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Other Hemiptera Sternorrhyncha (Aleyrodidae, Phylloxeroidea, and Psylloidea) and Hemiptera Auchenorrhyncha Chapter 9.4

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Abstract

Apart from aphids and scales, 52 additional Sternorrhyncha hemipteran species alien to Europe have been identified within Aleyrodidae (27 whitefly species), Phylloxeroidea (9 adelgids, 2 phylloxerans) and Psylloidea (14 species of jumping plant-lice) in addition to 12 Auchenorrhyncha species (mostly Cicadellidae- 8 species). At present, the alien species represent 39% of the total whitefly fauna and 36% of the total adelgid fauna occuring in Europe. The proportion is insignificant in the other groups. The arrival of alien phylloxerans and adelgids appeared to peak during the first part of the 20th century. In contrast, the mean number of new records per year of alien aleyrodids, psylloids and Auchenorrhyncha increased regularly after the 1950s. For these three groups, an average of 0.5–0.6 new alien species has been recorded per year in Europe since 2000. The region of origin of the alien species largely differs between the different groups. Alien aleyrodids and psylloids mainly originated from tropical regions whilst the adelgids and phylloxerans came equally from North America and Asia. A major part of the alien Auchenorrhyncha originated

from North American. Most of these alien species are presently observed in man-made habitats, especially in parks and gardens but alien adelgids are mainly observed in forests because of their association with conifer trees used for afforestation.

Keywords
alien, Europe, Adelgidae, Aleyrodidae, Cicadellidae, Psyllidae, Phylloxeridae, Auchenorrhyncha

9.4.1. Introduction

This chapter will consider the hemipteran species alien to Europe belonging to the Sternorrhyncha superfamilies other than Aphidoidea and Coccoidea (i.e., Aleyrodoidea, and superfamilies Phylloxeroidea and Psylloidea) and to the Auchenorrhyncha (Cicadomorpha and Fulgoromorpha suborders). We will mainly follow the higher classification used in Fauna Europaea (Asche and Hoch 2004, Nieto Nafria and Binazzi 2005).

Both **Aleyrodoidae** (whiteflies) and **Psylloidea** (jumping plant-lice or psylloids) are distributed throughout the major zoogeographical regions of the World, with their greatest diversity in tropical and south temperate regions. They are all sap-sucking insects and most of them are narrowly host-plant specific. This is particularly true for the psylloids were such specificity may also be present at higher taxonomic levels and not just at species level. Both adult whiteflies and psylloids possess a feeding rostrum, two pairs of flying wings and are fully mobile. Reproduction in both groups is generally sexual with some rare cases of *parthenogenetic** development. The eggs in both groups are laid directly onto the host-plant surface.

Whiteflies comprise a relatively small group of insects in a unique family Aleyrodidae, and we will later us only this family name. Whiteflies are the least speciose among the four groups of sternorrhynchous Hemiptera (whiteflies, aphids, jumping plant-lice and scale insects) with only 1,556 described species accommodated in 161 genera (Martin and Mound 2008). Adult whiteflies are very small insects, most measuring between 1–3 mm in body length. Life-cycles of whiteflies are somewhat unusual. The first-instar larvae are able to walk around (crawler) short distances on the host plant until a suitable feeding site is found; then, the remaining three larval instars are sessile. The final whitefly larval stage is usually termed as a *puparium** where feeding goes on during the first part of this stage. It is also this stage which is used for almost all whitefly taxonomy and systematic with adults being identified only rarely. All whitefly species are free living during their larval stages.

Jumping-plant lice (Psylloidea) comprise some 3,000 described species accommodated in the six currently recognized families. Adults range from 1–12 mm in body length. Life-cycles of psylloids are very straightforward with eggs laid singly or in clusters on the host plant, the immatures undergoing five larval instars (being all mobile unless gall-dwelling) and after these adults emerge. In jumping-plant lice, both adults and nymphal stages are used for species identifications. More than three-quarters of

psylloid species are free-living during their larval stages, but some are gall-inducing and others live under protective scales or lerps (waxy constructions covering the body).

The feeding activity of whiteflies and psylloids may negatively affect the host-plant by rendering weakness and thus more susceptibility to other diseases. The feeding activity of these insects (especially in whiteflies) may produce copious honeydew which may cover underlying leaves and fruits/flowers of the host-plant. Usually, this honeydew is immediately covered by black sooty mould which impairs photosynthesis and/or renders unmarketable plant parts such as flowers and fruits. Notorious pest species in both groups (adults) are vectors of a number of plant pathogens such as viruses and phytoplasmas.

Phylloxeroidea (adelgids and phylloxerans) is a closely related superfamily, which include some of the most destructive introduced plant pests in the World. They include minute insects (1–2 mm in body length), which are highly host specific but with a simple morphology. The two groups are distinguished from typical aphids (Aphididae) by the complete absence of *siphunculi** and the retention of the ancestral trait of oviparity in all generations. Phylloxerans feed on angiosperms, particularly hickories and ashes (Juglandaceae), oaks and beeches (Fagaceae) and grapes (Vitaceae) but adelgids only develop on certain genera of the Pinaceae family, retaining their ancestral relationships with gymnosperms. Such as their host plants, adelgids are endemic to the Northern Hemisphere in boreal and temperate habitats. Despite the broad geographical distribution of these host plants, there are less than 70 and ca. 75 species of known adelgids and phylloxerans, respectively (Havill and Foottit 2007). However, there is considerable taxonomic uncertainty in both groups since several described species may not represent unique taxa but are actually different morphological forms of the same species found on different host plants. Both groups exhibit cyclical parthenogenesis and possess complex, multigenerational, polymorphic life cycles. Five generations make up the typical two- year adelgid *holocycle**, three produced on the primary host, *Picea* spp. (noticed as -I- in Table 9.4.1) where sexual reproduction and gall formation occurs, and the last two are produced on a secondary host (*Abies*, *Larix*, *Pseudotsuga*, *Tsuga*, or *Pinus,* noticed as -II- in Table 9.4.1) which supports a series of asexual generations. Adelgids that are *anholocyclic** complete their entire life cycle on either *Picea* or on a secondary host genus. Some anholocyclic species may in fact be holocyclic, but forms on the alternate host have not been described. Typically, sexual reproduction and host alternation nymphs and galls are formed in spring. Winged *gallicolae** can disperse or can stay to lay eggs near the gall from which they emerged.

Auchenorrhyncha, with some 42,000 described species worldwide is probably paraphyletic but composed of two well supported monophyletic groups, **Fulgoromorpha** (planthoppers) and **Cicadomorpha** (leafhoppers, froghoppers, treehoppers and cicadas). Hemipteran phylogeny is still controversial (Cryan 2005, Yoshizawa and Saigusa 2001) although Sternorrhyncha, Fulgoromorpha, Cicadomorpha, Coleorrhyncha and Heteroptera are considered monophyletic by most authors (Bourgoin and Campbell 2002,

Dietrich 2002, Nielson 1985). Auchenorrhyncha usually feed on plant sap, either on phloem, xylem or parenchyma, and they occur therefore in almost all habitats colonized by vascular plants. Many are of economic importance due to the transmission of phytopathogenic organisms causing plant diseases such as phytoplasmas and virus diseases (Bourgoin and Campbell 2002, Carver et al. 1991, Dietrich 2005, Kristensen 1991, Nielson 1985). Most Auchenorrhyncha have a bisexual reproduction. Eggs are usually laid into plant tissue and there are 5 nymphal instars. While some species are good flyers and can be carried by wind over relatively long distances (Della Giustina and Balasse 1999), most of the translocations are considered due to anthropogenic causes. All the species introduced from North American and east Asiatic are assumed to have been imported with plants, either as eggs in the tissue or as nymphs or adults feeding on the host plants.

Planthoppers (Fulgoromorpha) with 21 families and some 12,000 described species occur worldwide but are most diverse in the tropics. Only the widely distributed families Cixiidae and Delphacidae occur also in colder regions such as Northern Europe. In Europe, ca. 750 species of Fulgoromorpha are expected to occur (Asche and Hoch 2004). They can be distinguished by the following characters: pedicel of antenna bulbous or enlarged; presence of *tegulae** on the mesothorax; bases of mid-coxae widely separated. The body size varies from 2–114 mm but most species are small (O'Brien and Wilson 1985).

Cicadomorpha are characterised by following characters: antennal pedicel small; tegulae absent; meso-coxae small and narrowly separated. To date, 30,000 species of Cicadomorpha have been described in over than 5,000 genera and 13 families. Dietrich (Dietrich 2002) estimated that about 6–10% of plant-feeding insects belong to the Cicadomorpha. Despite their economic importance, there are surprisingly still many gaps in the knowledge on the taxonomy, phylogeny, life history and biology of Auchenorrhyncha.

9.4.2. Taxonomy and invasion history of the Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha alien to Europe

The literature about alien species of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha in Europe is relatively scattered, most of the studies dealing with alien pests of economic importance such as *Bemisia tabaci* and *Trialeurodes vaporarium* (Bedford et al. 1994, Martin et al. 2000) for Aleyrodidae or *Metcalfa pruinosa* and *Scaphoideus titanus* (Arzone et al. 1987, Dlabola 1981) for Auchenorrhyncha. Indeed, comprehensive data on alien species were available for only a few European countries. i.e., Albania, Bulgaria and Macedonia (Tomov et al. 2009), Austria (Essl and Rabitsch 2002), the Czech Republic (Šefrová and Laštùvka 2005), Germany (Geiter et al. 2002), Great Britain (Hill et al. 2005), Slovenia (Seljak 2002) and Switzerland (Kenis 2005). The 'Handbook of alien species in Europe' (DAISIE 2009), generated by the DAISIE project, listed a number of species alien to Europe (i.e, of exotic origin or cryptogenic) and alien in Europe (introduced by man from a European region to another where the species is not native) but the status of some of these species also

needed to be reviewed. At the end of each group, we provide information on the species of this group we excluded from the alien list either because of confusion in their actual status or of misidentifications. Apart from the established species, the alien lists of Aleyrodidae, Phylloxeroidea and Psylloidea will also include species which were observed only in greenhouses and for which no data is available on their establishment in the wild in the mentioned territory. In contrast, the list of alien Auchenorrhyncha will only include established species in the wild.

9.4.2.1 Aleyrodidae

A total of 27 species alien *to* Europe were recorded. Although the family Aleyrodidae include three subfamilies only two of these are represented in both the alien and the native European fauna. At present, the alien species represent 39% of the total whitefly fauna observed in Europe (Figure 9.4.1). Twenty alien species belong to Aleyrodinae, which is the most widespread and largest subfamily with over 1,400 described species. Seven species belong to the subfamily Aleurodicinae, which is mainly confined to South America, plus very few species in South-Eastern Asia and other geographical regions (121 described species) (Martin 1996). It is usually regarded as being more primitive than Aleyrodinae. In general, Aleurodicinae represent much larger species than typical whitefly, their additional wing venation being possibly a functional necessity associated with their large size. The pupal cases of the Aleurodicinae are generally more complex than those of the Aleyrodinae, bearing large compound wax-secreting pores on the dorsal surface. Species of whiteflies intercepted in greenhouses (occasionally or once) are rather few. Such species were included in the list because additional introductions as well as establishment in the wild are not to be excluded especially under global change conditions. These species include *Filicaleyrodes williamsi*, a species whose origin remains obscure; *Aleuropteridis filicicola,* an African species found on ferns; *Aleurotulus nephrolepidis*, a specialist fern feeder often found in greenhouses which is already known to occur in the wild in Macaronesia (Martin et al. 2000); *Ceraleurodicus varus*, an Aleurodicinae species which was found to colonize orchids in 1939- 1940 in an orchid house at the Budapest Botanical Garden, but was never intercepted again or recorded in other European countries; *Aleurodicus destructor* of which a single specimen was collected from *Olea* at a Garden Festival in Liverpool, UK, but which is occasionally intercepted by quarantine inspections in Europe (Martin 1996); a neotropical whitefly, *Aleurotrachelus trachoides* was intercepted in Great Britain on sweet potato leaves imported from Gambia (Malumphy 2005); and, *Pealius azaleae*. This latter species is often regarded as a minor pest of ornamental azaleas (*Rhododendron* spp.). It was originally described from Belgian material intercepted by quarantine officials in the United States but its origin is likely Eastern Asia. The occurrence of this species in Europe is very sporadic and records often reflect newly introduced populations with azalea hosts being kept indoors, in greenhouses or in very sheltered places.

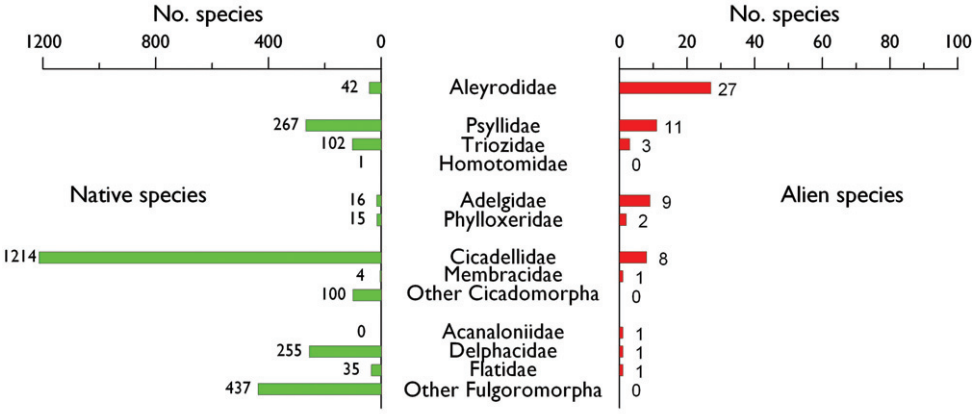

Figure 9.4.1. Comparison of the relative importance of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha in the alien and native entomofauna in Europe. The number right to the bar indicates the number of species per family.

An emergent whitefly pest in Europe is *Alerocanthus spiniferus*, commonly known as the Orange Spiny Whitefly. This species is listed as a quarantine threat to Europe and is included in the EPPO A1-List of species recommended for regulation as quarantine pests and in the EU Annex II/A1 under: "Pests known not to occur in the EU, whose introduction into, and/or whose spread within, all EU Member States is prohibited, with reference to specific plants or plant products". The accidental introduction, acclimatization and spreading of this species in southern Italy (Porcelli 2008) is thus of concern to all the European Union. As pointed out by Porcelli (Porcelli 2008), the origin of the infestation of this species is still unknown, and the species has already spread in the Apulia Region to make its eradication impossible. *A. spiniferus* is a widespread tropical species, occasionally a pest on *Annona* and *Citrus*, but it is also recorded from woody hosts of more than 15 plant families (Martin 1996). *Aleuroclava aucubae*, a species described from Japan and most likely of Oriental origin, was recently recorded from Italy (Pellizari and Šimala 2007) and may also prove to be a potential pest in Europe. It is known to occur on more than 15 plant families (Mound and Halsey 1978) and in the Veneto region, the species was found on both greenhouse plants (*Citrus x limon* (L.) Osb., *Ficus sycomorus* L.) and outdoor host plants (*Pittosporum tobira* (Thunb.) Aiton , *Prunus armeniaca* L., *Photinia*).

Some whitefly species not native to Europe have been found in Macaronesia and some of these are also penetrating into Europe. *Aleuroplatus perseaphagus* is a species of Neotropical origin, but was first described from Madeira. The species is common on avocado. *Aleurotrachelus atratus* is also a species of Neotropical origin, but was found in the Canary Islands (Martin et al. 2000) and is now being recorded on several endangered palm species on various islands in the south-western Indian Ocean and in glasshouses in Paris (Borowiec et al. 2010). *Acaudaleyrodes rachipora* was described from India and is probably native to Asia but the species is also known from the Ca-

nary islands (Martin et al. 2000). *Crenidorsum aroidephagus*, introduced in Madeira, is a native of New World, colonising several plant species of the Araceae family in Central and South America, southern USA, and the Pacific Region. It is is also reported as a minor pest for growers of ornamental-foliage plants (Martin et al. 2001).

Massilieurodes chittendeni is most probably a species originating from northern Asia, from where its host plant, rhododendrons, mainly originate. This species was described on material collected in England in 1928 (Laing 1928). Klasa et al. (2003) reported the introduction of this species to central Poland, the Czech Republic, Germany and the Netherlands. Two whitefly species with an uncertain area of origin include *Dialeurodes kirkaldyi* and *Singiella citrifolii* both potential pests of *Citrus*-plantations. *D. kirkaldyi* was originally described from Hawaii and later reported in several states in North America (Russell 1964). The species is also known from Africa and Asia. In Europe it was so far found in Cyprus and Portugal. *S. citrifolii* was originally described from the United States. It is known from the Oriental Regions and from the Neotropics and the Nearctic Region. In Europe the species is known from Madeira (Aguiar 1998) and recently it was reported from the Mediterranean Region (Lebanon) (Martin 2000). *Parabemisia myricae*, commonly known as the Japanese bayberry whitefly, is probably native to Japan. It arrived in the Mediterranean Basin and Southern Europe in the mid 1980s and in a very short time it invaded most of the Mediterranean countries with considerable damage to citrus plantations (Rapisarda et al. 1990).

Some alien whitefly species show little dispersion in Europe. *Trialeurodes packardi*, a species native to the Nearctic Region where it is extremely polyphagous, was only noted in Hungary (Kozár et al. 1987) as a pest on strawberries. *T. packardi* is closely related to *T. vaporariorum*, and the two species can only be distinguished via microscopic examination of pupal cases, and this may also be a reason why the species was not recorded elsewhere in Europe.

A highly polyphagous Neotropical species is *Aleurodicus dispersus*, commonly known as the Spiralling Whitefly. This species is occasionally detected in northern Europe on plants imported from the Far East (Martin 1996). In the 1970s this species began a rapid expansion of its range, westwards from the New World, and crossed the Pacific to the Philippines by 1983, and in 1990 its arrival in the Malay Peninsula was noted. Since then its spread continued into Thailand, Sri Lanka, southern India, the Maldive Islands, and Western Africa (Martin 1996). Its establishment in the Canaries dates back to the early 1960s, but the species is also known from Macaronesia where it is common on trees and shrubs in the open and seems to be a well established species. A species which co-exists with *A. dispersus* in the Canary Island is *Lecanoides floccissimus*, a second Neotropical species which is particularly damaging to numerous unrelated host-plants due to direct feeding and by the enormous populations depriving plants of sap and thus inhibiting growth. The species is also known to secrete copious honeydew on which sooty mould immediately grows and a final effect to people living in the area where this species is abundant, is the fluffy white "wool" secreted by the larval stages, which blows from trees, sticks to clothing and garden furniture, and even causes allergic reactions (Martin et al. 1997). The genus *Paraleyrodes*, also native to the

Neotropical Region, is represented in the West Palaearctic by three species. *Paraleyrodes* species are all very small, comparable in size to members of the Aleyrodinae, and similarly having their fore wing venation reduced to a single unbranched main vein. However, the larval instars all possess wax-producing pores of compound structure, claws on the puparial legs and a quadrisetose *ligula**, all being diagnostic characteristics for the Aleurodicinae. *P. bondari*, is well established in Madeira with material collected on several host-plants since 1995 and likelwise, *P. citricolus,* established on the same island at least since 1994 and is common on both *Citrus* spp. and *Persea americana* Miller (Martin 1996). *P. minei*, although originally described from Syria, is native to the Neotropics. This species has been established in Spain since the early 1990s where it provokes substantial damage on citrus plantations (Garcia Garcia et al. 1992). A fourth species, *P. pseudonaranjae* Martin has become established in Florida, Hawaii, Bermuda and Hong Kong and seems to be rapidly extending its native geographical range (Martin 2001). This species is polyphagous with *Citrus* included in its host-plant records and Europe should be alerted with respect to the high risk of introducing this species.

With regard to the DAISIE list of alien Aleyrodidae published in the 'Handbook of alien species in Europe'(DAISIE 2009), the identification of *Aleuroclava guyavae* by Pellizari and Šimala (Pellizari and Šimala 2007) was incorrect and should refer to *A. aucubae*, a closely related species (Martin, J. pers. comm., 2010). *Bemisis afer* (Priesner & Hosny) was not included as an alien species to Europe in this work as this group is in need of taxonomic revision. Several samples from Britain do however come from glasshouses and its status in Britain was reviewed by Malumphy (2003). Besides, several forms are known from Macaronesia, and before a proper revision of the group is done to define species boundaries no account on European material is included. *Aleurolobus marlatti* (Quaintance) was also removed from the list of alien species in Europe. The species has a very wide geographical distribution with native records from Southern Europe (Sicily and Malta). We also excluded *Aleurolobus olivinus* (Silvestri), a species which is widely found in Europe and wherever its preferred host-plant (olive tree) grows. Finally, *Dialeurodes formosensis* Takahashi was also excluded because the unconfirmed record to species level of Iaccarino (1985) was incorrect and should refer to *Dialeurodes setiger* (Goux), a species native of the Mediterranean area.

9.4.2.2 Psylloidea

Jumping plant-lice alien *to* Europe include 14 species belonging to two families, Psyllidae (11 species) and Triozidae (3 species) (Figure 9.4.1). The Psyllidae family is the largest family of jumping lant-lice with a cosmopolitan distribution and some 1,800 described species accommodated in more than 150 genera. As presently constituted this family is difficult to define as, effectively, it comprises all those species that do not belong in any other of the five psylloid families. The family has a wide range of host-plants with many species utilising woody legumes. Some species are gall-inducers and all of the solitary lerp-forming species belong to this family. The genus *Acizzia* currently

accommodates more than 30 described species of psylloids mainly found in Australia, New Zealand, the Old World tropics and extending through North Africa and the Middle East to the Mediterranean Basin (Hodkinson and Hollis 1987). Among other characteristics, male adults of this genus have a *proctiger** with a conspicuous posterior lobe, forewing with a tapered pterostigma and distinct costal break, basal metatarsus with 1 or 2 black spures and apical segment of aedeagus often complex. Species feed on mimosoid legumes, particularly *Acacia* and *Albizia*. In Europe, four species are considered alien introductions. *Acizzia hollisi* was described from Saudi Arabia and Israel (Burckhardt 1981) on *Acacia raddiana* Savi and was found on the island of Lampedusa in 1987 (Conci and Tamanini 1989). *Acizzia acaciaebaileyanae* and *A. uncatoides* were originally described from Australia and New Zealand, respectively. Both species have been introduced and established in several European locations; *A. acaciaebaileyanae* in France (Malausa et al. 1997), Italy (Fauna Italia, Rapisarda 1985) and Slovenia (Seljak et al. 2004) whereas *A. uncatoides* in France, Italy, Portugal (Hodkinson and Hollis 1987), Montenegro (Lauterer 1993), Malta (Mifsud 2010) and the Canary Islands. Within this psylloid group, the latest arrival in Europe was *Acizzia jamatonica*, originally described from Asia. This species was first noted in Italy (Zandigiacomo et al. 2002), and it was later recorded from a number of European countries including France and Corsica (Chapin and Cocquempot 2005), Slovenia (Seljak 2003), Switzerland (Kenis 2005), Croatia (Seljak et al. 2004), and Hungary (Redel and Penzes 2006). Since 2006, this species was also introduced in the Nearctic Region and its occurrence in the south-eastern United States was surveyed (Wheeler Jr and Richard Hoebeke 2009).

Another group of psylloids which are being accidentally introduced and established in Europe are those associated with eucalyptus plantations. The psylloid subfamily Spondyliaspidinae represents a group of insects associated with Myrtaceae, in particular with eucalyptus. Eucalypts, native to Australia, are planted for a variety of uses in many warmer regions throughout the Old and the New World. The commercial value of selected species for the production of ornamental foliage used in the cut flower industry and/or for pulp timber production has resulted in the widespread planting of *Eucalyptus* trees. Psylloids associated with such host-plants, have become established outside their native range and are sometimes responsible for severe damage to such plantations (Burckhardt and Elgueta 2000). One such psylloid is *Blastopsylla occidentalis* described from Australia, New Zealand and California, and subsequently reported from Mexico, Brazil and Chile (Burckhardt and Lauterer 1997). The species was recently reported in Italy (Laudonia 2006) and most likely this psylloid is already established in other Mediterranean countries. *Glycaspis brimblecombei,* commonly known as the Redgum Lerp Psyllid, originally described from Brisbane in Australia, is also expanding its range with records from Mauritius and California (late 1990s), and it has recently been intercepted in Spain and Portugal (Valente and Hodkinson 2008). The Redgum Lerp Psyllid is becoming a major ornamental pest of Red Gum Eucalyptus, but also occurs on Sugar Gum, Glue Gum and other *Eucalyptus* spp. Three species of *Ctenarytaina* also established in Europe, the first being *C. eucalypti*, com-

monly known as the Eucalyptus psyllid. Originally described from specimens collected on blue gum in New Zealand, this species was first introduced into southern England, northern France and South Africa as early as the 1920s (Laing 1922, Mercier and Poisson 1926, Pettey 1925). This psylloid pest expanded and its current distribution includes France, Germany, Italy, Portugal, Madeira, the Azores, Spain, the Canary Islands, Switzerland and Great Britain (Hodkinson 1999, Wittenberg 2005). The two other species of *Ctenarytaina* have been introduced more recently. *C. spatulata* was first reported from France and Italy (Costanzi et al. 2003) and later from Portugal (Valente et al. 2004) and Spain (Mansilla et al. 2004), whereas C. *peregrina* was first intercepted and described from England (Hodkinson 2007) and recently reported from France and Italy (Cocquempot and Constanzi (Unpubl.)).

The genus *Cacopsylla* includes more than 100 described species distributed mainly in the Holarctic Region, with species that penetrate the Oriental, Afrotropical and Neotropical Regions. Cocquempot and Germain (Cocquempot and Germain 2000) recorded *Cacopsylla fulguralis*, a species native to western Asia, for the first time from France and subsequently the species was found in Belgium (Baugnée 2003), Italy (Süss and Salvodelli 2003), Spain (Cocquempot 2008), Switzerland (Cantiani 1968) and the United Kingdom (Malumphy and Halstead 2003). *Cacopsylla pulchella*, a species strictly associated with the Juda's tree (*Cercis siliquastrum* L.) is probably native to the Eastern Mediterranean basin but since the 1960s the species was found in various localities in Central and Northern Europe (Cantiani 1968, Hodkinson and White 1979b).

The family Triozidae is the second largest family of Psylloidea with some 1,000 described species accommodated in 50 poorly diagnosed genera (Hollis 1984) with a worldwide tropical/temperate distribution. Species utilise host plants in a wide variety of families but never on legumes and many species produce characteristic galls on their host-plants. Four species are recorded as alien for Europe. *Trioza neglecta* was introduced to Europe from south-western and Central Asia, the area of its origin, with its host plant, *Elaeagnus angustifolia* L. grown as an ornamental shrub in parks and along roads. It is now widely distributed from Georgia, Armenia, Azerbaijan, Iran and Anatolia through Russia, Ukraine, Moldavia, Bulgaria, the former Yugoslavia and Romania to Central Europe (Hungary, Slovakia, the Czech Republic, Austria) (Lauterer and Malenovský 2002b). The other two introduced triozid psylloids include *T. erytreae* and *T. vitreoradiata*, both of economic importance and which are treated in detail under section 9.4.8. An additional triozid species, *Bactericera tremblayi* (Wagner), was included in the list of aliens of the DAISIE 'Handbook of alien species in Europe' (DAISIE 2009) but was removed from the present list. This species was abundant in Southern Italy and caused problems on onions since the late 1950s. However, around 1980 the populations of this species declined and now the species seems to be rare and localised. According to Tremblay (1988) the species could have been a recent introduction in Italy from the former USSR. There is not much to sustain such a statement given the fact that apart from Italy, the species is known to occur in Switzerland, France, Turkey, Iran and questionably from Syria and also because the species is polyphagous on herbaceous plants (Burckhardt and Mühlethaler 2003, Lauterer et al. in prep).

In addition, several other psylloid species can be considered as alien *in* Europe. One is a species from the small Homotomidae family, which includes 80 described species in the world, accommodated in 11 genera. Host plants all belong to the Moraceae family, and mainly to the genus *Ficus*. Most known larvae are free-living, although some live in colonies under communal lerps and very few species are gall-inducers. Most species have a pan-tropical distribution but *Homotoma ficus* (L.), a native of Central-Southern Europe and the Middle East feeding on *Ficus carica* L., has been introduced in Southern England where it seems to be confined (Hodkinson and White 1979a). It is alien to North America (Hollis and Broomfield 1989).

In the same category of alien *in* Europe are two Psyllidae species. *Calophya rhois* (Löw), a southern-European species, was reported as introduced in Britain on the basis of a single record from Scalpay in the Hebrides (Hodkinson and White 1979a). The genus *Calophya* is species-poor and distributed in the Neotropical, Holarctic and Oriental Regions with jumping plant-lice associated mainly with Anacardiaceae. *Livilla variegata* (Löw), is probably native to Eastern Europe. The species is known from France, Italy, Switzerland, Bosnia, Romania, Spain, Great Britain, Hungary, Germany, Austria and the Czech Republic (Hodkinson and White 1979b, Lauterer and Malenovský 2002b). This species is strictly oligophagous on *Laburnum anagyroides* Medik. and *L.. alpinum* (Mill.) Bercht. & Presl., and it is already a widespread element in Central Europe, where it colonises its host plant, *L. anagyroides*, an introduced Mediterranean ornamental tree commonly planted in parks and gardens, towns and villages and on roadsides. The introduction and spread of *L. variegata* in Central Europe escaped the notice of entomologists, similar to what happened in England, where it was collected for the first time in 1978 (Hollis 1978), but by which time it was already widespread in that country. A last species, *Trioza alacris* Flor, is most likely of Mediterranean origin but was introduced throughout central and Northern Europe (only in greenhouses or on laurels placed temporarily outside during summer) on cultivated bay laurel. It mostly develops on Laurel (*Laurus nobilis* L.) but is also reported on *L. azoricus* Seub., producing characteristic large leaf galls by rolling the leaf margins down to the lower leaf surface. Most probably the earliest record in Central Europe was that of Schaefer (1949) with material collected from Switzerland in 1917. The species was also introduced in USA (California and New Jersey), Brazil, Chile and Argentina (Conci and Tamanini 1985).

9.4.2.3. Phylloxeroidea

– Adelgidae

Following the 2007 revision by Havill and Footit (2007), a total of 9 adelgid species were identified as alien *to* Europe, including 6 species in the genus *Adelges* (subgenera *Cholodovskaya*, *Dreyfusia*, and *Gilletteella*) and 3 species in the genus *Pineus* (subgenera *Pineus* and *Eopineus)*. At present, these alien species represent 36% of the total adelgid

fauna observed in Europe (Figure 9.4.1). Most of them were introduced during the late 19th century- early 20th century alongside with their exotic conifer host trees which were massively used at that time for afforestation in Europe, e.g. Douglas-fir (*Pseudotsuga menziesii* Mirb. (Franco)) for *Adelges cooleyi* (Chrystal 1922) and *A. coweni* (Roversi and Binazzi 1996), Caucasian fir (*Abies nordmanianna* Spach.) for *Adelges (Dreyfusia) nordmanianna* (Marchal 1913) , *A. prelli* (Eichhorn 1967) and *A. merkeri* (Binazzi and Covassi 1988), and oriental spruce, *Picea orientalis* (L.) Link., for *Pineus orientalis*. Some other species were introduced along with ornamental trees originating from North America such as *Pineus* (*Eopineus*) *strobi* with the eastern white pine, *Pinus strobus* (Steffan 1972), and *Pineus similis* with Sitka spruce, *Picea sitchensis* (Bong.) Carrière (Carter 1975, Carter 1975). A majority (five out of nine) of the alien species are holocyclic, one is anholocyclic of first type developing entirely on *Picea* (*Pineus similis*) and three anholocyclic of second type developing entirely on *Pseudotsuga* (*Adelges coweni*), *Larix* (*A. viridula*) or *Pinus strobus* (*Pineus strobi*).

In addition, several adelgid species native of the Alps and/or Central Europe can be considered as alien *in* Europe. Their primary host is mostly spruce (*Picea*), and then larch (*Larix*), fir (*Abies*), or pine (*Pinus*). They include *Adelges (Adelges) laricis* Vallot, which accompanied the plantations of larch in the lowlands (Glavendekić et al. 2007, Hill et al. 2005), and several species introduced from continental Europe to Great Britain, i.e. *Adelges (Adelges) piceae* Ratzeburg, *A. (Sacchiphantes) abietis* L. , *A. (Sacchiphantes) viridis* Ratzeburg , and *Pineus pineoides* Cholodkovsky (Hill et al. 2005). Similarly, the alpine *Pineus cembrae* (Cholodokovsky) colonized the Faroe islands with Swiss stone pine, *Pinus cembra* L. *Adelges (Aphrastasia) pectinatae* (Cholodkovsky), a species which develops on spruce and fir was first considered as an alien in Europe (DAISIE 2009) having established in Central and Northern Europe, including the Baltic countries (Gederaas et al. 2007, Holman and Pintera 1977). However, its origin is difficult to be ascertained since Havill and Footit (2007) indicated 'Europe, China and Japan'.

– Phylloxeridae

There are two species of phylloxerans alien *to* Europe with regard to 15 native species (Figure 9.4.1). *Moritziella corticalis* is of unknown origin (cryptogenic) and was first reported as introduced in Britain (Barson and Carter 1972). The genus *Moritziella* accommodates two species living on Fagaceae. They are distinguished from Palaearctic species of *Phylloxera* by the absence of abdominal spiracles on segment 2–5 and by the presence of numerous well-developed, pigmented dorsal tubercles. Generic distinction between North American species of *Phylloxera* and *Moritziella* is however not satisfactory.

The other species is the well-known 'Phylloxera', *Viteus vitifoliae* (=*Dactylosphaera vitifoliae*) which has devastated the European vineyards at the end of 19th century. The genus *Viteus* is a monotypic genus, the *alatae** of which have paler abdominal *stigmal** plates and a shorter distal *sensorium** on the third antennal segment than the common

European *Quercus*-feeding *Phylloxera*. *Viteus vitifoliae* typically goes through a two-year cycle involving a sexual phase and leaf-galling and root-feeding stages on American vines. On European vines it normally lives continuously on the roots, reproducing parthenogenetically. Leaf-galls occur in Europe on cultivars derived from hybrids between *Vitis vinifera* L. and American vines. The economic significance of this species is discussed in some detail under section 9.4.8.

9.4.2.4. Auchenorrhyncha

A total of 12 species alien *to* Europe have been considered (Figure 9.4.1). Not surprisingly most of them belong to the species- rich family of Cicadellidae (17,000–20,000 worldwide; 1,236 species in Europe). Other families are represented only by a single species in each.

Within Cicadomorpha, the Cicadellidae (leafhoppers) is the largest family with 50 subfamilies and 17,000–20,000 described species. Leafhoppers live in all zoogeographical regions and feed on a wide range of host plants, though individual species have often trophically and geographically restricted ranges (Dolling 1991, Nielson 1985). Cicadellidae varies in body length from 2–30 mm. Leafhoppers feed on a large range of plants (grasses, herbaceous plants, trees and shrubs). The majority of leafhoppers feed on phloem, some on xylem (especially the subfamily Cicadellinae), and only members of the subfamiliy Typhlocybinae are specialised parenchyma-feeder. Leafhoppers are well known vectors of plant diseases and of economic importance worldwide. For some leafhopper species migratory behaviour is documented (Della Giustina 2002). Eight leafhopper species are certainly alien to Europe. Probably most famous is the Rhododendron leafhopper, *Graphocephala fennahi*, a native to North America. The species was first reported from southern England in the 1930s but it crossed the Channel only after 1960, to the Netherlands from where it spread rapidly within continental Europe. Two other North American species, *Scaphoideus titanus* and *Erythroneura vulnerata*, are pest species on grapes. Especially *Scaphoideus titanus* has become an important pest since it is the vector of 'flavescence dorée' phytoplasma to grapevine. The Neartic leafhopper *Kyboasca maligna* does not seem to be problematic as an alien species to Europe for the time being. From Eastern Asia four cicadellid species have been introduced: *Japananus hyalinus*, *Macropsis elaeagni*, *Orientus ishidae* and *Igutettix oculatus*. None of them have yet been found to transmit plant diseases in Europe and are therefore not of economic importance. *O. ishidae* was only recently reported new to Europe (Günthart et al. 2004) but is spreading rapidly in Europe (Switzerland, Italy, Germany, Slovenia, France, Austria, Czech Republic). *I. oculatus* (=*Vilbasteana oculata* (Lindberg)) is originally an eastern Palaearctic species which was first found in Moscow in 1984 and is now spreading to the west (Finland (Söderman 2005)). It lives on *Syringa*.

With around 3,200 described species Membracidae is the largest family of treehoppers. Membracids are widespread worldwide but only few species occur in Eu-

rope. This family is most diverse in the Neotropics and North America. Characteristic is the enlarged pronotum with sometimes bizarre shaped extensions and elongations. They are medium sized with a body length of 2–24 mm. As with other members of Cicadomorpha, Membracidae lay their eggs into living plant tissue. If populations are too big this can cause serious damages to the host plant and therefore can be regarded as crop pests (e.g. apple trees, see e.g. (Arzone et al. 1987)). Only four species are native to Europe. One species (*Stictocephala bisonia*) was introduced from North America.

The Fulgoromorpha group yet contributed for only three species alien to Europe, with one per family Delphacidae, Flatidae and Acanaloniidae, to be compared to 727 species native in Europe. Delphacidae are characterized by a moveable spur on the hind tibia. Species are generally small (2–6 mm) and are widely distributed also in colder regions. Worldwide around 1,500 delphacid species are described. They feed on monocotyledons and are economically important as pest species on rice, maize, wheat and sugarcane. *Nilaparvata lugens* (Stål) for example is a serious pest of rice in Asia (O'Brien 2002, Wilson and Claridge 1991). In Europe there are some 260 species. Only one alien delphacid has established in Europe, *Prokelisia marginata*, which was first found on the Algarve (Portugal) in 1994 and in Spain in 1998 (unpublished data M.R. Wilson). In Slovenia a well established population was found in 2004 (Seljak 2004). New, unpublished records are from southern England (2008) and France (2009). It is very likely that this planthopper is expanding its range rapidly along the European coasts.

Species of the family Flatidae have often colourful opaque wings and can be distinguished from other Fulgoromorpha by the numerous parallel crossveins along the costal margin of the forewing and a single spine at each side of the second tarsomere of the hind leg. The body size varies between 4.5–32.0 mm. Flatids feed on different shrubs, trees and herbs (O'Brien 2002). The North American *Metcalfa pruinosa* has been introduced to Europe probably in plant material and was first recorded in Italy in 1983. From there it is spreading rapidly to the rest of southern Europe (France, Slovenia, Switzerland, Austria, the Czech Republic) causing damages on grapes (Della Giustina 1986, Dlabola 1981, Holzinger et al. 1996, Lauterer and Malenovský 2002a, Mani and Baroffio 1997, Seljak 2002).

The Acanaloniidae is a small family of Fulgoromorpha with c. 80 described species accommodated in 14 genera. In general they resemble flatid planthoppers. This family is not native to Europe and the north American species *Acanalonia conica* was only recently introduced into northern Italy (D'Urso and Uliana 2006). *A. conica* has a similar biology to *Metcalfa pruinosa* and can often be found in mixed nymphal feeding groupings with the latter (Wilson and MacPherson 1981). Therefore this species could potentially be another pest insect for European vineyards.

Tropiduchidae is a small family within the Fulgoromorpha with some 400 described species worldwide. Body size varies between 5–13 mm; the mesonotum with its apical angle is separated by a transverse groove. They feed on ferns, palms, grasses and Dicotyledonae (O'Brien 2002). *Ommatissus lybicus* Bergevin, the dubas bug, was

for a long time regarded as a variety of *O. binotatus* Fieber (but see Asche and Wilson 1989). *O. lybicus* is a severe pest of date palms in the Middle East causing the death of trees. *O. binotatus* was described from Spain and feeds on *Chamaerops humilis* L. It was also found in Sicily and Portugal and is a native European species and should be deleted from the DAISIE list.

Species with an Eurosiberian or a Holarctic distribution, *Edwardsiana ishidai* Matsumura and *Kyboasca bipunctata* (Oshanin), have been excluded from Table 9.4.1. Other leafhopper species with a doubtful alien status include: *Cicadulina bipunctata* (Melichar), a North African species which occurs also in the eastern Mediterranean; *Empoasca punjabensis* Singh-Pruthi, originally described from India but is also reported from the southern parts of European Russia , Ukraine, Bulgaria, Serbia and Greece; *Jacobiasca lybica* (Bergevin & Zanon), another North African species which is reported from other Mediterranean regions (Sicily, Sardinia and Greece); *Melillaia desbrochersi* (Lethierry), a North African species also reported from Greece, Sicily and Corsica; *Psammotettix saxatilis* Emeljanov, described from Kazakhstan and found in France but possibly conspecific with *P. sierranevadae* Dlabola from Spain.

There are some papers reporting mainly records of Mediterranean Auchenorrhyncha new to Northern European regions (Maczey and Wilson 2004, Nickel and Holzinger 2006, Wilson 1981). Due to lack of sufficient historical information on the distribution of most Auchenorrhyncha species it is difficult to determine if anthropogenic factors and/or climatic influence are the main causes of range extension. There are for example some southern European *Eupteryx* species, which appear to have become in the last decades more common in central Europe or even extended their range to northern latitudes such as Denmark and the UK. These species may exploit certain man made habitats, e.g. in greenhouses where herbal plants are cultivated (such as Lamiaceae e.g. *Melissa*, *Oreganum*, etc.) but may also build up localised 'wild' populations. Such populations may be stable over years under good environmental conditions but can also easily break down depending on several conditions including weather, pressure of predators, parasites and others. Continental European Auchenorrhyncha species introduced to European islands are also excluded of this overview. Thus, five Cicadellidae species (*Empoasca pteridis* (Dahlbom), *Grypotes puncticollis* (Herrich-Schaffer), *Iassus scutellaris* (Fieber), *Placotettix taeniatifrons* (Kirschbaum) and *Wagneripteryx germari* (Zetterstedt)) are reported to be alien in the UK (Stewart 1993). On the other hand it is very likely that *Philaenus spumarius* L. (Aphrophoridae) was introduced into Iceland in the late 1970s.

9.4.3 Temporal trends of introduction in Europe of alien species of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha

The first records in Europe are approximately known for 60 of the 64 species considered here. Dates given are relatively imprecise, as most of these tiny species have probably been introduced several years before they were reported.

The number of new records per time period largely differed among Aleyrodidae, Psylloidea, Phylloxeroidea and Auchenorrhyncha (Figure 9.4.2.). The arrival of alien phylloxerans and adelgids appeared to peak during the first part of the 20th century. Some species such as the Grape Phylloxera, *Viteus vinifoliae*, and the silver fir adelgid, *Adelges nordmannianae*, arrived earlier in the 19th century but most species, especially the ones associated with Douglas-fir (*Adelges cooleyi* and *A. coweni*) were probably introduced in the early 1900s. Only one new species having been introduced later (*Pineus simi*lis in 1971), and apparently none during the last ten years.

In contrast, the mean number of new records per year of Aleyrodids, Psylloids and Auchenorrhyncha increased regularly from the 1950s. For these three groups, an average of 0.5–0.6 new alien species has been recorded per year in Europe since 2000. The first documented introduced alien Auchenorrhycha to Europe was *Stictocephala bisonia* (at that time under the name *Ceresa bubalus*) in eastern Europe (former Austro-Hungarian Empire) in 1912 (Horvaáth 1912). This treehopper was probably introduced with fruit tree cuttings and is now widespread all over Europe except the northern regions. It was followed by another North American species, *Graphocephala fennahi*, which was first found on rhododendrons in southern England in 1933. Since then other Auchenorrhyncha species from North America or East Asia have been introduced mainly to Central or Southern Europe benefiting from international trade of plants. In the case of *Scaphoideus titanus* it seems that this species had a first ancient introduction followed by multiple colonization events (Bertin et al. 2007).

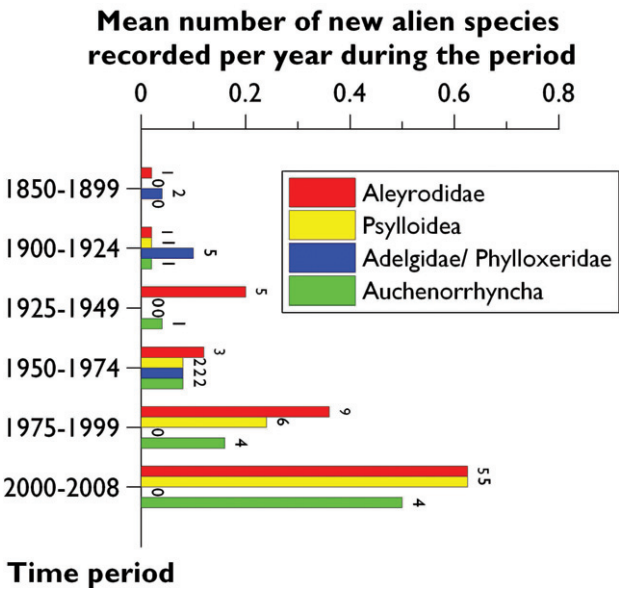

Figure 9.4.2. Temporal changes in the mean number of new records per year of Aleyrodidae, Psylloidea, Phylloxeroidea (Adelgidae/ Phylloxeridae) and Auchenorrhyncha alien *to* Europe from 1800 to 2009. The number right to the bar indicates the total number of species recorded per time period.

9.4.4 Biogeographic patterns of the Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha alien to Europe

9.4.4.1 Origin of alien species

The region of origin of the alien species largely differs between groups (Figure 9.4.3). Aleyrodids and psylloids mainly originated from tropical regions, the Neotropics and Australasia, respectively. Adelgids and phylloxerans came equally from North America and Asia, mostly because a number of adelgids were introduced from the Caucasus Mountains together with their conifer hosts. In contrast, most of the alien Auchenorrhyncha have a North American origin. For a few species, the area of origin remains uncertain.

9.4.4.2 Distribution of alien species in the European countries

For whiteflies and psylloids, the distribution of alien species to Europe or to certain parts of Europe has been highlighted and documented in 9.4.2 and is also presented in Table 9.4.1. Most of the alien species of aleyrodids, psylloids, phylloxerans and adelgids did not spread largely within Europe yet. Indeed, 31 species out of 52 (i.e., 60%) have colonized less than five European countries. Only 4 species, two aleyrodids (*Bemisia ta-*

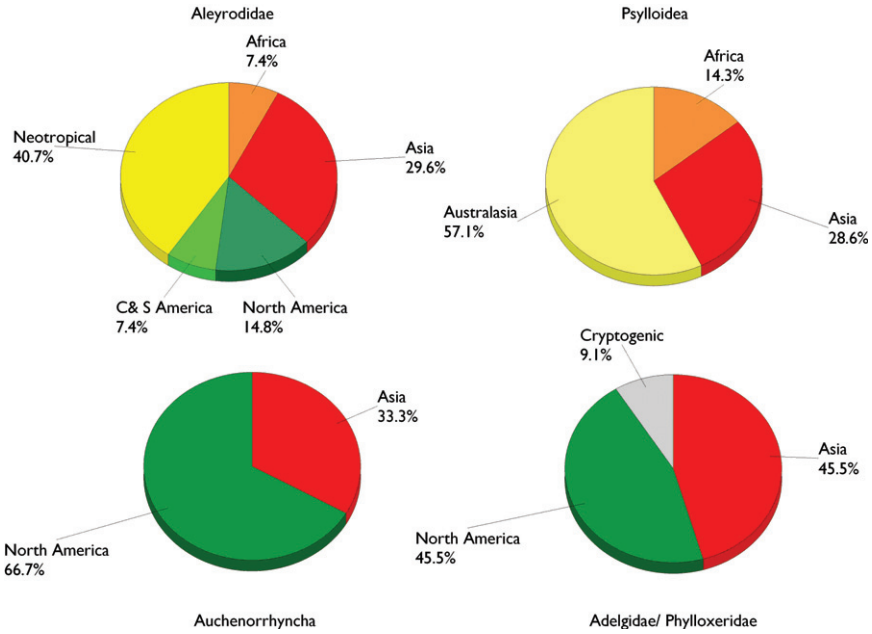

Figure 9.4.3. Comparative origin of the Aleyrodidae, Psylloidea, Phylloxeroidea (Adelgidae/ Phylloxeridae) and Auchenorrhyncha species alien *to* Europe

baci and *Trialeurodes vaporariorum*), one phyloxeran (*Viteus vinifoliae*) and one adelgid (*Adelges nordmannianae*) have colonized more than 20 countries (Table 9.4.1).

Due to the lack of comprehensive data we cannot give appropriate information on the distribution of alien Auchenorrhyncha in Europe. However three species (*Scaphoideus titanus*, *Metcalfa pruinosa* and recently *Acanalonia conica*) could have first established in the Mediterranean region from where they spread northbound. Other species expanded their range from eastern Europe (*Stictocephala bisonia*, *Macropsis eleagni*) or central Europe (*Japananus hyalinus*, *Orientus ishidae*), one species started from the UK (*Graphocephala fennahi*). It is also possible that some of the alien species had multiple introductions (*Scaphoideus titanus*, *Prokelisia marginata*). Generally the introduced species could spread easily as long as the environmental conditions are appropriate for them (climate, host plants, etc.). Five out of the 12 alien species spread in more than 10 countries, with *Stictocephala bisonia* having expanded in 26 countries and islands (Table 9.4.1).

9.4.5 Pathways of introduction to Europe of the alien species of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha

Most alien species of whiteflies, psylloids, phylloxerids and adelgids were accidentally introduced with their host plant. In most circumstances such introductions occurred via trade of the host plant or of parts of the host plants such as fruit or cut flowers.

It is reported that Auchenorrhyncha can migrate. Usually they are short-distance migrants to leave non-permanent habitats but some species are able to migrate over long distances (Della Giustina 2002). The probably most amazing example is the cicadellid *Balclutha pauxilla* Lindberg which invaded in swarms the Ascension Island in the Atlantic Ocean (about half way between South America and Africa) in 1976. The specimens must have flown more than 2,000 km over the sea probably coming from Africa (Ghauri 1983).

Despite of the fact of possible migration, alien Auchenorrhyncha certainly profit of the worldwide trade of fruit trees, vine cuttings and ornamental plants. Especially eggs in the plant tissue can survive the transport even over long distances and time. Once arrived, the nymphs hatch and without their specific parasites they can build up strong populations. Not surprisingly some alien Auchenorrhyncha were first found around harbours (e.g. *Prokelisia marginata*) or cities (*Orientus ishidae*), an unmistakable trace of their pathway of introduction.

9.4.6 Ecosystems and habitats invaded in Europe by the alien species of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha

Apart from those species so far intercepted only in greenhouses and of which no reports exist of their establishment in Europe, the other introduced species of the five groups treated in this account are often confined to few related host plants. For exam-

ple, several species of whiteflies which in their area of origin are highly polyphagous have shown to be strictly oligophagous in their new territories, occurring mainly on Citrus and some other woody hosts.

Thus, the major part of these alien species is presently observed in man-made habitats, especially in parks and gardens where a number of exotic plants have been planted (Figure 9.4.4). Natural and semi-natural habitats are yet little colonized by alien Auchenorrhyncha and psylloids (<20%) and quite none by aleyrodids. A noticeable exception concerns adelgids because of their association with conifer trees used for afforestation. More than 60% of the alien adelgids are thus found in forest habitats together with fir, spruce and larch trees.

Interestingly so far only one grassland species (*Prokelisia marginata*) was introduced to Europe. This species lives originally in salt marshes along the East-Coast of North America and is associated with *Spartina* grasses. All other alien Auchenorrhyncha colonize mainly anthropogenic habitats (vine yards, orchards, gardens, parks). Some of them are polyphagous and can therefore also be found in natural environments (e.g. *Stictocephala bisonia* in dry habitats or *Orientus ishidae* on willows and birch trees).

9.4.7 Ecological and economic impact of the alien species of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha

In terms of economic losses, the two most important whiteflies in Europe are *Trialeurodes vaporariorum*, commonly known as the glasshouse or greenhouse whitefly and *Bemisia tabaci,* commonly known as the Cotton Whitefly. *T. vaporariorum* is a member of a North American species-group. It was however described in 1856 from England, at which time the species was an already widespread and established pest. *B. tabaci*,

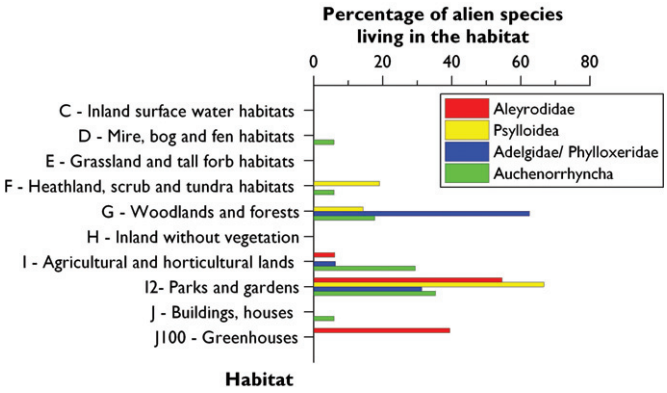

Figure 9.4.4. Main European habitats colonized by the established alien species of Aleyrodidae, Psylloidea, Phylloxeroidea (Adelgidae/ Phylloxeridae) and Auchenorrhyncha. The number over each bar indicates the absolute number of alien species recorded per habitat. Note that a species may have colonized several habitats.

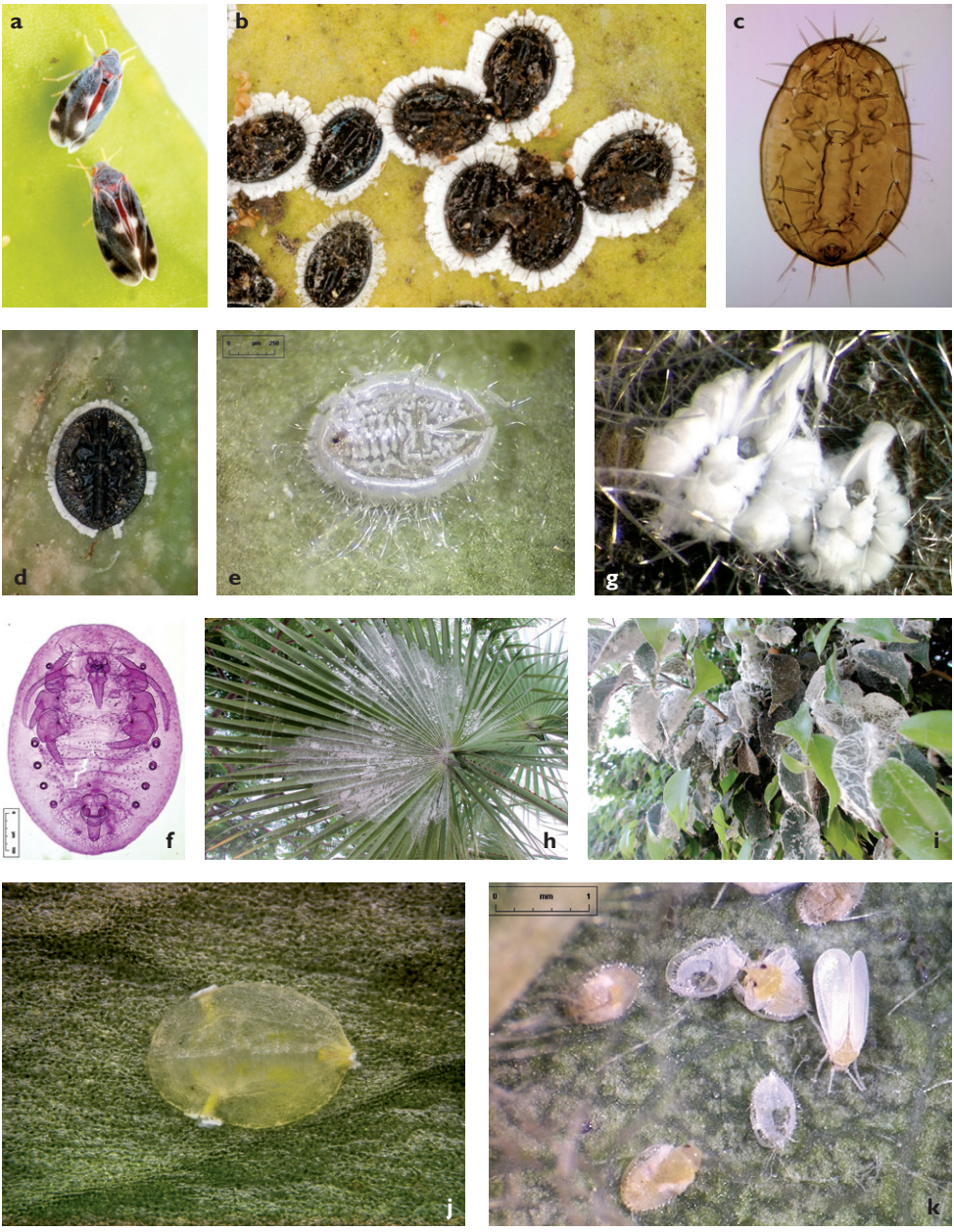

Figure 9.4.5. Aleyrodid species alien *to* Europe. **a** *Aleurocanthus spiniferus* adult **b** *Aleurocanthus spiniferus* puparium **c** *Aleurocanthus spiniferus* puparium from palm leaf (East-Timor) **d** *Acaudaleyrodes rachipora* puparium on leaf of *Argania* (Agadir, Morocco) **e** *Aleurothrixus floccosus* puparium on leaf of *Citrus reticulata* (France) **f** *Aleurodicus dispersus* puparium from leaf of *Psidium gajava* (Martinique) **g** *Aleurodicus dispersus* puparium on leaf of *Psidium gajava* (Martinique) **h** *Aleurodicus dispersus* damage on palm leaf **i** *Aleurodicus dispersus* damage on leaf **j** *Bemisia tabaci* from Thailand intercepted at Roissy airport, France on leaf of *Eryngium foetidum* **k** *Trialeurodes vaporariorum* adults and puparium on leaf of *Fragaria* (France). (Credit: **a, b, h, i** - Francesco Porcelli; **c, d, e, f, g, j, k** - LNPV Montpellier).

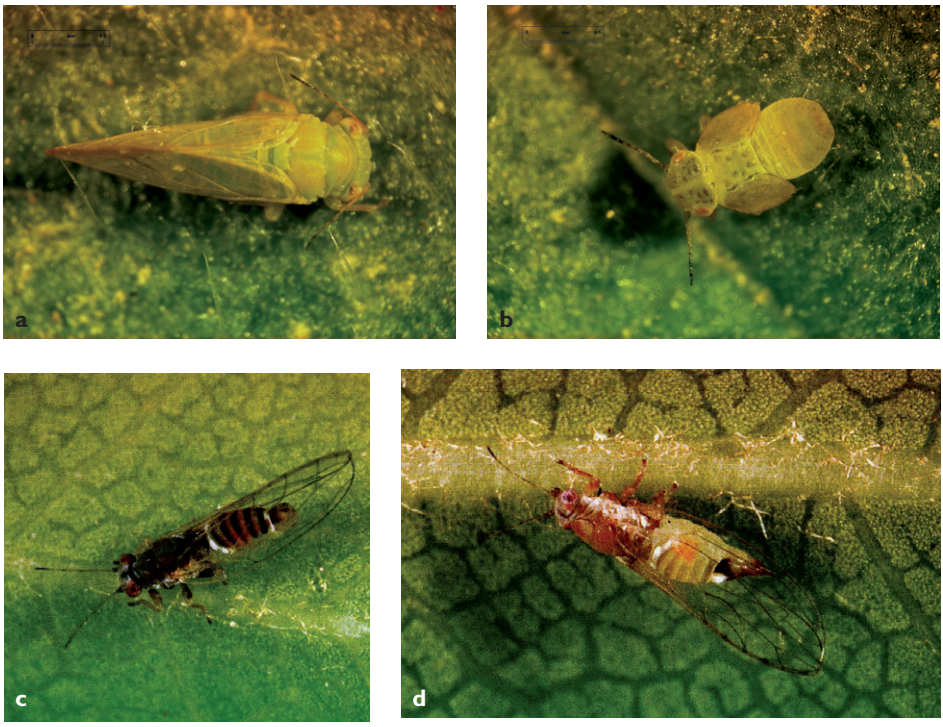

Figure 9.4.6. Psylloid species alien *to* Europe. **a** *Acizzia jamatonica* adult on leaf of *Albizia* (Bordeaux, France) **b** *Acizzia jamatonica* immature on leaf of *Albizia* (Bordeaux, France) **d** *Trioza vitreoradiata* male under a leaf of *Pittosporum tobira* **e** *Trioza vitreoradiata* female. (Credits: **a, b** - LNPV Montpellier; **c, d** - Jean-Marie Ramel and Christian Cocquempot).

probably of Asian origin, is now virtually cosmopolitan, usually found under glass in areas with continental climates. Several biotopes of this species are known (De Barro et al. 1998) and this taxon is known to transmit geminiviruses to cultivated plants of various unrelated groups (Bedford et al. 1994) and is a serious pest of both open-air and protected cropping. Some of the "emerging" whitefly pests in Europe may also prove to be of high economic impact to European agriculture and within this group the most promising species seems to be *Aleurocanthus spiniferus*.

One of the most important species of psylloid in terms of economic losses is *Trioza erytrea*, a native to the Afrotropical Region. This species is a major pest of citrus plantations, but in its native range is also known to develop on *Vepris undulata* (Thunb.) Verdoorn & C.A. Sm. *Zanthoxylum* (=*Fagara*) *capense* (Thunb.) Harvey and *Clausena anisata* (Willd.) Hook. f. ex Benth. (Hollis 1984). The main economic importance of *T. erytreae* is as vector of the citrus disease caused by citrus greening bacterium (also transmitted by the psylloid, *Diaphorina citri* Kuwayana). Both psylloids are listed as A1 quarantine pests by EPPO and other phytosanitary organisations. Isolated outbreaks of this species were first noted in Europe in Madeira in 1994 and it seems that the species is now established on both the Canary Islands and Madeira (Borges et al. 2008, Gonzalez

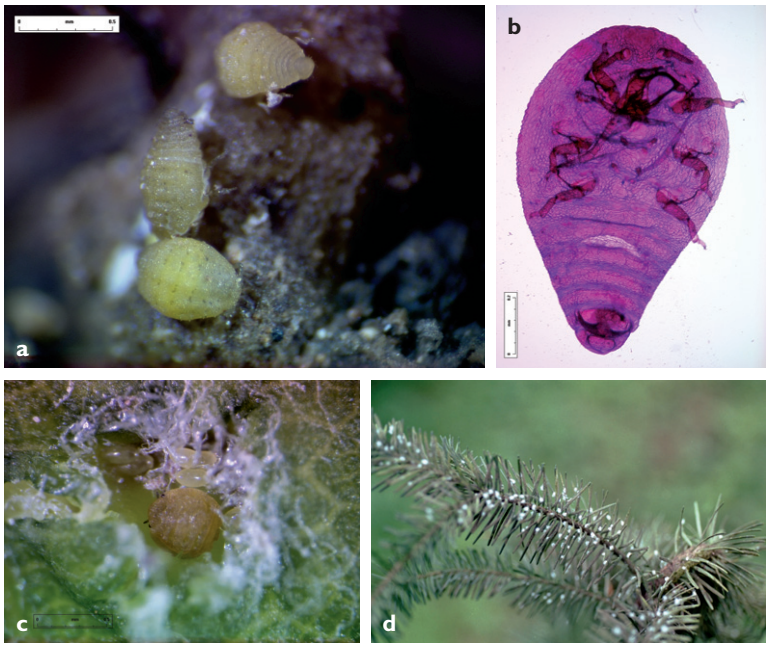

Figure 9.4.7. Adelgid and phylloxeran species alien alien *to* Europe. **a, b** - *Viteus vitifoliae* on roots of *Vitis vinifera* (France) **c** *V. vitifoliae* from galls on leaf of *V.vinifera* (France) (Credit: LNPV Montpellier) **d** *Adelges cooleyi* on needles of Douglas-fir (France) (Credit: A. Roques).

2003). *T. erytrea* is also a species of considerable taxonomic interest as it is part of a complex of species, all of which are difficult to define morphologically, but which have discrete host plant preferences (Hollis 1984). Another important psylloid of economic significance is *Trioza vitreoradiata*, a species native to New Zealand but recently established in Britain (Martin and Malumphy 1995), Ireland (O'Connor et al. 2004), and France (Cocquempot 2008). This psylloid is specific to *Pittosporum* where apart from direct loss by the plant in the form of sap depletion caused by the feeding activity of the psylloid, shallow pit galls are formed on young leaves, which remain visible for the life of the leaf. Sooty mould is also very common due to the large amounts of honeydew droppings on underlying leafs. The galling and presence of such sooty moulds make unmarketable ornamental plants of *Pittosporum tenuifolium* Gaertner, which are often grown for the cut-flower industry and also harvested for its foliage (Martin and Malumphy 1995).

Two of the introduced Auchenorrhyncha are of high economical importance. Both are regarded as pest species of vine. *Scaphoideus titanus* is a vector of 'flavescence dorée', a phytoplasma disease (grape vine yellows), which can cause big crop losses. *Metcalfa pruinosa* affects the plants directly. Strong populations can weaken the plant by sucking and the excreted honeydew is medium for fungi, which can cause reduction in the quality of the fruits.

The only phylloxerid of devastating economic significance and which was the cause of much trouble for the wine industry in Europe was the Grape Phylloxera, *Viteus vitifoliae*. This serious pest of grapes originated in North America where the local

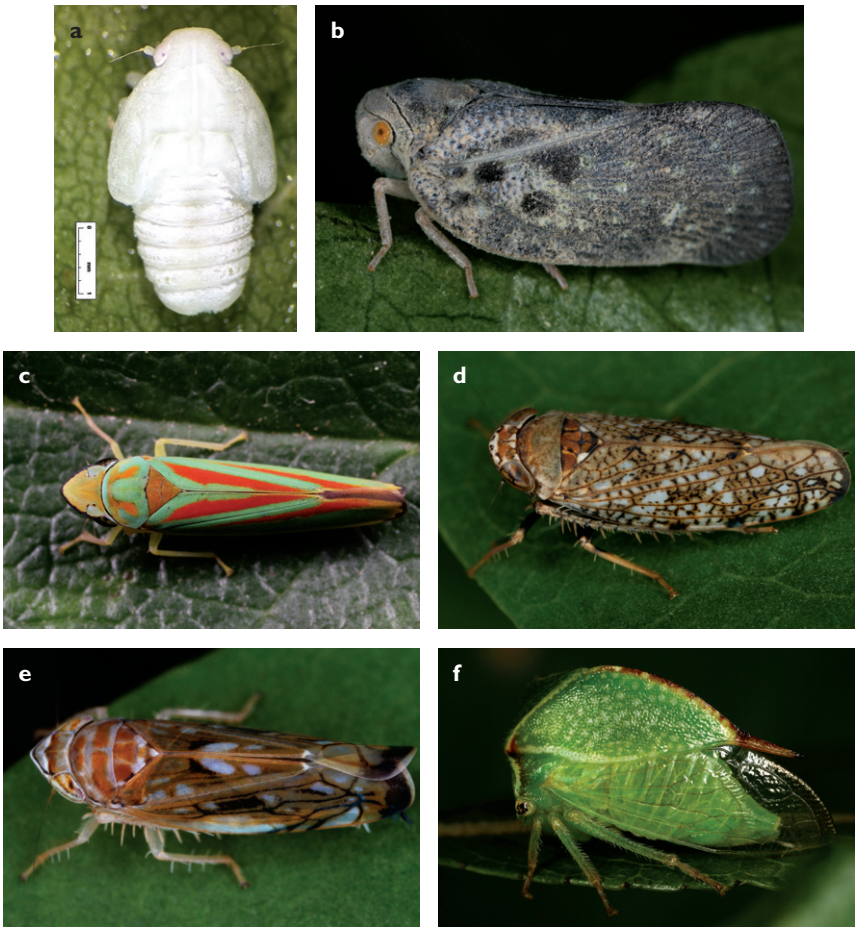

Figure 9.4.8. Auchenorrhyncha species alien *to* Europe. **a** *Metcalfa pruinosa* larvae **b** *Metcalfa pruinosa* adult **c** *Graphocephala fennahi* adult **d** *Orientus ishidae* adult **e** *Scaphoideus titanus* adult **f** *Stictocephala bisonia* adult. (Credit: **a** - LNPV Montpellier; **b–f** - Gernot Kunz)

vines evolved with it and are not severely damaged by its feeding activity. The species was accidentally introduced to Europe around 1860. In Italy, the species was first reported in 1879 and one year later it was also found in Sicily. In certain countries, possibly due to strict quarantine notices of this new pest, several years passed by before its introduction (e.g. in Malta, Grape Phylloxera was introduced in 1919 (Mifsud and Watson 1999)) but eventually the species was introduced everywhere. It invaded the Mediterranean Region, the Middle East, Africa, Korea, Australia, New Zealand and parts of South America. Grape Phylloxera feeds on species of *Vitis* including grape vines. Foliar attack does not seem to be unduly damaging, but asexual forms attacking roots all year round can kill plants that did not originate from North America. Grafting European vines onto North American rootstocks has successfully solved this problem in the past, but concern has increased in recent years because this resistance

is being broken in some parts of the World as new biotypes of Grape Phylloxera are evolving (King and Rilling 1985).

9.4.8. Conclusion

Only few European countries produced comprehensive lists of alien Aleyrodidae, Psylloidea, Phylloxeroidea and Auchenorrhyncha. Most of these alien insects were probably introduced by plant material and once established could spread quickly into other European countries. Fortunately, only few species (*Trioza erythrea*, *Trioza vitreoradiata*, *Scaphoideus titanus*, *Metcalfa pruinosas* and *Stictocephala bisonia*) have to be regarded as pest or potential pest species so far. However, recent introductions (*Acanalonia conica*, *Orientus ishidae*, *Prokelisia marginata*) show that trade is the main factor of introduction and that at any time new problematic species can occur.

On the other hand we have still not sufficient information on the migration of Auchenorrhyncha within European regions. Several observations indicate that in the last decades Mediterranean species expanded their distribution to the North but it is not clear if they can establish wild populations or not. Usually these species profit from anthropogenic habitats (e.g. agricultural areas and parks) and can cause problems. Therefore we need to monitor species migration carefully.

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References

Aguiar AMF (1998) New records of whiteflies (Homoptera : Aleyrodidae) from Madeira Island with some taxonomic notes. *Boletim do Museu Municipal do Funchal* Suplemento 5: 9–26.

Aloi A. (1898) Un nuovo e serio pericolo per l'odierna viticoltura. *Agricoltore calabro-siculo*, 23: 229–230.

Anonymous (1894) Đrazprostranenie na filoksernata zaraza u nas. *Oralo* 1, 29–30, 234–236.

Arzone A, Vidano C, Alma A (1987) Auchenorrhyncha introduced into Europe from the Nearctic region: taxonomic and phytopathological problems. In Wilson MR, Nault LR (eds) *Proceedings of the 2nd International Workshop on leafhoppers and Planthoppers of Economic Importance*. London: CIE, 3–17.

Asche M, Hoch H (2004) *Fauna Europaea: Cicadomorpha*. Fauna Europaea version 1.1, available at http://www.faunaeur.org [accessed at 05.02.2010].

Asche M, Wilson M R (1989) The palm-feeding planthopper genus *Ommatissus* (Homoptera: Fulgoroidea: Tropiduchidae). *Systematic Entomology* 14: 127–147.

Barson G, Carter CI (1972) A species of Phylloxeridae, *Moritziella corticalis* (Kalt.) (Homoptera) new to Britain, and a key to the British oak-feeding Phylloxeridae. *Entomologist* 105: 130–134.

Baudyš E (1935) *Hospodářská fytopathologie.* [Economic phythopathology]. Brno, 630 pp.

Baugnée JY (2003) Sur la présence en Belgique du Cicadellidae *Kyboasca maligna* (Walsh, 1862) et du Psyllidae *Cacopsylla fulguralis* (Kuwayama, 1907) (Hemiptera Homoptera). *Bulletin de la Société royale belge d'Entomologie* 139: 72–73.

Bayer E (1914) *Moravské hálky (Zoocecidia)*. Pokorný a spol., Brno, 181 pp.

Bayer E (1920) *Synopsis zoocecidií středoevropských se zřetelem k zemím českým* [Synopsis of the Central-European galls with regard to the Czech country] Brno: Moravy Muzeum Zemské. 237 pp.

Bedford ID, Briddon RW, Brown JK, Rosell RC, Markham PG (1994) Geminivirus transmission and biological characterisation of Bemisia tabaci (Gennadius) biotypes from different geographical regions. *Annals of Applied Biology* 125: 311–325.

Bertin S, Guglielmino CR, Karam N, Gomulski LM, Malacrida A R, Gasperi G (2007) Diffusion of the Neartic leafhopper *Scaphoideus titanus* Ball in Europe: a consequence of human trading activity. *Genetica* 131: 275–285.

Binazzi A, Covassi M (1988) Le specie del Gen. *Dreyfusia* in Italia. Nota preliminare (Homoptera Adelgidae). *Atti del XV Congresso Nazionale Italiano di Entomologia*, L'Aquila, 267–273.

Borges PAV, Franquinho Aguiar AM, Boiero M, Carles-Tolra M, Serrano ARM (2008) Capítulo 10.1 - Lista dos Artrópodes (Arthropoda) in Borges PAV, Abreu C, Franquinho Aguiar AM, Carvalho P, Jardim R, Melo I, Oliviera P, Sergio C, Serrano ARM, Vieira P (eds.) *Listagem dos fungos, flora e fauna terrestres dos arquipélagos da Madeira e Selvagens, Secretaria Regional do Ambiente e dos Recursos Naturals do Governo regional da Madeira, Funchal*: 271–438.

Borowiec N, Quilici S, Martin J, Issimaila MA, Chadhouliati AC, Youssoufa MA, Beaudoin-Ollivier L, Delvare G, Reynaud B (2010) Increasing distribution and damage to palms by the Neotropical whitefly, *Aleurotrachelus atratus* (Hemiptera: Aleyrodidae). *Journal of Applied Entomology* 134 (in press).

Bourgoin T, Campbell BC (2002) Inferring a phylogeny for hemiptera: Falling into the 'autapomorphic trap'. *Denisia* 04: 67–82.

Burckhardt D (1981) Insects of Saudi Arabia. Sternorrhyncha: Suborder Psyllodea. *Fauna of Saudi Arabia* 3: 213–226.

Burckhardt D (1998) *Ctenarytaina eucalypti* (Maskell) (Hemiptera, Psylloidea) neu für Mitteleuropa mit Bemerkungen zur Blattflohfauna von *Eucalyptus*. *Mitteilungen der Entomologischen Gesellschaft Basel* 48: 59–67.

Burckhardt D, Elgueta M (2000) *Blastopsylla occidentalis* Taylor (Hemiptera: Psyllidae), a new introduced Eucalyptus pest in Chile. Revista Chilena de Entomología 26: 57–61.

Burckhardt D, Lauterer P (1997) A taxonomic reassessment of the triozid genus *Bactericera* (Hemiptera: Psylloidea). *Journal of Natural History* 31: 99–153.

Burckhardt D, Mühlethaler R (2003) Exotische Elemente der Schweizer Blattflohfauna (Hemiptera, Psylloidea) mit einer Liste weiterer potentieller Arten. *Mitteilungen der Entomologischen Gesellschaft Basel* 53: 98–110.

Cantiani M (1968) L'afide lanigero della Douglasia (*Gilletteella cooley* Gill.) in Italia. *L'Italia forestale e montana* 23, 195–198..

Carter CI (1983) Some new aphid arrivals to Britain's forests, *Proceedings and Transactions of the British Entomological and Natural History Society*, 16: 81–87.

Carter CI (1975) A gall forming adelgid (*Pineus similes* (Gill)) new to Britain with a key to the adelgid galls on Sitka spruce, *Entomologist's Monthly Magazine*, 111, 29–32.

Carver M, Gross GF, Woodward TE (1991) Hemiptera. InCSIRO (Ed) *The Insects of Australia*. Melbourne: Melbourne University Press, 429–509.

Chapin E, Cocquempot, C (2005) Psylle de l'Albizia: 1ers signalements en France. *PHM-Revue horticole* 467: 49–52.

China WE (1935) A North American Jassid (Homoptera) in Surrey. *Entomologist's Monthly Magazine* 71: 277–279.

Chrystal RN (1922) *The Douglas fir Chermes* (*Chermes cooleyi*). *Forestry Commision Bulletin No. 4*. London: His Majesty's Stationery Office. 50 pp.

Cocquempot C (2008) Un nouveau psylle sur pittospore du Japon en France. *PHM-Revue horticole*, 498: 33–36.

Cocquempot C, Constance, unpublished observations.

Cocquempot C, Germain JF (2000) Un nouveau ravageur de l'*Elaeagnus* x *ebbingei* en France : *Cacopsylla fulguralis*. *PHM-Revue horticole* 416: 32–34.

Conci C, Tamanini L (1985) *Lauritrioza* n. gen. for *Trioza alacris* (Homoptera Psylloidea). *Atti della Societa italiana di Scienze Naturali (Museo Civico di Storia Naturali di Milano*) 126: 237–256.

Conci C, Tamanini L (1989) *Acizzia hollisi*, new for Europe, and other psyllids from Isles Lampedusa and Linosa (Sicily) (Hemiptera, Homoptera). *Naturalista Siciliano* S. IV,13 (1–2): 75–80.

Costanzi M, Malausa JC, Cocquempot C (2003) Un nouveau psylle sur les Eucalyptus de la Riviera Ligure et de la Côte d'Azur. Premières observations de *Ctenarytaina spatulata* Taylor dans le Bassin méditerranéen occidental. *Phytoma – La Défense des Végétaux* 556: 48–51.

Covassi M, Binazzi A (1981) - Contributi alla conoscenza degli Afidi delle Conifere. IV, Note su alcune specie di Adelgidi reperite in Italia (Homoptera Adelgidae). *Redia* 64, 303–329.

Cryan JR (2005) Molecular phylogeny of Cicadomorpha (Insecta: Hemiptera: Cicadoidea, Cercopoidea and Membracoidea): adding evidence to the controversy. *Systematic Entomology* 30: 563–574.

DAISIE (2009) *Handbook of Alien Species in Europe*. Dordrecht:: Springer, 399 pp.

De Barro PJ, Liebregts W, Carver M (1998) Distribution and identity of biotypes of *Bemisia tabaci* (Gennadius) (Hemiptera : Aleyrodidae) in member countries of the Secretariat of the Pacific Community. *Australian Journal of Entomology* 37: 214–218.

Della Giustina W (1986) *Metcalfa pruinosa* (Say, 1830), nouveauté pour la Faune de France. *Bulletin de la Société Entomologique de France* 91: 89–92.

Della Giustina W (2002) Migration in Auchenorrhyncha. *Denisia* 04: 513–522.

Della Giustina W, Balasse H (1999) Gone with the wind: Homoptera Auchenorrhyncha collected by the French network of suction traps in 1994. *Marburger Entomologische Publikationen* 3: 7–42.

Della Giustina W, Remane R (2001) Compléments à la faune de France des Auchenorrhyncha: espèces et données additionnelles; modifications à l'ouvrage de Nast (1987) (Homoptera). *Bulletin de la Société Entomologique de France* 106: 283–302.

Dietrich CH (2002) Evolution of Cicadomorpha (Insecta, Hemiptera). *Denisia*, 04: 155–170.

Dietrich CH (2005) Keys to the families of Cicadomorpha and subfamilies and tribes of Cicadellidae (Hemiptera: Auchenorrhyncha). *Florida Entomologist* 88: 502–517.

Dimitrov T, Ruskov M (1927) Nasekomni I gubni vrediteli v naschite gori. *Gorski pregled* 13: 207–214.

Dlabola J (1981) *Metcalfa pruinosa* (Say, 1830), eine schadliche nordamerikanische Flatide als Erstfund in der Palaearktis (Insecta, Homoptera, Auchenorrhyncha). *Faunistische Abhandlungen (Dresden)* 8: 91–94.

Dolling WR (1991) *The Hemiptera*. London: Oxford University Press. 274 pp.

D'Urso V, Uliana M (2006) *Acanalonia conica* (Hemiptera, Fulgoromorpha, Acanaloniidae), a Nearctic species recently introduced in Europe. *Deutsche Entomologische Zeitschrift* 53: 103–107.

Duso C, Bressan A, Mazzon L, Girolami V (2005) First record of the grape leafhopper *Erythroneura vulnerata* Fitch (Hom., Cicadellidae) in Europe. *Journal of Applied Entomology* 129: 170–172.

Eichhorn O (1967) On methods of differentiating the species of the harmful white woolly aphids (Genus *Dreyfusia* CB. = *Adelges* AN.) on fir, and the consequences for forest protection. *Technical Bulletin of the Commonwealth Institute of Biological Control* 8: 53–82.

Eichhorn O (1991) On the generation cycle of *Dreyfusia nordmannianae* Eckst. (Hom., Adelgidae). *Journal of Applied Entomology* 112: 217–219.

Eichhorn O, Carter CI (1978) Investigation into conifer woolly aphids (Hemiptera: Adelgidae) in Japan, with the descriptions of two new species. *Zeitschrift fur Angewandte Entomologie* 86: 273–289.

Essl F, Rabitsch W (2002) Neobiota in Österreich. Umweltbundesamt, Wien, 432 pp.

Fauna Italia. *Checklist of the species of the italian fauna*. On-line version 2.0. www.faunaitalia.it/checklist/invertebrates/families/.

Forster B (2002) Auswirkungen eingewanderter oder eingeschleppter Insekten auf die Wald- und Parkbäume der Schweiz. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* 75: 135–136.

Francke-Grossmann H (1937) Ökologie und Schadwirkung von *Dreyfusia prelli* Grossman. *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* 47: 497–516.

Francke-Grossmann H (1937) Zur Morphologie der Tannenlaus *Dreyfusia prelli* Grossmann und ihrer Galle auf *Picea orientalis* Lk. *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* 47: 465–482.

Garcia Garcia EJ, Garijo Alba C, Garcia Segura S (1992) Presencia de *Paraleyrodes* sp. pr. *citri* (Bondar, 1931) (Insecta: Homoptera: Aleyrodidae) en los cultivos de cítricos de la pro-

vincia de Málaga (sur de Espana) : aspectos biológicos y ecológicos de la plaga. *Boletin de Sanidad Vegetal* 18: 3–9.

Gederaas L., Salvesen I, Viken Å (Eds) (2007) *Økologiske risikovurderinger av fremmede arter [2007 Norwegian Black List – Ecological Risk Analysis of Alien Species]*. Trondheim: Artsdatabanken. 152 p.pp.

Geiter O, Homma S, Kinzelbach R (2002) *Bestandsaufnahme und Bewertung von Neozoen in Deutschland*. Berlin: Umweltbundesamt 25: 1–173.

Ghauri MSK (1983) A case of long-distance dispersal of a leafhopper. In Knight WJ, Pant NC, Robertson TS, Wilson MR (Eds) Proccedings of the *1st International Workshop on leafhoppers and planthoppers of economic importance*. London: CIE. 249–255.

Glavendekić M, Mihajlović L, Petanović R (2007) Introduction and spread of invasive mites and insects in Serbia and Montenegro. In: Alford DV & Backhaus GF (Eds) *Abstracts of the Conference on Plant Protection and Plant Health in Europe, 'Introduction and spread of invasives species'.* Berlin, Germany: Humboldt University, June 2005

Gonzalez AD (2003) *Trioza erytreae* (Del Guercio, 1918): nueva plaga de los cítricos de Canarias. *Phytoma España*, 153: 112–120.

Guglielmino A (2005) Observations on the genus *Orientus* (Rhynchota, Cicadomorpha, Cicadellidae) and description of a new species*: O. amurensis* n.sp. from Russia (Amur Region and Maritime Territory) and China (Liaoning Province). *Marburger Entomologische Publikationen* 3, 99–110.

Günthart H, Mühlethaler R, Lauterer P (2004) Für die Schweiz neue Zikadenarten und Ergänzungen zu bereits bekannten Arten (Hemiptera, Auchenorrhyncha*). Mitteilungen der Entomologischen Gesellschaft Basel* 54, 150–160.

Havill NP, Foottit RG (2007) Biology and Evolution of Adelgidae. Annual *Review of Entomology* 52: 323–349.

Hill M, Baker R, Broad G, Chandler PJ, Copp GH, Ellis J, Jones D, Hoyland C, Laing I, Longshaw M, Moore N, Parrott D, Pearman D, Preston C, Smith RM, Waters R (2005) *Audit of non-native species in England. English Nature Research Reports N° 662*. Peterborough: English Nature, 81 pp.

Hodkinson ID (1999) Biocontrol of eucalyptus psyllids *Ctenarytaina eucalypti* by the Australian parasitoid *Psyllaephagus pilosus*: a review of current programmes and their success. *Biocontrol News and Information* 20 (4): 129–134.

Hodkinson ID (2007) A new introduced species of *Ctenarytaina* (Hemiptera, Psylloidea) damaging cultivated *Eucalyptus parvula* (=*parvifolia*) in Europe. *Deutsche Entomologische Zeitschrift* 54 (1): 27–33.

Hodkinson ID, Hollis D (1987) The legume-feeding psyllids (Homoptera) of the west Palaearctic Region. *Bulletin of the British Museum of natural History* 56: 1–86.

Hodkinson ID, White IM (1979a) *Homoptera Psylloidea*. *Handbooks for the Identification of British Insects. Vol II, Part 5 (a*). London: Royal Entomological Society. 98 pp.

Hodkinson ID, White IM (1979b) New psyllids from France with redescriptions of the type species of *Floria* Löw and *Amblyrhina* Löw (Homoptera Psylloidea). *Entomologica Scandinavica*, 10: 55–63.

Hollis D (1978) *Floria variegata* Löw (Homoptera: Psylloidea) on *Laburnum* in Britain. *Plant Patology* 27: 149.

Hollis D (1984) Afrotropical jumping plant lice of the family Triozidae (Homoptera: Psylloidea). *Bulletin of the British Museum (Natural History), Entomology series 49*: 1–102.

Hollis D, Broomfield PS (1989) *Ficus*-feeding psyllids (Homoptera), with special reference to the Homotomidae. *Bulletin of the British Museum (Natural History)*, *Entomology series* 58: 131–183.

Holman J, Pintera A (1977) Check-list of Czechoslovak Insects. *Acta Faunistica Entomologica Musei Nationalis Pragae* I: 101–116.

Holzinger WE, Jantscher E, Remane R (1996) Erstnachweise von Zikaden aus Österreich, mit Bemerkungen zu zwei weiteren Arten (Ins.: Homoptera, Auchenorrhyncha). *Linzer Biologische Beitraege* 28: 1149–1152.

Holzinger WE, Remane R (1994) Zikaden-Erstnachweise aus Österreich (Ins.: Homoptera, Auchenorrhyncha). *Mitteilungen des naturwissenschaftlichen Vereins für Steiermark* 124, 237–240.

Horvaáth G (1912) Az amerikai bivalykabócza Magyarországon. *Rovartani lapok. Budapest* 19: 145–147.

Iaccarino FM (1985) Nuovi generi e specie di Aleirodidi per la fauna italiana. *Bolletino del laboratorio di entomologia agraria "Filippo Silvestri"* 42: 135–141.

Kenis M (2005) Insects-Insecta. In: Wittenberg R (Ed) *An inventory of alien species and their threat to biodiversity and economy in Switzerland*. Délemont: CABI Bioscience Switzerland, 131–212.

King PD, Rilling G (1985) Variations in the galling reaction of grapevines: evidence of different Phylloxera biotypes and clonal reaction of Phylloxera. *Vitis*, 24: 32–42.

Klasa A, Soika G, Labanowski G (2003) *Massilieurodes chittendeni* (Laing, 1928) (Hemiptera: Aleyrodidae) – the whitefly species new to the Polish fauna. *Wiadomosci Entomologiczne* 22 (4): 197–200.

Kozár F, Bink-Moenen RM, Darvas B, Urfiné-Fogarsi E (1987) Új kártevö, a szamóca-molytetü (Trialeurodes packardi Morrill; Homoptera: Aleyrodidae) megjelenése Magyarországon. *Növényvédelem* 23: 351–354.

Kristensen NP (1991) Phylogeny of Extant Hexapods. In CSIRO (Ed) *The Insects of Australia*. Melbourne: Melbourne University Press, 125–140.

Laing F (1922) *Rhinocola eucalypti* Mask. In England. *Entomologist's Monthly Magazine* 58: 141.

Laing F (1928) Description of a white fly pest of rhododendrons. *Entomologist's Monthly Magazine* 64: 228–230.

Laudonia S (2006) Un nuovo psillide su eucalipto. *L'Informatore Agrario* : 89.

Lauterer P (1993) Notes on the bionomics and occurrence of some Psyllids (Homoptera, Psylloidea) in Czechoslovakia and the Balkan Peninsula. *Acta Musei Moraviae* 77: 147–156.

Lauterer P, Malenovský I (2002a) *Metcalfa pruinosa* (Say, 1830) introduced into the Czech Republic (Hemiptera, Flatidae). *Beiträge zur Zikadenkunde* 5: 10–13.

Lauterer P, Malenovský I (2002b) New distributional and biological data on European Psylloidea (Hemiptera, Sternorrhyncha), with special reference to the fauna of the Czech Republic and Slovakia. *Entomologica Basiliensia* 24: 161–177.

Louro V, Cabrita P (1989) Contribuição para o conhecimento da sua cultura em Portugal. Estudos e Informação Nº 126, 128. Lisboa: Direcção Geral das Florestas.

Maczey N, Wilson MR (2004*) Eupteryx decemnotata* Rey (Hemiptera, Cicadellidae) new to Britain. *British Journal of Entomology and Natural History* 17: 111–114.

Malausa JC, Sappei J, Franco E (1997) *Psylla acaciae-baileyanae*, un second psylle sur le mimosa dans le sud-est de la France. *Phytoma – La Défense des Végétaux*, 490: 57–59.

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

Malumphy C (2005) The Neotropical solanum whitefly, *Aleurotrachelus trachoides* (Back) (Hem., Aleyrodidae), intercepted in the U.K. on sweet potato leaves imported from Gambia. *Entomologist's Monthly Magazine* 141: 94.

Malumphy C, Halstead C (2003) *Cacopsylla fulguralis* (Kuwayama), an Asian jumping plant louse (hemiptera: psyllidae), causing damage to *Elaeagnus* in Britain. *British Journal of Entomology and Natural History* 16: 89–93.

Mani E, Baroffio C (1997) Biologische Bekämpfung der San-José-Schildlaus im Kanton Zug mit der Schlupfwespe *Encarsia perniciosi*. *Schweizer Zeitschrift für Obst- und Weinbau* 133, 392.

Mansilla J-P, Perez R, Del Estal P, Blond A (2004) Deteccion en Espana de *Ctenarytaina spatulata* Taylor sobre *Eucalyptus globulus* Labill. *Boletín de Sanidad vegetal, Plagas*, 30: 57–63.

Marchal P (1913) Contribution à l'étude de la biologie des Chermes. *Annales des Sciences Naturelles-Zoologie et Biologie Animale* 18: 153–385.

Martelli M (1960) Cenni su alcuni degli insetti più preoccupanti per le conifere a rapido incremento. Atti I Convegno nazionale Pioppo e Conifere a rapido incremento, Torino 23–25 aprile 1960, 3–9.

Martin JH (1996) Neotropical whiteflies of the subfamily Aleurodicinae established in the western Palaearctic (Homoptera: Aleyrodidae). *Journal of Natural History* 30: 1849–1859.

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

Martin JH (2001) Description of an invasive new species of Neotropical aleurodicine whitefly (Hemiptera : Aleyrodidae) – a case of complete or partial misidentification ? *Bulletin of Entomological Research* 91: 101–107.

Martin JH, Aguiar AMF, Baufeld P (2001) *Crenidorsum aroidephagus* Martin & Aguiar sp. nov. (Sternorrhyncha : Aleyrodidae), a New World whitefly species now colonising cultivated Araceae in Europe, Macaronesia and the Pacific. *Zootaxa* 4: 1–8.

Martin JH, Hernandez-Suarez E, Carnero A (1997) An introduced new species of *Lecanoideus* (Homoptera : Aleyrodidae) established and causing economic impact on the Canary Islands. *Journal of Natural History* 31: 1261–1272.

Martin JH, Malumphy CP (1995) *Trioza vitreoradiata*, a New Zealand jumping plant louse (Homoptera : Psylloidea), causing damage to *Pittosporum* spp. in Britain. *Bulletin of Entomological Research* 85: 253–258.

Martin JH, Mound LA (2008) An annotated check list of the world's whiteflies (Hemiptera: Aleyrodidae). *Zootaxa* 1492: 1–84.

Martin JH, Aguiar A, Pita M (1996) Aleyrodidae of Madeira - Description of three new species and notes on a pan-mediterranean species of *Aleurotrachelus*. *Journal of Natural History* 30: 113–125.

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

Mercier L, Poisson R (1926) Un hémiptère de la famille des psyllines, parasite d'eucalyptus cultivés à Cherbourg. *Bulletin de la Société Linnéan de Normandie, Series 79*: 34–37.

Mifsud D (2010) Jumping plant-lice (Hemiptera : Psylloidea) of the Maltese Islands. *Bulletin of the Entomological Society of Malta* 3: in press.

Mifsud D, Watson GW (1999) Introduced sap-feeding insect pests of crop plants in the Maltese Islands. *The Central Mediterranean Naturalist* 3: 29–34.

Mound L (1961) A new genus and four new species of whitefly from ferns (Homoptera, Aleyrodidae). *Revue de Zoologie et de Botanique Africaine* 64: 127–132.

Mound LA, Halsey SH (1978) *Whitefly of the World*. Chichester, British Museum (Natural History): John Wiley & Sons. 340 pp.

Nickel H, Holzinger WE (2006) Rapid range expansion of Ligurian leafhopper, *Eupteryx decemnotata* Rey, 1891 (Hemiptera: Cicadellidae), a potential pest of garden and greenhouse herbs, in Europe. *Russian Entomological Journal* 15: 57–63.

Nielson MW (1985) Leafhopper systematics. In Nault LR, Rodriguez JG (Eds) *The leafhoppers and planthoppers*. New York: Wiley-Interscience. 11–39.

Nieto Nafria JM, Binazzi A (2005) *Super family Phylloxeroidea, Fauna Europaea*. http//www.faunaeur.org [accessed 07.03.2005].

O'Connor J-P, Dunne R, Whelton A (2004) *Trioza vitreoradiata* (Maskell) (Homoptera: Psylloidea), a New Zealand species new to Ireland. *Irish Naturalist' Journal* 27: 349–350.

O'Brien LB (2002) The Wild Wonderful World of Fulgoromorpha. *Denisia* 4: 83–102.

O'Brien L, Wilson SW (1985) Planthopper systematics and external morphology. In: Nault LR, Rodriguez JG (Eds) *The leafhoppers and planthoppers*. New York: Wiley-Interscience. 61–102.

OEPP/EPPO (1988) Data sheets on quarantine organisms No. 151, Citrus greening bacterium and its vectors *Diaphorina citri* & *Trioza erytreae*. *Bulletin OEPP/EPPO Bulletin* 18: 497–507.

Pašek V (1954) *Vošky našich lesných* drevín [Adelgids of our. Coniferous Trees]. Bratislava: Veda. 322 pp.

Pellizari G, Šimala M (2007) First record of *Aleuroclava guyavae* (Takahashi, 1932) (Hemiptera, Aleyrodidae) in Europe. *Bollettino di Zoologia Agraria e di Bachicoltura Serie II* 39(2): 91–95.

Pettey FW (1925) New South African psyllids. *South African Journal of Natural History* 5: 125–142.

Porcelli F (2008) First record of *Aleurocanthus spiniferus* (Homoptera: Aleyrodidae) in Apulia, Southern Italy. *Bulletin OEPP/EPPO Bulletin* 38: 518–520.

Priore R (1969) Il *Dialeurodes citri* (Ashmead) (Homoptera: Aleyrodidae) in Campania. *Bolletino del laboratorio di entomologia agraria "Filippo Silvestri"* 27: 287–316.

Rapisarda C (1985) Sulla presenza in Italia di *Acizzia acaciaebaileyanae* (Froggatt) (Homoptera, Psylloidea), nuovo parassita di Acacie ornamentali. *Informatore fitopatologico* 1985: 45–49.

Rapisarda C, Siscaro G, Leocata S, Asero C (1990) *Parabemisia myricae*, un nuovo aleirode degli agrumi in Italia. *Informatore fitopatologico* 40 (12): 25–30.

Redel D, Penzes B (2006) First occurrence of *Acizzia jamatonica* (Kuwayama, 1908) (Sternorrhyncha: Psyllidae: Acizziinae) in Hungary. *Novenyvedelem* 42: 153–157.

Roll E, Dayan T, Simberloff D (2007) Non-indigenous species in Israel and adjacent areas. *Biological Invasions* 9: 629–643.

Roversi PF, Binazzi A. 1996. Life cycle of the Douglas-fir woolly aphid *Gilletteella coweni* (Gillette) in central Italy (Homoptera Adelgidae). *Redia* 79: 241–45.

Russell LM (1964) *Dialeurodes kirkaldyi* (Kotinsky), a whitefly new to the United States (Homoptera : Aleyrodidae). *The Florida Entomologist* 47: 1–4.

Schaefer HA (1949) Beiträge zur Kenntnis der Psylliden der Schweiz. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* 22: 1–96.

Šefrová H, Laštùvka Z (2005) Catalogue of alien animal species in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis* 53: 151–170.

Seljak G (2002) Non-european Auchenorrhyncha (Hemiptera) and their Geographical distribution in Slovenia. *Acta Entomologica Slovenica* 10: 97–101.

Seljak G (2003) *Acizzia jamatonica* endangers Albizia trees. *Moj mali svet* 35: 20–21.

Seljak G (2004) Prokelisia marginata (Van Duzee, 1897) - nearkticna vrsta škržatkov, nova za Slovenijo in Evropo (Auchenorrhyncha: Delphacidae) *Prokelisia marginata* (Van Duzee, 1897) - a nearctic planthopper, new to Slovenia and Europe (Auchenorrhyncha: Delphacidae). *Acta Entomologica Slovenica* 12: 260–262.

Seljak G, Simala M, Stigter H (2004) Three new non-European psyllids (Hemiptera, Psyllidae) in Slovenia and Croatia. In: *Abstracts of the Third European Hemiptera Congress*, St Petersburg, November 2004: 66–67.

Sergel R (1987) On the occurrence and ecology of the Rhododendron-leafhopper *Graphocephala fennahi* Young 1977, in the western palaearctic region (Homoptera, Cicadellidae). *Anzeiger für Schädlingskunde, Pflanzenschutz, Umweltschutz* 60: 134–136.

Söderman G (2005) The eastern palaearctic leafhopper *Igutettix oculatus* (Lindberg, 1929) in Finland: morphology, phenology and feeding (Insecta, Hemitpera, Cicadellidae, Typhlocybinae). *Beiträge zur Zikadenkunde* 8: 1–4.

Stani A, Murraj Xh, Kapidani A (1974) *Entomologjia Bujqësore*-cited in Tomov et al (2009) [147].

Steffan AW (1972) Unterordnung Aphidina, Blattläuse. In: Schwenke W (Ed) (1972) *Die Forstschädlinge Europas, I. Band. Würmer, Schnecken, Spinnentier, Tausendfüssler und Hemimetabole Insecten.* Paul Parey, Hamburg and Berlin. pp. 162–386.

Stewart AJA (1993) *Placotettix taeniatifrons* (Kbm.) (Hem., Cicadellidae) in Bedfordshire. *Entomologist's Monthly Magazine* 129: 80.

Streito JC (2004) Découverte en France de *Crenidorsum aroidephagus* Martin & Aguiar, 2001, description de la femelle, caractères permettant de la différencier d'autres aleurodes d'intérêt agronomique (Hemiptera, Aleyrodidae). *Nouvelle Revue d'Entomologie* 21: 375–382.

Süss L, Salvodelli S (2003) Rinvenimento di *Cacopsylla fulguralis* (Kuwayama) (Homoptera Psyllidae) in Italia. *Bollettino di Zoologia agraria e di Bachicoltura* 35: 95–98.

Teodorescu I, Manole T, Iamandei M, Vadineanu A (2005) The main alien/invasive insect species in Romania. *Revue Roumaine de Biologie - Série de Biologie Animale* 51: 43–61

Tomov R, Trencheva K, Trenchev G, Cota E, Ramadhi A, Ivanov B, Naceski S, Papazova-Anakieva I, Kenis M (2009) *Non-indigenous insects and their threat to biodiversity and economy in Albania, Bulgaria and Republic of Macedonia*. Sofia-Moscow: Pensoft, publishers, 112 pp.

Trehan KN (1938) Two new species of Aleurodidae found on ferns in greenhouses in Britain (Hemiptera). *Proceedings of the Royal Entomological Society of London* (B) 7: 182–189.

Tremblay E (1981) *Entomologia applicata*, vol II (1), Napoli: Liguori Editore, 310pp.

Tremblay E (1988) Avversità delle colture di recente o temuta introduzione. Parassiti animali: Insetti. *Italia agricola* 115–128.

Tsitsipis JA, Katis N, Margaritopoulos J, Lykouressis D, Avgelis A, Gargalianou I, Zarpas K, Perdikis D, Papapanayotou A (2007) A contribution to the aphid fauna of Greece. *Bulletin of Insectology* 60: 31–38.

Valente C, Hodkinson I (2008) First record of the Red Gum Lerp Psyllid, *Glycaspis brimblecombei* Moore (Hem.: Psyllidae) in Europe. *Journal of Applied Entomology* 133: 315–317.

Valente C, Manta A, Vaz A (2004) First record of the Australian psyllid *Ctenarytaina spatulata* Taylor (Homoptera: Psyllidae) in Europe. *Journal of Applied Entomology* 128: 369–370.

Varty IW (1956). *Adelges Insects of Silver Firs*. Edinburgh: Her Majesty's Stationery Office. 75 pp.

Visnya A (1941) A gigantic species of Aleurodidae (Homoptera) from greenhouse-Orchideas. *Folia Entomologica Hungarica* 6: 4–15.

Wheeler Jr AG, Richard Hoebeke E (2009) *Acizzia jamatonica* (Kuwayama) (Hemiptera: Sternorrhyncha: Psyllidae): U.S. distribution of a recently detected Asian Psyllid. *Proceedings of the Entomological Society of Washington* 111 (2) : 505–514.

Wilson MR (1981) Identification of European *Iassus* species (Homoptera: Cicadellidae) with one species new to Britain. *Systematic Entomology* 6: 115–118.

Wilson MR, Claridge MF (1991)*Handbook for the identification of leafhoppers and planthoppers of rice*. Wallingford, Oxon: CAB International,142 pp.

Wilson SW, MacPherson JE (1981) Life histories of *Anormenis septentrionalis*, *Metcalfa pruinosa*, and *Ormenoides venusta* with descriptions of immature stages. *Annals of the Entomological Society of America* 74 (3): 299–311.

Wittenberg R (2005) *An inventory of alien species and their threat to biodiversity and economy in Switzerland*. CABI Bioscience Switzerland Centre report to the Swiss Agency for Environment, Forests and Landscape: 417pp.

Yoshizawa K, Saigusa T (2001) Phylogenetic analysis of paraneopteran orders (Insecta: Neoptera) based on forewing base structure, with comments on monophyly of Auchenorrhyncha (Hemiptera). *Systematic Entomology* 26: 1–13.

Zandigiacomo P, Bernardinelli I, Stergule F (2002) Psilla dell' albizzia: prima segnalazione per l'Italia nord-orientale. *Notizia/ERSA* 2002: 18–20

Table 9.4.1. List and main characteristics of Aleyrodidae, Psylloidea, Phylloxeroidea, and Auchenorrhyncha species alien *to* Europe. Country codes abbreviations refer to ISO 3166 (see Appendix I). Habitat abbreviations refer to EUNIS (see Appendix II). Only selected references are given

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Sternorrhyncha								
Aleyrodidae *(Aleyrodinae)*								
Acaudaleyrodes rachipora (Singh, 1931)	A	Phyto-phagous	Oriental Region	2000, ES-CAN	ES-CAN	I2	Polyphagous	Martin et al. (2000)
Aleurocanthus spiniferus (Quaintance, 1903)	A	Phyto-phagous	Oriental Region	2008, IT	IT	I	Polyphagous; occasionally a pest on *Annona* and *Citrus*	Porcelli (2008)
Aleuroclava aucubae (Kuwana, 1911)	A	Phyto-phagous	Oriental Region	2007, IT	IT	I2, J100	*Psidium*, *Cinnamomum*, *Citrus*, *Ficus*, *Pittosporum*, *Prunus*, *Photinia*	Pellizari and Šimala (2007)
Aleuroplatus perseaphagus Martin et al., 1996	A	Phyto-phagous	Neotropical Region	1991, ES-MAD	PT-MAD	I2	Avocado mainly	Martin et al. (1996)
Aleuropteridis filicicola (Newstead, 1911)	A	Phyto-phagous	Africa	1961, GB	GB	J100	*Pteris togoensis, Cyclosorus dentatus, Oleandra articulata*	Mound (1961)[1]
Aleurothrixus floccosus Maskell, 1895	A	Phyto-phagous	Neotropical Region	1968, ES-CAN; 1969, FR	AL, ES-CAN, FR, FR-COR, GR, IL, IT, IT-SAR, IT-SIC, MT, PT, GB	I2, J100	Polyphagous; a preference for *Citrus* where established	Martin et al. (2000)
Aleurotrachelus atratus Hempel, 1922	A	Phyto-phagous	Neotropical Region	2000, ES-CAN	ES-CAN, FR	I2, J100	*Cocus* spp.	Borowiec et al. (2010)

[1] Mound (Mound 1961) redescribed this species under the name of *A. douglasi* from material collected on ferns in Kew Gardens, UK.

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Aleurotrachelus trachoides (Back, 1912)	A	Phyto-phagous	Neotropical Region	2005, GB	GB	? J100	Sweet potato leaves	Malumphy (2005)
Aleurotulus nephrolepidis (Quaintance, 1900)	A	Phyto-phagous	C & S America	1938, GB	ES, ES-CAN, GB, HU	J100	Ferns	Trehan (1938)
Bemisia tabaci (Gennadius, 1889)	A	Phyto-phagous	? Asia	?	AL, AT, BE, BG, CH, CY, CZ, DE, ES, ES-BAL, ES-CAN, FR-COR, FR, DE, GR-CRE, GR, HU, HR, IL, IT, IT-SAR, IT-SIC, MT, NL, NO, PL, PT, RO, RU	I1, J100	Polyphagous crops & greenhouses	Martin et al. (2000)
Crenidorsum aroidephagus Martin & Aguiar, 2001	A	Phyto-phagous	C & S America	1998, PT-MAD	DE, FR, PT-MAD	J100, I2	Araceae	Martin et al. (2001), Streito (2004)
Dialeurodes citri (Ashmead, 1885)	A	Phyto-phagous	Oriental Region	1945 ?	AL, FR, FR-COR, IL, IT, IT-SAR, IT-SIC, MT, SI	I2	Polyphagous; a preference for *Citrus* where established	Priore (1969)
Dialeurodes kirkaldy (Kotinsky, 1907)	? A	Phyto-phagous	? New World	?	CY, IL, PT	I2	Polyphagous; a preference for *Jasminum* and *Morinda citrifolia*	Russell (1964)
Filicaleyrodes williamsi (Trehan, 1938)	A	Phyto-phagous	? Tropical Africa	1938, GB	GB, HU	J100	Ferns	Trehan (1938)
Massilieurodes chittendeni (Laing, 1928)	A	Phyto-phagous	Northern Asia	1928, GB	BE, CH, CZ, DE, DK, FI, FR, GB, IT, NL, PL, SE	I2	Rhododendron	Laing (1928)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Parabemisia myricae (Kuwana, 1927)	A	Phyto-phagous	Asia	mid 1980's	CY, ES, ES-CAN, FR, FR-COR, GR-CRE, IL, IT, IT-SAR, IT-SIC, PT	I2	Polyphagous; a preference for citrus and avocados (in Europe)	Rapisarda et al. (1990)
Pealius azaleae (Baker & Moles, 1920)	A	Phyto-phagous	Eastern Asia	1920, BE	BE, GB, IT, NL	I2, J100	Rhododendron	Martin et al. (2000)
Singiella citrifolii (Morgan, 1893)	? A	Phyto-phagous	? New World	1998, PT-MAD	PT-MAD	I2	*Citrus* mainly	Martin (2000)
Trialeurodes packardi (Morrill, 1903)	A	Phyto-phagous	Nearctic Region	1987, HU	HU	I2	Strawberries (in Europe)	Kozár et al. (1987)
Trialeurodes vaporariorum (Westwood, 1856)	A	Phyto-phagous	North America	1856, GB	AL, AT, BG, CH, CZ, DE, DK, EE, FR, HU, IT, IT-SAR, IT-SIC, LT, MT, PT, RO, RS, SI	I2, J100	Polyphagous	Martin et al. (2000)
Aleyrodidae *(Aleurodicinae)*								
Aleurodicus destructor Mackie, 1912	A	Phyto-phagous	Neotropical Region	?, GB	GB	J100	Polyphagous	Martin (1996)
Aleurodicus dispersus Russell, 1965	A	Phyto-phagous	Neotropical Region	1962, ES-CAN	ES, ES-CAN, PT-MAD	I2	Polyphagous; a preference for *Citrus* where introduced	Martin (1996)
Ceraleurodicus varus (Bondar, 1928)	A	Phyto-phagous	Neotropical Region	1939	HU	J100	Orchids	Visnya (1941)
Lecanoideus floccissimus Martin et al., 1997	A	Phyto-phagous	Neotropical Region	1994, ES-CAN	ES-CAN	I2	Polyphagous	Martin et al. (1997)
Paraleyrodes bondari Peracchi, 1971	A	Phyto-phagous	Neotropical Region	1995, PT-MAD	PT-MAD	I2	Polypagous, also on *Citrus* spp.	Martin (1996)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Paraleyrodes citricolus Costa Lima, 1928	A	Phyto-phagous	Neotropical Region	1994, PT-MAD	PT-MAD	I2	*Citrus* spp., *Persea Americana*	Martin (1996)
Paraleyrodes minei Iccarino, 1990	A	Phyto-phagous	Neotropical Region	1990, ES	ES	I2	Mainly on *Citrus* spp.	Garcia Garcia et al. (1992)
Psylloidea								
Psyllidae								
Acizzia acaciaebaileyanae (Froggatt, 1901)	A	Phyto-phagous	Australia	1981, FR	FR, IT, IT-SIC, SI	I2, F	*Acacia baileyana*	Malausa et al. (1997), Rapisarda (1985),Stoch (2003), Seljak et al. (2004)
Acizzia hollisi Burckhardt, 1981	A	Phyto-phagous	Africa	1987, IT	IT (Lampedusa)	I2, F	*Acacia raddiana*, cultivated *Acacia* spp.	Conci and Tamanini (1989)
Acizzia jamatonica (Kuwayama, 1908)	A	Phyto-phagous	Western Asia	2002, IT	CH, FR, FR-COR, HR, HU, IT	I2, F	*Albizzia julibrissima*	Chapin and Cocquempot (2005), Seljak et al. (2004), Seljak (2003), Wittenberg (2005), Rédei and Pénzes (2006), Zandigiacomo
Acizzia uncatoides (Ferris & Klyver, 1932)	A	Phyto-phagous	Australia	1974, FR	ES-CAN, FR, IL, IT, IT-SIC, ME, MT, PT	I2, F	*Acacia floribunda*	Hodkinson and Hollis (1987), Lauterer (1993), Malausa et al. (1997), Stoch (2003), Seljak et al. (2004)
Blastopsylla occidentalis Taylor, 1985	A	Phyto-phagous	Australia	2006, IT	IT	I2	*Eucalyptus* spp.	Laudonia (2006)
Cacopsylla fulguralis (Kuwayama, 1908)	A	Phyto-phagous	Western Asia	1999, FR	BE, CH, ES, FR, GB, IT	I2	*Elaeagnus* x *ebbingei*	Baugnée (2003), Cocquempot (2008), Cocquempot and Germain (2000), Malumphy and Halstead (2003), Süss and Salvodelli (2003), Wittenberg (2005)
Cacopsylla pulchella (Löw, 1877)	A	Phyto-phagous	Eastern Medi-terranean	1964, FR	FR, GB, CH, IT, IT-SIC	I2	*Cercis siliquastrum*	Klimaszewski (1973), Hodkinson and White (1979a), Hodkinson and White (1979b), Burckhardt (1983), Stoch (2003)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Ctenarytaina eucalypti (Maskell, 1890)	A	Phyto-phagous	Australia	1922, GB	CH, DE, ES, FR, GB, IE, IT, PT	I2, G5	*Eucalyptus* spp.	Burckhardt (1998), Cavalcaselle (1982), Hodkinson (1999), Hodkinson and White (1979a), Laing (1922), Mercier and Poisson (1926), Nogueira (1971), Rupérez and Cadahia (1973), Wittenberg (2005)
Ctenarytaina peregrina Hodkinson, 2007	A	Phyto-phagous	Australia	2006, GB	FR, GB, IT	I2	*Eucalyptus parvula*	Hodkinson (2007)
Ctenarytaina spatulata Taylor, 1967	A	Phyto-phagous	Australia	2002, PT	ES, FR, IT, PT	I2, G5	*Eucalyptus* spp.	Costanzi et al. (2003), Mansilla et al. (2004), Valente et al. (2004)
Glycaspis brimblecombei (Moore, 1964)	A	Phyto-phagous	Australia	2008, ES, PT	ES, PT	I2, G5	*Eucalyptus* spp.	Valente and Hodkinson (2008)
Triozidae								
Trioza erythreae (Del Gercio, 1918)	A	Phyto-phagous	Western Africa	1994, MAD	ES-CAN, PT-MAD	I2	*Citrus* trees	Borges et al. (2008), Gonzalez (2003)
Trioza neglecta (Loginova, 1978)	A	Phyto-phagous	South-western and Central Asia	1982, CZ	AT, BG, CZ, HU, SK, RO, YU	I2	*Elaeagnus angustifolia*	Lauterer (1993), Lauterer and Malenovský (2002b)
Trioza vitreoradiata (Maskell, 1879)	A	Phyto-phagous	New Zealand	1993, GB	FR, GB, IE	I2	*Pittosporum* spp.	Cocquempot (2008), Malumphy et al. (1994), O'Connor et al. (2004)
Phylloxeroidea								
Adelgidae								
Adelges (*Gilletteella*) *cooleyi* (Gillette, 1907)	A	phyto-phagous	Western North America	1913, GB	AT, CH, CZ, DE, DK, FR, GB, IE, IT, NL, PL, PT, RO, RS, SE, SK, UA	G3, I2	*Picea (I), Pseudotsuga (II)*	Chrystal (1922), Covassi and Binazzi (1981), Essl and Rabitsch (2002), Forster (2002), Glavendekić et al. (2007), Nieto Nafria and Binazzi (2005), Pašek (1954)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Adelges (*Gilletteella*) *coweni* (Gillette, 1907)	A	phyto-phagous	North America	>1900, IT	AT, IT, PT	G3, I2	*Pseudotsuga* (anholocyclic)	Carter (1983), Essl and Rabitsch (2002), Louro and Cabrita (1989), Nieto Nafria and Binazzi (2005), Roversi and Binazzi (1996), Steffan (1972)
Adelges (*Dreyfusia*) *merkeri* Eichhorn 1957	A	phyto-phagous	Asia Minor	>1900, IT	AT, CZ, DE, IT, SE	G3	*Picea (I), Abies (II)*	Binazzi and Covassi (1988), Fauna Italia, Nieto Nafria and Binazzi (2005)
Adelges (*Dreyfusia*) *nordmannianae* (Eckstein, 1890)	A	phyto-phagous	Caucasus Mountains	1840, DE	AT, BG, CH, CZ, DE, DK, EE, FR, GB, HU, IE, IT, LV, NL, PL, PT, RS, SE, SI, SK, UA	G3	*Picea (I), Abies (II)*	Binazzi and Covassi (1988), Dimitrov and Ruskov (1927), Eichhorn (1967), Eichhorn (1991), Essl and Rabitsch (2002), Fauna Italia, Glavendekić et al. (2007), Marchal (1913), Nieto Nafria and Binazzi (2005), Pašek (1954), Varty (1956)
Adelges (*Dreyfusia*) *prelli* Grosmann, 1935	A	phyto-phagous	Caucasus mountains	<1900, IT	AT, CH, CZ, DE, IT, SE, SK	G3	*Picea, Picea orientalis (I), Abies (II)*	Binazzi and Covassi (1988), Eichhorn (1967), Francke-Grossmann (1937a), Francke-Grossmann (1937b), Nieto Nafria and Binazzi (2005), Šefrová and Laštùvka (2005)
Adelges (*Cholodkovskya*) *viridula* (Cholodkowsky, 1911)	A	phyto-phagous	North-western Russia	?, CZ	CZ, DK, ES, GB, SE, SI, SK, YU	G3	*Larix* (anholocyclic)	Nieto Nafria and Binazzi (2005), Šefrová and Laštùvka (2005), Steffan (1972)
Pineus (*Pineus*) *orientalis* (Dreyfuss, 1889)	A	phyto-phagous	Caucasus mountains	1913, CZ	CZ, DE, DK, GB, IT, NL, SK, UA	G3, I2	*Picea orientalis (I), Pinus (II)*	Bayer (1914), Covassi and Binazzi (1981), Hill et al. (2005), Marchal (1913), Nieto Nafria and Binazzi (2005)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Pineus (*Pineus*) *similis* (Gillette 1907)	A	phyto-phagous	North America	1971, GB	GB	G3	*Picea sitchensis* (anholocyclic)	Carter (1975), Carter (1975)
Pineus (*Eopineus*) *strobi* (Hartig, 1837)	A	phyto-phagous	Eastern North America	1900, CZ	AT, BG, CH, CZ, DE, DK, GB, IT, LV, NL, PL, RO, RS, SE, SK, UA	G3, I2	*Pinus strobus* (anholocyclic)	Bayer (1920), Essl and Rabitsch (2002), Glavendekić et al. (2007), Martelli (1960), Nieto Nafria and Binazzi (2005), Steffan (1972)
Phylloxeridae								
Moritziella corticalis (Kaltenbach, 1867)	C	phyto-phagous	Cryptogenic	1970, GB	AT, DE, GB, IT, MD, NL, UA	G,I2	*Quercus petreae*	Barson and Carter (1972), Fauna Italia, Nieto Nafria and Binazzi (2005)
Viteus vitifoliae (Fitch, 1855)	A	phyto-phagous	North America	1860, FR	AL, AT, BG, CH, CZ, DE, ES, FR, GR, HR, HU, IE, IL, IT, IT-SAR, IT-SIC, MD, MT, PT, PT-MAD, RO, RS, SI, UA	I	*Vitis*	Aloi (1898), Anonymous (1894), Baudyš (1935), Essl and Rabitsch (2002), Fauna Italia, Glavendekić et al. (2007), Nieto Nafria and Binazzi (2005), Roll et al. (2007), Stani et al. (1974), Teodorescu et al. (2005), Tremblay (1981), Tsitsipis et al. (2007), Wittenberg (2005)
Auchenorrhyncha								
Cicadomorpha								
Cicadellidae								
Erythroneura vulnerata (Fitch, 1851)	A	Phyto-phagous	North America	2004, IT	IT	I	*Vitis*	Duso et al. (2005)
Graphocephala fennahi Young, 1977	A	Phyto-phagous	North America	1933, GB	AT, BE, CH, CZ, DE, DK, FR, GB, IT, NL, SI	FB, G, I2, X11, F	*Rhododendron*	Sergel (1987)
Igutettix oculatus (Lindberg, 1929)	A	Phyto-phagous	East Asia	1984, RU	FI, RU	I2	*Syringa*	Söderman (2005)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Japananus hyalinus (Osbom, 1900)	A	Phyto-phagous	East Asia	1942, AT	AT, BG, CH, CZ, DE, ES, FR, HU, IT, ME, RO, RS, RU, SI, SK	I2, G1	*Acer*	Seljak (2002)
Kyboasca maligna (Walsh, 1862)	A	Phyto-phagous	North America	1997, FR	BE, FR	I	*Pyrus, Crataegus*	Della Giustina and Remane (2001)
Macropsis elaeagni Emeljanov, 1964	A	Phyto-phagous	Asia (Caucasus)	1982, CZ	AT, BG, CZ, DE, HU, RO, SI, UA	I2, G5	*Elaeagnus*	Holzinger and Remane (1994)
Orientus ishidae (Matsumura, 1902)	A	Phyto-phagous	East Asia	2002, CH	AT, CH, CZ, DE, FR, IT, SI	I2	*Salix, Betula,* fruit tress	Guglielmino (2005), Günthart et al. (2004)
Scaphoideus titanus Ball, 1932	A	Phyto-phagous	North America	1958, FR	AL, AT, BG, CH, ES, FR, HU, IT, PT, RS, SI	I1	*Vitis*	Arzone et al. (1987)
Membracidae								
Stictocephala bisonia Kopp & Yonke, 1977	A	Phyto-phagous	North America	< 1912, HU	AL, AT, BA, BE, BG, CH, CZ, DE, ES, FR, HR, HU, IT, IT-SAR, IT-SIC, MD, ME, MK, NL, PL, RO, RS, SI, SK, UA	I2	Polyphagous	Arzone et al. (1987), Seljak (2002)
Fulgoromorpha								
Acanaloniidae								
Acanalonia conica (Say, 1830)	A	Phyto-phagous	North America	2003, IT	IT	I, J	Polyphagous	D'Urso and Uliana (2006)
Delphacidae								
Prokelisia marginata (Van Duzee,1897)	A	Phyto-phagous	North America	2003, SI	ES, FR, GB, PT, SI	D6	*Spartina maritima*	Seljak (2004)

Suborder *Superfamily* Family (*Subfamily*)	Status	Regime	Native range	1st record in Europe	Invaded countries	Habitat	Hosts	References
Flatidae								
Metcalfa pruinosa (Say, 1830)	A	Phyto-phagous	North America	1970, FR	AL, AT, BA, BG, CH, CZ, FR, FR-COR, GR, HR, HU, IT, IT-SAR, IT-SIC, RS, SI, SK	I	Polyphagous	Dlabola (1981), Lauterer and Malenovský (2002a)