

# SCALE INSECTS AND WHITEFLIES (HEMIPTERA: COCCOIDEA AND ALEYRODOIDEA) OF WATSONIAN KENT; WITH A DISCUSSION ON THE IMPACT OF NATURALISED NON-NATIVE SPECIES

C. MALUMPHY<sup>1</sup> & J. S. BADMIN<sup>2</sup>

<sup>1</sup>*The Food and Environment Research Agency, Sand Hutton, York YO41 1LZ, UK  
Email: chris.malumphy@fera.gsi.gov.uk*

<sup>2</sup>*Coppice Place, Perry Wood, Selling, nr Faversham, Kent ME13 9RP*

## ABSTRACT

An annotated list of 79 species of Coccoidea (37 native, 16 naturalised introductions, 17 introduced species established on indoor plantings and 9 non-established introductions on growing plants), and 17 species of Aleyrodoidea (five native, six naturalised introductions, two introduced species established on indoor plantings and four non-established introductions on growing plants), recorded from Watsonian Kent is presented. The mealybug *Balanococcus kwoni* Pellizzari & Danzig, an Asian pest of bamboo, is recorded from Britain for the first time. Eleven species of scale insect and seven species of whitefly are recorded outdoors from Watsonian Kent for the first time. A third of all scale insect species and half the whitefly species found outdoors in Watsonian Kent are non-native introductions. None of the introduced species, however, appear to have any serious negative impact on native biodiversity, ecosystems, forestry or crops, although they do have an economic and aesthetic impact on ornamental plants in urban areas. *Diaspidiotus pyri* (Lichtenstein) has been recorded as an occasional, minor pest of apple; and the presence of non-native scales on ornamental plants has prevented the issuing of plant-passports for export. Naturalised non-native scale insect species are more abundant and frequently more damaging to ornamental plants in urban areas than native scale species. This is due in part to the frequency of non-native host plants in urban areas. The most common and widely distributed non-native species in urban areas are *Pulvinaria floccifera* (Westwood) and *P. regalis* Canard; both species also occur in rural areas but often at much lower densities.

## INTRODUCTION

The purpose of this paper is to record the scale insects and whiteflies (Hemiptera: Coccoidea and Aleyrodoidea) found in Watsonian Kent (Vice Counties 15 (East) and 16 (West)), and to discuss the impact of naturalised non-native (alien) species in the county. Watsonian Kent is important for monitoring non-native insect introductions in England for several reasons including:

1. It is the closest county to continental Europe and species expanding their geographical range northwards in Europe, due to factors such as climate change and trade, might be expected to be detected in Kent early on during their establishment in Britain. Recent examples of non-native introductions, where the earliest or some of the earliest UK records were from Kent, include field maple whitefly *Aleurochiton acerinus* Haupt (Dolling & Martin, 1985), *Balanococcus kwoni* Pellizzari & Danzig (reported here), horse chestnut leaf-miner *Cameraria ohridella* Deschka & Dimić (Tilbury & Evans, 2003), cottony cushion scale *Icerya purchasi* Maskell (Watson & Malumphy, 2004), western

conifer seed bug *Leptoglossus occidentalis* Heidemann (Malumphy *et al.*, 2008) and aquilegia flower bud gall midge *Macrolabis aquilegiae* (Keiffer) (Halstead & Harris, 2011).

2. It is an important trade route into Britain, for example, via the Channel Tunnel, Kent International Airport Manston, Port of Dover, Port of Folkestone, Sheerness Docks and Thamesport. Kent is often referred to as the 'gateway to Britain'.
3. The climatic conditions in the county are milder than found in more northerly areas of Britain, and are more conducive for thermophilic non-native species to naturalise.
4. The north west of the county is occupied by part of Greater London (Bexley, Bromley, Greenwich, Lewisham and part of Newham), which acts as an urban heat island which may allow species that have previously been limited to warmer, more southerly latitudes, or those usually restricted to indoor plantings in northern Europe, to overwinter and breed outdoors.
5. Kent has a wide variety of habitats, including many protected semi-natural areas (English Heritage properties, Kent Wildlife Trust and National Trust sites, Kent Downs, Country Parks etc.), rich agricultural land, and the largest collection of fruit trees and plants in the World (Brogdale Farm, home of the National Fruit Collection). It is famous for its deciduous fruit orchards and is commonly referred to as 'The Garden of England'.
6. The fauna of Kent has been studied in more detail than most other counties of Britain, so the introduction of new pests can be more easily and accurately monitored.

Data on the scale insects and whiteflies of Watsonian Kent were obtained from published records, unpublished records (primarily from the Royal Horticultural Society (RHS) and the Natural Resources Institute (NRI)), specimens deposited at the Natural History Museum, London (NHM) and samples collected by the authors. The RHS records are based on samples submitted to the RHS Members' Advisory Service. A small number of samples were collected by the Plant Health and Seeds Inspectorate (PHSI) of the Department of Food and Rural Affairs (Defra) during statutory plant health inspections.

The study of the scale insect fauna of Watsonian Kent appears to have begun earlier (22 species collected before 1903, when Robert Newstead completed his monograph on the coccoids of Britain) and been more comprehensive than for perhaps any other county in Britain. The only other counties where the scale fauna have been intensively studied are Bedfordshire (VC 30) (Malumphy, 2010b), Berkshire (VC 22) (K. L. Boratynski and The Food and Environment Research Agency (Fera), unpublished data), Cheshire (VC 58) (Newstead, 1901, 1903; Fera, unpublished data), Surrey (VC 17) (several publications by Green and Williams; Fera and RHS, unpublished data) and Yorkshire (VC 61-65) (Malumphy, 2009b). John William Douglas was one of the earliest entomologists to study scale insects and whiteflies in Britain and recorded many species from the area surrounding his residence in Lewisham (VC 16) during the 1880s and 1890s. Ernest Edward Green was one of the most important British coccidologists (describing more new species (26) of scale insect from specimens collected in Britain than any other collector) and resided for a few years in the 1890s at Bearsted (VC 15). He recorded many rare mealybugs (Pseudococcidae) and felt scales (Eriococcidae) from Kent, particularly species that live on grasses and herbaceous plants. Professor Frederick Vincent Theobald, an eminent entomologist working at the South-Eastern Agricultural

College, Wye (VC 15), published a series of articles on pests of agricultural, horticultural and forestry importance, including many records of scale insects (identified by Newstead) found in Kent. The whiteflies of Kent have not been studied in so much detail and published records that are available are disparate. The availability of literature on British scale insects and whiteflies was reviewed briefly by Dolling (1991) and Malumphy (2010b).

Malumphy (2009b, 2010b) discussed the complication of compiling check lists of scale insects and whiteflies. The main factors being that these are among the arthropod groups most commonly dispersed between countries as a consequence of international trade, and non-native species are continually being accidentally introduced on imported plant material and occur as transient populations; scale insects are one of the most successful arthropod groups in terms of invading new geographical areas and many species have become cosmopolitan due to anthropogenic activities. Large numbers of non-native scale insect species have been intercepted by the PHSI on imported produce, such as citrus and mango fruit, and African leafy vegetables, at Kent International Airport Manston, Sheerness Docks and Thamesport. Those non-native species found only on imported produce are excluded from this work as they are unlikely to survive for long and their inclusion has little scientific value.

## METHODS

Data on the scale insects and whiteflies of Kent were obtained from published records, the RHS, NRI, NHM slide depository and recent collecting by the authors, the PHSI and others. Only part of the NHM collections were examined (due to time constraints) and it is likely that there are specimens of scale insects and whiteflies found in Kent deposited at the NHM that are not listed below. Methods used for collecting, slide-mounting and identification follow Malumphy (2009b, 2010a, 2010b). Slide-mounted and some dry voucher specimens are deposited at the NHM and Fera. The nomenclature of scale insects used here follows Ben-Dov, Miller & Gibson (2010) and whiteflies follows Martin & Mound (2007). Morphological descriptions and keys for the identification of the majority of native and naturalised species of scale insects and whiteflies may be found in Kosztarab & Kozár (1988) and Martin, Misfud & Rapisarda (2000), respectively.

All specimens listed under 'Collection data' have been examined by the author, with the exception of some *Aleyrodes* samples.

## RESULTS

### COCCOIDEA – Scale insects

Seventy-nine species of Coccoidea are recorded (37 native, 16 naturalised introductions, 17 introduced species known to be established in the UK on indoor plantings and 9 non-established introductions on growing plants) from Watsonian Kent. Eleven species of scale insect are recorded outdoors for the first time from the county.

### NATIVE AND INTRODUCED NATURALIZED SPECIES

#### ORTHEZIIDAE – ensign scales

##### *Newsteadia floccosa* (De Geer) – boreal ensign scale

Trans-Palaearctic; found among mosses, lichens and leaf litter, and the roots of a wide range of herbaceous and woody plants; locally common but rarely recorded in Britain.

**Published record.** VC 16: Bexley wood, 28.v., on grass stems and dead leaves (Douglas, 1881); Chislehurst (Newstead, 1903).

***Orthezia urticae* (L.)** – nettle ensign scale (Plate 2, Fig. 1)

Trans-Palaearctic; polyphagous on herbaceous plants and occasionally woody plants; locally common but rarely recorded in Britain.

**Published record.** VC 15: Bearsted, on *Potentilla*, *Ranunculus* and *Vicia*, ix.1927 (Green, 1928).

**MONOPLEBIDAE** – giant scales

***Icerya purchasi* (Maskell)** – cottony cushion scale (Plate 2, Fig. 2)

Present throughout the warmer parts of the world; broadly polyphagous; naturalized in Greater London where it is occasionally a serious pest (Watson & Malumphy, 2004).

**Published records.** VC 15: Maidstone, on *Citrus*, 10.xi.1999 (Watson & Malumphy, 2004). VC 16: Chislehurst, on *Citrus*, 5.ii.2001 (Watson & Malumphy, 2004).

**RHS records.** VC 16: Beckenham, on *Acacia baileyana*, 1.xi.2006; Eynsford, on *Citrus*, 3.xi.2003; London, 22.iv.2005, 23.vi.2009, on *Pittosporum*, 1.viii.2008, on *Acacia dealbata*, 24.xi.2003; Rochester, on *Acacia*, 27.viii.2009. **Collection data.** VC 15: Hawkhurst, nursery, on *Acacia longifolia* from Italy, 23.xi.2006 (*PHSI*). VC 16: Sevenoaks, wholesale, on *Citrus limon* from Italy, 19.ii.2008 (*PHSI*).

**PSEUDOCOCCIDAE** – mealybugs

***Atrococcus cracens* (Williams)** – slender mealybug

European; polyphagous on herbaceous plants; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Bearsted, on *Chrysanthemum leucanthemum*, 16.ix.1932 (*E. E. Green*) (Williams, 1962).

***Balanococcus diminutus* (Leonardi)** – phormium or New Zealand flax mealybug

Occurs widely in temperate regions; host specific to *Phormium tenax*; widely naturalised in England and Wales and occasionally a serious pest (Malumphy, 2009b).

**Collection data.** VC 15. Grove Green, Weavering (TQ7856), 22.iv.2011 (*C. Malumphy*); Ramsgate (TR3966), 23.iv.2011 (*C. Malumphy*).

***Balanococcus kwoni* (Pellizzari & Danzig)** (Plate 2, Fig. 3)

Native to South Korea; introduced to Italy and Britain; oligophagous on bamboo. Between December 1998 and June 2011 it was found in the English counties of Derbyshire, Hampshire, Kent, Lancashire, South Yorkshire, Surrey and West Yorkshire at commercial nurseries and botanical gardens, on *Bambusa vivax*, *Bambusa*, *Pharus*, *Phyllostachys bambusoides*, *Phyllostachys nigra*, *Phyllostachys*, *Pleioblastus linearis*, *Pleioblastus variegatus*, *Pleioblastus*, *Sinarundinaria nitida*, *Thamnocalamus crassinodus* and unspecified bamboos. The mealybug has only been found at a commercial nursery in Kent, statutory action was not taken and infested plants may have been sold and planted in private gardens. The mealybug was originally identified as *Trionymus* sp. until it was described as a new species in 2007 from specimens collected in Italy and South Korea (Pellizzari & Danzig, 2007). This species is recorded from the UK for the first time here. It produces conspicuous waxy deposits and has the potential to be a damaging pest.

**Collection data.** VC 16. Tonbridge, nursery, on *Pleioblastus*, various dates between i.–iv.1999 (*PHSI*).

***Brevinnia pulveraria* (Newstead)** – bluegrass mealybug

European; oligophagous on Poaceae; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 16: Chislehurst, on *Agrostis vulgaris* and other Poaceae (Newstead, 1903).

***Dysmicoccus walkeri* (Newstead)** – Walker’s mealybug

European; polyphagous on Poaceae and occasionally other herbaceous plants; widespread but rarely recorded in Britain (Williams, 1962).

**Published records.** VC 15: Bearsted, on grasses, 14.ix.1926 (Green, 1928; Williams, 1962). **Collection data.** VC 16: Polhill, 27.vii.1976 (*W. Dolling* det. *L. Huddleston*).

***Fonscolombia europaea* (Newstead)** – grass mealybug

European; polyphagous on Poaceae; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Dover, in a nest of *Lasius niger* (L.) (Hymenoptera: Formicidae), 6.ix.1924 (*H. Donisthorpe*) (Williams, 1962).

***Mirococcopsis subterranea* (Newstead)** – Russian root mealybug

European; polyphagous on the roots of Poaceae; found in ants’ nests, rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Charing, in a nest of *Lasius niger* (Williams, 1962).

***Phenacoccus aceris* (Signoret)** – polyphagous tree mealybug (Plate 2, Fig. 4)

Holarctic; polyphagous on trees and shrubs, especially Rosaceae; locally common throughout Britain (Williams, 1962) and an occasional pest of apple, currants and ornamentals.

**Published records.** VC 15: Bearsted, on *Ulex europaeus*, 1.iv.1896 (Williams, 1962); Bilting, on *Malus domestica*, 1911 (Theobald, 1912); Wye (Theobald, 1912). VC 16: Blackheath, on *U. europaeus* (Douglas, 1888b; Newstead, 1903; Theobald, 1912); Brockley, on *Ulmus campestris*, v.1886 (Douglas, 1888c); Chislehurst and surrounding district (Theobald, 1912); Lewisham (Williams, 1962); Royal Tunbridge Wells, on *U. europaeus* (Theobald, 1912). **Collection data.** VC 15: Kent International Airport Manston (TR3366), on *Acer pseudoplatanus*, 23.iv.2011 (*C. Malumphy*); Olantigh (TR0648), on *Quercus robur*, 24.iv.2011 (*C. Malumphy*); Ramsgate (TR3865), on *Fagus sylvatica*, 24.iv.2011 (*C. Malumphy*). VC 16: Four Elms (TQ4648), on *Crataegus monogyna*, 19.vi.2011 (*C. Malumphy*).

***Trionymus perrisii* (Signoret)** – Perris’ grass mealybug

European; broadly polyphagous on Poaceae and occasionally other herbaceous plants; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Deal, ix.1899 (*B. Tomlin*) (Newstead, 1903, misidentified as *Brevinnia pulveraria* (Newstead); Williams, 1962).

***Trionymus radicum* (Newstead)** – thrift root mealybug

European species; oligophagous on Poaceae; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Charing, in a nest of *Ponera coarctata* (Latreille) (Hymenoptera: Formicidae) (*H. Donisthorpe*) (Williams, 1962).

***Trionymus thulensis* (Green)** – northern mealybug

Palaeartic; polyphagous on Poaceae; rarely recorded in Britain (Williams, 1962).

**Published record.** VC 15: Thurnham, on *Trisetum flavescens*, 13.vii.1921 (*E. E. Green*) (Williams, 1962).

**COCCIDAE** – soft scales

***Coccus hesperidum* L.** – brown soft scale

Cosmopolitan; broadly polyphagous; ubiquitous on indoor plantings and also very common outdoors in urban areas in Britain. A major pest of ornamental plants grown indoors.

**Published records.** VC 15: Sittingbourne, on *Pachypodium* from the Netherlands, xi.1979 (Seymour & Kilby, 1979). VC 16: Lewisham, on *Laurus nobilis* (outdoors), 9.iv.1888, x.1890 (Douglas, 1888a, 1891c); Sevenoaks, on *Camellia* from the Netherlands, x.1982 (Seymour, Davis & Roberts, 1986a); Sidcup, on *Ficus benjamina* from Belgium, ii.1977 (Seymour, 1978). **RHS records.** The large number of records have been summarised here. VC 15: Ashford; Birchington-on-sea; Broadstone; Broadstairs; Canterbury; Chartham; Chatham; Cranbrook; Dover; Hawkhurst; Kingsdown; Maidstone; Ramsgate; Sheldwich; Tenterden; Westwell; Whitstable. VC 16: Beckenham; Bexley; Bexleyheath; Biggin Hill; Blackheath; Bromley; Crayford; Dulwich; Farnborough; Forest Hill; Hartley; Keston; Leigh; London; Longfield; Plumstead; Orpington; Royal Tunbridge Wells; Sevenoaks; Southborough; Sydenham; Tonbridge, on *Antirrhinum*, *Callistemon*, *Camellia*, *Ceratonia siliqua*, *Choisya ternata*, *Choisya*, *Citrus limon*, *Citrus sinensis*, *Citrus*, *Clematis*, *Euonymus japonicus*, *Euonymus*, *Ficus benjamina*, *Gardenia*, *Hedera canariensis*, *Hedera helix*, *Hedera*, *L. nobilis*, *Olea europaea*, *Nerium oleander*, *Persea americana*, *Prunus armeniaca*, *Schefflera*, *Vitis* and unspecified plants, from 1943 onwards. **Collection data.** VC 15: Canterbury, nursery, on *Citrus*, 16.iv.2004, 7.vi.2005, on *Citrus aurantifolia*, 27.iv.2006 (*PHSI*); Broadstairs (TR3967), on *Buxus sempervirens*, *Elaeagnus x ebbingei* and *L. nobilis* (all outdoors), 25.iv.2011 (*C. Malumphy*); Dumpton (TR3966), on *L. nobilis* (outdoors), 25.iv.2011 (*C. Malumphy*); Grove Green, Maidstone (TQ7856), on *Hedera helix* (outdoors), 22.iv.2011 (*C. Malumphy*); Ramsgate (TR3865, TR3866), on *L. nobilis* (outdoors), 22–24.iv.2011 (*C. Malumphy*); Selling (TR0456), 10.ix.1984, indoor plants, 2009, on *L. nobilis* (outdoors), 10.vi.2011 (*J. Badmin*); Wye (TR0546) 32.iv.1990 (*J. Badmin*). VC 16: Tunbridge Wells (TQ5839) 24.ii.1990 (*J. Badmin*).

### ***Eriopeltis* sp.**

Early records of *Eriopeltis festucae* (Fonscolombe) may refer to any of three native species of *Eriopeltis* now known to occur in Britain (Manawadu, 1986). The identity of the *Eriopeltis* sp. recorded in Kent requires confirmation.

**Published record.** VC 15: Folkestone Warren (*C. O. Waterhouse*) (Douglas, 1887c; Newstead, 1903, recorded as *E. festucae*).

### ***Eulecanium ciliatum* (Douglas) – ciliate oak scale**

European; feeds on *Quercus*; widespread but rarely recorded in Britain.

**Published records.** Kent (Green, 1916). VC 16: ?1890s, Chislehurst, on *Quercus* (Newstead, 1903). **NHM.** VC 15: Bearsted, v.1916 (*E. E. Green*).

### ***Eulecanium excrescens* (Ferris) – wisteria scale**

Asian, introduced to North America and South-East England; polyphagous; occasionally a serious pest of *Wisteria* in London (Malumphy, 2005; Salisbury, Malumphy & Halstead, 2010).

**Published record.** VC 16: Bromley, on *Wisteria*, 7.xi.2006 (Salisbury, Malumphy & Halstead, 2010).

### ***Eulecanium tiliae* (L.) – nut scale**

European, introduced to the Middle East, North Africa, North America and Tasmania; broadly polyphagous on woody plants, especially Rosaceae; common throughout Britain, an occasional pest of woody ornamentals and fruit trees.

**Published records.** VC 16: Catford, on *Alnus glutinosa*, 9.vi.1886 (Douglas, 1886b); Lewisham, on *A. glutinosa*, 24.xii.1885 (Douglas, 1886b), on *Rubus*, 10.vi.1891 (Douglas, 1892a), on *Salix alba*, vi.1885 (Douglas, 1892b). **RHS records.** VC 15: Gillingham, on *Corylus avellana*, 3.vi.2004. **NHM.** VC 15: Biddenden, on *Carpinus*

*betulus*, 26.vi.1973 (*D. Dielier*). VC 16: East Malling, on *C. avellana*, 5.iv.1972 (*G. H. L. Dicker*). **Collection data.** VC 15: Blean Wood (TR0861), *Malus*, 25.iv.2011 (*C. Malumphy*); Kent International Airport Manston (TR3366), *Sorbus aria*, 23.iv.2011 (*C. Malumphy*); Olantigh (TR0648), *Quercus robur*, 24.iv.2011 (*C. Malumphy*); Pegwell (TR3564), *C. monogyna*, 23.iv.2011 (*C. Malumphy*); Ramsgate (TR3865, TR3866, TR3965), on *C. monogyna* and *Leycesteria formosa*, 22-24.iv.2011 (*C. Malumphy*). **VC 16:** Tonbridge, Golden Stable Wood Reserve (TQ6050), on *A. glutinosa*, *Betula pendula*, *Crataegus monogyna* and *Tilia europaea*, 18.v.1989 (*C. Malumphy*).

***Lichtensia viburni* (Signoret)** – viburnum cushion scale

European; polyphagous, most frequently on *Hedera* and *Viburnum*; occurs widely in England and Wales, locally common and an occasional pest.

**RHS records.** VC 15: Kingsdown, on *H. helix*, 9.vi.1986. VC 16: Sevenoaks, on *H. helix*, 9.vi.2003. **Collection data.** VC 15: Bearsted (TQ7955, TQ8055), on *H. helix* and *V. tinus*, 22.iv.2011 (*C. Malumphy*); Faversham (TR0161), on *Viburnum*, 11.ix.2011 (*J. Badmin*); Ramsgate (TR3864, TR3865, TR3866, TR3965), on *H. helix*, *V. tinus* and *Viburnum*, 22-24.iv.2011 (*C. Malumphy*); Selling (TR0456), on *Viburnum*, 1.ix.2011 (*J. Badmin*). VC 16: Borough Green (TQ6057) on *H. helix*, 22.iv.2011 (*C. Malumphy*); Four Elms (TQ4648), on *H. helix*, 19.vi.2011 (*C. Malumphy*).

***Luzulaspis frontalis* (Green)** – long-headed soft scale

European; oligophagous, most frequently found on *Carex* and *Luzula*; rarely recorded in Britain. Originally described by Green (1928) from specimens collected from Bearsted on *Carex remota*.

**Published record.** VC 15: Bearsted, on *C. remota*, ix.1927 (Green, 1928).

***Luzulaspis luzulae* (Dufour)** – woodrush soft scale (Plate 2, Fig. 6)

European; polyphagous, most frequently on Juncaceae; widespread but rarely recorded in Britain.

**Published record.** VC 15: Bearsted, on *Luzula*, ix.1927 (Green, 1928).

***Palaeolecanium bituberculatum* (Signoret)** – bituberculate scale (Plate 3, Fig. 1)

Western Palaearctic; feeds on Rosaceae; widespread in Britain but rarely recorded.

**Published records.** VC 15: Orpington, on *Crataegus* (Newstead, 1903). VC 16: Lee, on *Crataegus*, 4.iv.1888 (Douglas, 1888a).

***Parthenolecanium corni* (Bouché)** – European fruit lecanium or brown scale

Occurs widely in temperate regions; broadly polyphagous on woody plants; widespread and locally common throughout Britain, a pest of many ornamentals and fruit crops. Green (1930) noted that all earlier publications of *P. persicae* in Britain were referable to *P. corni*.

**Published records.** VC 15: Bearsted (*E. E. Green*) (Newstead, 1903); Canterbury, on *Ribes uva-crispa*, 1905 (*Hammond*) (Theobald 1906), on *Rosa* (*G. S. Saunders*) (Douglas, 1892b); near Canterbury, on *Ribes*, 1906 (Theobald, 1907); Dover (*Tomlin*) (Newstead, 1903); East Malling, on *Ribes*, 1912 (*Roberts*) (Theobald, 1913); Linton, on *R. uva-crispa* and *Ribes*, 1911 (*Clive Murdock*) (Theobald, 1912); Lyminge, on *R. uva-crispa*, 1907 (Theobald 1908); Mereworth, on *Ribes*, 1906 (Theobald, 1907); Rainham, on *R. uva-crispa* (*Wakely*) (Theobald, 1910); Southfleet, on *Ribes* (*W. Chambers*) (Theobald, 1913); Teynham, on *Ribes rubrum*, *R. uva-crispa* and *Ribes*, 1911 (*Colonel Honeyball*) (Theobald, 1912); Wye, on *Ribes*, 1906 (Theobald, 1907). VC 16: Borough Green, on *Ribes* (*King Smith*) (Theobald, 1912). **RHS records.** The large number of records have been summarised here. VC 15: Birchington-on-Sea; Broadstairs; Canterbury; Chatham; Dover; Hythe; Maidstone;

Sittingbourne; Yalding. VC 16: Bromley; Orpington; Farningham; Keston; London; Rochester; Royal Tunbridge Wells; Sevenoaks; West Dulwich, on *Berberis verruculosa*, *Berberis*, *Carpenteria californica*, *Ceanothus*, *Clematis*, *Corylus*, *Prunus persica*, *Pyracantha*, *Rhododendron*, *Ribes sanguineum*, *R. uva-crispa*, *Ribes*, *Rosa*, *Rubus loganobaccus*, *Viburnum x bodnantense*, *Vitis* and *Wisteria*, from 1944 onwards. **Collection data.** VC 15: Bearsted (TQ8055), on *Fraxinus excelsior*, 22.iv.2011 (C. Malumphy); Broadstairs (TR3967), on *R. sanguineum*, 25.iv.2011 (C. Malumphy); Dumpton (TR3966), on *R. sanguineum*, 25.iv.2011 (C. Malumphy); Ramsgate (TR3864, TR3865, TR3866, TR3965), on *Pyracantha coccinea*, *Ribes sanguineum*, *Rosa canina*, *R. spinosissima*, *Wisteria sinensis* and unidentified shrubs, 23–24.iv.2011 (C. Malumphy). VC 16: Dunton Green (TQ5158) 11.viii.197 (W. Dolling); Four Elms (TQ4648), on *Viburnum* and *Ulmus*, 19.vi.2011 (C. Malumphy).

***Parthenolecanium persicae* (Fabricius)** – European peach scale

Virtually worldwide; broadly polyphagous; widespread in Britain, often found on *Vitis* and ornamentals grown indoors, or on plants grown in warm sunny situations.

**NHM.** Kent, on *Forsythia*. VC 15: Canterbury, on *Vitis vinifera*, 23.iv.1957 (J. MacFarland). VC 16: Bromley, on *V. vinifera*, 1976 (F. C. Fraser).

***Parthenolecanium pomericum* (Kawecki)** – yew scale

European; introduced to Britain in the 1920s and has become widely naturalised. It is an occasional pest (Malumphy, Halstead & Salisbury, 2011).

All records are on *Taxus baccata* unless otherwise specified. **Published record.** VC 15: Selling, Perry Wood, vii.2007 (Malumphy & Badmin, 2007). **RHS records.** VC 15: Canterbury, viii.1948; Cranbrook, x.1944, viii.1946, 15.v.1950, 29.v.1952; Langley, xi.1948; Sissinghurst Castle, viii.1948; Sutton Valence, 10.vii.2006; Yalding, xi.1944, x.1946. VC 16: Edenbridge, 14.x.1941, vi.1948; Horsmonden, 20.ix.1963; Lamberhurst, ix.1943; Penshurst, vi.1947; Royal Tunbridge Wells, 7.xii.1938; Tonbridge, i.1950, 31.v.1960; Westerham, vi.1946. **NHM.** VC 15: Wye, 5.vii.1972 (D. J. Williams). VC 16: Sevenoaks, 14.ii.1982 (W. Dolling). **Collection data.** VC 15: Bearsted (TQ8055), 22.iv.2011 (C. Malumphy); Dargate (TR0861), 25.iv.2011 (C. Malumphy); Selling (TR0456), 25.viii.2011 (J. Badmin).

***Parthenolecanium rufulum* (Cockerell)** – oak soft scale (Plate 3, Fig. 2)

European; feeds on *Quercus*, and occasionally other woody plants; widespread, locally common in southern England but rarely recorded.

**Collection data.** All records are on *Q. robur*. VC 15: Olantigh (TR0648), 24.iv.2011 (C. Malumphy). VC 16: Ide Hill (TQ4851), 19.vi.2011 (C. Malumphy); Tonbridge, Golden Stable Wood Reserve (TQ6050), 18.v.1989 (C. Malumphy).

***Physokermes hemicryphus* (Dalman)** – small spruce-bud scale

European, introduced to North America; feeds on *Picea*, and rarely *Abies*; widespread in Britain but rarely recorded. Malumphy (2009a) showed that early records of *P. piceae* in Britain were referable to *P. hemicryphus*.

**Published record.** VC 15: Wye, on *Picea abies* (J. V. Theobald) (Malumphy, 2009a).

***Pulvinaria floccifera* (Westwood)** – cottony camellia scale

Cosmopolitan; broadly polyphagous; naturalized throughout Britain. It has increased its host plant range and abundance in England and Scotland during recent decades (Malumphy & Badmin, 2007), and is a serious pest of *Camellia*, *Ilex* and *Rhododendron* (Malumphy, 2009b).



**Published record.** VC 15: Selling, near Perry Wood, on *Taxus baccata*, July 2007 (Malumphy & Badmin, 2007). **RHS records.** The large number of records have been summarised here. VC 15: Birchington-on-Sea; Canterbury; Folkestone; Gillingham; Hempstead; Hythe; Maidstone; Saltwood; Tenterden; Warehorne; Wouldham; Yalding. VC 16: Beckenham; Bexley; Bexleyheath; Bickley; Chislehurst; Gravesend; Kennington; London; Orpington; Royal Tunbridge Wells; Sevenoaks; Tonbridge; West Wickham; Westerham, on *Camellia*, *Choisya*, *Euonymus*, *Ilex*, *Pittosporum*, *Rhododendron*, *Taxus* and *Trachelospermum jasminoides*, from 1981 onwards. **Collection data.** VC 15: Ashford, nursery, on *Choisya ternata*, 5.vi.2007 (*PHSJ*); Saltwood, nursery, on *Rhododendron*, 12.vi.2007 (*PHSJ*); Bearsted (TQ7955, TQ8055), on *Euonymus japonicus* 'albomarginatus' and *Ilex aquifolium*, 22.iv.2011 (*C. Malumphy*); Bilting (TR0549), on *I. aquifolium*, 24.iv.2011 (*C. Malumphy*); Dargate (TR0861), on *I. aquifolium* and *T. baccata*, 25.iv.2011 (*C. Malumphy*); Perry Wood (TR0455), on *Ilex*, 5.vii.2010, 25.viii.2011, (*J. Badmin*); Ramsgate (TR3864, TR3865, TR3866, TR3965, TR3966), on *Camellia sinensis*, *I. aquifolium*, *I. aquifolium* 'argentea marginata' and *T. baccata*, 22-24.iv.2011 (*C. Malumphy*); Selling (TR0456), on *Camellia*, *E. japonicus* and *Rhododendron ponticum* variegated, 5.vii.2010, 25.viii.2011 (*J. Badmin*). VC 16: Goudhurst, nursery, on *Juniperus chinensis* from China, 6.iii and 20.iii.2009 (*PHSJ*); Borough Green (TQ6057), on *E. japonicus* 'albomarginatus', *I. aquifolium* and *Skimmia japonica*, 22.iv.2011 (*C. Malumphy*); Ide Hill (TQ4851), on *I. aquifolium*, *Rhododendron* (several species including azaleas) and *T. baccata*, 19.vi.2011 (*C. Malumphy*); Four Elms (TQ4648), on *I. aquifolium*, 19.vi.2011 (*C. Malumphy*); Toys Hill (TQ4651), on *I. aquifolium*, 19.vi.2011 (*C. Malumphy*).

***Pulvinaria hydrangeae* (Steinweden)** – hydrangea scale (Plate 3, Fig. 3)

Widespread in Europe, North America, Australia and New Zealand; polyphagous; found throughout England. A serious pest of *Hydrangea*, *Viburnum* and other ornamental plants.

**RHS records.** All records are on *Hydrangea*, unless stated otherwise. VC 15: Ashford, on *Prunus*, 25.vi.2007; Bilting, 22.vi.2007; Maidstone, 7.ix.2007; Maidstone, 6.xi.2007; Old Wives Lees, 24.ix.1996; Sittingbourne, 16.vii.2007, 12.iii.2008. VC 16: Beckenham, 16.vi.1993, 20.vii.1998, on *Rheum*, 30.vi.2003; Bexley, 4.vi.2007; Bromley, 21.vi.1999; Charlton, on *Lavatera*, 29.vi.1990; Dartford, 11.vi.2003; East Dulwich, 24.v.2007; Eltham, 18.viii.1997; London, 15.vii.2008, 28.ii.1991, 23.vi.2005, 11.iii.1992, 17.vi.2009, 26.vi.2009, 11.ii.1999, on *Prunus*, 28.vii.2005; Orpington, 24.viii.2004; Rochester, 13.vi.2008, on *Acer*, 17.viii.2007 and 9.x.2007; Sydenham, 11.vii.1994; Tonbridge, 17.vi.2010; Welling, 24.vi.2003, 29.vii.1997; West Malling, 25.vi.1998; West Norwood, 17.vii.1995. **Collection data.** VC 15: Bilting (TR055491), on *Viburnum*, 24.iv.2011 (*C. Malumphy*); Faversham (TR0160), on *Acer* (*J. Badmin* & *W. Denne*); Ramsgate (TR3865), on *Viburnum*, 24.iv.2011 (*C. Malumphy*).

***Pulvinaria regalis* (Canard)** – horse chestnut scale (Plate 3, Fig. 4)

Occurs widely in Europe; polyphagous on woody plants; present throughout Britain except for the north of Scotland, and frequently found at very high densities. It is the most abundant coccid in urban areas throughout Britain (see Fig. 1).

**Published records.** All Badmin (1990, 1992). VC 15: Boughton Street, on *Aesculus hippocastanum*, 9.vi.1990; Canterbury, on *A. hippocastanum* and *Tilia*, 16.vi.1990, and *Acer negundo*, 25.vii.1990; Chatham, Natural Resources Institute, on *Tilia*, 12.vi.1990; Faversham, on *Laurus nobilis*, 16.xii.1989, and *Tilia*, 2.vi.1990; Maidstone, Springfield, on *A. hippocastanum*, 8.vi.1990; Selling, on *Acer pseudoplatanus*, 2.vi.1990; Sittingbourne, on *Tilia*, 20.vi.1990; Tonbridge, Golden Stable Wood Reserve

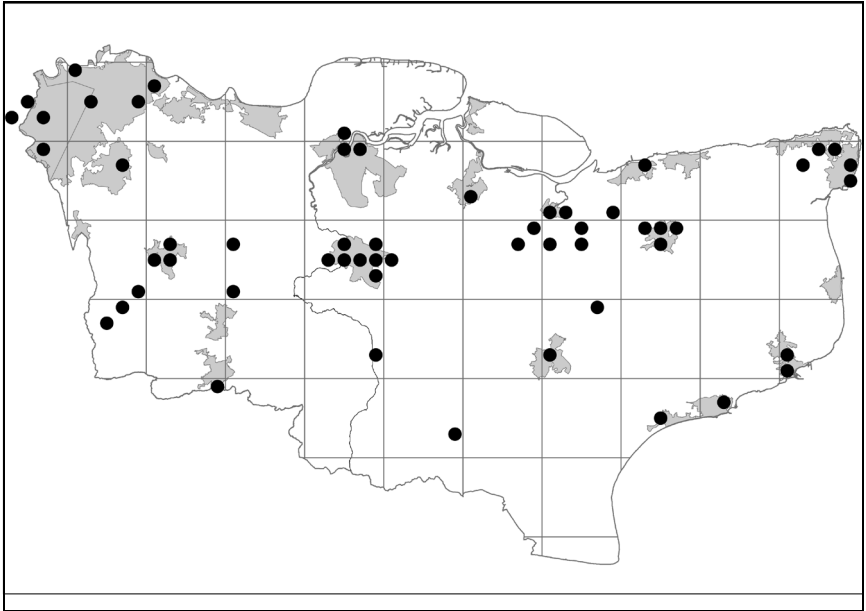


Figure 1. Distribution of horse chestnut scale *Pulvinaria regalis* in relation to the main urban areas of Kent. Map produced by A.Witts, Kent & Medway Biological Records Centre.

(TQ6050), 18.v.1989 (*C. Malumphy*). VC 16: Frindsbury and Upnor, on *A. pseudoplatanus*, 10.vi.1990. **RHS records.** VC 15: Eastling, on *Cornus controversa*, 29.v.1998; Folkestone, on *Acer*, 27.v.1993; Maidstone, on *Aesculus*, 8.vi.2007. VC 16: Beckenham, on *Acer*, 14.v.2007; Bexleyheath, on *A. negundo*, 12.v.1998; Catford, on *Cornus alba*, 22.ii.1996; Charlton, on *Acer platanoides* 'Drummondii' and *Magnolia*, 4.viii.1995; Dulwich, on *Aesculus* and *Tilia*, 18.vii.1972; Eltham, on *Aesculus*, 28.ix.1993; London, on *Aesculus*, 13.vii.1970, *Acer* and *Magnolia*, 3.viii.2010; Nunhead, on *Cornus*, 28.vi.1995; Orpington, on *L. nobilis*, 5.ii.1996; Rochester, 25.v.2000, on *Tilia*, 21.v.2008; Royal Tunbridge Wells, on *L. nobilis*, 6.viii.1987; Sevenoaks, on *Skimmia* and *Hedera*, 9.vi.2003, *Skimmia*, 4.viii.1989, and *L. nobilis*, 7.vii.2010. **Collection data.** All samples were collected by C. Malumphy, unless stated otherwise. VC 15: Bearsted (TQ7955, TQ8055), on *Acer campestre*, *A. pseudoplatanus* and *Viburnum*, 22.iv.2011; Broadstairs (TR3967), on *A. pseudoplatanus*, 25.iv.2011; Canterbury (TR1557, TR1358, TR1457, TR1659), on *Acer*, various dates vi.2011 and 4.ix.2011 (*J. Badmin*); Chestfield (TR1366), on *Acer*, 16.viii.2011 (*J. Badmin*); Dargate (TR0861), on *A. pseudoplatanus*, 25.iv.2011; Dumpton (TR3966), on *A. campestre*, *A. platanoides*, *A. platanoides* 'Crimson King', *A. pseudoplatanus* and *Tilia × europaea*, 25.iv.2011; Dumpton Gap (TR3966), on *A. campestre*, *A. pseudoplatanus*, *A. pseudoplatanus* 'atropurpurea' and *Ulmus procera*, 25.iv.2011; East Barming, Maidstone (TQ7355), on *Acer*, 10.vii.2011 (*J. Badmin*); Faversham (TR0161, TR0261), on *Acer*, 4.vii.2010, 28.viii.2011 (*J. Badmin*); Grove Green, Maidstone (TQ7856), on *A. hippocastanum*, 22.iv.2011; Kent International Airport Manston (TR3366), on *A. pseudoplatanus* and *T. × europaea*, 23.iv.2011; Maidstone (TQ7555, TQ7853), on *Acer*, 2.vii.2010, 10.vii.2011 (*J. Badmin*); Margate

(TR3669, TR3569), on *Acer*, 2010 (*J. Badmin*); Olantigh (TR0648), on *A. pseudo-platanus*, 24.iv.2011; Painter's Forstal (TQ9958), on *Acer*, 10.vii.2011, (TQ9959) heavy infestation on *A. pseudoplatanus*, 10.vi.1992 (*J. Badmin*); Ramsgate (TR3864, TR3865, TR3866, TR3965, TR3966), on *A. platanoides*, *A. pseudoplatanus*, *A. pseudoplatanus* 'atropurpurea', *Aesculus hippocastanum*, *Euonymus*, *T. × europaea*, *Tilia*, *Ulmus glabra*, *U. procera* and unidentified shrubs and trees, 22–25.iv.2011; Selling (TR0456), on *Acer*, 5.vii.2010 (*J. Badmin*); Sheldwich (TR0156), on *Acer*, 6.vii.2010 (*J. Badmin*); Staplehurst (TQ7842), on *Acer*, 11.vii.1998 (*J. Badmin*); Tenterden (TQ8833), on *Acer*, 20.vii.2011 (*J. Badmin*). VC 16: Barnehurst, on *L. nobilis*, vi.1988 (*J. H. Martin*); Bessells Green, Sevenoaks (TQ5055), on *Acer*, 3.vii.2011 (*J. Badmin*); Borough Green (TQ6057), on *A. pseudoplatanus* 'atropurpurea' and *T. × europaea*, 22.iv.2011; Edenbridge (TQ4446), on *A. campestre*, *A. pseudoplatanus*, *Aesculus hippocastanum* and *Tilia*, 19.vi.2011; Four Elms (TQ4648), on *A. campestre*, 19.vi.2011; Ide Hill (TQ4851), on *A. campestre*, *A. palmatum*, *A. palmatum* 'dissectum', *A. pseudoplatanus*, *Aesculus hippocastanum*, ?*Magnolia*, *T. cordata*, *T. × europaea* and *U. glabra*, 19.vi.2011; Riverhead, Sevenoaks (TQ5256), on *Acer*, 3.vii.2011 (*J. Badmin*); Royal Tunbridge Wells (TQ5839, TQ5939), on *Acer*, 10.ix.2011 (*J. Badmin*); Saint Johns, Sevenoaks (TQ5356), on *Acer*, 3.vii.2011 (*J. Badmin*).

### ***Pulvinaria vitis* (L.)** – woolly vine scale

Palearctic and Nearctic; polyphagous; widespread and locally common throughout Britain. It is an occasional pest of grapevine, peach and currants. Badmin (1990) reported a *Pulvinaria* sp. from Woodstock, on *Cotoneaster horizontalis*, 1988, which is suspected to be *P. vitis*, as it is the only *Pulvinaria* species known on *Cotoneaster* in Britain. Two dead immature coccids suspected to be *P. vitis* were collected from Biltong (VC 15), on *Viscum album*, 24.iv.2011 (*C. Malumphy*). This is not a confirmed host plant and the scales may have simply wandered off the *Malus domestica* (a known host for *P. vitis*) on which the *V. album* was growing.

**Published records.** VC 15: Barming, on *Ribes uva-crispa*, v.1909 (*Selby Smith*) (Theobald 1910); near Maidstone (*A. O. Walker*) (Newstead, 1903; Theobald, 1908); Sittingbourne, Borden Hall, on *R. uva-crispa* and *Ribes nigrum*, 13.vi.1911 (*L. Levy*) (Theobald, 1912 – 'severe infestation practically killing plants'). VC 16: Lewisham, on *Alnus glutinosa*, 23.xii.1885 (Douglas, 1891a; Newstead, 1903), and *Crataegus*, v.1884 (Douglas, 1891d); Lee, on *Crataegus*, 5.vi.1891 (Douglas, 1891d). **RHS records.** VC 15: Broomfield, on *Ribes*, 17.viii.1993; Faversham, on *Pyracantha*, 27.xi.1990; Gillingham, on *Betula*, 9.vi.2004; Wye, on *Pyracantha*, 19.v.1944. VC 16: London, 28.vi.2001, and *Ribes*, 7.vii.1995; Orpington, on *R. nigrum*, 4.vi.2007; Sidcup, on *Rubus*, 15.i.2002, *Ribes rubrum*, 10.vii.1979, and *Vitis*, 29.vi.1994; Tonbridge, on *Pyracantha*, vi.46. **NHM.** Kent, on *Ribes*, 21.v.1949 (*Fitchew*). VC 16: East Malling, on *Populus*, vi.1929 (*A. M. Massee*); Lewisham, on *Crataegus*, vi.1891 (*R. Newstead*). **Collection data.** VC 15: Dumpton (TR3966), on *Alnus glutinosa*, 25.iv.2011 (*C. Malumphy*); Ramsgate (TR3866, TR3965) on *Crataegus monogyna*, 23–24.iv.2011 (*C. Malumphy*). VC 16: Lewisham, on *C. monogyna*, 21.v.1989 (*C. Malumphy*); Tonbridge, Golden Stable Wood Reserve (TQ6050), on *A. glutinosa*, 18.v.1989 (*C. Malumphy*).

### **KERMESIDAE** – gall scales

#### ***Kermes roboris* (Fourcroy)** – English oak kermes

Trans-Palearctic; feeds on *Quercus*; rarely recorded in Britain.

**Published record.** VC 15: Blean Wood, Herne, on *Q. robur*, ix.1897 (*C. O. Waterhouse*) (Newstead, 1903).

## ERIOCOCCIDAE – felt scales

### *Cryptococcus fagisuga* (Lindinger) – beech bark scale (Plate 3, Fig. 5)

European, introduced to North America; feeds on *Fagus*; common and widespread throughout Britain, frequently at very high densities (Williams, 1985). It is associated with the transmission of a fungal beech bark disease caused by *Nectria coccinea* var. *faginata* and *Neonectria galligena* (Ascomycota: Hypocreales: Nectriaceae) (Kosztarab & Kozár, 1988). Theobald (1905) described beech bark scale 'as the most destructive forest pest in Britain'.

All the records were on *F. sylvatica*. **Published records.** Kent (Theobald, 1904). VC 15: Bearsted (*E. E. Green*) (Newstead, 1903), 27.vii.1913 (*E. E. Green*) (Williams, 1985); near Canterbury, 19.v.1973 (*L. M. Hanford*) (Williams, 1985); Faversham, ix.1911 (*H. Horden*) (Theobald, 1912); Leeds, 1905 (Theobald, 1906); near Maidstone, 1910 (Theobald, 1911). VC 16: Blackheath, v.1886 (Douglas, 1886c); Chislehurst (Newstead, 1903); Combe Bank, Sevenoaks, 1907 (*C. Day*) (Theobald, 1908); East, 1906 (Theobald, 1907); Malling (Newstead, 1903), ix.1895 (*E. E. Green*) (Williams, 1985); Sevenoaks, Chevening House, 1904–5 (Theobald, 1905, 1906). **RHS records.** VC 15: Eastry, 29.iv.1993; Lyminge, 10.ix.1985; Ospringe, 13.ii.1978, 29.ii.1980; Sittingbourne, 27.viii.1959; Woodnesborough, 14.iv.1997. VC 16: Bickley, 7.vi.1993; Bromley, 29.xi.1939; Gravesend, 3.ix.1984. **Collection data.** VC 15: Ramsgate (TR3866), 24.iv.2011 (*C. Malumphy*).

### *Eriococcus cantium* (Williams) – Kentish felt scale

England and Poland; on *Brachypodium sylvaticum*; rarely recorded in Britain. Described by Williams (1985) from specimens collected from Bearsted and named after the Latin word for Kent.

**Published record.** VC 15: Bearsted, on *B. sylvaticum*, 30.vii.1925 (*E. E. Green*) (Williams, 1985).

### *Eriococcus greeni* (Newstead) – Newstead's felt scale (Plate 3, Fig. 6)

European, introduced to North America; polyphagous on Poaceae; widespread but rarely recorded in Britain (Williams, 1985).

**Published records.** VC 15: Bearsted, on grass, ix.1927 (Williams, 1985); Thurnham, on grass, 15.ix.1926 (Green, 1928).

### *Eriococcus insignis* (Newstead) – conspicuous felt scale

European, introduced to North America; polyphagous on Poaceae and herbaceous plants; widespread but rarely recorded in Britain (Williams, 1985).

**Published records.** VC 15: Bearsted, Chislehurst and Orpington (*E. E. Green*) (Newstead, 1903); Thurnham, on grass, 15.ix.1926 (*E. E. Green*) (Williams, 1985).

### *Eriococcus placidus* (Green) – smooth felt scale

European; oligophagous on Poaceae; rarely recorded in Britain (Williams, 1985).

**Published records.** VC 15: Bearsted, on *Brachypodium sylvaticum*, 30.vii.1925 (*E. E. Green*) (Williams, 1985); Thurnham, on *Avena flavescens* and *B. sylvaticum*, 13.vii.1921 (*E. E. Green*), on ?*Festuca*, 8.ix.1920 (*E. E. Green*) (Williams, 1985).

### *Eriococcus pseudinsignis* (Green) – boreal felt scale

European; polyphagous on Poaceae and herbaceous plants; widespread but rarely recorded in Britain (Williams, 1985).

**Published record.** VC 15: Thurnham, on *Festuca*, 9.ix.1920 (*E. E. Green*) (Williams, 1985).

***Pseudochermes fraxini* (Kaltenbach)** – ash bark scale

European; feeds on *Fraxinus* and occasionally *Syringa*; widespread and common throughout Britain (Williams, 1985), frequently at very high densities together with *Chionaspis salicis* (L.).

All records are on *F. excelsior*. **Published record.** VC 15: Bearsted, vii.1913 (*E. E. Green*) (Green, 1915; Williams, 1985). **Collection data.** VC 15: Bearsted (TQ8055), 22.iv.2011 (*C. Malumphy*); Blean Wood (TR0861), 25.iv.2011 (*C. Malumphy*); Dumpton (TR3966), 25.iv.2011 (*C. Malumphy*); Olantigh (TR0648), 24.iv.2011 (*C. Malumphy*); Ramsgate (TR3865, TR3866), 24.iv.2011 (*C. Malumphy*); Selling (TR0456), 10.vi.1985, 25.vii.2011 (*J. Badmin*). VC 16: Whitley Forest (TQ5053) 29.v.1977 (*W. Dolling det. D. Williams*).

**ASTEROLECANIIDAE** – pit scales***Asterodiaspis quercicola* (Bouché)** – small oak pit scale

Western Palaearctic species, introduced to North America, South Africa, New Zealand and Mauritania; feeds on *Quercus*; widespread and common throughout Britain.

**Published records.** All records are on *Quercus*. VC 15: Bearsted, vii–viii (Green, 1895). VC 16: Eltham and Lee, xi.1885 (Douglas, 1886a); Royal Tunbridge Wells (*G. S. Saunders*) (Douglas, 1885).

***Asterodiaspis variolosa* (Ratzeburg)** – golden pit scale

Western Palaearctic species that has become almost cosmopolitan; feeds on *Quercus*; widespread and common throughout Britain.

**Published records.** All records are on *Quercus*. VC 15: Bearsted (*E. E. Green*) (Newstead, 1903); Kent International Airport Manston (TR3366), on *Q. robur*, 23.iv.2011 (*C. Malumphy*). VC 16: Chislehurst, Farnborough and Orpington (Newstead, 1903).

**DIASPIDIDAE** – armoured scales

In addition to the diaspidids recorded below the RHS have records of *Carulaspis* sp. from Beckenham, on *Chamaecyparis lawsoniana*, 29.x.1941; Bromley, on *Juniperus*, 28.viii.2003; Sevenoaks, Knockholt, on × *Cupressocyparis leylandii*, 12.x.2005; Royal Tunbridge Wells, on *Juniperus*, 4.x.1972 and × *C. leylandii*, 12.iii.2008. There are two species of *Carulaspis* recorded on these host plants present in Britain, *C. juniperi* (Bouché) and *C. minima* (Targioni-Tozzetti) (Boratynski, 1957), and voucher specimens were unavailable to confirm the identity of these records.

***Aulacaspis rosae* (Bouché)** – rose scurfy scale

Cosmopolitan; polyphagous, especially Rosaceae; widespread but only occasionally recorded in Britain, a pest of roses.

**Published records.** VC 15: Bearsted, on *Rosa canina* and *Rosa* ‘Gloire de Dijon’, July–August (Green, 1895); Sellindge, on *Rosa* ‘Maréchal Neil’ grown under glass, ?1893 (Theobald, 1905). **RHS records.** VC 15: Faversham, on *Rosa*, 16.xii.2009; Rainham, on *Rosa*, 26.ix.1994. VC 16: Gravesend, on *Rosa centifolia* and *Rosa* ‘scharlachglut’, 29.i.1976. **Collection data.** VC 15: Broadstairs (TR3967), on *Rosa*, 25.iv.2011 (*C. Malumphy*); Dumpton (TR3966), on *Rosa*, 25.iv.2011 (*C. Malumphy*); Ramsgate (TR3864, TR3865, TR3866), on *Rosa* and *R. spinosissima*, 23–24.iv.2011 (*C. Malumphy*).

***Carulaspis juniperi* (Bouché)** – juniper scale

Mediterranean, introduced to Australia, New Zealand, and North and South America; feeds on Cupressaceae (and occasionally Pinaceae, Taxaceae and

Taxodiaceae); rarely recorded in Britain but recently found to occur widely in southern England by the author.

**Collection data.** VC 15: Bearsted (TQ8055), on *Cupressus torulosa*, 22.iv.2011 (*C. Malumphy*); Ramsgate (TR3966), on *Cupressus*, *Juniperus*, *Thuja* and unidentified Cupressaceae, 23.iv.2011 (*C. Malumphy*); Woodstock (TQ9060) 30.x.1984 (*J. Badmin*). VC 16: Gouldhurst, nursery, on *Juniperus chinensis* and *J. rigida* from China, 6.iii.2009 (PHSI).

***Carulaspis minima* (Signoret) – minute cypress scale**

Mediterranean, introduced to West Africa, Hawaii, North and South America, and the Caribbean; feeds on Cupressaceae (and occasionally Cephalotaxaceae and Taxodiaceae); rarely recorded in Britain but recently found to occur widely in northern and southern England by the author.

**Collection data.** VC 15: Ramsgate (TR3864), on *Juniperus scopulorum*, 24.iv.2011 (*C. Malumphy*). VC 16: nursery, on *J. chinensis* and *J. rigida* from China, 6.iii.2009 (PHSI); Borough Green (TQ6057), on × *Cupressocyparis leylandii*, 22.iv.2011 (*C. Malumphy*); Four Elms (TQ4648), on × *C. leylandii*, 19.vi.2011 (*C. Malumphy*). Borough Green (TQ6057), on × *Cupressocyparis leylandii*, 22.iv.2011 (*C. Malumphy*); Four Elms (TQ4648), on × *C. leylandii*, 19.vi.2011 (*C. Malumphy*).

***Chionaspis salicis* (L.) – willow scale (Plate 4, Fig. 1)**

Palaeartic, introduced to parts of Asia and North America; broadly polyphagous on woody plants; widespread and very common throughout Britain, an occasional pest of willow and currant.

**Published records.** Kent, on *Fraxinus excelsior* (Theobald, 1904). VC 15: Bearsted (*E. E. Green*) and near Orpington on *Ulmus campestris*, *Euonymus europaeus*, *Viburnum lantana* and *Acer campestre* (Newstead, 1901); Wye, on *F. excelsior*, *Ribes rubrum*, *R. sanguineum* and *Ribes*, v.1911 (Theobald, 1912). VC 16: Lee, on *Acer*, *F. excelsior* and *Salix* (Douglas, 1885, 1886a); Lewisham, on *Ahnus glutinosa* (Douglas, 1886a). **Collection data.** VC 15: Olantigh (TR0648), on *A. glutinosa* and *Salix alba*, 24.iv.2011 (*C. Malumphy*); Ramsgate (TR3965), on *F. excelsior*, 23.iv.2011 (*C. Malumphy*). VC 16: Four Elms (TQ4648), on *A. campestre* and *Quercus robur*, 19.vi.2011 (*C. Malumphy*).

***Diaspidiotus bavaricus* (Lindinger) – blueberry armoured scale**

European; feeds on Ericaceae; occurs widely in Britain but is rarely recorded.

**Published records.** VC 15: Bearsted, on *Calluna vulgaris* (*E. E. Green*) (Newstead, 1901). NHM. VC 15: Hothfield, vi.1913 and Maidstone, iii.1896 on *C. vulgaris* (*E. E. Green*).

***Diaspidiotus ostreaeformis* (Curtis) – pear oyster-shell scale**

Trans-Palaeartic species, spread to North and South America, Australia and New Zealand; broadly polyphagous, mainly on trees and common on Rosaceae; widespread but rarely recorded in Britain, a pest of deciduous fruit trees (Kozár, 1990).

**Published records.** VC 15: Maidstone and Sittingbourne on *Malus domestica*, *Prunus armeniaca*, *Prunus domestica*, *Prunus persicae* and *Pyrus communis* (Theobald, 1907). VC 16: Lewisham, on *M. domestica*, *Prunus cerasi*, *P. domestica* and *P. communis* (Douglas, 1887a; Newstead, 1901).

***Diaspidiotus pyri* (Lichtenstein) – pear oyster-shell scale**

European; polyphagous; rarely recorded in Britain, a pest of pear and plum, and occasionally apple and peach. Information on this species is scarce partially due to confusion with *D. ostreaeformis*.

**NHM.** VC 16: East Malling, on *Malus domestica*, viii.1970 (G. H. L. Dicker), *Pyrus*, 26.ii.1971, 9.x.1970, 13.xii.1970, *Pyrus malus*, 13.i.1971, and *Prunus domestica*, 6.vii.1972 (D. J. Williams).

***Diaspidiotus zonatus* (Frauenfeld)** – zonate armoured scale (Plate 4, Fig. 2)

European; feeds on woody plants, most frequently on *Quercus*; widespread and locally common in Britain but rarely recorded.

All the following records are on *Quercus robur*. **Published records.** VC 15: Bearsted, August-September (Green, 1895); Bearsted (E. E. Green), Orpington and district, Chislehurst, Frant Wood (Saunders) (Newstead, 1901). VC 16: Lewisham, 27.ix.1886 (Douglas, 1886c; Newstead, 1901). **Collection data.** VC 15: Blean Wood (TR0861), 25.iv.2011 (C. Malumphy); Kent International Airport Manston (TR3366), 23.iv.2011 (C. Malumphy). VC 16: Four Elms (TQ4648), 19.vi.2011 (C. Malumphy); Ide Hill (TQ4851), 19.vi.2011 (C. Malumphy).

***Dynaspidiotus britannicus* (Newstead)** – holly scale (Plate 4, Fig. 3)

Present in Europe, North and South America; polyphagous, most commonly found on *Buxus*, *Hedera*, *Ilex* and *Laurus*; rarely recorded in Britain.

**RHS records.** VC 16: Benenden, on *Buxus*, 7.ii.2006. **Collection data.** VC 15: Ramsgate (TR3965), on *Ruscus aculeatus*, 22.iv.2011 (C. Malumphy).

***Lepidosaphes ulmi* (L.)** – mussel scale

Widespread in temperate regions; broadly polyphagous on woody hosts, especially Rosaceae; common throughout Britain, a pest of apple, pear, cherry, walnut and many others.

**Published records.** VC 15: on *Fraxinus excelsior* (Theobald, 1908); Borden Hall, Sittingbourne, on *Malus domestica* and *Ribes uva-crispa*, (L. Levy) (Theobald, 1913); Chart Sutton, on *Ribes*, 1913 (Roberts) (Theobald, 1913); Harbledown, on *M. domestica*, ii.1911 (Theobald, 1912); Patricxbourne, 1911 (Theobald, 1912); Sittingbourne (Theobald, 1908); Smarden (Theobald 1911); Woodstock, on *Cotoneaster horizontalis*, i.1990 (Badmin, 1990); Wye, on *M. domestica*, 1906 (Theobald, 1907), and fruit trees, 1911 (Theobald, 1912); Yalding (Theobald, 1911). VC 16: Blackheath, on *Ulex europaeus*, 14.xii.1885 (Douglas, 1886a); Borough Green, on *M. domestica*, 1911 (Theobald, 1912); Mereworth, on *M. domestica*, 1906 (Theobald, 1907). **RHS records.** VC 15: Birchington-on-sea, on *Malus*, 9.i.1986; Chatham, on *Pyrus*, 28.v.1962; Cranbrook, on *Buxus*, 25.viii.1998; Eastling, on *Cornus controversa*, 29.v.1998; Sandwich, on *Buxus*, 6.ii.2007, 10.ix.2007. VC 16: Bromley, on *Buxus*, 12.iii.1997; Catford, on *Cornus alba*, 22.ii.1996; Dartford, on *Buxus*, 23.ix.2010; Forest Hill, on *Malus*, viii.1954; London, on *Malus*, 15.vii.1965; London, on *Malus*, 18.xii.1969, on *Buxus*, 4.v.2005; Longfield, on *Malus*, 26.viii.2008; Orpington, on *Malus*, 7.iii.1968; Sevenoaks, on *Malus*, 15.x.1935; Sevenoaks, on *Sorbus aria*, 1.viii.1966; West Dulwich, on *Cotoneaster*, 25.viii.1993. **Collection data:** All samples were collected by C. Malumphy, unless stated otherwise. VC 15: Bearsted (TQ8055), on *M. domestica*, 22.iv.2011; Bilting (TR0549), on *M. domestica*, 24.iv.2011; Dumpton (TR3966), on *Crataegus monogyna* and *Prunus cerasifera* 'atropurpurea', 25.iv.2011; Kent International Airport Manston (TR3366), on *Sorbus aria*, 23.iv.2011; Ramsgate (TR3865, TR3965), on *Crataegus* and *M. domestica*, 23-24.iv.2011; Selling (TR0456), on *Malus*, 17.viii.1985 (J. Badmin); Woodstock (TQ9060) 2.i.1990 (J. Badmin).

***Unaspis euonymi* (Comstock)** – euonymus scale (Plate 4, Fig. 4)

Widespread in warm temperate regions; polyphagous; naturalized throughout England, a major pest of *Euonymus*, in particular *E. japonicus*.

All records are on *Euonymus*. **RHS records.** VC 15: Broadstairs, 8.ix.1989, on *E. japonicus*, 30.v.1997; Canterbury, 13.viii.1993; Faversham, 18.viii.2005; Folkestone, 11.viii.2010; Gillingham, 13.viii.2009; Great Mongeham, on *E. japonicus*, 30.vi.1993; Maidstone, 23.vii.2009, 13.ix.2010; Swale, Newington, 1.vi.2005. VC 16: Beckenham, on *E. japonicus*, 30.viii.1994; Bexley, 22.iv.2009, 20.viii.2009; Bexleyheath, 24.ix.2003; Bromley, 29.viii.1995; Catford, 9.viii.2001; Crayford, on *E. japonicus*, 8.xi.1996; Gravesend, 29.viii.2008; London, 16.xi.2009; Orpington, unidentified, 10.iii.2003; Petts Wood, 22.viii.2000; Royal Tunbridge Wells, 15.viii.2000; Sevenoaks, on *E. fortunei*, 7.iii.2000; Tonbridge, 21.viii.2008. **Collection data.** All samples were collected by C. Malumphy. VC 15: Broadstairs (TR3967), on *E. japonicus*, 25.iv.2011; Dumpton (TR3966), on *E. japonicus*, 25.iv.2011; Dumpton Gap (TR3966), on *E. japonicus*, 25.iv.2011; Ramsgate (TR3865, TR3866, TR3965), on *E. japonicus* and *E. japonicus 'albomarginatus'*, 22–24.iv.2011.

#### INTRODUCED SPECIES ESTABLISHED ON INDOOR PLANTINGS

Scale insects found on indoor plantings often occur as transient populations that exist for as long as suitable host plants are available or until measures are taken to control them. Therefore, not all of the following species will be present continuously in Kent, although they are established elsewhere in the UK. Some of the species may be found outdoors during the summer months.

#### **PSEUDOCOCCIDAE** – mealybugs

Theobald (1906, 1913) reported *Pseudococcus longispinus* (Targioni Tozzetti) from Ashford and Blackheath on several host plants, but did not distinguish *P. longispinus* from *P. viburni* (Signoret) and there are no voucher specimens available, so it is not possible to be certain which species was recorded.

#### ***Geococcus coffeae* (Green)** – coffee root mealybug

Pantropical and subtropical; broadly polyphagous, feeds on roots; restricted to a small number of botanical collections and rarely recorded in Britain.

**Published record.** VC 16: Meopham, on *Dieffenbachia* from India, iv.1976 (Seymour, 1978).

#### ***Nipaecoccus nipae* (Maskell)** – coconut mealybug

Cosmopolitan, restricted to indoor plantings in cooler regions; polyphagous, especially on Arecaceae; restricted to a small number of botanical collections and rarely recorded in Britain.

**Published record.** VC 16: Blackheath, on palms, ix.1905 (*M. Putsch*) (Theobald, 1906).

#### ***Planococcus citri* (Risso)** – citrus mealybug

Cosmopolitan; polyphagous; very common on indoor plantings throughout Britain since the 19th Century (Newstead, 1903; Theobald, 1906), occurs outdoors in sheltered situations during the summer.

**Published records.** VC 15: Dover, on *Hoya carnosa* from Belgium, ix.1982 (Seymour, Roberts & Davis, 1986a). VC 16: Lewisham, on *Cucumis sativus*, 18.v.1886 (H. T. Stainton) (Douglas, 1886c).

#### ***Pseudococcus longispinus* (Targioni Tozzetti)** – long-tailed mealybug

Cosmopolitan; polyphagous; common pest on indoor plantings (particularly in public botanical collections) throughout Britain since the 19th Century (Newstead, 1903).

**Published record.** VC 16: South Darenth, on *Scindapsus aureus* from Jamaica, vi.1978 (Seymour & Kilby, 1978).



***Pseudococcus viburni* (Signoret)** – glasshouse mealybug

Cosmopolitan; polyphagous; very common on indoor plantings throughout Britain.

**Published record.** VC 15: Wye, on *Erythrina lysistemon* from Zimbabwe (Rhodesia), vi.1979 (Seymour & Kilby, 1979). **Collection data.** VC 15: Ashford, nursery, on *Euphorbia pulcherrima*, 8.xii.2008 (*PHSI*); Hawkhurst, nursery, on *Acacia longifolia* from Italy, 23.xi.2006, 6.xii.2006 (*PHSI*).

**COCCIDAE** – soft scale***Parasaissetia nigra* (Nietner)** – nigra scale

Occurs widely in tropical and subtropical areas; polyphagous; found in botanical collections in Britain; listed in the plant health legislation of the European Union (EU) (Malumphy, 2002).

**RHS record.** VC 16: Sevenoaks, on *Nerium oleander*, 8.viii.1995.

***Saissetia coffeae* (Walker)** – hemispherical scale

Occurs widely in tropical and subtropical areas; polyphagous; common on indoor plantings in Britain, especially ferns and orchids.

**Published records.** VC 15: Canterbury, on ferns and orchids, ii.1886 (*G. S. Saunders*) (Douglas, 1886b; Newstead, 1903). VC 16: Deptford, on *Adiantum capillus-veneris*, iv.1887 (*W. Morris*) (Douglas, 1888a) **RHS records.** VC 15: Dover, on *Hoya*, 9.vi.1992; Hythe, on *Nerium oleander*, 19.iii.1984; Maidstone, on *Peperomia*, 10.ii.1977. VC 16: Pembury, on Pteridophyta, 19.x.1998; Sevenoaks, on *Cymbidium*, 30.iv.1993; Royal Tunbridge Wells, on *Nerium oleander*, 23.iv.1982.

***Saissetia oleae* (Olivier)** – black scale

Occurs widely in tropical and subtropical areas; polyphagous; occurs widely on indoor plantings in Britain and has been found breeding outdoors in London.

**Published records.** VC 15: Dover, on *Olea europaea* from Greece, xi.1978 (Seymour & Kilby, 1978); Yalding (*E. E. Green*) (Newstead, 1903). **RHS records.** VC 15: Sittingbourne, 8.x.2007. VC 16: Lewisham, on *O. europaea*, 19.vii.2006; London, on *O. europaea*, 20.x.1999.

**DIASPIDIDAE** – armoured scales***Abgrallaspis cyanophylli* (Signoret)** – cyanophyllum scale

Cosmopolitan; polyphagous; occurs widely in Britain in botanical collections and occasionally found breeding outdoors in southern England.

**Published record.** VC 16: Meopham, on *Calathea picturata*, i.1976 (Seymour, 1978). **Collection data.** VC 16: Tonbridge, nursery, on *Leucospermum cordifolium* from Australia, 30.iv.2008 (*PHSI*).

***Aonidiella aurantii* (Maskell)** – Californian red scale

Occurs widely in tropical, subtropical and warm temperate areas; polyphagous, shows a strong preference for *Citrus*; ubiquitous on citrus fruit imported into Britain and occasionally detected on growing plants. Recently found breeding on *Dracaena* in a botanical collection in West Yorkshire.

**Collection data.** VC 16: Sevenoaks, wholesale, on *Citrus limon* plant from Italy, 19.ii.2008 (*PHSI*).

***Aspidiotus nerii* (Bouché)** – oleander scale

Cosmopolitan; polyphagous; occurs widely in Britain in botanical collections and occasionally found breeding outdoors in southern England.

**Published records.** VC 15: Canterbury, on *Aucuba* and *Dracaena*, ii.1886 (*G. S. Saunders*) (Douglas, 1886c). **RHS records.** VC 15: Beckenham, on *Howea forsteriana*, 1.ix.1988; Chatham, on Arecaceae, 10.x.1988. VC 16: Northfleet, on *Phoenix dactylifera*, 3.iii.1978; Royal Tunbridge Wells, on *Nerium oleander*, 23.iv.1982. **Collection data.** VC 15: Canterbury, nursery, on *Citrus*, 7.vi.2005 (*PHSI*); Hawkhurst, nursery, on *Acacia longifolia* from Italy, 23.xi.2006, 6.xii.2006 (*PHSI*).

***Diaspis boisduvalii* (Signoret) – boisduval scale**

Cosmopolitan; polyphagous; occurs widely in botanical collections in Britain.

**Published record.** VC 16: Paddock Wood, on *Rhapis excelsa* from Spain, xi.1983 (Seymour, Roberts & Kilby, 1985). **Collection data.** VC 15: Wye, nursery, on *Trachycarpus fortunei* from Italy, 5.vi.2007, 21.vi.2007 (*PHSI*).

***Hemiberlesia lataniae* (Signoret) – latania scale**

Cosmopolitan; polyphagous; occurs widely in Britain in botanical collections.

**Published record.** VC 16: South Darenth, on *Nerium* from India, iv.1976 (Seymour, 1978).

***Iscchnaspis longirostris* (Signoret) – black thread scale**

Cosmopolitan; polyphagous; rare in botanical collections in Britain.

**Collection data.** VC 15: Wye college botanical collection, on *Ficus*, ix.1998 (*C. Malumphy*).

***Parlatoria proteus* (Curtis) – proteus scale**

Cosmopolitan; polyphagous; occasionally found in Britain in botanical collections.

**Published record.** VC 15: Maidstone, on orchids from Australia, ix.1977 (Seymour, 1978).

***Pinnaspis strachani* (Cooley) – lesser snow scale**

Occurs widely in the tropics, subtropics and warm temperate regions; polyphagous; recently found breeding on Arecaceae in a botanical collection in West Yorkshire.

**RHS record.** VC 16: London, Greenwich, on Arecaceae, 8.ix.2009.

***Pseudaulacaspis cockerelli* (Cooley) – false oleander scale**

Cosmopolitan; polyphagous; occasionally found in Britain in botanical collections.

**Collection data.** VC 16: Tonbridge, nursery, on *Callistemon phoeniceus*, *Callistemon viminalis* ‘red clusters’, *Callistemon* cv *subulatus* and *Melaleuca steedmanii* from Australia, various dates i.–iii.2009 (*PHSI*).

## NON-ESTABLISHED INTRODUCTIONS

### ORTHEZIIDAE – ensign scales

***Insignorthesia insignis* (Browne) – greenhouse orthezia**

Cosmopolitan; polyphagous; transient populations have occurred at several botanical collections in Britain but there is no recent evidence that it has established.

**Published record.** VC 16: Blackheath, on *Nerine*, vi.1906 (Theobald, 1907). **RHS record.** VC 16: Peckham Rye, on *Solenostemon*, 23.v.1939.

### PSEUDOCOCCIDAE – mealybugs

***Phenacoccus avenae* (Borchsenius) – oat mealybug**

European; polyphagous, on roots, corms and rhizomes of various ornamental plants and inside the leaf sheaths of grasses.

**Published record.** VC 15: Dover, on *Galanthus elwesii* from Turkey, x.1977 (Seymour, 1978, as *Phenacoccus* sp.).

***Phenacoccus hurdi* (McKenzie)** – Hurd's phenacoccus mealybug

Found in North and South America; oligophagous.

**Collection data.** VC 15: Canterbury, nursery, on *Psidium guajava* from the USA, 18.vi and 5.vii.2004 (*PHSI*).

***Planococcus ficus* (Signoret)** – Mediterranean vine mealybug

Pantropical and subtropical; polyphagous.

**Published record.** VC 16: Sidcup, on *Ficus benjamina* from Belgium, ii.1977 (Seymour, 1978).

## DIASPIDIDAE – armoured scales

***Diaspis coccoides* (Lichtenstein)** – cocos scale

Present in North and South America, Caribbean and the Mediterranean; polyphagous on Arecaceae. Some coccidologists consider *D. coccoides* to be a junior synonym of *D. boisduvalii*.

**Published record:** VC 16: Paddock Wood, on *Rhaphis excelsa* from Spain, xi.1983 (Seymour, Roberts & Kilby, 1985).

***Lepidosaphes conchyformis* (Gmelin)** – fig oystershell scale

Found in temperate areas worldwide; polyphagous, most common on *Ficus*; occasionally found in botanical collections in Britain.

**RHS record.** VC 15: Tenterden, on *Ficus carica*, x.1938.

***Lepidosaphes laterochitinosus* (Green)**

Present in Asia and the Pacific region; broadly polyphagous.

**Collection data.** VC 15: Folkestone, on *Codiaeum* sp. (Euphorbiaceae) imported from Sri Lanka, 9.iii.2009.

***Parlatoria* sp.**

There are several species of non-native *Parlatoria* that occur in India and the specimens were in poor condition, preventing identification to species.

**Collection data.** VC 15: Canterbury, nursery, on *Jasminum* from India, 28.ix.2004 (*PHSI*).

***Pseudaulacaspis pentagona* (Targioni Tozzetti)** – white peach scale

Found throughout the warmer areas of the world; polyphagous. Transient populations occurred in Kent on several *Catalpa bignonioides* trees grown outdoors for approximately four or five years; statutory action was taken to eradicate this pest. It has recently been found infesting *Prunus persicae* trees grown indoors in a botanical garden in Cornwall; control measures are being taken.

**Collection data.** VC 15: Ashford, private garden, on *Catalpa bignonioides* from Italy, 12.ix.2006, 13.vi.2007 (*PHSI*).

## ALEYRODOIDEA – whiteflies

Seventeen species of Aleyrodidae were recorded (five native, six naturalised introductions, two introduced species established on indoor plantings and four non-established introductions on growing plants).

## NATIVE AND INTRODUCED NATURALIZED SPECIES

In addition to the whitefly species below, there are slides of *Tetralicia ericae* Harrison deposited at the NHM labelled “?Kent, *Erica tetralix*, E. E. Green, Reference 197/62”. Bink-Moenen (1989) reviewed the whiteflies found on heather in Europe and published a distribution map but did not indicate *T. ericae* from Kent. *Tetralicia ericae* occurs widely in Britain, wherever *E. tetralix* occurs. Although it is likely to occur in Kent, its presence requires confirmation.

***Aleurochiton acerinus* (Haupt)** – field maple whitefly

Central Europe; feeds on *Acer campestre* (Martin *et al.*, 2000); only known from one location in Britain (Dolling & Martin, 1985).

**Published record.** VC 16: Polhill Down, on *Acer campestre* leaf litter, 21 and 27.v.1983 (Dolling & Martin, 1985).

***Aleurochiton aceris* (Modeer)** – Norway maple whitefly

Widespread in Europe; feeds on *Acer platanoides* (Martin *et al.*, 2000); locally common in southern *England*, where its presence was unproven until 1976 (Martin, 1978; Martin *et al.*, 2000).

**Collection data.** VC 16: Sevenoaks, on *A. platanoides*, 2009 (*A. Polazcek*).

***Aleurotuba jelinekii* (Frauenfeld)** – viburnum whitefly (Plate 4, Fig. 5)

European, introduced to North and South America; oligophagous on *Arbutus* and *Viburnum*; very common throughout England in urban areas.

All records are on *V. tinus*. **RHS records.** VC 15: Selling, 25.iv.1988. VC 16: Beckenham, 20.v.1988; Bromley, 25.iii.1974; London, 29.iii.1972; Tonbridge, 15.ii.1960. **Collection data.** VC 15: Bearsted (TQ8055), 22.iv.2011 (*C. Malumphy*); Bilting (TR0549), 24.iv.2011 (*C. Malumphy*); Ramsgate (TR3864), 24.iv.2011 (*C. Malumphy*); Selling (TR0456), 28.viii.2011 (*J. Badmin*); Sittingbourne (TQ9062), 1980 (*J. Badmin*); Tenterden (TQ8833), 20.vii.2011 (*J. Badmin*).

***Aleyrodes lonicerae* (Walker)** – honeysuckle or strawberry whitefly

European; polyphagous; common and widespread in Britain (Mound, 1966; Malumphy, 2010a & b), an occasional pest of honeysuckle and strawberry. This species is likely to be much more widespread and common in Watsonian Kent (particularly on *Fragaria*, *Lonicera* and *Rubus*) than the records below indicate.

**Collection data.** VC 15: Faversham, Lorenden Park, 18.vii.2011 (*S. Springate*); Herne Bay Downs, on *Lonicera*, 28.v.2011 (*R. Moyse & Springate*); Painter’s Forstal, Badgin Wood (TQ0057), on *Lonicera*, 23.vii.2011 (*J. Badmin*); Perry Wood (TR0455), on *Lonicera*, 12.vii.2011 (*J. Badmin*); Selling (TR0456), on *Lonicera*, 10.vii.2011 (*J. Badmin*); Rainham, on *Lonicera*, 4.vi.2011 (*S. Springate*). VC 16: nursery, on *Euphorbia pulcherrima* from Germany, 10.ix.2010 (*PHSI*); Ide Hill (TQ4851), on *L. periclymenum*, 19.vi.2011 (*C. Malumphy*).

***Aleyrodes proletella* L.** – cabbage whitefly

European, spread to many other parts of the world; polyphagous, shows a preference for brassicas and *Chenopodium*; common and widespread throughout Britain (Mound, 1966; Malumphy, 2010a & b) and a frequent pest of *Brassica*.

**Published records.** VC 15: Frittenden and Selling, on *Brassica oleracea*, 1910 (Theobald, 1911). **Collection data.** All records on *B. oleracea*, unless specified otherwise. VC 15: Cliffe, 30.ix.2010 (*J. Shorter*); Doddington, 18.x.2009 (*R. Moyse*); Dover, 13.x.2009, 3.viii.2010 (*S. Springate*); Faversham, Lorenden Park, on *Lactuca serriola*, 18.vii.2011 (*S. Springate*); Folkestone Warren, 29.vii.2009 (*S. Springate*); Grain, 9.x.2009 (*S. Springate*); Kingsdown, 5.vi.2010 (*S. Springate*); Rainham,

2.vi.2009 (*S. Springate*); Ramsgate, 25.iv.2011 (*S. Springate*); St Margarets at Cliffe, 5.vi.2010 (*S. Springate*); Samphire Hoe, 13.x.2009 (*S. Springate*); Selling (TR0456), 6.iv.2011 (*J. Badmin*); Sheldwich (TR0157), on *Chenopodium*, 6.iv.2011 (*J. Badmin*); South Foreland, 13.x.2009 (*S. Springate*); Staplehurst, nursery, on *Euphorbia pulcherrima* from Germany, 15.x.2010 (PHSI); Swanley, 20.x.2010 (*S. Springate*); Tankerton, 23.x.2009 (*S. Thompson*); Worth, 24.iv.2009 (*S. Springate*). VC 16: Borough Green (TQ6057), on *Sonchus*, 22.iv.2011 (*C. Malumphy*); Dartford, on *Euphorbia pulcherrima* from The Netherlands, 9.xi.2006 (PHSI); Four Elms (TQ4648), on *Sonchus*, 19.vi.2011 (*C. Malumphy*); Luddesdown, 4.v.2008 (*S. Springate*); Pembury, 14.ix.2009 (*C. Wallwork*).

***Asterobemisia carpini* (Koch)** – hornbeam whitefly

European; polyphagous, particularly on Rosaceae (Martin *et al.*, 2000); widespread but rarely recorded in Britain. Early instar whitefly larvae suspected to be this species were found at a commercial nursery (VC 16), on *Corylus avellana*, 12.ix.2007 (PHSI).

**Published records.** VC 16: Bexley, on *Carpinus betulus*, 28.v.1881 (Douglas, 1895); Blackheath, on *Rubus*, 15.vi.1891 (Douglas, 1891b). **NHM.** VC 16: Bexley wood, on *Lonicera*, 9.vi.1867 (*J. Douglas*).

***Massilieuodes chittendeni* (Laing)** – rhododendron whitefly

Asian; feeds on *Rhododendron*. Locally common in southern England, rarely recorded.

**Collection data.** VC 15: Saltwood, nursery, on *Rhododendron*, 12.vi.2007 (PHSI).

***Pealius azaleae* (Baker & Moles)** – azalea whitefly

East Asian, introduced to Europe, North America, the Middle East, Australia and New Zealand; feeds on *Rhododendron*; only been recorded from a small number of locations in south east England.

**RHS records.** VC 15: Folkestone, on *Rhododendron* (azalea), 4.ii.1991. VC 16: Hawkhurst, on *R. macranthum*, 29.xi.1968.

***Pealius quercus* (Signoret)** – oak whitefly

European; oligophagous on Betulaceae and Fagaceae; rarely recorded in Britain.

**Published record.** VC 15: Wye, *Quercus*, 1932 (Trehan, 1940). **Collection data.** VC 15: Ambley Wood (TQ7965), on *Quercus robur* (1 puparium), 16.x.2011 (*S. Springate*); Blean Wood (TR0861), on *Carpinus betulus* (not a confirmed host as only one adult found) and *Quercus robur* (20+ adults and eggs), 25.iv.2011 (*C. Malumphy*).

***Siphoninus immaculatus* (Heeger)** – ivy whitefly

Central and northern Europe, and Iran; monophagous on *Hedera*; rarely recorded in Britain, an occasional pest of ornamental ivy (Malumphy, 2010a).

**NHM.** VC 16: Dunton Green, on *H. helix*, iii.1981 (*W. R. Dolling*).

**Collection data.** VC 15: Blean Wood (TR0861), on *H. helix*, 25.iv.2011 (*C. Malumphy*).

***Siphoninus phillyreae* (Halliday)** – ash whitefly (Plate 4, Fig. 6)

Mediterranean species that has spread to many other parts of the World, including southern England; polyphagous; rarely recorded in Britain (Mound, 1966; Malumphy, 2010c). Malumphy (2010c) recorded it damaging ornamental olive plants in a glasshouse in Hampshire.

**NHM.** VC 16: Beckenham, on *Pyrus communis*, x.1950 (*C. B. Williams*), and *Fraxinus excelsior*, 2.x.1988 (*J. H. Martin*).

## INTRODUCED SPECIES ESTABLISHED ON INDOOR PLANTINGS

***Aleurothrixus floccosus* (Maskell)** – woolly whitefly

Present throughout the warmer parts of the World, restricted to indoor plantings in cooler regions; polyphagous, most common on *Citrus*; restricted to a small number of indoor botanical collections in Britain.

**Collection data.** VC 15: Ashford, botanical collection, on *Citrus*, ix.1998 (*C. Mahumphy*).

***Trialeurodes vaporariorum* (Westwood)** – glasshouse whitefly

Cosmopolitan; polyphagous; widespread and very common throughout Britain on indoor plantings, and breeds outdoors during the summer. Theobald (1906) recorded whiteflies feeding on *Ageratum* and *Bouvardia* in Blackheath (VC 16), iii.1905, which are almost certainly this species.

**Published records.** VC 15: Cranbrook, on *Vaccinium* from the Netherlands, xi.1985 (Seymour, Davis & Roberts, 1986b). **RHS records.** The large number of records have been summarised here. VC 15: Acrise Place, Ashford, Bearsted, Broadstairs, Canterbury, Chart Sutton, Chislehurst, Cranbrook, Eastling, Gillingham, Maidstone, Minster, Old Wives Lees, Ramsgate, Sandwich, Shepherdswell, Sittingbourne, Smarden, Tenterden. VC 16: Beckenham, Bermondsey, Biggin Hill, Bromley, Chelsfield, Dartford, Edenbridge, Eynsford, Farningham, Gravesend, Hayes, Hever Castle, Hildenborough, Horsmonden, Kemsing, Keston, London, Orpington, Rochester, Royal Tunbridge Wells, Sevenoaks, Sidcup, Swanley, Tonbridge, West Wickham, on *Abutilon*, *Arum*, *Brassica*, *Brunfelsia*, *Capsicum*, *Cucumis sativus*, *Datura*, *Fuchsia*, *Geranium*, *Gerbera*, *Lantana*, *Lonicera*, *Pelargonium*, *Solanum lycopersicum*, *Sparmannia africana*, *Tagetes* and unidentified plants from 1949 onwards. **Collection data.** VC 15: Sutton Valence and Staplehurst, nurseries, on *Euphorbia pulcherrima*, 28.ix.2007, 25.x.2007 (*PHSI*).

## NON-ESTABLISHED INTRODUCTIONS

***Bemisia tabaci* (Gennadius)** – tobacco whitefly

There is increasing biological and molecular evidence to support the hypothesis that *tabaci* is a complex of cryptic species (De Barro *et al.*, 2011). It is the most geographically widespread, polyphagous, and economically important whitefly pest (group) in the world and is listed in the plant health legislation of the EU. All interceptions on growing plants and incursions on indoor plantings of *B. tabaci* have been, or are being, eradicated under the direction of Fera.

**Published records.** VC 15: Ashford, on *Cucumis sativus* from Oman, xi.1978 (Seymour & Kilby, 1978). VC 16: East Malling, Oaken Wood, on *Veronica* (outdoors), 30.vii.1943 (*A. M. Masee*) (Mound, 1966). **Collection data.** It has been found on *Euphorbia pulcherrima* imported from Germany, Netherlands and Portugal, and on *Psidium guajava* from the USA, at warehouses and plant nurseries throughout VC 15 and 16.

***Orchamoplatus mammaeferus* (Quaintance & Baker)** – croton whitefly

Widespread in Asia, Caribbean, USA and Iran; polyphagous.

**Collection data.** VC 15: Folkestone, on *Codiaeum variegatum* from Sri Lanka, 9.iii.1999 (*PHSI*).

***Dialeurodes kirkaldyi* (Kotinsky)** – Kirkaldy whitefly

Found throughout the warmer parts of the World; polyphagous.

**Collection data.** VC 15: Canterbury, nursery, on *Jasminum* from India, 22–28.ix.2004 (PHSI).

***Dialeurodes vulgaris* (Singh)**

Recorded from India and Iran; polyphagous; a pest of Jasmine.

**Collection data.** VC 15: Canterbury, nursery, on *Jasminum* from India, 22–28.ix.2004 (PHSI).

## DISCUSSION

Seventy-nine species of Coccoidea and 17 species of Aleyrodidae are recorded from Watsonian Kent. Eleven species of scale insect and seven species of whitefly are recorded outdoors in Watsonian Kent for the first time, including *Balanococcus kwoni*, an Asian mealybug new for Britain.

The percentages of scale insect and whitefly species present in Watsonian Kent (including those on indoor plantings and outdoors) that are non-native introductions are 52% and 58%, respectively. This compares with the European average of 30% for scale insects (Pellizzari & Germain, 2010) and 39% for whiteflies (Misfud *et al.*, 2010). A likely reason that the percentages are higher for Watsonian Kent is due in part to Mediterranean species being regarded as non-native in Kent (they are excluded from the work by Pellizzari & Germain (2010)), and in part to the fauna having been more comprehensively studied in the county than in most other areas of Europe.

Most of the non-native scale insect and whiteflies introductions into Kent are likely to have been human-assisted, that is, accidentally brought in on imported plants. Smith *et al.* (2007) highlighted the predominant role of the ornamental plant trade in introducing new plant pests to the European continent. Even those species that are native to southern Europe and the Mediterranean are likely to have been introduced with plant trade, as they have a relatively low natural dispersal potential (adult female scale insects are neotenic, and adult whiteflies are poor fliers). Other factors, however, including natural expansion and range expansions driven by climate change, may have played a minor role. Range expansions within Britain are likely to continue to occur both as a result of climate change and passive dissemination by man, resulting in the spread and increased abundance of many of these species, which are often at the northern limits of their distributions in the UK (Cannon, 1998).

Forty-four per cent of the non-native scale insect species found outdoors in Watsonian Kent are native to Asia and 31% are native to the Mediterranean region. The corresponding percentages for non-native whiteflies in Kent are 60% from Asia and 40% from the Mediterranean region.

Invasive non-native species (animals and plants) are estimated to cost the British economy at least £1.7 billion per annum (Williams *et al.*, 2010) and non-native arthropods alone cause yield losses of £609 million per year for the British Isles, since each year arthropods damage or destroy approximately 10% of the crops, and 30% of these pests are of exotic origin (Pimentel, 2002). Approximately a third (16 spp.) of the scale insect species found outdoors in Watsonian Kent are non-native introductions (Table 1), all of which feed on cultivated, mainly non-native, woody plants, and therefore have a potential direct economic impact. Invasive scale insects have had a major detrimental impact on agriculture in some countries, e.g. USA (Miller *et al.*, 2005). None of the introduced species of scale insect, however, has had a discernible negative impact on native biodiversity, ecosystems or forestry in

Table 1. Non-native scale insects and whiteflies (Hemiptera: Coccoidea and Aleyrodoidea) naturalised in Watsonian Kent, England

FAMILY Species	Origin	Introduction date to UK; Refs.	Main hosts in Britain	Distribution in UK	Impact
<b>ALEYRODIDAE</b>					
<i>Aleurochiton aceris</i>	Europe	1976; Martin, 1978	<i>Acer platanoides</i>	S. England	None
<i>Aleurochiton acerinus</i>	Europe	1983; Dolling & Martin, 1985	<i>Acer campestre</i>	Single location in Kent	None
<i>Aleurotuba jelinekii</i>	Mediterranean	1936; Mound, 1962	<i>Viburnum tinus</i>	Widespread	Occasional, sooty mould
<i>Massilieuodes chittendeni</i>	Northern Asia	1928; Laing, 1928	<i>Rhododendron</i>	Local in S. England	Rare, minor
<i>Pedilus azaleae</i>	Eastern Asia	1930s; Mound, 1966	<i>Rhododendron</i>	Local in S.E. England	Rare, minor
<i>Siphoninus phillyreae</i>	Mediterranean	?early 20th C.; Mound, 1966	Polyphagous, <i>Crataegus</i> , <i>Fraxinus</i> , <i>Olea</i>	Local in S. England	Rare, sooty mould
<b>COCCIDAE</b>					
<i>Coccus hesperidum</i>	Tropical	1843; Curtis, 1843	Polyphagous, <i>Hedera</i> , <i>Ilex</i> , <i>Laurus</i>	Widespread	Occasional leaf loss and dieback
<i>Eulecanium excrescens</i>	Asia	1998; Malumphy, 2005	Polyphagous, <i>Wisteria</i>	Greater London, spreading	Occasional die-back
<i>Parthenolecanium persicae</i>	?Mediterranean	1940s; Boratynski & Williams, 1964	Polyphagous, <i>Vitis</i>	Widespread	Occasional pest, sooty mould
<i>Parthenolecanium pomericum</i>	Europe	1928; Green, 1930	<i>Taxus baccata</i>	Widespread	Occasional dieback
<i>Pulvinaria floccifera</i>	Asia – temperate	1886; Douglas, 1886b	Polyphagous, <i>Ilex</i> , <i>Rhododendron</i> , <i>Taxus</i>	Widespread	Frequent serious pest, sooty mould, leaf loss, dieback
<i>Pulvinaria hydrangeae</i>	Asia – temperate	1987; Halstead, 1992	Polyphagous, <i>Hydrangea</i> , <i>Viburnum</i>	Widespread	Disfigures plants with waxy ovisacs
<i>Pulvinaria regalis</i>	Asia – temperate	1964; Canard, 1968	Polyphagous, <i>Acer</i> , <i>Aesculus</i> , <i>Tilia</i> , <i>Ulmus</i>	Widespread	Disfigures plants with waxy ovisacs
<b>DIASPIDIDAE</b>					
<i>Aulacaspis rosae</i>	Mediterranean	1880s; Douglas, 1887b	<i>Rosa</i> , <i>Rubus</i>	Local, southern England	Occasional dieback
<i>Carulaspis juniperi</i>	Mediterranean	?1950s; Boratynski, 1957	Cupressaceae	Common, S. England	Occasional severe chlorosis
<i>Carulaspis minima</i>	Mediterranean	1898; Newstead, 1900, 1901	Cupressaceae	Common, widespread	Occasional severe chlorosis
<i>Diaspidiotus pyri</i>	Mediterranean	1916; Boratynski & Williams, 1964	<i>Prunus</i> , <i>Pyrus</i> , <i>Malus</i>	Locally abundant in S. England	Occasional leaf loss, dieback, disfigures fruit
<i>Dynaspidiotus britannicus</i>	Asia	1896; Newstead, 1901	<i>Buxus</i> , <i>Ilex</i>	Local	Occasional severe chlorosis
<i>Unaspis euonymi</i>	Eastern Asia – temperate	1950s; Dennis, 1969	<i>Euonymus</i>	Widespread	Leaf loss, dieback, regularly kills plants
<b>MONOPLEBIDAE</b>					
<i>Icerya purchasi</i>	Australia	1996; Watson & Malumphy, 2004	Polyphagous, <i>Acacia</i> , <i>Citrus</i> , <i>Laurus</i> , <i>Pittosporum</i>	Greater London	Occasional leaf loss, dieback and rarely death
<b>PSEUDOCOCCIDAE</b>					
<i>Balanococcus diminutus</i>	New Zealand	1970s; Bartlett, 1981	<i>Phormium tenax</i>	Widespread	Occasional dieback and rarely death
<i>Balanococcus kwoni</i>	South Korea	1990s; recorded here	bamboo	Widespread	Disfigures plants with wax



Watsonian Kent (or elsewhere in Britain). There may, however, be long-term impacts due to progressive debilitation caused by infestations, or changes in host range and phenology, that have so far not been observed, but which have been recorded for other introduced insects. There is no evidence of direct competition between non-native introduced species and native species although several species share the same hosts (particularly in the Rosaceae). Only one species, *Diaspidiotus pyri*, has been reported to be an occasional minor pest of deciduous fruit trees (especially apple) in Kent (Boratynski, 1977). It can lower the market value of produce by causing uneven ripening (spotting) and discolouring of fruit. There is, however, very little published on the economic importance of *D. pyri* in Britain, and it appears to be far less damaging to fruit trees and occurs less frequently on fruit than the native *Lepidosaphes ulmi* (the latter is commonly found on Kentish apples for sale in the UK, although they are completely harmless to human health). On rare occasions the presence of non-native scale insects (for example, *Parthenolecanium pomericum* and *P. floccifera* on *Taxus*) on plants at a commercial nursery has prevented the PHSI from issuing a plant passport to allow plants to be exported (Fera, unpublished data). This can result in considerable costs to an individual nursery.

Non-native scale insects do have an economic impact on plants in urban areas (gardens, parkland, amenity areas and roadsides) where they are often more abundant and damaging than native scale insect species. For example, 70% of the scale insect species submitted to the RHS Advisory Services from RHS members in Kent during 2010 were non-native (Andrew Salisbury, RHS, pers. comm., 2011). All of the non-native species found in Kent have occasionally been recorded causing serious damage (leaf loss, dieback and even death), usually to individual plants in urban areas, in England. The most common scale insects in urban areas in Kent are *Pulvinaria floccifera* and *P. regalis*, followed by *P. hydrangeae* and *Unaspis euonymi*, all suspected to be Asian in origin. *Pulvinaria* species cause a loss of aesthetic appeal to ornamental and amenity plants due to the conspicuous waxy ovisacs and the black sooty moulds that grow on the sticky honeydew excreted by the scales. Mature trees, however, can withstand enormous populations of *Pulvinaria* scales, although they are likely to have reduced vigour over time. The frequency of *P. floccifera* and *P. regalis* can be demonstrated by the fact that they were the third and eighth most commonly reported garden pests to the RHS Members' Advisory service during 2010. They are also the scale insect species that members of the public report most frequently to Fera. Individual *Euonymus* plants, and occasionally whole *Euonymus* hedges, suffer serious dieback and may be killed by large infestations of *U. euonymi*. *Aulacaspis rosae* is an occasional pest of roses in southern England but also has the potential to be a pest of deciduous fruit trees (Kozár, 1990). *Carulaspis juniperi* and *C. minima* are widespread and common in southern England and can cause serious chlorosis to Cupressaceae. *Balanococcus diminutus* is an occasional pest of *Phormium tenax*, killing susceptible plants (Malumphy, 2009b). *Eulecanium excrescens* is a pest of *Wisteria* and is spreading in South East England (Salisbury, Halstead & Malumphy, 2010). *Icerya purchasi* is a serious polyphagous pest of indoor plantings throughout Britain and outdoors in London (especially of *Laurus nobilis*) (Watson & Malumphy, 2004). *Parthenolecanium persicae* is an occasional pest of *Vitis vinifera* and *Prunus* sp. growing in sunny sheltered situations, such as against a southern facing wall, but it has not yet been recorded as a pest in commercial vineyards or orchards in Britain.

Non-native scale insects incur costs in terms of insecticides (and biocontrol agents on indoor plantings), replacement of plants, and lowering the market value of ornamentals and produce. There is, however, no detailed information available to

determine the economic impact due to introduced non-native scale insects, either in Kent or in the rest of Britain. The cost will inevitably vary from year to year as the scale insect populations fluctuate. The social (e.g. aesthetic) impacts are harder to quantify, but are likely to be important, particularly for gardeners if their plants suffer severe damage or are killed.

Very high levels of mortality (90–99%) were observed in large populations of *P. regalis* in Ramsgate during April 2011 due to a naturally occurring entomopathogenic fungus *Lecanicillium* sp. (*Hypocreales*: *Clavicipitaceae*). The fungus was also observed attacking other coccid species (native and non-native) including *P. floccifera*, *P. vitis* and *L. viburni*. The author has observed *Lecanicillium* sp. causing similar high levels of mortality to coccids in several locations throughout England and it has also been observed causing high levels of mortality to *P. regalis* in Cardiff, Wales (C. Hodgson, pers. comm., 2011).

It is possible that some non-native introduced scale insects may be beneficial for biodiversity as they provide food directly for native insectivorous species (e.g. Coccinellidae, Chrysopidae and birds), or indirectly by excreting honeydew on which native insects may feed (e.g. Formicidae, Apiidae, and Syrphidae), although this thesis requires further investigation.

Approximately half of the whitefly species found outdoors in Kent (six spp.) are non-native introductions (Table 1). Although some of the introduced whiteflies have become occasional, local, minor pests (often of individual ornamental woody plants in urban gardens), none of them have had a significant impact to biodiversity, ecosystems, forestry, crops or urban plantings. *Aleurotuba jelinekii* is the most common naturalised whitefly in urban areas in England, but only feeds on *Arbutus unedo* and *Viburnum tinus*. It frequently occurs in enormous numbers, but appears to have little or no detrimental impact. It is possible, however, that the impact and distribution of introduced non-native whiteflies could change as a result of climate change (Hellmann *et al.*, 2008).

One likely reason that non-native scale insects are more frequent than native scales in urban areas is that their non-native host plants are commonly planted. For example, 70% of all plant species found in gardens in cities located throughout the UK are non-native and the majority (66%) of the 50 most commonly recorded species (including weeds) are non-native (Loram *et al.*, 2008). Fifteen (30%) of the 50 plant species most frequently found in UK city gardens are host plants for non-native scale insect and whitefly species naturalized in Kent (see Table 2) (Loram *et al.*, 2008). The non-native plants *Laurus nobilis*, *Prunus* spp., *Rhododendron* spp. and *Rosa* spp. are host to four or more of the non-native scale insect and whitefly species naturalised in Kent.

The abundance of non-native scales in urban areas may also be due to factors such as pollution affecting host stress and susceptibility. For example, Alford, Cronin & Ponsonby (1998) investigated *Pulvinaria regalis* on *Acer*, *Aesculus* and *Tilia* in rural and urban areas of Kent and South London related to environmental factors such as stress due to poor growing conditions, traffic volume and nitrogen dioxide levels. A significant positive relationship was found between the mean scale insect infestation levels and the maximum monthly NO<sub>2</sub> levels.

Moraal & Jagers op Akkerhuis (2011) stated that *P. hydrangeae* and *P. regalis* feed exclusively on trees in cities in the Netherlands. This is not true in Kent or elsewhere in Britain (and very unlikely in the Netherlands) where *P. regalis* is common in rural areas in gardens, roadsides and natural habitats, particularly on *Acer pseudoplatanus*. It occurs, however, at much lower densities than observed in cities and is therefore much more difficult to detect. *Pulvinaria hydrangeae* also occurs in rural areas but is

less common, probably due to its preferred hosts being less commonly available. *Pulvinaria floccifera* is common and widespread in rural areas, both in gardens and in natural habitats, wherever its preferred hosts *Ilex* and *Rhododendron* are found.

The detrimental economic impact of non-native scale insects and whiteflies to indoor plantings in Britain, to ornamentals and vegetable crops, is far more significant. For example, *Coccus hesperidum* and *Trialeurodes vaporariorum* are among the most common pests of indoor plants throughout Kent (and the rest of Britain) and frequently require control measures. *Coccus hesperidum* is also widely naturalised and *T. vaporariorum* occurs commonly outdoors during the summer but populations rarely develop to damaging levels. There are also three species of mealybug which are very common and widespread on indoor plantings throughout Britain: *Planococcus citri*, *Pseudococcus longispinus* and *P. viburni*. The UK has protected zone (PZ) status against the quarantine-listed whitefly *Bemisia tabaci*. The costs to the horticultural industry of maintaining the PZ status are considerable; for example, the pest management costs alone of eradicating an outbreak of *B. tabaci* at an ornamental nursery range between £81 and £321 per 0.1 ha, depending on whether biological control agents are used. Cost-benefit ratios calculated in 2010, however, favour maintaining the current PZ status (Fera, 2010).

The importance of Watsonian Kent, in terms of monitoring introduced non-native species, may be demonstrated by the fact that it is the only county in Britain where the following non-native species have been recorded breeding outdoors: *Aleurochiton acerinus*, *B. tabaci*, *Pseudaulacaspis cockerelli* and *P. pentagona*. *Aleurochiton acerinus* feeds exclusively on *Acer campestre* and is only recorded from a single location in Britain (Polhill Down). *Bemisia tabaci* is an economically important worldwide pest, a vector of more than 111 plant pathogenic viruses, and listed in the top 100 of the worst non-native invasive species in Europe ([Table 2. A list of non-native plants commonly found in urban gardens in the UK that are hosts for non-native scale insect and whitefly species found in Watsonian Kent](http://www.europe-</a></p></div><div data-bbox=)

Host family	Host species	Scale insect and whitefly species
Celastraceae	<i>Euonymus fortunei</i>	<i>Unaspis euonymi</i>
Cupressaceae	<i>X Cupressocyparis leylandii</i>	<i>Carulaspis juniperi</i> , <i>C. minima</i>
Ericaceae	<i>Rhododendron</i> spp.	<i>Coccus hesperidum</i> , <i>Massilieuodes chittendeni</i> , <i>Pealius azaleae</i> , <i>Pulvinaria floccifera</i>
Hydrangeaceae	<i>Hydrangea macrophylla</i>	<i>Pulvinaria hydrangeae</i>
Lamiaceae	<i>Rosmarinus officinalis</i>	<i>Coccus hesperidum</i>
Lauraceae	<i>Laurus nobilis</i>	<i>Coccus hesperidum</i> , <i>Dynaspidiotus britannicus</i> , <i>Icerya purchasi</i> , <i>Pulvinaria regalis</i>
Oleaceae	<i>Forsythia</i> × <i>intermedia</i>	<i>Parthenolecanium persicae</i>
Onagraceae	<i>Fuchsia</i> spp.	<i>Coccus hesperidum</i>
Ranunculaceae	<i>Clematis</i> spp.	<i>Coccus hesperidum</i> , <i>Parthenolecanium persicae</i>
Rosaceae	<i>Fragaria</i> × <i>ananassa</i>	<i>Aulacaspis rosae</i>
	* <i>Cotoneaster</i> spp.	<i>Coccus hesperidum</i> , <i>Icerya purchasi</i> , <i>Siphoninus phillyreae</i>
	<i>Malus domestica</i>	<i>Diaspidiotus pyri</i> , <i>Pulvinaria hydrangeae</i> , <i>P. regalis</i> , <i>Siphoninus phillyreae</i>
	* <i>Prunus</i> spp.	<i>Coccus hesperidum</i> , <i>Diaspidiotus pyri</i> , <i>Dynaspidiotus britannicus</i> , <i>Icerya purchasi</i> , <i>Parthenolecanium persicae</i> , <i>Pulvinaria floccifera</i> , <i>P. hydrangeae</i> , <i>Siphoninus phillyreae</i> , <i>Unaspis euonymi</i>
	* <i>Rosa</i> spp.	<i>Aulacaspis rosae</i> , <i>Coccus hesperidum</i> , <i>Icerya purchasi</i> , <i>Pulvinaria floccifera</i> , <i>P. regalis</i>
Sapindaceae	<i>Acer palmatum</i>	<i>Pulvinaria regalis</i>

\*Native plant species assigned to these genera are excluded from this study

[aliens.org/species/TheWorst.do](http://aliens.org/species/TheWorst.do)). It has only been recorded breeding outdoors once (transient population) in Britain (Oaken Wood, VC 16) and it is not currently established in Britain. *Pseudaulacaspis cockerelli* is an important pest of ornamental plants in the Mediterranean region and is currently only known to be established on indoor plantings at a single botanical garden in Britain. It has only been recorded breeding outdoors once in Britain (at a commercial plant nursery in VC 16). *Pseudaulacaspis pentagona* is a major pest of ornamental plants and some fruit trees in Europe and is not currently established in Britain (control measures are currently being taken against a single incursion on peach trees grown indoors in Cornwall), it has been recorded breeding outdoors at a single location in Britain (at a private garden in VC 15).

The frequency of non-native scale insects and whiteflies in Kent has increased during the last century. For example, Green (1895) studied the coccoid fauna in great detail around Bearsted in the 1890s where he found one non-native introduced species outdoors (*Aulacaspis rosae*). The first author found four non-native species (*Carulaspis juniperi*, *Parthenolecanium pomericum*, *Pulvinaria floccifera* and *P. regalis*), during a brief visit to Bearsted in April 2011. *Pulvinaria regalis* was by far the most widespread and common species of the scale insects observed. The only whitefly found was the non-native *Aleurotuba jelinekii*.

Non-native scale insects and whiteflies will inevitably continue to be accidentally introduced to Watsonian Kent and some will become naturalised. There are two Asian species which occur widely in continental Europe that could potentially have a greater detrimental impact, if they become naturalised in Kent, than previous non-native introductions. The San José scale *Diaspidiotus perniciosus* (Comstock) and *Pseudaulacaspis pentagona* (see above). *Diaspidiotus perniciosus* is a broadly polyphagous, destructive pest of deciduous fruit trees which could establish in the UK and on rare occasions become a serious pest in Kentish orchards, although the impact is likely to be negligible in most years (MacLeod, 2009). The unregulated movement of many of their host plants within the EU provides a pathway of introduction and it may be only a matter of time before they become naturalised in Kent and elsewhere in Britain.

#### ACKNOWLEDGEMENTS

The authors would like to thank the following for supplying information on scale insects and whiteflies in Kent; Clare Caless of Maidstone Museum, Tony Witts of Kent & Medway Biological Records Centre, Andrew Halstead and Andy Salisbury of the Royal Horticultural Society, Andy Polazcek of the Natural History Museum, and Simon Springate of the Natural Resources Institute, Chatham; Dr Jon Martin for allowing access to the NHM collections; Monica Malumphy and Lorraine Morgan for their hospitality, while CM and his family visited Kent; and Gillian Watson, formerly of the International Institute of Entomology, for identifying *Phenacoccus hurdi*. Thanks are also due to Tony Witts for preparing the distribution map of *P. regalis*. This work was partly funded by Defra.

#### REFERENCES

- Alford, J., Cronin, M. & Ponsonby, D. 1998. Effect of host plant and selected environmental factors on the abundance of *Pulvinaria regalis* Canard. 10. VIIIth International Symposium on Scale Insect Studies, Wye, UK. 41 pp.

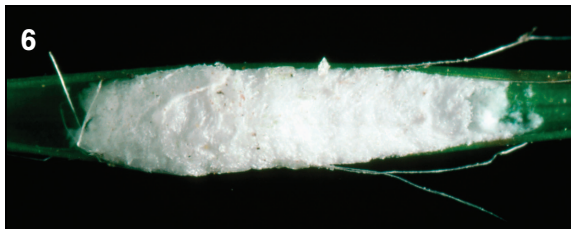
- Badmin, J. 1990. First records of horse chestnut scale in Kent. *Bulletin of the Kent Field Club* **35**: 44–45.
- Badmin, J. 1992. Horse-chestnut scale *Pulvinaria regalis* Canard (Hem., Coccidae) in Kent. *Entomologist's Monthly Magazine* **128**: 118.
- Bartlett, P. W. 1981. *Trionymus diminutus* (Leonardi) (Homoptera: Pseudococcidae) infesting New Zealand flax in England. *Plant Pathology* **30**: 56–58.
- Ben-Dov, Y., Miller, D. R. & Gibson, G. A. P. December 2010. ScaleNet. <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>. Accessed 5 July 2011.
- Bink-Moenen, R. M. 1989. A new species and new records of European whiteflies (Homoptera: Aleyrodidae) from heathers (*Erica* spp.). *Entomologist's Gazette* **40**: 173–181.
- Boratynski, K. L. 1957. On the two species of the genus *Carulaspis* MacGillivray (Homoptera: Coccoidea, Diaspidini) in Britain. *Entomologist's Monthly Magazine* **93**: 246–251.
- Boratynski, K. L. & Williams, D. J. 1964. A note on some British Coccoidea, with new additions to the British Fauna. *Proceedings of the Royal Entomological Society of London, Series B: Taxonomy* **33**: 103–110.
- Boratynski, K. L. 1977. Scale insects on fruit trees. Advisory Leaflet, Ministry of Agriculture, Fisheries, and Food. London 88 (Rev.): 7 pp.
- Canard, M. 1968. Un nouveau *Pulvinaria* (Hom. Coccoidea) nuisible aux arbres d'alignement dans la région Parisienne. *Annales de la Société Entomologique de France (NS)* **4**: 951–958.
- Cannon, R. J. C. 1998. The implications of predicted climate change for insect pests in the UK, with emphasis on non-indigenous species. *Global Change Biology* **4**, 785–796.
- Curtis, J. (Ruricola) 1843. *Coccus patellaeformis* (Curtis). The brown limpet-scale. *Gardeners' Chronicle and Agricultural Gazette* **30**: 517–518.
- 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.
- Dennis, E. B., 1969. Control of *Euonymus* scale. *Plant Pathology* **1**: 78–82.
- Dolling, W. R. 1991. *The Hemiptera*. 276 pp. Oxford University Press.
- Dolling, W. R. & Martin, J.H. 1985. *Aleurochiton acerinus* Haupt, a maple-feeding whitefly new to Britain. *Entomologist's Monthly Magazine* **121**: 143–144.
- Douglas, J. W. 1881. XVII. Observations on the species of the homopterous genus *Orthezia* with a description of a new species. *Transactions of the London Entomological Society* 1881: 297–303.
- Douglas, J. W. 1885. Note on some British Coccidae. *Entomologist's Monthly Magazine* **22**: 157–160.
- Douglas, J. W. 1886a. Notes on some British Coccidae (No. 2). *Entomologist's Monthly Magazine* **22**: 243–250.
- Douglas, J. W. 1886b. Note on some British Coccidae (No. 4). *Entomologist's Monthly Magazine* **23**: 77–82.
- Douglas, J. W. 1886c. Notes on some British Coccidae (No. 5). *Entomologist's Monthly Magazine* **23**: 150–155.
- Douglas, J. W. 1887a. Note on some British Coccidae (No. 6). *Entomologist's Monthly Magazine* **23**: 239–243.
- Douglas, J. W. 1887b. Note on some British Coccidae (No. 7). *Entomologist's Monthly Magazine* **24**: 21–28.
- Douglas, J. W. 1887c. Note on some British Coccidae (No. 8). *Entomologist's Monthly Magazine* **24**: 95–101, 165–171.
- Douglas, J. W. 1888a. Notes on some British and exotic Coccidae (No. 9). *Entomologist's Monthly Magazine* **25**: 57–60.
- Douglas, J. W. 1888b. Notes on some British and exotic Coccidae (No. 10). *Entomologist's Monthly Magazine* **25**: 86–89.
- Douglas, J. W. 1888c. Notes on some British and exotic Coccidae (No. 11). *Entomologist's Monthly Magazine* **25**: 124–125.
- Douglas, J. W. 1891a. Notes on some British and exotic Coccidae (No. 20). *Entomologist's Monthly Magazine* **27**: 95–100.
- Douglas, J. W. 1891b. A new species of *Aleurodes*? *Entomologist's Monthly Magazine* **27**: 200.

- Douglas, J. W. 1891c. Notes on some British and exotic Coccidae (No. 21). *Entomologist's Monthly Magazine* **27**: 244–247.
- Douglas, J. W. 1891d. *Pulvinaria oxyacanthae*, Linn. *Entomologist's Monthly Magazine* **27**: 307.
- Douglas, J. W. 1892a. Notes on some British and exotic Coccidae (No. 22). *Entomologist's Monthly Magazine* **28**: 105–107.
- Douglas, J. W. 1892b. Notes on some British and exotic Coccidae (No. 24). *Entomologist's Monthly Magazine* **28**: 278–280.
- Douglas, J. W. 1895. On *Aleurodes carpini* Koch. *Entomologist's Monthly Magazine* **31**: 117–118.
- Fera, 2010. Consultation on the Protected Zone Status of *Bemisia tabaci*. <http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/bemisiaConsultPaper.pdf>
- Green, E. E. 1895. Notes on coccids from Kent. *Entomologist's Monthly Magazine* **31**: 229–233.
- Green, E. E. 1915. Observations on British Coccidae in 1914, with descriptions of new species. *Entomologist's Monthly Magazine* (ser. 3) **51**: 175–185.
- Green, E. E. 1916. On two new British Coccidae, with notes on some other British species. *Entomologist's Monthly Magazine* **52**: 23–31.
- Green, E. E. 1928. Observations on British Coccidae - XI. With descriptions of new species. *Entomologist's Monthly Magazine* **64**: 20–31.
- Green, E. E. 1930. Observations on British Coccidae. - XII. *Entomologist's Monthly Magazine* **66**: 9–17.
- Halstead, A. J. 1992. The 1991 Presidential Address – Part 2. Some Horticultural Pests to Britain in Recent Years. *British Journal of Entomology and Natural History* **5**: 41–47.
- Halstead, A. & Harris, K. 2011. The aquilegia flower bud gall midge *Macrolabis aquilegiae* (Keiffer) (Diptera: Cecidomyiidae) confirmed as being present in Britain. *Cecidology* **26**: 2–3.
- Hellmann, J. A., Byers, J. E., Bierwagen, B. G. & Dukes, J. S. 2008. Five potential consequences of climate change for invasive species. *Conservation Biology* **22**: 534–543.
- Kosztarab, M. & Kozár, F. 1988. *Scale Insects of Central Europe*. Akademiai Kiado, Budapest. 456 pp.
- Kozár, F., 1990. 3.9.7 Deciduous fruit trees. In: D. Rosen (ed.), *Armoured scale insects, their biology, natural enemies and control. Vol. 4B. World Crop Pests*. Elsevier, Amsterdam, the Netherlands: 593–602.
- Laing, F. 1928. Description of a white fly pest of rhododendrons. *Entomologist's Monthly Magazine* **64**: 228–230.
- Loram, A., Thompson, K., Warren, P. H. & Gaston, K. J. 2009. Urban domestic gardens (XII): The richness and composition of the flora in five UK cities. *Journal of Vegetation Science* **19** (3): 321–330.
- MacLeod, A. 2009. Pest Risk Analysis for *Diaspidiotus perniciosus*. The Food and Environment Research Agency, York, UK. April 2009. 10 pp. <http://fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/sanJoseScale.pdf>
- Malumphy, C. 2002. *Parasaissetia nigra*. Diagnostic protocols for regulated pests. *OEPP/EPPO Bulletin* **32**: 293–298.
- Malumphy, C. P. 2005. *Eulecanium excrescens* (Ferris) (Hemiptera: Coccidae), an Asian pest of woody ornamentals and fruit trees, new to Britain. *British Journal of Entomology and Natural History* **18**: 45–49.
- Malumphy, C. P. 2009a. Confirmation of the presence of small spruce bud scale, *Physokermes hemicryphus* (Dalman) (Hemiptera: Coccidae), in Britain. *British Journal of Entomology and Natural History* **22**, 15–22.
- Malumphy, C. 2009b. The scale insects (Hemiptera: Coccoidea) of Watsonian Yorkshire. *The Naturalist* **134**: 57–74.
- Malumphy, C. 2010a. Whiteflies (Hemiptera: Aleyrodidae) of Watsonian Yorkshire. *Naturalist* **135**: 3–13.
- Malumphy, C. 2010b. The scale insects and whiteflies (Hemiptera: Coccoidea, Aleyrodidae) of Bedfordshire. *British Journal of Entomology and Natural History* **23**: 243–257.
- Malumphy, C. 2010c. Ash whitefly, *Siphoninus phillyreae* (Haliday) (Hemiptera: Aleyrodidae), damaging olive plants for the first time in Britain. *Entomologists Monthly Magazine* **146**: 207–8.

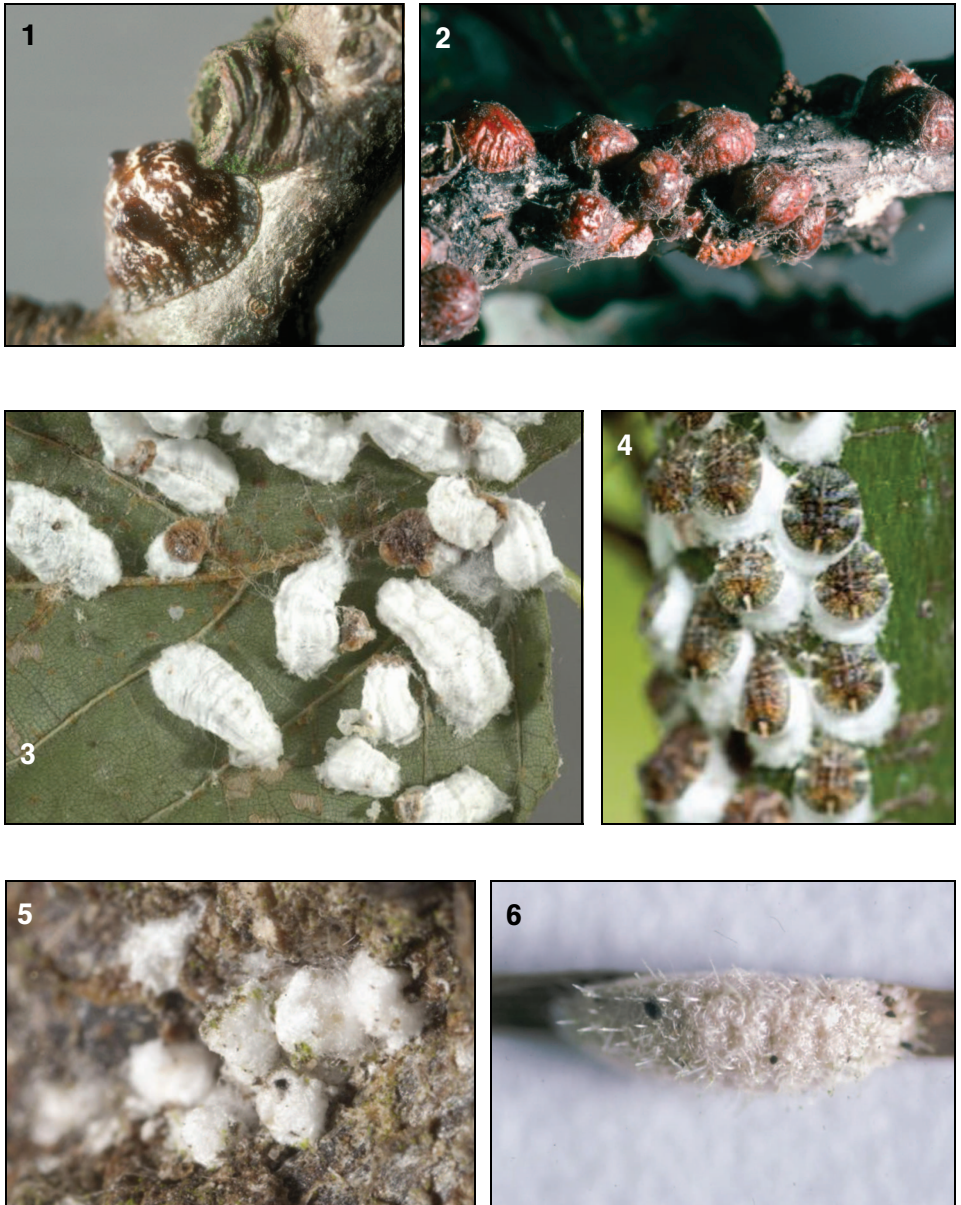
- Malumphy, C. & Badmin, J. 2007. The occurrence of soft scales (Coccidae) on ornamental yew, *Taxus baccata*. *British Journal of Entomology and Natural History* **20**: 153.
- Malumphy, C., Botting, J., Bantock, T. & Reid, S. 2008. Influx of *Leptoglossus occidentalis* Heidemann (Coreidae) in England. *Het News* **12**, 7–9.
- Malumphy, C., Halstead, A. & Salisbury, A. 2011. Changes in pest status and distribution of yew scale *Parthenolecanium pomranicum* (Kawecki) (Hemiptera: Coccidae) in Britain between 1944 and 2010. *British Journal of Entomology and Natural History* **24**, 133–138.
- Martin, J. H. 1978. *Aleurochiton complanatus* (Baerensprung) (Aleyrodidae) – confirmation of occurrence in Britain. *Entomologists Monthly Magazine* **113**: 7.
- Martin, J. H., Misfud, D. & Rapisarda, C. 2000. The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean. *Bulletin of Entomological Research* **90**: 407–448.
- Martin J. H. & Mound L. A. 2007. An annotated checklist of the world's Aleyrodidae (Insecta: Hemiptera: Sternorrhyncha). *Zootaxa*. **1492**: 1–84.
- Mifsud, D., Cocquempot, C., Mühlethaler, R., Wilson, M. & Streito, J. 2010. Other Hemiptera Sternorrhyncha (Aleyrodidae, Phylloxeroidea, and Psylloidea) and Hemiptera Auchenorrhyncha. In *BioRisk 4(1) Alien Terrestrial Arthropods of Europe*, pp 511–552.
- Miller, D., Miller, G., Hodges, G. & Davidson, J. 2005. Introduced Scale Insects (Hemiptera: Coccoidea) of the United States and Their Impact on U.S. Agriculture. *Proceedings of the Entomological Society of Washington* **107**: 123–158.
- Moraal, L. G. & Jagers op Akkerhuis, G. A. J. M. 2011. Changing patterns in insect pests on trees in The Netherlands since 1946 in relation to human induced habitat changes and climate factors. An analysis of historical data. *Forest Ecology and Management* **261**: 50–61.
- Mound, L. A. 1962. *Aleurotrachelus jelinekii* (Frauen.) (Homoptera, Aleyrodidae), in Southern England. *Entomologists Monthly Magazine* **97**: 196–197.
- Mound, L. A. 1966. A revision of the British Aleyrodidae (Hemiptera: Homoptera). *Bulletin of the British Museum (Natural History) Entomology* **17**: 399–428.
- Newstead, R. 1900. The injurious scale insects and mealy bugs of the British Isles. *Journal of the Royal Horticultural Society* **23**: 219–262.
- Newstead, R. 1901. *Monograph of the Coccidae of the British Isles*. Ray Society, London. 220 pp.
- Newstead, R. 1903. *Monograph of the Coccidae of the British Isles*. Vol. 2. Ray Society, London. 270 pp.
- Pellizzari, G. & Danzig, E. M. 2007. The bamboo mealybugs *Balanococcus kwoni* n.sp. and *Palmicultor lumpurensis* (Takahashi) (Hemiptera, Pseudococcidae) *Zootaxa* **1583**: 65–68.
- Pellizzari, G. & Germain, J. 2010. Scales (Hemiptera, Superfamily Coccoidea). In *BioRisk 4(1) Alien Terrestrial Arthropods of Europe*. pp 475–510.
- Pimentel, D., 2002. Non-native invasive species of arthropods and plant pathogens in the British Isles. In: Pimentel, D. (Ed) *Biological Invasions. Economic and Environmental costs of Alien Plants, Animal and Microbe Species*. Boca Raton, USA: CRC Press, 151–155.
- Salisbury, A., Halstead, A. J. & Malumphy, C. 2010. Wisteria scale, *Eulecanium excrescens* (Ferris), (Hemiptera: Coccidae) spreading in South East England. *British Journal of Entomology and Natural History* **23**, 225–228.
- Seymour, P. R. 1978. *Insects and other invertebrates intercepted in check inspections of imported plant material in England and Wales during 1977 and 1977*. MAFF. 54 pp.
- Seymour, P. R., Davis, M. E. & Roberts, H. 1986a. *Insects and other invertebrates found in plant material imported into England and Wales, 1982*. MAFF (Publications) Reference Book 442/82. 85 pp.
- Seymour, P. R., Davis, M. E. & Roberts, H. 1986b. *Insects and other invertebrates found in plant material imported into England and Wales, 1985*. MAFF (Publications) Reference Book 442/85. 72 pp.
- Seymour, P. R. & Kilby, L. J. 1978. *Insects and other invertebrates intercepted in check inspections of imported plant material in England and Wales during 1978*. MAFF. 33 pp.
- Seymour, P. R. & Kilby, L. J. 1979. *Insects and other invertebrates intercepted in check inspections of imported plant material in England and Wales during 1979*. MAFF. 29 pp.
- Seymour, P. R., Roberts, H. & Kilby, L. J. 1985. *Insects and other invertebrates found in plant material imported into England and Wales, 1983*. MAFF (Publications) Reference Book 442/83. 68 pp.

- Smith, R. M., Baker, R. H. A., Malumphy, C. P., Hockland, S., Hammon, R. P., Ostoj -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.
- Theobald, F. V. 1904. Report on economic zoology. *The Journal of the South-eastern Agricultural College, Wye, Kent* **13**: 231 pp.
- Theobald, F. V. 1905. Report on economic zoology. *The Journal of the South-eastern Agricultural College, Wye, Kent* **14**: 274 pp.
- Theobald, F. V. 1906. Report on economic zoology. *The Journal of the South-eastern Agricultural College, Wye, Kent* **15**: 288 pp.
- Theobald, F. V. 1907. Report on economic zoology for the year ending April 1st, 1907. *The Journal of the South-eastern Agricultural College, Wye, Kent* **16**: 429 pp.
- Theobald, F. V. 1908. Report on economic zoology for the year ending April 1st, 1908. *The Journal of the South-eastern Agricultural College, Wye, Kent* **17**: 478 pp.
- Theobald, F. V. 1910. Report on economic zoology for the year ending April 1st, 1910. *The Journal of the South-eastern Agricultural College, Wye, Kent* **19**: 426 pp.
- Theobald, F. V. 1911. Report on economic zoology for the year ending April 1st, 1911. *The Journal of the South-eastern Agricultural College, Wye, Kent* **20**: 519 pp.
- Theobald, F. V. 1912. Report on economic zoology for the year ending April 1st, 1912. *The Journal of the South-eastern Agricultural College, Wye, Kent* **21**: 476 pp.
- Theobald, F. V. 1913. Report on economic zoology for the year ending April 1st, 1913. *The Journal of the South-eastern Agricultural College, Wye, Kent* **22**: 561 pp.
- Tilbury, C. & Evans, H. 2003. Exotic Pest Alert Horse chestnut leaf miner, *Cameraria ohridella* Desch. & Dem. (Lepidoptera: Gracillariidae). Forestry Commission, UK. [http://www.forestryresearch.gov.uk/pdf/horsechestnut.pdf/\\$FILE/horsechestnut.pdf](http://www.forestryresearch.gov.uk/pdf/horsechestnut.pdf/$FILE/horsechestnut.pdf)
- Trehan, K. N. 1940. Studies on the British Whiteflies (Homoptera-Aleyrodidae). *Transactions of the Royal Entomological Society of London* **90**: 575–616.
- Watson, G. W. & Malumphy, C. P. 2004. *Icerya purchasi* Maskell, cottony cushion scale (Hemiptera: Coccoidea: Margarodidae), causing damage to ornamental plants growing outdoors in England. *British Journal of Entomology and Natural History* **17**: 105–109.
- Williams, D. J. 1962. The British Pseudococcidae (Homoptera: Coccoidea). *Bulletin of the British Museum (Natural History) Entomology* **12**: 1–79.
- Williams, D. J. 1985. The British and some other European Eriococcidae (Homoptera: Coccoidea). *Bulletin of the British Museum (Natural History) Entomology Ser.* **51**: 347–393.
- Williams, F., Eschen, R., Harris, A., Djeddour, D., Pratt, C., Shaw, R. S., Varia, S., Lamontagne-Godwin, J., Thomas, S. E., & Murphy, S. T. 2010. *The Economic Cost of Invasive Non-Native Species on Great Britain*. CAB/001/09. 198 pp.





**PLATE 2.** Fig. 1. Adult female *Orthezia urticae* covered in wax plates. Fig. 2. Adult hermaphrodite *Icerya purchasi* with ovisac. Fig. 3. Adult female *Balanococcus kwoni*. Fig. 4. Young adult female *Phenacoccus aceris* on *Quercus*. Fig. 5. Young adult female *Luzulaspis luzulae* on *Luzula*. Fig. 6. Mature adult female *L. luzulae* completely enveloped in a cotton-like cover that protects the eggs (Fig. 1, © Gabrijel Seljak; Figs 2–6 David Crossley, Fera).



**PLATE 3.** Fig. 1. Adult female *Palaeolecanium bituberculatum* with dorsal tubercles on *Crataegus*. Fig. 2. Colony of *Parthenolecanium cornutum* on *Quercus*. Fig. 3. Adult female *Pulvinaria hydrangeae* with ovisacs on *Acer*. Fig. 4. Adult female *Pulvinaria regalis* with ovisacs on *Acer*. Fig. 5. Colony of *Cryptococcus fagisuga* on *Fagus*. Fig. 6. Mature adult female *Eriococcus greeni* completely enveloped in a felt-like sack on grass (Figs 1–6 © David Crossley, Fera).





**PLATE 4.** Fig. 1. *Chionaspis salicis* adult female scale covers on *Salix*. Fig. 2. *Diaspidiotus zonatus* female scale (left) and female body with cover removed (right) on *Quercus*. Fig. 3. *Dynaspidiotus britannicus* adult females causing chlorotic spotting on *Ruscus*. Fig. 4. *Euonymus* plant killed by huge infestation of *Unaspis euonymi* (left) which completely smothers the stems (right). Fig. 5. *Aleurotuba jelinekii* puparium (left) and adult (right) on *Viburnum*. Fig. 6. *Siphoninus phillyreae* puparia (left) and adult (right) on *Fraxinus*. (Figs 1–6 © David Crossley, Fera).