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Some additions to the Scale insect fauna (Hemiptera: Coccoidea) of Crete with a check list of the species known from the island

Abstract - A list of the scale insects (Homoptera: Coccoidea) recorded by the authors for the Greek island of Crete is reported. This includes twenty-seven species new to the island The most interesting records are *Kermes palestiniensis* Balachowsky (Kermesidae), only recorded previously from Israel, and *Getulaspis bupleuri* (Marchal) (Diaspididae), only known previously from North Africa and the Middle East. With the present additions, the number of scale insect species recorded on Crete has reached 82. A revised check list of the scales presently known from the island is also provided.

Riassunto - *Nuovi reperti per la fauna di Homoptera Coccoidea di Creta e check list delle specie note nell'isola*

Viene riportato l'elenco di cocciniglie (Hemiptera, Coccoidea) raccolte dagli autori, in periodi diversi, nell'isola di Creta (Grecia). Di queste, 27 sono le specie non ancora note per l'isola. Di particolare interesse biogeografico è il reperimento di *Kermes palestiniensis*, Balachowsky (Kermesidae), noto finora solo per Israele e di *Getulaspis bupleuri* (Marchal) (Diaspididae), nota per Nordafrica e Medio Oriente. Viene presentata una check list delle cocciniglie finora note per l'isola.

Key words: Greece, *Kermes palestiniensis*, *Getulaspis bupleuri*

This paper deals with the scale insect species collected by the authors on Crete at different periods. These records stimulated a deeper study on the scale insect fauna of this Mediterranean island, as it was apparent that the present knowledge on this subject was poor and largely incomplete. According to ScaleNet (Ben-Dov *et al.*, 2010), there are only 43 scale insect species recorded from Crete. Recently Jansen *et al.* (2011) added six species to this list, raising to 49 the total number of species known to occur on the island. This number is much lower than expected. Even very common, widely distributed species in the Mediterranean basin, and significant agricultural and forestry pest species had not been recorded there, although they are generally listed for the Greek fauna.

Several authors (Podsiadlo, 1983; Kozár *et al.*, 1991; Kozár & Nagy, 1998) have provided valuable contributions to the knowledge of Greek scale insects, but many records from Crete were either overlooked or had been included in the Greek mainland fauna (Ben-Dov *et al*., 2010). On the other hand, Milonas *et al*. (2008) list 168 scale insect species for the whole of Greece. This list includes also species only known to occur in Crete.

Argyriou (1984), in her paper dealing with scales of agricultural plants in Greece, only mentions explicitly *Lichtensia viburni* Signoret, *Filippia follicularis* Targioni Tozzetti, *Marchallina hellenica* Gennadius and *Pollinia pollini* (A. Costa) as being present in Crete. Other common agricultural scale pests are reported as being "widely distributed all over the country" (i.e. *Sphaerolecanium prunastri* (Fonscolombe) and *Planococcus ficus* (Signoret)), possibly inferring that they are present also in Crete.

From a biogeographic point of view, the flora and fauna of the larger Mediterranean islands (Corsica, Sardinia, Sicily, Crete, Cyprus) are kept in separated lists from their mainland country of pertinence as they often host endemic species.

Due to the uncertainty of the occurrence of some species in Crete, each bibliographic source recorded in ScaleNet, as being present in Crete, has been checked by reading the original paper. This has led to the discovery of several trivial mistakes, so that species clearly referred in the original papers as being present on the Greek mainland only, have been listed for Crete, (i.e. *Eumyrmococcus corinthiacus* Williams (Williams, 1993), *Eulecanium ciliatum* Douglas and *Scythia festuceti* (Šulc) (Kozár *et al*., 1991)). In addition, species recorded from Crete only have been listed for mainland Greece (i.e *Rhizococcus agropyri* Borchsenius), whilst other species are not known from either mainland Greece or Crete (i.e. *Atrococcus arakelianae* (Ter-Grigorian) (Kozár & Nagy, 1998)).

The present paper lists the species collected by the authors in Crete, along with the localities, collecting dates and host plants. Species newly recorded from the island are marked with an asterisk. A provisional check-list of the scale insects now known from Crete, along with bibliographic sources, is given in Table 1. Erroneous and uncertain previous records have been omitted.

Among the collected species, *Diaspidiotus lenticularis* and *Lepidosaphes flava* were infected by *Septobasidium* sp., a fungus often associated with armoured scale insects, and which changes the scale morphology (Couch, 1938).

Fam. Ortheziidae

Orthezia urticae (Linnaeus): Knossos, 25.ix.2009, undetermined plant (F. Kozár).

Fam. Monophlebidae

Gueriniella serratulae (Fabricius): Vai, 10.iv.2010, *Genista acanthoclada* (G. Pellizzari). Previously recorded in Crete (Stalis) by Podsiadlo (1983).

Icerya purchasi Maskell: Iraklion, 21-26.ix.2009, Citrus (F. Kozár); Chania, 8.iv.2010, *Pittosporum tobira* (G. Pellizzari).

Fam. Marchalinidae

Marchalina hellenica Gennadius: High infestations were observed at Agios Ioannis, 7.iv.2010, *Pinus brutia* (G. Seljak); Anopoli, 7.iv.2010, Cupressus sp., *Pinus halepensis*

Table 1 - Species recorded in Crete and validation source

Fam. Ortheziidae

Species	**Validation source**
Orthezia urticae (Linnaeus)	Present paper

Fam. Monophlebidae

Species	**Validation source**
Gueriniella serratulae (Fabricius)	Podsiadlo, 1983; present paper
Icerya purchasi Maskell	Ayoutantis, 1940; Podsiadlo, 1983

Fam. Marchalinidae

Species	**Validation source**
Marchalina hellenica Gennadius	Argyriou, 1984; Hodgson & Gounari, 2006

Family Matsucoccidae

Species	**Validation source**
Matsucoccus josephi Bodenheimer & Harpaz	Mendel, 1998

Fam. Pseudococcidae

Species	**Validation source**
Atrococcus arakelianae (Ter-Grigorian)	Kozár & Nagy, 1998
Coccidohystrix sp. n.?	Present paper
Chorizococcus rostellum Lobdell	Present paper
Heliococcus bohemicusŠulc	Jansen *et al*., 2010
Heterococcus nudus Green	Present paper
Peliococcus kimmericus (Kiritshenko)	Kozár *et al*., 1991
Phenacoccus bicerarius Borchsenius	Kozár *et al*., 1991
Phenacoccus madeirensisGreen	Jansen *et al*., 2010
Planococcus citri(Risso)	Ayoutantis, 1940
Planococcus ficus (Signoret)	Argyriou, 1984,
Planococcus vovae(Nasonov)	Williams & Moghaddam, 2000; present paper
Pseudococcus longispinus(Targioni Tozzetti)	present paper
Spilococcus halli(McKenzie & Williams)	Present paper
Trionymus aberrans Goux	Kozár *et al*., 1991
Trionymus multivorus	Present paper

Fam. Eriococcidae

Species	Validation source
Acanthococcus sp. n.,	Present paper
Acanthococcus desertus (Matesova)	Present paper
Acanthococcus munroi Boratynski	Kozár *et al*., 1991
Rhizococcus agropyri Borchsenius	Kozár *et al*., 1991
Rhizococcus cynodontis Kiritchenko	Kozár *et al*., 1991

Family Kermesidae

Species	Validation source
Kermes palestiniensis Balachowsky	present paper
Kermes vermilio Planchon	Lindinger, 1912; Hoy, 1963; Present paper

Fam. Cerococcidae

Species	Validation source
Cerococcus cistarum Balachowsky	Kozár & Nagy, 1998

Fam. Coccidae

Species	Validation source
Ceroplastes floridensis Comstock	Present paper
Ceroplastes rusci (Linnaeus)	Ayoutantis, 1940; Podsiadlo, 1983; present paper
Ceroplastes sinensis Del Guercio	Present paper
Coccus hesperidum Linnaeus	Ayoutantis, 1940 Podsiadlo, 1983
Filippia follicularis (Targioni Tozzetti)	Argyriou, 1984
Lecanopsis formicarum (Newstead)	Present paper
Lichtensia viburni Signoret	Argyriou, 1984
Parthenolecanium corni (Bouché)	Kozár *et al*.,1991
Poaspis intermedia (Goux)	Kozár & Nagy, 1998
Protopulvinaria pyriformis (Cockerell)	Jansen *et al*., 2010; present paper
Pulvinariella mesembryanthemi (Vallot)	Kozàr *et al*.,1991
Saissetia coffeae (Walker)	Podsiadlo, 1983
Saissetia oleae (Olivier)	Ayoutantis, 1940; Argyriou & Michelakis, 1975
Sphaerolecanium prunastri (Boyer de Fonscolombe)	Argyriou & Paloukis, 1976; Podsiadlo, 1981; Kozár *et al*.,1991; present paper

Fam Asterolecaniidae

Species	Validation source
Pollinia pollini (A. Costa)	Alexandrakis, 1980a

Fam. Diaspididae

Species	**Validation source**
Abgrallaspis cyanophylli (Signoret)	Kozár *et al*.(1991); present paper
Acanthomytilus intermittens (Hall)	Kozár *et al*., 1991
Adiscodiaspis ericicola (Marchal)	Present paper
Aonidia mediterranea (Lindinger)	Present paper
Aonidia lauri (Bouché)	Present paper
Aonidiella aurantii (Maskell)	Ayoutantis, 1940; DeBach & Argyriou, 1967; present paper
Aonidiella yehudithae Ben-Dov	Ben-Dov, 2006; Jansen *et al*., 2010
Aspidiotus nerii Bouché	Koronéos, 1934; Ayoutantis, 1940
Aulacaspis rosae (Bouché)	Kozár *et al*., 1991
Carulaspis minima (Signoret)	Present paper
Chrysomphalus dictyospermi (Morgan)	Ayoutantis, 1940
Diaspidiotus lenticularis (Lindinger)	Present paper
Diaspidiotus osborni (Newell & Cockerell)	Kozár *et al*. 1991
Duplachionaspis berlesii Leonardi	Present paper
Duplachionaspis natalensis (Maskell)	Kozár *et al*., 1991
Dynaspidiotus britannicus (Newstead)	Koronéos, 1934
Dynaspidiotus greeni Balachowsky)	Kozár *et al*., 1991
Getulaspis bupleuri (Marchal)	Present paper
Gonaspidiotus minimus (Leonardi)	Jansen *et al*., 2010; present paper
Hemiberlesia lataniae (Signoret)	Rosen & DeBach, 1979; Podsiadlo,1983
Koroneaspis aegilopos (Koroneos)	Present paper
Lepidosaphes beckii Newman	Ayoutantis, 1940
Lepidosaphes conchiformis (Gmelin)	Kozár *et al*., 1991
Lepidosaphes flava (Signoret)	Present paper
Lepidosaphes ulmi (Linnaeus)	Podsiadlo, 1983; present paper
Leucaspis löwi Colvée	Kozár *et al*., 1991
Leucaspis pusilla Löw	Podsiadlo, 1983; Jansen *et al*., 2010
Leucaspis riccae Targioni Tozzetti	Lindinger, 1912; present paper
Lineaspis striata (Newstead)	Panis, 1981; present paper
Mercetaspis halli (Green)	Podsiadlo, 1983
Oceanaspidiotus spinosus (Comstock)	Present paper
Odonaspis ruthae Kotinsky	Present paper
Parlatoria oleae (Colvée)	Argyriou, 1967; present paper
Parlatoria parlatoriae (Šulc)	Jansen *et al*., 2010
Parlatoria ziziphi (Lucas)	Ayoutantis, 1940 present paper;
Pseudaulacaspis pentagona (Targioni Tozzetti)	Kozár *et al*., 1991; present paper
Prodiaspis tamaricicola (Malenotti)	Present paper
Rhizaspidiotus donacis (Leonardi)	Kozár *et al*., 1991
Unaspis euonymi (Comstock)	Present paper

(C.J. Hodgson). Its presence in the island was previously generally recorded by Argyriou (1984) and later confirmed by Hodgson & Gounari (2006).

Fam. Pseudococcidae

Chorizococcus rostellum Lobdell: Iraklion, 21-26.ix.2009, *Sorghum halepense*, unidentified Asteracea; Knossos, 25.ix.2009, *Piptatherum miliaceum* (F. Kozár).

*Coccidohystrix sp. n.: Knossos, 25.ix.2009, *Rosmarinus* sp. (F. Kozár).

*Heterococcus nudus Green: *Sorghum halepense*, Knossos, 25.9.2009 (F. Kozár).

Planococcus citri (Risso): Iraklion, 21-26.ix.2009, *Parietaria* sp., *Cynodon dactylon*, unidentified Asteracea (F. Kozár); collected also by pheromone traps in Iraklion.

Planococcus vovae (Nasonov): Chania, 23.iii.1997, *Cupressus* sp. (G. Pellizzari).

*Pseudococcus longispinus (Targioni Tozzetti): Chania, 8.iv.2010, *Pittosporum* sp. (G. Pellizzari).

Rhizoecus albidus Goux: Iraklion, 21-26.ix.2009, *Cynodon dactylon* (F. Kozár).

*Spilococcus halli (McKenzie & Williams): Iraklion, 21-26.ix.2009, *Cynodon*; Knossos, 25.ix.2009, *Piptatherum miliaceum* (F Kozár). Previously reported for the Greece mainland by Kozár (1985) as *Chorizococcus viktorinae*.

Trionymus aberrans Goux: Knossos, 25.ix.2009, *Piptatherum miliaceum* (F. Kozár). Previously recorded in Iraklion by Kozár *et al*. (1991).

*Trionymus multivorus (Kiritchenko): Iraklion, 21-26.ix.2009, undetermined Asteracea (F. Kozár).

Fam. Eriococcidae

*Acanthococcus sp. n.: Knossos, 25.ix.2009, host plant unknown (F. Kozár).

* ***Acanthococcus desertus*** (Matesova): Knossos, 25.ix.2009, *Piptatherum miliaceum* (F. Kozár)

Fam. Kermesidae

Kermes palestiniensis Balachowsky: Aradena, 35°13’22’’N 24°03’42’’S, 7.iv.2010; 04.vi.2011 *Quercus coccifera* (G. Pellizzari, F. Porcelli**,** S. Convertini).

Kermes vermilio Planchon: Aradena, 35°13’22’’N 24°03’42’’S, 04.vi.2011 *Quercus coccifera* (S. Convertini).

Fam. Coccidae

Ceroplastes floridensis Comstock; Iraklion, 35°20’16”N, 25°08’06”E, 10.iv.2010, *Citrus* sp., *Laurus nobilis, Ficus microcarpa* (G. Pellizzari, G. Seljak, F. Kozár).

Ceroplastes rusci (Linnaeus): Iraklion, 21-26.ix.2009, *Pittosporum* sp. (F. Kozár); Chania, 9.iv.2010, *Ficus carica, Nerium oleander* (G. Pellizzari); Aptera, 11.iv.2010, *Nerium oleander* (C.J. Hodgson).

****Ceroplastes sinensis*** Del Guercio: Chania – MAICh, 9.iv.2010, *Myrtus communis* (G. Pellizzari).

Coccus hesperidum Linnaeus: Iraklion, 21-26.ix.2009, *Citrus* sp. (F. Kozár); Kissamu, 7.iv.2010, *Ficus microcarpa*; Iraklion 10.iv.2010, *Ficus* sp., *Laurus nobilis* (G. Pellizzari). This very common species was first generically reported for Crete by Ayoutantis (1940) and later recorded in Knossos on *Iris craetensis* by Kozár *et al*. (1991).

****Lecanopsis formicarum*** (Newstead): Iraklion, 23.ix.2009, *Koeleria* sp. (F. Kozár).

Lichtensia viburni Signoret: Episkopi, 3.iv.2010, *Olea europea* (C.J. Hodgson).

Protopulvinaria pyriformis (Cockerell): Chania, 35°31’00”N, 24°00’54”E, 8.iv.2010, *Hedera helix* ssp. *canariensis*; Chania –MAICh 35°29’41”N, 24°03’01”E, 12.iv.2010, *Hedera helix* (G. Seljak).

Pulvinariella mesembryanthemi (Vallot): Chania, 8.viii.1975, *Mesembryanthemum* sp. (G. Pellizzari).

Sphaerolecanium prunastri Fonscolombe: Chania, 9.iv.2010, *Ficus carica,* (G. Pellizzari); Knossos, 35°17’50”N, 25°09’48”E, 10.iv.2010, *Prunus dulcis* (G. Seljak, F. Porcelli).

Fam. Diaspididae

Abgrallaspis cyanophylli (Signoret): Chania – MAICh 35°29’41”N, 24°03’01”E, 6.iv.2010, *Opuntia ficus-indica* (G. Seljak, G. Pellizzari). Previously recorded in Iraklion, on *Mesembryanthemum* sp., by Kozár *et al*. (1991).

Acanthomytilus intermittens (Hall): Iraklion, 21-26.ix.2009, *Cynodon dactylon, Piptatherum miliaceum* (F. Kozár). Previously recorded in Iraklion and Knossos on *Cynodon dactylon* and *Oryzopsis* sp. by Kozár *et al*. (1991).

****Adiscodiaspis ericicola*** (Marchal): Elafonisi, 10.viii.2000, *Erica manipuliflora*, (F. Porcelli).

****Aonidia mediterranea*** (Lindinger): Chania, 23.iii.1997, *Cupressus* sp., (G. Pellizzari); Iraklion, *Cupressus* sp., *Thuja* sp., 21-26.9.2009 (F. Kozár).

****Aonidia lauri*** (Bouché): Iraklion, 21-26.ix.2009, *Laurus nobilis* (F. Kozár).

Aonidiella aurantii (Maskell): Chania, 9.iv.2010, *Euonymus* sp. (G. Pellizzari)

Aspidiotus nerii Bouché: Aghia Sophia Cave - Topolia gorge, 01.viii.2000, *Lavatera cretica* & *Euphorbia* sp. (woody srubs); Agria Gramvousa, 28.vii.2000, *Thymelaea hirsuta*; Bali, 29.vii.2000, *Ceratonia siliqua* (F. Porcelli). Iraklion, 21-26.ix.2009, *Pittosporum tobira*, *Cercis* sp., (F. Kozár). Previously recorded at Iraklion and Knossos, on *Capparis spinosa*, *Nerium oleander*, *Pittosporum tobira*, *Sedum* sp., *Agave americana*, *Convolvolus* sp., *Eucayptus* sp., *Iris craetensis*, *Malva silvestris*, *Vitis* sp. by Kozàr *et al*. (1991).

****Carulaspis minima*** (Signoret): Iraklion, 21-26.ix.2009, *Cupressus* sp., *Thuja* sp. (F. Kozár).

****Diaspidiotus lenticularis*** (Lindinger): Potamida, 1.viii.2000, *Olea europea*, associated with and infected by *Septobasidium sp*. (F. Porcelli).

*__Duplachionaspis berlesii__ Leonardi: Chania – MAICh, 9.iv.2010, *Asparagus acutifolius* (G. Pellizzari).

*__Getulaspis bupleuri__ (Marchal): Elafonisi, 15.vii.2000, *Juniperus oxycedrus* (F. Porcelli).

Gonaspidiotus minimus (Leonardi in: Berlese & Leonardi): Aradena, 35°13'22''N 24°03'42''S, 04.vi.2011 *Quercus coccifera* (S. Convertini).

*__Koroneaspis aegilopos__ (Koroneos): Aradena, 7.iv.2010, *Quercus coccifera* (G. Pellizzari).

*__Lepidosaphes flava__ (Signoret): Potamida, 1.viii.2000, *Olea europaea,* associated with and infected by *Septobasidium sp*. (F. Porcelli).

Lepidosaphes ulmi (Linnaeus): Agyos Nicolaos, 8.viii.1975, *Ceratonia siliqua* (G. Pellizzari). Elafonisi, 15.vii.2000, *Pistacia lentiscus* (F. Porcelli).

*__Leucaspis riccae__ Targioni Tozzetti: Aghia Sophia Cave - Topolia gorge, 1.viii.2000, *Euphorbia* sp. (woody shrub); Agria Gramvousa, 28.viii.2000, *Euphorbia dendroides*; Elafonisi, 01.viii.2000, *Erica manipuliflora*; Bali, 29.vii.2000, *Olea europaea* (F. Porcelli).

Leucaspis pusilla Löw: Chania, 9.iv.2010, *Pinus halepensis* (G. Pellizzari).

Lineaspis striata (Newstead): Agios Nikolaos, 10.viii.1975, *Cupressus sempervirens* (G. Pellizzari); Iraklion, 21-26.9.2009, *Cupressus* sp. (F. Kozár).

*__Oceanaspidiotus spinosus__ (Comstock): Iraklion, 29.vii.2000, *Opuntia* sp. (F. Porcelli).

*__Odonaspis ruthae__ Kotinsky: Iraklion, 21-26.ix.2009, *Sorghum halepensis, Cynodon dactylon* (F. Kozár).

Parlatoria oleae Colvée: Iraklion, 21-26.ix.2009, *Pyrus* sp. (F. Kozár); Chania, 9.iv.2010, *Prunus* sp. (G. Pellizzari); Bali, 29.vii.2000, *Pyrus pyraster* (F. Porcelli).

Parlatoria ziziphi (Lucas): Potamida, 1.viii.2000, *Citrus aurantium* (F. Porcelli); Aptera, 12.iv.2010, *Citrus lemon* (C. J. Hodgson).

Pseudaulacaspis pentagona Targioni Tozzetti: Chania, 9.iv.2010; Chania- MAICh, by pheromone traps (F. Kozár); Aptera, 12.iv.2010, *Morus* sp. (C. J. Hodgson).

*__Prodiaspis tamaricicola__ (Malenotti): Iraklion, 30.vii.2000, Elafonisi, 15.vii.2000, *Tamarix gallica* (F. Porcelli). Agios Nektarios, 35°11'35"N, 24°12'56"E, 7.iv.2010, *Tamarix gallica* (G. Seljak).

*__Unaspis euonymi__ (Comstock): Iraklion, 01.viii.2000, *Euonymus japonicus* (F. Porcelli).

According to the new collections and including the revised list from previous records, the total number of species recorded from the island is now 82 (table 1). Twenty-seven of them are new to the Crete fauna. Some new records refer to species widely distributed in the Mediterranean basin (i.e. *Aonidia lauri*, *Carulaspis minima*), whilst others are common introduced pests (i.e. *Pseudococcus longispinus*, *Ceroplastes floridensis*, *Unaspis euonymi*), so that their presence on the island was predictable. Significant records of interest are *Kermes palestiniensis*, previously only known to occur in Israel (Balachowsky, 1953) and *Getulaspis bupleuri*, previously known only from the Canary islands, North African countries (Morocco, Tunisia, Algeria, Lybia) and Saudi Arabia

(Balachowsky, 1954; Matile Ferrero, 1984). The present list should be considered as a starting point for future biogeographic studies on the scale insects fauna of Crete.

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Two new species of scale insects (Hemiptera, Coccoidea) from Sardinia (Italy) with a check list of Sardinian Coccoidea

Abstract - Two new species of scale insects collected in Sardinia (Italy) are described and illustrated: *Spinococcus giuliae* sp. n. (Pseudococcidae) off the roots of *Umbilicus rupestris* (Crassulaceae) and *Micrococcus sardous* sp. n. (Micrococcidae) off the root of an undetermined grass (Poaceae) growing near the sea. An identification key to *Micrococcus* species and a revised list of the scales presently known in the island are also provided.

Riassunto - *Due nuove specie di cocciniglie (Hemiptera, Coccoidea) della Sardegna (Italia) con una check list dei Coccoidea sardi*

Vengono descritte due nuove specie di cocciniglie, *Spinococcus giuliae* sp. n. (Pseudococcidae) e *Micrococcus sardous* sp. n.(Micrococcidae), raccolte in Sardegna. Gli esemplari di *S. giuliae* sono stati raccolti su radici di *Umbilicus rupestris* (Crassulaceae) sul Monte Albo (Sassari), mentre *M. sardous* è stato raccolto su radici di una graminacea indeterminata sulla spiaggia di Capo Ceraso (Olbia). Vengono presentati una chiave di identificazione delle 8 specie di *Micrococcus* finora note e una check list degli Hemiptera Coccoidea di Sardegna.

Key words: Pseudococcidae, *Spinococcus giuliae* n. sp., Micrococcidae, *Micrococcus sardous* n.sp., genus *Micrococcus* identification key.

INTRODUCTION

One hundred and one species of scale insects (Hemiptera: Coccoidea) are currently known from Sardinia, (Pellizzari & Russo, 2006), including alien invasive species,. When one considers that almost 400 species of scale insect are known from mainland Italy (Pellizzari, 2010), the few recorded from Sardinia suggests that the scale insect fauna of the island is still largely unknown. During a survey, carried out some years ago, mostly in North-eastern Sardinia, some apparently new scale insect species were collected. Their presence on the island was briefly commented on a previous paper (Pellizzari & Fontana, 1996). In the present paper, two new species, one belonging to *Spinococcus* (Pseudococcidae) and the other to *Micrococcus* (Micrococcidae) are described and illustrated. The opportunity is taken to also revise the list of Sardinian scale insects based on previous papers (Pellizzari & Fontana, 1996; Pellizzari, 2003; Pellizzari & Russo, 2006) and on ScaleNet (Ben-Dov *et al*., 2011).

MATERIALS AND METHODS

Specimens were slide mounted according to the procedures of Kosztarab and Kozár (1988). Measurements and frequencies are given as mean, followed by the ranges in parentheses. Terminology follows that of Williams (1985) and Miller & Williams (1995) respectively for Pseudococcidae and Micrococcidae.

Specimens depository: The Scientific Museums of the University of Padova (Italy), Department of Environmental Agronomy & Crop Production - Entomology (DEAE);

PSEUDOCOCCIDAE

Spinococcus giuliae n. sp.

Adult female (Fig. 1)

Material studied: **Holotype**: adult female, Mount Albo, Nuoro province, Sardinia (**Italy**), off roots of *Umbilicus rupestris* (Crassulaceae), 21 May 1995, DEAE, slide n.651/3. **Paratypes:** 4 adult females, same data as holotype. Slides n.651/1, 651/2, 651/4, 651/5.

Living specimens: body broadly oval, convex. Derm covered with white powdery wax, body segmentation apparent.
Mounted specimen. Body broadly oval, 2 (1.7-2.2) mm long, 1.4 (1-1.6) mm wide; anal lobes poorly developed.
Venter. Labium 3-segmented, with 2 pairs of setae on unsclerotised basal segment, one pair on middle segment and 5 pairs on apical segment. Stylet loop not quite reaching level of second coxae Antennae 9-segmented; total length of each antenna 343 (325-370) μm. Scape with 3 setae, 2nd segment with 2 setae and 1 sensory pore, 3rd segment without setae, 4th segment with 2 setae, 5th segment with 1 fleshy seta, 6th segment with 1 fleshy seta + 2 setose setae, 7th segment with 3 fleshy setae + 7 flagellate or hair-like. Eyes near margin, protruding. Legs well developed; hind coxa without translucent pores; trochanter with 2 campaniform pores. Measurements of metathoracic leg (in μm): coxa 117 (100-125); trochanter + femur 216 (190-240); tibia 176 (150-200); tarsus 80 (70-90); tarsal digitules knobbed; claw digitules longer than claw, knobbed; claw about 18 μm long, with a small denticle. Body setae: ventral setae hair-like, distributed in a transvers single row on each abdominal segment, with the 2 medial setae usually longer; other setae present near coxae, on thorax, and on head. Minute hair-like setae sparse on abdominal segments; minute spine-like setae, each about 4-6 μm long, distributed on body submargin. Trilocular pores, each 3–4 μm wide, numerous, forming transverse bands on posterior abdominal segments, becoming less abundant anteriorly and sparse on head and on medial and submarginal parts of thorax; also with 2–6 pores laterad to each spiracle opening. Tubular ducts absent. Quinquelocular disc-pores and multilocular

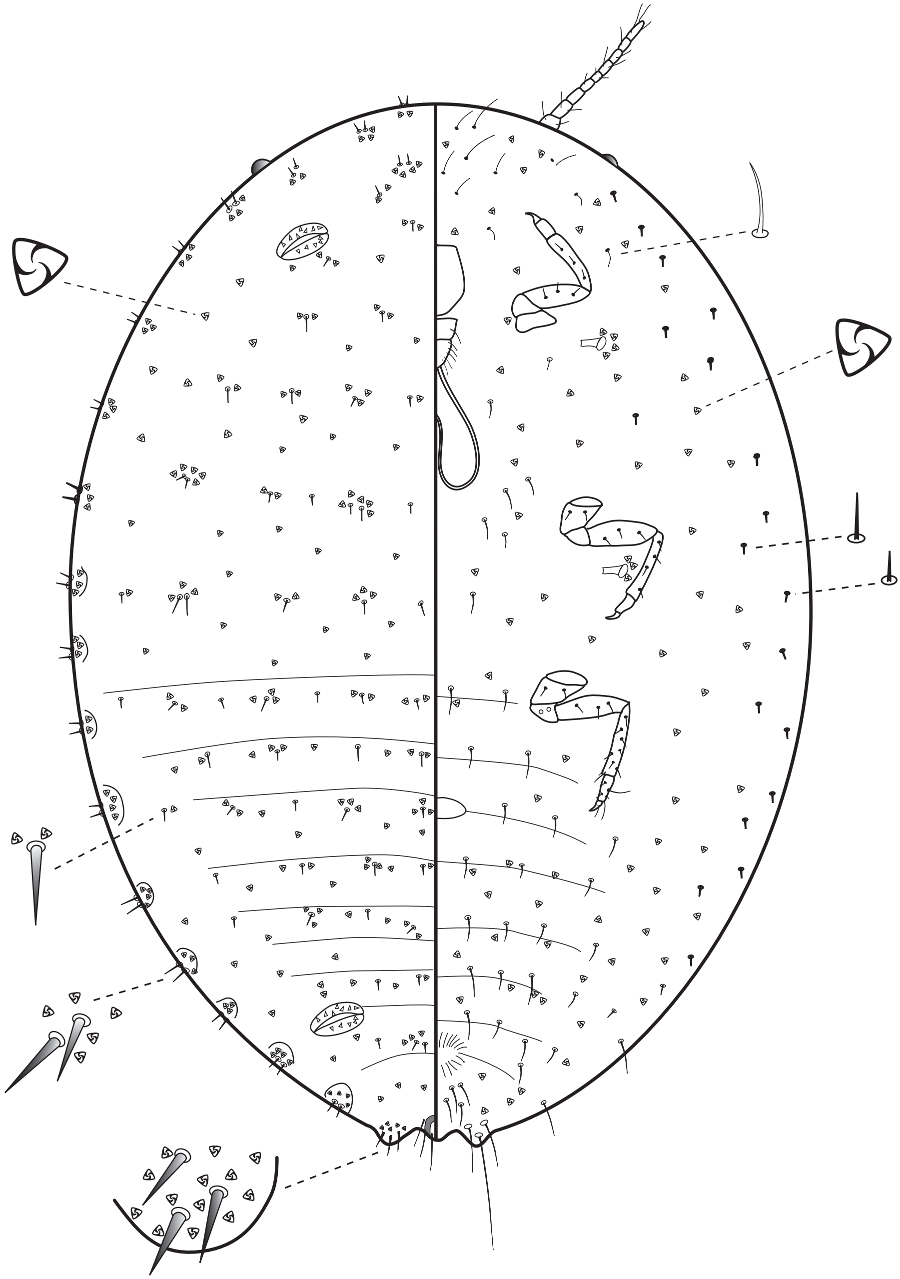

Fig. 1 - *Spinococcus giuliae* sp. n.: adult female.

disc-pores very rare or absent: one of the five specimens had one quinquelocular disc-pore and another had one multilocular disc-pore (slides n.651/3 and n.651/4) near vulva. Circulus present between segment III and IV, oval, poorly developed. Anal lobes each with one apical seta 117 (100-175) μm long and 2 subapical setae. Spinulae present on last abdominal segments.

Dorsum. Cerarii numbering 18 pairs, each with 2 spinose setae, each about 10 μm long, and 3-5 associated trilocular pores. On two specimens, some abdominal cerarii were elevated from surrounding derm (slides n.651/2 and n.651/4), suggesting that all cerarii could be elevated from surrounding derm on young females. Anal lobe cerarii with 3 spinose conical setae, longer than other cerarian setae, each about 16 μm long, and 9-12 trilocular pores.

Dorsal surface with spinose setae similar to cerarian setae, each 6-8 μm long, each often associated with 2 or 3 trilocular pores, but sometimes with 2 setae close together, plus 5 or 6 trilocular pores. Trilocular pores otherwise evenly distributed, each about 4 μm wide. Anterior pair of ostioles membranous but posterior ostioles with inner edge of lips lightly sclerotized; each lip with 5-8 trilocular pores. Multilocular pores absent. Tubular ducts absent. Anal ring with a double row of pores and 3 pairs of setae.

Derivatio nominis. The species is named after my younger daughter Giulia.

Comments

There is some disagreement about the status of *Spinococcus* Borchsenius, which was a replacement name for *Acanthococcus* Kiritchenko (a homonym of *Acathococcus* Signoret). Danzig (1980) synonymized *Spinococcus* with *Peliococcus* Borchsenius. According to Williams (1962), Kostzarab & Kozár (1988) and Tang (1992), the main morphological characters of the genus *Spinococcus* (presence of 17 or 18 pairs of cerarii, each consisting of two conical setae with some triloculars at their base, and presence of dorsal setae, similar to cerarian setae, associated with triloculars) differ from *Peliococcus* which is characterized by dorsal clusters of multilocular disc-pores, each cluster with one or more tubular ducts in centre (Williams, 1962; Kosztarab, 1996). The boundaries of the genus *Peliococcus* appear unclear since species previously placed in the genus *Spinococcus* (i.e. *S. morrisoni* Kiritshenko, *P. multispinus* Sirawa) were later included in *Peliococcus* (Danzig, 1980). Because of these differences, several authors (for instance, Kostzarab & Kozár, 1988; Tang, 1992; Marotta & Tranfaglia, 1995; Lagowska, 2005) have recognised both *Spinococcus* and *Peliococcus*. Indeed, Danzig herself, in a subsequent paper (2001), distinguishes two distinct forms in the genus *Peliococcus*, named respectively the "*Peliococcus* type" and the "*Spinococcus* type". For these reasons. the new species has been described in the genus *Spinococcus* Borchsenius.

The most peculiar character of *S. giuliae* is the absence, or extreme scarcity, of disc-pores and the absence of tubular ducts. Many Coccoidea have few or even no multilocular disc-pores near their genital opening and this character is generally associated with ovoviviparity. However, tubular ducts are usually present in Pseudococcids, at least on the venter.

In the Mediterranean basin, the genus *Spinococcus* previously included *S. convolvuli* Ezzat, recorded in Egypt, *S. mathisi* (Balachowsky) known from France and Tunisia, and *S. multispinus* (Siraiwa) recorded from southern Italy (Marotta & Tranfaglia, 1995).

MICROCOCCIDAE

Micrococcus sardous n. sp.

Adult female (fig. 2)

Material studied: **Holotype**: adult female, Capo Ceraso, Olbia province, Sardinia **(Italy)**, off roots of *Ammophila arenaria*? (Poaceae) growing near the beach, 24.v.1995, DEAE, slide n.712/1.
Paratypes: 6 adult females, same data as holotype. Slides n.712/2-7; 2 first instars, slide n.712/8.

Living specimens. Body shape broadly oval, very convex or almost spherical in reproductive females; red brown in colour.
Mounted specimen. Body broadly oval in pre-reproductive female, almost round in reproductive female, 3.12 (2.2-3.6) mm long, 2.9 (1.7-3.6) mm wide.
Venter. Antennae 3-segmented, segment I: 65 (56-70) μm long, II 46 (40-50) μm, III 105 (100-110) μm. Labium apparently of one segment, 110 μm long and 132 μm wide, with 4 pairs of setae, each about 34 μm long. Stylet loop reaching level of mid coxae. Legs well developed, femur enlarged, tarsus and tibia fused; trochanter + femur 216 (200-250) μm long, tibia + tarsus 233 (210-270) μm long, claw without denticle, 43 μm long, tarsal digitules 40 μm long.
Spiracles well developed, 80 μm wide and 90 μm long, each spiracle surrounded by a slightly sclerotised area; atrium of spiracle filled with about 50 intrastigmatic multilocular pores. Parastigmatic multilocular pores, each 8 μm wide with 7-20 loculi, distributed irregularly in a submarginal band on thorax, most numerous near spiracles, and forming 2 or 3 loose groups on submargin of abdominal segments, plus a few laterad to anal opening; rare on middle of abdominal segment V. Tubular ducts present, of two sizes: larger 20.4 (16-24) μm long, 6.4 μm wide, with thin inner filament about 16 μm long, distributed on mid-abdominal segments; smaller type slender, 27 (24-32) μm long and 2.4-3.3 μm wide, with inner filament about 20 μm long, distributed medially on thorax and head, but most abundant on apex of head. Ventral setae sparse, small, about 11 μm long. Discoidal pores circular, with sclerotised rim, each about 5-6.4 μm wide, scattered. Minute bilocular pores sparse, mainly on body submargin; larger bilocular pores sparse on thorax.
Dorsum. Apparent anal lobes broad, with long and stout setae, number variable, from 4 to 8 on each lobe, each seta 380 μm (335-416) long. True anal lobes modified into two crescentic anal plates surrounding anal opening, each bearing 4 setae, 2 on anterior

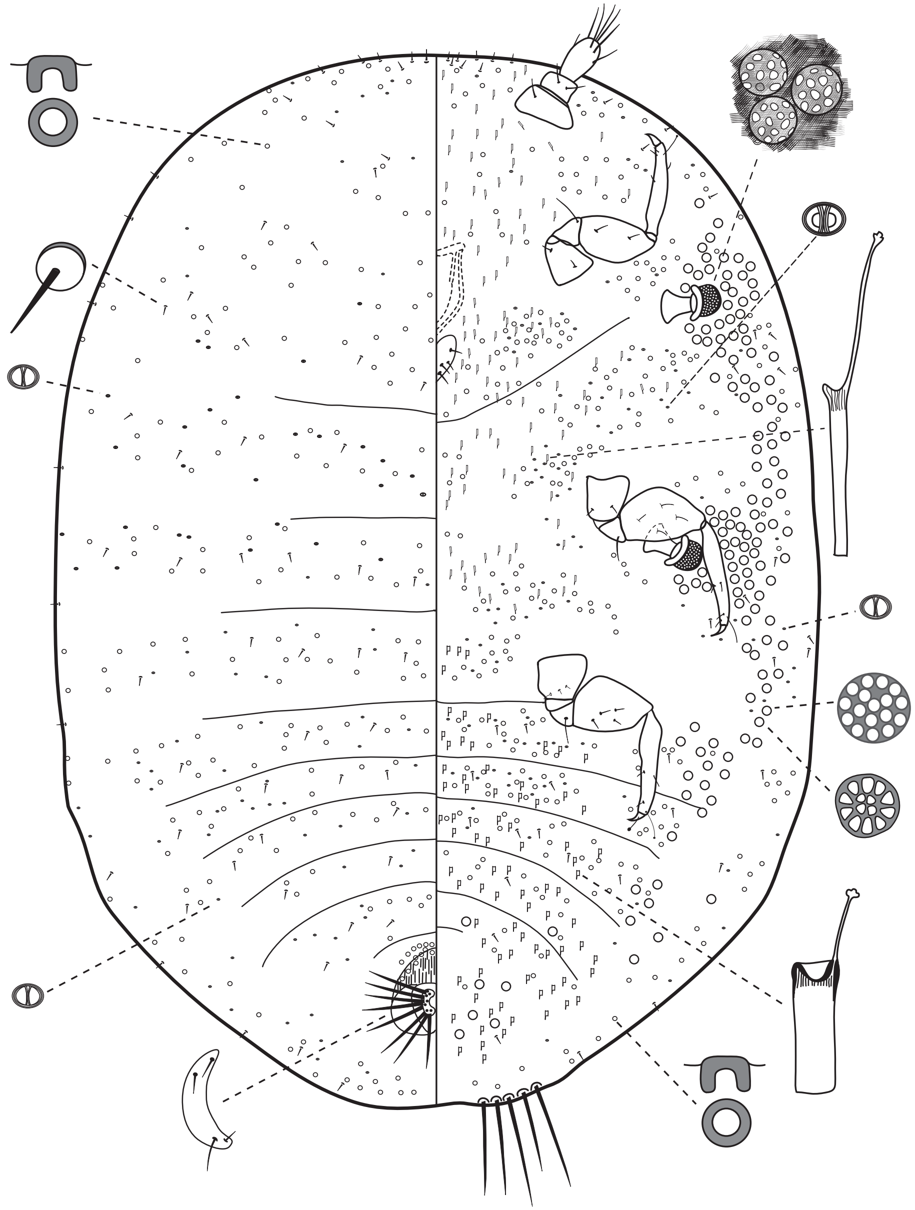

Fig. 2 - *Micrococcus sardous* sp. n.: adult female

edge, about 16 μm, long, 1 on posterior edge, 65 μm long, plus 1 near apex of posterior edge, about 10 μm.
Anal opening situated away from abdominal margin. Anal ring with 2 or 3 rows of cells and with 7-10 long setae on each side, longest 160 (120-200) μm long, smallest 138 (128-144) μm. Discoidal pores with sclerotised rim, circular, about 4.5-6.5 μm wide, scattered over dorsum. Short setae, each 6.5 μm long, scattered. Small and minute bilocular pores sparse throughout.

Derivatio nominis
The species name *sardous* is the Latin adjective, gender masculine, meaning "of Sardinia, pertinent to Sardinia", after the Italian island of Sardinia where this species was collected.

Comments
The genus *Micrococcus* was diagnosed by Marotta *et al*. (1995) and Miller *et al*. (2005). *M. sardous* is near to *M. baeticae* Matile-Ferrero & Williams, but differs mainly as follows (character-states on *M. baeticae* in brackets): 1) anal opening some distance from apex of abdomen (very close to apex of abdomen) 2) absence or paucity of parastigmatic multilocular pores on ventral abdominal segments (parastigmatic multilocular pores forming bands across abdominal segments), and 3) presence of several discoidal pores with a sclerotised rim around labium (absent on *M. baeticae*). On the other hand, the morphology of the first-instar nymph of *M. sardous* (slides n.712/8 and in.712/2, inside the female body) is close to that of *M. bodenheimeri* Bytinski-Salz (Miller & Williams, 1995): it has parastigmatic pores, each with 5-8 loculi) on each side of the body, in groups of 3 - 4 near each spiracle and hind coxa, with one pore inside each spiracle, and there are no pores on the body margin between the anterior and posterior spiracles.
The genus *Micrococcus* is presently known only in countries surrounding the Mediterranean basin (Morocco, Tunisia, Algeria, Spain, Sardinia and Italy mainland, Croatia, Turkey, Cyprus, Israel) (Marotta *et al*., 1995; Miller *et al*., 2005; Matile-Ferrero & Williams, 2006; Kaydan *et al*., 2007; Masten Milek & Simala, 2008). All were collected off roots of wild or cultivated Gramineae and are often associated with ants of the genus *Tapinoma*. With this new species, the known *Micrococcus* species reaches 8. In Sardinia, 2 other *Micrococcus* species are known, namely *M. silvestrii* Leonardi and *M. similis* Leonardi.

KEY TO ADULT FEMALE OF *MICROCOCCUS*
(modified after Miller & Williams, 1995)

1 Parastigmatic pores absent or restricted to thorax **2**
– Parastigmatic pores present on thorax and abdomen **5**

2 (1) Parastigmatic pores absent; with fewer than 10 setae on each anal plate...........**3**
– Parastigmatic pores present near each spiracular plate; with more than 10 setae on each anal plate. ....*similis* Leonardi

3 (2) Some marginal discoidal pores oval, with oval sclerotization in shape of an eye (according to Miller & Williams, based on 2nd instar female .... ***M. rungsi*** Balachowsky
– Marginal discoidal pores all round, or if oval, without sclerotization in shape of an eye **4**

4 (3) Antennae 3-segmented; longest seta on apparent anal lobes 237 (172-306) μm long .... ***M. bodenheimeri*** Bytinsky-Salz
– Antennae 2-segmented (segments III and II partially or completely fused); longest seta on apparent anal lobes 90 (83-96) μm long .... ***M. dumonti*** Balachowsky.

5 (1) Longest dorsal seta on metathorax longer than 100 μm; with 9 or more setae on each hind femur .... ***M. longispinus*** Miller & Williams
– Longest dorsal seta on metathorax shorter than 100 μm; with 8 or fewer setae on each hind femur **6**

6 (5) Tibia + tarsus more than 300 mm long; with more than 5 parastigmatic pores near each lateral margin of abdominal segment IV......................... ***M. silvestrii*** Leonardi
– Tibia + tarsus less than 300 mm long; parastigmatic pores absent on margin of abdominal segment I **7**

7 (6) Parastigmatic multilocular pores present on margin of head, thorax and abdominal segment I and II .... ***M. confusus*** Miller & Williams
– parastigmatic multilocular pores present on margin of head and thorax and also submarginally or medially on other abdominal segments **8**

8 (7) Anal ring situated on apex of abdomen. Parastigmatic multilocular pores forming wide bands across segments II-V of abdomen .... ***M. baeticae*** Matile Ferrero & Williams
– Anal ring situated far from apex of abdomen. Parastigmatic multilocular pores forming loose groups on submargin of abdominal segments II-VIII ....***M. sardous*** n. sp.

CONCLUSION

With the addition of the newly described species and the revision of the previous lists (Pellizzari & Fontana, 1996; Pellizzari & Russo, 2005), 105 scale insect species have now been recorded from Sardinia. The revised list is shown in Table 1. The previously recorded mealybug *Chaetococcus sulcii* (Green) (Ben-Dov *et al.*, 2011) proved to be an erroneous record for Sardinia. So far, *C. sulcii* is known in Italy only in Valle d'Aosta (North Italy) (Matile-Ferrero & Pellizzari, 2002). The diaspidid *Melanaspis inopinata* (Leonardi) is added to the list of known species from the island (Melis, 1930). The presence of the eriococcid *Acanthococcus devoniensis* (Green) in Sardinia is regarded as

Table 1 - Check-list of scale insects recorded in Sardinia. An asterisk marks the alien introduced species.

Family	Species	Validation source
ACLERDIDAE	*Aclerda berlesii* Buffa, 1897	Pellizzari & Russo, 2005
ASTEROLECANIIDAE	*Asterodiaspis bella* (Russell, 1941)	Pellizzari & Fontana, 1996
»	*Asterodiaspis ilicicola* (Targioni Tozzetti, 1888)	Pellizzari & Fontana, 1996
»	*Planchonia arabidis* Signoret, 1876	Pellizzari & Fontana, 1996
»	*Planchonia zanthenes* (Russell, 1941)	Pellizzari & Russo, 2005
»	*Pollinia pollini* (Costa, 1857)	Pellizzari & Russo, 2005
COCCIDAE	*Ceroplastes rusci* (Linnaeus, 1758)*	Pellizzari & Russo, 2005
»	*Ceroplastes sinensis* Del Guercio, 1900*	Pellizzari & Russo, 2005
»	*Coccus hesperidum* Linnaeus, 1758*	Pellizzari & Russo, 2005
»	*Eulecanium ericae* (Balachowsky, 1936)	Pellizzari & Fontana, 1996
»	*Eulecanium tiliae* (Linnaeus, 1758)	Pellizzari & Russo, 2005
»	*Filippia follicularis* Targioni Tozzetti, 1867	Pellizzari & Russo, 2005
»	*Lecanopsis myrmecophila* Leonardi, 1908	Pellizzari & Russo, 2005
»	*Lichtensia viburni* Signoret, 1873	Pellizzari & Fontana, 1996
»	*Parthenolecanium persicae* (Fabricius, 1776)	Pellizzari & Russo, 2005
»	*Pulvinaria floccifera* (Westwood, 1870)*	Pellizzari & Russo, 2005
»	*Pulvinaria vitis* (Linnaeus, 1758)	Pellizzari & Russo, 2005
»	*Pulvinariella mesembryanthemi* (Vallot, 1830)*	Pellizzari & Russo, 2005
»	*Rhizopulvinaria maritima* Canard, 1967	Pellizzari & Fontana, 1996
»	*Saissetia coffeae* (Walker, 1852)*	Pellizzari & Russo, 2005
»	*Saissetia ficinum* (Paoli, 1915)	Pellizzari & Russo, 2005
»	*Saissetia* oleae (Olivier, 1791)*	Pellizzari & Russo, 2005
»	*Sphaerolecanium prunastri* (Fonscolombe, 1834)	Pellizzari & Russo, 2005
»	*Stotzia ephedrae* (Newstead,1901)	Pellizzari, 2003
DIASPIDIDAE	*Abgrallaspis cyanophylli* (Signoret, 1869)	Pellizzari & Russo, 2005
»	*Adiscodiaspis ericicola* (Marchal, 1909)	Pellizzari & Russo, 2005
»	*Aonidia lauri* (Bouché, 1833)	Pellizzari & Russo, 2005
»	*Aonidia mediterranea* (Lindinger, 1910)	Pellizzari & Fontana, 1996
»	*Aonidiella aurantii* (Maskell, 1879)*	Pellizzari & Russo, 2005
»	*Aspidiotus nerii* Bouché, 1933*	Pellizzari & Russo, 2005
»	*Aulacaspis rosae* (Bouché, 1833)	Pellizzari & Russo, 2005
»	*Carulaspis minima* (Signoret, 1869)	Pellizzari & Russo, 2005
»	*Chionaspis etrusca* Leonardi, 1908	Pellizzari & Fontana, 1996
»	*Chrysomphalus dictyospermi* (Morgan, 1889)*	Melis, 1930, Longo *et a*l., 1995
»	*Diaspidiotus bavaricus* (Lindinger, 1912)	Pellizzari & Fontana, 1996
»	*Diaspidiotus cecconii* (Leonardi, 1908)	Pellizzari & Russo, 2005
»	*Diaspidiotus labiatarum* (Marchall, 1909)	Pellizzari & Fontana, 1996

»	*Diaspidiotus lenticularis* (Lindinger, 1912)	Pellizzari & Fontana, 1996
»	*Diaspidiotus ostreaeformis* (Curtis,1843)	Pellizzari & Russo, 2005
»	*Diaspidiotus perniciosus* (Comstock, 1881)*	Pellizzari & Russo, 2005
»	*Diaspis echinocacti* (Bouché, 1833)*	Pellizzari & Russo, 2005
»	*Duplachionaspis berlesii* (Leonardi, 1898)	Pellizzari & Russo, 2005
»	*Dynaspidiotus ephedrarum* (Lindinger, 1912)	Pellizzari & Russo, 2005
»	*Epidiaspis leperii* (Signoret, 1869)	Pellizzari & Russo, 2005
»	*Furchadaspis zamiae* (Morgan, 1890)*	Pellizzari & Russo, 2005
»	*Gonaspidiotus minimus* (Leonardi, 1896)	Pellizzari & Fontana, 1996
»	*Hemiberlesia lataniae* (Signoret, 1869)*	Pellizzari & Fontana, 1996
»	*Hemiberlesia rapax* (Comstock, 1881)	Pellizzari & Russo, 2005
»	*Lepidosaphes beckii* (Newmann, 1869)*	Pellizzari & Russo, 2005
»	*Lepidosaphes conchiformis* (Gmelin, 1789)	Pellizzari & Russo, 2005
»	*Lepidosaphes flava* (Signoret, 1870)	Pellizzari & Fontana, 1996
»	*Lepidosaphes gloverii* (Packard, 1869)*	Pellizzari & Russo, 2005
»	*Lepidosaphes ulmi* (Linnaeus, 1758)	Pellizzari & Russo, 2005
»	*Leucaspis pusilla* Loew, 1883	Pellizzari & Russo, 2005
»	*Leucaspis signoreti* Targioni Tozzetti, 1868	Pellizzari & Russo, 2005
»	*Lineaspis striata* (Newstead, 1897)	Pellizzari & Russo, 2005
»	*Melanaspis inopinata* (Leonardi)	Melis 1930
»	*Parlatoria oleae* (Colvée, 1880)	Pellizzari & Russo, 2005
»	*Parlatoria pergandii* Comstock, 1881	Pellizzari & Russo, 2005
»	*Parlatoria proteus* (Curtis, 1843)*	Pellizzari & Russo, 2005
»	*Parlatoria ziziphi* (Lucas, 1853)*	Pellizzari & Russo, 2005
»	*Pseudaulacaspis pentagona* (Targioni Tozzetti, 1886)*	Pellizzari & Russo, 2005
»	*Rungaspis capparidis* (Bodenheimer, 1929)	Pellizzari, 2003
»	*Saharaspis ceardi* (Balachowsky, 1928)	Pellizzari & Fontana, 1996
»	*Targionia nigra* Signoret, 1870	Pellizzari & Fontana, 1996
»	*Targionia vitis* (Signoret, 1876)	Pellizzari & Russo, 2005
»	*Unaspis euonymi* (Comstock, 1881)*	Pellizzari & Russo, 2005
ERIOCOCCIDAE	*Acanthococcus acutus* (Goux, 1938)	Pellizzari & Fontana, 1996
»	*Acanthoccus araucariae* araucariae (Maskell, 1879)*	Pellizzari & Fontana, 1996
»	*Acanthoccus* devoniensis (Green, 1896)??	Hoy, 1963 Longo *et a*l., 1995
»	*Acanthococcus ericae* Signoret	Tranfaglia & Esposito, 1985
»	*Gossyparia spuria* (Modeer, 1778)	Pellizzari & Russo, 2005
KERMESIDAE	*Kermes bacciformis* Leonardi, 1908	Pellizzari & Russo, 2005
»	*Kermes ilicis* (Linnaeus, 1758)	Pellizzari & Russo, 2005
»	*Kermes vermilio* Planchon, 1864	Pellizzari & Russo, 2005
LECANODIASPIDIDAE	*Lecanodiaspis sardoa* Targioni Tozzetti, 1869	Pellizzari & Russo, 2005

MONOPHLEBIDAE	*Gueriniella serratulae* (Fabricius, 1775)	Pellizzari & Russo, 2005
»	*Icerya purchasi* Maskell, 1879*	Pellizzari & Russo, 2005
MICROCOCCIDAE	*Micrococcus sardous* sp. n.	Present paper
»	*Micrococcus silvestrii* Leonardi, 1907	Pellizzari & Russo, 2005
»	*Micrococcus similis* Leonardi, 1907	Pellizzari & Russo, 2005
PSEUDOCOCCIDAE	*Balanococcus orientalis* Dantsig & Ivanova, 1976	Pellizzari & Russo, 2005
»	*Chorizococcus rostellum* (Lobdell, 1930)	Pellizzari & Fontana, 1996
»	*Dysmicoccus kozari* Pellizzari & Fontana, 1996	Pellizzari & Fontana, 1996
»	*Dysmicoccus pietroi* Marotta, 1992	Pellizzari & Fontana, 1996
»	*Euripersia inquilina* (Leonardi, 1908)	Pellizzari & Russo, 2005
»	*Euripersia sardiniae* (Leonardi, 1908)	Pellizzari & Russo, 2005
»	*Nipaecoccus delassusi* (Balachowsky, 1925)	Pellizzari & Russo, 2005
»	*Peliococcus manifectus* Borchsenius, 1949	Pellizzari, 2003
»	*Phenacoccus aceris* (Signoret, 1875)	Pellizzari & Fontana, 1996
»	*Phenacoccus asphodeli* Goux, 1942	Pellizzari, 2003
»	*Phenacoccus graminicola* Leonardi, 1908	Pellizzari & Russo, 2005
»	*Phenacoccus incertus* (Kiritchenko, 1940)	Pellizzari & Russo, 2005
»	*Planococcus citri* (Risso, 1813)	Pellizzari & Russo, 2005
»	*Planococcus ficus* (Signoret, 1875)	Pellizzari & Russo, 2005
»	*Planococcus vovae* (Nassonov, 1908)	Pellizzari & Fontana, 1996
»	*Pseudococcus calceolariae* (Maskell, 1878)°	Pellizzari & Russo, 2005
»	*Pseudococcus longispinus* (Targioni Tozzetti, 1867)*	Pellizzari & Russo, 2005
»	*Pseudococcus viburni* (Signoret, 1875) *	Pellizzari & Russo, 2005
»	*Spinococcus giuliae* sp. n.	Present paper
»	*Trabutina mannipara* (Hemprich & Ehrenberg, 1829)	Pellizzari & Russo, 2005
»	*Trionymus multivorus* (Kiritchenko, 1936)	Pellizzari, 2003
»	*Trionymus myrmecarius* (Leonardi, 1908)	Pellizzari & Russo, 2005
PUTOIDAE	*Puto palinuri* Marotta e Tranfaglia, 1993	Pellizzari & Fontana, 1996
»	*Puto superbus* (Leonardi, 1907)	Pellizzari & Russo, 2005

doubtful. It was first reported from Sardinia by Leonardi (1908, p.159). Later, Leonardi himself (1920) placed this first record among the synonyms of *A. ericae* (Signoret) and clearly reported that the species was collected in Sardinia. Subsequent authors (Paoli, 1916; Hoy, 1963; Pellizzari & Russo, 2005) only referred to the first record of 1908. Tranfaglia & Esposito (1985) redescribed *A. ericae* from old specimens preserved in the Portici collection, collected in Sardinia possibly by Leonardi, and labelled *E. devoniensis*. Some specimens collected more recently in Sardinia by Pellizzari and Fontana and identified as *A. devoniensis* (Pellizzari & Fontana, 1996) have proved to be a misidentification of *A. ericae* (F. Kozár, personal communication, 2011). The old record of *Carulaspis visci* (Schrank) is regarded as a misidentification of *C. minima* or, likely, of *C.juniperi,* with which. it was in the past confused, until the situation was clarified by

Baccetti (1960). This is strengthen by the fact that the only host plant of the true *C. visci*, is *Viscum album*, and this epiphytic plant is absent in Sardinia (Zuber, 2004).

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A survey of scale insects (Hemiptera: Coccoidea) occurring on olives in Tunisia

Abstract - A survey performed in 2009 within 52 Tunisian olive groves, located in 17 different olive-growing sites, revealed the occurrence of six scale insects on olives. The identified species were: the armoured scales *Aspidiotus nerii* Bouché, *Lepidosaphes ulmi* (L.), and *Parlatoria oleae* (Colvée), the soft scales *Saissetia oleae* (Olivier) and *Filippia follicularis* (Targioni Tozzetti) and the mealybug species *Peliococcus cycliger* (Leonardi). The soft scale *F. follicularis* is a new record for the Tunisian insect fauna. Among these species, *S. oleae* was the predominant scale insect occurring throughout olive groves of northeastern Tunisia, whereas the mealybug *P. cycliger* was by far the most abundant species within olives groves of the Northwest region of Tunisia. However, *P. oleae* was the least abundant species, being present in only one olive-growing site in northeastern Tunisia. Larvae of the noctuid moth *Eublemma scitula* (Rambur) were reported feeding on *S. oleae* and the coccinellid *Chilocorus bipustulatus* L. was found feeding on both *S. oleae* and *A. nerii*. The two hymenopteran species *Scutellista cyanea* Motschulsky and *Metaphycus* spp. were recorded as the main parasitoids of *S. oleae*.

Riassunto - *Uno studio sulle cocciniglie (Hemiptera: Coccoidea) dell'olivo in Tunisia*

Una ricerca effettuata nel 2009 in 52 oliveti della Tunisia, situati in 17 località,ha rilevato la presenza di 6 specie di cocciniglie infestanti gli olivi. Si è trattato di *Aspidiotus nerii* Bouché, *Lepidosaphes ulmi* (L.), *Parlatoria oleae* (Colvée), *Saissetia oleae* (Olivier), *Filippia follicularis* (Targioni Tozzetti) e di *Peliococcus cycliger* (Leonardi. *F. follicularis* è un nuovo reperto per l'entomofauna della Tunisia. *S. oleae* è risultata predominante e presente in particolare negli oliveti del nord-ovest della Tunisia, mentre *P. cycliger* è stata la specie più frequente negli oliveti del nord-est. Invece, *P. oleae* è risultata la specie meno abbondante essendo presente solo in un oliveto del nord-ovest. Viene riferito che le larve del Nottuide *Eublemma scitula* (Rambur) si nutrono di *S. oleae*, mentre il coccinellide *Chilocorus bipustulatus* L. è stato osservato nutrirsi sia di *S. oleae*, che di *Aspidiotus nerii*. Gli Imenotteri *Scutellista cyanea* Motschulsky and *Metaphycus* spp. sono stati osservati come comuni parassitoidi di *S. oleae*.

Key words: Diaspididae, Coccidae, Pseudococcidae, *Olea europaea*, Tunisia.

INTRODUCTION

The olive (*Olea europapea* L.), a long-lived evergreen, is a worldwide economically important horticultural crop. Most olive growing countries are localized in the Mediterranean basin which has more than 90% of the world's cultivated olive trees. Although the Mediterranean climate is suitable for olive-tree production, this last is hampered by several biotic constraints. Indeed, olive tree can often be attacked by fungi, bacteria, viruses, weeds, nematodes and insects, inducing substantial economic losses.

Several insect pests are known to cause serious damages to olives. Although the olive fruit fly, *Bactrocera oleae* (Gmelin), is considered to be the most important insect pest of olives worldwide (Daane & Johnson, 2010), other groups including scale insects, could also have a negative impact on olive trees' production and productivity throughout olive-growing areas. In the Mediterranean basin about 15-20 are permanent or occasional pests on the olive tree and, of these, approximately 10 belong to the Coccoidea (scale insects) (Pellizzari, 1997). Among scale insect pests, the black scale *Saissetia oleae* (Olivier) (Hemiptera: Coccidae), for example, which is believed to be native to South Africa (De Lotto, 1976), is one of the most economically important species attacking olives throughout the world and especially in the Mediterranean area (Stratopoulou & Kapatos, 1991; Velimirovic, 1994; Pellizzari, 1997; Kumral & Kovanci, 2004; Dos Santos, 2007; Pereira *et al*., 2007; Longo & Suma, 2008; Tena *et al*., 2008; Delrio & Foxi, 2010). When feeding on olives (leaves and twigs), this species secrete honeydew which supports the growth of the black sooty mold fungi, hindering the photosynthetic capacity of the plant and resulting in a reduction of the tree vigor and twig dieback in the case of heavy infestations. For these reasons, appropriate regular inspections are highly required for Integrated Pest Management (IPM) issues. As such, in each olive production country, a suitable geographical and bio-ecological characterization of scale insects species occurring, in addition to *S. oleae*, on olives is strongly recommended. However, biological control of scale insects using parasitoids and predators could be useful in limiting pest's outbreaks (Rochat & Gutierrez, 2001; Kumral & Kovanci, 2004; Dos Santos, 2007; Longo & Suma, 2008; Santos *et al*., 2009; Delrio & Foxi, 2010). Consequently, investigations aiming to acquire further knowledge on natural enemies associated with olive scale insects is needed for suitably implementing biological control programs in olive groves.

In Tunisia, where the most commonly cultivated olive oil varieties are both Chemlali and Chetoui and the main table variety is Meski, very few studies involving surveys of scale insects attacking olive trees have been until recently carried out. The realized studies were especially focused on determining the scale insect fauna without accurate qualitative (geographical distribution) or quantitative (abundance) characterization.

The objective of the present study was to better investigate scale insects and, whenever possible, their natural enemies in Tunisian olive groves, through a field survey of the existing species with an emphasis on the assessment of their abundance (frequency) between different geographic olive-growing sites. Such a study would accordingly be a basis for implementing a suitable IPM program against these insects within Tunisian olive groves.

MATERIALS AND METHODS

The survey of scale insects was carried out from February to July 2009, in a total of 52 olive groves belonging to 17 different sites located in the Extreme North, the Northeast (Sahel and Cap-Bon areas), the Northwest and the Center-South regions of Tunisia (Table 1). These regions are characterized by the cultivation of various olive varieties. Indeed, Trigui *et al*. (2008) stated that the variety Chetoui is cultivated in the North, both varieties Chemlali and Gerboui are cultivated in the Northwest, the variety Oueslati is cultivated in the Sahel area (Northeast) and both Meski and Picholine varieties are cultivated in the Cap-Bon area (Northeast). For each selected olive grove, at least ten olive trees were randomly selected and sampled. Sampling consisted of collecting 4 shoots of 20 cm length and 10 leaves in each of the four directions (North, West, East, South) within each olive tree. In the laboratory, each collected sample was analyzed under a dissecting microscope by: a) counting the number of scale insect specimens found on either shoots or leaves; b) reporting parasitized and non parasitized specimens. Subsequently, collected specimens were stored in small vials containing alcohol 70% for slide-mounting, before their morphological identification to genus and species. Microscope slides were prepared following the method described by Williams & Watson (1988a, b). The abundance (between-sites and between-regions) of the collected scale insect species was then determined. Parasitized (mummified) specimens were stored in

Table 1 - Geographic distribution within Tunisia of the investigated olive groves

Geographical zone	Olive-growing site	Number of prospected olive groves
Extreme North	Rafraf	4
Northeast	Takelsa	5
	Zanghou	5
	Manzel Bouzalfa	2
	Beni Khalled	2
	Bouargoub	2
	Hamma met	3
	Grombalia	4
	Korba	2
	Slimene	2
	Sidi Saïd	4
	Boufícha	3
	Nadhour	3
Northwest	Le Kef	3
	Bousalem	2
	Testour	3
Center-South	Regueb	3

plastic boxes covered with a net. All stored mummified specimens were checked daily for parasitoid emergence.

RESULTS AND DISCUSSION

A total of 2080 samples were collected in the different sites. From these samples, six scale insect species were reported infesting olives in Tunisia. These species are: the armoured scales *Aspidiotus nerii* Bouché, *Lepidosaphes ulmi* (L.), and *Parlatoria oleae* (Colvée), the soft scales *S. oleae* and *Filippia follicularis* (Targioni Tozzetti), and the mealybug species *Peliococcus cycliger* (Leonardi). This is the first record of the soft scale *F. follicularis* in Tunisia. *F. follicularis* was found in 8 olive-growing sites of northeastern Tunisia and in one site of the Northwest region of Tunisia. This newly recorded soft scale was the most abundant scale insect species on olives of Sidi Saïd in the Sahel area (northeastern Tunisia) (Table 2). Overall, *S. oleae* was the predominant species, representing 72% of the total number of specimens collected from all the prospected olive groves, followed by the mealybug *P. cycliger* (9.7%) and the Oleander scale *A. nerii* (9.3%). The three other species were less abundant with *P. oleae* was the least observed (< 1%) on olive trees, being present in only one olive grove. Regarding the within-site distribution, there was a clear variability based on the abundance of the existing scale insect species. Indeed, in the olive groves belonging to Testour, Beni Khalled, and Le Kef sites, only one scale insect species was found, namely either the black scale *S. oleae* or the mealybug *P. cycliger*; whereas in each of all the other investigated sites, except for Nadhour (Northeast) and Regueb (Center-South) sites where scale insects were totally absent, at least two scale insect species were reported to occur on olives (Table 2). The mealybug *P. cycliger* was the most common (93% of the collected specimens) species reported within olives groves of the Northwest region of Tunisia. In the extreme North and Northeast regions, *P. cycliger* was recorded in all investigated olive groves except those belonging to Beni Khalled and Bouargoub sites (northeastern Tunisia). In contrast, *S. oleae* was proven to be the most abundant scale insect occurring throughout olive groves of the Northeast region of Tunisia. Additionally, *S. oleae* appeared to be the most serious scale insect species due to its noteworthy damages (sooty mold fungi widely widespread on olive sections) observed on all infested olive trees. However, it should be noted that *S. oleae* was totally absent on olives of the Northwest region (Table 2). Longo & Suma (2008) stated that in Italian olive groves, the most common and injurious scale insect species are the Pit scale *Pollinia pollini* (Costa), *S. oleae*, *P. oleae* and in restricted areas the Oystershell scale, *L. ulmi*. Besides, the same authors indicated that the mealybug *P. cycliger* and the Oleander scale *A. nerii* are little common and of no practical economic importance on olive. Likewise, *S. oleae* is the key pest of olives in Bursa (Turkey); *Ph. oleae* and *P. oleae* were also found, but they were not common in olive orchards (Kumral & Kovanci, 2004). The present study provided evidence that *P. oleae* was rarely found on olive trees in Tunisia. Such a result is in total contradiction

Table 2 - Within-site distribution of the scale insect species recorded in Tunisian olive groves

Investigated olive-growing sites	Total number of samples	Identified species	Percentage of abundance/site
Rafraf	160	- *S. oleae* - *A. nerii* - *L. ulmi* - *P. cycliger* - *F. follicularis*	43 27 19 9 2
Takelsa	200	- *S. oleae* - *P. cycliger* - *A. nerii*	85 13 2
Zanghou	200	- *S. oleae* - *P. cycliger* - *A. nerii*	91 8 1
Manzel Bouzalfa	80	- *S. oleae* - *P. cycliger* - *A. nerii* - *F. follicularis*	73 19 4 4
Beni Khalled	80	- *S. oleae*	100
Bouargoub	80	- *S. oleae* - *A. nerii* - *P. oleae*	91 8 1
Hammamet	120	- *S. oleae* - *A. nerii* - *F. follicularis*	71 26 3
Grombalia	160	- *P. cycliger* - *S. oleae* - *F. follicularis*	48 46 6
Korba	80	- *S. oleae* - *P. cycliger* - *F. follicularis* - *A. nerii*	74 19 5 2
Slimene	80	- *S. oleae* - *P. cycliger* - *A. nerii* - *F. follicularis*	68 19 12 1
Sidi Saïd	160	- *F. follicularis* - *S. oleae* - *P. cycliger* - *A. nerii*	47 31 21 1
Bouficha	120	- *S. oleae* - *P. cycliger* - *F. follicularis* - *A. nerii*	74 18 4 4
Nadhour	120	-	-
Le Kef	120	- *P. cycliger*	100
Bousalem	80	- *P. cycliger* - *F. follicularis*	80 20
Testour	120	- *P. cycliger*	100
Regueb	120	-	-

with the current situation in Algeria where *P. oleae* is considered to be the most redoubtable pest affecting olive trees (Biche & Sellami, 2011). Our finding also is in contrast to the results found by Longo (1984) that in eastern Sicilian olive groves, *P. oleae* was widely distributed and also was among the most serious scale insect species on olives.

In the present study, it was highlighted that *S. oleae* was attacked by larvae of the moth *Eublemma scitula* (Rambur) (Lepidoptera: Noctuidae), however the coccinellid *Chilocorus bipustulatus* L. (Coleoptera: Coccinellidae) was found feeding on both *S. oleae* and *A. nerii*. Additionally, the two species *Scutellista cyanea* Motschulsky (Hymenoptera: Pteromalidae) and *Metaphycus* spp. (Hymenoptera: Encyrtidae) were recorded as the main parasitoids of *S. oleae*. Similarly, in the olive groves of Bursa (Turkey), *S. cyanea* and *Metaphycus* sp. are the main parasitoids of *S. oleae*, causing high mortality of black scales (Kumral & Kovanci, 2004). In the region of Magnesia (Greece), *S. oleae* is mainly parasitized by *Metaphycus helvolus* (Compere) (Stratopoulou & Kapatos, 1998). Moreover, Longo (1984) pointed out that in the Italian olive groves, the most common predators attacking *S. oleae* are the coccinellids *C. bipustulatus* and *Exochomus quadripustulatus* (L.) and the moth *E. scitula*, while the most common parasitoids of the black scale are the Pteromalids *S. cyanea* and *Moranila californica* (Howard), the Calcidids *Metaphycus lounsbury* (Howard), *Diversinervus elegans* Silvestri, *Coccophagus lycimnia* (Walker) and *M. helvolus*. More specifically, in Sardinian olive groves, currently *M. helvolus* and *M. lounsburyi*, introduced for the first time 30 years ago, are well established and provide biological control of black scale (Delrio & Foxi, 2010). By contrast, Tena *et al*. (2008) stated that *Metaphycus flavus* (Howard) and *Scutellista caerulea* (Fonscolombe) appeared as the main parasitoids of black scale in eastern Spain, whereas *M. helvolus* and *M. lounsburyi* had a limited incidence. In the olive groves of Trás-os-Montes region (Portugal), four coccinellid species, *C. bipustulatus*, *Scymnus (Scymnus) interruptus* (Goeze), *Scymnus (Pullus) subvillosus* (Goeze) and *Scymnus (Mimopullus) mediterraneus* Iablokoff-Khnzorian, are the most common predators, being potential candidates of natural control agents against *S. oleae* (Dos Santos, 2007).

In conclusion, of great interest is that an IPM strategy in Tunisian olives groves would be developed based on the results obtained in the present study which clearly emphasized an unequal abundance and a diverse geographical distribution of the existing scale insects on olives. Thus, pest management tools will especially be targeted towards the most common species, namely the soft scale *S. oleae* (northeastern Tunisia) and the mealybug *P. cycliger* (northwestern Tunisia) and this should involve further knowledge on the bio-ecology of both species. As such, further studies on the auxiliary fauna associated with these insects would prove useful in decision making for sufficient pest's control. Besides, future surveys of scale insects in other important olive-growing areas such as in Sfax and in Zarzis (southern Tunisia) should be performed for refining the overall knowledge related to this group of insects on olives in Tunisia.

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Comparative testing of different methods for evaluation of *Varroa destructor* infestation of honey bee colonies

Abstract - Different methods for evaluation of the degree of *Varroa destructor* infestation of honey bee colonies were tested. The methods using *in vivo* evaluation were the most sparing for the bees but less precise. The methods using evaluation with the killing of the bees or brood were the most precise but less sparing for bees.

Riassunto - *Test comparativi su diversi metodi per la valutazione dell'infestazione di* Varroa destructor in colonie d'api

Sono stati testati diversi metodi per valutare il grado di infestazione da *Varroa destructor* in colonie di api. I metodi che utilizzano la valutazione *in vivo*, preservano le api, ma si sono rivelati meno precisi. I metodi più invasivi, che prevedono l'uccisione di api adulte o covata, sono risultati i più precisi.

Key words: Infestation, evaluation, precise, destructive or sparing methods.

INTRODUCTION

Among the parasites infesting *A. mellifera* the varroa mite, *Varroa destructor* Anderson & Trueman, is considered the most serious one (Bailey and Ball, 1991). It have become for two decades now the scourge of Italian and European beekeepers with losses of numerous colonies of bees annually. Studies on the biology of the mite, testing of new formulations for its control increases from year to year, along with the search of suitable and precise methods of evaluation of varroa infestation.

There are several methods to determine the rate of varroa infestation in bee colonies.

The most widely used methods include the following.

Evaluation of natural mite mortality with the use of a hive bottom drawer covered with adhesive substances retaining varroa mites falling from the body of bees. However, according to Branco *et al*. (2006), this method can be considered reliable only if there is an adequate amount of brood, and if the infestation is in the early stages. Close to the above method is the analysis of the debris collected from the bottom of the hive for the presence of the fallen varroa mites (Calatayud and Verdu, 1993). However, this method is efficient only at low-level infestation (Fries *et al*., 1991).

Evaluation of the mite infestation by sampling of adult bees taken from the hive and exposed to treatment by different ways: washing with different liquids and detergents (De Jong *et al*., 1982), rotating in a jar with little amount of ether (Shabanov *et al*., 1980; Ellis *et al*., 1988) to separate and count the mites. However, the latter procedure can show overrated values in a survey with higher infestation levels and is unsafe because of the high flammability of ether vapors (Fakhimzadeh, 2001).

Evaluation by sampling the preimaginal bee stages (larvae and pupae of workers and drones) taken from newly capped brood combs and examined for the presence of mites in cells (De Jong, 1979; Szabo, 1989). Brood examination, according to Herbert *et al*. (1989), is a protracted laborious procedure and can be implemented only when the brood is available.

Evaluation by using of toxic vapor chemicals placed in a hive to stimulate falling of mites (Ellis *et al*., 1988). However, there are some evidences that chemicals can contaminate honey (Atienza *et al*. 1993) and other products of hive (Chauzat and Faucon, 2007).

Some authors have published analytical works on comparison of different methods of evaluation of the mite infestation in a hive, but with different conclusions (Herbert *et al*., 1989; Garza and Wilson, 1994; Branco *et al*., 2006; Barlow and Fell, 2009).

Therefore, the evaluation and development of different diagnostic methods of *Varroa destructor* to find the most precise, suitable and sparing ones is vital for successful integrated pest management strategy of the mite control.

MATERIALS AND METHODS

Testing of different methods to value the degree of infestation was carried out on the basis of calculating the number of female mites per 100 adult bees and the percentage of cells with worker bee or drone brood affected by the mite.

The experiments were carried out in isolated apiary. The hives were placed so that drifting of foragers was reduced. Availability of nectar sources was sufficient. Colonies were not remarkably affected by diseases other than varroasis.

The colonies were inspected to note their conditions and the presence of the queen at the beginning and at the end of the experiment.

The following four methods were tested in the same four experimental colonies selected from colonies of the apiary. In every colony all four methods were tested to get the reliable average value. Experimental colonies were selected of approximately equal average strength of bees and brood.

Vivo *evaluation*

METHOD 1. Examination of adults. About 100 adult bees from the middle comb frame of the hive were collected using the exhauster and placed in the diagnostic device (a box 150×150 mm made of transparent plastic with a hinged lid and side walls having the interior height of 4 mm). In the closed box the bees were pressed by the lid and fixed in a stationary position. Then bees were inspected and the counts the number of bees

themselves, as well as mites on their body were made. The number of detected mites was divided by the number of bees in the box and multiplied by 100 to get the number of mites per 100 bees. After counts the bees were released back into their colony. This procedure was replicated 4 times to get the reliable average value.
METHOD 2. Examination of the brood. The newly constructed comb with the bee or drone brood before capping was taken and the square of 50 × 50 mm (containing approximately 100 worker bee or 80 drone cells) was viewed through a strong light source. Counts of number of mites were made, and calculated per 100 cells. The procedure was replicated 4 times to get the reliable average value.

Evaluation with the killing of bees or brood

METHOD 3. Approximately 100 bees were taken from a mid comb of a colony and shaken off in a bright tray filled with hot (+70...90 ° C) 1% water solution of soda, vigorously stirred for 3-5 minutes. The mites fallen from the bees were counted to get the number of mites per 100 bees.
METHOD 4. To detect mites in a brood, 100 cells with a bee or drone brood from a mid combs on the border of the upper and the middle third closer to the hive entrance were uncapped. The cell and larva/pupa taken by tweezers were examined for the presence of mites and the calculation of a percentage of cell infestation was made.
Both procedures were replicated 4 times to get the reliable average value.

RESULTS AND DISCUSSION

Vivo *evaluation*

METHOD 1. The testing of adult bees placed in the diagnostic device showed the following results (table 1).

Table 1 - Average rate of varroa infestation (%) in experimental colonies, evaluated by method 1.

Number of the colony	Average number of bees per device	Average number of mites per device	Average rate of infestation, %
1.	96.5	3.0	3.1
2.	102.3	2.5	2.5
3.	106.5	3.5	3.3
4.	98.0	1.8	1.8
Average	100.8	2.7	2.7

As seen from the table 1, the average rate of varroa infestation in experimental colonies evaluated by method 1 was 2.7 %.

Advantages of the method:

The diagnosis is carried out on adult bees and therefore can be implemented at any time of a season. The bees fixed in the device are able to move their legs, but cannot move. It contributed to careful counting of bees and mites, and more precise evaluation of the degree of infestation. After counts the bees can be returned back into their colony.

Disadvantages of the method:

Diagnosis of the varroasis is complicated by the fact that mites are afraid of daylight and try to hide between the segments of bees. In addition, mites have a gray-yellow color, which not always lets to notice them.

METHOD 2. *Vivo* diagnosis was carried out on the worker bee brood before capping. The results of counting mites by viewing the 50 × 50 mm square of comb through the strong sun light are presented in the table 2.

Table 2 - Average rate of varroa infestation (%) in experimental colonies, evaluated by method 2.

Number of the colony	**Average number of immature bees per 50 × 50 mm square of comb**	**Average number of mites per 50 × 50 mm square of comb**	**Average rate of infestation, %**
1.	100.8	4.5	4.5
2.	82.0	3.8	4.6
3.	96.3	5.0	5.2
4.	85.8	2.3	2.7
Average	91.2	3.8	4.2

As seen from the table 2, the average rate of varroa infestation in experimental colonies evaluated by method 2 was 4.2 %. It would seem that this method is more precise than method 1, because it gives higher values of infestation of the same colonies.

However, the average ratio of infestation of worker bee brood and adult bees in late summer/beginning of autumn is usually about 2:1. If we compare the average rate of infestation of immature bees evaluated by method 2 (4.2%) with the average rate of infestation of adult bees evaluated by method 1 (2.7%), the ratio of infestation of brood and adult bees will only be 1.55: 1. This means that not all the mites in samples were seen and fell into account.

Advantages of the method:

The method does not demand special devices. The diagnosis is carried out on brood before capping, thus keeping bees alive.

Disadvantages of the method:

The diagnosis is carried out on bee brood and therefore it cannot be implemented at any time of a season. The method demands the acute eyesight of the viewer. The method is not too accurate.

Thus, method 2 can be used for the evaluation of rate of varroa infestation of bee colonies only to a limited extent.

Evaluation with the killing of bees or brood

METHOD 3. The testing of adult bees placed in plastic trays filled with hot 1% water solution of soda was conducted on the same specimens, which were used for testing by method 1.

The results are presented in the table 3.

As it is seen in the table 3, the average rate of varroa infestation in experimental colonies evaluated by method 3 was 3.5%.

The comparison of the average rate of infestation of bees evaluated by method 1 (2.7%) with the average rate of infestation of the same specimens of bees evaluated by method 3 (3.5%) shows that method 3 is 1.3 times more precise than method 1. It is obvious that not all the mites in the samples can be seen when bees are tested by method 1 and significant amount of mites escapes from counts when testing bees by this method.

Table 3 - Average rate of varroa infestation (%) in experimental colonies, evaluated by method 3.

Number of the colony	Average number of bees per tray	Average number of mites per tray	Average rate of infestation, %
1.	96.5	3.3	3.1
2.	102.3	4.5	4.4
3.	106.5	3.8	3.6
4.	98.0	2.8	2.9
Average	100.8	3.6	3.5

Thus, method 3 is more precise than method 1, because it makes possible to distinguish higher values of *Varroa* infestation.

Advantages of the method:

The diagnosis is carried out on adult bees and therefore can be implemented at any time of a season. The method does not demand complicated devices and can be carried out in field conditions with any suitable tray. The method does not require expensive chemicals. The method is more accurate.

Disadvantages of the method:

The main disadvantage of the method is that it is a destructive one because of killing of captured bees during the evaluation process. The using of plastic trays did not let to use boiling water which kills bees quickly and makes mites to fall on bottom immediately. Therefore, it is better to use glass containers.

METHOD 4. The evaluation of bee brood infestation by the mite was carried out on the worker bee brood. The results of the cell and taken brood examination for the presence of mites are presented in the table 4.

As seen from the table 4, the average rate of varroa infestation in experimental colonies evaluated by method 4 was 6.8%. This figure should be considered as a true rate of varroa infestation of the brood in experimental colonies, because these data were obtained by the direct counting of mites on the brood. This method proved to be the most precise of all other methods, because it gives the highest values of infestation of the same colonies.

Table 4 - Average rate of varroa infestation (%) in experimental colonies, evaluated by method 4.

Number of the colony	**Number of immature bees per sample**	**Average number of mites per sample**	**Average rate of infestation, %**
1.	100.0	6.5	6.5
2.	100.0	5.8	5.8
3.	100.0	6.3	6.3
4.	100.0	8.5	8.5
Average	100.0	6.8	6.8

In addition, the average ratio of infestation of worker bee brood and adult bees in late summer/beginning of autumn is usually about 2:1. If we compare the average rate of infestation of immature bees evaluated by method 4 (6.8%) with the average rate of infestation of adult bees evaluated by method 3 (3.5%), the ratio of infestation of brood and adult bees will be 1.9 : 1, which is very close to the mentioned above theoretical ratio - 2:1.

Advantages of the method:

The method is the most precise because it makes possible the direct counting of mites on bees. All mites are confined in cells, what contributes to more careful counting of mites and therefore more precise evaluation of the rate of infestation. The method does not require special devices and can be carried out in field conditions.

Disadvantages of the method:

The shortcomings of the method are the continuation of its merits. The main disadvantage of the method is that it is a destructive one because of killing of opened immature bees during the evaluation process. The method is labor consuming. The diagnosis is carried out on a bee brood and therefore it cannot be implemented at any time of a season.

The comparison of the significance of average rates of varroa infestation (%) in experimental colonies, evaluated by different methods using t-criterion of Student (table 5) showed that difference between the averages obtained by methods 1 and 2 was significant at $P<0.01$; between methods 1 and 4 ; 3 and 4 were significant at $P<0.05$. The differences between the averages obtained by methods 1 and 3; 2 and 3; 2 and 4 were non significant.

Table 5 - The comparison of the significance of average rates of varroa infestation (%) in experimental colonies, evaluated by different methods.

The comparison of the significance of differences between the averages obtained by different methods using t-criterion of Student												
1 vs. 2		1 vs. 3		1 vs. 4		2 vs. 3		2 vs. 4		3 vs. 4		Values of Student's t-criterion at 4 degrees of freedom
2.7	4.2	2.7	3.5	2.7	6.8	4.2	3.5	4.2	6.8	3.5	6.8	
t = 5,85		t = 1,93		t = 4,72		t = 1,70		t = 2,27		t = 3,18		t_{05} = 3,18 t_{01} = 5,84
difference significant at P<0.01		non signifi-cant		difference significant at P<0.05		non signifi-cant		non signifi-cant		difference significant at P<0.05		

PRELIMINARY CONCLUSIONS

1. All tested methods of the evaluation of a rate of varroa infestation of bee colonies have their aadvantages and disadvantages. The methods using *vivo* evaluation are the most sparing for bees but less precise. The methods using evaluation with the killing of bees or brood are the most precise but less sparing for bees.
2. The methods 1 and 2 are not too precise, because not all the mites in the samples can be noticed when testing bees by these methods, though method 2 is more precise than method 1.
3. Method 3 is 1.3 times more precise than method 1, because it lets to distinguish higher values of *varroa* infestation.
4. The most precise is method 4, because it gives the opportunity of direct counting of mites on bees. However, the method is the most destructive because of killing of opened immature bees during the evaluation.
5. The difference between the average rates of varroa infestation obtained by methods 1 and 2 was significant at P<0.01; 1 and 4 ; 3 and 4 were significant at P<0.05. The differences between the averages obtained by methods 1 and 3; 2 and 3; 2 and 4 were non significant.
6. Therefore it is necessary to continue the present research to develop the formula of the most precise extrapolation of the data obtained by *vivo* diagnosis to real degree of infestation.

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SHORT PAPERS

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First report of *Eurytoma plotnikovi* Nik. (Hymenoptera, Eurytomidae), a seed parasite of pistachio, in Sicily (Italy)

Abstract - The pistachio seed wasp, *Eurytoma plotnikovi* Nik.(Hymenoptera, Eurytomidae), is a new pest recently arrived in pistachio orchards in central-western Sicily (Italy). Information on the damaging effects of this seed wasp in the affected areas is provided.

Riassunto - *Prima segnalazione di* Eurytoma plotnikovi *Nik. (Hymenoptera, Eurytomidae), dannoso per il seme di pistacchio in Sicilia (Italia)*
La presenza di *Eurytoma plotnikovi* Nik. (Hymenoptera, Eurytomidae) in alcuni pistacchieti della Sicilia centro-occidentale viene segnalata per la prima volta. Vengono inoltre fornite informazioni sul danno prodotto dall'imenottero, nelle aree infestate.

Key words: pistachio seed wasp, new record, *Megastigmus pistaciae*.

Edible pistachio (*Pistacia vera* L.) nuts infested with larvae of an unidentified wasp were collected during an insect survey conducted in spring 2011 in pistachio orchards in central-western Sicily (latitude 37°51' 01" N; longitude 13°52'64" E). The wasp larvae, reared under laboratory conditions, developed into adults that were identified as *Eurytoma plotnikovi*, an indigenous pest of inedible nuts of the ornamental pistachio (*P. chinensis*) in China (Qin *et al*., 2007; Tian *et al*., 1994). The occurrence of this pistachio seed wasp in Sicily is a new record for Italy. In the surveyed orchards, *E. plotnikovi* was associated with another wasp, the pistachio seed chalcid, *Megastigmus pistaciae* Walker that is native to the Mediterranean region. In addition to China, the pistachio seed wasp is present in Tunisia (Jarraya & Helali, 1978), Iran (Basirat & Seyedoleslami, 2000), Israel (Izhaki, 1998), Turchia (Doğanlar *et al*., 2009), Greece (Mourikis, *et al*., 1998) and in other pistachio producing countries in the Middle East. A total of 553 nuts were collected in the infested Sicilian pistachio orchards and dissected for wasp infestation. All the nuts presenting the wasp larvae (254) were isolated under laboratory conditions waiting for the eclosion of the adults. An association of 177 and 77 specimens of *E. plotnikovi* and *M. pistaciae* Walker, respectively was produced. The damage induced by *E. plotnikovi* in the surveyed orchards has been noticed since 2009 by the growers

Eurytoma plotnikovi Nik.: lateral (top) and dorsal view (bottom) of adult.

who confused it with that caused by *M. pistaciae*. According to the literature, this new pistachio seed wasp completes one generation per year. The insect overwinters as a full grown larva inside the infested pistachio nuts which remain on the tree or fall to the ground. Adult emerges from the seeds in late April early May. The newly emerged females search for unripe pistachio nuts left on the trees or on the ground to deposit their eggs. The hatched larvae feed on the nuts until all or almost all the seed embryo is consumed and then enter diapause usually by July (Braham, 2005). According to Basirat and Seyedoleslami, (2000) each pistachio nut allows the development of only one wasp specimen. However, studies conducted in Iran and Tunisia, where the two pistachio wasps are present, indicate that *E. plotnikovi* is able to outperform *M. pistaciae* displacing it and becoming the dominant species infesting pistachio orchards (Basirat and Seyedoleslami, 2000; Braham, 2005). The early emergence (about one month earlier) of *E. plotnikovi* adults, compared to *M. pistaciae,* favors its spread and rapid colonization of pistachio nuts (Jerraya and Bernard, 1971; Braham, 2005). Poor management practices of the wasp infestations may also influence the spread of *E. plotnikovi* in pistachio orchards (Wu *et al*., 2009). The results of chemical control trials reported in the literature indicate that stem injections of neonicotinoids are the most effective measures for managing infestations of *E. plotnikovi*, providing better results than spray and drench applications of this product. Taking into consideration the importance of the pistachio industry as an economic resource in eastern Sicily, the only Italian region where pistachios are grown, biological and ecological studies of *E. plotnikovi* in the environmental conditions of Sicily are needed to prevent the spread of this pest from west into east Sicily (Bronte Municipality) and, in general, all over the country.

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