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The scale insects (Hemiptera: Coccoidea) of the Maltese Archipelago

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Abstract

Past works on scale insects (Hemiptera: Coccoidea) from the Maltese Archipelago are reviewed. Based on the literature and contemporary collections, a total of 93 species of scale insects belonging to 12 scale insect families are here reported (Acleridae 1 species; Asterolecaniidae 4; Coccidae 17; Diaspididae 46; Eriococcidae 5; Kermesidae 1; Margarodidae 1; Micrococcidae 1; Monophlebidae 2; Pseudococcidae 11; Putoidae 2 and Rhizoecidae 2). Of these, 17 species represent new distribution records. Ten species are excluded from the scale insect fauna of the Maltese Islands. Of the 93 species present, only 29 (31.18%) are probably indigenous and the rest (68.82%) represent established introductions from elsewhere. More than 65% of the indigenous species are typical Mediterranean in distribution, with a few species having a mainly European chorotype. A quarter of the established aliens originate from Eurasia, followed by an East Asian/Oriental component (20.31%); European (14.06%); Neotropical (14.06%); cryptogenic (14.06%); African (7.81%) and Australasian (4.70%). Movement of live fruit trees and ornamental plants into the Maltese Archipelago from nearby countries is probably the main route for entry of alien scale insects into the country. Some possible future introductions are discussed.

Key words: Mediterranean, new records, Malta, invasive species

Introduction

The Maltese Archipelago is a group of low-lying islands aligned in a NW-SE direction, located in the central Mediterranean basin. It consists of three inhabited islands: Malta, Gozo and Comino, and a number of small uninhabited islets such as Cominotto, Filfla and St. Paul's Islands. The total land area is about 316 km², with Malta (245.7 km²) and Gozo (67.1 km²) being the largest islands. The climate is typical of the Mediterranean, with mild, wet winters and hot, dry summers. The average annual precipitation is about 500 mm, but rainfall is highly variable from year to year, with only about 190 mm in extremely dry years and exceeding 1000 mm in extremely wet years. Human impact on the natural environment of the Maltese Islands is quite severe and has been ongoing since Neolithic times. Currently, the overall population density is 1,317 per km², making the archipelago one of the most densely populated regions in the World. This resident population is augmented by tourists, who have averaged between 1.1–1.4 million annually in the last five years. It is therefore not surprising that human impact on the natural environment is a key feature of the islands' ecology. Despite this, the islands still harbour a diverse array of natural and/or semi-natural habitats, with a total of about 1,100 species of vascular plants, of which around 77% are indigenous and the rest are naturalised aliens (Lanfranco *et al.*, 2013). The most common natural vegetation type is the garrigue community of rocky grounds. Other common habitat types include steppic grassland and disturbed ground. Less common and more restricted in distribution are the maquis habitats, found in relatively inaccessible sites such as the sides of steep valleys and at the foot of inland cliffs. The natural woodland habitat of Malta is all but extinct and only remnants of small copses of Holm Oak (*Quercus ilex* L.) remain. One locality (Buskett) can be best described as a semi-natural woodland, as it was originally planted by man but is now self-regenerating and has

the characteristics of a natural climax community. Coastal habitats such as saline marshlands and sandy beaches are rare, localised and much degraded due to human activities. Cliff-side habitats (rupestral communities) along the SW coasts provide important refuges for many species of Maltese flora and fauna, mainly due to their inaccessibility to humans. Another important habitat type in the Maltese Islands is that of freshwater communities, most of which, however, dry out during the summer months. Very few permanent springs and freshwater pools manage to retain water all year round.

Although scale insects (Hemiptera: Coccoidea) can be important crop pests, few studies have been carried out on this economically important insect group in the Maltese Islands, especially in recent years. Five publications that discuss scale insects from the Maltese Islands published between the late 1800's and the 1930's are worth mentioning here because they contain most of the information currently available. Unfortunately, these publications are often inaccessible to foreign scientists as they were published in Malta either as *separata*, as books or in obscure local journals. John Borg published a work entitled "Culture and diseases of the orange tree" (Borg, 1898), where 10 scale insects mostly affecting citrus cultivation in Malta were mentioned and brief popular descriptions for each were provided. In 1919, Mr Paul Borg, the Plant Pathologist at the Department of Agriculture, published an illustrated list of 26 scale insects present in Malta, providing popular descriptions, host-plant records, habitat preferences, natural enemies and control strategies (Borg, 1919). Of these 26 species, only 20 were valid records since some were misidentified and several were synonyms. In the same work, he included information on four additional scale insects that were not identified to species level. John Borg's (1922a) book entitled "*Cultivation and diseases of fruit trees in the Maltese Islands*", mentioned several scale insect species but sometimes it is not clear if they were actually found in Malta. In the same year, Borg [J.] (1922b) published a short note, read at the *Aula Magna* of the University of Malta on the 15th of November, 1922, which provided detailed information about the introduction of two scale insects to Malta: *Fiorinia fioriniae* (Targioni Tozzetti) and *Pseudaulacaspis pentagona* (Targioni Tozzetti) (both Diaspididae). Finally, Borg [J.] (1932) provided a list of 59 species of scale insects occurring in the Maltese Islands, and provided synonyms, host-plant data and other relevant information for each. Unfortunately, the material upon which the Borgs (1919, 1922a, 1932) based their records was not available for the present study and it is most likely lost. These authors never mentioned any depositories for such material but they collaborated with some of the best scale insect experts of that time, such as Prof. Filippo Silvestri and Prof. Luigi Savastano (Borg, 1922b), and the identification accuracy was presumably good.

Few foreign authors have ever published on Maltese scale insects. In his monograph on Italian scale insects, Leonardi (1920) mentioned two species of scales (*Aonidiella aurantii* (Maskell) and *Leucaspis riccae* Targioni Tozzetti, both Diaspididae) as occurring in Malta. Others (e.g. Hoy, 1963) have included Malta in the distribution range of already recorded species. The only scale species ever described as new from material collected in Malta was *Lacombia urbanii* (Boratynski, 1968) (Pseudococcidae), which was subsequently synonymised under *L. dactyloni* (Bodenheimer) by Ben-Dov (1990). This scale was included in the Red Data Book for the Maltese Islands, presumably because it was thought to be an endemic species (Schembri, 1989).

Saliba's (1963) book entitled "*Insect pests of crop plants in the Maltese Islands*" included 24 scale insects; for each species he gave very brief information on their local status and preferred host-plants. Presumably, this work lacks taxonomic backing and some records are likely to be incorrect. Most of the data included therein was based on the earlier published works of John and Paul Borg. Vella (1991) published a semi-popular book in Maltese about pests and diseases of grape vines, and in this work he mentioned four species of scales associated with this crop. Farrugia (1998) collected scale insects from Malta and Gozo between January 1996 and December 1997 and recorded 11 species from citrus trees. The main aim of Farrugia's work was to rear parasitic Hymenoptera from these scales, and he reported 25 hymenopteran parasites and hyperparasites belonging to five families of Chalcidoidea. Mifsud (1997) gave an overview of parasites and predators of scale insects in Malta. Two undergraduate dissertations undertaken at the University of Malta and supervised by the senior author focused on arthropod species associated with olives and *Ficus* spp. in the Maltese Islands. From these works two publications were produced, which recorded six species of scales associated with each of these mentioned host plants (Haber & Mifsud, 2007; Mifsud *et al.*, 2012). Two short communications were also published in the *Bulletin of the Entomological Society of Malta*, a recently launched journal that is serving as a good platform for publication of insect studies on Malta. Of these, one included the first report of *Protopulvinaria pyriformis* (Cockerell) (Coccidae) in Malta (Mifsud & Porcelli, 2011) and the other included the first report of *Ripersiella planetica* (Williams) (Rhizoecidae) in Europe (Malumphy, 2012) based on material collected in Malta.

Two electronic databases are worth mentioning: the Fauna Europaea (FaEu) database (Danzig & Watson, 2014—the data of which was entered in 2004), which records 62 species of scale insects from Malta; and ScaleNet (Ben-Dov *et al.*, 2014), which contains 55 records pertaining to Malta. Three of the 62 scale species recorded from Malta in FaEu, namely *Aspidiotus hedericola* Leonardi, *Carulaspis minima* (Signoret) and *Diaspis boisduvalii* Signoret (Diaspididae), were new records based on museum specimens included in the present work. Four other FaEu records are here regarded as incorrect and are discussed further under “Scale insects erroneously recorded from Malta” below. The FaEu record of *Asphodelococcus berlesii* Buffa (Pseudococcidae) is an erroneous combination and refers to *Aclerda berlesii* Buffa.

ScaleNet (Ben-Dov *et al.*, 2014), which is based only on published literature rather than museum specimens, is more conservative than FaEu with respect to scale insect records pertaining to Malta. The only exceptions are the records of *Lepidosaphes pinnaeformis* (Bouché) and *Parlatoria proteus* (Curtis), both of which are removed from the scale insect fauna of Malta in the present work. However, despite the fact that ScaleNet cites both works of Borg (1919; 1932), several records therein are not included in the database at the time of writing. These include: *Dimargarodes mediterraneus* (Silvestri), *Gueriniella serratulae* (Fabricius), *Amonostherium rorismarinis* (Boyer de Fonscolombe), *Planococcus citri* (Risso), *Planococcus ficus* (Signoret), *Rhizoecus falcifer* Kunckel d'Herculais, *Asterodiaspis ilicicola* (Targioni Tozzetti), *Aonidia lauri* (Bouché), *Aonidiella aurantii* (Maskell), *Diaspidiotus ostraeformis* (Curtis), *Diaspidiotus pyri* (Lichtenstein), *Dynaspidotus britannicus* (Newstead), *Gonaspidotus minimus* (Leonardi in Berlese & Leonardi), *Hemiberlesia cyanophylli* (Signoret), *Hemiberlesia lataniae* (Signoret) and *Melanaspis inopinata* (Leonardi).

Only in the last 15–20 years have field surveys and taxonomic studies been undertaken to evaluate the scale insect fauna of the Maltese Archipelago. Some of these surveys were part of larger projects funded from overseas, such as the technical co-operation project (TCP/MAT/2351) funded by FAO in 1994 to strengthen the plant quarantine facilities of the then Ministry for Agriculture and Fisheries in Malta (Mifsud *et al.*, 2009). For this project, one of us (GW) was responsible for collecting and identifying scale insects found in Malta, which data forms a substantial part of the present work. We have also incorporated original data on 30 species of scale insects collected and identified by Dr Christopher Malumphy during a short holiday he took in Malta, 12–19 February, 2012. Two of the present authors (AR and GM) were invited by the senior author for additional field work 17–19 May, 2012 and further new records of scale insects were collected, which are also included herein.

Material and methods

Infested plant samples were collected in the field. In the laboratory, infested plant fragments were preserved in 70% alcohol. Permanent slide mounts of adult females from the samples were prepared using the method given by Watson & Chandler (2000). Slide-mounted specimens were examined using a compound microscope with phase contrast illumination and magnifications of x25–x800. The specimens were identified using keys, diagnoses and illustrations available in the literature and reference specimens in The Natural History Museum, London, UK (BMNH).

The material examined was collected by the following people:

AR—Agatino Russo
BW—Brian Wheeler
CC—Cormac Cullinan
CF—Charles Farrugia
CM—Chris Malumphy
DM—David Mifsud
GM—Gaetana Mazzeo
GW—Gillian W. Watson
JI—John W. Ismay
PB—Paul Borg
SA—Stephania Aquilina

Slide mounts and voucher material are mainly deposited in the private collection of one of us (DM) with the exception of the material collected by CM, which is deposited at The Food and Environment Research Agency (FERA), York, UK, and some other material deposited at The Natural History Museum, London, UK (BMNH).

While the Coccoidea are recognized as a monophyletic group, their phylogeny is not fully understood and was probably not a simple, linear descent (Hodgson & Hardy, 2013); this makes any attempt to treat the families in phylogenetic order unrealistic. The families are therefore covered in alphabetical order, following the classification used by Ben-Dov *et al.* (2014), and in alphabetical order of genera within each family and species within each genus. New records are indicated with a black spot, ●.

The following information is included for each species: (i) for material collected in Malta, scientific name/s which are different from the current accepted names and the author/s who cited them; (ii) all authors who cited material from Malta; (iii) host-plant data, localities and other useful information which was published in Borg (1898; 1919; 1922a; 1922b; 1932) and Saliba (1963), since these publications are almost inaccessible for foreign scientists. The only exception is for Borg (1922a), where only those scale insect records for which reference to the Maltese Islands was clearly indicated are included, and since this is a rather bulky book, such citations are followed by the page number/s where they are mentioned; (iv) material examined and (v) any other relevant comments.

Annotated faunistic list

Family Aclerididae Ferris in Teague, 1925

Aclerda berlesii Buffa, 1897

Borg (1932) recorded this species as very common in both Malta and Gozo. Malta was also included in its distribution range by Borchsenius (1960). The record of *Asphodelococcus berlesii* Buffa (Pseudococcidae) for Malta in Danzig & Watson (2014) is an erroneous combination and refers to this acclerid species.

Material examined: MALTA, Valletta, x.1919, 2 ♀♀ on *Arundo donax*, PB (BMNH); Għajn Rihana, 17.v.2012, 6 ♀♀ on *A. donax*, AR, DM & GM; Qawra, 15.ii.2012, 4 ♀♀ on *A. donax*, CM; Floriana, St. Philip's Garden, 18.ii.2012, 2 ♀♀ on *A. donax*, CM.

Family Asterolecaniidae Cockerell, 1896

Asterodiaspis ilicicola (Targioni Tozzetti, 1888)

Recorded by Borg (1932) (as *Asterolecanium ilicicola*) as a rare species occurring “here and there on *Quercus ilex* at Wardija, Buskett and Wied Hazrun”. No Maltese specimens have been seen during the present work.

● *Bambusaspis bambusae* (Boisduval, 1869)

The species is probably of Oriental origin and represents an established introduction.

Material examined: MALTA, Attard, San Anton Gardens, 19.v.2012, 10 ♀♀ on *Bambusa* sp., DM, GM & AR.

Pollinia pollini (Costa, 1857)

Recorded by Haber & Mifsud (2007) as relatively common on *Olea europea*. In unpublished correspondence by D.J. Williams of the Commonwealth Institute of Entomology, London to J.M. Wilkinson of the Government of

Malta, dated 4th February 1970, the presence of this scale insect was confirmed from material collected in Malta at that time, indicating its presence in Malta earlier than the records in Haber & Mifsud (2007).

***Russellaspis pustulans* (Cockerell, 1892)**

This species is not native to the Mediterranean basin. Stumpf & Lambdin (2006) said it had been reported from Malta, but gave no further details on the source of this information. *Russellaspis pustulans* is present also in Cyprus, Egypt, Israel and Italy in the Mediterranean region (Ben-Dov *et al.*, 2014). No Maltese specimens have been seen during the present work.

Family Coccidae Fallèn, 1814

***Ceroplastes floridensis* Comstock, 1881**

A Neotropical species recorded by Saliba (1963) as fairly common on citrus, and by Farrugia (1998).

Material examined: MALTA, Lija, 18.iii.1994, 2 ♀♀ on *Citrus reticulata*, DM; Bir id-Deheb, 27.iii.94, 4 ♀♀ on *Cydonia oblonga*, DM.

***Ceroplastes rusci* (Linnaeus, 1758)**

Another Neotropical introduction, first recorded by Borg (1898). Borg's (1919; 1922a: 85) records of *Ceroplastes cirripediformis* Comstock represent misidentifications of *C. rusci* (Ben-Dov *et al.*, 2014). Borg (1922a: 85) wrote that this scale "has been introduced in these islands probably towards 1905, and sometimes is common on the false pepper (*Schinus molle*) and on the quince, but has not been noticed on Citrus trees". He also recorded it as rather rare on pear (Borg, 1922a: 242) and on strawberry (Borg, 1922a: 621). Borg (1932) stated that it was "very common on the common Fig (*Ficus carica*) and on the Custard Apple (*Annona cherimolia*), in both islands. It is also frequent on the Quince, the Vine and the Apple. It is rare on Citrus trees, the Pear, and on certain creepers, such as *Ipomoea*, *Phaseolus caracalla*, etc." Saliba (1963) stated that this scale was very common on apple, citrus, fig, mulberry and pear. It was recorded again by Farrugia (1998) and Mifsud *et al.* (2012).

Material examined: MALTA, Żejtun, 10.iii.1994, 1 ♀ on *Citrus limon*, DM; Żejtun, 11.iii.1994, 1 ♀ on *C. sinensis*, DM; Chadwick lakes, 12.iii.1994, 2 ♀♀ on *Ficus carica*, GW; Rabat 12.iii.1994, 3 ♀♀ on *Pittosporum* sp., GW; Buskett, 24.iii.1994, 1 ♀ on *Pistacia lentiscus*, DM; Mellieħa, 8.x.1994, 2 ♀♀ on *Ficus carica*, MS.

***Ceroplastes sinensis* Del Guercio, 1900**

Borg (1932) stated that this scale has been present in Malta since 1912, with records from *Schinus molle* and the common fig from Ħamrun and Birkirkara. No Maltese specimens have been seen during the present work.

***Coccus hesperidum* Linnaeus, 1758**

Borg (1898; 1919; 1922a: 83) recorded this scale (as *Lecanium hesperidum*) as fairly common on citrus trees. Borg (1932) recorded it as "frequent and often common in summer on Citrus trees. Found also on several ornamental trees and climbers", whereas Saliba (1963) stated that it was occasionally found on mulberry. *Coccus hesperidum* was recorded again by Farrugia (1998) and Mifsud *et al.* (2012).

Material examined: MALTA, Żejtun, 10.iii.1994, 1 ♀ on *Citrus limon*, DM; Żejtun, 11.iii.1994, 1 ♀ on *C. sinensis*, DM; Mosta, 12.iii.1994, 2 ♀♀ on *C. sinensis*, SC; Burmarrad, 14.iii.1994, 1 ♀ on *Chamerops* sp., DM; Bir id-Deheb, 20.iii.1994, 1 ♀ on *Eriobotrya japonica*, DM; Marsa, 21.iii.1994, 1 ♀ on *Nerium oleander*, DM;

Żejtun, 29.iii.1994, 1 ♀ on *Ficus nitida*, DM; Wied Babù, 17.iv.1994, 1 ♀ on *Rhamnus oleoides*, DM; Marsa, Għammieri, 7.iii.1995, 3 ♀♀ on *Laurus nobilis*, DM; Marsa, Għammieri, 12.xi.1996, 2 ♀♀ on *Nerium oleander*, CF; Marsa, Għammieri, 5.iii.1997, 1 ♀ on *C. aurantium*, CF; Marsa, Għammieri, 3.iv.1997, 3 ♀♀ on *C. aurantium*, CF; Valletta, Upper Barrakka Gardens, 13.ii.2012, 2 ♀♀ on *Cycas* sp., CM; Valletta, Upper Barrakka Gardens, 13.ii.2012, 4 ♀♀ on *L. nobilis*, CM; Bugibba, 14.ii.2014, 2 ♀♀ on *Citrus sinensis*, CM; Qawra, 14.ii.2014, 2 ♀♀ on *L. nobilis*, CM; Qawra, 15.ii.2014, 2 ♀♀ on *Schinus terebinthifolius*, CM; Mdina, 15.ii.2012, 1 ♀ on *C. limon*, CM; Mdina, 15.ii.2014, 2 ♀♀ on *C. sinensis*, CM; Attard, San Anton Gardens, 19.v.2012, 4 ♀♀ on *Citrus*, AR, DM & GM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 1 ♀ on *L. nobilis*, SA; Kercem, Dawara Valley, 16.iii.1994, 1 ♀ on *C. sinensis*, GW.

● *Coccus longulus* (Douglas, 1887)

This cryptogenic tropical to subtropical species is an established introduction.

Material examined: MALTA, Żejtun, 13.iii.1994, 3 ♀♀ on *Laurus nobilis*, DM.

Eulecanium tiliae (Linnaeus, 1758)

Borg (1932) stated that this species (as *Eulecanium coryli* (Linnaeus)) had been “long known to exist on the Pear-tree in most gardens and groves where this fruit tree is grown, but is far from common, except in very sheltered situations”. No Maltese specimens have been seen during the present work.

Filippia follicularis (Targioni Tozzetti, 1867)

This species was correctly recorded by Borg (1919). Borg’s (1932) record of *Philippia oleae* (Costa) was a misidentification and should refer to *Filippia follicularis* (Ben-Dov *et al.*, 2014). Borg (1932) stated that the species was found “here and there on the olive tree in both islands; more frequent at St. Julian’s, Sliema and San Anton Gardens”. No Maltese specimens have been seen during the present work.

Lichtensia viburni Signoret, 1873

Borg (1932) said that *Lichtensia viburni* was present here and there on olive trees on both islands, more frequently in St. Julian’s, Sliema and San Anton Garden. Haber & Mifsud (2007) recorded it as widely distributed in the Maltese Islands.

Material examined: MALTA, Qawra, 16.ii.2012, 4 ♀♀ on *Olea europaea*, CM.

Parthenolecanium corni (Bouché, 1844)

Borg (1919) recorded this species as *Lecanium corni* and stated that it might be considered as one of the rarer species. Borg (1932) recorded it as *Eulecanium corni* and said that it was “an uncommon species occasionally met with on the Peach, *Maclura aurantiaca*, Rose and other non-specified host plants”. No Maltese specimens have been seen during the present work.

Parthenolecanium persicae (Fabricius, 1776)

Borg’s (1919) record of *Lecanium nigrofasciatum* Pergande was a misidentification of *P. persicae* (Ben-Dov *et al.*, 2014). Borg (1932) recorded it (as *Eulecanium persicae*) as rare in Malta, on peaches and nectarine at Attard, Lija, Birkirkara, Sliema and other non-specified localities.

Material examined: MALTA, Rabat, 13.vi.1994, 2 ♀♀ on *Morus* sp., JI; Qawra, 16.ii.2012, 5 ♀♀ on unidentified Fabaceae, CM.

***Protopulvinaria pyriformis* (Cockerell, 1894)**

Recorded by Mifsud & Porcelli (2011).

Material examined: MALTA, Vittoriosa, 16.ii.2012, 5 ♀♀ on *Hedera helix*, CM; Vittoriosa, 16.ii.2012, 3 ♀♀ on *Schefflera actinophylla*, CM; Floriana, St. Philip's Garden, 18.ii.2012, 2 ♀♀ on *H. helix*, CM; Attard, San Anton Gardens, 19.v.2012, on *Myrtus communis*, DM, GM & AR.

***Pulvinaria floccifera* (Westwood, 1870)**

Recorded by Borg (1932) as being frequent on orange and bay trees at San Anton Gardens and its neighbourhood in Spring and early Summer, but much less frequent later in the season.

Material examined: MALTA, Rabat, 12.iii.1994, 1 ♀ on *Pittosporum* sp., GW.

***Pulvinaria vitis* (Linnaeus, 1758)**

Borg (1919; 1922a: 595) recorded this species as occasionally present in vineyards. Borg (1932) indicated the species was rare, occurring on grape vines at Ġhajj Żnuber, Ġhajj Tuffieħa and Bahrija. It was recorded again by Saliba (1963) as fairly common on vines, and by Vella (1991). No Maltese specimens have been seen during the present work.

***Pulvinariella mesembryanthemi* (Vallot, 1829)**

Borg (1932) recorded this species as “common on *Mesembryanthemum acinaciforme* and other species, at Buskett, Floriana Gardens etc. Found also at Xlendi etc. in Gozo”. No Maltese specimens have been seen during the present work.

•*Rhizopulvinaria artemisiae* (Signoret, 1873)

Material examined: GOZO, Xlendi, 29.iv.2012, 12 ♀♀ on *Phagnalon rupestre*, SM.

***Saissetia coffeae* (Walker, 1852)**

Borg (1898; 1919) recorded this species as *Lecanium hemisphaericum* Targ. and Borg (1932) as *Saissetia hemisphaerica* (Targioni Tozzetti). The latter report stated that it is “frequent, and often common, on *Schinus molle*, *Antigonon leptopus*, species of *Begonia* and *Aralia*, Ferns, *Cestrum fastigiatum*, *Cycas revoluta*, etc. Rare on Citrus trees.” Saliba (1963) recorded it as fairly common on citrus. Ferns are a favoured host of this insect.

Material examined: MALTA, Bir id-Deheb, 27.iii.1994, 1 ♀ on *Dieffenbachia* sp., DM; Żejtun, 13.xi. 2004, 2 ♀♀ on *Phalenopsis* sp., DM; Qawra, 12.ii.2012, 4 ♀♀ on *Olea europaea*, CM; Qawra, 13.ii.2012, 2 ♀♀ on *Adiantum capillus-veneris*, CM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 5 ♀♀ on *A. capillus-veneris*, DM.

***Saissetia oleae* (Olivier, 1791)**

Borg (1898; 1919) recorded this species (as *Lecanium oleae*) as an important pest affecting citrus and to a lesser extent olive cultivation. Borg (1922a: 83) wrote that this scale was “very common everywhere in our groves, and is also found on the Olive, stone-fruit-trees, and many ornamental trees and shrubs, as well as on Capsicums and

other annuals” and was also found on pear growing near citrus (Borg, 1922a: 242) and on cherries (Borg, 1922a: 381). Borg (1932) described *S. oleae* as very common on citrus and olive trees, *Cycas revoluta*, *Abutilon*, *Hibiscus*, *Myrtus*, *Nerium oleander*, *Pistacia lentiscus*, *P. terebinthus*, *Punica granatum*, and other non-specified host plants. Saliba (1963) stated that it was very common on orange, fairly common on other citrus, apple, pear, olive, cherry and mulberry. More recently, it was recorded again by Farrugia (1998), Haber & Mifsud (2007) & Mifsud *et al.* (2012).

Material examined: MALTA, Rabat, Buskett, 9.iii.1994, 1 ♀ on *Olea europaea*, DM; Żejtun, 10.iii.1994, 1 ♀ on *Citrus limon*, DM; Rabat, 12.iii.1994, 2 ♀♀ on *Pittosporum* sp., CC; Rabat, 12.iii.1994, 3 ♀♀ on *Cycas revoluta*, GW; Rabat, 12.iii.1994, 3 ♀♀ on *Euonymus* sp., CC; Marsa, 13.iii.1994, 1 ♀ on *Casuarina* sp., GW; Marsa, 13.iii.1994, 4 ♀♀ on *O. europaea*, BW; Marsa, 13.iii.1994, 1 ♀ on *Citrus* sp., GW; Mosta, 13.iii.1994, 4 ♀♀ on *Howeia foersteriana*, GW; Wied Babù, 17.vi.1994, 2 ♀♀ on *Rhamnus oleoides*, DM; Marsa, Għammieri, 7.xi.1996, 6 ♀♀ on *O. europaea*, CF; Marsa, Għammieri, 24.iii.1997, 4 ♀♀ on *O. europaea*, CF; Qawra, 14.ii.2012, 2 ♀♀ on *Nerium oleander*, CM; Mdina, 15.ii.2012, 2 ♀♀ on *O. europaea*, CM; Qawra, 14.ii.2012, 2 ♀♀ on *O. europaea*, CM; Attard, San Anton Gardens, 19.v.2012, 2 ♀♀ on *Myrtus communis*, AR, GM & DM. GOZO, Victoria, 17.ii.2012, 2 ♀♀ on *Nerium oleander*, CM.

Family Diaspididae Targioni Tozzetti, 1868

Adiscodiaspis ericicola (Marchal, 1909)

Recorded by Borg (1932) as being frequently found on *Erica multiflora* at Buskett, Wardija and Wied Incita. No Maltese specimens have been seen during the present work.

Aonidia lauri (Bouché, 1833)

Recorded by Borg (1932) as being frequently or commonly found wherever *Laurus nobilis* grows.

Material examined: MALTA, Buskett, 24.iii.1994, 2 ♀♀ on *Laurus nobilis*, MS; Valletta, Upper Barrakka Gardens, 13.ii.2012, 7 ♀♀ on *L. nobilis*, CM; Qawra, 14.ii.2012, 10 ♀♀ on *L. nobilis*, CM.

Aonidia ? mediterranea (Lindinger, 1910)

Recorded as *Aonidia ? mediterranea* by Nucifora & Watson (2001) from material collected by DM on *Cupressus sempervirens*, in Mosta, Malta, 13.iii.1994.

Aonidiella aurantii (Maskell, 1879)

First reported as occurring in Malta by Leonardi (1920). Borg (1932) wrote that this species seemed to be of recent importation and was frequently found on citrus trees. It was also recorded by Saliba (1963) (as *Anidiella aurantii*) as common on oranges, and again by Farrugia (1998).

Material examined: MALTA, Żejtun, 10.iii.1994, 1 ♀ on *Citrus limon*, DM; Mosta, 13.iii.1994, 3 ♀♀ on *Ficus carica*, DM; Marsa, 13.iii.1994, 3 ♀♀ on *Citrus* spp., DM; Marsa, Għammieri, 24.ii.1997, 1 ♀ on *Morus* sp., CF; Valletta, 13.ii.2012, 2 ♀♀ on *Euonymus japonica*, CM; Floriana, 13.ii.2012, 2 ♀♀ on *E. japonica*, CM; Bugibba, 14.ii.2012, 8 ♀♀ on *E. japonica*, *Rosa* sp. and *C. sinensis* CM; Mdina, 15.ii.2012, 8 ♀♀ on *C. sinensis* and *C. limon*, CM; Attard, San Anton Gardens, 19.v.2012, 5 ♀♀ on *Citrus* sp., AR, DM & GM.

Aspidiotus hedericola Leonardi, 1918

Recorded from the Maltese Islands for the first time in FaEu (Danzig & Watson, 2014), based on the material listed below.

Material examined: GOZO, Xewkija, 16.iii.1994, 3 ♀♀ on *Hedera helix*, DM.

Aspidiotus nerii Bouché, 1833

Borg (1898; 1919) recorded this species under three different names: *Aspidiotus hederæ*, *A. limon* and *A. nerii*. Borg (1922a: 77, 242, 337, 381) recorded it (as *Aspidiotus limonii* Signoret) being “very prevalent in our Citrus groves; as common on pear; a frequent source of trouble on our peach and nectarine trees; and as common on cherries”. Borg (1932) recorded this species as “very common on ivy, oleander, acacias, olive trees, carob trees, lemon trees, cycads, agave, roses, caper bush, etc”. It was also recorded by Saliba (1963) as common on almond, cherry, citrus, carob, mulberry, peach, pear and plum. Haber & Mifsud (2007) said that the scale was rather frequent on Malta, Gozo and Comino.

Material examined: MALTA, Buskett, 9.iii.1994, 3 ♀♀ on *Olea europaea*, DM; Rabat, 12.iii.1994, 1 ♀ on *Pittosporum* sp., GW; Mosta, 12.iii.1994, 2 ♀♀ on *O. europaea*, SC; Mosta, 13.iii.1994, 5 ♀♀ on *O. europaea*, BW; Mosta, 13.iii.1994, 7 ♀♀ on *Dracaena*, GW; Burmarrad, 14.iii.1994, 4 ♀♀ on *Chamaerops*, DM; Mosta, 16.iii.1994, 2 ♀♀ on *Pittosporum* sp., GW; Mistra Valley, 24.iv.1994, 2 ♀♀ on *Ceratonia siliqua*, DM; Mosta, 23.vi.1994, 3 ♀♀ on *Asparagus* sp., DM; Mosta, 23.vi.1994, 2 ♀♀ on *Hedera helix*, DM; Marsa, Għammieri, 7.xi.1996, 4 ♀♀ on *O. europaea*, CF; Wied Has-Sabtan, 20.xii.1996, 6 ♀♀ on *Teucrium flavum*, DM; Marsa, Għammieri, 24.ii.1997, 4 ♀♀ on *Morus* sp., CF; Rabat, 12.iii.1994, 7 ♀♀ on *Euonymus* sp., CC; Marsa, Għammieri, 9.i.1999, 1 ♀ on *Ceratonia siliqua*, CF; Marsa, Għammieri, 23.ii.2007, 5 ♀♀ on *O. europaea*, DM; Qawra, 12.ii.2012, 6 ♀♀ on *O. europea* and *Pittosporum tobira*, CM; Valletta, Upper Barrakka Gardens, 13.ii.2012, 2 ♀♀ on *P. tobira*, CM; Valletta, St. John Square, 13.ii.2012, 2 ♀♀ on *Strelitzia*, CM; Qawra, 14.ii.2012, 6 ♀♀ on *Nerium oleander* and *Cycas revoluta*, CM; Mdina, 15.ii.2012, 4 ♀♀ on *O. europaea*, CM; Vittoriosa, 16.ii.2012, 12 ♀♀ on *O. europaea*, *Hedera helix* and *Yucca* sp., CM; Floriana, St. Philip's Garden, 18.ii.2012, 4 ♀♀ on *Nerium oleander*, CM; Sliema, 18.ii.2012, 2 ♀♀ on *Strelitzia*, CM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 3 ♀♀ on *Howardia*, JC; Xewkija, 16.iii.1994, 9 ♀♀ on *Erica multiflora*, DM.

Aulacaspis rosae (Bouché, 1833)

Recorded by Borg (1932) as frequent and injurious on roses, particularly on climbers. No Maltese specimens have been seen during the present work.

Carulaspis juniperi (Bouché, 1851)

Borg (1932) recorded this species (as *Diaspis visci* (Schr.) Linding.) as frequent on *Cupressus sempervirens*, *Juniperus virginiana*, *Callitris quadrivalvis* and *Thuja occidentalis*. It was also recorded by Danzig & Pellizari (1998), who gave no further details.

Material examined: MALTA, Mosta, 13.iii.1994, 3 ♀♀ on *Cedrus atlantica*, GW.

Carulaspis minima (Signoret, 1869)

Recorded by Danzig & Watson (2014) as present in Malta, based on the first sample listed below.

Material examined: MALTA, Mosta, 13.iii.1994, 8 ♀♀ on *Cupressus sempervirens*, DM; Dingli, 13.vi.1994, 4 ♀♀ on *C. sempervirens*, DM; Marsa, Għammieri, 7.xi.1996, 4 ♀♀ on *C. sempervirens*, CF; Marsa, Għammieri, 15.ii.1997, 5 ♀♀ on *C. sempervirens*, DM; Valletta, St. John Square, 13.ii.2012, 2 ♀♀ on *C. sempervirens*, CM; Bugibba, 14.ii.2012, 8 ♀♀ on *C. sempervirens*, CM; Qawra, 14.ii.2012, 14 ♀♀ on *Thuja* sp., CM; Qawra, 14.ii.2012, 12 ♀♀ on *C. sempervirens*, CM; Rabat, 15.ii.2012, 6 ♀♀ on *C. sempervirens*, CM; Floriana, St. Philip's Garden, 18.ii.2012, 11 ♀♀ on *C. sempervirens*, CM. GOZO, Victoria, 17.ii.2012, 22 ♀♀ on *C. sempervirens*, CM.

● *Chionaspis etrusca* Leonardi, 1908

Material examined: MALTA, Marsaxlokk, 17.v.2012, 5 ♀♀ on *Tamarix africana*, DM, AR & GM.

***Chionaspis salicis* (Linnaeus, 1758)**

Recorded by Borg (1932) as frequent on *Salix* spp., *Populus* spp., *Pyrus sorbus*, *Fraxinus excelsior* and *Ulmus* spp. No Maltese specimens have been seen during the present work.

***Chrysomphalus aonidum* (Linnaeus, 1758)**

Reported by Saliba (1963) as fairly common on citrus.

Material examined: MALTA, Żejtun, 24.ii.2007, 9 ♀♀ on *Citrus limon*, DM; Żejtun, 2.ii.2007, 3 ♀♀ on *C. aurantium*, DM; Vittoriosa, 16.ii.2012, 5 ♀♀ on *Ficus benjamina*, CM.

***Chrysomphalus dictyospermi* (Morgan, 1889)**

Borg (1919; 1922a: 78) wrote that “this scale has been introduced in Malta from Catania (Sicily) in 1911 on rose-bushes and other ornamental plants, and in three or four years it has spread with marvellous rapidity to most groves and gardens in the island”. Borg (1922a: 242) said that it was often troublesome to pear cultivation. Borg (1932) stated that it was especially injurious to lemon trees and roses, often killing them, and that it was also frequent on Gozo. Saliba (1963) recorded this species as common on citrus and occasional on pear.

Material examined: MALTA, Mosta, 12.iii.1994, 2 ♀♀ on *Citrus sinensis*, SC; Marsa, Għammieri, 13.iii.1994, 5 ♀♀ on *C. sinensis* and *C. auranti*, DM; Vittoriosa, 16.ii.2012, 5 ♀♀ on *Ficus benjamina*, CM.

***Diaspidiotus ostreaeformis* (Curtis, 1843)**

Recorded by Borg (1932) (as *Aspidiotus ostreaeformis*) as common on *Populus alba*, *Morus papyrifera*, *M. alba*, *M. nigra*, *Crataegus oxyacantha*, *C. azalorus*, *Ficus carica*, *F. elastica*, *F. dealbata*, *Acacia cyanophylla*, *A. saligna*, *A. eburnean* and *Wigandia caracasana*. Saliba (1963) recorded this scale as occasional on fig and mulberry. No Maltese specimens have been seen during the present work.

***Diaspidiotus pyri* (Lichtenstein, 1881)**

Borg (1932) recorded this species (as *Aspidiotus pyri*) as infrequent on apple and pear trees at Balzan, Lija and Attard. No Maltese specimens have been seen during the present work.

***Diaspidiotus viticola* (Leonardi, 1913)**

Reported by Saliba (1963) as occasional on grape vines. No Maltese specimens have been seen during the present work.

***Diaspis boisduvalii* Signoret, 1869**

This scale was recorded from Malta by Danzig & Pellizzari (1998); no further details were provided.

Material examined: MALTA, Qawra, 12.ii.2012, 4 ♀♀ on unhealthy palm, CM.

***Diaspis bromeliae* (Kerner, 1778)**

Diaspis bromeliae was recorded from Malta by Danzig & Pellizzari (1998), who did not provide any collection details. No Maltese specimens have been seen during the present work.

***Diaspis echinocacti* (Bouché, 1833)**

Recorded by Borg (1932) (as *Diaspis calyptroides* Costa), occurring on *Cereus peruvianus*, *C. grandiflorus*, *C. macdonaldi*, *Echinopsis eyriesii* and various species of *Opuntia*.

Material examined: MALTA, Siggiewi, 19.iii.1994, 2 ♀♀ on *Zygocactus truncatus*, SA; Gharghur, 11.viii.1994, 11.viii.1994, 3 ♀♀ on *Opuntia* sp., DM; Qawra, 17.ii.2012, 5 ♀♀ on *Opuntia* sp., CM.

***Duplachionaspis berlesii* (Leonardi, 1898)**

Borg (1932) recorded this species (as *Chionaspis berlesei* Leon.) on *Asparagus aphyllus*, *A. acutifolius* and *Smilax aspera*, from Wied Incita, Iklin, Wied il-Ghasel on Malta; and from Mgarr ix-Xini, Ta' Cenc and Nadur on Gozo. No Maltese specimens have been seen during the present work.

•*Duplachionaspis sicula* (Lupo, 1938)

Material examined: MALTA, Wied il-Ghasel, 19.i.1997, 4 ♀♀ on *Hyporrhena huta*, CF.

***Epidiaspis leperii* (Signoret, 1869)**

Borg (1919) recorded this species as *Epidiaspis piricola* del Guercio and reported its presence in crevices and depressions of the bark of plums, peaches, apple and other fruit trees. It was recorded again by Borg (1932) (as *Diaspis leperii*) and Saliba (1963) on apple, pear and plum. No Maltese specimens have been seen during the present work.

***Fiorinia fioriniae* (Targioni Tozzetti, 1867)**

Borg (1922b; 1932) gave an account of the introduction of this species to Malta and recorded it on *Camellia japonica*, *Howeia* spp. and other palms, fruits and leaves of citrus, and on evergreen woody shrubs at the following localities: Argotti Botanical Gardens (Floriana), San Anton Gardens (Attard), Lija, Mosta and other non-specified locations.

Material examined: MALTA, Mosta, 13.iii.1994, 5 ♀♀ on *Camellia* sp., GW; Sliema, 2.xi.1995, 5 ♀♀ on *Strelitzia reginae*, EL; Attard, San Anton Gardens, 19.v.2012, 3 ♀♀ on *Howeia* sp., AR, DM & GM.

***Gonaspidotus minimus* (Leonardi in Berlese & Leonardi, 1896)**

Recorded by Borg (1932) (as *Hemiberlesia minima*), as frequently found on *Quercus ilex* at Buskett and Wardija. No Maltese specimens have been seen during the present work.

***Hemiberlesia cyanophylli* (Signoret, 1869)**

Recorded by Borg (1932) (as *Aspidiotus cyanophylli*) on *Annona cherimolia*, *Brachychiton populneum*, *Aralia veitchii*, *A. elegantissima*, *Monstera deliciosa*, *Anthurium* spp., *Cereus*, *Ficus altissima*, *F. rubiginosa*, and other non-specified greenhouse plants. The genus *Abgrallaspis* was synonymised under *Hemiberlesia* by Normark *et al.* (2014).

Material examined: MALTA, Sliema, 10.ii.2007, 3 ♀♀ on *Crassula* sp., DM. GOZO, Xewkija, 16.iii.1994, 4 ♀♀ on *Eriobotrya japonica*, DM; Xewkija, 16.iii.1994, 1 ♀ on *Hypericum aegypticum*, DM; Kercem, Dawara Valley, 16.iii.1994, 1 ♀ on *Laurus nobilis*, SA; Xlendi, 16.iii.1994, 5 ♀♀ on *H. aegypticum*, SA.

Hemiberlesia lataniae (Signoret, 1869)

Recorded by Borg (1932) as frequent on *Livistona chinensis*, *L. australis* and other palms.

Material examined: MALTA, Bir id-Deheb, 20.iii.1994, 5 ♀♀ on unidentified succulent plant, DM; Bir id-Deheb, 22.iv.1994, 2 ♀♀ on *Vitis vinifera*, DM; Bir id-Deheb, 22.iv.1994, 2 ♀♀ on *V. vinifera*, DM; Marsa, Għammieri, 24.ii.1997, 4 ♀♀ on *Morus* sp., CF; Valletta, Upper Barrakka Gardens, 13.ii.2012, 2 ♀♀ on *Cycas revoluta*, CM; Qawra, 14.ii.2012, 4 ♀♀ on *C. revoluta*, CM; Qawra, 15.ii.2012, 6 ♀♀ on *Ficus carica*, CM; Qawra, 16.ii.2012, 22 ♀♀ on bark of *Lonicera implexa*, CM; Qawra, 16.ii.2012, 3 ♀♀ on *Olea europaea*, CM; Vittoriosa, 16.ii.2012, 14 ♀♀ on *Hedera helix* and *Yucca* sp., CM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 5 ♀♀ on *Laurus nobilis*, SA; Xewkija, 16.iii.1994, 5 ♀♀ on *Eriobotrya japonica*, GW.

Hemiberlesia rapax (Comstock, 1881)

Borg (1919) recorded this species (as *Aspidiotus rapax*), as having “appeared in Malta quite recently on some vegetable marrow, in the vicinity of Hamrun, and was probably imported from Sicily”. Recorded also by Farrugia (1998) and Haber & Mifsud (2007); the latter reported large numbers of this scale on the stems of olives.

Material examined: MALTA, Rabat, 12.iii.1994, 7 ♀♀ on *Euonymus* sp., CC.

Lepidosaphes beckii (Newman, 1869)

Borg (1898; 1919) recorded this scale under the names *Mytilaspis citricola* Pachard and *M. flavescens*. Borg (1922a: 82) wrote that the scale had been “established in these islands since 1870–73. When this parasite first made its appearance in Malta, it caused a great deal of uneasiness, many [Citrus] groves suffering severely and becoming unproductive, and numbers of young trees as well as trees in full bearing were killed or became too much exhausted to be retained”. Recorded also by Saliba (1963) as occasional on orange, and by Farrugia (1998).

Material examined: MALTA, Marsa, Għammieri 3.iv.1999, 2 ♀♀ on *Citrus aurantii*, CF; Marsa, Għammieri, 6.iii.1997, 1 ♀ on *C. aurantii*, CF; Żurrieq, 17.ii.2007, 1 ♀ on *Citrus* sp., DM; Bugibba, 14.ii.2012, 8 ♀♀ on *C. sinensis*, CM; Luqa, 19.ii.2012, 2 ♀♀ on *C. limon*, CM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 2 ♀♀ on *C. sinensis*, GW; Vittoriosa, 26.ii.1995, 1 ♀ on *Citrus* sp., DM.

Lepidosaphes conchiformis (Gmelin, 1790)

Borg (1932) recorded this species (as *Lepidosaphes ficifoliae*), as “very common on the lower surface of the leaves of the common fig (*Ficus carica*) and also of *Ficus Pseudo-carica* and *Ficus Parcelli*”, whereas Saliba (1963) indicated it was uncommon, occurring mostly on fig. More recently, Mifsud *et al.* (2012) confirmed the presence of this species on both Malta and Gozo.

Material examined: MALTA, Valletta, 13.ii.2012, 10 ♀♀ on bark of *Ficus* sp., CM; Qawra, 15.ii.2012, 22 ♀♀ on *F. carica*, CM.

Lepidosaphes gloverii (Packard, 1869)

Recorded by Farrugia (1998).

Material examined: MALTA, Żejtun, 10.iii.1994, 12 ♀♀ on *Citrus limon*, DM; Żejtun, 11.iii.1994, 3 ♀♀ on *C. sinensis*, DM; Mosta, 12.iii.1994, 2 ♀♀ on *C. sinensis*, MS; Marsa, Għammieri, 6.iii.1997, 1 ♀ on *C. aurantium*, CF; Marsa, Għammieri, 3.iv.1997, 1 ♀ on *C. aurantium*, CF; Marsa, Għammieri, 3.iv.1999, 6 ♀♀ on *C. aurantium*, CF; Żurrieq, 17.ii.2007, 2 ♀♀ on *C. sinensis*, DM; Bugibba, 14.ii.2012, 8 ♀♀ on *C. sinensis*, CM; Mdina, 15.ii.2012, 7 ♀♀ on *C. sinensis*, CM.

● ***Lepidosaphes juniperi* Lindinger, 1912**

Material examined: MALTA, Rabat, 15.ii.2012, 12 ♀♀ on *Cupressus sempervirens*, CM.

***Lepidosaphes ulmi* (Linnaeus, 1758)**

Apart from the above name, Borg (1919) recorded this species also as *Mytilaspis pomporum* Bouché, a name which was also used by Borg (1922a: 242), who wrote that this scale was frequently found on pear trees growing in sheltered and shaded situations. Borg (1932) recorded it as very common on citrus, less frequent on pears and apples and rare on plums; whereas Saliba (1963) wrote that it was common on apple, pear and plum and fairly common on citrus.

Material examined: MALTA, Mosta, 13.iii.1994, 2 ♀♀ on *Ficus carica*, DM.

***Leucaspis pini* (Hartig, 1839)**

Recorded by Borg (1932) as very common on *Pinus halepensis*, *P. pinea* and other *Pinus* species. No Maltese specimens have been seen during the present work.

***Leucaspis pusilla* Löw, 1883**

Recorded by Borg (1932) as frequent at Buskett and Addolorata Cemetery on *Pinus halepensis*, *P. pinea* and *P. canariensis*.

Material examined: MALTA, Mosta, 13.iii.1994, 11 ♀♀ on *Pinus* sp., DM; Qawra, 14.ii.2012, 22 ♀♀ on *Pinus* sp., CM; Rabat, 15.ii.2012, 8 ♀♀ on *Pinus* sp., CM; Floriana, St. Philip's Garden, 18.ii.2012, 4 ♀♀ on *Pinus* sp., CM.

***Leucaspis riccae* Targioni Tozzetti, 1881**

First reported from Malta by Leonardi (1920). Borg (1932) recorded this species as found "here and there; on olive trees at Boschetto, San Antonio, Vallone Lia, Notabile, etc". It was recorded again by Saliba (1963) as being occasionally found on olives, also by Haber & Mifsud (2007) and Mifsud *et al.* (2012).

***Melanaspis inopinata* (Leonardi, 1913)**

Recorded by Borg (1932) (as *Aonidiella inopinata*), as occasionally found here and there on pear and apple trees. No Maltese specimens have been seen during the present work.

● ***Oceanaspidiotus spinosus* (Comstock, 1883)**

This species tends to occur on plants in nurseries.

Material examined: MALTA, Sliema, 10.ii.2007, 5 ♀♀ on *Crassula portulacea*, DM.

***Parlatoria camelliae* Comstock, 1883**

Recorded by Borg (1932) (as *Parlatoria pergandii* var. *camelliae*) as frequent on citrus trees and *Camellia japonica*. No Maltese specimens have been seen during the present work.

***Parlatoria oleae* (Colvée, 1880)**

Recorded by Borg (1932) as very frequent on olive, plum, almond, *Jasminum officinale* and *J. azoricum*. Saliba (1963) recorded it as common on olive, almond and plum. No Maltese specimens have been seen during the present work.

***Parlatoria pergandii* Comstock, 1881**

Borg (1898) recorded this species as a recent introduction from Italy, and as being present only in some orange groves at “Casal Lia”. Borg (1919) wrote that it “is rarely met with on wild plants and its ravages in Malta are limited to a few localities in the central parts of the island”. Borg (1922a: 79) said that this “scale has now spread to most [Citrus] groves of the Island, but so far not given cause of complaint”. It was recorded again by Saliba (1963) as common on citrus, and by Farrugia (1998).

Material examined: MALTA, Żejtun, 11.iii.1994, 6 ♀♀ on *Citrus sinensis*, DM; Marsa, Għammieri, 5.iii.1999, 2 ♀♀ on *C. aurantium*, CF; St. Paul’s Bay, 22.i.1999, 6 ♀♀ on *C. limon* and *C. aurantium*, CF; Bugibba, 14.ii.2012, 3 ♀♀ on *C. sinensis*, CM; Mdina, 15.ii.2012, 8 ♀♀ on *C. limon* and *C. sinensis*, CM; Qawra, 16.ii.2012, 4 ♀♀ on ? *Viburnum* sp., CM. GOZO, Vittoriosa, 26.ii.1995, 3 ♀♀ on *Citrus* sp., DM.

***Parlatoria ziziphi* (Lucas, 1853)**

Recorded by Borg (1898; 1919; 1922b) as *Parlatoria lucasi* Targ-Tozz. The latter two works stated that the species was spreading all over both islands and that there was no orange tree which was not infested. Borg (1922a: 80) wrote that “this scale insect appeared for the first time in Malta in 1892, in certain orange groves at “Casal Lia”, having been imported from Palermo along with a collection of ornamental varieties of citrus trees. Its dissemination was overlooked for the first three years, but soon after the infection began to spread rapidly, and orange merchants refused to purchase the unsightly fruit”. It was also recorded by Borg (1932), Saliba (1963) and Farrugia (1998).

Material examined: MALTA, Mosta, 12.iii.1994, 2 ♀♀ on *Citrus sinensis*, SC; Mosta, 13.iii.1994, 4 ♀♀ on *Citrus* sp., GW; Bugibba, 14.ii.2012, 10 ♀♀ on *C. sinensis*, CM; Mdina, 15.ii.2012, 4 ♀♀ on *C. sinensis*, CM.

***Pinnaspis aspidistrae* (Signoret, 1869)**

Recorded by Borg (1932) (as *Hemichionaspis aspidistrae*), as frequently found on *Aspidistra elatior*. *Aspidistra* and *Ophiopogon* are favoured hosts. No material of this polyphagous species has been collected during this study and the possibility that it has died out of the Maltese Archipelago is not excluded.

***Pseudaulacaspis pentagona* (Targioni Tozzetti, 1886)**

Borg (1922a: 76, 167) wrote about the introduction of this scale to Malta in 1912 with ornamental shrubs brought over from Sicily; early action was taken and the insect was completely eradicated. He also said that “this is a solitary case of an insect parasite introduced in these islands and stamped out at once by human agency before it could spread and become established”. Strangely enough, in the same year Borg (1922b) then provided detailed information on the introduction of this species to Malta, which he first observed in May at Attard and Lija. The infestation was so severe, affecting different host-plants, and much more widespread in both Malta and Gozo, that he even said that probably the insect must have been present in Malta for at least six or seven years. He made no cross reference to what he had written in Borg (1922a); apparently the above-mentioned eradication campaign in 1912 was not as effective as Borg had described. Borg (1932) recorded this species (as *Aulacaspis pentagona*) as frequent or common on peach, nectarine, almond, plum, white and black mulberry, paper mulberry, citrus and rose; whereas Saliba (1963) reported the scale as common on almond, citrus, peach and mulberry.

Material examined: MALTA, Marsa, Għammieri, 15.iii.1994, 3 ♀♀ on *Geranium* sp., DM; Lija, 18.iii.1994, 4 ♀♀ on *Pelargonium* sp., DM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 1 ♀ on *Coprosina* sp., DM.

***Targionia vitis* (Signoret, 1876)**

Recorded by Borg (1932) as found here and there on grape vines. Vella (1991) stated that it was still not clear whether or not this species had already been introduced to Malta. Danzig (1993) and Borchsenius (1966) both listed Malta in the distribution of *T. vitis*, but gave no further locality or other source details.

Material examined: MALTA, Buskett, 8.vii.1994, 3 ♀♀ on *Quercus ilex*, DM; Marsaxlokk, 17.v.2012, 3 ♀♀ on *Q. ilex*, DM, AR & GM. GOZO, Victoria, 17.ii.2012, 4 ♀♀ on *Q. ilex*, CM.

***Unaspis euonymi* (Comstock, 1881)**

Recorded by Borg (1932) (as *Chionaspis evonymii*), as frequently found on *Euonymus japonica* and *Aspidistra elatior*. No Maltese specimens have been seen during the present work.

***Voraspis ceratoniae* (Marchal, 1904)**

Recorded by Saliba (1963) (as *Chionaspis ceratoniae*), as fairly common on carob. No Maltese specimens have been seen during the present work.

Family Eriococcidae Cockerell, 1899

***Acanthococcus ericae* (Signoret, 1875)**

Recorded by Borg (1932) as occurring “here and there on *Erica multiflora* at Buskett, Wardija and Wied Incita”. Malta was also included in the distribution range of this species by Hoy (1963) and Kozár *et al.* (2013). No Maltese specimens have been seen during the present work.

***Anophococcus formicicola* (Newstead, 1897)**

Borg (1932) recorded this species (as *Eriococcus formicicola* [*sic.*]) as common on *Cynodon dactylon* on both Malta and Gozo. Hoy (1963) and Kozár *et al.* (2013) included Malta in the distribution range of this species. No Maltese specimens have been seen during the present work.

***Rhizococcus cactearum* (Leonardi, 1918)**

Recorded by Borg (1932) as frequently found on various species of *Mammillaria*, *Cereus*, *Echinocactus*, *Peleciphora* and other non-specified plants. Hoy (1963) and Kozár *et al.* (2013) included Malta in the distribution range of this species. No Maltese specimens have been seen during the present work.

***Rhizococcus devoniensis* Green, 1896**

Recorded by Köhler (1998), and Kozár *et al.* (2013) included Malta in the distribution range of this species; no further details were provided in either paper. No Maltese specimens have been seen during the present work.

***Uhlaria araucariae* (Maskell, 1879)**

Borg (1919; 1932) recorded this species (as *Eriococcus araucariae*) as being frequently found on *Araucaria excelsa*, and that young trees often succumb to heavy attacks. Hoy (1963) and Kozár *et al.* (2013) included Malta in the distribution range of this species.

Material examined: GOZO, Kercem, Dawara Valley, 16.iii.1994, 8 ♀♀ on *Araucaria excelsa*, DM.

Family Kermesidae Signoret, 1875

• *Kermes vermilio* Planchon, 1864

Material examined: MALTA, Buskett, 9.iii.1994, 5 first-instar larvae on *Quercus ilex*, GW; Floriana, 5.iv.1995, 12 first-instar larvae on *Q. ilex*, DM; Buskett, 18.v.2012, numerous ♀♀ on *Q. ilex*, AR, DM & GM.

Family Margarodidae Morrison, 1927

Dimargarodes mediterraneus (Silvestri, 1908)

Borg (1932) recorded this species (as *Margarodes mediterraneus* Silvestri) as being “frequent on the rhizomes of couch-grass (*Cynodon dactylon*) in many localities in Malta and probably also in Gozo”. No Maltese specimens have been seen during the present work.

Family Micrococcidae Silvestri, 1939

• *Micrococcus* sp.

The identification of this material to species level is still underway; more material is required to understand variation in this population.

Material examined: MALTA, Migra Ferħa, 26.xii.1994 and 20.xii.1996, 6 ♀♀ on roots of Graminaceae, DM.

Family Monophlebidae Morrison, 1927

Gueriniella serratulae (Fabricius, 1775)

Recorded by Borg (1932) (as *Monophaebus serratulae* (Fab.) Leon.) [*sic.*] as common on thistles and other non-specified plants at St. Julian’s and Salina in Malta.

Material examined: MALTA, 1910, 3 ♀♀ on “thistle-like plant” (BMNH).

Icerya purchasi Maskell, 1879

First intercepted at Malta in 1907, on ornamental plants coming from Sicily. The scale was first noticed in some gardens in St. Julian’s, from where it rapidly spread to Sliema and Msida; in two to three years it was well established everywhere in Malta and Gozo (Borg, 1919; 1922a: 86; Mifsud & Watson, 1999; Dandria, 2010). Borg (1932) recorded the species on citrus, *Acacia*, *Pittosporum tobira*, rose trees, *Robinia pseudo-acacia*, *Caesalpinia sappan* and many other non-specified plants. It was also recorded by Saliba (1963) as “very common on citrus, less so on pear and mulberry”, and by Vella (1991).

Material examined: MALTA, Mosta, 13.iii.1994, 2 ♀♀ on *Rosmarinus officinalis*, GW; Mosta, 13.iii.1994, 1 ♀ on *Pittosporum tobira*, GW; Mgarr, 14.iii.1994, 1 ♀ on *Pistacia lentiscus*, DM; Marsa, Għammieri, 12.iii.1994, 1 ♀ on *Artemisia vulgaris*, CF; Qawra, 14.ii.2012, 2 ♀♀ on *Pittosporum tobira*, CM; Valletta, 13.ii.2012, 1 ♀ on *P. tobira*, CM; Bugibba, 18.ii.2012, 5 ♀♀ on *Citrus sinensis*, CM; Mdina, 19.ii.2012, 2 ♀♀ on *C. sinensis*, CM; Qawra, 19.ii.2012, 2 ♀♀ on *Rosa* sp., CM; Luqa, 2 ♀♀ on *P. tobira*, CM. GOZO, Kercem, Dawara Valley, 16.iii.1994, 2 ♀♀ on *Arisarum vulgare*, DM; Victoria, 15.ii.2012, 2 ♀♀ on *P. tobira*, CM.

Family Pseudococcidae Westwood, 1840

Amonostherium rorismarinis (Boyer de Fonscolombe, 1834)

Recorded by Borg (1932) (as *Eriococcus rorismarini* (Boyer de Fonscolombe)) as being frequent but nowhere

common on *Rosmarinus officinalis* and *Salvia officinalis*, from the following localities on Malta: Buskett, Bahrija and Ġnejna. No Maltese specimens have been seen during the present work.

● ***Atrococcus achilleae* (Kiritchenko, 1936)**

Material examined: MALTA, Ras il-Fenek, 20.iv.1995, 6 ♀♀ on *Darniella melitensis*, DM.

***Lacombia dactyloni* (Bodenheimer, 1943)**

This species was recorded from Malta under its synonym *Lacombia urbani* Boratynski, 1968 (Ben-Dov, 1990), which was described from material collected on Comino Island (Malta) in the nest of the ant *Tapinoma erraticum* (Boratynski, 1968).

Material examined: MALTA, Birzebbugia, Wied Has-Sabtan, 16.v.2012, 3 ♀♀ on roots of *Chiliadenus bocconeii*, DM.

● ***Peliococcus cycliger* (Leonardi, 1908)**

Material examined: MALTA, Ghajn Rihana, 18.v.2012, 4 ♀♀ on new shoots of *Olea europaea*, AR, DM & GM.

● ***Phenacoccus neohordei* Marotta, 1992**

The species was described from Italy and Sicily on the roots of an assortment of host plants.

Material examined: MALTA, St. Paul's Bay, 17.v.2012, 3 ♀♀ on roots of *Daucus carota*, AR, DM & GM; St. Paul's Bay, 19.v.2012, 6 ♀♀ on roots of *Urospermum picroides*, AR, DM & GM.

● ***Phenacoccus peruvianus* Granara de Willink in Granara de Willink & Szumik, 2007**

First record from the Maltese Islands of this Neotropical species, which was first introduced to Europe (Spain) in 1999 (Beltrà *et al.*, 2010) on nursery plants, and has spread since to the United Kingdom and several European countries in the Mediterranean basin (Beltrà *et al.*, 2010; Gkounti & Milonas, 2013).

Material examined: MALTA, Valetta, Upper Barrakka Gardens, 13.ii.2012, immatures on *Bougainvillea* sp., CM; Mdina, 15.ii.2012, immatures on *Bougainvillea* sp., CM; Qawra, 16/17.ii.2012, several adult ♀♀ on *Bougainvillea* sp., CM; Zejtun, 12.iv.2012, several adult ♀♀ on *Bougainvillea* sp., DM.

***Planococcus citri* (Risso, 1813)**

Borg (1898; 1919; 1922a: 86) recorded this species as *Dactylopius citri* Signoret and *D. destructor* Comstock. Borg (1922a: 86) wrote that "it cannot be described as very destructive to our groves...". He also recorded the mealybug from pear (Borg, 1922a: 242). Borg (1932) recorded it (as *Pseudococcus citri* (Risso)) as frequently and commonly found on citrus, *Erythrina corallodendron*, *Phaseolus caracalla* and on many other trees and shrubs in the Maltese Islands. Saliba (1963) stated that it was common on citrus, pear, grape vine and mulberry. It was also recorded by Vella (1991), Farrugia (1998) and Mifsud & Watson (1999) as occurring mainly on citrus.

Material examined. MALTA, Bir id-Deheb, 20.iii.1994, 9 ♀♀ on *Dieffenbachia* sp., DM; Marsa, Ghammieri, 12.ii.1997, on *Cucurbita* sp., GW; Marsa, Ghammieri, 12.ii.1997, 9 ♀♀ on *Urtica* sp., CF; Marsa, Ghammieri, 3.iv.1999, 3 ♀♀ on *Citrus aurantium*, CF; Luqa, 25.iii.1997, 8 ♀♀ on *Geranium* sp., CF; Siggiewi, 26.x.1997, 1 ♀, DM.

***Planococcus ficus* (Signoret, 1875)**

Borg (1919) recorded this species as *Dactylopius vitis* Niedl. Borg (1932) recorded it under two different names: *Pseudococcus vitis* (Mendel) Leon. and *P. ficus* Fern.. For *P. vitis*, he stated that it was found on grape vines at Wied Qannotta, Fiddien and other non-specified locations, and for the latter name he reported it as frequent on the fruit and foliage of the common fig. The species was reported again from Malta by Mifsud & Watson (1999) and Mifsud *et al.* (2012).

Material examined: MALTA, Bir id-Deheb, 22.iv.1994, 2 ♀♀ on *Vitis vinifera*, DM; Bingemma, 4.xii.2003, 2 ♀♀ on *V. vinifera*, DM; Siggiewi, 28.vii.2009, 5 ♀♀ on *Ceratonia siliqua*, DM.

● ***Planococcus vovae* (Nasonov, 1909)**

Material examined: MALTA, Dingli, 13.iv.1994, 8 ♀♀ on *Cupressus* sp., DM; Marsa, Għammieri, 15.v.1995, 2 ♀♀ on *Cupressus* sp., DM; Ta' Qali, 15.ix.1997, 4 ♀♀ on *Cupressus* sp., CF; Valletta, 15.ii.2012, 10 ♀♀ on *C. sempervirens*, CM.

***Pseudococcus longispinus* (Targioni Tozzetti, 1867)**

Recorded by Borg (1932) (as *Pseudococcus adonidum* (Targioni Tozzetti)) as common on many plants, especially in greenhouses. The species was reported again by Mifsud & Watson (1999), when extensive damage to *Citrus*, *Prunus* and *Ficus* spp. was observed, and by Mifsud *et al.* (2012).

Material examined: MALTA, Rabat, 12.iii.1994, 1 ♀ on *Euonymus* sp., CC; Rabat, 12.iii.1994, 4 ♀♀ on *Cycas revoluta*, GW; Żejtun, 29.iii.1994, 1 ♀ on *Ficus nitida*, DM; Mosta, 15.iv.1997, 1 ♀ on *C. revoluta*, CF; Marsa, Għammieri, 15.ix.1997, 4 ♀♀ on *C. revoluta*, CF; Valletta, Upper Barrakka Gardens, 12.ii.2012, 4 ♀♀ on *Pittosporum tobira*, CM; Qawra, 13.ii.2012, 11 ♀♀ on *Laurus nobilis*, *P. tobira*, *Nerium oleander*, *Schinus terebinthifolius*, *Viburnum* sp., *Bougainvillea* sp., CM. GOZO, Victoria, 16.iii.1994, 2 ♀♀ on *Coprosina* sp. DM; Kercem, Dawara Valley, 16.iii.1994, 5 ♀♀ on *Laurus nobilis*, SA; Victoria, 14.ii.2012, 3 ♀♀ on *P. tobira*, CM; Floriana, St. Philip's Garden, 18.ii.2012, 2 ♀♀ on *P. tobira*, CM.

● ***Pseudococcus viburni* (Signoret, 1875)**

The species often occurs on nursery stock, which may be how it reached the archipelago.

Material examined: MALTA, Siggiewi, 23.xii.1997, 1 ♀, in soil under *Ceratonia siliqua*, DM.

Family Putoidae Beardsley, 1969

● ***Puto palinuri* Marotta & Tranfaglia, 1993**

Material examined: MALTA, Buskett, 24.iii.1994, 1 ♀ on *Teucrium fruticans*, DM.

● ***Puto superbus* (Leonardi, 1907)**

Material examined: MALTA, Hagar Qim, 12.iv.1995, 3 ♀♀ on *Convolvulus elegantissimus*, DM.

Family Rhizoecidae Williams, 1969

***Rhizoecus falcifer* Kunckel d'Herculais, 1878**

Borg (1932) recorded this species as occurring on the roots of grape vines and *Convolvulus arvensis*; also on roots of roses and other plants grown in pots. No Maltese specimens have been seen during the present work.

***Ripersiella planetica* (Williams, 2004)**

Malumphy (2012) recorded this species from Malta on the roots of *Sonchus oleraceus*.

Scale insects erroneously recorded from Malta

Diaspididae

***Aonidia campylanthi* (Lindinger, 1911)**

Recorded by Danzig & Watson (2014) in FaEu, but since we have been unable to trace the original source or collect material of this species from Malta, we are excluding it from the Maltese scale insect fauna.

***Chionaspis furfura* (Fitch, 1857)**

Recorded by Borg (1919), but the record was not used in subsequent publications pertaining to scale insect studies from Malta except by Borg (1932), incorrectly, as a synonym of *C. salicis*. *C. furfura* is therefore here excluded from the Maltese fauna.

***Dynaspidiotus britannicus* (Newstead, 1898)**

This is probably an erroneous record based on a misidentification. Borg (1932) recorded this species (as *Aspidiotus britannicus*), as frequent in many places on *Pittosporum tobira*, *Viburnum tinus*, *Euonymus japonicus*, *Hedera helix* and others. However, there are no further records of this species from Malta and all recent records from the above-mentioned host-plants are *Aspidiotus nerii*. In addition, *D. britannicus* has never been recorded on either *Pittosporum* or *Euonymus*, whereas *A. nerii* has been recorded on all four of the above mentioned host plants. On the *Dynaspidiotus britannicus* catalogue page, ScaleNet (Ben-Dov *et al.*, 2014) says: “*Aspidiotus hederae*; Newstead, 1896: 279. Misidentification; discovered by Newstead, 1898: 94”. Since Borg (1932) included *Aspidiotus hederae* Newst. *non* Vallot as a synonym of *Aspidiotus britannicus*, it seems likely that he was following Newstead’s misidentification. *Dynaspidiotus britannicus* is therefore excluded from the Maltese scale insect fauna.

***Lepidosaphes flava* (Signoret, 1870)**

Recorded by Borg (1919), but this record was not used in subsequent publications pertaining to scale insect studies from Malta except by Borg (1932), incorrectly, as a synonym of *L. pinnaeformis*. *L. flava* has not been collected during this study either, so it is here excluded from the Maltese fauna.

***Lepidosaphes pinnaeformis* (Bouché, 1851)**

Lepidosaphes pinnaeformis has been confused with *L. beckii* in the past and much of the literature pertaining to *L. pinnaeformis* on citrus should refer to *L. beckii* (Ben-Dov *et al.*, 2014). Borg (1932) recorded this species as frequent on citrus trees and this record was the basis for the Malta record in the ScaleNet catalogue (Ben-Dov *et al.*, 2014), and probably also for the Malta record in Danzig & Watson (2014). It is worth mentioning that three of the four synonyms of *L. pinnaeformis* listed by Borg (1932) are incorrect and should refer to *L. beckii*. For these reasons, and because *L. pinnaeformis* was not collected in any of the recent surveys, this species is being removed from the Maltese fauna.

***Parlatoria proteus* (Curtis, 1843)**

Malta was included in the distribution of this species in the ScaleNet catalogue (Ben-Dov *et al.*, 2014) on the authority of Borg (1922), but he gave no precise indication of its occurrence in Malta (see Material and methods section). *Parlatoria proteus* was not listed by later workers studying the scale insect fauna of Malta (not even by John Borg himself), and the species has not been collected during this study, so it is here excluded from the Maltese fauna.

***Parlatoria theae* Cockerell, 1896**

Recorded by Danzig & Watson (2014) in FaEu, but since we have been unable to trace the original source or collect material of this species from Malta, we are excluding it from the Maltese scale insect fauna.

***Unaspis citri* (Comstock, 1883)**

This species was recorded from Malta in the FaEu database when it was compiled by E.M. Danzig and G.W. Watson in 2004, based on a record in the European Plant Protection Organization (EPPO) Plant Quarantine Database (EPPO, 2014). This important plant quarantine species was not collected in Malta during this study, despite repeated investigations, and we are of the opinion that the EPPO record is erroneous. For these reasons, *U. citri* is excluded from the Maltese scale insect fauna.

Coccidae

***Parasaissetia nigra* (Nietner, 1861)**

This species was listed as being present in Malta by Pellizzari & Germain (2010) in error (G. Pellizzari (University of Padova, Italy) and J-F. Germain (Laboratoire National de la Protection des Végétaux, Station de Montpellier, France), pers. comm.). The species is regulated in the European Union but has never been collected in the archipelago.

***Sphaerolecanium prunastri* (Boyer de Fonscolombe, 1834)**

Borg (1922a: 357) mentioned a species of *Lecanium*, probably *L. prunastri*, as common on plums and apricots in local orchards. Since this record was not mentioned in his subsequent work (Borg, 1932), and *S. prunastri* has not been collected in the Maltese Islands since, it is here excluded from the Maltese scale insect fauna.

Discussion

Of the 93 species listed as present in the Maltese Archipelago, 29 (31.18%) are probably indigenous and 64 (68.82%) are established introductions originating from elsewhere (based on distribution data in Ben-Dov *et al.* (2014) and information compiled by Pellizzari & Germain (2010)). This differs strongly from the continent of Europe as a whole, where the proportion of introduced species is only about 30% (Pellizzari & Germain, 2010).

The 29 species likely to be indigenous to the Maltese archipelago are listed in Appendix 1, of which 19 (65.52%) are confined to the Mediterranean basin; one (3.45%) can be considered as sub-endemic as it is only found in southern Italy (including Sicily) and Malta; three (10.34%) are known from the central to the eastern parts of the Mediterranean; one (3.45%) is confined to the eastern Mediterranean; two (6.90%) are Central European and present throughout the Mediterranean basin and another three (10.34%) are European with range extensions into the Mediterranean basin.

The 64 introduced scale insect species are listed in Appendix 2, of which five probably originated from Africa, nine from mainland Europe, 16 from Eurasia, 13 from East Asia or the Oriental Region, three from Australasia, and nine from the Neotropical Region. The origins of nine species are not known (cryptogenic).

The high proportion of introduced species (68.82%) reflects the long history of the Maltese Archipelago as a strategic and shipping centre, although many introductions have probably occurred since 1850 due to increased importation of live plants and fresh produce to supply the growing Maltese population and increasing tourism. Sicily, the nearest land mass, has a similarly high number of introduced scale insect species (68 species according to Mazzeo *et al.*, 2011); its close proximity to the Maltese Archipelago and frequent traffic and trade between them increases the probability of alien species introduction.

Several invasive species of mealybugs are extending their geographical range into the Mediterranean basin due to free trade in live plants and fresh produce. The Neotropical species *Phenacoccus peruvianus* was first found on Malta in 2012, and several other members of this genus from the New World are spreading into the region. In addition, several species of root mealybugs in the genera *Rhizoecus* and *Ripersiella* are established in Sicily (Ben-Dov *et al.*, 2014) and could easily enter the Maltese Archipelago on the roots of nursery stock.

Some invasive scale insect species that may be accidentally introduced to the Maltese Archipelago in the near future are listed in Table 1. Most of these species would present an economic or environmental threat to the Maltese archipelago if they were accidentally introduced. The following comments are based on information in Bartlett (1978); Rosen & DeBach (1978); McFadyen (1979); Gill (1993); Malumphy (1997); Kondo *et al.* (2002); EPPO (2003); Ben-Dov (2005); Wang *et al.* (2010); EFSA Panel on Plant Health (2013); Ben-Dov (2014); CABI (2014); and Malumphy (2014).

TABLE 1. Some invasive scale insect species that may be accidentally introduced to the Maltese Archipelago in the near future.

Family	Species	Type of plants impacted	Closest to Malta	References
Coccidae	<i>Ceroplastes japonicus</i> Green	Ornamental shrubs and trees including <i>Citrus</i> spp.	Italy	Kozár <i>et al.</i> (1984), Pellizzari & Germain (2010)
	<i>Neopulvinaria innumerabilis</i> (Rathvon)	Grape vines and maple trees	France, Italy	Hodgson (1994)
	<i>Parasaissetia nigra</i> Nietner	Ornamentals and fruit trees	Sicily, Italy	Marotta (1987)
Diaspididae	<i>Comstockaspis perniciosus</i> (Comstock) (= <i>Diaspidiotus perniciosus</i> based on Normark <i>et al.</i> , 2014)	Rosaceae, stone and pome fruit trees	Sicily, Italy	Pellizzari & Germain (2010)
Eriococcidae	<i>Acanthococcus coccineus</i> (Cockerell)	Cactaceae	Sicily, Italy	Marotta & Garonna (1992), Kozár <i>et al.</i> (2013)
Phoenicococcidae	<i>Ovaticoccus agavacearum</i> Pellizzari & Kozár	<i>Agave</i> spp.	Italy	Pellizzari & Kozár (2011)
	<i>Ovaticoccus agavium</i> (Douglas)	<i>Agave</i> spp.	France, Sicily, Italy	Longo <i>et al.</i> (1995), Kozár <i>et al.</i> (2013)
	<i>Ovaticoccus exoticus</i> Pellizzari & Kozár	<i>Agave</i> spp.	Sicily, Italy	Pellizzari & Kozár (2011)
Pseudococcidae	<i>Phoenicococcus marlatti</i> Cockerell	Palms	Sicily, Italy	Pellizzari & Germain (2010)
	<i>Hypogeococcus pungens</i> Granara de Willink ¹	Succulents and cacti	Sicily, Italy	Mazzeo <i>et al.</i> (2008)
	<i>Phenacoccus defectus</i> Ferris	Succulents and other plants, including Euphorbiaceae	Italy, France, United Kingdom	Pellizzari & Porcelli (2013), Germain & Matile-Ferrero (2006), Malumphy (1997)
	<i>Phenacoccus madeirensis</i> Green	Ornamental plants, vegetables and herbs, some fruit crops	Sicily, Italy, Crete	Russo & Mazzeo (1997), Longo <i>et al.</i> (1995), Jansen <i>et al.</i> (2010)
	<i>Phenacoccus solani</i> Ferris	Ornamentals, greenhouse and field crops especially Solanaceae	Sicily, Italy	Mazzeo <i>et al.</i> (1999), Pellizzari & Russo (2005)
	<i>Phenacoccus solenopsis</i> Tinsley	Ornamentals, field crops, especially Malvaceae	Egypt, Cyprus, Turkey	Kaydan <i>et al.</i> (2013), Abd-Rabou <i>et al.</i> (2010)
	<i>Pseudococcus calceolariae</i> Maskell	Ornamentals, pome fruit and <i>Citrus</i> trees	Sicily, Italy	Longo <i>et al.</i> (1995), Russo & Mazzeo (1997)
	<i>Trochiscococcus speciosus</i> (De Lotto)	Liliaceae <i>sensu lato</i>	France, Italy	Williams & Pellizzari (1997)

¹ Originally recorded as *Hypogeococcus festerianus* (Lizer y Trelles)

Fruit crops could be impacted by the accidental introduction of *Comstockaspis pernicios*a (Comstock) on stone and pome fruit and *Rubus* spp. (this scale is also known to damage *Ribes*, but this is not grown in Malta); *Pseudococcus calceolariae* Maskell on pome fruit and *Citrus*; *Ceroplastes japonicus* Green on *Citrus* and *Morus* spp.; *Parasaissetia nigra* Nietner on fruit trees including pomegranate and *Citrus* spp.; and *Neopulvinaria innumerabilis* (Rathvon) on grape vines, on which it is a vector of Grapevine Leafroll Virus 1 (GLRV-1) and Grapevine Virus A (GVA).

Ornamental plants could be impacted by introduction of the polyphagous *Pa. nigra*, *Phenacoccus solani* Ferris, *Ph. solenopsis* Tinsley and *Ph. madeirensis* Green, the latter species occurring particularly on *Lantana camara*, *Pelargonium* sp. and *Gerbera* sp.; *Ce. japonicus* on many ornamentals including *Nerium oleander*, which is widely cultivated in the Maltese archipelago; also by *Co. pernicios*a on rosaceous plants like *Crataegus* spp.; *Phoenicococcus marlatti* Cockerell on palms; *Ph. defectus* Ferris on ornamentals, particularly succulents including Crassulaceae and Euphorbiaceae; *Hypogeococcus pungens* Granara de Willink on succulents including cacti; *Acanthococcus coccineus* (Cockerell) on Cactaceae; *Ovaticoccus agavacearum* Pellizzari & Kozár, *O. agavium* (Douglas) and *O. exoticus* Pellizzari & Kozár on *Agave* spp.; and *Trochiscococcus speciosus* (De Lotto) on Liliaceae *sensu lato*—although the potential economic impact of the latter species is not known.

Crops in the Maltese archipelago could be impacted by introduced *Ph. solani*, particularly solanaceous crops in the field and under glass; *Ph. solenopsis* on field crops, particularly Malvaceae even though such crops (e.g. cotton and okra) which were widely cultivated in the past, are no longer grown in Malta; *Ph. madeirensis* in the field and under glass on *Capsicum* sp., legumes and herbs, and some fruit crops; and *Phoen. marlatti* on date palms, although the latter host is grown only as an ornamental and not for fruit production.

Lastly, native plants in the natural environment might be impacted by accidental introductions, e.g. *Co. pernicios*a on rosaceous plants like *Crataegus monogyna*, *Cr. azarolus*, their hybrid *Cr. x ruscionensis*, and *Rubus ulmifolius*; *Ph. defectus* on native euphorbiaceous shrubs such as the endemic *E. melitensis* as well as *E. dendroides* and the rare *E. characias*; and *Ce. japonicus* on *Laurus nobilis* and *Myrtus communis*.

Of the potential invasive species listed in Table 1, *Co. pernicios*a probably presents the greatest threat, potentially impacting fruit crops, ornamental and native plants. If introduced in the absence of its natural enemies this species can be highly destructive, although its impact can largely be minimised in the long term if biological control can be implemented successfully (Rosen & DeBach, 1978).

On the basis of the records assembled here, it is apparent that the movement of live fruit trees and ornamental plants into the Maltese Archipelago, particularly from Sicily, is the main route for entry of alien scale insects into the country. Since Sicily has 169 recorded species of scale insects (Mazzeo *et al.*, 2011), it is anticipated that more accidental introductions to the Maltese Archipelago are likely to occur in the future. Future introductions may present significant threats to crops, ornamental plants and the environment there.

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APPENDIX 1. Coccoidea occurring in the Maltese Archipelago that are probably indigenous, with their possible areas of origin, based on Ben-Dov *et al.* (2014).

Family	Species	Distribution
Aclerdidae	<i>Aclerda berlesii</i>	Mediterranean
Asterolecaniidae	<i>Asterodiaspis ilicicola</i>	Mediterranean
	<i>Pollinia pollini</i>	Mediterranean
Coccidae	<i>Filippia follicularis</i>	Mediterranean
Diaspididae	<i>Adiscodiaspis ericicola</i>	Mediterranean
	<i>Aonidia lauri</i>	Mediterranean
	<i>Aonidia mediterranea</i>	Mediterranean
	<i>Aspidiotus hedericola</i>	Mediterranean
	<i>Carulaspis juniperi</i>	European extending in Mediterranean
	<i>Carulaspis minima</i>	Mediterranean
	<i>Diaspidiotus viticola</i>	Mediterranean
	<i>Duplachionaspis berlesii</i>	Mediterranean
	<i>Duplachionaspis sicula</i>	Mediterranean
	<i>Gonaspidotus minimus</i>	Mediterranean
	<i>Leucaspis pini</i>	European extending in Mediterranean
	<i>Leucaspis pusilla</i>	European extending in Mediterranean
	<i>Leucaspis riccae</i>	Central and eastern Mediterranean
Eriococcidae	<i>Melanaspis inopinata</i>	Central and eastern Mediterranean
	<i>Targionia vitis</i>	Mediterranean and Central European
Eriococcidae	<i>Anophococcus formicicola</i>	Eastern Mediterranean
	<i>Rhizococcus cactearum</i>	Mediterranean
Kermesidae	<i>Kermes vermilio</i>	Mediterranean
Micrococcidae	<i>Micrococcus</i> sp.	Mediterranean
Monophlebidae	<i>Gueriniella serratulae</i>	Mediterranean
Pseudococcidae	<i>Lacombia dactyloni</i>	Central and eastern Mediterranean
	<i>Peliococcus cycliger</i>	Mediterranean
	<i>Phenacoccus neohordei</i>	Sub-endemic (southern Italy including Sicily and Malta)
Putoidae	<i>Puto palimuri</i>	Mediterranean
	<i>Puto superbus</i>	Mediterranean and Central European

APPENDIX 2. Coccoidea occurring in the Maltese Archipelago that are probably introduced, with their possible areas of origin, based on Ben-Dov *et al.* (2014) and Pellizzari & Germain (2010).

Family	Species	Distribution
Asterolecaniidae	<i>Bambusaspis bambusae</i> <i>Russellaspis pustulans</i>	Oriental Possibly Neotropical
Coccidae	<i>Ceroplastes floridensis</i> <i>Ceroplastes rusci</i> <i>Ceroplastes sinensis</i> <i>Coccus hesperidum</i> <i>Coccus longulus</i> <i>Eulecanium tiliae</i> <i>Lichtensia viburni</i> <i>Parthenolecanium corni</i> <i>Parthenolecanium persicae</i> <i>Protopulvinaria pyriformis</i> <i>Pulvinaria floccifera</i> <i>Pulvinariella mesembryanthemi</i> <i>Pulvinaria vitis</i> <i>Rhizopulvinaria artemisiae</i> <i>Saissetia coffeae</i> <i>Saissetia oleae</i>	Neotropical Neotropical Neotropical Cryptogenic Cryptogenic Europe Europe Europe Europe Possibly Oriental Eurasia Southern Africa Europe Europe Afrotropical Afrotropical
Diaspididae	<i>Aonidiella aurantii</i> <i>Aspidiotus nerii</i> <i>Aulacaspis rosae</i> <i>Chionaspis etrusca</i> <i>Chionaspis salicis</i> <i>Chrysomphalus aonidum</i> <i>Chrysomphalus dictyospermi</i> <i>Diaspis boisduvalii</i> <i>Diaspis bromeliae</i> <i>Diaspis echinocacti</i> <i>Diaspidiotus ostreaeformis</i> <i>Diaspidiotus pyri</i> <i>Epidiaspis leperii</i> <i>Fiorinia fioriniae</i> <i>Hemiberlesia cyanophylli</i> <i>Hemiberlesia lataniae</i> <i>Hemiberlesia rapax</i> <i>Lepidosaphes beckii</i> <i>Lepidosaphes conchiformis</i> <i>Lepidosaphes gloverii</i> <i>Lepidosaphes juniperi</i> <i>Lepidosaphes ulmi</i> <i>Oceanaspidotus spinosus</i> <i>Parlatoria camelliae</i> <i>Parlatoria oleae</i> <i>Parlatoria pergandii</i> <i>Parlatoria ziziphi</i> <i>Pinnaspis aspidistrae</i> <i>Pseudaulacaspis pentagona</i> <i>Unaspis euonymi</i> <i>Voraspsis ceratoniae</i>	East Asia Afrotropical Eurasia Eurasia Eurasia Neotropical Oriental Neotropical Neotropical Neotropical Eurasia Eurasia Eurasia Oriental Cryptogenic Cryptogenic Cryptogenic Cryptogenic Eurasia Cryptogenic Possibly Oriental Central Eurasia Cryptogenic Oriental Eurasia Cryptogenic Oriental Oriental Possibly Oriental East Asia North Africa
Eriococcidae	<i>Acanthococcus ericae</i> <i>Rhizococcus devoniensis</i> <i>Uhleria araucariae</i>	Europe Europe Australasia
Margarodidae	<i>Dimargarodes mediterraneus</i>	Eurasia

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APPENDIX 2.(Continued)

Family	Species	Distribution
Monophlebidae	<i>Icerya purchasi</i>	Australasia
Pseudococcidae	<i>Amonotherium rorismarinis</i>	South-West Europe
	<i>Atrococcus achilleae</i>	Eurasia
	<i>Planococcus citri</i>	Possibly Oriental
	<i>Planococcus ficus</i>	Possibly Eurasia
	<i>Planococcus vovae</i>	Eurasia
	<i>Phenacoccus peruvianus</i>	Neotropical
	<i>Pseudococcus viburni</i>	Possibly Eurasia
	<i>Pseudococcus longispinus</i>	Australasia
Rhizoecidae	<i>Rhizoecus falcifer</i>	Possibly Eurasia
	<i>Ripersiella planetica</i>	Possibly Oriental