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# NEW AND LITTLE KNOWN SCALE INSECT SPECIES (HEMIPTERA: COCCOIDEA) IN TURKEY

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Scale insects (Hemiptera: Coccoidea) are notorious pests, especially of perennial plants. They are serious pests of fruit and nut trees, ornamental shade trees and shrubs, forest trees, greenhouse and indoor plantings. In the present study, new data are given for 13 species of scale insects from Turkey as follows: Coccidae (1 sp.), Cerococcidae (1 sp.), Diaspididae (2 spp.), Pseudococcidae (8 spp.) and Rhizoecidae (1 sp.). *Chorizococcus malabadiensis* Kaydan sp. n. is described and illustrated as a new species and 8 species are recorded for the first time from Turkey.

Key words: Pseudococcidae, Cerococcidae, Coccoidea, scale insects, Turkey.

## INTRODUCTION

Scale insects (Hemiptera: Coccoidea) are notorious pests, especially of perennial plants. They are serious pests of fruit and nut trees, ornamental shade trees and shrubs, forest trees, greenhouse and indoor plantings (Kosztarab & Kozár 1988). The main damage is caused by direct feeding of the plant sap and consequently by reducing vigor and producing chlorotic areas at feeding locations; and, by causing various symptoms such as premature leaf drop and distortion of the stem and bark. Large populations may contaminate foliage with their sticky honeydew excretions, which provide a substrate for sooty mould growth and some species can transmit viral diseases as well (Sforza *et al.* 2003).

The superfamily Coccoidea contains many agricultural pests throughout the world. The first detailed study on scale insect fauna of Turkey was made by Bodenheimer (1952, 1953). The last comprehensive checklist of the Turkish scale insect fauna reporting on 267 species distributed in 12 families was published by Kaydan *et al.* (2007). Later, additional studies were conducted and published by several authors such as Kaydan *et al.* (2008), Kaydan and Kondo (2008), Ülgentürk *et al.* (2008), Kaydan and Kozár (2010), Kaydan and Kozár (2010*a, b*, 2011*a, b*), Kaydan and Gavrilov (2010), Erkiliç *et al.* (2011), Kaydan (2011), Kaydan *et al.* (2012), Ülgentürk *et al.* (2012), Ülgentürk and Kozár (2012), Kaydan *et al.* (2013), Ülgentürk and Pellizzari (2013) recording numerous new species for the Turkish scale insect fauna.

Turkey with 779,000 km$^2$ territory, is fairly plain, lies among Asia, Africa and Europe, and is surrounded from three sides by seas (Black Sea, Mediterranean Sea and Aegean Sea) having different ecological characteristics, with very different altitudes from sea level to above 5000 meters (Anonymous 2014). These conditions result in a wide variety of climatic conditions within the country (Anonymous 2014). Three different biogeographic regions namely Eurosiberian (Kars–Erzurum plate), Iranian–Turanian (from eastern part of Turkey till Middle Anatolia), and Mediterranean are present in Turkey and these regions show different types of ecosystems including transitional ecosystems between the zones (Anonymous 2014). Although the most important ecosystems are steps in the country, the Turkish territory consists of forests, mountains, wetlands, coastal and marine ecosystems and different combinations of these systems (Anonymous 2014). In this paper, we list new scale insect records and describe and illustrate a new species of mealybug collected at different regions in Turkey.

## MATERIAL AND METHODS

Scale insect samples were collected at several regions of Turkey (Adana, Ağrı, Erzincan, Erzurum, Hakkari, Igdır, İzmir, Rize, and Van) between 2005 and 2010. Specimens were taken from both wild and cultivated plants twice a week during the spring and summer seasons. Collecting data, province, locality, GIS coordinates, date of collection, collector, data on the phenological stages of the host plant and the KPCT collection numbers are given.

Each sample was placed in a plastic bag and taken to the laboratory for examination. Specimens were slide-mounted for light microscopy using the method of Kosztarab and Kozár (1988). Morphological terminology follows that of Kosztarab and Kozár (1988) and Williams (2005) for description of the new mealybug species. Measurements and counts of the new species were taken from all available material, i.e., holotype and all paratype specimens.

Earlier distribution and host plant data are given according to information taken from ScaleNet (Ben-Dov *et al*. 2014).

Both dry and mounted of other materials are deposited in the Scale Insect Collection in Çukurova University, Adana, Turkey (KPCT). Holotype and one paratype of the new species are deposited in the Scale Insect Collection of Çukurova University, Adana, Turkey (KPCT) one paratype will be deposited in the Scale Insect Collection in the Zoological Museum, Russian Academy of Science, St. Petersburg (ZIN).

## RESULTS AND DISCUSSIONS

A total of 25 samples were collected from both natural areas and indoor plants from different parts of Turkey. 13 species of scale insects were identified from the following families: Coccidae (1 sp.), Cerococcidae (1 sp.), Diaspididae (2 spp.), Pseudococcidae (8 spp.) and Rhizoecidae (1 sp.) of which 8 species are new records for the Turkish scale insect fauna and one mealybug species belonging to the genus *Chorizococcus* McKenzie, 1960 is described as new to science.

Species marked with asterisk (*) are new records for the Turkish scale insect fauna.

## Coccidae

### **Pulvinaria peregrina* (Borchsenius, 1953)

Material examined. Rize, 16.vii.2010, N: 41°01′867″, E: 040°30′757″, 4 m, *Hibiscus* sp., 2 ♀♀, collected by M. B. Kaydan (KPCT: 4940).

Host plants. *Acer japonica* (Aceraceae), *Diospyros* sp., *Diospyros kaki*, *Diospyros lotus*, *Vaccinium* sp., *Vaccinium myrtillus* (Ericaceae), *Hibiscus japonica* (Malvaceae), *Rosa* sp., *Cydonia vulgaris*, *Pyrus caucasica* (Rosaceae), *Citrus* sp., *Poncirus trifoliata* (Rutaceae), *Celtis sinensis* (Ulmaceae) (Ben-Dov *et al.* 2014).

Distribution. Azerbaijan, China, Georgia (Ben-Dov et al. 2014), Turkey (present study).

## Cerococcidae

### **Cerococcus polyporus* (Matesova, 1975)

Material examined. Artvin, Şavşat, 15.vii.2010, N: 41°16′441″, E: 042°15′253″, 716 m, *Thymus* sp., 6 ♀♀, collected by M. B. Kaydan and F. Kozár (KPCT: 4858).

Host plants. *Artemisia terrae-albae* (Asteraceae) (Ben-Dov *et al.* 2014).

Distribution. Kazakhstan (Ben-Dov *et al.* 2014), Turkey (present study).

## Diaspididae

### **Discodiaspis salicorniae* (Gómez-Menor Ortega, 1928)

Material examined. Hakkari, Esendere, 23.v.2008, N: 37°42′405″, E: 044°32′040″, 1785 m, undetermined plant, 3 ♀♀, collected by M. B. Kaydan and F. Kozár (KPCT: 4309).

Host plants. *Arthrocnemum glaucum*, *Atriplex* sp., *A. fructicosa*, *A. portulacoides*, *Salicornia* sp., *S. fruticosa*, *S. macrostachya*, *Suaeda fruticosa*, *S. maritima* (Chenopodiaceae), *Thymelaea hirsuta* (Thymelaeaceae) (Ben-Dov et al. 2014).

Distribution. Greece (Ben-Dov et al. 2014), Turkey (present study).

### *Rhizaspidiotus donacis* (Leonardi, 1920)

Material examined. Antalya, 29.v.2009, 25 m, *Phragmites* sp., 2 ♀♀, collected by L. Erkılıç (KPCT: 5141)

Host plants. *Arundo donax*, *Phragmites australis* (Poaceae) (Ben-Dov *et al.* 2014).

Distribution. Algeria, Crete, Croatia, France, Italy, Spain, Turkey (Ben-Dov *et al.* 2014).

Remarks. Previously, this species was found on *Phragmites australis* at Adana in Turkey (Kaydan *et al*. 2007). This scale insect occurs beneath the leaf sheaths, especially at the nodes (Ferris 1943). The species was regarded as a potential biological control agent for *Arundo donax* L. in North America (Goolsby *et al.* 2009).

## Pseudococcidae

### **Chorizococcus malabadiensis** Kaydan sp. n.
(Fig. 1)

Holotype, female. Diyarbakır, Malabadi, 26.v.2008, N: 38°09′305″, E: 041°12′785″, 624 m, *Chrysopogon grillus* (Poaceae), collected by M. B. Kaydan and F. Kozár, (KPCT: 4326).

Paratypes. Diyarbakır, Malabadi, 26.v.2008, N: 38°09′305″, E: 041°12′785″, 624 m, *Chrysopogon grillus* (Poaceae), 2 ♀♀, collected by M. B. Kaydan and F. Kozár (KPCT: 4326), one paratype placed in the Scale Insect Collection in ZIN (Zoological Museum, Russian Academy of Science, St. Petersburg) (Reg. No: ZIN-01-2014).

Diagnosis of adult female. *Chorizococcus malabadiensis* sp. n. can be diagnosed by the following combination of features: translucent pores present on hind coxa and tibia; two pairs of cerarii present on the last two abdominal segments; circulus present; multilocular discpores present on venter of abdominal segments; 15–17 pores on segment II–III, 22–29 pores on segment IV, 34–52 pores on segment V, 47–57 pores on segment VI, 63–74 on segment VII, 36–45 on segments VIII+IX; anal lobe cerarii each with 2 conical setae; abdominal and thoracic ostioles present; antennae 8-segmented, usually 430–455 μm long.

Live appearance. Adult female body oval, light pink, with two white filaments at the end of abdomen.

Mounted adult female. Body elongate oval, 1.67–2.16 mm long, 0.67–0.98 mm wide. Eyes marginal, 32–40 μm wide. Antennae 8 segmented, each 430–455 μm long; apical segment 92.5–95.0 μm long, 27.5–35.0 μm wide. Clypeolabral shield 160–170 μm long, 110–145 μm wide. Labium 110–120 μm long, 85 μm wide. Anterior spiracles 55–65 μm long, 27.5–37.5 μm wide across atrium; posterior spiracles 65–85 μm long, 40.0–47.5 μm wide across atrium. Circulus oval, 110–145 μm wide. Legs well developed; coxa 145–170, hind trochanter + femur 270–330 μm long, hind tibia + tarsus 315–330 μm long, hind claw 25.0–27.5 μm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.16–1.00, ratio of lengths of hind tibia to tarsus 2.26–2.71, ratio of length of hind trochanter + femur to greatest width of femur 3.72–5.50. Tarsal digitules subequal, each 30–35 μm long slightly knobbed. Claw digitules subequal, each 20–25 μm long, and knobbed. Translucent pores present on coxa and tibia of hind legs, numbering 42–71 in total. Both pairs of ostioles present; each anterior ostiole, with 18–32 trilocular pores and 3 or 4 setae; each posterior ostiole with 24–41 trilocular pores and 3–5 setae. Anal ring 75.0–77.5 μm wide, with 6 anal-ring setae, each setae 85.0–102.5 μm long.

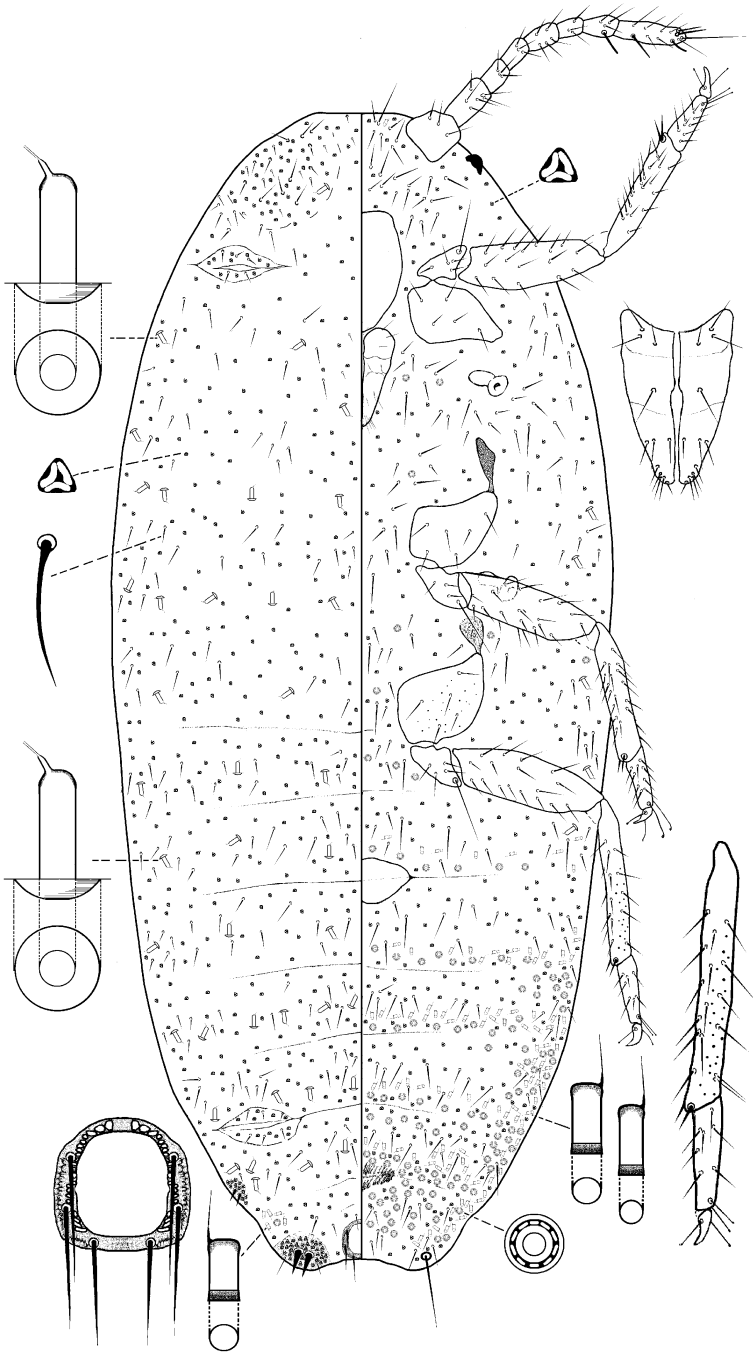

**Fig. 1.** *Chorizococcus malabadiensis* Kaydan sp. n., adult female.

Dorsum. Cerarii numbering 2 pairs situated on last two abdominal segments, anal lobe cerarii, each with 2 conical setae, 20 μm long, with 25–42 trilocular pores and 4 or 5 auxiliary setae. Dorsal body setae slender, each 12–35 μm long. Trilocular pores each 4–5 μm in diameter, scattered on entire body. Oral rim tubular ducts totaling 72–100 on dorsum, each duct 10–13 μm long, 5.0–7.5 μm wide at mid-width, rim of duct opening, 8–11 μm wide, ducts on head, thorax, and all abdominal segments (except last abdominal segment); 12–16 ducts on segment I–II, 7 or 8 ducts on segment III, 7–13 ducts on segment IV, 12–16 ducts on segment V, 6–9 ducts on segment VI, 9–14 ducts on segment VII, 14–26 ducts on head and thorax; oral-collar tubular ducts on each side of last abdominal segment each 7.0–9.0 μm long, 2–3 μm wide, numbering 14–19.

Venter. Body setae slender, each 7.5–65.0 μm long, longest setae medially on head; apical setae of anal lobe 125 μm long. Multilocular disc pores present on abdominal segments: 15–17 pores on segment II–III, 22–29 pores on segment IV, 34–52 pores on segment V, 47–57 pores on segment VI, 63–74 on segment VII, 36–45 on segments VIII + IX; each pore 8–10 μm in diameter. Trilocular pores each 3–4 μm in diameter scattered all body. Minute discodial pores scattered, each 2.5 μm in diameter. Oral rim tubular ducts similar to those on dorsum, each duct 10–13 μm long, 5.0–7.5 μm wide at mid-width, rim of duct opening, 8–11 μm wide, ducts on margin of thorax and first abdominal segment. Oral-collar tubular ducts each 7.5–10.0 μm long, 2.5–3.5 μm wide (oral collar tubular ducts on margin slightly larger than tubular ducts on mid venter), in a wide band on the posterior abdominal segments; distributed as follows: 0–4 on head and thorax, 0–3 on segment II–II; 18–27 on segment III; 34–62 on IV; 74–105 on V; 79–107 on VI; 60–94 on VII; 35–55 on VIII + IX.

Remarks. *Chorizococcus malabadiensis* Kaydan sp. n. is most similar to *Spilococcus halli* (McKenzie et Williams, 1965) as both species have two pairs of cerarii and translucent pores on tibia of third leg. *Chorizococcus malabadiensis* can readily be distinguished from *Spilococcus halli* in having translucent pores on coxa, multilocular pores on all abdominal segments on venter (including head and thorax), and by having oral-collar tubular ducts on dorsum of last abdominal segment.

Etymology**.** The species epithet refers to the locality where specimens were collected.

### **Crisicoccus matesovae* (Danzig, 1986)

Material examined. Erzincan, Refahiye, 08.vii.2010, N: 39°52′230″, E: 039°03′195″, 2009 m, *Juniperus* sp., 3 ♀♀, collected by M. B. Kaydan and F. Kozár (KPCT: 4775).

Host plants. *Juniperus sabina* (Cupressaceae) (Ben-Dov *et al.* 2014).

Distribution. Kazakhstan (Ben-Dov *et al.* 2014), Turkey (present study).

Remarks. The species was collected from the branches that were touching the soil. The plants were found on natural vegetation and we assume that this species is native to this environment. Although Williams and Moghadamm (2000) discussed the close taxonomic relation of *Planococcus vovae* (Nasonov, 1908) and *Crisicoccus matesovae* and mentioned that these two taxa can only be

variants of the same species, we believe that these two species are different. However, there is a lot of confusion in the literature concerning the identifications of these two species and further studies are needed to clear their real distribution.

### *Longicoccus festucae* (Koteja, 1971)

Material examined. Van; Çaldıran-Doğubeyazıt road, 27.ix.2005, N: 39°11′255″, E: 044°00′916″, 2084 m, *Stipa* sp., 18 ♀♀, collected by M. B. Kaydan (KPCT: 2418); Erciş road, 22.vi.2007, N: 38°38′454″, E: 043°18′947″, 1646 m, *Poa* sp., 1 ♀, collected by M. B. Kaydan (KPCT: 3744).

Host plants. *Festuca* sp., *F. pallens*, *Poa pratensis* (Poaceae) (Ben-Dov *et al*. 2014).
Distribution. Hungary, Poland, Turkey (Ben-Dov *et al.* 2014).

Remarks. This species has been recorded previously on *Poa pratensis*, *Stipa* sp. in Ankara province, Turkey (Kaydan *et al.* 2007).

### **Metadenopsis halogetonis* Matesova, 1966

Material examined. Van; Edremit, 22.v.2005, N: 38°19′939″, E: 043°18′702″, 1704 m, undetermined plant, 1 ♀, collected by M. B. Kaydan (KPCT: 3334); Iğdır, Aşağı Aktaş, 13.vi.2007, N: 40°06′392″, E: 043°30′813″, 1118 m, Undetermined plant, 1 ♀, coll. M. B. Kaydan (KPCT: 3617).

Host plants. *Halogeton glomeratus* (Chenopodiaceae) (Ben-Dov *et al.* 2014).
Distribution. Kazakhstan (Ben-Dov *et al*. 2014), Turkey (present study).

### *Metadenopus festucae* Šulc, 1933

Material examined. Ağri, Hamur-Tutak road 29.ix.2005, N: 39°35′724″, E: 042°55′389″, 1616 m, Poaceae, 6 ♀♀, coll. M. B. Kaydan (KPCT: 2484); Hakkari, Esendere-Altınbaşak, 03. viii.2005, N: 37°42′415″, E: 044°32′033″, 1810 m, Poaceae, 3 ♀♀, coll. M. B. Kaydan (KPCT: 2193).

Host plants. *Aneurolepidium chinense*, *Elymus* sp., *E. chilensis*, *Festuca* sp., *F. ovina*, *F. valesiaca*, *Heteropappus altaicus*, *Poa* sp., *P. pratensis* (Poaceae) (Ben-Dov *et al.* 2014).
Distribution. China, Czech Republic, France, Hungary, Italy, Moldova, Mongolia, Poland, Russia, Turkey, Ukraine (Ben-Dov *et al.* 2014).

Remarks. This species was found on a plant from the family Poaceae (Kaydan *et al*. 2014). This mealybug generally occurs on the roots and in the leaf sheaths of the host plant (Kosztarab & Kozár 1988).

## **Palmicultor palmarum* (Ehrhorn, 1916)

Material examined**.** İzmir**,** Karşıyaka (Green house), 29.v.2008, 25 m, *Washingtonia* sp., 7 ♀♀, coll. L. Erkılıç (KPCT: 5144); İzmir**,** Karşıyaka (Green house), 30.v.2008, 25 m, *Washingtonia* sp., 3 ♀♀, coll. L. Erkılıç (KPCT: 5145).

Host plants. *Areca catechu*, *A. lutescens*, *Borassus flabellifer*, *Caryota mitis*, *Chrysalidocarpus lutescens*, *Cocos nucifera*, *Elaeies guineensis*, *Kentia* sp., *Latania glaucaphylla*, *Licula* sp., *Roystonea regia*, *Thrinax* sp., *Washingtonia flifera* (Arecaceae) *Freycinetia* sp. (Pandanaceae), *Phyllostachys* sp. (Poaceae).

Distribution. Andaman Islands, Bahamas, Bangladesh, Bermuda, Bonin Islands, Canary Islands, Caroline Islands, China. French Polynesia, Guadeloupe, Hawaiian Islands, India, Indonesia, Jamaica, Kiribati, Kosrae, Malaysia, Maldives, Marshall Islands, Mexico, New Caledonia, Niue, Palau, Philippines, Phoenix Islands, Ponape Island, Saint Martin & St. Barthelemy, Saint Martin, Singapore, Sri Lanka, Sumatra, Tonga, Truk Islands, USA, Vietnam and Turkey (present study).

Remarks. The specimens were collected in a greenhouse.

## **Rhodania occulta* Schmutterer, 1952

Material examined**.** Hakkari, Yüksekova, 23.v.2008, N: 37°40′881″, E: 044°03′376″, 1758 m, Poaceae, 2 ♀♀, coll. M. B. Kaydan and F. Kozár (KPCT: 4283).

Host plants. *Agrostis vulgaris*, *Corynephorus* sp., *Festuca* sp. (Poaceae) (Ben-Dov *et al*. 2014).

Distribution. Germany, Greece, Netherlands, Poland (Ben-Dov *et al.* 2014), Turkey (present study).

## *Volvicoccus volvifer* (Goux, 1945) (Fig. 2)

Material examined. Iğdır-Tuzluca-Gaziler, 29.v.2008, N: 40°06′218″, E: 043°27′952″, 1000 m, *Stipa* sp., 1 ♀, coll. M. B. Kaydan (KPCT: 4367); Iğdır-Tuzluca-Gaziler, 29.v.2008, N: 40°06′218″, E: 043°27′952″, 1000 m, *Stipa* sp., 2 ♀♀, coll. M. B. Kaydan (KPCT: 4361); Iğdır-Tuzluca-Gaziler, 29.v.2008, N: 40°06′218″, E: 043°27′952″, 1000 m, *Agropyron repens*, 1 ♀, coll. M. B. Kaydan (KPCT: 4361); Erzurum, 09.vii.2010, N: 39°37′386″, E: 040°59′697″, 2134 m, Poaceae, 2 ♀♀, coll. M. B. Kaydan (KPCT: 4819); Iğdır-Tuzluca-Gaziler, 29.v.2008, N: 40°06′218″, E: 043°27′952″, 1000 m, *Stipa* sp., 3 ♀♀, coll. M. B. Kaydan (KPCT: 4715); Hakkari, Yüksekova, 23.v.2008, N: 37°40′419″, E: 044°03′589″, 1686 m, *Stipa* sp., 1 ♀, coll. M. B. Kaydan (KPCT: 4277); Muş, Bulanık, 10.vi.2009, N: 33°45′709″, E: 041°53′478″, Poaceae, 1 ♀, coll. M. B. Kaydan (KPCT: 4529).

Host plants. *Aegilops* sp., *Festuca ovina*, *Koeleria glauca*, *Stipa* sp., *S. capillata*, *S. lessingiana*, *S. pennata*, *S. pennata*, *S. pulcherrima*, *Taeniatherum asperum* (Poaceae) (Ben-Dov *et al.* 2014).

Distribution. Armenia, Bulgaria, France, Hungary, Italy, Poland, Turkey and Ukraine (Ben-Dov *et al.* 2014).

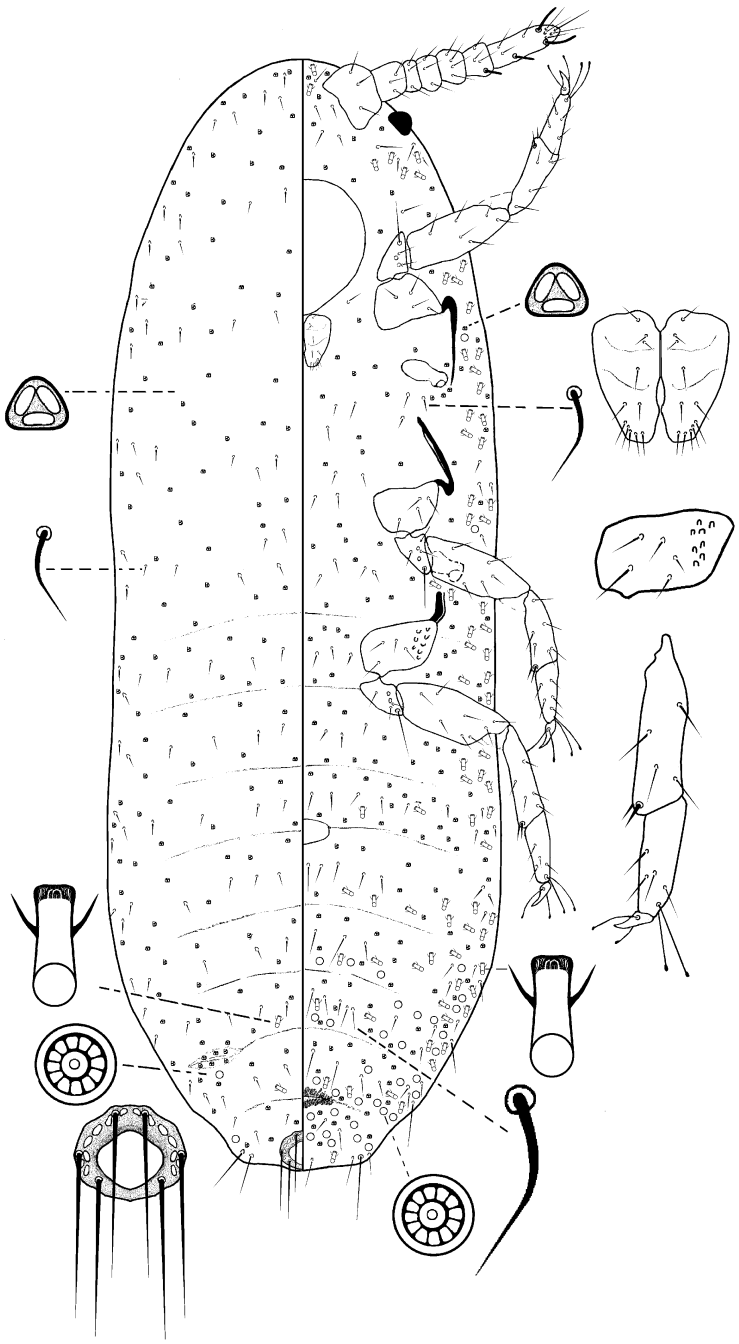

**Fig. 2.** *Volvicoccus volvifer* (Goux), adult female. Based on specimens collected in Turkey.

Remarks. This species was previously recorded on *Aegilops* sp., *Stipa* sp. in Central and East Anatolian regions of Turkey (Kaydan *et al.* 2007). It was noted that *V. volvifer* lives under the leaf sheaths of the host plant and rarely on the roots. The genus *Volvicoccus* is characterized by the presence of characteristic oral collar tubular ducts (Fig. 2). This species shows great variations regarding the number of multilocular pores and oral collar tubular ducts on dorsum and venter among the different populations (Gavrilov 2007, Kalandyk-Kołodziejczyk & Simon 2011). Because of this reason a drawing of a Turkish specimen is given.

## Rhizoecidae

### **Geococcus coffeae* Green, 1913

Material examined. Mersin, Yenice (green house), 23.v.2008, 34 m, *Dieffenbachia* sp., 4 ♀♀, coll. L. Erkılıç.

Host plants. *Eranthemum variegatum*, *Strobilanthes* sp. (Acanthaceae), *Mangifera indica* (Anacardiaceae), *Nerium oleander* (Apocynaceae), *Caladium bicolor*, *Colocasia esculenta*, *Dieffenbachia* sp., *D. leopoldii*, *Philodendron selloum*, *Scindapsus* sp., *Syngonium* sp., *Xanthosoma helleborifolium*, *X. violaceum* (Araceae), *Hedera* sp., *Schefflera* sp. (Araliaceae), *Agathis* sp. (Araucariaceae), *Chamaedorea* sp., *Ptychosperma elegans*, *Trachycarpus fortunei* (Arecaceae), *Eupatorium* sp., *Gnaphalium* sp. (Asteraceae), *Aechma miniata*, *Ananas comosus*, *Billbergia nutans* (Bromeliaceae), *Canna indica* (Cannaceae), *Dichorisandra* sp. (Commelinaceae), *Ipomoea batatas* sp. (Convolvulaceae), *Cyperus rotundus*, *C. tonerrimus* (Cyperaceae), *Dioscorea* sp. (Dioscoreaceae), *Codiaeum* sp., *Croton* sp., *Diasperus montanus* (Euphorbiaceae), *Acacia koa*, *Caesalpinia pulcheriana*, *Glycine max*, *Indigofera anil* (Fabaceae), *Coleus* sp. (Lamiaceae), *Sida acuta*, *Theobroma cacao* (Malvaceae), *Ficus carica*, *F. religiosa*, (Moraceae), *Musa* sp. (Musaceae), *Eugenia caryophyllata*, *Syzygium aromaticum* (Myrtaceae), *Osmanthus* sp. (Oleaceae), *Peperomia* sp. (Peperomiaceae), *Eleusine indica*, *Paspalum virgatum* (Poaceae), *Coffea arabica*, *C. liberica*, *Diodia polymorpha*, *Serissa* sp. (Rubiaceae), *Citrus* sp., *Severinia buxifolia* (Rutaceae), *Capsicum annua*, *Nicotiana tabacum*, *Physalis edulis*, *Solanum* sp., *S. melongena* (Solanaceae), *Desplatsia dewevrei* (Tiliaceae), *Pilea* sp. (Urticaceae), *Vitis vinifera* (Vitaceae), *Zingiber zerumbet* (Zingiberaceae).

Distribution. Angola, Antigua and Barbuda, Australia, Brazil, Chile, China, Colombia, Comoros, Costa Rica, Cuba, Denmark, Dominican Republic, Ecuador, El Salvador, Fiji, France, Galapagos Islands, Ghana, Guadeloupe, Guatemala, Haiti, Hawaii, Honduras, India, Indonesia, Kenya, Madagascar, Malaysia, Maldives, Martinique, Mexico, New Caledonia, New Zealand, Nigeria, Palau, Panama, Papua New Guinea, Peru, Philippines, Puerto Rico & Vieques Island, Sao Paulo, Seychelles, Solomon Islands, Sri Lanka, Sulawesi, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Uganda, United Kingdom, USA, Vanuatu, Vietnam, Zanzibar and Turkey (present study).

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