

Whiteflies of Bulgaria, including two species new to the fauna (Hemiptera: Aleyrodidae)

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An overview is given of to the knowledge of the Aleyrodidae fauna of Bulgaria. *Aleyrodes proletella* and *Aleurochiton pseudoplatani* are recorded for the first time. At least twelve species have been found so far in Bulgaria and many species occurring in the open, greenhouses and the pathway of imported plants are waiting for discovery. The introduction of exotic species in the near future is expected.

Introduction

Whiteflies (Aleyrodidae) are an economic important, but poorly studied, small group of insects. They are related to the scale insects (Coccoidea) and the aphids (Aphidoidea). The systematics is almost entirely based on the morphological structures on the fourth nymphal or puparial stage and adults can only be rarely identified. The nymphs of all species are phytophagous sap feeders and many of them are economically important plant pests. Feeding may cause the transmission of plant viruses, plant withering and discolorations of leaves and fruits. Heavy honeydew, in which a black sooty mold grows, causes the reduction of photosynthetic activity and plant weakening. Martin & Mound (2007) list 1556 described species worldwide, but many species have been described since this publication. In this article, we present an overview of the whitefly fauna of Bulgaria.

Faunas of neighbouring countries

The faunas of the countries that border Bulgaria are not thoroughly investigated. The fauna of Rumania is studied by Dobreanu & Manolache (1969) who treated sixteen species. One additional species, *Aleyrodes asari* (Schnak), was recorded by Martin *et al.* (2000). Ulusoy *et al.* (2013) reported 39 species for Turkey and studied the fauna of several Turkish regions and provinces (Ulusoy *et al.* 2012a, 2012b). However, the species number on the northern side of the Bosphorus near Istanbul is still unknown. Little is known about the fauna of Serbia, whereas nine species are reported from Montenegro (Malumphy *et al.* 2015). One addition is the exotic *Aleurocanthus spiniferus* (Quaintance) (Radonjić *et al.* 2014). Martin *et al.* (2000) recorded *Aleurolobus wunni* (Ryberg), *Aleyrodes lonicerae* Walker, *Asterobemisia carpini* (Koch), *Bulgarialeurodes cotesii* (Maskell), *Dialeurodes citri* (Ashmead) and *Trialeurodes lauri* (Signoret) from the former Yugoslavia. There exists no species list from Greece: more than 25 species are mentioned in the literature (e.g., Katsoyannos *et al.* 1997, Martin *et al.* 2000, Michalopoulos 1989, Wang *et al.* 2016).

Material and methods

In the framework of two international meetings, several short field trips on different locations were made at the end of July to the beginning of August 2009 and the first half of September 2013. The identification of puparia of the species was carried out with the key of Martin *et al.* (2000) in which many faunistic details are included. Huldén (1986) gives a key to the adults of some of the species. Collected specimens were slide mounted using the overall slide making procedure of Martin *et al.* (2000) with some changes.

Results

Fourteen samples of whiteflies containing seven species were collected from seven localities. For the records, the collector, date, and host plant are given.

Aleurochiton acerinus Haupt

A monophagous species living on *Acer campestre* (Martin *et al.* 2000). The first specimens however, were collected at Sofia-Vitosha on *Acer tataricum* (Kozár & Bink-Moenen 1988).

Aleurochiton aceris (Modeer)

Leg. M. Jansen & I. Ivanova: Sofia-Vitosha reserve, 10.ix.2013, *Acer platanoides*, some dozens of puparia; Sofia-town centre, 5.ix.2013, *Acer platanoides*.

Field recognition The puparia are of two types. Puparia of the summer generation are small, whitish to transparent, without pigment and wax cover, whereas those of the winter generation are generally of a larger size and have a black and sclerotized dorsal disk. These winter puparia are, depending from the sex and from the specimen, partly covered with a thick white wax layer. Male puparia of the winter generation are smaller and have an oval shape, whereas female puparia have a larger size and a pear like shape. Puparia which are morphological in between have been observed but are fairly rare (Müller 1962a).



1. Microscopic view of the pupal case of *Aleurochiton pseudoplatani* on a dry leaf of *Acer pseudoplatanus*, Sofia, 4.ix.2013. Photo: Maurice Jansen

1. Microscopische opname van de lege pop van *Aleurochiton pseudoplatani* op een gedroogd blad van gewone esdoorn, Sofia, 4.ix.2013.



2. Microscopic view of the puparium of *Aleurochiton pseudoplatani*, Sofia, 6.viii.2009. Photo: Maurice Jansen

2. Microscopische opname van de pop van *Aleurochiton pseudoplatani*, Sofia, 6.viii.2009.

Economic importance This species has never been recorded as economically important.

Biology *Acer platanoides* is the most recorded host but the species also lives on *A. tataricum* and has been rarely recorded from *Acer cappadocicum* (Abd-Rabou et al. 2013). The species overwinters as a pupa and the adults emerge in May and June.

Geographical distribution The species is widely distributed across Europe (Martin et al. 2000)

Aleurochiton pseudoplatani Visnya (figure 1-2)

New for the Bulgarian fauna. Leg. M. Jansen: Sofia, 6.viii.2009, *Acer pseudoplatanus*; Sofia, park, 4.ix.2013, *Acer pseudoplatanus*; Arbanassi near Veliko Tarnovo, 6.ix.2013, *Acer pseudoplatanus*; Etara, 6.ix.2013, *A. pseudoplatanus*; leg. I. Ivanova: Sofia, 3.xi.2009, *Acer spec.*

Field recognition As the other species of the genus, *A. pseudoplatani* exhibits puparial dimorphism with puparial characters differing between summer with a pale derm and winter with a sclerotized form. The puparia can be recognized by the greyish yellow colour and the surrounding waxy band (Müller 1962a, Müller 1962b).

Economic importance This species has never been recorded as economically important.

Biology The species has one or two annual generations (Zahradnik 1987). Only 15% of the summer puparia developed early enough during the season to produce a second generation Müller (1962b). The rest of the puparia appeared fairly late in the season during fall and not developing a second generation. Puparia overwinter and are present on the underside of the leaves of their hosts from July till the end of the winter. They may be obtained by seeking them on the leaves on their host or on fallen leaves during the wintertime. The adult is present from May but the species is rarely observed in this stage. This

species is predominantly known to live on *Acer pseudoplatanus* whereas it is also recorded from *A. opalus*, *A. turcomanicum* and *A. monspessulanum* (Danzig 1969, Martin et al. 2000).

Geographical distribution Europe: Austria, Czech Republic, France, Germany, Hungary, Italy (incl. Sicily), the Netherlands, Poland, Romania, Switzerland and Russia (Martin et al. 2000).

Aleurolobus wunni (Ryberg)

Leg. M. Jansen & I. Ivanova: Sofia, Vitosha reserve, 10.ix.2013, *Clematis vitalba*, three puparia.

In Europe the species is recorded on eleven species from five plant families (Martin et al. 2000).

Aleyrodes proletella (Linnaeus) (figure 3-4)

New for the Bulgarian fauna. Leg. M. Jansen: Arbanassi near Veliko Tarnovo, 6.ix.2013, *Chelidonium majus*; Petarch near Sofia, 2.viii.2009, *Brassica*. Several cultivars of cabbage plants (*Brassica*) growing in allotments were found to be heavily infested with eggs, nymphal stages and adults of the cabbage whitefly, *Aleyrodes proletella*. Although Martin et al. (2000) mentions its presence throughout Europe and the Mediterranean countries, there appear to be no published records of its presence in Bulgaria. The species is present widespread across the region and countries may have no specific records. The only reason of the absence of any records is because of the lack of collecting (Jon Martin personal communication).

Field recognition Puparia of *A. proletella* may differ in colour between yellow to dark grey and different coloured varieties may be present next to each other on the same leaf. Contrary to most other whitefly species, adults have two greyish spots on the wings. The eggs are laid in semi-circles.



3. The habitat of *Aleyrodes proletella* at Petarch, 2.viii.2009. Photo: Maurice Jansen

3. Het leefgebied van *Aleyrodes proletella*, Petarch, 2.viii.2009.

Economic importance The cabbage whitefly is a pest of cabbage varieties (*Brassica oleracea*) such as Brussels sprouts (var. *gemmifera*), kale (var. *sabellica*) and broccoli (var. *botrytis*) in Europe, being especially troublesome to home gardeners. Long periods of a local presence (being rare and only a minor pest), may be interrupted by periods of spreading and high populations causing serious damage in commercial cabbage fields. The species is hardly affected by pesticide spraying. Large populations give rise to optic damage because of their presence, adults cause a spotty appearance of wax on the host whereas the leaves of the host plant become covered by a sticky layer of honeydew and the subsequent growth of sooty moulds. Since early 1999, *A. proletella* has become a serious pest in greenhouse grown gerbera crops (*Gerbera jamesonii*) in the Netherlands (Jansen 2001) and from cucumber (*Cucumis sativus*) in Belgium (Snels 2004).

Biology The cabbage whitefly is polyphagous and recorded from representatives of fourteen plant families (Evans 2007, Mound & Halsey 1978) including Apaceae, Asteraceae, Balsaminaceae, Berberidaceae, Brassicaceae, Campanulaceae, Euphorbiaceae, Fabaceae, Fagaceae, Papaveraceae, Ranunculaceae and Scrophulariaceae. The main hosts are *Chelidonium majus* and *Brassica* especially the varieties borecole (kale), Brussels sprout and green cabbage. In Central Europe, there are three overlapping generations (Bährmann 1973) although Bink *et al.* (1980) mention four to five overlapping generations forming colonies containing different growth stages in the Netherlands. Overwintering is in the adult stage as reported by Huldén (1986) for populations in Finland. Iheagwam (1977) observed that the species overwinters mainly as adult, but also in the immature stages when temperature falls below the threshold for development. It is most commonly found and widely distributed in Europe and the Mediterranean countries.

Geographical distribution Palaearctic Region: Europe, Asia and Macaronesia. Ethiopian Region: Angola, Cape Verde Islands, Kenya, Mozambique and South Africa. Oriental Region: Taiwan. Australia: South Australia and Victoria. Pacific Region: New Zealand; Neotropical Region: Brazil; Nearctic Region: eastern USA (Martin *et al.* 2000).

Aleyrodes sp.

Leg. M. Jansen & I. Ivanova: Sofia, Student Park, 10.ix.2013, *Lactuca serriola*, only adults; Sofia, Vitosha, 10.ix.2013, *Lapsana*.

There are no clear and reliable distinguishing characters which separate adults from *Aleyrodes loniceriae* and *A. proletella*. The two species don't share host plants and puparia tend to be quite variable in morphological structures. Occasionally, depending on the host plant, puparia are found with intermediate characters. Future research both by morphological and molecular means regarding the variability on different hosts is needed to elucidate their status.

Asterobemisia carpini (Koch) (= *A. avellanae*)

The first specimens were found on *Rosa x damascene*, *Rosa x alba* and *R. canina* and reported by Nikolova & Natskova (1965) who studied the biology of the species in the neighbourhood of the town of Klisura.

Asterobemisia obenbergeri (Zahradnik)

The first specimens were collected at Sofia on *Kochia prostrata* (Kozár & Bink-Moenen 1988).

Bemisia tabaci (Gennadius)

Leg. M. Jansen: Mineralni bani, 8.ix.2013, *Solanum nigrum* ssp. *schultesii* plant alongside the road, one specimen.

Karadjova (2006) described its occurrence in Bulgaria and the results of a monitoring program of greenhouse pests in the period 1998-2006. The species was found on poinsettia (*Euphorbia pulcherrima*), hibiscus (*Hibiscus rosa-sinensis*) and mandevilla (*Mandevilla*). In all cases, infected plants were destroyed and the whitefly population eradicated. The introduction of imported seedlings and other crops for propagation include a serious risk to introduce *B. tabaci* outdoors and in greenhouses in the southern regions of the country. The species is native outdoors in the Mediterranean region and its first description was based on Greek material (Gennadius 1889). Therefore, it is likely that the



4. Adult of *Aleyrodes proletella*, Petarch, 2.viii.2009. Photo: Maurice Jansen

4. Volwassen koolwittevlieg, *Aleyrodes proletella*, Petarch, 2.viii.2009.

species is native in Bulgaria as well and is able to become a pest in greenhouses. Early recognition during import interceptions and in greenhouses of *Bemisia tabaci* and related whitefly pest species is important to prevent species to survive and establish in greenhouses.

Bulgarialeurodes cotesii (Maskell)

This species occasionally is a pest of roses and already recorded for Bulgaria in 1920 (Kozár & Nagy-Dávid 1986).

Neopealius rubi Takahashi

In 1979, specimens were collected at Varna on *Rubus caesius* and at Bebrevo on *R. fruticosus* (Bink-Moenen 1991).

Siphoninus phillyreae (Haliday)

This polyphagous species, which feeds on plants belonging to more than ten families, was noted for the first time in Bulgaria in 1966 near Kuystendil and has also been reported from Kostinbrod, on a spot named 'Sofiisko' where the Institute for Plant Protection is located, and at Sindel, about 25 km from the Black Sea coast. *Pyrus* and *Crataegus* were infested and adults appeared in spring as the leaves began to open and were observed to emerge up till the end of August or the early part of September. It was inferred that the species overwinters in the puparial stage (Pelov & Trenchev 1973). In 1971, a group of pear trees in the Kyustendil province were severely damaged by whiteflies. Larvae and adults fed on the lower surface of the leaves, which prematurely turned yellow (Kolev 1973). Later on, Kozár & Bink-Moenen (1988) erroneously recorded it as new for the fauna and collected the species at Kresna on *Ulmus* (?) in 1983 and at Sofia-Vitosha on *Fraxinus excelsior* in 1982.

Trialeurodes vaporariorum (Westwood)

Leg. M. Jansen: Plovdiv, 8.ix.2013, *Lamium galeobdolon*; Mineralni Bani, 8.ix. 2013, *Solanum nigrum* ssp. *schultesii* alongside a road.

This polyphagous species is an important pest in tomatoes and many other plants of economic importance (e.g., Georgiev & Sotirova 1988).

Discussion

The outdoor fauna from the Atlantic Ocean to the Black Sea between 40-45° latitude probably consists of about 40-45 species (Bink-Moenen & Mound 1990). The actual number of Bulgarian species is twelve (table 1, excluding one possible additional species that could not be identified) and it is to be expected that a number of species are waiting for discovery. The two worldwide most often recorded species of economic concern, *Bemisia tabaci* Gennadius and *Trialeurodes vaporariorum* are present in Bulgaria as well. These are harmful pests both outdoors and in greenhouses. Three other species of economic importance with local outbreaks are *Bulgarialeurodes cotesii*, *Siphoninus phillyreae* and *Aleyrodes lonicerae*. The last one is common in Europe and the Mediterranean region. It is of particular concern in allotments and of less importance in commercial cabbage cultures. Monitoring and faunistic inventories are of importance for an early detection and management.

New species are to be expected in three categories: (i) native species not earlier discovered, (ii) species which are spreading

Table 1. List of Bulgarian whitefly species with their hosts. Underlined names of plants refer to Bulgarian observations by the authors.
Tabel 1. Lijst van Bulgaarse wittevliessoorten en hun voedselplant. Planten waarop wittevliesen door de auteurs werden gevonden zijn onderstreept.

<i>Aleurochiton aceris</i> (Modeer)	<i>Acer platanoides</i> , <i>A. tataricum</i> , <i>A. cappadocicum</i>
<i>Aleurochiton acerinus</i> Haupt	<i>Acer campestre</i>
<i>Aleurochiton pseudoplatani</i> Visnya	<i>Acer monspessulanum</i> , <i>A. opalus</i> , <i>A. pseudoplatanus</i>
<i>Aleurolobus wunni</i> (Ryberg)	<i>Asarum europaeum</i> , <i>Cimicifuga</i> , <i>Clematis vitalba</i> , <i>Linnaeus borealis</i> , <i>Lonicera fragrantissima</i> , <i>L. nigra</i> , <i>L. tatarica</i> , <i>Phlomis</i> , <i>Spiraea</i> , <i>Symphoricarpos albus</i> , <i>S. racemosus</i>
<i>Aleyrodes proletella</i> (Linnaeus)	<i>Chelidonium majus</i>
<i>Asterobemisia carpini</i> (Koch)	polyphagous on trees and shrubs including <i>Rosa</i>
<i>Asterobemisia obenbergeri</i> (Zahradnik)	<i>Globularia</i> , <i>Satureja</i> , <i>Thymus</i>
<i>Bemisia tabaci</i> (Gennadius)	polyphagous including <i>Solanum nigrum</i> ssp. <i>schultesii</i>
<i>Bulgarialeurodes cotesii</i> (Maskell)	<i>Rosa</i>
<i>Neopealius rubi</i> Takahashi	woody plants in 7 families e.g. <i>Rubus</i> , <i>Rosa</i>
<i>Siphoninus phillyreae</i> (Haliday)	polyphagous but preferring woody hosts including <i>Crataegus</i> , <i>Fraxinus</i> , <i>Olea</i> , <i>Phillyrea</i> , <i>Citrus</i> .
<i>Trialeurodes vaporariorum</i> (Westwood)	polyphagous including <i>Lamium galeobdolon</i> and <i>Solanum nigrum</i> ssp. <i>Schultesii</i>

their natural range as a result of, for example, climate change, and (iii) newly imported exotic species. The recognition and management of the last category is an increasing challenge. Measures taken after introduction rely on early and reliable identifications based on the global knowledge of this species group. This is hampered by the worldwide erosion of taxonomical knowledge. The increase of global trade and touristic activities enhance the chance on the infiltration of these exotic

species, as is the case with the introduction of the Asian species *Aleurocanthus spiniferus* and *Aleuroclava aucubae* (Kuwana) which are spreading in Italy (Cioffi et al. 2012) and Croatia (Šimala et al. 2015). A recent example of new introduced species in the Balkan region is the discovery of the Asian species *Pealius mori* (Takahashi) and *Pealius machili* Takahashi and the spread of *Paraleyrodes minei* Iaccarino, a species which originates in the New World (Wang et al. 2016).

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Samenvatting

De wittevliegen van Bulgarije, inclusief twee nieuwe soorten voor de fauna (Hemiptera: Aleyrodidae)

Een overzicht en lijst wordt gegeven van de wittevliegen van Bulgarije bestaande uit twaalf soorten, plus een mogelijke extra soort die niet kon worden gedetermineerd. Er worden ongeveer 40-45 soorten verwacht. *Aleyrodes proletella* en *Aleurochiton pseudoplatani* zijn twee soorten die gewoon zijn in Europa, maar niet eerder gerapporteerd uit Bulgarije. Vijf soorten zijn van economisch belang: *Bemisia tabaci* en *Trialeurodes vaporariorum* op wereldschaal, *Siphoninus phillyreae* en *Aleyrodes proletella* op beperkte schaal in Europa en *Bulgarialeurodes cotessi* alleen lokaal.



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