

Original article (Orijinal araştırma)

Armored scale insects (Hemiptera: Sternorrhyncha: Diaspididae) on ornamental plants in Adana, Turkey¹

Adana ili süs bitkilerinde zararlı Kabuklubit (Hemiptera: Sternorrhyncha: Diaspididae) türleri

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Summary

A study in 2011-2013 to identified armored scale insect species (Hemiptera: Diaspididae) feeding on ornamental plants in Adana, Turkey. Scale insect samples were collected from leaves, stems and fruits from different host plants and examined in the laboratory. Twenty-three species of Diaspididae were determined from 180 samples: *Aonidia lauri* (Bouché, 1833), *Aonidiella aurantii* (Maskell, 1879), *Aspidiotus hedericola* Leonardi 1920, *Aspidiotus nerii* (Bouché, 1833), *Carulaspis juniperi* (Bouché, 1851), *Carulaspis minima* (Signoret, 1869), *Chrysomphalus dictyospermi* (Morgan, 1889), *Comstockaspis perniciosus* (Comstock, 1881), *Diaspis echinocacti* (Bouché, 1833), *Diaspidiotus pyri* (Lichtenstein, 1881), *Diaspidiotus uvae* (Comstock, 1881), *Epidiaspis leperii* (Signoret, 1869), *Hemiberlesia cyanophylli* (Signoret, 1869), *Hemiberlesia lataniae* (Signoret, 1869), *Lepidosaphes conchiformis* (Gmelin, 1790), *Lepidosaphes gloverii* (Packard, 1869), *Leucaspis pusilla* Löw, 1883, *Melanaspis inopinata* (Leonardi, 1913), *Unaspis euonymi* (Comstock, 1881), *Parlatoria oleae* (Colvée, 1880), *Parlatoria pergandii* (Comstock, 1881), *Pseudaulacaspis pentagona* (Targioni Tozzetti, 1886) and *Torosaspis farsianus* (Balachowsky & Kaussari, 1955). Among these species, *D. uvae* and *T. farsianus* are new records for Turkey.

Keywords: Armored scale insects, new records, Turkey

Özet

Bu çalışma, 2011-2013 yılları arasında Adana İli park ve süs bitkileri üzerindeki zararlı kabuklubit türlerinin saptanması amacıyla yürütülmüştür. Yapılan survey çalışmalarında farklı konukçu bitkilerden, kabuklubitin üzerinde bulunduğu yaprak, dal ve meyve örnekleri alınarak laboratuvarında incelenmiştir. Toplanan 180 örneğin teşhis edilmesi sonucunda Diaspididae familyasına ait 23 tür saptanmıştır. Bu türler; *Aonidia lauri* (Bouché, 1833), *Aonidiella aurantii* (Maskell), *Aspidiotus hedericola* Leonardi 1920, *Aspidiotus nerii* (Bouché, 1833), *Carulaspis juniperi* (Bouché, 1851), *Carulaspis minima* (Signoret, 1869), *Chrysomphalus dictyospermi* (Morgan, 1889), *Comstockaspis perniciosus* (Comstock, 1881), *Diaspis echinocacti* (Bouché, 1833), *Diaspidiotus pyri* (Lichtenstein, 1881), *Diaspidiotus uvae* (Comstock, 1881), *Epidiaspis leperii* (Signoret, 1869), *Hemiberlesia cyanophylli* (Signoret, 1869), *Hemiberlesia lataniae* (Signoret, 1869), *Lepidosaphes conchiformis* (Gmelin, 1790), *Lepidosaphes gloverii* (Packard, 1869), *Leucaspis pusilla* Löw, 1883, *Melanaspis inopinata* (Leonardi, 1913), *Unaspis euonymi* (Comstock, 1881), *Parlatoria oleae* (Colvée, 1880), *Parlatoria pergandii* (Comstock, 1881), *Pseudaulacaspis pentagona* (Targioni Tozzetti, 1886) ve *Torosaspis farsianus* (Balachowsky & Kaussari, 1955). Bu türler arasında, *D. uvae* ile *T. farsianus* ülkemiz için yeni kayıt niteliğindedir.

Anahtar sözcükler: Kabuklubit, yeni kayıtlar, Türkiye

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Introduction

In recent decades, plant pests have been spreading very quickly because the trade of live plant material has increased sharply. Scale insects (Hemiptera: Sternorrhyncha: Coccoidea: Diaspididae) are often cryptic in habit and can escape detection during quarantine inspection of plants; they have become one of the most important invasive pest groups worldwide (Miller et al., 2002; Kaydan et al., 2013a; Ülgentürk et al., 2014). Scale insects are important pests, especially on perennial plants such fruit and nut trees, ornamental shade trees and shrubs and forest trees, as well as on plants grown in greenhouses and indoors (Kosztarab & Kozár, 1988). They cause serious damage to plants, such as by direct feeding on phloem sap. Due to sap depletion, the plant vigor is reduced and chlorotic areas may develop at the feeding sites. Moreover, premature leaf drop, and distortion of the stems and bark can be damage caused by scale insects. Also, some scale insect species can transmit viral diseases (Sforza et al., 2003).

The armored scale insects, Diaspididae is the largest family of scale insects including 2400 species in 380 genera (Miller & Davidson, 2005). Of these, 638 species in 118 genera occur in the Palearctic Region. Members of this family are highly specialized, such as having legless, wingless, eyeless sap-feeding females covered by a waxy shield, and unusual life histories with males that do not feed in the adult stage (Rosen, 1990). In the countries where they cause damage, most armored scale insect pests are known to be invasive species (Miller & Davidson, 2005). Due to the increase in international trade in live plants, scale insects have started to become a serious threat to the agricultural economy. Armored scales are usually known as pests of perennial plants; Miller & Davidson (1990) compiled a list of 199 species considered as pests in some part of the world.

Armored scales have a rather unusual biology. Each female is enclosed beneath or within a separate, non-living scale cover constructed of wax and other compounds. This enclosed lifestyle has mandated that armored scales no longer produce honeydew waste from the anus, and has caused them to alter their feeding behavior to tap individual plant cells rather than feeding on phloem sap like other, related scale insects. Armored scales can feed on any part of the plant, including as leaves, fruits, stems, branches and roots (Miller & Davidson, 2005). Heavy infestations can become so dense that they cover the bark of twigs and branches and frequently are associated with plant dieback.

The first study of Diaspididae in Turkey was conducted by Bodenheimer (1941); many others have since studied the family in different regions of Turkey and on various host species (Çanakçioğlu, 1977; Yaşar, 1995; Şengonca et al., 1998; Uygun et al., 1998; Karsavuran et al., 2001; Kaydan et al., 2001, 2005, 2009a, b; Yaşar et al., 2003; Tanyürek & Yaşar, 2005). More recently Kaydan et al. (2013b) reported that, among all the scale insect families in Turkey, Diaspididae is the most abundant, represented by 134 species in 42 genera.

Adana is one of the largest cities in southeastern Turkey, and has been developing for many years in terms of agriculture, industry and trade. The city has many parks and gardens, most of them well maintained, which in the warm climate are open all year long without the need of winter maintenance. The main woody trees in parks and streets are in the genera *Citrus* (Rutaceae), *Hibiscus* (Malvaceae), *Quercus* (Fagaceae), *Nerium* (Apocynoidae), *Fraxinus* (Oleaceae) and *Juniperus* (Cupressaceae). Many scale insect species are regarded as important pests in parks. Although several studies have been conducted to identify the pest species on ornamental plants in Adana (Çalışkan et al., 2015; Kaydan et al., 2013a), until now there has no specific and comprehensive study of armored scale insect species. This paper reports the survey and identification of armored scale insects in Adana, with data on their hosts and distribution.

Material and Methods

Armored scale insects were collected from woody ornamental plants and shrubs in parks and recreation areas in Adana during spring and summer in 2011 to 2013. Samples consisted of plant material infested by scale insects. Each sample was put into a labeled plastic bag and taken to the laboratory for examination. Samples were prepared for observation under the light microscope using the slide-mounting method described by Kosztarab & Kozár (1988). The morphological terminology used follows that of Miller & Davidson (2005).

All the samples in the 2011-2013 survey were collected by the first author. The collection data (host locality, collection date and phenological stages of the host plant) are given in the results section. Previously recorded distribution and host-plant data were taken from ScaleNet (García et al., 2016).

Dry material and permanent slide mounts are deposited at the collection of the Plant Protection Department, Agricultural Faculty, Çukurova University, Balcalı-Adana, Turkey.

Results and Discussion

The research material consisted of 180 adult samples from Adana. Among these samples, 23 species were determined, and are listed and discussed below.

Aspidiotinae

Aonidia lauri (Bouché, 1833) (Figure 1a)

Synonyms: *Aspidiotus lauri* Bouché, 1833; *Aonidia purpurea* Targioni Tozzetti 1868 (García et al., 2016).

Material examined: Atatürk Park, *Laurus nobilis* L. (Lauraceae), 04.II.2012, 4 ♀♀; Kurttepe, *L. nobilis*, 07.II.2012, 17 ♀♀; Adnan Menderes Avenue, *Ficus retusa* L. (Moraceae), 10.III.2012, 1 ♀; Sanatçılar Park, *L. nobilis*, 21.III.2012, 7 ♀♀; Cumhuriyet Park, *L. nobilis*, 04.IV.2012, 4 ♀♀; Kazım Karabekir Park, *L. nobilis*, 08.IV.2012, 1 ♀; Botanik Park, *L. nobilis*, 04.VII.2012, 1 ♀.

Comments: The species occurs mainly in the Palearctic Region; there are only two records from the Nearctic (García et al., 2016). It has been recorded in Turkey previously, from the Mediterranean, Southeastern Anatolia and Marmara Regions, on *L. nobilis* (Kaydan et al., 2013b).

Aonidiella aurantii (Maskell, 1879)

Synonyms: *Aspidiotus aurantii* Maskell, 1879; *Chrysomphalus coccineus* (Maskell, 1879) Lindinger (García et al., 2016).

Material examined: Kenan Evren Avenue, *Citrus aurantium* L. (Rutaceae), 23.XI.2011, 13 ♀♀; Balcalı, *Euonymus japonicus* Thunb. (Celastraceae), 15.I.2012, 2 ♀♀; Atatürk Park, *E. japonicus*, 04.III.2012, 3 ♀♀; Merkez Park, *E. japonicus*, 09.III.2012, 3 ♀♀; Reşatbey, *C. aurantium*, 09.III.2012, 3 ♀♀; Adnan Menderes Avenue, *L. nobilis*, 10.III.2012, 16 ♀♀; Çoban Dede, *C. aurantium*, 11.III.2012, 2 ♀♀; Sakıp Sabancı Natural Park II, *Rosa* spp. (Rosaceae), 25.III.2012, 3 ♀♀; Cumhuriyet Park, *L. nobilis*, 04.IV.2012, 7 ♀♀; Kurttepe, *Acacia saligna* (Labill.) H. L. Wendl. (Fabaceae), 07.IV.2012, 6 ♀♀; Barış Park, *L. nobilis*, 22.IV.2012, 5 ♀♀; Barış Park, *Ceratonia siliqua* L. (Fabaceae), 22.IV.2012, 2 ♀♀; Mavi Avenue, *C. siliqua*, 22.IV.2012, 10 ♀♀; Sinanpaşa Park, *L. nobilis*, 06.V.2013, 4 ♀♀; Beyazevler, *Rosa* spp., 06.VIII.2013; 6 ♀♀; Hayal Park, *C. aurantium*, 18.I.2013, 6 ♀♀.

Comments: *Aonidiella aurantii* has a relatively cosmopolitan distribution (García et al., 2016). It has been recorded on 263 plant host species belonging to 87 families (García et al., 2016). In Turkey, it has been recorded only in the Mediterranean and Aegean Regions, on *Acacia* spp., *Citrus* spp., *Rosa* spp. and *Amaranthus viridis*, and (Kaydan et al., 2013b). The species is regarded as one of the most important pests of *Citrus* worldwide.

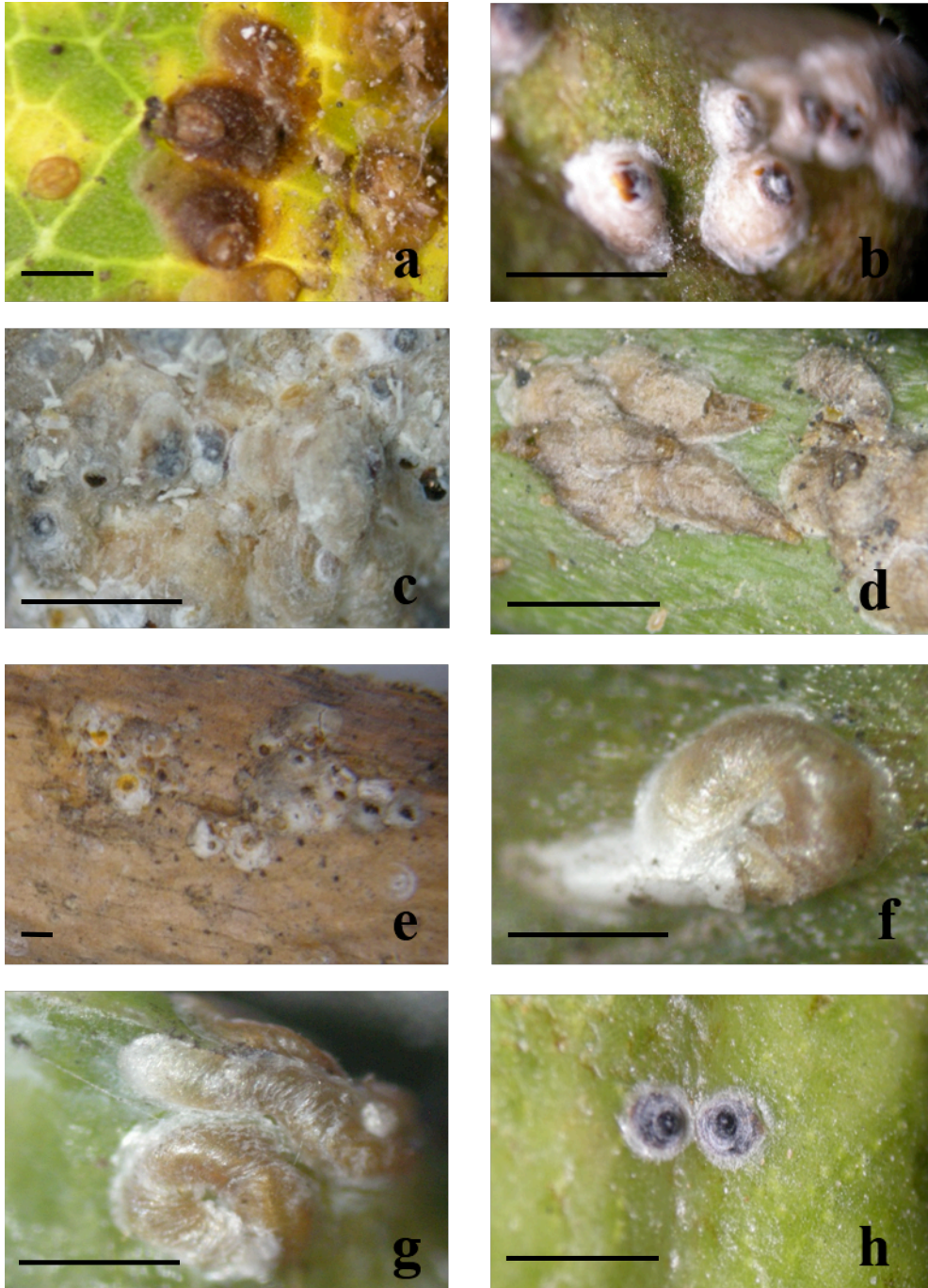


Figure 1. a. *Aonidia lauri*; b, c. *Diaspidiotus uvae*; d. *Unaspis euonymi*; e. *Pseudaulacaspis pentagona*; f, g. *Torosaspis farsianus*; h. *Parlatoria oleae*. (The scale bar in each figure = 0.5 cm).

Aspidiotus hedericola Leonardi, 1920

Synonym: *Aspidiotus hedericola* Leonardi, 1920 (García et al., 2016).

Material examined: Atatürk Park, *Hedera helix* L. (Araliaceae), 29.III.2012, 9 ♀♀; Balcalı, *H. helix*, 16.VII.2013, 3 ♀♀; Beyazevler, *H. helix*, 06.VIII.2013, 2 ♀♀.

Comments: This Palearctic species was recorded previously on *H. helix* and *L. nobilis* and in the Mediterranean, Aegean and Marmara Regions of Turkey (Kaydan et al., 2013b).

Aspidiotus nerii (Bouché, 1833)

Synonyms: *Diaspis obliquum* Costa, 1829; *Aspidiotus vagobundus* (Bouché, 1833) Tao, 1999 (García et al., 2016).

Material examined: Çoban Dede, *A. saligna*, 11.III.2012, 1 ♀; Çoban Dede, *Nerium oleander* L. (Apocynaceae), 11.III.2012, 9 ♀♀; Şehit Tolga Kargioğlu Park, *A. saligna*, 21.IV.2012, 13 ♀♀; Galeria, *N. oleander*, 26.V.2012, 1 ♀; Balcalı, *N. oleander*, 02.VI.2012, 5 ♀♀; Botanik Park, *C. siliqua*, 04.VII.2012, 1 ♀; Botanik Park, *A. saligna*, 04.VII.2012, 4 ♀♀; Botanik Park, *Punica granatum* L. (Lythraceae), 04.VII.2012, 2 ♀♀; Balcalı, *Melia azedarach* L. (Meliaceae), 04.VII.2012, 2 ♀♀; Aytaç Durak Rest Area, *Elaeagnus pungens* var. *aurea* L. (Elaeagnaceae), 18.VII.2012, 3 ♀♀; Adnan Menderes Avenue, *N. oleander*, 20.VII.2012, 10 ♀♀; Adnan Menderes Avenue, *Cercis siliquastrum* L. (Fabaceae), 20.VII.2012, 1 ♀; Yalçın Park, *Robinia pseudoacacia* L. (Fabaceae), 16.VIII.2012, 2 ♀♀; Balcalı, *Ligustrum japonicum* L. (Oleaceae), 21.IX.2012, 1 ♀; Balcalı, *H. helix*, 01.VI.2013, 5 ♀♀; Balcalı, *Jasminum officinale* L. (Oleaceae), 16.VII.2013, 4 ♀♀.

Comments: This species has a cosmopolitan distribution and has been recorded on 546 plant species belonging to more than 100 families (García et al., 2016). In Turkey, it has been recorded in the Mediterranean, Aegean, Black Sea and Marmara Regions, on *Acacia* spp. (Kaydan et al., 2013b).

Chrysomphalus dictyospermi (Morgan, 1889)

Synonyms: *Aspidiotus dictyospermi* Morgan, 1889; *Chrysomphalus jamaucebsis* (Morgan, 1889) Chou, 1985 (García et al., 2016).

Material examined: Merkez Park, *F. retusa*, 03.III.2012, 3 ♀♀.

Comments: This polyphagous species has a cosmopolitan distribution (García et al., 2016). It has been recorded previously in the Mediterranean, Aegean and Black Sea Regions of Turkey on *Aralia* spp., *Buxus microphylla* Siebold & Zucc., *C. siliqua*, *Citrus × aurantium* L., *Citrus limon* (L.) Osbeck, *Citrus × sinensis* (L.) Osbeck, *Dracena* spp., *Dracena deremensis* (L.) Ker Gawl., *Eriobotrya japonica* (Thunb.) Lindl. (Rosaceae), *Euonymus japonicus* Thunb., *Ficus carica* L. (Moraceae), *Jacobaea maritima* (L.) Pelsler & Meijden and *Taxus* sp. (Kaydan et al., 2013b).

Comstockaspis perniciosus (Comstock, 1881)

Synonyms: *Aonidia fusca* Maskell, 1895; *Quadraspidotus perniciosus* (Comstock, 1881) Ferris, 1938 (García et al., 2016).

Material examined: Balcalı, *Pittosporum heterophyllum* Franch. (Pittosporaceae), 15.II.2012, 2 ♀♀; 75th Year Park, *Pyracantha coccinea* M. Roem. (Rosaceae), 06.IV.2012, 2 ♀♀; Huzurevleri 3rd Park, *P. coccinea*, 21.IV.2012, 3 ♀♀.

Comments: This species has a cosmopolitan distribution and quite a wide range of host species worldwide (García et al., 2016). *Comstockaspis perniciosus* has been recorded previously as a polyphagous species on many ornamental and fruit trees in the Mediterranean, Aegean, Black Sea and Middle Anatolia Regions of Turkey (Kaydan et al., 2013b).

Diaspidiotus pyri (Lichtenstein, 1881)

Synonyms: *Aspidiotus pyri* Lichtenstein, 1881; *Diaspidiotus pyri* (Lichtenstein, 1881) Danzig & Pellizzari, 1998 (García et al., 2016).

Material examined: Sinanpaşa Park, *Viburnum opulus* L. (Adoxaceae), 06.V.2013, 1 ♀.

Comments: *Diaspidiotus pyri* is a Palearctic species that has been recorded on 22 plant host species belonging to the families Betulaceae, Fabaceae, Hippocastanaceae, Carpinaceae, Moraceae, Oleaceae, Platanaceae, Rosaceae and Salicaceae. It has been recorded on *Malus sylvestris* (L.) Mill., *Salix* spp. in the East Anatolian, Black Sea, Marmara and Middle Anatolia Regions of Turkey (Kaydan et al., 2013b).

Diaspidiotus uvae (Comstock, 1881) (Figures 1b,c and 2)

Synonyms: *Aspidiotus uvae* Comstock, 1881; *Aspidiotus uvaspis* Lindinger, 1937 (García et al., 2016).

Material examined: Atatürk Park, *L. nobilis*, 04.III.2012, 1 ♀; Adnan Menderes Avenue, *L. nobilis*, 10.III.2012, 2 ♀♀; Adnan Menderes Avenue, *A. saligna*, 10.III.2012, 1 ♀; Çoban Dede, *Berberis thunbergii* DC. (Berberidaceae), 11.III.2012, 2 ♀♀; Adnan Menderes Avenue, *Fraxinus excelsior* L. (Oleaceae), 21.III.2012, 31 ♀♀; Adnan Menderes Avenue, *Morus alba* L. (Moraceae), 21.III.2012, 6 ♀♀; Şehit Ast. Ahmet Umut Kahya Park, *Schinus molle* L. (Anacardiaceae), 04.IV.2012, 5 ♀♀; Belediye Evleri District, *A. saligna*, 06.IV.2012, 7 ♀♀; Zübeyde Hanım Park, *Prunus cerasifera* Ehrh. (Rosaceae), 08.IV.2012, 4 ♀♀; Mehmet Akif Ersoy Park, *Forsythia × intermedia* Zabel (Oleaceae), 08.IV.2012, 1 ♀; Kurttepe, *A. saligna*, 12.IV.2012, 12 ♀♀; Güney Yıldız Park, *F. excelsior*, 15.IV.2012, 3 ♀♀; Güney Yıldız Park, *Duranta erecta* L. (Verbenaceae), 15.IV.2012, 5 ♀♀; Barış Park, *P. cerasifera*, 22.IV.2012, 3 ♀♀; Dilberler Park, *Celtis caucasica* Willd. (Cannabaceae), 02.VI.2012, 1 ♀; Balcalı, *B. thunbergii*, 23.VI.2012, 1 ♀; Mahfesiğmaz District, *Platanus orientalis* L. (Platanaceae), 04.VII.2012, 1 ♀; Dilberler Park, Merkez Park, *R. pseudoacacia*, 20.V.2012, 2 ♀♀; Merkez Park, *Paulownia tomentosa* (Thunb.) Steud. (Paulowniaceae), 26.V.2012, 2 ♀♀; Turgut Özal Avenue, *P. coccinea*, 30.V.2012, 2 ♀♀; Çoban Dede, *Philadelphus coronarius* L. (Hydrangeaceae), 18.VII.2012, 2 ♀♀; Yüreğir, *M. alba*, 20.VII.2012, 12 ♀♀; Adnan Menderes Avenue, *C. siliquastrum*, 20.VII.2012, 1 ♀; Çınarlı Park, *Jacaranda mimosifolia* D. Don (Bignoniaceae), 27.VII.2012, 3 ♀♀; Doğal Park, *R. pseudoacacia*, 02.VIII.2012, 3 ♀♀; Atatürk Avenue, *H. helix*, 08.IX.2012, 2 ♀♀; Karacaoğlan, *R. pseudoacacia*, 09.IX.2012, 5 ♀♀; *C. siliquastrum*, 08.V.2013, 2 ♀♀; Kenan Evren Avenue, *M. alba*, 27.VII.2013, 9 ♀♀.

Field characters: Adult female scale cover with white or grayish white, flat, circular or slightly elongate felted scale with central or subcentral exuviae yellow or orange. The small yellow/orange parts are the cast skins (exuviae) and the larger gray part is the felted secretions produced by the insect.

Adult female body pear shaped, head and thorax often sclerotized in older adult females. Eyes usually each represented by sclerotized spur or dome on prothorax near the intersegmental line with mesothorax, rarely absent. Antennae each with one seta. Median lobes developed, second and third pairs of lobes absent or rarely represented by small, unsclerotized points. Median lobes separated by narrow space, medial margins of lobes usually slightly divergent apically, lateral margins converging towards midline, each with one lateral notch and one medial notch. Lobes 2 and 3, when present, simple, each represented by unsclerotized point, without lateral notches. Plates between median lobe and lobe 2, and between lobes 2 and 3, usually with noticeable tines; plates between median lobes absent. Paraphyses as follows: each median lobe with small paraphysis on medial margin; paraphysis present in each space between position of lobe 2 and median lobe, on medial margin of each of lobes 2 and 3, and in space between positions of lobes 2 and 3. On dorsum of pygidium, anal opening located between median lobes and level of vulva. Long dorsal seta situated laterad of each lobe. Macroducts of two sizes: larger size present on pygidium between median lobes and on segments V to VII in marginal and submarginal areas. Pygidial macroducts absent; prepygidial macroducts of two sizes, large size in submedial areas of any or all of metathorax to abdominal segment IV, smaller size in submarginal areas of head or prothorax to segment II or III. On venter, pygidial microducts present in submarginal and marginal areas of segment V, sometimes on VI; prepygidial ducts of one size in submarginal and marginal areas of segments III and IV, present submedially near mouthparts and spiracles. Preulvar pores in five indefinite clusters (median cluster composed of one or two pores only) (based on Miller & Davidson, 2005).

Comments: *Diaspidiotus uvae* has been recorded on 12 different host species belonging to the Agavaceae, Betulaceae, Juglandaceae, Moraceae, Platanaceae, Rosaceae and Vitaceae in the Nearctic Region, and in the Azores, Canary Islands, Italy, Madeira Islands, Portugal and Spain in the Palearctic Region (García et al., 2016).

This is the first record of *D. uvae* in Turkey. The species is regarded as a plant pest in vineyards in the USA. (Hollinger, 1923; Johnson et al., 1999; Miller & Davidson, 2005; Zimmer, 1912). Further studies are needed to understand its distribution and host-plant diversity in Turkey and other Mediterranean countries.

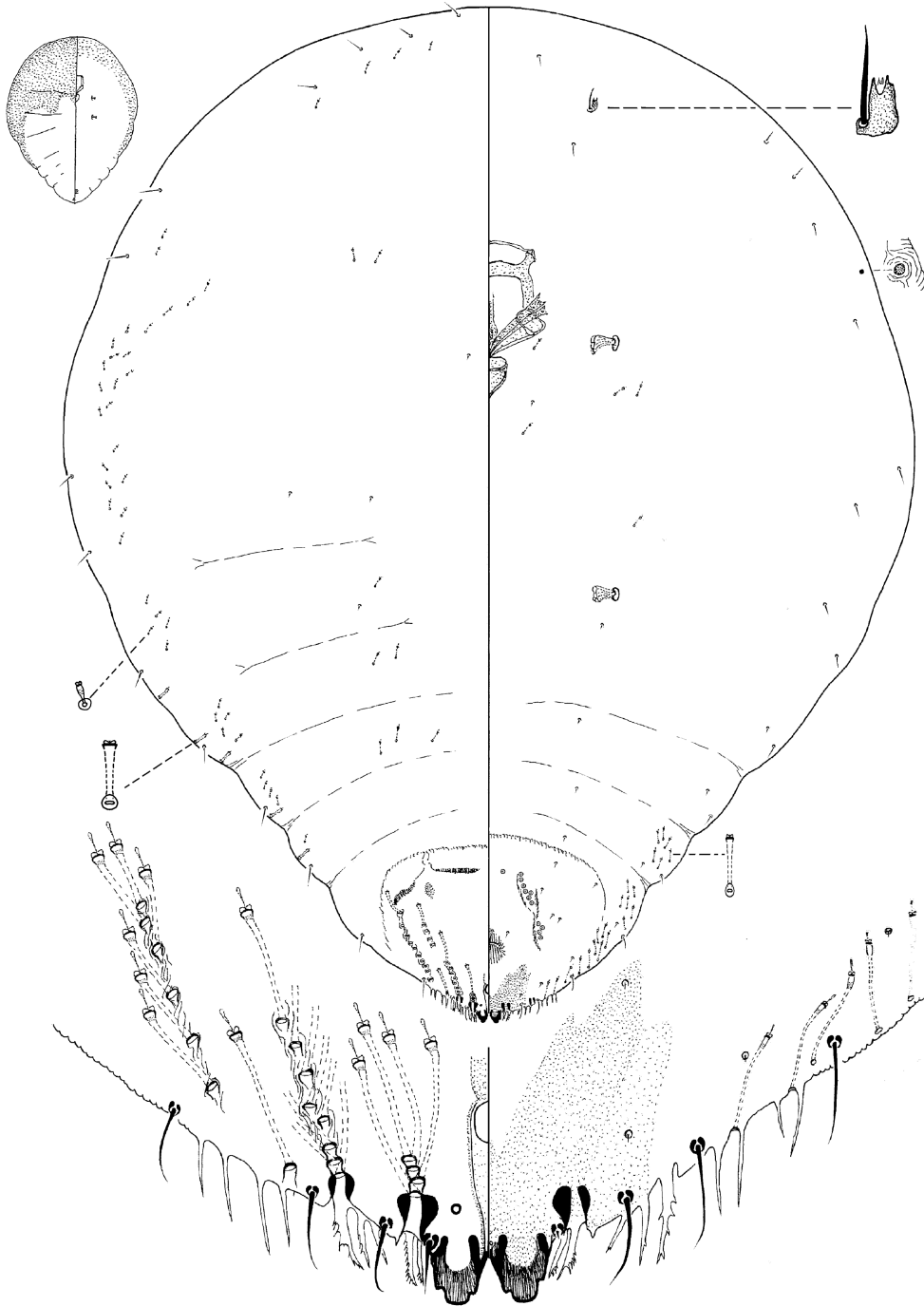


Figure 2. *Diaspidiotus uvae* after Miller & Davidson (2005), with modifications.

Hemiberlesia cyanophylli (Signoret, 1869)

Synonyms: *Aspidiotus cyanophylli* Signoret, 1896; *Aspidiotus cyanophylli* (Signoret, 1896) Chou, 1985 (García et al., 2016).

Material examined: Balcalı, *Gazania rigens* (L.) Gaertn var. *rigens* (Asteraceae), 13.X.2012, 7 ♀♀; Barajyolu, *G. rigens* var. *rigens*, 31.VII.2013, 3 ♀♀.

Comments: *Hemiberlesia cyanophylli* feeds on more than 180 plant species belonging to 72 families, with a worldwide distribution (García et al., 2016). It has been recorded previously in the Aegean, Marmara and Middle Anatolia Regions of Turkey on *Brasiliopuntia brasiliensis* (Willd.) A.Berger, *Cactus* spp., *Echinopsis chamaecereus* H.Friedrich & Glaetzle, *Dianthus caryophyllus* L., *Gasteria bicolor* (L.) Haw., *Gasteria carinata verrucosa* (Mill.) van Jaarsv. and *J. maritima* (Kaydan et al., 2013b).

Hemiberlesia lataniae (Signoret, 1869)

Synonyms: *Aspidiotus lataniae* Signoret, 1869; *Aspidiotus implocatus* (Signoret) Chou, 1985 (García et al., 2016).

Material examined: Hayal Park, *Albizia julibrissin* Willd. (Leguminosae), 18.I.2014, 2 ♀♀.

Comments: This cosmopolitan and polyphagous species has been recorded previously in the Aegean and Marmara Regions of Turkey (Kaydan et al., 2013b).

Melanaspis inopinata (Leonardi, 1913)

Synonyms: *Aonidiella inopinata* Leonardi, 1913; *Pelomphala inopinata* (Leonardi, 1913) Lupo, 1954 (García et al., 2016).

Material examined: Sanatçılar Park, *Chaenomeles speciosa* (Sweet) Nak. (Rosaceae), 21.III.2012, 3 ♀♀; Adnan Menderes Avenue, *F. excelsior*, 25.III.2012, 3 ♀♀; Balcalı, *P. coccinea*, 15.V.2012, 7 ♀♀; Balcalı, *Pistacia atlantica* Desf. (Anacardiaceae), 04.VII.2012, 1 ♀.

Comments: *Melanaspis inopinata* has a Palearctic distribution, with 42 host records from 13 different families (García Morales et al., 2016). The species has been recorded previously in the Aegean, Mediterranean and Middle Anatolian Regions of Turkey on *Arbutus unedo* L., *Bauhinia* sp., *Celtis* sp., *C. siliquastrum*, *Malus pumila* Miller, *Prunus* sp., *P. avium*, *Pyrus communis* L. and *Astragalus* sp. (Kaydan et al., 2013b).

Diaspidinae

Carulaspis juniperi (Bouché, 1851)

Synonyms: *Aspidiotus juniperi* Bouché, 1851; *Diaspis taxicola* (Bouché, 1851) Baccetti, 1960 (García et al., 2016).

Material examined: Yüreğir, *Platyclusus orientalis* (L.) Franco (Cupressaceae), 18.VII.2012, 1 ♀.

Comments: *Carulaspis juniperi* has a wide range of distribution all over the world (García Morales et al., 2016). Juniper scale is restricted to conifers, but is most commonly collected on *Juniperus* spp. (Miller & Davidson, 2005). It has been recorded previously in the Aegean and Mediterranean Regions of Turkey on *Cupressus sempervirens* L., *Juniperus excelsa* and *Platy. orientalis* (Kaydan et al., 2013b).

Carulaspis minima (Signoret, 1869)

Synonyms: *Diaspis carueli* Signoret, 1869; *Carulaspis carueli* (Signoret, 1969) Borchsenius, 1966 (García et al., 2016).

Material examined: Merkez Park, *Cupressus arizonica* Greene (Cupressaceae), 09.III.2012, 1 ♀; Balcalı, *Platy. orientalis*, 04.VII.2012, 5 ♀♀; Balcalı, *C. sempervirens*, 04.VII.2012, 2 ♀♀; Balcalı, *C. sempervirens* var. *pyramidalis*, 02.VIII.2012, 2 ♀♀.

Comments: *Carulaspis minima* has a cosmopolitan distribution (García et al., 2016). It is restricted to conifers but, like *C. juniperi*, is most commonly collected on *Juniperus* spp. (Miller and Davidson, 2005). The species has been recorded previously in the Marmara and Mediterranean Regions of Turkey on *Juniperus drupacea* Labill., *Chamaecyparis lawsoniana* (A. Murray) Parl., *C. arizonica*, *Juniperus communis* L. and *Platy. orientalis* (Kaydan et al., 2013b).

Diaspis echinocacti (Bouché, 1833)

Synonyms: *Coccus luteus* Lancry, 1791; *Carulaspis calyptroides* (Bouché, 1833) Bodenheimer, 1953 (García et al., 2016).

Material examined: Reşatbey, *Dypsis lutescens* (H. Wendl.) Beentje & J. Dransf. (Arecaceae), 15.XII.2012, 10 ♀♀; Garden Koala, *Ferocactus macrodiscus* (Mart.) Britton & Rose (Cactaceae), 28.II.2013, 5 ♀♀.

Comments: *Diaspis echinocacti* occurs wherever cacti are grown, including on indoor plants in a continental climate globally (García et al., 2016). It has been recorded previously in Turkey in the Mediterranean Region (under natural conditions) and the Middle Anatolia Region (indoors) on *Cactus* spp. and *Opuntia ficus-indica* (L.) Mill. (Kaydan et al., 2013b).

Epidiaspis leperii (Signoret, 1869)

Synonyms: *Diaspis leperii* Signoret, 1869; *Epidiaspis peperii* (Signoret, 1869) Schvester, Milaire & Gireau, 1955 (García et al., 2016).

Material examined: Balcalı, *P. atlantica*, 04.VII.2012, 2 ♀♀.

Comments: *Epidiaspis leperii* is a polyphagous species recorded on 48 species from 13 plant families such as Juglandaceae, Moraceae, Lauraceae and Rosaceae (García et al., 2016). The species has been recorded in almost all regions of Turkey on *Cactus* spp., *Opuntia ficus-indica*, *Pistacia* sp., *Prunus* sp., *P. domestica* and *Aesculus hippocastanum* L. (Kaydan et al., 2013b).

Lepidosaphes conchiformis (Gmelin, 1790)

Synonyms: *Coccus conchiformis* Gmelin, 1790; *Insulaspis minima* (Gmelin, 1790) Borchsenius, 1963 (García et al., 2016).

Material examined: Mavi Avenue, *F. carica*, 18.I.2014, 2 ♀♀.

Comments: Fig scale occurs in Argentina, Chile, Europe, Iran, Iraq, Israel, North Africa, Pakistan, the former USSR and Syria. *Lepidosaphes conchiformis* has been recorded previously on *F. carica*, Lamiaceae, *Rhamnus* spp. and *Ulmus* spp. in the Mediterranean and Aegean Regions of Turkey (Kaydan et al., 2013b).

Lepidosaphes gloverii (Packard, 1869)

Synonyms: *Aspidiotus gloverii* Packard, 1869; *Cornuaspis gloverii* (Packard, 1869) Alayo Soto, 1976 (García et al., 2016).

Material examined: Mavi Avenue, *C. aurantium*, 26.VII.2012, 7 ♀♀.

Comments: *Lepidosaphes gloverii* is widely distributed in tropical and subtropical parts of the world and is often found on *Citrus* spp. (Miller & Davidson, 2005). The species has been recorded previously in Turkey in the Aegean, Marmara and Mediterranean Regions on *Citrus* spp. (Kaydan et al., 2013b).

Pseudaulacaspis pentagona (Targioni Tozzetti, 1886) (Figure 1e)

Synonyms: *Diaspis pentagona* Targioni Tozzetti, 1886; *Diaspis geranii* (Targioni Tozzetti, 1886) Borchsenius, 19966 (García et al., 2016).

Material examined: Merkez Park, *Morus alba*, 09.III.2012, 19 ♀♀; Adnan Menderes Avenue, *M. alba*, 21.III.2012, 10 ♀♀; Atatürk Park, *M. alba*, 21.III.2012, 58 ♀♀; Doğal 2 Park, *M. alba*, 25.III.2012, 6 ♀♀; Şehitler Park, *M. alba*, 29.III.2012, 42 ♀♀; Cumhuriyet Park, *M. alba*, 04.IV.2012, 20 ♀♀; Ulus Park, *M. alba*, 08.IV.2012, 8 ♀♀; Mehmet Akif Ersoy Park, *F. excelsior*, 08.IV.2012, 1 ♀; Merkez Park, *P. tomentosa*, 26.V.2012, 4 ♀♀; Dilberler Park, *E. pungens*, 23.VI.2012, 4 ♀♀; Dilberler Park, *R. pseudoacacia*, 23.VI.2012, 9 ♀♀; Çoban Dede District, *A. saligna*, 08.VIII.2012, 14 ♀♀; Balcalı, *M. alba*, 09.XI.2012, 12 ♀♀; Merkez Park, *M. alba*, 14.III.2013, 25 ♀♀; Doğal Park, *M. alba*, 11.IV.2013, 2 ♀♀; Kazım Karabekir Park, *M. alba*, 02.V.2013, 12 ♀♀.

Comments: White peach scale is one of the most polyphagous armored scale insect species, feeding on at least 393 plant host species belonging to 90 families (García et al., 2016). Reportedly it is one of 43 principal armored scale pests worldwide (Beardsley & Gonzalez, 1975). It has been recorded in all regions of Turkey as polyphagous, and is regarded as an important pest (Kaydan et al., 2013b).

Torosaspis farsianus (Balachowsky and Kaussari, 1955) (Figures 1f,g and 3)

Synonym: *Acanthomytilus farsianus* Balachowsky & Kaussari, 1955 (García et al., 2016).

Material examined: Merkez Park, *C. arizonica*, 09.III.2012, 2 ♀♀; Balcalı, *C. sempervirens* var. *horizontalis*, 05.V.2012, 4 ♀♀; Hayal Park, *C. sempervirens* var. *horizontalis*, 18.I.2014, 8 ♀♀; Türkmenbaşı Avenue, *C. sempervirens* var. *pyramidalis*, 18.I.2014, 1 ♀.

Live appearance: scale cover of adult female flat, elongate, oyster-shell shaped, broadest posteriorly, light brown, with two larval exuviae pale yellow and transparent. Live female beneath scale cover cream-colored, pygidium darker. Test of second-instar male yellowish-brown, parallel-sided, narrower and shorter than that of female.

Adult female: Body elongate oval, widest across abdominal segment I; membranous, except for sclerotized pygidium. Each antenna with two large flagellate and two short conical setae. Anterior spiracles each with one associated trilocular disc pore. Pygidium rounded, slightly sclerotized, with two pairs of lobes. Median lobes prominent, rounded, with space between as wide as one lobe. Lobe 2 unilobular, similar in shape to median lobe but smaller; lobe 3 barely perceptible, unilobular, triangular and finely pointed. Gland spines each twice the length of the median lobe. Dorsum with marginal macroducts on pygidium singly present on each of segments IV-VII (formula 1-1-1-1). Anal opening situated near anterior margin of pygidium on abdominal segment V. Venter with macroducts smaller than dorsal macroducts, present in a submarginal group on abdominal segments I and II, and present on the submargin of prothorax and mesothorax. Posterior spiracles each associated with three to five glandular tubercles and five to eight macroducts in a transverse band extending to margin. Microducts few, present on the head and thorax.

Comments: *Torosaspis farsianus* has only been recorded previously in Iran on *Cupressus* sp. and *C. sempervirens* (Balachowsky & Kaussari, 1951; Moghaddam, 2013). Its detection in Turkey is a new country record. It is considered that this scale is an element of the local fauna, rather than a recent introduction.

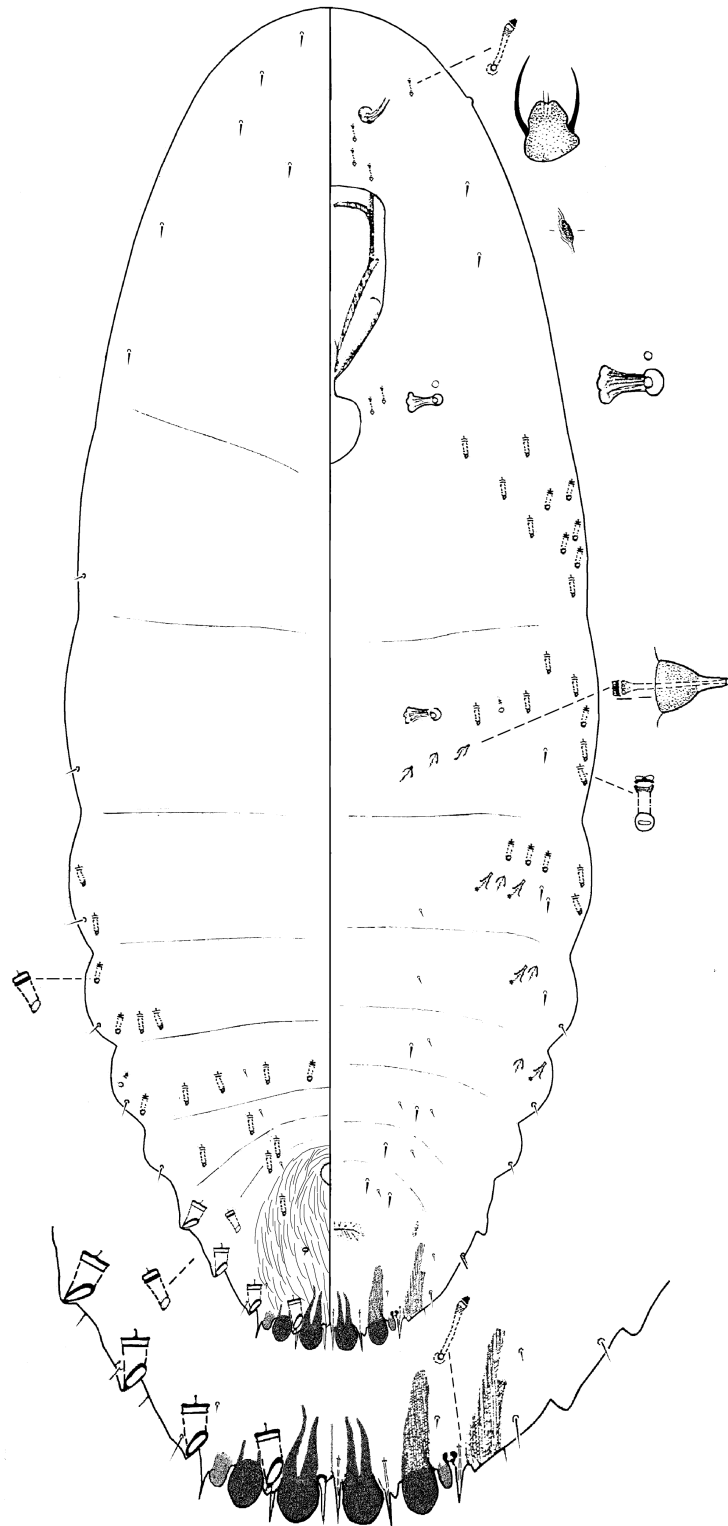


Figure 3. *Torosaspis farsianus* after Balachowsky & Kaussari (1955), with modifications.

Unaspis euonymi (Comstock, 1881) (Figure 1d)

Synonyms: *Chionaspis euonymi* Comstock, 1881; *Unaspis nakayamai* Takahashi & Kanda, 1939 (García et al., 2016).

Material examined: Uğur Mumcu Avenue, *E. japonicus*, 20.IV.2011, 5 ♀♀; Balcalı, *E. japonicus*, 15.XI.2011, 1 ♀; Mahfesiğmaz District, *E. japonicus*, 04.III.2012, 4 ♀♀; Adnan Menderes Avenue, *E. japonicus*, 10.III.2012, 19 ♀♀; Çoban Dede District, *E. japonicus*, 11.III.2012, 14 ♀♀; Doğal Park, *E. japonicus*, 25.III.2012, 2 ♀♀; Balcalı, *E. japonicus*, 26.IV.2012, 18 ♀♀; Dilberler Park, *E. japonicus*, 23.VI.2012, 1 ♀; Süleyman Demirel Avenue, *E. japonicus*, 04.VIII.2012, 10 ♀♀; Doğal Park, *E. japonicus*, 02.VIII.2012, 8 ♀♀; Merkez Park, *E. japonicus*, 14.III.2013, 15 ♀♀; Doğal Park, *E. japonicus*, 11.IV.2013, 5 ♀♀.

Comments: *Unaspis euonymi* has a cosmopolitan distribution and has been found on 43 plant species belonging to 20 families. It has been recorded in almost all regions of Turkey on *Buxus sempervirens*, *Rosa* spp., *Euonymus fortunei* (Turcz.) Hand.-Maz. and *E. japonicus* (Kaydan et al., 2013b), and is regarded as a pest species on ornamental Japanese spindle in many cities in Turkey.

Leucaspidinae

Leucaspis pusilla (Löw, 1883)

Synonyms: *Leucaspis pusilla* Löw, 1883; *Pusillaspis pusilla* (Löw, 1883) Lindinger, 1957 (García et al., 2016).

Material examined: Yurt Park, *Pinus pinaster* Aiton (Pinaceae), 30.V.2012, 3 ♀♀; Balcalı, *P. pinea* L., 04.VII.2012, 1 ♀.

Comments: *Leucaspis pusilla* has a Palearctic distribution and has been recorded on 25 plant species belonging only to the family Pinaceae (García et al., 2016). The species has been found in almost all regions of Turkey, on *Cedrus* spp., *Pinus* sp., *Pinus brutia* Tenore, *Pinus halepensis* Miller and *Pinus pinea* L. (Kaydan et al., 2013b).

Parlatoria oleae (Colvée, 1880) (Figure 1h)

Synonyms: *Diaspis oleae* Colvée, 1880; *Parlatoria morrisoni* Bodenheimer, 1944 (García et al., 2016).

Material examined: Atatürk Park, *L. nobilis*, 04.III.2012; 2 ♀♀; Stadium District, *E. japonica*, 09.III.2012, 8 ♀♀; Çoban Dede District, *B. thunbergii*, 11.III.2012, 9 ♀♀; Sanatçılar Park, *C. speciosa*, 21.III.2012, 4 ♀♀; Adnan Menderes Avenue, *F. excelsior*, 25.III.2012, 20 ♀♀; Çoban Dede District, *Cotoneaster franchettii* Bois. (Rosaceae), 02.VIII.2012, 4 ♀♀; Doğal Park, *Acacia homalophylla* A. Cunn. ex. Benth. (Fabaceae), 02.VIII.2012, 7 ♀♀; Pınar 2 Park, *Lagerstroemia indica* (L.) Pers. (Lythraceae), 12.VIII.2012, 4 ♀♀.

Comments: *Parlatoria oleae* is known from Asia, Australia, Mexico, North Africa, South America, southern Europe and southern former USSR. The species is regarded as a polyphagous pest on more than 200 plant species belonging to 56 families (García et al., 2016). It occurs in almost all regions of Turkey, feeding on *Eriobotrya* sp, *Fraxinus* sp., *Rosa* spp., *M. sylvestris*, *Prunus* spp. and *Syringa vulgaris* L. (Kaydan et al., 2013b).

Parlatoria pergandii (Comstock, 1881)

Synonyms: *Parlatoria sinensis* Maskell, 1897; *Parlatoreopsis pergandii* (Comstock, 1881) Kawai, 1972 (García et al., 2016).

Material examined: Balcalı, *Hoya carnosa* (L. f.) R. Br. (Apocynaceae), 15.IV.2011, 3 ♀♀; 5 Ocak Lions Park, *C. aurantium*, 03.III.2012, 6 ♀♀; Mahfesiğmaz District, *E. japonicus*, 04.III.2012, 4 ♀♀; Adnan Menderes Avenue, *L. nobilis*, 10.III.2012, 2 ♀♀; Turgut Özal Avenue, *P. coccinea*, 30.V.2012, 4 ♀♀;

Dilberler Park, *B. thunbergii*, 23.VI.2012, 2 ♀♀; Balcalı, *C. siliqua*, 04.VII.2012, 1 ♀; Sanatçılar Park, *C. aurantium*, 16.V.2013, 6 ♀♀.

Comments: Miller and Davidson (1990) listed this insect as a serious and widespread pest of citrus, although some researchers regard it as a relatively minor citrus pest (Rosen & DeBach, 1978). The species is a very important pest in southern Japan and Italy, and an important pest in Spain, Lebanon, Israel, Southeast Asia, Central America, Mexico, and USA. (García et al., 2016). *Parlatoria pergandii* was recorded previously in the Mediterranean Region of Turkey on *Citrus* spp. and *M. sylvestris* by Kaydan et al. (2013b).

Due to the geographical location of Turkey, different climates in different regions, as well as different altitudes from sea level, cause different and rich in plant and animal ecosystem. For this reason, the insect species richness of Turkey is always dynamic and it is thought that it will continue to increase in future.

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