Faunal review of the whiteflies of the Maltese Archipelago (Hemiptera, Aleyrodidae)

Chris MALUMPHY[1] & David MIFSUD[2]

ABSTRACT. The whiteflies (Hemiptera, Aleyrodidae) of the Maltese Archipelago are reviewed, including two Asian species, *Aleuroclava jasmini* and *Dialeurodes kirkaldyi* that are recorded from Malta for the first time. Forty percent of the whitefly species recorded from Malta are of non-European origin. A dichotomous key for the identification of the puparial stage of the 17 species of whitefly now known to occur in Malta is presented.

KEY WORDS. *Aleuroclava jasmini*, *Dialeurodes kirkaldyi*, Mediterranean, non-native introductions.

INTRODUCTION

Whiteflies comprise a single family, Aleyrodidae, which currently contains 1,556 extant species in 161 genera (Martin & Mound, 2007). All whiteflies are phytophagous and have six developmental stages: egg, four larval and adult. Many species are economically important plant pests, of both outdoor crops and ornamentals, and of indoor plantings. Feeding by immature whiteflies reduces plant vigour by depletion of plant sap, and foliage becomes contaminated with eliminated honeydew on which black sooty mould grows, thereby reducing the photosynthetic area and lowering the aesthetic appearance of ornamentals. Adults of a small number of species, most notably *Bemisia tabaci* (Gennadius), are important vectors of plant viruses (Jones, 2003). Three species of whitefly, *Aleurocanthus woglumi* Ashby, *A. spiniferus* (Quaintance) and *Bemisia tabaci*, are regulated within the European Union.

The whiteflies of Malta were comprehensively studied by Mifsud (1995), who recorded 12 named and one undescribed species. Subsequently, the latter species was named *Aleurolobus teucrii* Mifsud & Palmieri (Mifsud & Palmieri, 1996), and two further species added: *Aleurolobus olivinus* (Silvestri) by Mifsud & Porta-Puglia (2005) and *Singhiella citrifolii* (Morgan) by Mifsud *et al.* (2012). Two further species are added in this present work, making a total of 17 whitefly species recorded for the Maltese archipelago.

National checklists are essential as baseline data from which faunistic changes, due to factors such as international trade and climate change can be monitored and accurately assessed. Exotic plant pests are regularly dispersed among countries as a consequence of trade, and due to the small size of whiteflies, cryptic nature and immature stages firmly attached to the host-plant, they are one of the arthropod groups most commonly transported. They are also among the most successful groups in terms of invading new geographical areas (Pellizzari & Dalla Monta, 1997; Mifsud *et al*., 2010; Malumphy & Badmin, 2012). Some species, such as *Bemisia tabaci* and *Trialeurodes vaporariorum* (Westwood), have become cosmopolitan due to anthropogenic activities. Climate change will also influence the distribution of whiteflies within Europe and the Mediterranean, as

[1] The Food and Environment Research Agency, Sand Hutton, York YO41 1LZ, United Kingdom. E-mail: chris.malumphy@fera.gsi.gov.uk

[2] Department of Biology, Juinor College, University of Malta, Msida MSD 1252, Malta. E-mail: david.a.mifsud@um.edu.mt

species once restricted to more southerly latitudes are likely to expand their range northwards. Milder winters mean that winter mortality rates of some species will decrease and they may start breeding earlier in the year. Changes in regional faunas and phenology have implications for agriculture and horticultural industries, and the environment.

The purpose of this communication is to update our knowledge of the whiteflies of the Maltese Archipelago; report the presence of two non-native plant pests, *Aleuroclava jasmini* (Takahashi) and *Dialeurodes kirkaldyi* (Kotinsky), from Malta for the first time; and to present a morphological key to encourage the identification and recording of these insects in Malta.

MATERIAL AND METHODS

Whitefly data were obtained from published records, and from samples of immature whitefly collected in Malta and Gozo, mainly from woody ornamental plants in natural and urban areas mostly in 2012. In several cases whitefly immatures were only detected when foliage was examined in the laboratory, and were not seen in the field due to their small size and cryptic nature. Puparia were slide-mounted following standard published methods (Martin, 1987) and identified using the diagnostic keys provided by Mifsud (1995) and Martin *et al*. (2000). The nomenclature used follows Martin & Mound (2007). Slide-mounted specimens were deposited at The Food and Environment Research Agency, York, UK.

Collectors are abbreviated as follows: CM - Chris Malumphy and David Mifsud - DM.

ANNOTATED LIST OF WHITEFLIES

ALEYRODIDAE

Aleuroclava jasmini (Takahashi, 1932)

(Fig. 1)

Material examined. MALTA: Qawra, 17.ii.2012, abundant puparia (some parasitized) on *Bougainvillea* sp., (together with *Dialeurodes kirkaldyi* (Kotinsky)), CM; Vittoriosa, 16.ii.2012, abundant, more than 30 puparia per leaf, most vacated and some parasitized, on *Bougainvillea* sp., CM.

Notes. *Aleuroclava jasmini* represents a new record for Malta. The species is native to Asia but during the least two decades it has spread widely in tropical and subtropical regions of Africa, the Caribbean, and South and North America. Within the Mediterranean, it is recorded from Egypt (Amin *et al*., 1997) and Croatia (Šimala & Milek, 2008), although the status in the latter country is uncertain. It is frequently transported with international trade (Malumphy & Anderson, 2011). It is polyphagous, feeding on plants belonging to seven families. It is recorded as a pest in Egypt and India, and was observed causing chlorotic spotting to *Bougainvillea* in Malta. The puparia of *A. jasmini* are morphologically highly variable, particularly the development of dorsal setae, submarginal tubercles and dorsal pigmentation. The majority of the puparia found in Malta have a distinct pair of dorsal black spots, although these are frequently absent.

***Aleurolobus marlatti* (Quaintance 1903)**
(Fig. 2)

Recorded from Malta (Għar Lapsi, Valletta and Wardija) on *Capparis* sp. by Mifsud (1995, as *A. niloticus* Priesner & Hosny).

Additional data. MALTA: St. Thomas Bay, 1.x.2012, numerous puparia on *Capparis* sp., DM.

Notes. *Aleurolobus marlatti* occurs in the Eastern Mediterranean, Middle East, Asia, Africa and Australia. It is broadly polyphagous, feeding mostly on woody plants (Martin *et al*., 2000).

***Aleurolobus olivinus* (Silvestri, 1911)**
(Fig. 3)

Recorded from Malta (Birkirkara, Blata l-Bajda, Għargħur, Gzira, Ħamrun, Mellieħa, Msida and Ta' Qali) on *Olea europaea* by Mifsud & Porta-Pugulia (2005) and Haber & Mifsud (2007).

Additional data. MALTA: Mdina, 15.ii.201, puparia on *Olea europaea*, CM; Qawra, near salt pans, 16.ii.2012, puparia and early larval-instars on *O. europaea*, CM; Zejtun, 1.x.2012, puparia on *O. europaea*, DM.

Notes. *Aleurolobus olivinus* occurs widely in the Mediterranean (Martin *et al*., 2000) but appears to have been only recently introduced to Malta (Mifsud & Porta-Puglia, 2005). It is now common throughout the archipelago but is of no economic importance. It is oligophagous on two plant families, and is most commonly found on *Olea* and *Phillyrea* (Martin *et al*., 2000). The puparia of *A. olivinus* occur on both the upper and lower leaf surfaces, unlike the puparia of most whitefly species which are usually restricted to the lower surface.

***Aleurolobus teucrii* Mifsud & Palmeri, 1996**
(Fig. 4)

Recorded from Gozo (Għajnsielem, Xlendi Valley) and Malta (Mellieħa, Mistra) on *Teucrium fruticans* by Mifsud & Palmeri (1996).

Notes. This species is only known from the Maltese Islands and Sicily (Italy), and feeds exclusively on *Teucrium fruticans*.

***Aleurothrixus floccosus* (Maskell, 1896)**
(Fig. 5)

Aleurothrixus floccosus is widespread in Malta and Gozo and occurs wherever *Citrus* is grown (Mifsud, 1995).

Additional data. MALTA: Bugibba, 14.ii.2012, abundant on *Citrus sinensis*, CM (together with *Dialeurodes citri* and *Singhiella citrifolii*); Mdina, 15.ii.2012, abundant on *Citrus limon* and *C. sinensis*, CM (with *D. citri*); Vittoriosa, 16.ii.2012, sparse on *C. limon* and *C. sinensis*, CM.

Notes. *Aleurothrixus floccosus* is native to the Neotropical Region but is now found throughout the warmer parts of the world, wherever citrus is grown. It is restricted to indoor plantings in cooler regions, such as Northern Europe. It is broadly polyphagous, feeding on more than 20 plant families, and exhibits a strong preference for citrus. It is a serious pest of citrus in the Mediterranean and large populations were observed in the Maltese Islands. It is however, effectively controlled in many citrus orchards by the introduced parasitoid *Cales noacki* (Howard) (Hymenoptera: Aphelinidae) (Mifsud, 1995; Mifsud *et al*., 1995).

***Aleurotrachelus rhamnicola* (Goux 1940)**
(Fig. 6)

Recorded from Malta (Wardija) on *Rhamnus alaternus* by Mifsud (1995).

Additional data. MALTA: Buskett, 1.x.2012, puparia on *Rhamnus alaternus*, DM; Buskett, 1.x.2012, puparia on *Punica granatum*, DM.

Notes. *Aleurotrachelus rhamnicola* is widespread in the Mediterranean and the Middle East, and is polyphagous, feeding on plants belonging to eight families (Martin *et al*., 2000). *Punica granatum* represents a new host-plant record for *A. rhamnicola*.

***Aleyrodes proletella* (Linnaeus 1758)**
(Fig. 7)

Recorded from Malta (Baħrija, Girgenti, Manikata and Marsaskala) and Gozo (Għajnsielem, Għasri and Marsalforn), on *Brassica* spp., by Mifsud (1995) and Farrugia (1997).

Notes. *Aleyrodes proletella* is native to the Palaearctic but is now almost cosmopolitan in distribution. It is broadly polyphagous, feeding on herbaceous plants in numerous families, showing a preference for Cruciferae and Compositae (Martin *et al*., 2000). It is a pest of *Brassica* crops and has recently become a minor pest of some glasshouse ornamental crops in Britain, such as poinsettia.

***Bemisia afer* (Priesner & Hosny 1934) complex**
(Fig. 8)

Recorded from Malta (Buskett, Msida and Qrendi) on *Ceratonia siliqua* by Mifsud (1995).

Notes. *Bemisia afer* appears to be an assemblage of taxa which displays pronounced phenotypic variation, most notably with the lengths of dorsal setae and with the development of dorsal sculpturing that varies from granular elevations to star-shaped tubercles (Gill & Brown, 2012); Hernandez-Suarez *et al*., 2012). The *B. afer* complex has recently been studied in the Canary Islands (Hernandez-Suarez *et al*., 2012) where extremes of morphological variation have been encountered. Ten distinct puparial forms have been described, of which only two have been named as new species, as it was considered prudent not to name them all until a more extensive comparative study of populations from a wider geographic area was completed. The puparia of *B. afer* most commonly found in the Mediterranean region, particularly on plants with smooth leaves, exhibit relatively little variation, compared to *B. afer* puparia observed from the Canary Islands and Sub-Saharan Africa. *Bemisia afer* complex occurs throughout the warmer parts of the world and is found outdoors as far north as the north of England (Malumphy, 2003). It is a polyphagous feeding on plants belonging to more than 50 families (Evans, 2008; Hernandez-Suarez *et al*., 2012).

Bemisia tabaci (Gennadius, 1889) complex
(Fig. 9)

Widely recorded in Malta, Gozo and Comino, on *Brassica* spp., *Ficus carica*, *Helianthus tuberosus*, *Euphorbia pinea*, *Jaccobina pohliana*, *Lantana camara*, *Ocimum basilicum*, *Solanum* spp. by Mifsud (1995), Farrugia (1997) and Mifsud *et al.* (2012).

Additional data. MALTA: Qawra, 18.ii.2012, abundant, several parasitized puparia, on *Hibiscus rosa-sinensis*, CM.

Notes. *Bemisia tabaci* appears to be an assemblage of taxa with pronounced phenotypic variation, similar to that shown in the *B. afer* compex. There is increasing biological and molecular evidence to support the hypothesis that *B. tabaci* is a complex of cryptic species, and according to De Barro *et al*. (2011) there are at least 24 morphocryptic species that are only distinguishable at molecular level. *Bemisia tabaci* complex is native to the tropics but is now cosmopolitan. It is broadly polyphagous, feeding on plants belonging to 80 plant families. It vectors more than 100 plant viruses (Jones, 2003) and is the most economically important whitefly pest in most parts of the world.

Dialeurodes citri (Ashmead, 1885)
(Fig. 10)

Recorded in Malta (Birzebbuga, Buskett, Zebbug and Zejtun), on *Citrus* spp. and *Fraxinus angustifolia* by Mifsud (1995). Also recorded from Malta by CAB (1996).

Additional data. MALTA: Bugibba, 14.ii.2012, abundant on *Citrus sinensis* (together with *A. floccosus* and *Singhiella citrifolii*), CM; Floriana, St. Philip Gardens, 18.ii.2012, sparse on *C. sinensis*, CM; Mdina, 15.ii.2012, huge population on *C. limon* and *C. sinensis* (together with *A. floccosus*), CM; Qawra, 16.ii.2012, sparse on an unidentified shrub, CM.

Notes. *Dialeurodes citri* is native to Asia but is now found throughout the warmer parts of the world. It is broadly polyphagous, feeding on plants belonging to more than 30 families, with a strong preference for citrus (Mifsud, 1995; Martin *et al*., 2000; Mifsud *et al*., 2010). It is an economic pest of citrus in parts of the Mediterranean.

Dialeurodes kirkaldyi (Kotinsky, 1907)
(Fig. 11)

Material examined. MALTA: Qawra, 17.ii.2012, abundant pupal cases on *Bougainvillea* (together with *A. jasmini*), CM.

Notes. *Dialeurodes kirkaldyi* is a new record for Malta. This species is suspected to be native to Asia, and is now found throughout the warmer parts of the World including the Mediterranean (Cyprus, Egypt, Israel, Lebanon, Portugal and Syria) and the Middle East (Iran). It is broadly polyphagous, feeding on some 20 plant families, but its preferred hosts are *Jasminum* sp. (Oleaceae) and *Morinda citrifolia* (Rubiaceae).

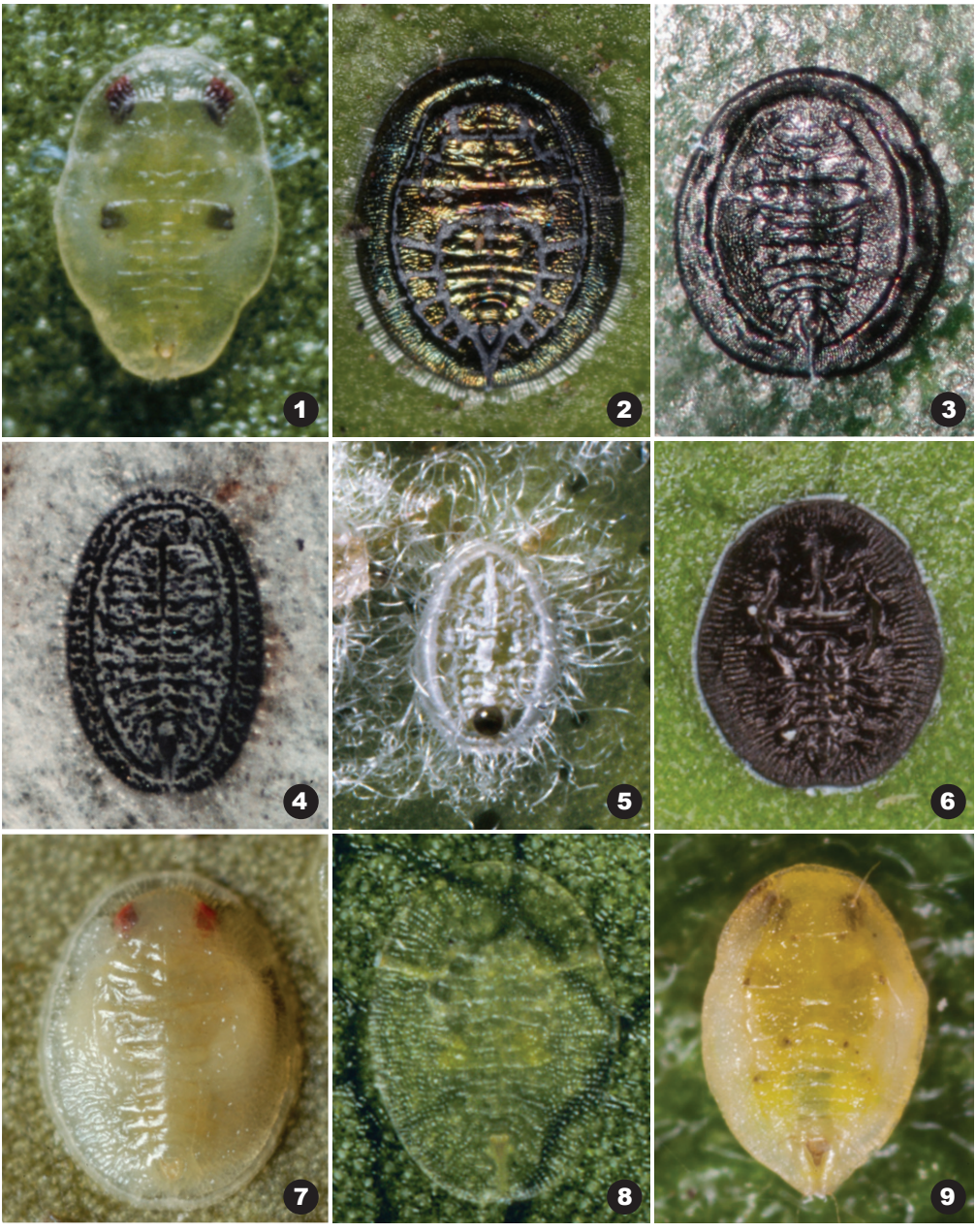

Figure 1: *Aleuroclava jasmini*; **Figure 2**: *Aleurolobus marlatti*; **Figure 3**: *Aleurolobus olivinus*; **Figure 4**: *Aleurolobus teucrii*; **Figure 5**: *Aleurothrixus floccosus*; **Figure 6**: *Aleurotrachelus rhamnicola*; **Figure 7**: *Aleyrodes proletella*; **Figure 8**: *Bemisia afer* complex; **Figure 9**: *Bemisa tabaci* complex.

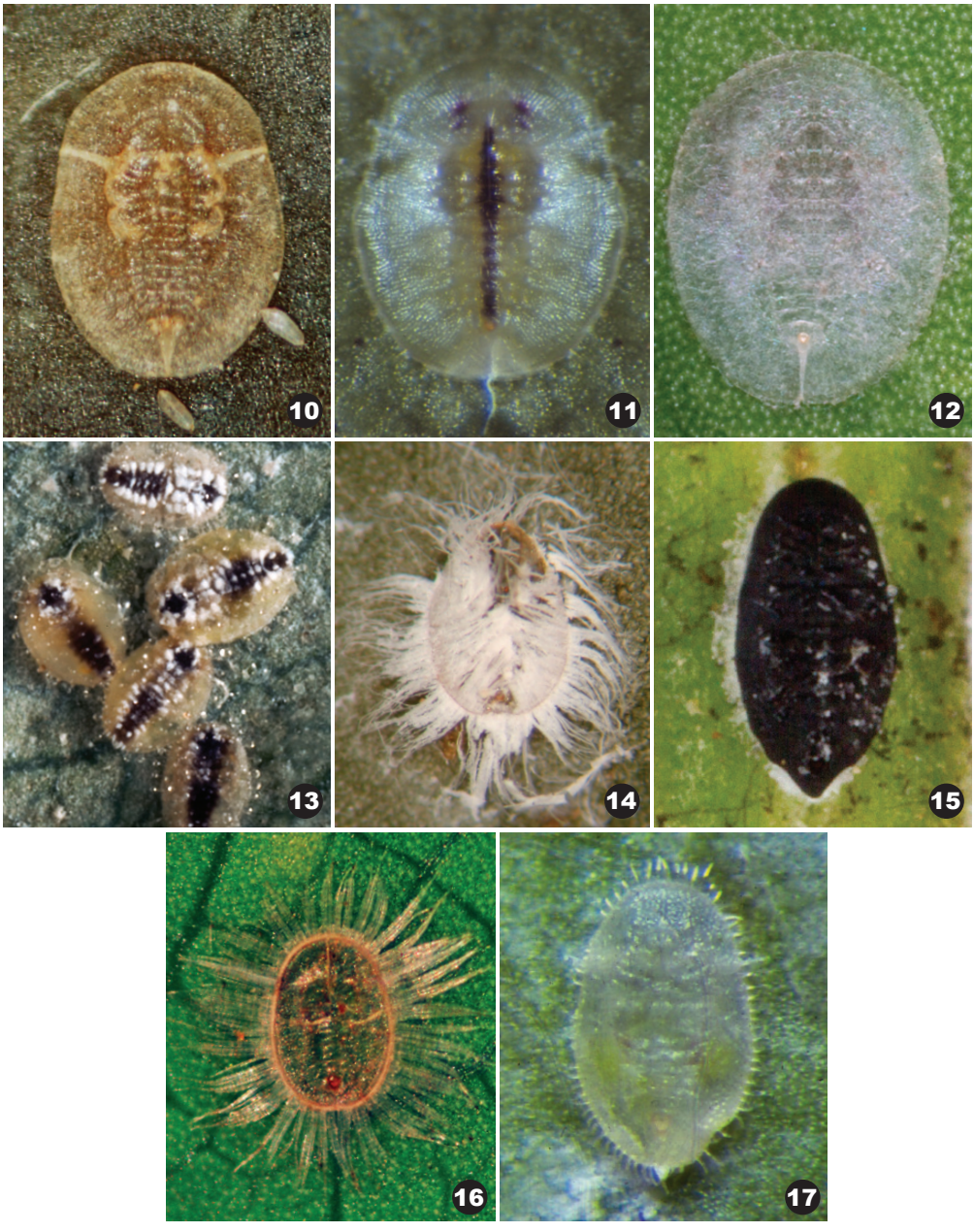

Figure 10: *Dialeurodes citri*; **Figure 11**: *Dialeurodes kirkaldyi*; **Figure 12**: *Singhiella citrifolii*; **Figure 13**: *Siphoninus phillyreae*; **Figure 14**: *Tetraleurodes hederae*; **Figure 15**: *Tetralicia ericae*; **Figure 16**: *Trialeurodes lauri*; **Figure 17**: *Trialeurodes vaporariorum*.

***Singhiella citrifolii* (Morgan, 1893)**
(Fig. 12)

Recorded from Gozo (Victoria) on *Ficus microcarpa* by Mifsud *et al*. (2012).

Additional data. MALTA: Bugibba, 14.ii.2012, abundant on *Citrus sinensis* (together with *A. floccosus* and *D. citri*), CM.

Notes. This species is native to Asia but now found widely throughout the warmer parts of the world including the Eastern Mediterranean (Lebanon, Morocco) and the Middle East (Iran) (Martin, 2000). It has been intercepted in the USA on *Citrus* imported from Albania (Evans, 2008). It is broadly polyphagous, feeding on more than 16 plant families, with a preference for *Citrus* (Rutaceae).

***Siphoninus phillyreae* (Haliday)**
(Fig. 13)

Recorded in Malta (Buskett) on *Fraxinus angustifolia* by Mifsud (1995).

Notes. *Siphoninus phillyreae* is native to the Mediterranean Region (Martin *et al*., 2000) and has been introduced to Macaronesia, Africa, the Middle East, Asia, Pacific Region, North America and South America. It is polyphagous, feeding on more than 12 families, with a preference for Oleaceae, Punicaceae and Rosaceae. It is an infrequent agricultural pest in the Mediterranean on apple, olive and pear. In Egypt, it is the most important pest of pomegranate and has proved to be an important pest of ash, olive, pear, pomegranate and woody ornamental plants in many areas where it has been introduced (Malumphy, 2010).

***Tetraleurodes hederae* Goux, 1939**
(Fig. 14)

Recorded from Malta (Buskett) on *Hedera helix* by Mifsud (1995).

Additional data. MALTA: Vittoriosa, 16.ii.2012, single puparium on *Hedera helix*, CM.

Notes. *Tetraleurodes hederae* occurs in France, Italy and Malta and is specific to *Hedera* spp. (Araliaceae).

***Tetralicia ericae* Harrison, 1917**
(Fig. 15)

Recorded from Malta (Birzebbuga, Għar Lapsi, Manikata, Mosta and Selmun) and Gozo (Wied tal-Lunzjata) on *Erica multiflora* by Mifsud (1995).

Notes. *Tetralicia ericae* occurs widely in Europe and is oligophagous on *Erica* spp. (Ericaceae) (Martin *et al*., 2000).

***Trialeurodes lauri* (Signoret, 1882)**
(Fig. 16)

Recorded from Malta (Buskett) on *Laurus nobilis* by Mifsud (1995).

Additional data. MALTA: Valletta, Upper Barrakka Gardens, 13.ii.2012, on *Laurus nobilis* (abundant puparia causing chlorosis to foliage), CM; Marsa, Għammieri, 14.xi.2011, abundant puparia on *Laurus nobilis*, DM.

Notes. *Trialeurodes lauri* occurs widely in the Mediterranean, developing on *Laurus nobilis*, and less frequently on *Arbutus andrachne*, *A. unedo* (Martin *et al*., 2000) and *Myrtus communis* (Malumphy *et al*., 2007).

Trialeurodes vaporariorum (Westwood, 1856)

(Fig. 17)

Recorded in Malta (Zejtun, Birkirkara, Gnien il-Kbir, Zebbieġħ and Sliema) on *Brassica* sp., *Fuchsia* sp., *Lycopersicon esculentum*, *Mentha spicata*, *Pelargonium regale*, *Phaseolus* cf. *vulgaris*, *Solanum melongena* and *Ulmus canescens* by Mifsud (1995).

Notes. *Trialeurodes vaporariorum* is native to North America but is now cosmopolitan. It is one of the most polyphagous of all whitefly species, and a vector of plant pathogenic viruses (Jones, 2003).

KEY TO PUPARIA OF WHITEFLY SPECIES OCCURRING IN MALTA

Adapted from Mifsud (1995) and Martin *et al*. (2000), with the additions of *Aleuroclava jasmini* and *Singhiella citrifolii*.

1. Dorsal disc with elongate siphon-like setae ..... ***Siphoninus phillyreae***

− Elongate siphon-like setae absent **2**

2. Cuticle evenly dark-brown or black (parasitized puparia of some species, most notably *Trialeurodes vaporariorum*, may be evenly black) **3**

− Cuticle pale, dusky or with variable dark brown to black patches **7**

3. Wide submargin separated from dorsal disc by a distinct furrow that extends around the body, except for the posterior abdominal segments **4**

− Submargin not separated from dorsal disc by a distinct furrow that extends around the body **6**

4. Outline subcircular; thoracic tracheal openings at margin marked only by a few minute teeth which are much finer than remainder of marginal crenulations. On Oleaceae .... ***Aleurolobus olivinus***

− Outline ovoid; thoracic tracheal openings at margin differently, or not, marked **5**

5. Thoracic and caudal tracheal openings at margin each marked as a comb of three teeth modified from marginal crenulations, often appearing as a notch with a median tooth; comma-shaped pale eyespots present ..... ***Aleurolobus marlatti***

− Thoracic tracheal openings at margin completely unmarked; caudal tracheal opening indented, between caudal setae, marked as a comb of fine crenulations; eyespots absent ... . ***Aleurolobus teucrii***

6. Puparial margin broadly deflexed, with morphological true margin located in the 'subdorsal' zone of venter; body outline elongate oval, much longer than wide; inner subdorsum without a pair of furrows. On *Erica* spp. ..... ***Tetralicia ericae***

– Puparial margin not deflexed; body sub-oval; inner subdorsum with a pair of furrows, concentric with margin, from thorax to abdominal segment II, that overlie the outer edges of the legs. Not on *Erica* spp. ..... ***Aleurotrachelus rhamnicola*** [in part]

7. Puparial outline distinctive, symmetrically laterally indented anteriorly and posteriorly, giving a sinuous margin ..... ***Aleuroclava jasmini***

– Puparial outline not indented, unless plant hairs have forced asymmetrical indents **8**

8. Submarginal row of papillae present **9**

– Submarginal row of papillae absent **10**

9. Middle and hind legs each with a pair of stout spines; papillae acute, those in submarginal row contiguous ..... ***Trialeurodes lauri***

– Middle and hind legs each with only tiny setae, often difficult to see; papillae more truncate, often rounded apically, and those in submarginal row not contiguous .... ***Trialeurodes vaporariorum***

10. Tracheal notch or pore present; caudal furrow present **11**

– Tracheal notch or pore absent; caudal furrow present or absent **13**

11. Ventral parts of caudal and thoracic tracheal areas almost always smooth; head region not defined by faint suture; 13-15 pairs of submarginal setae present ..... ***Singhiella citrifolii***

– Ventral parts of caudal and thoracic tracheal areas lined with spinules; head region defined by faint suture, which may be difficult to see; 10-12 pairs of submarginal setae present **12**

12. Median line of puparium often pigmented brownish (examine several specimens); first abdominal setae present but very small; eighth abdominal setae opposite, or posterior to, widest part of operculum ..... ***Dialeurodes kirkaldyi***

– Puparium always pale; first abdominal setae absent; eighth abdominal setae anterior to widest part of operculum ..... ***Dialeurodes citri***

13. Subdorsal furrow present; margin with pronounced crenulations or regular teeth **14**

– Subdorsal furrow absent; margin with fine crenulations **16**

14. Inner subdorsal furrows, concentric with margin, from thorax to abdominal segment II, that overlie the outer edges of the legs; submargin with a row of small toothlike, conical processes ..... ***Aleurotrachelus rhamnicola*** [in part]

– Subdorsal furrows extends from head to posterior; submargin without row of small tooth-like, conical processes **15**

15. Vasiform orifice small, elliptical; subdorsal folds often coming to a point over the head. Not on *Hedera* spp. ..... ***Aleurothrixus floccosus***

– Vasiform orifice subcordate; subdorsal folds never coming to a point over the head. On *Hedera* spp. ..... ***Tetraleurodes hederae***

16. Abdominal segment VII not significantly reduced in length medially, eight subequal segments clearly visible between transverse moulting sutures and vasiform orifice .... ***Aleyrodes proletella***

– Abdominal segment VII significantly reduced in length medially, abdomen sometimes superficially appearing seven-segmented between transverse moulting sutures and vasiform orifice **17**

17. Caudal setae always stout, usually at least as long as vasiform orifice whose sides are almost straight; vasiform orifice always inset from puparial margin by less than its own length; with a single germinate pore/porette pair between median line and first abdominal seta ..... ***Bemisia tabaci*** **complex**

– Caudal setae usually less than half length of vasiform orifice, often minute; vasiform orifice, sides usually distinctly concave, and inset from puparial margin by at least its own length; most puparia with a two germinate pore/porette pairs between median line and first abdominal seta ..... ***Bemisia afer*** **complex**

DISCUSSION

Seventeen species of whitefly have been recorded from the Maltese Archipelago, of which 40% are of non-European origin. Two Asian species are recorded here for the first time from Malta: *Aleuroclava jasmini* and *Dialeurodes kirkaldyi*. Both species have spread widely throughout the warmer parts of the world. *Aleuroclava jasmini* has been recorded from Croatia and Egypt, and *D. kirkaldyi* is established in the Eastern Mediterranean, and has been recorded from Portugal. The presence of these two species in Malta, at the centre of the Mediterranean basin, is therefore of no surprise. *Aleuroclava jasmini* was found causing chlorotic spotting to *Bougainvillea* in Malta. However, there is no published data showing that it is an economic pest in its native range and it is unlikely to have a significant economic impact in Malta, although it may damage individual ornamental plants. *Dialeurodes kirkaldyi* is a potential pest of citrus, but is likely to be less damaging than *D. citri*, which is already widespread in the islands, and may be controlled by the same parasitoids, and managed where necessary, using the same pesticides.

Three species of Asian whitefly were discovered for the first time in Malta during 2012: *Aleuroclava jasmini* and *Dialeurodes kirkaldyi* (both reported here) and *Singhiella citrifolii* (Mifsud *et al.*, 2012). Smith *et al*. (2007) reported that plant trade, particularly of ornamental plants, accounted for 90% of human-assisted introductions of non-native invertebrate plant pests in Great Britain. It is most probable that recent introductions of non-native whiteflies into Malta have been through the trade of ornamental plants, which are in continuous demand for private gardens and landscaping for tourist developments. There are several other whitefly species present in the neighbouring island of Sicily and whose host-plants are also found in Malta that have not yet been recorded from Malta. These include for example *Aleurotuba jelinekii* (Frauenfeld), *Aleuroviggianus adrianae* Iaccarino and *Aleyrodes lonicerae* Walker. The free movement of plant material within Europe provides a pathway for the introduction of these, and other whiteflies, in the future.

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REFERENCES

Amin, A.H., Emam A.K. & Helmi, A. (1997) A new record on a whitefly species of the genus *Aleurotuberculatus* (Homoptera: Aleyrodidae) on citrus trees in Egypt. *Mededelingen Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen*, *Universiteit Gent*, **62**(2a): 349-354.

CAB (1996) *Dialeurodes citri* (Ashmead). Distribution Maps of Pests Map no. 111.

De Barro, P.J., Liu, S.S., Boykin, L. M. & Dinsdale, A. (2011) *Bemisia tabaci*: a statement of species status. *Annual Review of Entomology*, **56**: 1-19.

Gill, R.G. & Brown, J.K. (2012) Systematics of *Bemisia* and *Bemisia* relatives: Can molecular techniques solve the *Bemisia tabaci* complex conundrum – A taxonomist´s viewpoint (pp. 5-29). In: Stansly, P.A. & Naranjo S.E. [eds.], *Bemisia: Bionomics and Management of a global pest*. Springer, New York, USA., 540 pp.

Evans, G.A. (2008) *The whiteflies (Hemiptera: Aleyrodidae) of the world and their host plants and natural enemies*, version 2008-09-23. USDA.

Farrugia, C. (1997) Insect pests on cauliflower (*Brassica oleracea* var. *botrytis*) in Gozo (Maltese Islands, Central Mediterranean). *The Central Mediterranean Naturalist*, **2** (4): 152-165.

Haber, G. & Mifsud, D. (2007) Pests and diseases associated with olive trees in the Maltese Islands (Central Mediterranean). *The Central Mediterranean Naturalist*, **4**(3): 143-161.

Hernandez-Suarez, E., Martin, J.H., Gill, R.J., Bedford, I.D., Malumphy, C.P., Reyes Betancort, A.J. & Carnero, A. (2012) The Aleyrodidae (Hemiptera: Sternorrhyncha) of the Canary Islands with special reference to *Aleyrodes*, *Siphoninus,* and the challenges of puparial morphology in *Bemisia*. *Zootaxa*, **3212**: 1-76.

Jones, D.R. (2003) Plant viruses transmitted by whiteflies. *European Journal of Plant Pathology*, **109**: 195-219.

Malumphy, C. (2003) The status of *Bemisia afer* (Priesner & Hosny) in Britain (Homoptera: Aleyrodidae). *Entomologist's Gazette*, **54**: 191-196.

Malumphy, C. (2010) Ash whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera: Aleyrodidae), damaging olive plants for the first time in Britain. *Entomologists Monthly Magazine*, **146**: 207-208.

Malumphy, C. & Anderson, H. (2011) Rapid Assessment of the need for a detailed Pest Risk Analysis for *Aleuroclava jasmini* (Takahashi). 21 September 2011. www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/aleuroclavaJasmini.pdf

Malumphy, C. & Badmin, J. (2012) Scale insects and whiteflies (Hemiptera: Coccoidea and Aleyrodoidea) of Watsonian Kent; with a discussion on the impact of naturalised non-native species. *British Journal of Entomology and Natural History*, **25**: 1-32.

Malumphy, C., Suarez, M.B., Glover, R., Boonham, N. & Collins, D.W. (2007) Morphological and molecular evidence supporting the validity of *Trialeurodes lauri* and *T. ricini* (Hemiptera: Sternorrhyncha: Aleyrodidae). *European Journal of Entomology*, **104**: 295-301.

Martin, J.H. (1987) An identification guide to common whitefly pest species of the world. *Tropical Pest Management*, **33** (4): 298-322.

Martin, J.H. (2000) The occurrence of *Dialeurodes citrifolii* and *Aleurochiton pseudoplatani* (Hemiptera: Aleyrodidae) in Lebanon – important new records in the Europe-Mediterranean Region. *Bulletin of Entomological Research*, **90**: 527-528.

Martin, J.H., Mifsud, D. & Rapisarda, C. (2000) The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean Basin. *Bulletin of Entomological Research*, **90**: 407-448.

Martin, J.H. & Mound L.A. (2007) An annotated check list of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae. *Zootaxa*, **1492**: 1-84.

Mifsud, D. (1995) Whiteflies (Homoptera, Aleyrodidae) from the Maltese islands. *The Central Mediterranean Naturalist*, **2**(3): 61-78.

Mifsud, D., Cocquempot, C., Mühlethaler, R., Wilson, M. & Streito, J-C. (2010) Other Hemiptera Sternorrhyncha (Aleyrodidae, Phylloxeroidea, and Psylloidea) and Hemiptera Auchenorrhyncha. Chapter 9.4. In: Roques, A. *et al*. [eds.], Alien terrestrial arthropods of Europe. *BioRisk*, **4**(1): 511-552. doi: 10.3897/biorisk.4.63

Mifsud, D., Falzon, A., Malumphy, C., de Lillo, E., Vovlas, N. & Porcelli, F. (2012) On some arthropods associated with *Ficus* species (Moraceae) in the Maltese Islands. *Bulletin of the Entomological Society of Malta*, **5**: 5-34.

Mifsud, D. & Palmieri, V. (1996) A new species of *Aleurolobus* Quaintance et Baker (Homoptera, Aleyrodidae) from southern Europe. *Bollettino del Laboratorio di Entomologia Agraria - Portici 'Filippo Silvestri'*, **52**: 89-95.

Mifsud, D. & Porta-Pugulia, A. (2005) First record of *Aleurolobus olivinus* (Silvestri) (Hemiptera: Aleyrodidae) in Malta. *The Central Mediterranean Naturalist*, **4**(2):139.

Mifsud, D., Viggiani, G., Dandria, D., & Lanfranco, E. (1995) Whitefly parasitisoids from the Maltese islands. *The Central Mediterranean Naturalist*, **2**(3): 101-107.

Pellizzari, G. & Dalla Montà, L. (1997) 1945-1995: Fifty years of incidental insect pest introduction to Italy. *Acta Phytopathologica et Entomologica Hungarica*, **32**: 171-183.

Šimala, M. & Milek, T.M. (2008) A check-list of whiteflies (Insects: Hemiptera: Aleyrodidae) of Croatia. *Natura Croatica*, **17**(3): 169-181.

Smith, R.M., Baker, R.H.A., Malumphy C.P., Hockland S., Hammon R.P., Ostojá-Starzewski J.C. & Collins D.W. (2007) Recent non-native invertebrate plant pest establishments in Great Britain: origins, pathways, and trends. *Agricultural and Forest Entomology*, **9**: 307-326.

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