The whiteflies (Hemiptera: Aleyrodidae) of Europe and the Mediterranean Basin

J.H. Martin¹*, D. Mifsud² and C. Rapisarda³

¹Department of Entomology, The Natural History Museum, Cromwell Road, London, SW7 5BD, UK; ²Naturhistorische Museum Basel, Augustinergasse 2, 4001 Basel, Switzerland; ³Dipartimento di Scienze e Tecnologie Fitosanitarie, Università degli Studi, Via Valdisavoia 5, 95123 Catania, Italy

Abstract

The whitefly fauna of Europe and the Mediterranean Basin comprises 56 species that are considered to be native or naturalized, accommodated within 25 genera. Presented here are a check-list, an identification key to puparia, and a brief account of each species including its distribution and host-plant range. The puparium of each species is illustrated. One new nomenclatural combination (Aleuroclava similis, from Aleurotuberculatus) and two new synonymies (Parudamoselis kesselyaki with Ceraleurodicus varus, Asterobemisia nigrini with A. paveli) are proposed. Three nominal species (Aleurodes capreae, A. fraxini, and Aleyrodes campanulae) are here treated as nomina dubia. Species which, in the study area, have only been recorded from glasshouses are discussed. Four additional species, not yet recorded from the region, are included in the discussion, two of them because a particular quarantine risk is perceived and two because they are notifiable pests in European Union quarantine legislation.

Introduction

In recent years, whitefly pests have become a major problem for agriculturalists, almost worldwide. Although a mainly tropical group, injurious species are to be found in all warmer parts of the world and several are serious pests in glasshouses in temperate areas. Throughout the 20th century, species like Bemisia tabaci (Gennadius) and Trialeurodes vaporariorum (Westwood) have been notorious as pests of field crops in warmer climes, and of crops under glass or polythene. The emergence of destructive biotypes, particularly of B. tabaci, has led to increased resources being expended on the study of these insects.

Recently, an increasing problem has been the sudden economic impact caused by previously little-known whitefly species becoming established in new geographical areas. The most notorious of these is undoubtedly Aleurodicus dispersus Russell, the so-called 'spiralling whitefly', which is now found in the Canary Islands and Madeira, with close links to the important agricultural area of the Mediterranean Basin.

With the number of whitefly pest incursions increasing, identification guides to the whiteflies of specified geographical areas become especially important. This is not only to enable the accurate naming of native species discovered causing problems, but also to increase the chances of early detection of newly introduced species. Mound & Halsey (1978) provided a comprehensive catalogue of whiteflies worldwide, including host plant records and distributional data. Subsequently, there have been a number of publications dealing with aspects of systematics and local faunistics of whiteflies in Europe and in the Mediterranean area (see Survey of records in literature and collections). However, there has been no account of the group across the whole region, nor any identification guide.

Discussions at the first meeting of the European Whitefly Studies Network (an EC-funded Concerted Action, EWSN - FAIR6 CT98-4303), held in Norwich, UK, 3–7 May 1999) pinpointed the lack of any ready means, for agricultural and quarantine staff or other non-specialists, to identify

* Fax: (0)20 7942 5229
E-mail: jhm@nhm.ac.uk
Almost all adult whiteflies possess seven-segmented antennae and a fore-wing venation that is reduced to a simple 'vasiform orifice' which is unique to aleyrodids, and comprises the orifice (terminology of Brummit, 1992) such as those of *Aleyrodes proletella* (terminology of Brummit, 1992) such as *Trialeurodes vaporariorum* on a cycad, *Dixon spinulosum*. The systematics of both whitefly subfamilies is currently based almost entirely on the puparial stage, and adults in isolation can be identified only rarely. This situation has arisen, in part, because puparia are often discovered in the absence of adult insects (see below). Unfortunately for systematists, whitefly puparia are notorious for displaying variation induced by, particularly, the physical characteris-
tics of leaf surfaces, as indicated by Russell (1948) and subsequently demonstrated experimentally by Mound (1963). The phenomenon of puparial variation has become particularly well known amongst certain polyphagous species, notably species of *Bemisia* and *Trialeurodes*. In contrast, puparia of the polyphagous *Aleurodicus dispersus* display no such variation. Amongst some whitefly species with narrower host ranges, there is sufficient evidence of variation (for example, see discussion of *Dialeurodes setiger* (Goux) and *D. citri* (Ashmead)) for systematists to be cautious before regarding visible differences as specific. Where puparia develop on both surfaces of leaves, the differing characteristics of the upper and lower leaf surfaces may also induce such variation on a single plant (e.g. *Aleuroviggianus polymorphus* Bink-Moenen). There is, thus, a situation where major characters may be of limited taxonomic significance because of their variability within species, and aleyrodid systematists need to be alert to this problem. With such problems of variation in the puparial stage, the future of whitefly systematics undoubtedly lies in the concurrent use of both puparial and adult characteristics (Bink-Moenen & Mound, 1990), and this approach has been particularly effectively used by Bink-Moenen (1992). Adult characters have been used with most success in the least speciose subfamily, Aleyrodicinae, but a fundamental appraisal is much needed before adults are likely to be used more widely in whitefly systematics. The use of modern molecular techniques also promises to assist our understanding of the systematics of this insect group.

As well as displaying the variation discussed above, many aleyrodis also exhibit puparial sexual dimorphism, which usually manifests itself as male puparia being consistently smaller than those of females in the same colony. Other sexual differences are uncommon but, in addition to their smaller size, male puparia of species of *Aleurocanthus* have fewer dorsal glandular spines than those of females: in some other groups (e.g. some species of *Aleurolobus*) the antennae of male puparia are distinctly longer than those of females. In species without size dimorphism, sex-determination of individual puparia is not usually possible even though Russell (1948) reported that a tiny invagination, or ‘bifid sac’, is present between the posterior abdominal spiracles of male puparia: this was discussed by Martin (1999). Instead of sexual dimorphism, a few temperate species exhibit distinct seasonal dimorphism, with puparia of summer generation(s) and overwintering puparia being markedly different (see comments on *Aleurochiton* and figure pairs 5/6 and 7/8).

With the exception of continuously breeding species, which tend to be polyphagous on herbaceous plants (and hence often pests), colonies of immature whiteflies are frequently discovered without associated adults, and this is one of the main reasons for the historical development of puparium-based taxonomy in this insect group. The frequent absence of adults appears likely to be because their emergence is often delayed until the host plant is physiologically suitable for the development of the next generation. The delay in adult emergence is often considerable, thus making the term 'puparium' particularly appropriate for the final larval stage.

### Economic importance of whiteflies

Whiteflies feed via stylet mouthparts with which they pierce plant tissues and suck phloem sap. These insects often produce a large amount of sugar-rich excreta, whilst extracting sufficient protein-building amino acids from the sap to facilitate body growth. These excreta, termed 'honeydew', may support the growth of sooty mould on affected plants. Large infestations of whiteflies may thus adversely affect their hosts, both by causing excessive sap loss and through sooty mould interfering with photosynthesis. Although relatively few whiteflies are normally ant-attended, ants may be attracted to the honeydew of large colonies, and their presence may interfere with natural enemies of the whiteflies and of other pests in the vicinity. Secondary damage can be caused by some whitefly species, as copious production of woolly 'wax' secretions soils the plant canopies. Some whiteflies (particularly tropical species – J.H. Martin, personal observations) may also deform the leaves, which would be detrimental to the marketability of such plants, even if the whiteflies themselves have been eradicated. A major problem with whiteflies is that some species act as vectors of viral plant diseases, and such viruses themselves can cause a range of symptoms in crops (Bedford et al., 1994).

The list of cultivated plants colonized by whiteflies is extensive, but a great many records concern the relatively few highly polyphagous whitefly species (Mound & Halsey, 1978; Carver & Reid, 1996). In the geographical area covered by this study, whiteflies are primarily pests of vegetable crops (especially in greenhouses), citrus and ornamental plants.

A special note is needed on the importance of quarantine as a means of preventing the introduction of more whitefly species to Europe and the Mediterranean countries. With the ever-increasing worldwide trade in living plant material, whether as vegetables for human consumption or as ornamental plants, several whitefly species have already significantly extended their distributions and it may be expected that this trend will continue, despite the best efforts of port quarantine officials. This risk is probably underestimated by many, if not most, countries. The European Union has drawn up official lists of quarantine pests (Smith et al., 1997) which include two whitefly species, not yet recorded in Europe, which represent a particular risk to citrus (see discussion of *Aleurocanthus* spp.). However, no official mention is made of some other polyphagous whitefly pests that may easily cross the phytosanitary barriers of mainland Europe. Indeed, no mention is made of significant pest species that have already entered territories (the Macaronesian islands) that are politically part of the European Union (see accounts of *Aleurodicus dispersus* and *Leucoideus flavissimus*).

### Materials, methods and terminology

Slide-mounting of specimens is usually required for accurate identification, whether puparia or adults are to be examined. Techniques for slide preparation have been described by Bink (1979), Bink-Moenen (1983) and by Martin (1987, 1996), involving heating to macerate and remove wax; Pizza & Porcelli (1993) described a method for cold maceration and de-waxing. The complex choice of mountants, and some of the associated problems, were discussed by Upton (1993) and by Brown (1997). The mountant chosen depends on factors such as the desired degree of permanence of preparations. When preparations are destined for reference collections, the authors favour use...
of Canada balsam or Euparal. Fortunately for agricultural entomologists, who require a rapid identification and are not concerned with the permanence of their preparations, quick-mounts can often be made. These may be prepared using pupal cases from which adults have emerged, and the technique simply comprises carefully removing a few specimens from the leaf and placing them gently into almost any proprietary mountant. The microscope objective is then protected by covering the specimen(s) with a glass coverslip, and the slide-mount may be examined without any further procedures.

The most important tool to aid the identification of whitefly species, in the area of coverage, is the key to puparia herein. This key inevitably uses specialist whitefly puparial terminology, and this is annotated on fig. 2. Other publications that may be consulted for whitefly morphological terminology include Russell (1948), Dobreau & Manolache (1969), Bink-Moenen (1983) and Gill (1990). When on slides, the puparia of most taxa can be seen to have legs which are more-or-less curved, with the apical pads (often termed 'adhesion pads', but of uncertain function) of the middle and hind legs directed mesad, as in most illustrations here. The legs of second and third-instar larvae are rather triangular, with their apices directed laterad.

All the drawings reproduced here have previously appeared in other publications, and the original source is stated in the relevant figure caption, even where the originals were the work of one of the present authors. Although there is thus a considerable divergence of styles, and although very small setae are often not featured, it is not felt that this is an impediment to effectiveness in aiding identification. Scale bars are felt to be of limited use, and do not accompany the illustrations used here.

In individual species accounts, the quoted host-plant information refers to the whole geographical range of each whitefly species. Although many of these hosts will not be found growing in the area covered by this work, our intention is to indicate each whitefly's overall preferences, and it was felt to be impractical to attempt to distinguish between European-Mediterranean hosts and others. All host-plant familial and generic names use the system of Brummitt (1992). Host records considered to be doubtful are quoted in square brackets and are discussed.

The Europe-Mediterranean region defined

The area included in this study lies west of the dashed line on the map (fig. 1) and is defined as follows: all countries of western and northern Europe, with the following included countries limiting the extent of coverage to the east – Finland, Estonia, Latvia, Lithuania, Poland, Slovakia, Hungary, Romania, Bulgaria; all countries directly bordering the Mediterranean Basin, including those in North Africa; Jordan is also included because of its close proximity to the Mediterranean. North Atlantic islands, such as Orkney, Shetland, Faroes, Iceland and Svalbard qualify for inclusion in this study, but the authors are not aware of any whitefly records to date.

Many published records refer to the former composite states of Czechoslovakia and Yugoslavia. In order to avoid the laborious checking of, often obscure, localities quoted in such records, these former country names are retained here, throughout the Distribution sections of the individual species accounts.

The whitefly fauna of Egypt is treated selectively. The Nile valley provides a narrow floristic corridor which enables several natives of the Ethiopian Region to approach the Mediterranean Basin, but Egyptian species are only included here if they are also recorded from elsewhere in the region. For more detail on the Egyptian whitefly fauna, Priesner & Hosny (1932, 1934a,b) and Bink-Moenen (1983) may be consulted.

Inclusion of the Canary Islands, Madeira and the Azores (collectively termed Macaronesia) in this work was considered. However, although politically part of Europe, these islands have a whitefly fauna that is substantially different to that found on the mainland, albeit with a considerable number of shared species. In particular, a great variety of morphological forms of the Bemisia afer-group have been discovered on many of the islands recently and detailed studies will be required to define their species limits. Work towards providing an account of the aleyrodids of the Macaronesian islands is currently in progress. A list of whitefly species currently known to occur in Macaronesia is presented here (appendix 1), for comparison with the main European-Mediterranean check-list.

The area covered by this study is very varied climatically and floristically. The Mediterranean basin is characterized by very warm summers, with its winters cool but certainly not cold at lower altitudes. Areas fringing the Atlantic seaboard, particularly the British Isles, the Benelux countries and parts of France, Portugal and Spain, are cool year-round, with abundant rainfall. Much of continental Europe, remote from coasts, is hot in summer and very cold in winter. With climate varying to such a degree, and with diverse soil types, the area enjoys a rich flora and may be divided into a wide range of vegetational zones, with about one hundred proposed by Polunin & Walters (1985). It is perhaps surprising, therefore, that there are so few whitefly species found in the area under consideration. The answer appears to be that whiteflies are predominantly tropical, and thus are not particularly diverse even in the warmer parts of the Mediterranean and Middle East.

Survey of records in literature and collections

Mound & Halsey (1978) published a complete catalogue of the world’s whitefly fauna, with host-plant data. Data from collections made subsequently have been extracted directly from material in the collections of The Natural History Museum, London, UK (BMNH), the University of Catania, Italy, the Department of Agriculture, Malta, and the collection of Rosita Bink-Moenen (Netherlands). In particular, the BMNH collection contains significant holdings of post-1978 material from Corsica, Egypt, Israel, Malta, Morocco, Sicily, Spain and Turkey. Other additional country records have been obtained from a variety of published sources, major ones being the following:

Albania: Zahradnik (1991)
Austria: Zahradnik (1991)
former Czechoslovakia: Zahradnik (1985, 1987a,b, 1989b)
Finland: Huldén (1986)
Germany: Zahradnik (1991)
Fig. 1. Outline map of area covered by this study.

Israel: Bink-Moenen & Gerling (1992), Argov (1994)
Lithuania: Zahradnik (1991)
Netherlands: Bink et al. (1980)
Poland: Szelegiewicz (1979), Klasa (1987)
Portugal: Bink-Moenen (1989)
Romania: Zahradnik (1991)
Sweden: Gertsson (1987)
Switzerland: Zahradnik (1989a)
Syria: Iaccarino (1990)
former Yugoslavia: Zahradnik (1991)

Papers providing more general distributional data within the study area, for selected whitefly species, include faunistic studies by Bink-Moenen (1989, 1991, 1992). An economic account with a European bias, especially covering Spanish whitefly species and heavily illustrated with colour photographs of all life-cycle stages, was provided by Llorens-Climent & Garrido Vivas (1992). Hernández-Suárez et al. (1997) provided an account of the problems posed by Aleurodicus dispersus and Lecanoideus floccissimus in the Canary Islands, similarly illustrated with many colour habitus photographs, which will greatly assist the recognition of these species in the event of any future introduction to new geographical areas. More general works on agricultural whitefly pests, especially of citrus crops, include those by Rapisarda (1990) and Passos de Carvalho (1994).
In the accounts of individual whitefly species, country records that are based on published lists only, and are considered to be doubtful, are placed in square brackets and discussed.

Check-list of whiteflies of Europe and the Mediterranean Basin

* Species not recorded from the area of study but discussed in this account for quarantine reasons.
† Species only recorded from glasshouses in the area of study, and not included in key.

**Aleurocanthus** woglumi
**Aleurocanthus** spiniferus
**Aleurotulus** nephrolepidis
**Aleuropteridis** filicicola
**Asterobemisia** paveli
**Asterobemisia** obenbergeri
**Asterobemisia** carpini
**Aleyrodes** singularis
**Aleyrodes** proletella
**Aleyrodes** lonicerae
**Aleyrodes** elevatus
**Aleyrodes** campanulae
**Aleurochiton** acerinus
**Aleurochiton** aceris (Modeer)
**Aleurochiton** pseudoplatani Visnya
**Aleuroclava** similis (Takahashi) comb. n.
**Aleurodes** caprae Signoret nom. dub.
**Aleurodes** fraxini Signoret nom. dub.
**Aleurolobus** marlatti (Quaintance)
**Aleurolobus** olivinus (Silvestri)
**Aleurolobus** teucrri Mifsud & Palmeri
**Aleurolobus** wunni (Ryberg)
* **Aleuropteridis** filicicola (Newstead)
**Aleurothrixus** floccosus (Maskell)
**Aleurotrachelus** globulariae Goux
**Aleurotrachelus** rhamnicola
**Aleurotrachelus** globulariae Goux
**Aleuroviggianus** polymorphus
**Aleuroviggianus** graecus
**Aleuroviggianus** adanaensis
**Aleurotuba** jelinekii
**Aleurotrachelus** globulariae Goux
**Aleurothrixus** floccosus (Maskell)
**Aleuroclava** similis (Takahashi)
**Aleurothrixus** globulariae Goux

Key to puparia of whitefly species occurring in Europe and countries surrounding the Mediterranean Basin

Notes: This key uses terminology which is peculiar to whitefly puparial systematics, and all the major characters are illustrated and annotated in fig. 2. Host plant preferences are mentioned in this key where these are sufficiently specific to assist identification. Absence, in the key, of such host information implies a degree of polyphagy, or insufficiently known preferences, and more detail is given in the individual species accounts.

1. With subdorsal compound pores, each of which may bear a central process (figs 82b, 83) or be ring-like (fig. 84). Lingula large, tongue-shaped, with four stout setae. Each leg with an apical claw .................................................. Aleurodicinae ...... 58

   – Without subdorsal compound pores. Lingula with two setae (e.g. figs 11e, 28b, 31b), or none visible. Legs without claws (e.g. figs 5a, 6, 11a, 18a) .................................................. **Aleurodicinae** ...... 2

2. Dorsal disc with elongate spines or siphon-like setae, which may be apically acute (fig. 4), rounded (fig. 19) or variously expanded (figs 58, 59) .............................................. 3

   – Dorsal disc without elongate spines or siphon-like setae, but stout normal setae may be present on dorsal disc (figs 28, 29, 30a, 32, 42, 50) or submarginally (figs 6, 25, 26, 53) .................................................. 6

3. Pupal margin regularly toothed (figs 4, 19b); operculum fully occupying vasiform orifice and obscuring lingula; dorsum with many acute spines, or with just four pairs of blunt siphon-like setae; vasiform orifice often slightly elevated .............................................. 4

   – Pupal margin smooth or slightly irregular, not toothed; operculum only occupying basal part of vasiform orifice, lingula head exposed (figs 58d, 59b); dorsum with many siphon-like setae with expanded apices (figs 58a, 59a); vasiform orifice not elevated ................. ................................. **Siphoninus** ...... 5

4. With acute spines, distributed in a regular, paired pattern (fig. 4). Cuticle coloration very variable ................................................................. **Aleurocanthus** spp. (see comments on *Aleurocanthus zizyphi*)
Fig. 2. Stylized whitefly puparium with major morphological features annotated (from Martin, 1987).

- With blunt siphon-like setae, restricted to single cephalic, meso- and metathoracic and eighth abdominal pairs (fig. 19). Cuticle evenly dark, often requiring bleaching, although marginal teeth paler. Usually on Viburnum tinus or Arbutus unedo. 

5. Most siphons distinctly bifurcate apically (fig. 58b,c); sculpture of vasiform orifice floor usually with one especially large areola posteriorly (fig. 58d). On Hedera helix. 

Siphoninus immaculatus

- Most siphons blunt, expanded but rounded apically (fig. 59a); sculpture of vasiform orifice floor typically with more, smaller, areolae (fig. 59b). Favouring Oleaceae and Rosaceae, but not feeding on Hedera helix. 

Siphoninus phillyreae

6. Extreme outer submargin with a row, of normally 14 pairs, of fine but distinct setae which clearly extend beyond puparial margin; transverse moultong sutures reach puparial margin (fig. 53a); vasiform orifice (fig. 53b) triangular, posteriorly indistinct; lingula head exposed, basally bilobed, included in vasiform orifice.
and with a prominent pair of apical setae; caudal furrow absent; cuticle pale ........................................... Parabemisia myricae
- If outer submarginal setae present, then much coarser (figs 6, 25a, 26a), smaller and indistinct (fig. 45a), or significantly less in number (figs 8a, 20a, 27a); combination of other characters different .................................................. 7

7. Operculum and lingula together occupying less than basal half of vasiform orifice whose floor is patterned with fine stippling; operculum much wider than long, lingula minute (fig. 3a,c); small groups of tubercle-like markings present along median line of abdominal segments; cuticle unicolorous, brown to black; margin regularly toothed (fig. 3b) but the teeth may be obscured by down-curling on slides .......... Acuadaleuros rachiopa
- If operculum only occupying basal part of vasiform orifice then lingula always clearly visible and operculum and lingula together occupying more than half of orifice (e.g. figs 9c, 22d) ........................................................ 8

8. Lingula head distinctly lobulate, usually about as long as wide, at least partially exposed and always bearing a pair of apical setae; submargin, and sometimes also dorsal disc, with glandular papillae of various shapes (figs 65, 66, 69–80); margin either not modified at tracheal openings, or with subtle combs present (as in fig. 79) ...................................................... Trialeurodes spp. .... 9
- Lingula head usually of different form, sometimes with just a pair of basal lobes or without apical setae, or it is obscured by operculum; if lingula lobulate then submargin and dorsal disc without papillae (fig. 52) ..................................................................... 14

9. Puparia elongate-oval (figs 65, 66); submarginal papillae present in several ranks and/or submedian thoracic setae are present. On Erica spp. ......................................................... 10
- Puparia more broadly oval (figs 69–72, 74, 75, 77, 78); submarginal papillae usually present in a single row, with sometimes a few papillae in a second rank; submedian thoracic setae never present. On Erica spp. only rarely .......................................................... 11

10. Puparium black; with a broad submarginal zone of distinct papillae in several ranks (fig. 66) ................................................................. Trialeurodes sardiniae
- Puparium pale brownish to almost black; submarginal papillae usually in one to two rows (fig. 65a); papillae usually distinct but sometimes faint .................................................... Trialeurodes ericae

11. Middle and hind legs each with a pair of stout spines (fig. 74); papillae acute, those in submarginal row contiguous (figs 69, 74) or very irregular (fig. 75) ...... 13
- Middle and hind legs with only tiny setae (fig. 81); papillae more truncate, often rather rounded apically (figs 70–72, 77–79) .......................................................... 12

12. Eighth abdominal setae placed anterior to widest part of operculum (figs 79, 80); margin crenulations coarser, usually less than 13 occupying 0.1 mm; with a tiny tongue-like structure usually visible protruding beyond apical notch of vasiform orifice (fig. 80) .............................................................. Trialeurodes vaporeariorum
- Eighth abdominal setae placed posterior to widest part of operculum (fig. 73); marginal crenulations finer, usually more than 23 occupying 0.1 mm; apical notch of vasiform orifice clear (fig. 73) ....................... Trialeurodes packardi

13. Cephalic setae present and conspicuous (figs 74, 75); submarginal papillae often in an irregular row .............................................................. Trialeurodes ricini
- Cephalic setae usually absent, or very inconspicuous if present; submarginal papillae in a regular single row, almost contiguous (fig. 69b). On Laurus nobilis and Arbutus andrachne .......................................... Trialeurodes lauri

14. Lingula exposed but small, its head either little differentiated from stalk or short and rather 'D'-shaped; vasiform orifice rounded-trapezoidal, leading posteriorly into a wide and sculptured anterior caudal furrow (figs 5d, 7d, 8b, 9c, 54b, 55c) which sometimes continues to the puparial margin after narrowing. On Acer, azalea, deciduous Fagaceae or Betulaceae .......... 15
- Lingula often covered by operculum (e.g. figs 10d, 11d, 15b, 18c) or with its head much larger (e.g. figs 31b, 32c, 33c); if lingula head short and/or 'D'-shaped, then it is without apical setae (fig. 27d); if caudal furrow sculptured, then along whole length from vasiform orifice to puparial margin (figs 10d, 21a, 45c). On other hosts .................................................. 19

15. Operculum almost fully occupying vasiform orifice (figs 5d, 7d, 8b, 9c), lingula usually slightly overlapping posterior margin of orifice; transverse moulting sutures reaching puparial margin. On Acer spp. .......................................................... Aleurochiton spp. .... 16
- Operculum occupying about two-thirds of, and lingula included within, vasiform orifice (figs 54b, 55c); transverse moulting sutures terminating in subdorsum. On azalea, deciduous Fagaceae or Betulaceae .......................................................... Pealius spp. .......... 18

16. Anterior part of caudal furrow poorly defined lateral to vasiform orifice (fig. 9c); submedian abdominal depressions on thorax and abdominal segments I–VII subcircular (fig. 9b). Usually on Acer pseudoplatanus .......................................................... Aleurochiton pseudoplatani
- Anterior part of caudal furrow sharply defined lateral to vasiform orifice (figs 5d, 7d, 8b); submedian abdominal depressions on thorax and abdominal segments I–VII almost indistinguishable from other cuticular folding. Usually on Acer campestr e or A. platanoides ........................................... 17

17. Spring/summer puparia with a submarginal row of normally 12 pairs of long, stout setae in outer submargin (fig. 6); overwintering puparia with submedian zone of venter delineated by an irregular fold, which is best defined cephalically and near the posterior abdominal spiracles (fig. 5a). Usually on Acer campestr e ................................................................. Aleurochiton acerinus
- Spring/summer puparia with submarginal setae minute (fig. 8a), often difficult to detect; overwintering puparia with submedian zone of venter not defined. Usually on Acer platanoid es .......................................................... Aleurochiton aceris

18. Puparial outline broadly oval (fig. 55a). With the occasional exception of the posterior marginal pair, all dorsal setae are normally minute, much shorter than opercular length; thoracic tracheal openings at margin modified into rather long combs of teeth faintly marked on the ventral submargin (fig. 55b), but marginal crenulations themselves not modified. On deciduous Fagaceae or Betulaceae .......................................................... Pealius quercus
- Puparial outline elongate-oval (fig. 54a). Caudal, and sometimes also the cephalic, setae very long and stout, considerably longer than length of vasiform orifice (fig.
Puparial outline circular (fig. 57a), extremely convex (on slides, puparium often splits when deformed by cover slip); margin with coarse teeth, each of which is longer than wide basally. Cuticle black. On Oleaceae:

- If outline circular, then puparia less convex, often almost flat dorsally ........................................ 20

Subdorsum defined by two rows of close-set pores, the inner row delineating a submedian area of characteristic shape, and the outer row marking the boundary with the submargin (fig. 43a); cuticle of subdorsum of fine porous, glandular, structure. On Rosa spp. .......................................................... 

- Subdorsum not thus defined as a glandular zone ......... 21

Vasiform orifice rounded-triangular, fully occupied by similarly-shaped operculum, which covers lingula, but with lingula remaining clearly visible through operculum (figs 11a, 11c, 12a, 13, 15d) ......................... 22

- If vasiform orifice fully occupied by operculum, it is shaped differently and opacity of operculum usually obscures lingula (e.g. figs 10d, 47, 48b, 50c) ............... 26

22. Wide submargin separated from dorsal disc by a suture-like fold (figs 11–15). Cuticle black .......................................................... Aleurolobus spp. ..... 23

- Submargin not defined; transverse moulting sutures curving strongly anteriorly, almost meeting puparial margin opposite fore legs (fig. 51a). Cuticle black or, more rarely, pale ......................................... Dialeurolobus rhamni

Outline subcircular (fig. 12a); thoracic tracheal openings at margin marked only by a few minute teeth which are much finer than remainder of marginal crenulations. On Oleaceae .......................................................... Aleurolobus olivinus

- Outline ovoid (figs 11, 13–15); thoracic tracheal openings at margin differently, or not, marked ...................... 24

Thoracic and caudal tracheal openings at margin each marked as a comb of three teeth modified from marginal crenulations, often appearing as a notch with a median tooth (fig. 11b); comma-shaped pale eyespots present (fig. 11a); vasiform orifice significantly longer than wide at its anterior end (fig. 11d) .......................... Aleurolobus marlatti

- Thoracic and caudal tracheal openings at margin differently, or not, marked; eyespots absent; vasiform orifice sometimes not longer than wide at its anterior end (fig. 13) .............................................................. 25

Thoracic tracheal openings at margin completely unmarked; caudal tracheal opening indented, between caudal setae, marked as a comb of fine crenulations; vasiform orifice broadly cordate, smoothly rounded posteriorly (fig. 13). On Teucrium fruticans .............................................. Aleurolobus teucii

- Thoracic tracheal teeth slightly protuberant from marginal outline (fig. 15a), but the crenulations themselves differing little from those on remainder of margin; caudal tracheal opening not differentiated; vasiform orifice more elongate (fig. 15a,b) ............................................. Aleurolobus winni

26. Vasiform orifice triangular or elongate-cordate, operculum only occupying anterior half of orifice and head of lingula clearly defined, mostly or fully exposed, elongate and similar in length to operculum (figs 28b, 30, 31b, 32c, 33–42, 44, 52b); lingula head always with a pair of apical setae; cuticle pale or brownish ..................... 27

- Vasiform orifice usually subcircular or cordate, with lingula completely or partially concealed by operculum (figs 10d, 16, 17c, 18c, 45c, 47, 48b, 50c, 60–64). If lingula fully exposed, its head is without a pair of apical setae (figs 20e, 22d, 23b, 24b, 25c, 26d, 27d) ........................................ 38

27. Transverse moulting sutures curving abruptly anteriorly and becoming margin-concentric before meeting on the median line, forming a cordate emergence trapdoor which is bisected by the longitudinal moulting suture (figs 33–37) ........................................ Asterobemisia spp. .... 28

- Transverse moulting sutures normal, terminating posterior to meso- metathoracic suture (figs 28–32, 38–42, 44, 45) .......................................................... 30

28. The pair of shallow ridges which border vasiform orifice meet posteriorly, forming a rounded 'V'-shaped figure; caudal furrow absent (figs 33, 34) .............................................. Asterobemisia cappini

- The pair of shallow ridges which border vasiform orifice do not meet posteriorly, but continue towards puparial margin, defining a caudal furrow (figs 35–37) ........... 29

29. Thoracic tracheal folds (ventral) densely punctuated by tiny subcircular tubes (fig. 36b); marginal crenulations fine, about 14–16 occupying 0.1 mm of lateral margin ................... Asterobemisia obenbergeri

- Thoracic tracheal folds (ventral) marked by a pair of boundary folds but not, or only slightly, punctuated (fig. 37c); marginal crenulations often coarser, ≤12 occupying 0.1 mm of lateral margin ................ Asterobemisia paveli

30. Abdominal segment VII not significantly reduced in length mediadly, eight subequall segments clearly visible between transverse moulting sutures and vasiform orifice (figs 28–32) .................. Aleurodes spp. ...... 31

- Abdominal segment VII much reduced in length mediadly (figs 38–42, 52), abdomen sometimes superficially appearing seven-segmented between transverse moulting sutures and vasiform orifice (as arrowed in fig. 39a) .............................................................. 35

31. Vasiform orifice broadly cordate, situated on an elevation; lingular apex extends to or slightly beyond lip of vasiform orifice; inner submargin with a regular row of hairs (fig. 32) .......................... Aleurodes singularis

- Vasiform orifice rounded-triangular, more acute, not elevated; submargin without a regular row of hairs (figs 28–31) .............................................................. 32

32. Puparia rather elongate-oval and typically developing in large colonies with much secreted mealy wax; usually with cephalic, meso- and metathoracic, first, fourth and eighth abdominal and caudal setal pairs long and stout; abdominal segments II–VI with shallow median tubercles; often with short median abdominal pigmentation (fig. 28). On Asarum europaeum .............................. Aleurodes asari

- Puparia more broadly oval (figs 30, 31) and colonies with secreted wax less obvious; if puparia elongate-oval then with outline distorted by development amongst leaf hairs (fig. 29), and often with longitudinal subdorsal
bands of cuticular pigmentation; dorsal disc setae usually only enlarged when feeding on hairy-leaved hosts (fig. 30a); shallow median abdominal tubercles present or absent. Not on Asarum europaeum ........................................ 33

33. Caudal setae always very small, usually hardly extending beyond puparial margin; cephalic, first and eighth abdominal setae similar (fig. 31); abdominal segments without median tubercles; vasi form orifice usually rounded-truncate posteriorly ................................................................. Aleyrodes proletella

- At least some individuals with caudal setae extending beyond puparial margin (figs 29, 30), even when feeding on smooth-leaved hosts; often these, and 0–6 pairs of dorsal disc setae, may be longer than vasi form orifice (figs 29, 30a); abdomen usually with shallow, smooth median tubercles segments II–V or II–VI; vasi form orifice often with a triangular apical lobe evident ..... 34

34. Puparium rather elongate (fig. 29), with dorsum strongly elevated above leaf surface, supported by up-curved venter which is protected by a waxy palisade; cuticle often partially pigmented, with a pair of longitudinal stripes visible with a hand lens. Usually on Ficus carica ...

- Puparium ovoid and not strongly elevated (fig. 30) ................................................................. Aleyrodes lonicerae

35. Transverse moulting sutures reaching submargin, sometimes almost to puparial margin (figs 44a, 52a); thoracic tracheal folds each marked as a narrow band of tiny rounded tubercles (fig. 44b), or are unmarked (fig. 52a) ........................................................................ 36

- Transverse moulting sutures shorter, terminating in substernum (figs 38–42); if thoracic tracheal folds punctuated, then by fine stippling only ......................................................... Bemisia spp. ................................ 37

- Transverse moulting sutures almost reach puparial margin (fig. 44a); thoracic tracheal folds each marked as a narrow band of tiny rounded tubercles (fig. 44b); vasi form orifice triangular; lingula head acute. On Calluna spp. ........................................ Callin Lynyrodites calluna

- Transverse moulting sutures terminate in inner submargin (fig. 52a); thoracic tracheal folds unmarked; vasi form orifice elongate-cordate; lingula head apically obtuse and somewhat lobulate (fig. 52b). Not on Calluna ...................................... Neopealius rubi

37. Caudal setae always stout, usually at least as long as vasi form orifice whose sides are almost straight (figs 40–42); vasi form orifice always inset from puparial margin by less than its own length; with a single geminate pore/porete pair between median line and first abdominal seta ........................................ Bemisia tabaci

- Caudal setae usually less than half length of vasi form orifice whose sides are usually distinctly concave (figs 38, 39); vasi form orifice usually inset from puparial margin by at least its own length; most puparia with two geminate pore/porete pairs between median line and first abdominal seta ........................................ Bemisia afer

38. Puparium margin broadly (and usually rather unevenly) deflexed, with morphological true margin located in the ‘subdorsal’ zone of venter (figs 63a, 64a); vasi form orifice trapezoidal, completely occupied by operculum (figs 63b, 64b). Puparia black. On Erica spp. ........................................ Tetralicia spp. ........ 39

- If puparial margin slightly and evenly deflexed, then lingula fully or partly exposed (but note that down-curling may often occur in slide-preparations of some species) ..................................................................................... 40

39. Puparium elongate-oval; caudal setae usually protruding beyond margin (fig. 63a)......... Tetralicia ericae

- Puparium broadly oval; caudal setae short and obscured by the marginal deflexion (fig. 64a) .......... Tetralicia iberica

40. Puparium margin distinctly deflexed; vasi form orifice not completely occupied by operculum; lingula fully or partly exposed, its head without apical setae (figs 21, 23, 24–26). On evergreen Quercus spp. ................................................................. Aleurovigganium spp. (in part) .... 56

- Puparial margin not deflexed (but note comment on down-curving in couplet 38) ................................................................. 41

41. Wide submargin separated from dorsal disc by a distinct dorsal suture-like margin-concentric fold (figs 13, 16, 60–62) ................................................................. 42

- Submargin and subdorsum not thus defined on dorsum ................................................................. 46

42. Although approximately margin-concentric overall, submarginal/subdorsal fold arranged in distinct sections (fig. 16); fold complete between vasi form orifice and puparial margin; inner submargin with a row of five pairs of tiny setae in cephalothorax and anterior abdomen ........................................ Aleyrodes floscus

- Submarginal/subdorsal fold not in distinct sections, usually smoothly margin-concentric (figs 13, 60–62); fold absent posterior to vasi form orifice; if with submarginal setae these are distributed differently .................. 43

43. Vasi form orifice cordate or rounded-triangular, not elevated; operculum covers lingula but much of lingular detail remains visible (fig. 13). Cuticle black ......................................................... Aleurolobus (in part) .......... 25

- Vasi form orifice subcircular to trapezoidal (figs 60–62), usually slightly elevated posteriorly; lingula hardly discernible beneath operculum. Cuticle pale or partly pigmented ........................................ Tetraleurodes .......... 44

44. Meso- and metathoracic submedian setal pairs absent (fig. 60a); submedian part of dorsal disc pigmented brownish. On Myrtus communis .......... Tetraleurodes bicolor

- Meso- and metathoracic submedian setal pairs present (figs 61a, 62a); cuticle pale or dusky, unicolorous .......... 45

45. A row of evenly-spaced geminate pore/poretes placed in inner submargin, closer to the submarginal/subdorsal furrow than to the marginal tooth-base glands (fig. 61a). On Hedera helix ........................................ Tetraleurodes hederae

- A row of unevenly-spaced geminate pore/poretes placed in outer submargin, just inside the row of marginal tooth-base glands (fig. 62a). Oligophagous, but not on Hedera .......... Tetraleurodes neemani

46. Puparial margin modified at thoracic tracheal openings, in form of distinct pores or shallow, toothed, notches (figs 10, 46, 48, 49, 50b) ........................................... 47

- If puparial margin modified at thoracic tracheal openings, then only as a slight indentation of the marginal outline ................................................................. 50

47. Puparial outline distinctive, laterally indented abdominally (fig. 10); puparial margin with very fine, even, crenulations .......... Aleuroclava similis
48. Thoracic and caudal tracheal openings at margin modified as shallow notches, each occupied by two or three (thoracic) or up to five (caudal) blunt teeth (fig 50); often with cephalic, mesothoracic and first abdominal setae very long and hair-like (fig 50a, left), but sometimes these are minute (fig 50a, right). On *Viburnum tinus* and *Arbutus unedo* .......................................................... *Dialeurodes kirkaldyi*

49. Median line of puparium often pigmented brownish (examine several); first abdominal setae present but very small (fig 48a); eighth abdominal setae opposite, or posterior to, widest part of operculum (fig. 48b).................. ........................................... Dialeurodes setiger

- Thoracic and caudal tracheal openings at margin in form of distinct invaginated pores which are smooth or finely crenate internally (figs 46, 48, 49) ........................................... 49

50. Transverse moult sutures not reaching beyond subdorsum; eight abdominal segments clearly visible medially, between transverse moult sutures and vasiform orifice; vasiform orifice approximately subcircular; operculum fully or mostly covering lingula head (figs 17, 18, 45); puparia of some species with a pair of longitudinal subdorsal folds (figs 17a, 18a) ...... 51

- Transverse moult sutures reaching, or almost reaching, puparial margin; abdominal segment VII much reduced medially, abdomen superficially appearing seven-segmented between transverse moult sutures and vasiform orifice; vasiform orifice cordate or rounded-triangular; lingula head usually fully, sometimes only partially, exposed and always without a pair of apical setae (figs 20–27); dorsal characters variable but without a pair of longitudinal subdorsal folds. On evergreen *Quercus* spp. .......................................................... *Aleuroviggianus* spp. .... 53

51. Without a pair of longitudinal subdorsal folds (fig. 45); margin with rather irregular and very fine crenulations; cuticle entirely pale. On *Rhododendron* spp. ........................................... *Dialeurodes chittendeni*

- With a pair of longitudinal cephalothoracic subdorsal folds, overlying outer edges of legs (figs 17, 18); margin with pronounced, regular teeth; cuticle may be very dark, dusky or completely pale. Not on *Rhododendron* ........................................... *Aleurotrachelus* .... 52

52. Vasiform orifice ovoid, inset from puparial margin by less than twice its own length (fig 17); marginal crenulations coarse, ten or less occupying 0.1 mm. On *Globularia alpium* ........................................... *Aleurotrachelus globulariae*

- Vasiform orifice cordate, usually inset from puparial margin by at least twice its own length (fig 18); marginal crenulations fine, 12 or more occupying 0.1 mm. On several hosts but not *Globularia* ........................................... *Aleurotrachelus rhamnicola* .... 53

53. Abdominal suture VI/VII visible medially, anterior to the abdominal pockets (figs 20, 22, 27; abdominal segment VII indicated in figs 20a, 22a); puparial margin not deflexed ........................................... 54

- Abdominal suture VI/VII not visible anterior to the abdominal pockets, the pockets themselves thus marking the segment VI/VII boundary submedially (figs 21, 23, 24–26); puparial margin narrowly deflexed ... 56

54. Cuticle pale; apex of lingula usually extends beyond vasiform orifice (fig. 20e); abdomen with three or four distinct outer submarginal setae on each side but not apparently precisely paired) .......................................................................................................................... *Aleuroviggianus adamaensis*

- Cuticle brown or black; if apex of lingula reaches posterior extremity of vasiform orifice, then it hardly overlaps it (fig. 22d); if abdomen with outer submarginal setae, then they are usually more difficult to discern ... 55

55. Lingula entirely included within vasiform orifice, its head short and 'D'-shaped (fig. 27d); abdomen with three or four outer submarginal setae on each side, often minute; first abdominal setae always absent ........................................... *Aleuroviggianus zonalis*

- Lingula just included within vasiform orifice, but reaching its posterior extremity (fig. 22d); without outer submarginal abdominal setae; first abdominal setae inconsistently present ........................................... *Aleuroviggianus graecus* .... 56

56. Cuticle pale or brownish; with host-dependent morphological variability (figs 24–26); if submargin with tubercle clusters, then each cluster bearing a stout seta (fig. 25a) ........................................... *Aleuroviggianus polymorphus*

- Cuticle opaque-black; not morphologically variable, always with submarginal tubercle clusters (figs 21, 23); if tubercle clusters bear setae then only on abdomen and the setae are minute ............ 57

57. Caudal furrow very narrow, unpunctuated; puparial outline indented posteriorly; abdomen distinctly wider than cephalothorax (fig. 23)........ *Aleuroviggianus halperini*

- Caudal furrow broader and punctuated by subcircular rounded-reticulate markings; puparial outline not indented posteriorly; abdomen not wider than cephalothorax (fig. 21) .......... *Aleuroviggianus adrianeae* .... 58

58. Compound pores with anteriormost two abdominal pairs much smaller than cephalic and posteriormost four abdominal pairs (fig. 84a). Puparia generally smaller (usually ≤ 0.90 mm and often ≤ 0.75 mm) ........................................... *Paraleurodes mini*

- Compound pores with cephalic pair similar in size to anteriormost two abdominal pairs; each pore usually with a central process visible (figs 82b, 83). Puparia relatively large (often ≥ 1.00 mm) .......... 59

59. Outer submarginal zone with a distinct ring of double-rimmed pores; dorsal disc mesad of compound pores densely punctuated by septate pores (fig. 82b); on slides, central processes of compound pores usually directed laterally as in fig. 82a........... *Aleurodis diatus dispersus* (currently not reported from Europe or the Mediterranean)

- Submarginal zone without a ring of double-rimmed pores, only with a band of crowded wide-rimmed pores (fig. 83, inset detail); dorsal disc mesad of compound
pores only sparsely punctuated by septate pores; on slides, central processes of compound pores usually directed mesally as in fig. 83) 

*Lecanoides floccissimus* (currently not reported from Europe or the Mediterranean)

**Species native or naturalized in the study region**

**Subfamily ALEYRODINAE**

**Genus Acaudaleyrodes** Takahashi


*Acaudaleyrodes rachipora* (Singh) Russell, 1962: 64


*Aleurochiton pseudoplantatus* (Visnya) Zahradnik, 1963: 12.


**Acaudaleyrodes rachipora** (Singh) Russell, 1962: 64

(*fig. 3*)

*Aleurotrachelus rachipora* Singh, 1953: 57–59


**Distribution.** Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, England, France, Germany, Hungary, Italy, Poland, Romania, Sardinia, Sicily, Yugoslavia. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer pseudoplatanus*, *Acer platanoides*, *Acer saccharum*.

Comments. This species is widely distributed across Europe, but is usually found in areas with a continental climate, where its usual host, *A. pseudoplatanus*, normally grows. *Aleurochiton aceris* is now common in southern England, where its presence was unproven until 1976 (Mound, 1966; Martin, 1978).

**Aleurochiton acerinus** (Modeer) (figs 7, 8)

*Coccus aceris* Modeer 1778: 21.


*Aleurochiton complanatus* (Baerensprung) Schumacher, 1918: 404.


**Distribution.** Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Italy, Lithuania, the Netherlands, Norway, Poland, Romania, Sweden, Switzerland, Yugoslavia. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer platanoides*, *A. tataricum*.

Comments. This species is widely distributed across Europe, but is usually found in areas with a continental climate, where its usual host, *A. platanoides*, normally grows. *Aleurochiton aceris* is now common in southern England, where its presence was unproven until 1976 (Mound, 1966; Martin, 1978).

**Aleurochiton pseudoplantatus** Visnya (fig. 9)


*Nealeurochiton pseudoplantatus* Visnya; Danzig, 1966: 366 [198].

**Distribution.** Europe and Mediterranean countries: Austria, Czechoslovakia, France, Germany, Hungary, Italy, Netherlands, Poland, Romania, Sicily, Switzerland. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer monspessulanum*, *A. opalus*, *A. pseudoplantatus*.

Comments. This species bears closer resemblance to the sole North American species, *A. forbesii* (Ashmead), than to the other two European species. In contrast to *A. forbesii*, this species is usually rather unevenly dusty to brownish, but may be pale.

**Genus Aleurochiton** Tullgren


*Nealeurochiton* Sampson; Zahradnik, 1963: 8, 12.

Comments. In common with other whiteflies whose members feed only on deciduous hosts in temperate climes, all the species of *Aleurochiton* overwinter as robust puparia which fall to the ground on the senescing leaves. Adults then emerge in the spring and fly back onto their host to lay the eggs of the spring generation. *Aleurochiton* is unusual in displaying marked puparial dimorphism, especially in *A. aceris* and *A. acerinus*, with summer and overwintering puparia differing greatly. Their summer puparia have pale cuticle, whereas the overwintering ones are more sclerotic: also, overwintering puparia often secrete a thick coating of wax, which is absent in summer forms.

**Aleurochiton acerinus** Haupt (figs 5, 6)


**Distribution.** Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, England, France, Germany, Hungary, Italy, Poland, Romania, Sardinia, Sicily, Yugoslavia. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer campestre*.

Comments. This species is apparently more common in southern parts of Europe than in the north, in contrast to *A. aceris* which is a more northerly species, but both species are found in many European countries. The record for the British Isles is based upon a single known occurrence in southern England, involving successfully overwintering puparia and emergent adults (Dolling & Martin, 1985).

**Aleurochiton aceris** (Modeer) (figs 7, 8)

*Coccus aceris* Modeer 1778: 21.


*Aleurochiton complanatus* (Baerensprung) Schumacher, 1918: 404.


**Distribution.** Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Italy, Lithuania, the Netherlands, Norway, Poland, Romania, Sweden, Switzerland, Yugoslavia. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer platanoides*, *A. tataricum*.

Comments. This species is widely distributed across Europe, but is usually found in areas with a continental climate, where its usual host, *A. platanoides*, normally grows. *Aleurochiton aceris* is now common in southern England, where its presence was unproven until 1976 (Mound, 1966; Martin, 1978).

**Aleurochiton pseudoplantatus** Visnya (fig. 9)


*Nealeurochiton pseudoplantatus* Visnya; Danzig, 1966: 366 [198].

**Distribution.** Europe and Mediterranean countries: Austria, Czechoslovakia, France, Germany, Hungary, Italy, Netherlands, Poland, Romania, Sicily, Switzerland. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Aceraceae: *Acer monspessulanum*, *A. opalus*, *A. pseudoplantatus*.

Comments. This species bears closer resemblance to the sole North American species, *A. forbesii* (Ashmead), than to the other two European species. For this reason, Zahradnik (1963) included *pseudoplantatus* in *Nealeurochiton* Sampson, which had been proposed by Sampson (1943) to accommodate *forbesii*. However, Mound & Halsey (1978) considered that *Nealeurochiton* should be regarded as a junior synonym of *Aleurochiton*.

Although usually developing on *Acer pseudoplantatus*, this species has also been noted in Europe on *Acer monspessulanum* and *A. opalus* (R.M. Bink-Moenen, personal communication).

**Genus Aleuroclava** Singh


Figs 3–6. 3, Acaudaleyrodes rachipora, puparium (from Priesner & Hosny, 1934a); 4, Aleurocanthus zizyphi, puparium (from Priesner & Hosny, 1934b); 5, Aleurochiton acerinus, overwintering puparium (adapted from Rapisarda, 1982); 6, Aleurochiton acerinus, summer puparium (from Rapisarda, 1982).
**Genus Aleurolobus Quaintance & Baker**


**Aleurolobus marlatti** (Quaintance) *(fig. 11)*


*Host plants.* A wide variety of hosts, mostly woody dicotyledonous plants. Hosts from 24 families were listed by *Mound & Halsey* (1978), and this whitely species has been found on many other hosts since.

*Comments.* The characters of the vasiiform orifice vary slightly across the range of this species, but the examination of type material of *A. marlatti* (Japan) and *A. niloticus* (Egypt) led to the conclusion that the two species are synonymous (Martin, 1999).

**Aleurolobus olivinus** (Silvestri) *(fig. 12)*


**Distribution.** Europe and Mediterranean countries: Corsica, Crete, Cyprus, France, Greece, Israel, Italy, Jordan, Mallorca, Morocco, Portugal, Sardinia, Sicily, Spain, Syria, Turkey.

*Host plants.* Ericaceae: *Erica arborea*; Oleaceae: *Olea europaea*, *Phillyrea angustifolia*, *P. latifolia*.

*Comments.* This species is only known from the Mediterranean countries, where it occasionally becomes a minor pest of olives. Although clearly favouring oleaceous hosts, it has also been recorded from *Erica* (Bink-Moenen, 1989).

**Aleurolobus teucii** Mifsud & Palmeri *(fig. 13)*


**Distribution.** Europe and Mediterranean countries: Malta, Sicily.

*Host plants.* Labiatae: *Teucrium fruticans*.

*Comments.* This species is currently only known from colonies on Malta and Sicily, all on the same small, herbaceous host plant.

**Genus Aleurotrachelus Quaintance & Baker**


**Aleurotrachelus floccosus** (Maskell) *(fig. 16)*


*Host plants.* Although only known as a pest of citrus crops in the Mediterranean area, *A. floccosa* is a polyphagous species, 18 families having been listed by *Mound & Halsey* (1978) and with many more recorded since (BMNH, London). *Aleurotrachelus floccosus* has occasionally been discovered feeding on monocotyledonous hosts.

*Comments.* There is a question over the identity of this species, with some populations having the puparial subdorsum darkly coloured, whilst others have the puparia entirely pale; the significance of this difference remains to be investigated (see discussion by Martin, 1999).

**Genus Aleurothrixus Quaintance & Baker**


**Aleurothrixus globulariae** Goux *(fig. 17)*


**Distribution.** Europe and Mediterranean countries: France, Israel, Morocco.

*Host plants.* Globulariaceae: *Globularia alpina*.

*Comments.* This species has been little collected, despite its only known host being widely distributed in the Mediterranean area. Detailed examination of many plants in the Alicante area of Spain failed to yield any whitely specimens (R.M. Bink-Moennen, personal communication) but, nonetheless, its disjunct recorded distribution is unlikely to represent reality.

**Aleurothrixus rhamnicola** (Goux) *(fig. 18)*


**Aleurothrixus wunni** (Ryberg) *(figs 14, 15)*


**Distribution.** Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania; Poland, Romania, Sweden, Switzerland, Yugoslavia. Elsewhere in Palearctic Region: Federation of Independent States.


*Comments.* *Aleurothrixus wunni* is a European species which appears to be at least moderately polyphagous.
Figs 11-15. 11, Aleurolobus mariatti, puparium (adapted from Martin, 1999 and Rapisarda, 1985); 12, Aleurolobus olivinus, puparial dorsum (from Martin, 1987); 13, Aleurolobus teucrii, puparium (from Mifsud & Palmeri, 1996); 14, Aleurolobus wunni, puparium with wax patterning (from Goux, 1942, as A. clematidis); 15, Aleurolobus wunni, puparium (adapted from Goux, 1942, as A. clematidis).

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**Figs 20-23** 

23. *A. halperini*. 

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*J.H. Martin et al.*
**Genus Aleurotuba Tremblay & Iaccarino**

*Aleurotuba Tremblay & Iaccarino, 1978: 60–61. Type species *Aleurodes jelinekii* Frauenfeld, 1867:

**Distribution.** Europe and Mediterranean countries: Corsica, Crete, France, Greece, Italy, Mallorca, Malta, Morocco, Portugal, Sicily, Spain. Elsewhere in Palaearctic Region: Madeira.


**Comments.** *Aleurotrachelus rhamincola* appears to be polyphagous and widely distributed across the Mediterranean Basin. Its puparia are sometimes evenly dark and sometimes pale to dusky, and this variation was discussed in connection with the proposal to place *A. esponae* as a junior synonym of *rhamincola* (Martin et al., 1996). The records of *Berberis* and *Quercus* as hosts, quoted above, are questionable: Gomez-Menor recorded *Berberis* as the sole host when describing *A. esponae* (1945), but subsequently (1953) stated that *esponae* was ‘only encountered on *Quercus*’.

**Genus Aleuroviggianus Iaccarino**

*Aleuroviggianus Iaccarino, 1982: 36. Type species *Aleuroviggianus adrianae* Iaccarino.*

**Distribution.** Europe and Mediterranean countries: France, Morocco, Spain. Elsewhere in Palaearctic Region: Georgia.

**Host plants.** Quercus coccifera, *Aristolochiaceae: Aristolochia clematitis*.


**Distribution.** Europe and Mediterranean countries: Albania, Crete, Kos, Rhodes, Turkey.

**Host plants.** Fagaceae: *Quercus calliprinos*, *Q. coccifera*, *Q. ithaburensis*.

**Genus Aleyrodes Lateille**


**Distribution.** Europe and Mediterranean countries: Corsica, Crete, Egypt, Italy, France, Morocco, Sardinia, Sicily, Spain.

**Host plants.** Fagaceae: *Quercus ilex*, *Q. rotundifolia*, *Q. suber*.

**Aleyrodes asari** (Schrank) Lindinger, 1932: 223.

**Distribution.** Europe and Mediterranean countries: Albania, Austria, Czechoslovakia, Greece, Hungary, Lithuania, Poland, Romania.

**Host plants.** Aristolochiaceae: *Aserum europaeum*.

**Comments.** This species is only known from colonies on a single host plant species. Its rather elongate puparial outline, combined with its usual pattern of six pairs of enlarged dorsal disc setae and occurrence in mealy colonies, renders this species readily recognizable on *Aserum europaeum*. However, its similarity to some puparia of *A. lonicerae* on other hosts raises a question as to whether *asari* really is a distinct species.

**Aleyrodes elevatus Silvestri**

*Aleyrodes elevatus Silvestri, 1934: 394–396.*

**Distribution.** Europe and Mediterranean countries: Corsica, France, Israel, Italy, Rhodes, Sicily, Spain, Turkey. Elsewhere in Palaearctic Region: Georgia.
Host plants. Euphorbiaceae: *Mercurialis annua*; Moraceae: *Ficus carica*; Urticaceae: *Parthenia officinalis*.

Comments. This species usually develops with characteristically tall puparia which are protected laterally by a waxy palisade, and is most commonly encountered on fig trees, occasionally in enormous numbers. Some puparia have a longitudinal dark band on either side of the median line, but this character is most pronounced in living specimens, and is best viewed with a hand lens. The exuviae of earlier instars usually remain attached to the puparial dorsum, providing a useful secondary recognition character. Puparia of *A. elevatus* developing on *Mercurialis* are not readily distinguishable from those of *A. lonicerae*, but their determination as *elevatus* has been indicated by study of the adults (see generic comments, above).

*Aleyrodes lonicerae* Walker (fig. 30)


Distribution. Europe and Mediterranean countries: Austria, Channel Islands, Corsica, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Isle of Man, Israel, Italy, Monaco, Netherlands, Norway, Poland, Romania, Sicily, Sweden, Switzerland, Turkey, Wales, Yugoslavia. Elsewhere in Palaearctic Region: Federation of Independent States.

Host plants. Recorded on more than 18 different plant families by Mound & Halsey (1978) and many more since. This species favours herbaceous and woody hosts in the families Caprifoliaceae and Rosaceae.

Comments. This species is widespread throughout Europe and more western parts of Russia. It is polyphagous, although not to such a great extent as other species such as *Bernisia tabaci* and *Trialeurodes vaporariorum*. This species is discussed, in literature, under several names now placed in synonymy and Mound & Halsey (1978) may be consulted for details.

*Aleyrodes proletella* (Linnaeus) (fig. 31)

*Phalaena (Tinea) proletella* Linnaeus, 1758: 537-538 [in Lepidoptera].

*Aleyrodes proletella* (Linnaeus) Latreille, 1801-02: 264 [Aleyrodidae].

*Coccus prenanthis* (Schrank, 1801: 147 [Coccidae].

*Aleyrodes prenanthis* (Schrank) Cockerell, 1902: 281 [Aleyrodidae] [synonymized by Klimaszewski & Szelégiewicz, 1962: 42].


Host plants. Polyphagous, mostly on herbaceous hosts, with a marked preference for Cruciferae and, to a lesser extent, Compositae. Hosts belonging to 12 angiosperm families were listed by Mound & Halsey (1978) but a record for *Quercus* (Fagaceae), attributed to Salsaas (1942b) who actually merely quoted Kirkaldy (1907), is almost certainly erroneous.

Comments. The often-called European cabbage whitefly is principally a minor pest of brassica crops, but is found on a range of other hosts, usually those with smooth leaves. Puparial cuticle is usually entirely pale but is sometimes slightly to moderately pigmented, especially in autumn in temperate regions. As is the case with *A. lonicerae*, *A. proletella* has several synonyms additional to those detailed above and these are listed by Mound & Halsey (1978).

Schrank (1801), in describing *Coccus prenanthis* as a scale insect, spoke of the emerging male as having four wings, of which the four pairs were slightly the larger, and described the colour as being whitish: this was sufficient for Cockerell (1902) to place the species in the Aleyrodidae, where it was simply listed without comment. Again, Kirkaldy (1907) simply listed *A. prenanthis* and made no comments. Harrison (1953) stated that the species was abundant on *Prenanthes purpurea* in Switzerland but, even if his material could be traced, it could not be said with certainty that it was conspecific with the sample upon which Schrank based his brief description. Despite this uncertainty, Klimaszewski & Szelégiewicz (1962) placed *prenanthis* as a junior synonym of *proletella* but regarding *Coccus prenanthis* as nonem dubium would have reflected the situation more realistically.

*Aleyrodes singularis* Danzig (fig. 32)

*Aleyrodes singularis* Danzig, 1964: 645 [330].

Distribution. Europe and Mediterranean countries: Jordan, Israel, Syria. Elsewhere in Palaearctic Region: Canary Islands, Federation of Independent States (Georgia), Iran.


Comments. *Lactuca* appears to be the preferred host of this species, at least in the Middle East. The puparia often develop in large and very dense colonies under the leaves, with mealy wax being secreted. Samples from *Crabbe* and *Canarina* in the Canary Islands have been identified following comparison with paratypes in BMNH.

Genus Asterobemisia Trehan


Comments. As understood here, the genus *Asterobemisia* includes species with a triangular vasiiform orifice, acute lingula head which is exposed but included within the vasiiform orifice, and with the transverse moulding sutures curving anteriorly to meet the longitudinal moulding sutures, such that adult emergence causes 'trapdoors' to fall away from the puparium. Although there has been discussion by Bink-Moennen & Mound (1990) of whether *A. carpini* (without a puparial caudal furrow) is congeneric with the other species occurring in the study area (whose puparia have a well-developed caudal furrow) the resolution of this question is beyond the scope of this work.

*Asterobemisia carpini* (Koch) (figs 33, 34)

*Alaeodes carpini* Koch, 1857: 327.


*Asterobemisia carpini* (Koch) Trehan, 1940: 593.

Distribution. Europe and Mediterranean countries: Austria, Bulgaria, Czechoslovakia, Denmark, England, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Romania, Spain, Sweden, Yugoslavia. Elsewhere in Palaearctic Region: Japan, Federation of Independent States.

Host plants. Polyphagous, with 15 angiosperm plant families listed by Mound & Halsey (1978). This species clearly favours tree and shrub hosts.

Comments. *Zahradník* (1989b, 1991) did not accept the synonymy of *avellanae* with *carpini* and continued to list them as two separate species. Pending more detailed studies, the synonymy proposed by Mound & Halsey (1978) is retained here, on the basis of considerable puparial phenotypic variation being likely, as in the *Bemisia*-group as a whole. This species has appeared in literature under several other names, and a full synonymy was given by Mound & Halsey (1978).

*Asterobemisia obenbergeri* (Zahradník) (fig. 36)


Distribution. Europe and Mediterranean countries: Albania, Bulgaria, Czechoslovakia, France, Greece, Hungary, Poland, Yugoslavia.


Comments. This species is still only known from the localities quoted in Zahradník’s description and later publications. *Asterobemisia obenbergeri* can be distinguished from the other European species of *Asterobemisia* by use of the key. Only three (paratype) puparia of this species have been examined as part of this study but the characteristics of the thoracic tracheal fold sculpture, combined with fine marginal crenulations (see key, couplet 29), serve to define *A. obenbergeri* as currently understood.
Asterobemisia paveli (Zahradnik)  
(figs 35, 37)

Neobemisia paveli Zahradnik, 1961: 75-78.  

Distribution. Europe and Mediterranean countries: Czechoslovakia, Germany, Hungary, Israel, Romania, Spain.  

Host plants. Euphorbiaceae: Euphorbia spp.; Leguminosae: Genista pilosa; Thymelaeaceae: Daphne gnidium.  

Comments. The published records of this species refer to its host plants as being species of Euphorbia (Zahradnik, 1961; Dobreau & Manolache, 1969). A colony was discovered in Spain in 1998, on a plant closely resembling Euphorbia but positively identified as Daphne gnidium. The proposal to place A. nigrini as a junior synonym of A. paveli (see below) provides a third host plant family for this species.  

The characters distinguishing A. nigrini from A. paveli were described as: marginal fringe comprising discrete ‘fingertips’ of wax (fig. 35b), rather than a continuous ring of such wax, the tracheal folds being wider, the caudal furrow shorter than or equal to length of vasiform orifice length, and the development of the larvae and puparia on the upper surfaces of the leaves. Paratypes of A. paveli were compared at a late stage of manuscript preparation with the holotype and one paratype of A. nigrini. The paveli paratypes have their caudal furrows subequal to vasiform orifice length. A sample of puparia collected on Daphne gnidium in Spain contains a mixture of individuals with the marginal wax waxes indicate that the degree of as in Zahradnik’s (1987a) photograph of nigrini, and others with a more continuous fringe; the puparia of this sample also display variations in the width of the thoracic tracheal folds, even varying on opposite sides of a single specimen; the individuals of this same sample have the caudal furrow length varying from longer than to equal to vasiform orifice length. Although the type specimens of A. nigrini were unusual, feeding on the upper surfaces of the leaves of their host, there are apparently no morphological characters that reliably define nigrini and it is here regarded as a synonym of A. paveli.  

Genus Bemisia Quaintance & Baker  

Bemisia Quaintance & Baker, 1914: 99-100. Type species Aleurododes inconspicua Quaintance, 1900: 28-29 [synonymized with Aleurododes tabaci Gennadius, 1889].  


Bemisia afer (Priesner & Hosny)  
(figs 38, 39)


Distribution. Europe and Mediterranean countries: Corsica, Egypt, [England], France, Greece, Israel, Italy, Malta, Rhodes, Sicily, Spain, Turkey. Elsewhere: widely distributed in warmer parts of the world, but see comments, below.  

Host plants. Polyphagous. Hosts belonging to 20 plant families, mostly dicots, listed by Mound & Halsey (1978), but see comments, below.  

Comments. Although B. hancocki was proposed as a junior synonym of B. afer by Bink-Moenen (1983), continuing studies indicate that the degree of puparial morphological variation, within and between populations of this group, remains poorly understood. This synonymy has been subject to comment by Martin (1987, 1999) but detailed studies of this group, using a variety of techniques, will be needed before the situation may be resolved.  

Future studies using modern taxonomic techniques may clarify the status of several existing species names in this complex. Within the Europe-Mediterranean area the following species names are also available within this species-group: B. citricola Gomez-Menor (1945), B. ovata (Goux, 1940) and B. spiraeoides Mound & Halsey (1978). Similar studies will also be needed to clarify the status of a remarkable variety of puparial ‘morphs’ recently discovered in most of the islands of Macaronesia (see appendix 1).  

Although material of several English samples are present in BMNH, they all concern colonies contaminating glasshouses.  

Bemisia tabaci (Gennadius)  
(figs 40-42)

Bemisia tabaci (Gennadius) Takahashi, 1936: 110.  


Distribution. Europe and Mediterranean countries: throughout, but usually found under glass in areas with continental climate. Elsewhere: cosmopolitan in all warmer parts of the world.  

Host plants. Bemisia tabaci is extremely polyphagous, reported to occur on hundreds of different plant species (Mound & Halsey, 1978; Greathead, 1986).  

Comments. Variation of puparial morphology was apparently recognized by Russell (1957), who published a paper placing nine Bemisia species in synonymy with B. tabaci, on the basis of having compared types and topotypes of the species concerned. Mound (1963) published supporting experimental evidence of puparial polymorphism, such variation usually correlating with physical characteristics of leaf surfaces and having implications for the study of all whiteflies. As a result of these publications, identifying puparia of B. tabaci became relatively easy; with the key puparial characters illustrated and discussed by Mound (1965), Patti & Rapisarda (1981) and by Martin (1987), and the variability of subdorsal setae and tubercles no longer caused confusion. However, the recognition of biotypes of B. tabaci in the 1980s, and their ensuing study, has caused the situation with B. tabaci to become complex once again.  

Nowadays, several biotypes have been recognized (Bedford et al., 1994; Guirao et al., 1997; De Barro et al., 1998), through the use of non-specific esterase banding pattern analysis and, more recently, techniques such as RAPD-PCR sequencing of DNA. Although such biotypes can be characterized by various means, none can be definitely distinguished from other tabaci biotypes by morphological examination alone. The description of the B biotype as a separate species, Bemisia argentifolii (the ‘silverleaf whitefly’), by Bellows & Perring (in Bellows et al., 1994) provided a species name for a taxon that can only be determined by means other than visual examination. This has always been controversial, but recent research has led to the conclusion that B. tabaci and B. argentifolii are members of a highly cryptic species complex (Rosell et al., 1997; Frolich et al., 1999). In such a situation opinion is moving strongly towards the view that, if silverleaf whitefly is to retain its own specific name, then other biotypes of B. tabaci would eventually need to be treated similarly (De Barro et al., 2000). The current situation provides unfortunate nomenclatural complications, with the terms ‘biotype B’ [of B. tabaci] and ‘B. argentifolii’ both widely used for the same entity, sometimes even within individual publications (discussions at meetings of the European Whitefly Studies Network, Norwich, May 1999 and May 2000). However, given the ascendency of the species-complex theory, the present authors consider that proposing B. argentifolii as a synonym of B. tabaci (often discussed) would be equally unjustified at a time when our knowledge is moving forward so rapidly.  

Bemisia tabaci is known to transmit geminiviruses to cultivated plants belonging to various families, especially Cucurbitaceae, Leguminosae, Euphorbiaceae, Malvaceae and Solanaceae (Bedford et al., 1994), and is a serious pest of both open-air and protected cropping (for example, in Spain and Israel in the Europe-Mediterranean area). The impact of B. tabaci on world agriculture has led to the expenditure of much research effort on this species and its biotypes, and an extensive literature on B. tabaci was listed by Cock (1986, 1993). There have been many specialist papers on aspects of B. tabaci research published subsequently, of which notable systematic/phylogenetic examples are discussed above.  

Genus Bulgarialaeurodes Corbett  


Bulgarialaeurodes cotesii (Maskell)  
(fig. 43)


Bulgarialaeurodes rosea Corbett, 1936:18 [synonymized by Russell, 1960: 30].  


Host plants. Rosaceae: Rosa damascena; Rosa sp.
Genus Calluneurodes Zahradnik

Calluneurodes callunae (Ossiannilsson) (fig. 44)
Distribution. Europe and Mediterranean countries: Czechoslovakia, Finland, Portugal, Sweden.
Host plants. Ericaceae: Calluna vulgaris, Calluna sp.; Erica arborea, Erica sp.
Comments. The puparia of this species are exceptionally difficult to see on the leaves of their host plants, possibly leading to the paucity of records of this interesting whitefly.

Genus Dialeurodes Cockerell
Dialeurodes Cockerell, Quaintance & Baker, 1914: 97.
Comments. With our current understanding of puparial systematics Dialeurodes is the most speciose whitefly genus, by a considerable margin, with over 140 species currently included worldwide (Martin, 1999). Jensen (1999) chose a selection of species of Dialeurodes sensu lato for a preliminary cladistic study of whitefly puparia. His results have indicated, for the first time, that such an approach to puparial systematics is entirely practicable, clearly indicating discrete groupings within the assemblage. In a subsequent development of his study, Jensen (in press) will present data providing a clearer separation of Dialeurodes from Singiellodes and Massilieurodes. Within Europe and the Mediterranean area, four species are included within Dialeurodes sensu lato.

Dialeurodes chittendeni Laing (fig. 45)
Distribution. Europe and Mediterranean countries: Belgium, Czechoslovakia, Denmark, England, Finland, Germany, Italy, Netherlands, Sweden, Switzerland.
Host plants. Ericaceae: Rhododendron spp.
Comments. Although clearly a member of Dialeurodes sensu lato, this species may prove not to be conspecific with the type species of Dialeurodes, and studies are continuing (A. Jensen, personal communication). Despite having been described from England, it is probable that D. chittendeni originates in northern Asia, from where many rhododendrons also originate.

Dialeurodes citri (Ashmead) (figs 46, 47)
Aleyrodes citri Ashmead, 1885: 704.
Host plants. Dialeurodes citri is known to occur on numerous angiosperm plant families (Mound & Halsey, 1978), but is almost always associated with Citrus in the Mediterranean area.
Comments. This species is now distributed widely through warmer temperate areas, where it often becomes a serious pest of citrus crops.

Dialeurodes citri has several junior synonyms (Mound & Halsey, 1978). It is probable that D. citri is a native of the Oriental Region, from where several puparial variants are known, but it remains uncertain whether these are simply examples of intra-specific variation of the sort commonly observed in, for example, Bemisia species.

Dialeurodes kirkaldyi (Kotinsky) (figs 48, 49)
Aleyrodes kirkaldyi Kotinsky, 1907: 95–96.
Dialeurodes kirkaldyi (Kotinsky) Quaintance & Baker, 1914: 98.
Host plants. Feeding on woody hosts, with 17 genera in ten dicotyledonous families listed by Russell (1964), but its favoured hosts are Jasminum spp. (Oleaceae) and Morinda citrifolia (Rubiaceae).
Comments. Dialeurodes kirkaldyi is a frequent quarantine intercept, especially at ports in the USA (Russell, 1964). Although described from Hawaii, its area of origin is uncertain.

Dialeurodes setiger (Goux) (fig. 50)
Aleuroplatus (Massilieurodes) setiger Goux, 1939: 81–82.
Distribution. Europe and Mediterranean countries: Corfu, Corsica, France, Italy, Morocco, Spain.
Host plants. Caprifoliaceae: Viburnum tinus; Ericaceae: Arbutus unedo.
Comments. This species clearly belongs to Dialeurodes sensu lato and, yet, its original placement, in Aleuroplatus, remained for 60 years. Jensen (in press) reports on a completed study in which evidence will be presented for the reinstatement of Massilieurodes as a full genus within the Dialeurodes group.
The extremely long subdorsal setae, which Goux considered a major diagnostic characteristic of this species, are present only sometimes and many specimens have been seen which bear only very short dorsal setae (personal observations).

Genus Dialeurolobus Danzig

Dialeurolobus ramni Bink-Moenen (fig. 51)
Host plants. Lythraceae: Punica granatum; Rhamnaceae: Rhamnus palaestina. [Rosaceae: Rosa canina].
Comments. Although described from specimens feeding on Rhamnus palaestina, there are several samples in BMNH, London, which were collected from pomegranate and have been identified in comparison with paratype material of D. ramni. Five pale Dialeurolobus puparia, collected from Rosa canina in Turkey, have been tentatively identified as D. ramni, with their apparent absence of first abdominal setae: the lack of sclerotization of these specimens may possibly be varietal (see discussion of Aleurotrachelus rhamnica, here and by Martin et al., 1996) or, alternatively, be the result of parasitism (a well-developed parasitoid is visible in one individual). It is possible that D. ramni may eventually prove to be a synonym of D. pulcher Danzig.

Genus Neopeplus Takahashi
Figs 44–50. 44, *Calluneyrodes callunae*, puparium (adapted from Zahradnik, 1985 and Ossiannilsson, 1947); 45, *Dialeurodes chittendeni*, puparium (from Zahradnik, 1987b); 46, *Dialeurodes citri*, puparium (from Martin, 1987); 47, *Dialeurodes citri*, vasiform orifice (from Martin, 1987); 48, *Dialeurodes kirkaldyi*, puparial dorsum with pigmentation (from Martin, 1999); 49, *Dialeurodes kirkaldyi*, puparial venter (adapted from Martin, 1987); 50, *Dialeurodes setiger*, puparium with long setae shown to left and short setae to right (adapted from Goux, 1939).
Parabemisia myricae (Kuwana)
(fig. 53)


**Host plants.** Recorded from woody dicotyledonous hosts in 14 families by Bink-Moenen (1991), but the rosaceous genera *Rubus* and *Rosa* are the preferred hosts and, subsequently, specimens have been found on *Craitegas monogyna* in Turkey.

**Comments.** In eastern Europe, this species was first placed in *Aleyrodes* (Takahashi) and then *Bemisia* (Takahashi), but Bink-Moenen (1991) recognized it as Takahashi's *Neopealius rubi*, as well as recording this species from Europe for the first time.

**Genus Parabemisia Takahashi**


**Parabemisia myricae** (Kuwana)


**Host plants.** Recorded from woody dicotyledonous hosts in 14 families by Bink-Moenen (1991), but the rosaceous genera *Rubus* and *Rosa* are the preferred hosts and, subsequently, specimens have been found on *Craitegas monogyna* in Turkey.

**Comments.** In eastern Europe, this species was first placed in *Aleyrodes* (Takahashi) and then *Bemisia* (Takahashi), but Bink-Moenen (1991) recognized it as Takahashi's *Neopealius rubi*, as well as recording this species from Europe for the first time.

**Genus Pealius Quaintance & Baker**


**Pealius azaleae** (Baker & Moles)

(fig. 54)


**Host plants.** Ericaceae: *Rhododendron* spp.

**Comments.** Originally described from Belgian material intercepted by quarantine officials in the USA, this species may have originated in eastern Asia (Martin, 1999). *Pealius azaleae* is mainly known as a minor pest of ornamental azaleas (*Rhododendron* spp.). The occurrence of this species in Europe is sporadic, and records may reflect newly introduced populations on each occasion, with its azalea hosts usually being kept indoors, in greenhouses or in very sheltered yards.

**Pealius quercus** (Signoret)

(fig. 55)

*Alaeurodes quercus* Signoret, 1868: 384-385.

**Pealius quercus** (Signoret) Trehan, 1939: 266.

**Distribution.** Europe and Mediterranean countries: Austria, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Ireland, Lithuania, Netherlands, Poland, Romania, Scotland, Spain, Sweden, Wales. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Betulaceae and deciduous Fagaceae – recorded from several hosts by Mound & Halsey (1978).

**Comments.** *Pealius quercus* is a predominantly northern and central European species. Records of *P. quercus* from Spain (it was described and illustrated by Gomez-Menor, 1945, 1958 and illustrated in 1953) for the most part clearly concern *Aleyrodivigignus polymoropus*, subsequently described by Bink-Moenen (1992), which feeds on Gomez-Menor’s quoted host, *Quercus ilex* (an evergreen oak). However, Gomez-Menor (1953) confusingly stated that this species was found (‘only’) on deciduous oak (‘robe’l) and on evergreen oak (‘encina’) [in Spain], and also on *Corylus avellana* beyond Spain. The present authors feel that, whilst it is extremely unlikely that *P. quercus* feeds on Mediterranean evergreen oaks, Gomez-Menor’s (1953) Spanish record on deciduous oak may be correct, but requires confirmation.

**Genus Simplaleurodes Goux**


**Simplaleurodes hemisphaerica Goux**

(figs 56, 57)

**Simplaleurodes hemisphaerica** Goux, 1945: 186-197.

**Distribution.** Europe and Mediterranean countries: Corfu, Corsica, Crete, France, Italy, Morocco, Spain.

**Host plants.** Oleaceae: *Phillyrea* spp.

**Comments.** With its almost circular and extremely convex black puparia (which often split when placed under a microscope slide coverslip), *S. hemisphaerica* is immediately recognizable. However, its flat third-instar larvae (fig. 56) are sometimes mistaken for puparia if the leg characteristics of the third-instar (see Materials, methods and terminology) are overlooked. This species is only known from the Mediterranean Basin.

**Genus Siphoninus Silvestri**


**Siphoninus immaculatus** (Heeger)

(fig. 58)

*Alaeurodes immaculata* Heeger, 1856: 33-36.

**Siphoninus immaculatus** (Heeger) Trehan, 1940: 601.

**Distribution.** Europe and Mediterranean countries: Austria, Czechoslovakia, England, Germany, Hungary, Ireland, Isle of Man, Italy, Sweden, Switzerland, Wales. Elsewhere in Palaearctic Region: Federation of Independent States.

**Host plants.** Araliaceae: *Hedera helix*.

**Comments.** *Siphoninus immaculatus* is only known from a single host plant, and is not commonly encountered although it is widely distributed in continental Europe.

**Siphoninus phillyreae** (Haliday)

(fig. 59)

*Alaeurodes phillyreae* Haliday, 1835: 119-120.

**Siphoninus phillyreae** (Haliday) Silvestri, 1915: 245-247.
Figs 51–57. 51, Diaceurolobus rhamni, puparium (from Bink-Moenen & Gerling, 1992); 52, Neopealius rubi, puparium (adapted from Bink-Moenen, 1991); 53, Parahemisia myricae, puparium (from Martin, 1987); 54, Pealius azaleae, puparium (from Martin, 1999); 55, Pealius quercus, puparium (from Zahradnik, 1987b); 56, Simplaleurodes hemisphaerica, third-instar larva (from Goux, 1945); 57, Simplaleurodes hemisphaerica, puparium (from Goux, 1945).

Host plants. Oligophagous but preferring woody hosts in the Oleaceae, Lythraceae [= Punicaeae] and Rosaceae, particularly Crataegus, Frazinus, Olea, Phillyrea and Pyrus. Citrus is a recorded host.

Comments. Sometimes known as the ash whitefly, S. phylloci is a native of the Mediterranean Basin, and infrequently causes problems to agriculturalists there. However, when first introduced into new geographical areas, this species has sometimes caused severe problems (Sorensen et al., 1990) before being brought under control by the introduction of natural enemies. It was first discovered in Australia in 1998, where it caused considerable communication. More widely distributed within the Mediterranean Basin than T. vaporariorum, it was first detected when colonies of T. vaporariorum were observed to overwinter on strawberries in the open, whereas T. vaporariorum, which it closely resembles, is difficult to detect, being located on the undersides of very narrow and laterally down-curled leaves.

**Tetraleurodes ibericae** Bink-Moenen (fig. 64)


Distribution. Europe and Mediterranean countries: Portugal, Spain.

Host plants. Ericaceae: Erica arborea, L. hispanica.

Comments. This species has been only recorded from the south-western part of the Iberian peninsula, and its puparia may be distinguished from those of the much more common and widespread T. ibericae by their broader outline.

**Genus Trialeurodes Cockerell**

Trialeurodes (Trialeurodes) Cockerell, 1902: 283. Type species Aleurodes (Trialeurodes) perileuca Cockerell, 1902: 283.


**Tetraleurodes bicolor** Bink-Moenen (fig. 60)


Distribution. Europe and Mediterranean countries: Israel, Turkey.

Host plants. Myrtaceae: Myrtus communis.

Comments. This species has only been recorded colonizing Myrtus communis, and is apparently native to the eastern Mediterranean Basin.

**Tetraleurodes hederae Goux** (fig. 61)

Tetraleurodes hederae Goux, 1939: 77-80.


Host plants. Araliaceae: Hedera helix.

Comments. More widely distributed within the Mediterranean Basin than is T. bicolor, this species has always been recorded feeding on Hedera.

**Tetraleurodes neemani** Bink-Moenen (fig. 62)


Distribution. Europe and Mediterranean countries: Cyprus, Israel, Lebanon, Rhodes, Syria, Turkey.

Host plants. Anacardiaceae: Pistacia palaestina; Caprifoliaceae: Viburnum tinus; Ericaceae: Arbutus andrachne; Lauraceae: Laurus nobilis; Leguminosae: Cercis siliqueatum; Myrtaceae: Myrtus communis; Rhamnaceae: Rhamnus alaternus; Rutaceae: Citrus limon; Vitaceae: Vitis sp.

Comments. Described as recently as 1992, this species displays a degree of polyphagy and may feed on other woody dicots in the eastern Mediterranean and Middle East area.

**Genus Tetralicia Harrison**

Tetralicia Harrison, 1917: 60. Type species Tetralicia ericae Harrison, 1917: 61-62.

**Tetralicia ericae** Harrison (fig. 63)

Tetralicia ericae Harrison, 1917: 61-62.

Distribution. Europe and Mediterranean countries: Austria, Corsica, Corto, Crete, Czechoslovakia, Denmark, England, France, Germany, Italy, Mallorca, Malta, Netherlands, Portugal, Scotland, Sicily, Spain, Sweden, Switzerland, Wales.

Host plants. Ericaceae: Erica spp.

Comments. This is a very common and widespread European whitefly species but, despite their black coloration, its tiny, elongate, puparia are
Figs 69–81. 69, Trialeurodes lauri, puparium (from Bink-Moeren & Gerling, 1992); 70–72, Trialeurodes packardi, puparial variants (from Russell, 1948); 73, Trialeurodes packardi, vasiform orifice (from Kozár et al., 1987); 74–75, Trialeurodes ricini, puparia ex- (74) Securinega sp. and (75) Ricinus sp. (from Martin, 1987); 76, Trialeurodes ricini, vasiform orifice (from Kozár et al., 1987); 77–78, Trialeurodes vaporariorum, puparial variants (from Russell, 1948); 79, Trialeurodes vaporariorum, posterodorsal puparial detail (from Martin, 1987); 80, Trialeurodes vaporariorum, vasiform orifice (from Kozár et al., 1987); 81, Trialeurodes vaporariorum, puparial legs (from Martin, 1987).
Trialeurodes ricini (Misra) (figs 74–76)

*Trialeurodes ricini* (Misra) Singh, 1931: 46–47.


**Host plants.** Hosts in eight angiosperm families were listed by Mound & Halsey (1978): many others have been recorded subsequently, with 14 plant families being listed by Bink-Moennen (1983) from Chad alone. It is most often associated with castor oil plants (*Ricinus communis*, Euphorbiaceae).

**Comments.** Although currently only recorded from Egypt in the area of study, this species is included in this account because its presence in Iran and Iraq indicates its likely occurrence in the countries bordering the eastern Mediterranean. *Trialeurodes ricini* may prove to be a senior synonym of *T. lurii* (above). *Trialeurodes ricini* occurs mainly across the Middle East, sub-Saharan Africa and in the Oriental Region.

**Trialeurodes sardiniae Rapisarda** (figs 66, 68)


**Distribution.** Europe and Mediterranean countries: Sardinia.

**Host plants.** Ericaceae: *Erica arborea*.

**Comments.** This little-known species is still only represented in collections by the type specimens. The nature of *Erica arborea* leaves, which are very small and have their lateral margins curled downwards, contributes to this whitely remaining obscure, because cryptic puparia are exceptionally difficult to see on such foliage.

**Trialeurodes vaporariorum** (Westwood) (figs 77–81)

*Trialeurodes vaporariorum* Westwood, 1856: 852.

**Distribution.** Europe and Mediterranean countries: throughout, although in northern countries it is found most readily in glasshouses. Elsewhere: cosmopolitan, although less common in tropical Asia.

**Host plants.** Extremely polyphagous being recorded from more than 200 plant genera, including many herbaceous and some monocotyledonous plants, and even a caycud, by Mound & Halsey (1978). Many more hosts have been recorded since.

**Comments.** *Trialeurodes vaporariorum*, often called the glasshouse or greenhouse whitefly, is one of the two most common and economically important whitefly species (the other being *Bemisia tabaci*). With its long name often shortened to ‘*T. vapor*’ by whitely workers, this species is often a considerable problem under glass, especially in more temperate areas. It is a member of a North American species-group (Russell, 1948), but was already a widespread pest at the time of its description (from England) in 1856, and was established in Australia by 1900 (Martin, 1999).

**Subfamily ALEURODICINAE**

**Genus Aleurodicus Douglas**


**Aleurodicus dispersus** Russell (fig. 82)


**Host plants.** Extremely polyphagous, including herbaceous and monocotyledonous plants.

**Comments.** At the time of manuscript preparation, no member of the *Aleurodicus/Lecanoideus* group is known to occur in mainland Europe or the Mediterranean seaboard countries. However, *A. dispersus* has been established in the Canary Islands since the 1960s, and has recently become established in Madeira and in west Africa. It is considered that there is a moderate risk of this species being introduced into the Mediterranean area in the future, although it was not listed for EU quarantine alert (Smith et al., 1997). Its current wide geographical distribution may be compared with its occurrence only in the neotropics, Florida and Canary Islands up to the mid-1970s, giving an indication of its potential to spread still further. Almost certainly, it will be climatic characteristics that determine its eventual distribution, regardless of quarantine vigilance.

**Genus Lecanoideus Quaintance & Baker**

*Aleurodicus* (Lecanoideus) Quaintance & Baker, 1913: 70. Type species *Aleurodicus (Lecanoideus) giganteus* Quaintance & Baker, 1913: 70–71.

**Lecanoideus Quaintance & Baker**; raised to genus by Costa Lima, 1928: 133

**Lecanoideus flocissimus Martin et al.**

(fig. 83)


**Distribution.** Europe and Mediterranean countries: not yet recorded. Elsewhere in Palaearctic Region: Canary Islands (Gran Canaria, La Gomera, Tenerife). Neotropical Region: Colombia, Ecuador, Trinidad.

**Host plants.** Polyphagous, with host records belonging to 30 plant genera collated by Hernández-Suárez et al. (1997).

**Comments.** Clearly an introduction from the Neotropics, this species was undescribed at the time of its establishment on Tenerife. In the Canary Islands, it currently causes extensive damage to banana plants, as well as to park and garden palms, trees, shrubs and ornamental monocots. It was actually recorded from more host plants in the Canary Islands, by Hernández-Suárez et al. (1997), than was *Aleurodicus dispersus*. *Lecanoideus flocissimus* may represent a considerable quarantine risk to the Mediterranean region, leading to its inclusion in this review.

**Genus Paraleyrodes Quaintance**


**Paraleyrodes minei** Iaccarino (fig. 84)


**Comments.** Although described from citrus crops in Syria, this species is a naive of the Neotropical Region, along with all species of *Paraleyrodes* and the great majority of the other members of the Aleurodicinae. *Paraleyrodes minei* is now often called the nestling whitefly, but this name should be used with caution, because it describes the wax-deposition habits of several members of this genus.

At the time of manuscript preparation, only *P. minei* is represented in mainland Europe and the Mediterranean area. However, several other species have recently become naturalized in countries beyond the New World tropics. Two of these other species, *P. bondari* Perachi and *P. citrulli* Costa Lima are already established on Madeira, and their recognition is discussed by Martin (1996). A third species, undescribed, is now common in Hawaii, Hong Kong, Bermuda and Florida, clearly indicating the ease with which species of *Paraleyrodes* can become established.

**Species found only in glasshouses in the study area**

There are a few species of whitflies which have been recorded, and some even described, from European glasshouses. They are not treated in the main part of this account, because there are no satisfactory records of their natural occurrence in the area of coverage.
Subfamily ALEYRODINAE

Aleuroteridis filicicola (Newstead)
Comments. This is a member of an African genus of fern-feeding whiteflies (Mound, 1961). As with Aleurotulus nephrolepidis (below), a population of A. filicicola from Kew Gardens (London, UK) was described as a new species, but was later synonymized.

Aleurotulus nephrolepidis (Quaintance)
Comments. This species is a specialist fern-feeder, and is often found on ferns in artificially protected conditions. It is found in the open air in Macaronesia, but there are no similar records from the area covered by this work. Aleurotulus kevensis was described as a new species, from Kew Gardens, but was later placed as a synonym of Aleurotulus nephrolepidis.

Filicaleurodes williamsi (Trehan)
Comments. There are published records of this species occurring in glasshouses in both England (from where it was described) and Hungary (Visnya, 1941b). Its geographical origin remains obscure.

Subfamily ALEURODICINAE

Ceralreadicus varus (Bondar)
Ceralreadicus varus (Bondar) Costa Lima, 1928: 137.
Comments. This species, under the name Paradamoselis kesselyaki, was reported by Visnya (1941a), occurring in considerable numbers in an orchid house at Budapest Botanical Garden, Hungary. It had colonized several orchid species, and was present for several months in 1939–1940. Paradamoselis kesselyaki was clearly an introduction from the Neotropical Region, as tentatively posited by Visnya, but its synonymy with C. varus was only revealed when the first author of the present study was able to compare material of both nominal species, in the whitefly collection of the United States National Museum of Natural History (housed at the US Department of Agriculture, Beltsville, Maryland).

Nomina dubia
Three species, described from Europe, have descriptions which are inadequate or ambiguous to the point where recognition of the species is not possible from literature. Such a situation may be resolved if type material exists and can be examined by systematists in the future. With the present unavailability of authentic material for study, these taxa are here regarded as nomina dubia, even though they were listed as valid species by Mound & Halsey (1978).

Aleurodes caprae Signoret
Aleurodes capreæ Signoret, 1868: 384.
Comments. Signoret (1868) stated of this species, found on Salix capro, that the 'larval state' [puparium] 'greatly resembles those of the preceding species [plural]. The preceding species in that account were Aleurodes rubi and A. fragariae, both now synonyms of Aleurodes lonicerae. Also, Signoret continued by stating that the dorsal disc bore the same setae, in the same positions as in fragariae Walker. Given this data, and the polyphagy of A. lonicerae, it is possible that Aleurodes capreæ is another synonym of lonicerae Walker. However, finding A. lonicerae colonizing tree hosts is unusual. Asterobemisia carpini is a more usual colonizer of trees, has been recorded from Salix, and its puparia sometimes develop stout dorsal setae in a similar configuration to those frequently seen adorning the puparia of Aleurodes lonicerae. Nevertheless, there is insufficient descriptive data for this species to be recognized with certainty.

Aleurodes campanulae Saalas
Comments. Aleurodes campanulae Salaas (1942a) answers the description of A. proletelia in most respects. However, its puparia appear in drawings to be subjectively more elongate than is usual. Asterobemisia carpini is a more usual colonizer of trees, has been recorded from Salix, and its puparia sometimes develop stout dorsal setae in a similar configuration to those frequently seen adorning the puparia of Aleurodes lonicerae. Nevertheless, there is insufficient descriptive data for this species to be recognized with certainty.

Aleurodes fraxini Signoret
Aleurodes fraxini Signoret, 1868: 386–387.
Comments. This species was described from adults alone, inhabiting leaves of 'frêne' (Fraxinus sp.). Although it is presumed that the taxa discussed by Signoret in his 1868 paper were from France unless otherwise stated, even this is not entirely certain. The description given by Signoret speaks of a blackish mark at the extremity of the main wing vein, indicating that this species was not Aleurodes dubia Heeger (a junior synonym of Siphoninus phyllareae). Given the mobility of adult whiteflies, it is not possible to say whether Signoret's adults were even true Fraxinus-feeders. Neither is it possible to match with certainty these adults, as described, to known species.

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Appendix 1

Check-list of whiteflies of the Macaronesian islands.
Abbreviations following each species name: A, Azores; C, Canaries; M, Madeira.

Aleyrodinae
Acaudaleyrodes rachipora (Singh)
Aleuroplatus perseaphagus Martin, Aguiar & Pita
Aleurothrixus floccosus (Maskell)
Aleurotrachelus atratus Hempel
Aleurotrachelus rhamnicola (Goux)
Aleurotulus nephrolepidis (Quaintance)
Aleyrododes proletella (Linnaeus)
Aleyrododes singularis Danzig
Aleyrododes sp.
Bemisia afer species-group (several morphological forms)
Bemisia lauracea Martin, Águia & Pita
Bemisia medinae Gomez-Menor (member of afer-group)
Bemisia tabaci (Gennadius)
Dialeurodes citrifolii (Ashmead)
Parabemisia myricae (Kuwana)
Pealius azaleae (Baker & Moles)
Pealius madeirensis Martin, Aguiar & Pita
Siphoninus sp./spp.
Trialeurodes ricini (Misra)
Trialeurodes vaporariorum (Westwood)
uncertain genus
uncertain genus
Aleurodicinae
Aleurodicus dispersus Russell
Lecanoideus floccissimus Martin, Hernández-Suárez & Carnero
Paraleurodes bondari Peracchi
Paraleurodes citricolus Costa Lima

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