P. vera* L. and *Pistacia* sp. (Bodenheimer 1953, Yanık and Yücel 2001, Ülgentürk and Çanakçıoğlu 2004, Kaydan et al. 2013a).

This species is meanly found on seven plants belonging to Anacardiaceae (especially *Pistacia* spp.) in Turkey (Kaydan et al. 2013a) and on some plants from Juglandaceae and Tamaricaceae families in Iran (Moghaddam 2013).

Ceroplastes floridensis Comstock, 1881

Material examined: 2 ♀♀, Sarıçam, ex *Artemisia annua* (L.) Cass. Spach (Asteraceae) 11.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex *A. dracunculus* L., 18.IX.2017; Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, *Laurus nobilis* L. (Lauraceae), 10.VIII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, *Myrtus communis* L. (Myrtaceae), 04.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, *Koelreuteria paniculata* Laxm. (Sapindaceae), 11.IX.2017; 2 ♀♀, Sarıçam, ex *Rhus coriaria* L. (Anacardiaceae), 18.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex *Senna x floribunda* (Cav.) H.S. Irwin & Barneby (Fabaceae), 18.IX.2017, Coll: N.Z. Elekcioğlu.

This species has worldwide distrubution (it is recorded in 102 countries) and regarded as cosmopolit species (CABI 2020). *C. floridensis* has been found on 257 plant species belonging to 70 families (García Morales et al. 2016). In Turkey it was found in Mediterranean, Southeast Anatolian and Aegean Regions on *Cedrus libani A. Rich.* (Pinaceae), *Arbutus unedo* L. (Ericaceae), *L. nobilis* and *M. communis* (Kaydan et al. 2013a, Ülgentürk et al. 2013).

Comment. This species was determined on *Nerium oleander* L. (Apocynaceae), *Cinnamomum* spp. (Lauraceae), *L. nobilis*, *L. azorica* (Seub.) Franco, *Coffea* spp. (Rubiaceae), *Aloysia citrodora* Paláu (Verbenaceae), *Citrus* spp. (Rutaceae) and *Camellia sinensis* (L.) Kuntze (Theaceae) as MAPs (García Morales et al. 2016, Kaydan et al. 2013a).

Ceroplastes rusci (Linnaeus, 1758)

Material examined: 2 ♀♀ Karaisalı, ex *Myrtus communis* L. (Myrtaceae); 27.VII.2015, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *Nerium oleander* L. (Apocynaceae), 20.XII.2015, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *N. oleander*, 23.V.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀ and *Pistacia lentiscus* L. (Anacardiaceae), 22.VII.2015, Coll: N.Z. Elekcioğlu.

It is known that *C. rusci* is a cosmopolit species and recorded in 59 countries all over the world (Anonymous 2020a). *C. rusci* has been recorded 131 plant species belonging to 48 different families. Akşit et al. (2003), Kaydan et al. (2013a) and Ülgentürk et al. (2013) recorded *C. rusci* on *M. communis*, *N. oleander*, *P. palaestina* Boiss, *P. vera* L., *Populus* sp. (Salicaceae), *Salix* sp. (Salicaceae), *Olea europea* L. (Oleaceae) and *Ficus carica* L. (Moraceae).

Rhus coriaria L. (Anacardiaceae), *N. oleander*, *Ruscus aculeatus* L. (Nolinaceae), *Artemisia monosperma* L. (Asteraceae), *Laurus nobilis* L. (Lauraceae), *M. communis*, *Piper nigrum* L. (Piperaceae) and *Citrus* spp. (Rutaceae) were recorded as host plants of *C. rusci* in terms of MAPs (Kaydan et al. 2013a, Ülgentürk et al. 2013).

Coccus hesperidum Linnaeus, 1758

Material examined: 2 ♀♀, Sarıçam, ex *Hyssopus officinalis* L. (Lamiaceae), 18.IX.2017, Coll: N.Z. Elekcioğlu.

This species is considered as cosmopolit species which was determined in 145 countries (CABI 2020). *C. hesperidum* has been recorded in Mediterranean, Blacksea, Middle Anatolia Regions in Turkey (Kaydan et al. 2013a). It has been recorded on 130 plant species of which *Nerium oleander* L. (Apocynaceae), *Plumeria* spp. (Apocynaceae), *Ruscus hypophyllum* L. (Asparagaceae), *Artemisia vulgaris* L. (Asteraceae), *Rhododendron* sp. (Ericaceae), *Ricinus communis* L. (Euphorbiaceae), *Pelargonium* sp. (Geraniaceae), *Ocimum basilicum* L. (Lamiaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Teucrium* sp. (Lamiaceae), *Thymus* sp. (Lamiaceae), *Vitex agnus-castus* L. (Lamiaceae), *Cinnamomum camphora* (L.) J. Presl. (Lauraceae), *Laurus nobilis* L. (Lauraceae), *Alcea rosea* L. (Malvaceae), *Hibiscus* spp. (Malvaceae), *Myrtus communis* L. (Myrtaceae), *Portulaca oleracea* L. (Portulacaceae), *Rosa* sp. (Rosaceae), *Rubus* spp. (Rosaceae) and *Coffea* spp. (Rubiaceae) are MAPs all over the world (García Morales et al. 2016). It was recorded on *Cedrus libani* A. Rich. (Pinaceae), *Acer pseudoplatanus* L. (Sapindaceae), *Crateagus monogyna* Jacq. (Rosaceae), *L. nobilis*, *Lonicera caprifolium* L. (Caprifoliaceae), *N. oleander*, *Pistacia atlantica* Desf. (Anacardiaceae), *Quercus* spp. (Fagaceae) and *Pinus* sp. (Pinaceae) (Alkan 1957, Ülgentürk and Toros 1999, Uygun et al. 2001, Kaydan et al. 2013a, Ülgentürk et al. 2013).

Parthenolecanium corni (Bouché, 1844)

Material examined: 2 ♀♀, Sarıçam, ex *Lycium barbarum* L. (Solanaceae), 18.IX.2017, Coll: N.Z. Elekcioğlu.

Parthenolecanium corni is recorded in 73 countries in the world and considered as cosmopolit species (CABI 2020). It was found on 225 plant species belonging to 48 families (García Morales et al. 2016). *P. corni* is known in East Anatolian, Aegean, Black Sea, Mediterrenean and Middle Anatolia Regions in Turkey (Kaydan et al. 2013a). In Turkey it was found on *Morus alba* L. (Moraceae), *Robinia pseudoacacia* L. (Fabaceae), *Vitis vinifera* L. (Vitaceae), *Prunus armeniaca* L., *P. persicae* L. (Rosaceae), *Corylus*

avellana L. (Betulaceae), *Elaeagnus* sp. (Elaeagnaceae), *Fagus* sp. (Fagaceae), *Quercus* sp. (Fagaceae), *Fraxinus* sp. (Oleaceae), *Salix* sp. (Salicaceae), *Ulmus* sp. (Ulmaceae) and *Crateagus* sp. (Rosaceae) (Ülgentürk and Toros 1999, Kaydan et al. 2013a, Kaydan et al. 2014). Among the host plant species *Rosmarinus officinalis* L. (Lamiaceae), *Mentha* sp. (Lamiaceae), *Thymus* sp. (Lamiaceae), *Pelargonium* sp. (Geraniaceae), *Tilia* spp. (Malvaceae) and *Urtica* spp. (Urticacea) are known as MAPs (Kaydan et al. 2013a).

Family: Diaspididae

Aonidiella aurantii (Maskell, 1879)

Material examined: 2 ♀♀, Sarıçam, ex *Ceratonia siliqua* L. (Fabaceae), 04.IX.2017, Coll: N.Z. Elekcioğlu; 2♀♀, Karaisalı, ex *Rosa* sp. (Rosaceae), 22.XII.2017, Coll: N.Z. Elekcioğlu.

Aonidiella aurantii is one of the most important citrus pest all over the world. It is a cosmopolit species and is present in 89 countries on 180 species from 86 families mainly Arecaceae, Asparagaceae, Fabaceae, Moraceae, Oleaceae, Rosaceae, Rutaceae (García Morales et al. 2016), and it has been found in Mediterranean and Aegean Region of Turkey (Kaydan et al. 2013a). In Turkey it was recorded on citrus, acacia, rosa, *Amaranthus viridis* L. (Amaranthaceae), *C. siliqua* and *Laurus nobilis* L. (Lauraceae) (Kaydan et al. 2013a, Kaydan et al. 2014). It was recorded on MAPs as; *Nerium oleander* L. (Apocynaceae), *Ruscus hypophyllum* L. (Asparagaceae), *Calendula officinalis* L. (Asteraceae), *Berberis* sp., (Berberidaceae), *Rhododendron* sp. (Ericaceae), *C. siliqua*, *Salvia* sp. (Lamiaceae), *L. nobilis*, *Hibiscus* sp. (Malvaceae), *Myrtus* sp. (Myrtaceae), *Rosa* sp., *Aloe vera* (L.) Burm.f. (Asphodelaceae) and *Citrus* spp. (Rutaceae) (Kaydan et al. 2013a, García Morales et al. 2016).

Aonidia lauri (Bouche, 1833)

Material examined: 2 ♀♀, Sarıçam, ex *Laurus nobilis* L. (Lauraceae), 21.VII.2017, Coll: N.Z. Elekcioğlu.

This species is a Palaearctic species but found in 2 countries in Nearctic Region although in Palearctic Region it is recorded on generally Mediterranean subregion (García Morales et al. 2016). *A. lauri* is recorded on L. nobilis in Mediterranean, Aegean, South East Anatolian and Marmara Region in Turkey (Kaydan et al. 2013a).

Aspidiotus nerii Bouche, 1833

Material examined: 2 ♀♀, Sarıçam, ex *Nerium oleander* L. (Apocynaceae), 19.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex *Ceratonia siliqua* L. (Fabaceae), 22.VII.2017; Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *Rhododendron* sp. (Ericaceae), 10.III.2016, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *C. siliqua*, 27.VII.2017, Coll: N.Z. Elekcioğlu.

Aspidiotus nerii is a cosmopolit species which has been found in 76 countries all over the world (García Morales et al. 2016). It's host plants has a quite wide range and can be on Anacardiaceae, Apocynaceae, Araliaceae, Arecaceae, Asparagaceae, Ericaceae, Euphorbiaceae, Fabaceae, Oleaceae, Proteaceae and Rutaceae (García Morales et al. 2016). In Turkey it was found on *Acacia cultiformis* A. Cunn. ex G. Don, *A. cyanophylla* Mill. (Fabaceae), *Aucuba japonica* Thunb. (Garryaceae), *Asparagus acutiformis* L. (Asparagaceae), *Campsis radicans* Seem. (Bignoniaceae), *Canna indica* L. (Cannaceae), *Cedrus libani* A. Rich. (Pinaceae), *Citrus limon* (L.) Osbeck (Rutaceae), *Cycas revoluta* Thunb. (Cycadaceae), *Hedera helix* L. (Araliaceae), *Jasminum* sp. (Oleaceae), *Laurus nobilis* L. (Lauraceae) (Kaydan et al. 2013a) of which some of them MAPs such as *Pistacia lentiscus* L., *P. terebinthus* L. (Anacardiaceae), *Foeniculum vulgare* Mill. (Apiaceae), *N. oleander*, *Ruscus aculeatus* L. (Nolinaceae), *Senecio* sp. (Asteraceae), *Berberis* sp. (Berberidaceae), *Capparis* spp. (Cappareceae), *Cistus* spp. (Cistaceae), *Rhododendron ponticum* L. (Ericaceae), *Ricinus communis* L. (Euphorbiaceae), *Salvia* sp. (Lamiaceae), *Sideritis* sp. (Lamiaceae), *Teucrium* spp. (Lamiaceae), *L. nobilis* and *Myrtus communis* L. (Myrtaceae) (García Morales et al. 2016).

Epidiaspis leperii (Signoret, 1869)

Material examined: 2 ♀♀, Sarıçam, ex *Pistacia terebinthus* L. (Anacardiaceae), 24.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, 22.VII.2015, *P. lentiscus* L., Coll: N.Z. Elekcioğlu.

Although this species has been regarded as Palaearctic species it was found in 42 countries worldwide. *E. leperii* is a polyphagus species which found on the plants belonging to Rosaceae Oleaceae, Juglandaceae, Moraceae, Sapindaceae and Lauraceae (CABI 2020). It has been recorded at all regions of Turkey (Kaydan et al. 2013a), found on Aesculus hippocastanum L. (Sapindaceae), *Cactus* spp. (Cactaceae), *Opuntia ficus-indica* (L.) Mill. (Cactaceae), *Pistacia* sp., *Prunus domestica* L. (Rosaceae), *Prunus* sp., *Pyrus communis* L. (Rosaceae), *Malus* sp. (Rosaceae) and *Robinia pseudoacacia* L. (Fabaceae) (Erözmen and Yaşar 2018, Kaydan et al. 2013a).

Lepidosaphes pistaciae Archangelskaya, 1930

Material examined: 2 ♀♀, ex *Pistacia terebinthus* L. (Anacardiaceae); Karaisalı, 22.VII.2015, Coll: N.Z. Elekcioğlu.

This species is almost a monofag species and found on *Pistacia* spp. which found in Palaearctic and Oriental Zoogeopraphic Regions (Kaydan et al. 2013a, Kozár 1998). In Turkey it is recorded on *P. tenebinthus*, *P. lentiscus* L. and *P. vera* L. as MAPs (Kaydan et al. 2013a).

Melonaspis inopinata (Leonardi, 1913)

Material examined: 2 ♀♀, Karaisalı, *Pistacia terebinthus* L. (Anacardiaceae), 22.VII.2015. Coll: N.Z. Elekcioğlu.

This Palaearctic species has been recorded in Palaearctic Region including Turkey (García Morales et al. 2016). It is recorded on *P. khinjuk* Stocks, *P. mutica* F. &. M., *Acer cinerascens* Boiss. (Aceraceae), *Anabasis* sp. (Brassicaceae), *Celtis* sp. (Cannabaceae), *Arbutus unedo* L. (Ericacea), *Ricinus communis* L. (Euphorbiaceae), *Bauhinia* sp. (Fabaceae), *Cercis siliquastrum* L. (Fabaceae), *Astragalus* sp. (Fabaceae), *Quercus* sp. (Fagaceae), *Juglans regia* L. (Juglandaceae), *Fraxinus excelsior* L. (Oleaceae), *Acacia* sp. (Fabaceae), *Malus communis* Lam., *M. domestica* Borkh. (Rosaceae), *Prunus communis* L., *P. avium* L., *Prunus* sp. (Rosaceae) and *Salix* sp. (Salicaceae) in Turkey (Anonymous 2020b). It is recorded on Astragalus sp. as MAPs in Turkey (Kaydan et al. 2013a).

Family: Monophlebidae

Icerya purchasi Maskell, 1879

Material examined: 2 ♀♀, Karaisalı, ex *Rosmarinus officinalis* L. (Lamiaceae), 19.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀ Karaisalı, *Origanum* onites L. (Lamiaceae), 19.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀ Karaisalı, O. *majorana* L., 12.IX.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, O. *majorana*, 22.XII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀ Karaisalı, *Rosa* sp. (Rosaceae), 22.XII.2017, Coll: N.Z. Elekcioğlu.

Icerya purchasi is a cosmopolit species, recorded in 148 countries and it was found in Mediterranean, Aegean, Black Sea and Marmara Regions in Turkey (Kaydan et al. 2013a). It has been regarded as an important citrus pest but also found on many MAPs such as *R. officinalis*, *Foenicum vulgare* Mill. (Apiaceae), *Nerium oleander* L. (Apocynaceae), *Ricinus communis* L. (Euphorbiaceae), *Ocimum basilicum* L. (Lamiaceae), *Laurus nobilis* L. (Lauraceae), *Alcea rosea* L. (Malvaceae), *Passiflora quadrangularis* L. (Passifloraceae), *Portulaca oleracea* L. (Portulacaceae), *Rosa centifolia* L. (Rosaceae), *Lantana camara* L. (Verbenaceae), *Berberis* sp. (Berberidaceae), *Hibiscus* sp. (Malvaceae), *Salvia* sp. (Lamiaceae), *Senna* spp. (Fabaceae) and *Citrus* spp. (Rutaceae) (Kaydan et al. 2013a, CABI 2020).

Family: Pseudococcidae

Phenacoccus madeirensis Green, 1923

Material examined: 2 ♀♀, Sarıçam, ex *Stevia rebaudiana* (Bertoni) Bertoni (Asteraceae), 03.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex *S. rebaudiana*, 16.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, ex *Pelargonium crispum* (P.J.Bergius) L'Her (Geraniaceae), 03.VII.2017, Coll: N.Z. Elekcioğlu.

The Madeira mealybug, *P. madeirensis*, is an important pest which has invading potential through new areas worldwide. It is a polyphagous insect species which has been recorded from 135 genera in 51 families. It is a pest of many fruit trees, fibre plants, food crops, vegetables, cacao and ornamental plants (Wang et al. 2019). It has a Neotropical origin, although it was first described on the island of Madeira in 1923 (Green 1923). It has spread to 88 countries and regions across five continents (CABI 2020, Garcia Morales et al. 2016). It has been recorded in Turkey first time in 2012 in Çanakkale, Adana and Antalya (Kaydan et al. 2012). As MAPs host plant it is recorded on *Petroselinum crispum* Hill (Apiaceae), *Matricaria chamomilla* L. (Asteraceae), *Ricinus communis* L. (Euphorbiaceae), *Ocimum basilicum* L. (Lamiaceae), *Salvia coccinea* Buc'hoz ex Etl. (Lamiaceae), *Passiflora edulis* Sims. (Passifloraceae), *Capsicum annuum* L. (Solanaceae), *Aloysia citrodora* Paláu (Verbenaceae), *Lantana camara* L. (Verbenaceae), *Pelargonium* spp., *Hibiscus* spp. (Malvaceae), *Mentha* sp. (Lamiaceae), *Datura* sp. (Solanaceae), *Rumex* sp. (Polygonaceae), *Althaea* sp. (Malvaceae), *Rosa* sp. (Rosaceae), *Citrus* sp. (Rutaceae) and *Calendula* sp. (Asteraceae) (García Morales et al. 2016).

Phenacoccus solenopsis Tinsley, 1898

Material examined: 2 ♀♀, Sarıçam, ex *Schinus molle* L. (Anacardiaceae), 08.XI.2015, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex S. molle, 15.V.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, ex *Brassica rapa* subsp. *nipposinica* L. (Brassicaceae), Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *Conyza* sp. (Asteraceae), 10.X.2015, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex Conyza sp., 21.X.2016, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *Capsicum* sp. (Solanaceae), 14.IX.2017, Coll: N.Z. Elekcioğlu.

The solenopsis mealybug is regarded as an important plant pest worldwide and recorded in 52 countries (CABI 2020, Hodgson et al. 2008). This mealybug may reach high populations and cause reduced plant growth or plant death and has the potential to inflict significant damage to field crops in all growing regions (Fand and Suroshe 2015). Although this species was found only on ornamental plants in Turkey it may have wider distribution in the open field and could become an important pest in all areas. It has been recorded on MAPs all over the world as *Nerium oleander* L. (Apocynaceae), *Plumeria rubra* L. (Apocynaceae), *Achillea* sp. (Asteraceae), *Calendula officinalis* L. (Asteraceae), *Tagetes erecta* L., *T. patula* L. (Asteraceae), *Capparis decidua* (Forssk.) Edgew. (Capparaceae), *Capsicum annuum* L., *Momordica charantia* L. (Cucurbitaceae), *Ricinus communis* L. (Euphorbiaceae), *Pelargonium* sp. (Geraniaceae), *Mentha spicata* L. (Lamiaceae), *Ocimum basilicum* L. (Lamiaceae), *Salvia officinalis* L. (Lamiaceae), *Thymus vulgaris* L. (Lamiaceae), *Vitex agnus-castus* L. (Lamiaceae), *Alcea rosea* L. (Malvaceae), *Althaea* sp. (Malvaceae), *Hibiscus* spp. (Malvaceae), *Passiflora edulis* Sims. (Passifloraceae), *Portulaca oleracea* L. (Portulacaceae), *Citrus* spp. (Rutaceae), *Nicotiana tabacum* L. (Solanaceae), *Physalis alkekengi* L. (Solanaceae), *Lantana camara* L. (Verbenaceae) and *Elettaria cardamomum* (L.) Maton (Zingiberaceae) (García Morales et al. 2016).

Planococcus citri (Risso, 1813)

Material examined: 2 ♀♀, Sarıçam, ex *Ceratonia siliqua* L. (Fabaceae), 17.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Sarıçam, ex *C. siliqua*, 21.VII.2017, Coll: N.Z. Elekcioğlu; 2 ♀♀, Karaisalı, ex *C. siliqua*, 21.VII.2017, Coll: N.Z. Elekcioğlu.

This polyphagous and cosmopolit species has been recorded all over the world and many different MAP species as *Rhus* sp. (Anacardiaceae), *Nerium oleander* L. (Apocynaceae), *Ruscus aculeatus* L. (Nolinaceae), *Artemisa dracunculus* L. (Asteraceae), Senecio sp. (Asteraceae), *Tagetes* sp. (Asteraceae), *Ricinus communis* L. (Euphorbiaceae), *C. siliqua*, *Mentha spicata* L. (Lamiaceae), *Ocimum basilicum* L. (Lamiaceae), *Rosmarinus officinalis* L. (Lamiaceae), *Laurus nobilis* L. (Lauraceae), *Hibiscus* sp. (Malvaceae), *Myrtus communis* L. (Myrtaceae), *Passiflora edulis* Sims. (Passifloraceae), *Portulaca oleracea* L. (Portulacaceae), *Nicotiana tabacum* L. (Solanaceae), *Coffea* spp. (Rubiaceae) and *Citrus* spp. (Rutaceae) (Bodenheimer 1953, CABI 2020, Kaydan et al. 2013a).

The present study shows that the regional faunal studies of scale insects are important to better understand their relationship with host plants. Medical and aromatic plant production has been increasing in Turkey in recent years and scale insects are one of the important agents affecting yield and quality. As a result, it is thought that more detailed studies on scale insects and other pest species at the regional and national level in the future regarding plant preferences will guide both the determination of agricultural control strategies and other studies to be carried out in Turkey.

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ÖZET

Tıbbi ve aromatik bitkiler öncelikle ilaç, yiyecek ve kozmetik endüstrisinde kullanılmaktadır. Kabuklubit (Hemiptera: Coccomorpha: Sternorryncha) türleri tıbbi ve aromatik bitkilerle beslenerek, bu ürünlerin verim ve ticari değerini düşürmektedirler. Bu çalışma Adana ilinde tıbbi ve aromatik bitkilerdeki kabuklubit türlerini belirlemek amacıyla 2015-2017 yılları arasında yürütülmüştür. Kabuklubit örnekleri 28 tıbbi ve aromatik bitki türünün yaprak, gövde, dal ve meyvelerinden toplanmış, laboratuvarda incelenmiş ve tanımlanmıştır. Çalışmada, bu infratakıma bağlı Coccidae (5 tür), Diaspididae (7 tür), Monophlebidae (1 tür) ve Pseudococcidae (3 tür) familyalarından toplam 16 tür saptanmıştır.

Anahtar kelimeler: Coccidae, Diaspididae, Monophlebidae, Pseudococcidae, tıbbi bitki, aromatik bitki

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