Türk. entomol. bült., 2012, 2 (2): 67-74
ISSN 2146-975X

Orijinal araştırma (Original article)

An invasive mealybug species *Phenacoccus madeirensis* Green (Hemiptera: Coccoidea, Pseudococcidae) introduced recently into Turkey

İstilacı tür *Phenacoccus madeirensis* Green (Hemiptera: Coccoidea, Pseudococcidae)'in Türkiye'de ilk kaydı

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Summary

Recently, several species of economically important mealybugs have been introduced into countries in the Mediterranean Region of the Palaearctic. One of the most important is the invasive pest species, *Phenacoccus madeirensis* Green, which is recorded here for the first time in Turkey and redescribed from Turkish material.

Key words: Madeira mealybug, new distribution, Pseudococcidae

Özet

Son yıllarda birçok ekonomik öneme sahip olan unlubit türü Palaearktik Zoocoğrafik Bölgesi'nin Akdeniz alt bölgesinde bulunan ülkelere giriş yapmıştır. Bu çalışmada, bu yayılıcı türlerden en önemlilerinden biri olan *Phenacoccus madeirensis* Green, Türkiye'de ilk defa tespit edilmiş ve Türkiye'den toplanan örneklerden yeniden tanımlamıştır.

Anahtar sözcükler: Madeira unlubiti, yeni yayılım, Pseudococcidae

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Alınış (Received): 08.05.2012 Kabul ediliş (Accepted): 04.06.2012

Introduction

The spread of insect pests has greatly increased in recent decades because of the increase in trade of plant species. Scale Insects (Coccoidea) are often cryptic in habit and can escape detection during quarantine inspection of plants. When scale insects are introduced without their natural enemies, they can establish themselves easily and become economically important pests. Invasive species can sometimes cause a change of biodiversity, modify the habitat and cause extensive environmental and economic harm (Muniappan, 2011). In recent years, several species of economically important mealybugs (Pseudococcidae) have been introduced into different countries in the Mediterranean Region and other areas of the Palaearctic Region. For example, *Pseudococcus comstocki* (Kuwana), recorded in Italy and France, has become an important pest (Pellizzari & Germain 2010). In the last decade, *Phenacoccus solenopsis* Tinsley has become an important pest species in Pakistan and India on cotton and cultivation of cotton is restricted (Abbas et al., 2009). The species is also known in Egypt and Iran. Another introduced species, *Phenacoccus solani* Ferris, is a very important pest on *Capsicum annum* L. cultivation in Israel and neighboring countries, and which is known now also in Egypt and Turkey (Ben-Dov et al., 2006). The *Bougainvillea* mealybug, *Phenacoccus peruvianus* Granara de Willink, which is of Neotropical origin, was reported for the first time time in Europe in 1999 in Spain. It has since been recorded in the open in France, Italy and Portugal and under glass in England (Beltrà et al., 2010).

Another important invasive mealybug species, the Madeiran mealybug, *Phenacoccus maderiensis* Green, is a widespread pest on ornamental plants both outdoors and in greenhouses, (Pellizzari and Germain 2010). Although this mealybug was described originally from Madeira by Green (1923), it is considered to be of Neotropical in origin (Williams, 1987, 2004; Williams & Granara de Willink, 1992) and is now widely distributed in the Afrotropical, Australasian, Nearctic, Neotropical and Oriental Zoogeographical Regions (Ben-Dov et al., 2012). This species was reported from Italy in the 1990's by Marotta and Tranfaglia (1990) and more recently (in alphabetical order) in Crete (Jansen et al., 2010), France (Matile-Ferrero & Germain, 2004), Portugal (Franco et al., 2011), and Spain (Beltrà & Soto, 2011). There are also several records of this species in the Far-East of the Palaearctic Region (Kondo et al., 2001). In the last decade, the Madeira mealybug has continued to spread in the Mediterranean region and in other parts of the world, such as southern Asia and the tropical Africa (Williams, 2004).

The Madeira mealybug is a polyphagous species, recorded on 154 plant species belonging to 42 plant families (Ben-Dov et al., 2012). In general it was found on many herbaceous crops, fruit trees, and ornamentals. (Ben-Dov et al., 2012). *P. madeirensis* has often been misidentified as the Mexican mealybug, *P. gossypii* Townsend & Cockerell as discussed by Kondo et al. (2001) and Williams (1987, 2004). The identity of *P. gossypii* is now established as a local species restricted to Mexico and southern U.S.A (Williams, 1987). The most important shared character for these two species is the "circulus of a very distinctive form, its central position somewhat oval, prolongated into a slender process on each side. The end of each lateral process is elevated on a pronounced scleratization of surrounding ring" (Ferris, 1950; Williams, 1987). However, these two species differ in that *P. madeirensis* lacks multilocular disc pores on the mid-dorsum of the thorax where as these are present on *P. gossypii*. On the other hand, Williams (1987) found some variation and believed that the numbers of ventral tubular ducts is fewer on specimens with short limbs than on specimens with larger limbs. Also, according to Williams (1987), the frequency of the multilocular disc pores could also vary depending on the locality. He argued that a possible explanation of this variation in the frequency and distribution of the ventral tubular ducts and multilocular pores might be that the species originated from southern U.S.A. or Mexico, the area of the main gene-pool, and that specimens introduced to the more tropical areas of Central and South America where the progeny are more stable through interbreeding (Williams, 1987).

In this paper we report the presence of *P. madeirensis* in Turkey and add a new locality record for the Palaearctic Region.

Materials and Methods

Samples were collected from Adana, Antalya and Çanakkale provinces in Turkey, which belong to the Mediterranean Region climatically, during 2010 and 2011. Each sample was placed into a plastic bag and taken to the laboratory for examination. Specimens were prepared for light microscopy using the slide-mounted method of Kosztarab & Kozár (1988). Morphological terminology follows that of Williams (2004), synonymy and distribution data were taken from Ben-Dov et al. (2012).

Both dry and mounted material is deposited in the Plant Protection Department, Faculty of Agriculture, Yüzüncü Yıl University, Van, Turkey (CCVT) and the Plant Protection Department, Faculty of Agriculture, Ankara University, Ankara Turkey. The drawing of *P. madeirensis* is reproduced with permission of Figure 8 page 349 from D. J. Williams (1987) "*Phenacoccus gossypii* Townsend &; Cockerell, *P. madeirensis* Green and some related mealybug species (Hemiptera: Pseudococcidae). Bulletin of Entomological Research, 77, pp 335-356 Copyright © Cambridge University Press 1987" but the redescription, measurements and counts are based on material collected in Turkey. The type material records are given according to ScelNet and Williams (1987).

Results and Discussions

Systematic

***Phenacoccus madeirensis* Green 1923**

***Phenacoccus madeirensis* Green, 1923: 90.**

HOLOTYPE: Female, Madeira, on unidentified plant, Funchal. Deposited in The Natural History Museum, London, England, UK.

Synonym:

Phenacoccus grenadensis Green & Laing, 1924: 416. Holotype: Female, Grenada: on egg-plant [= *Solanum melongena*]. Lectotype female, by subsequent designation Williams, 1987: 347. Deposited in The Natural History Museum, London, England, U.K. Synonymy by Williams, 1987: 347.

Phenacoccus harbisoni Peterson, 1965: 96. Holotype: Female, U.S.A.: California, Imperial County, sand hills near Gray's Well, on *Helianthus tephrodes*. Deposited in The Bohart Museum of Entomology, University of California, Davis, California, USA. Synonymy by Williams, 1987: 347.

***Phenacoccus gossypii*, Tranfaglia, 1981: 11. Misidentification.**

Material examined: 3 adult females, Kaş, Antalya, *Mirabilis jalapa* L. (Nyctaginaceae) *,* 06.viii.2010, coll. M. B. Kaydan; 3 adult females, Finike, Antalya, *Lantana camara* L. (Verbenaceae*),* 06.viii.2010, coll. M. B. Kaydan; 4 adult females, Adana, *Pelargonium* sp. (Geraniaceae) , 13.vii.2010, coll. L. Erkılıç; 1 adult female, Bozcaada, Çanakkale, *Vitis vinifera* L. (Vitaceae), 14.ix.2011, coll. S. Ülgentürk; 5 adult females, Bozcaada, Çanakkale, *Pelargonium* sp., 12.ix.2011, coll. S. Ülgentürk; 4 adult females, Bozcaada, Çanakkale, *Portulaca grandiflora* Hook. (Portulacaceae), 12.ix.2011, coll. S. Ülgentürk.

Common Name: Madeira mealybug.

Description of the adult female.

Unmounted female (Figure 1):

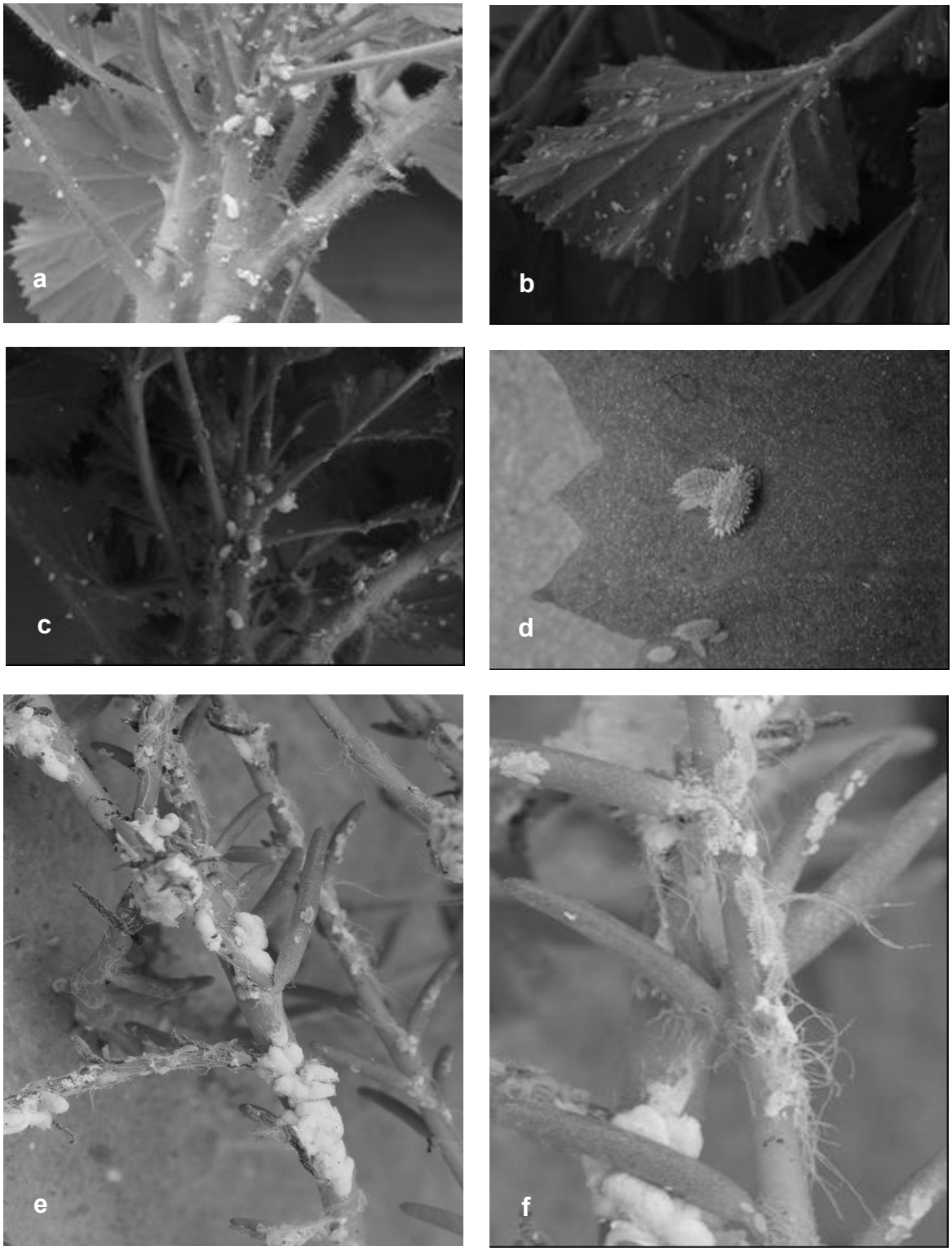

Figure 1. *Phenacoccus madeirensis* Green, a. view of the population, b. different life stages on the leaf of *Pelargonium* sp., c. ovisac, d. adult female., e. population on *Portulaca grandifolia,* f. adult female on *Portulaca grandifolia.*

Adult female, pale green, dusted with white mealy powder, waxy filaments on the margin can be seen clearly in young female. Ovisac white, irregular form on the plant. The mealybug was found with all stages including males in the populations.

Mounted adult female (Figure 2):

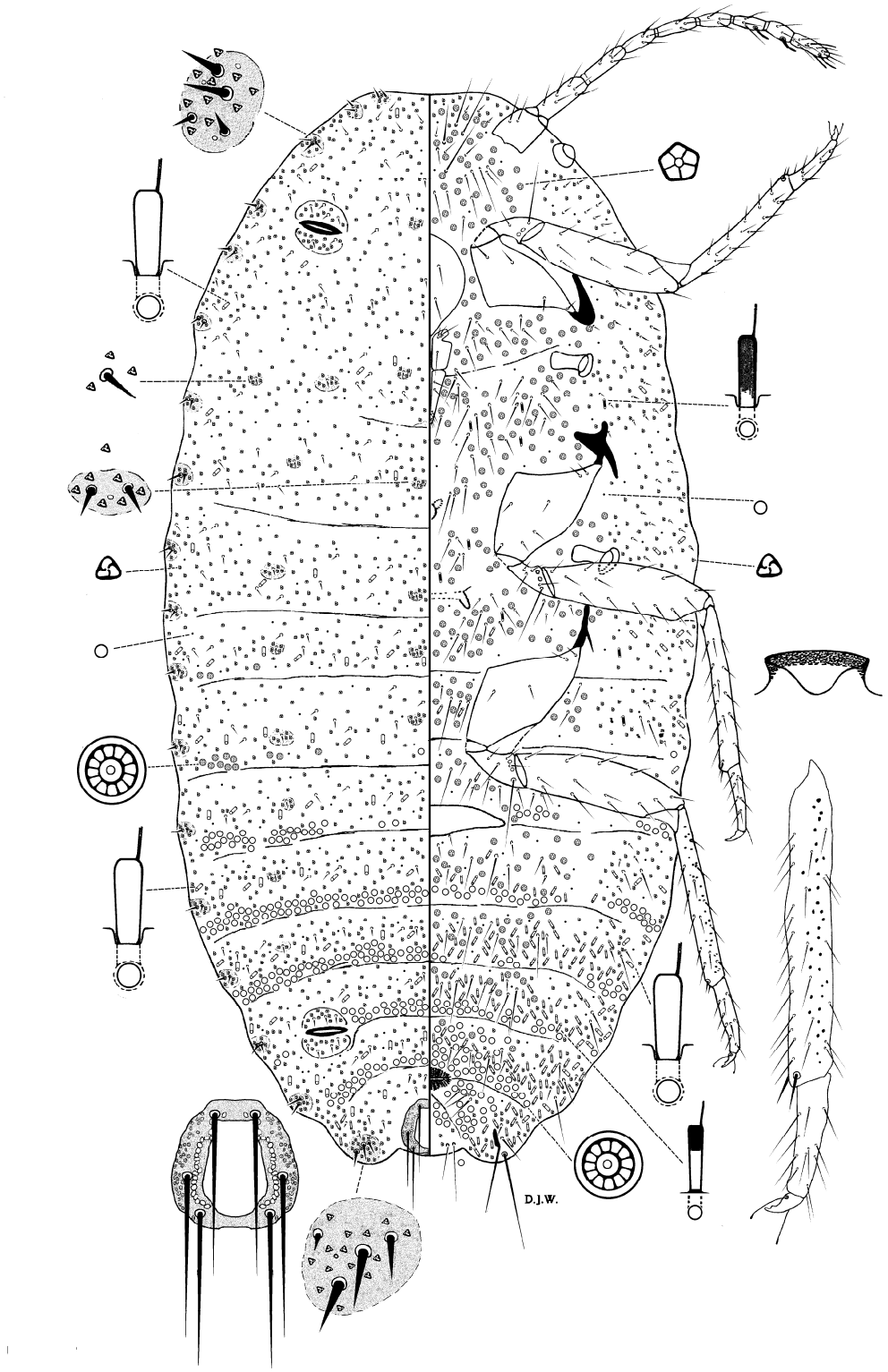

Figure 2. *Phenacoccus madeirensis* Green, after Williams (1987) with additions.

Body elongate oval, 1.88–2.38 mm long, 0.74–1.38 mm wide. Eye marginal, 55–70 µm wide. Antenna 9 segmented, 600–670 µm long; apical segment 65–85 µm long, 30–35 µm wide. Clypeolabral shield 195–200 µm long, 165–200 µm wide. Labium 175–200 µm long, 120–175 µm wide, stylet loop short. Anterior spiracles 75–80 µm long, 50–55 µm wide across atrium; posterior spiracles 90–95 µm long, 62.5–70.0 µm wide across atrium. Circulus large, oval, 245–260 µm wide elongate, slightly sclerotised. Legs well developed; hind coxa 235–280 µm long, hind trochanter + femur 380–430 µm long, hind tibia + tarsus 450–500 µm long, hind claw 35.0–37.5 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.14–1.20, ratio of lengths of hind tibia to tarsus 2.57–3.04, ratio of length of hind trochanter + femur to greatest width of femur 3.90–5.73. Hind tibia with 37–44 transculent pores. Tarsal digitules subequal, each 37.5–47.5 µm long, hairlike. Claw digitules subequal, each 35.0–37.5 µm long, and knobbed. Both pairs of ostioles present; each anterior ostiole, with 25–29 trilocular pores and 6–8 setae; each posterior ostiole with 46–58 trilocular pores and 7–9 setae. Anal ring 95–140 µm wide, with 6 anal-ring setae, each seta 160–195 µm long. Cerarii numbering 18 pairs; C3 with 3 or 4 conical setae and 7–9 trilocular pores, 2 or 3 simple pores and; anal lobe cerarii, each with 3 slender conical setae, 25–35 µm long, with 32–42 trilocular pores and 2 or 3 spine-like auxiliary setae.

Dorsum. Body setae spine like, each 7.5–17.5 µm long, many setae with trilocular pores near base, forming dorsal cerarii on head, thorax and abdominal segments. Multilocular disc pores present on abdominal segments (I–VII): 2–5 pores on segment II, 9–11 pores on segment III, 36–63 pores on segment IV, 52–70 pores on segment V, 19–31 pores on segment VI, 22–36 on segment VII; each pore 8–10 µm in diameter and with 12 loculi. Multilocular disc pores present on posterior (II–VIII +IX) abdominal segments in single or double rows: 3–5 pores on segment II, 8–16 pores on segment III, 36–63 pores on segment IV, 50–67 pores on segment V, 19–31 pores on segment VI, 22–36 on segment VII, each pore 7.5–10.0 µm in diameter and with 12 loculi. Quinquelocular pores scattered on middle area of head, thorax and abdominal segments (except last abdominal segment), each 6.0–7.5 µm in diameter. Trilocular pores each 5.0–7.5 µm in diameter, scattered over entire body. Minute discodial pores not in high numbers, scattered, each 2.5 µm in diameter. Oral collar tubular ducts of two sizes, smaller one only on last abdominal segment, each 10.0–12.5 µm long, 2.5–3.0 µm wide, 6–10 on the margin of last abdominal segment; larger one typical to wood-feeding mealybug, each duct 15.0–17.5 µm long, 6.0– 7.5 µm wide, ducts scattered on head, thorax, and all abdominal segments, forming transverse rows on abdomen: 9–11 ducts on segment I, 7–13 ducts on segment II, 9–16 ducts on segment III, 11–17 ducts on segment IV, 8–22 ducts on segment V, 7–14 ducts on segment VI, 11–17 ducts on segment VII, 6 or 7 ducts on segment VIII.

Venter. Body setae of two types: (i) hair-like setae slender, each 15–170 µm long, longest setae medially on head; (ii) spine-like setae each 5.0–12.5 µm long, situated submarginally in two or three rows. Apical setae of anal lobe each 300–340 µm long. Multilocular disc pores present on posterior (III – VIII + IX) abdominal segments: 2–4 pores on segment II, 9–22 pores on segment III, 18–56 pores on segment IV, 14–68 pores on segment V, 35–63 pores on segment VI, 82–98 on segment VII, 50–71 on segments VIII + IX; each pore 7.5–10.0 µm in diameter and with 12 loculi. Trilocular pores each 3–4 µm in diameter scattered over entire body. Minute discodial pores scattered, each 2.5 µm in diameter. Oral-collar tubular ducts of three sizes: (i) larger oral collar tubular ducts each 15–17.5 µm long, 6.0–7.5 µm wide on body margin with 2–4 ducts; (ii) middle ones each 10.0–13 µm long, 3–4 µm wide scattered on mid thorax and around spiracle; (iii) smallest one 10.0–12.5 µm long, 2.5–3.0 µm wide on abdominal segments (III– VIII + IX), 8–11 ducts on segment III, 16–32 ducts on segment IV, 84–106 ducts on segment V, 89–116 ducts on segment VI, 49–57 ducts on segment VII, 41–61 ducts on segment VIII + IX.

Discussion, Williams (1987) mentioned three variants of this species, one of which was collected from Madeira, one collected from Colombia on *Manihot esculenta* (Euphorbiaceae) and one collected from Louisiana, Baton Rouge (U.S.A), on *Althaea* sp. (Malvaceae) as discussed in the Introduction. In this study, the distribution and frequency of the multilocular pores on the dorsum and tubular ducts on the

venter also varied. Williams (1987) mentioned that the populations he studied from temperate areas had numerous multilocular pores on the dorsum and tubular ducts on the venter whereas these are less in specimens collected from relatively colder areas. The effect of collection site on the frequency and distribution of these structures has not been studied yet in Turkey, and it would be interesting to do molecular studies to ascertain the origin of the infestations in Turkey.

With 154 plant species belonging to 42 families as hosts, this mealybug is one of the most polyphagous mealybug species listed in ScaleNet (Ben-Dov et al., 2012). It is most common on cassava but causes little damage and is also recorded as a pest species on *Solanum tuberosum* (Solanaceae) in Peru (Williams, 2004). It is also recorded on *Capsicum annum* under greenhouse conditions in Portugal by Franco et al. (2011). Kondo et al. (2001) recorded this species on 25 plant species in 15 families in Japan and indicated that it was probably introduced into Japan in the 1990s. Longo et al. (1995) reported that *P. madeirensis* had 5 or 6 overlapping generations in a year in Italy and that each female produced more than 600 eggs. Longo et al. (1995) also mentioned that the colonies develop on the trunk, twigs, leaves and fruits of the host plants but preferably infested the lower surface of the leaves.

This paper reports the presence of *P. madeirensis* in Turkey and provides a new location record for the Palaearctic Region. It is here considered that this species is a significant invasive species and could spread to more regions in Turkey especially places with a Mediterranean climate and can be an important pest species of agriculture in Turkey.

Acknowledgements

The authors wish to thank to Dr. Doug WILLIAMS (Natural History Museum, London, UK) and Dr. Ferenc KOZÁR (Department of Zoology Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary) and Dr. Christopher, J. HODGSON (Department of Biodiversity and Biological Systematics, The National Museum of Wales, Cathay's Park, Cardiff, CF10 3NP, UK), for reviewing a draft of the manuscript. M.Bora KAYDAN was supported by TUBITAK-TOVAG grant no: 108 O 125.

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