

## First records of *Acizzia uncatoides* (Ferris & Klyver, 1932) and *Acizzia acaciaebaileyanae* (Froggatt, 1901) (Hemiptera: Psylloidea: Psyllidae) in Croatia

### Prvi nalazi vrsta *Acizzia uncatoides* (Ferris & Klyver, 1932) i *Acizzia acaciaebaileyanae* (Froggatt, 1901) (Hemiptera: Psylloidea: Psyllidae) u Hrvatskoj

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#### ABSTRACT

Alien species represent a significant component of European entomofauna. Intensive international trade of plants, particularly woody ornamentals, has increased introduction of alien species into Europe in the last two decades, where alien terrestrial invertebrates prevail as one of the most numerous groups of introduced organisms. As of 2010, fourteen species of alien psyllids (Hemiptera: Psylloidea) have been recorded in Europe. Five species have been reported from Croatia, including *Acizzia jamatonica* (Kuwayama, 1908), as the only species from genus *Acizzia* Heslop-Harrison, 1961 present in Croatia so far. This paper provides genus status in Croatia, with first records of Australian species *Acizzia uncatoides* (Ferris & Klyver, 1932) and *Acizzia acaciaebaileyanae* (Froggatt, 1901).

**Keywords:** *Acizzia*, alien species, Croatia, first record, psyllids

#### SAŽETAK

Strane vrste važna su komponenta europske entomofaune. Intenzivna međunarodna trgovina biljem, primarno drvenastim ukrasnim vrstama, u posljednja je dva desetljeća dovela do porasta broja unosa stranih vrsta u Europu pri čemu kopneni bezkralježnaci predstavljaju jednu od najbrojnijih skupina. Do 2010. godine 14 stranih vrsta lisnih buha (Hemiptera: Psylloidea) zabilježeno je u Europi. Pet je do danas registrirano u Hrvatskoj, uključujući i vrstu *Acizzia jamatonica* (Kuwayama, 1908), kao jedinog predstavnika roda *Acizzia* Heslop-Harrison, 1961. Rad donosi pregled vrsta roda *Acizzia* u Hrvatskoj, s prvim nalazima australskih vrsta *Acizzia uncatoides* (Ferris & Klyver, 1932) i *Acizzia acaciaebaileyanae* (Froggatt, 1901).

**Ključne riječi:** *Acizzia*, Hrvatska, lisne buhe, prvi nalaz, strane vrste

## INTRODUCTION

Anthropogenic effect on biodiversity, a result of combined impact of globalisation and climate change (DAISIE, 2009), has brought more attention to alien insect species and their accelerating spread outside of native habitats in the recent decades. Majority of new, exotic insect species enter Europe unintentionally through human activities (DAISIE, 2009), as new horticultural trends favour imports of plant species native to different regions of the world into Europe. Once imported, plant material carrying non-indigenous insect species moves through European market, allowing for their spread. Woody ornamentals prevail as vectors of alien plant pests into Europe (Smith et al., 2007). Intensive trade, in combination with global warming, encourages establishment of insect species from subtropical and tropical areas into European regions, which is particularly evident in the Mediterranean basin (Matošević and Pajač Živković, 2013).

The most comprehensive list of alien terrestrial invertebrates was published in 2009 in Handbook of Alien Species in Europe (DAISIE, 2009). According to DAISIE (2009), alien terrestrial invertebrates represent one of the most numerous groups of introduced organisms in Europe, with species from class Insecta being most abundant and accounting for 1306 species. At the order level, Hemipterans are second most represented, accounting for 26% of all alien insects, which differs significantly from taxonomic composition of native European entomofauna, where Hemipterans represent only 8% of accounted species (DAISIE, 2009). Small sap feeders, such as psyllids, can be unnoticeably carried outside of their native range, mostly as eggs attached to their host plants (Kenis et al., 2007; Malumphy and Luker, 2014). The number of alien psyllid species that have expanded their area of distribution in the past half of century is increasing, with an average of 0.5–0.6 new alien species recorded per year in Europe since 2000 (Mifsud et al., 2010). Most of alien psyllid species were observed in man-made habitats, such as parks and gardens (Mifsud et al., 2010), where exotic woody plants are often planted for ornamental purposes.

Jumping plant-lice or psyllids (Hemiptera: Sternorrhyncha: Psylloidea) are very small, exclusively phytophagous, sap-sucking insects. Generally, they are highly host specific phloem-feeders, feeding mostly on perennial Dicotyledonous plants (Hodkinson, 1974; Rapisarda and Belcari, 1999). Life cycle typically comprises of an egg stage, five larval instars and a sexually reproducing adult stage (Hodkinson, 2009). Adults are characterised by the ability to jump, a trait from which their common name “jumping plant-lice” stems (Rapisarda and Belcari, 1999). Some 4000 species have been described so far (Percy et al., 2018), classified in seven families (Burckhardt et al., 2021), with a distribution throughout all major zoogeographical regions of the World, but showing greatest diversity in tropical and south temperate regions (Mifsud et al., 2010). Psyllids cause direct damages to their host plants through feeding, by sucking the plant sap, or indirect damages through transmission of harmful phytoplasma diseases (Križanac, 2017; Percy et al., 2018) and abundant excretion of honeydew.

Checklist of alien insect species from superfamily Psylloidea Latreille, 1807, available in “Alien terrestrial arthropods of Europe” (Mifsud et al., 2010), was used as an inclusion-point of non-indigenous woody plants from *Albizia* Durazzini and *Acacia* Miller genera (Fabaceae: Mimosoideae) into conducted field research. According to Mifsud et al. (2010), 14 species of jumping plant-lice alien to Europe were recorded by 2010, originating from Australasia (57.1%), Asia (28.6%) and Africa (14.3%), five of which have been reported from Croatia. *Acizzia jamatonica* (Kuwayama, 1908) was the only species from genus *Acizzia* Heslop-Harrison, 1961 reported from Croatia so far (Seljak, 2003; Seljak et al., 2004), while European records additionally include *Acizzia acaciaebaileyanae* (Froggatt, 1901), *Acizzia hollisi* Burckhardt, 1981 and *Acizzia uncatoides* (Ferris and Klyver, 1932; Mifsud et al., 2010).

An inventory of alien genus *Acizzia* in Croatia is provided in this paper.

## MATERIALS AND METHODS

As a part of a PhD research, a survey of psyllid fauna was carried out in the period 2015-2020 in private gardens, commercial garden centres and on public greenery, on wild and cultivated flora all across Croatia. Seven counties along the Croatian Adriatic coast were in focus for *Acizzia* species, as this is the region where their host plants are commonly found. *Albizia julibrissin* (Durazz.) can also be occasionally found in private gardens in the continental part, and when found, the trees were inspected for the presence of psyllids. Adults of *Acizzia* were collected with fine mesh sweeping net and mouth aspirator. Infested leaves of host plants with eggs and nymphs were collected into transparent plastic bags. Samples were stored into a portable refrigerator before being brought into laboratory for identification. Morphological characters of adult psyllids were used to identify genus and species. Adult specimens were deposited into 70% ethanol and observed under stereomicroscope (Olympus SZX7). For an accurate identification, male genital terminalia were slide-mounted in Canada balsam according to a modified Watson and Chandler (1999) method and their highly specific characteristics were observed under optical microscope (Olympus BX 51). Descriptions and illustrations for *A. jamatonica* are provided in the literature by Burckhardt and Mühlethaler (2003) and Wheeler and Hoebeke (2009). Illustrations and identification keys for *A. acaciaebaileyanae* and *A. uncatoides* are provided in the literature by Hodkinson and Hollis (1987). Following identification, dry specimens were mounted on a 15x5 mm triangular cardboards using polyvinyl alcohol-based glue and together with slide-mounts of male genital terminalia deposited in the collection of Laboratory for Zoology at Centre for Plant Protection - CAAF in Zagreb.

## RESULTS AND DISCUSSION

Three species assigned to alien genus *Acizzia* were recorded in Croatia during conducted faunistic survey (Table 1). Species *A. uncatoides* and *A. acaciaebaileyanae* were recorded for the first time, while for previously recorded *A. jamatonica* new distribution was established.

According to the last revised classification by Burckhardt et al. (2021), genus *Acizzia* is classified within family Psyllidae Latreille, 1807 and single genus subfamily Acizziinae White & Hodkinson, 1985. Genus *Acizzia* currently comprises 77 species of non-European origin (Ouvrard, 2021), with *Psylla acaciae* Maskell, 1894 originally designated as the type species.

For identification of *Acizzia* species, following morphological characters were used: genal cones shorter than the vertex, triangular or broadly rounded; forewing with a distinct costal break and pterostigma, cell  $cu_{1a}$  high (Figure 1); basal metatarsus with 1 (*A. uncatoides*, *A. acaciaebaileyanae*) or 2 (*A. jamatonica*) apical spurs; male proctiger with a well-developed posterior lobe, bearing a subsidiary finger-like projection in *A. uncatoides* and *A. acaciaebaileyanae*.

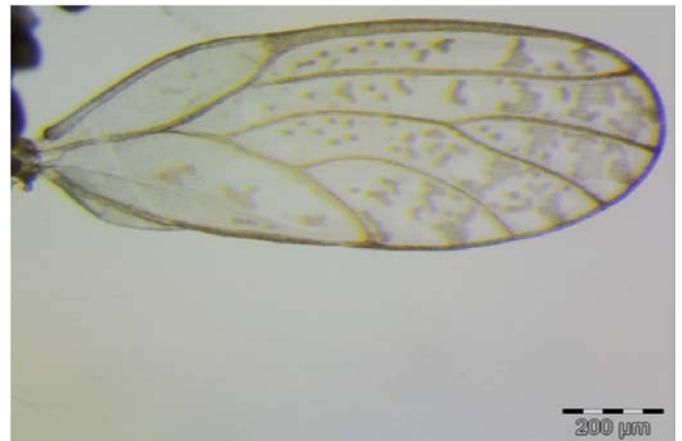


Figure 1. *A. acaciaebaileyanae* right forewing (photo M. Pintar)

Table 1. Species from alien genus *Acizzia* recorded in Croatia

Species	Native range	Year and locality of 1 <sup>st</sup> record in Croatia	Host plant	Reference
<i>Acizzia jamatonica</i> (Kuwayama, 1908)	East Asia (Japan, Korea, China)	2002, Istria county	<i>Albizia julibrissin</i> (Durazz.)	Seljak 2003; Seljak et al., 2004
<i>Acizzia uncatoides</i> (Ferris & Klyver, 1932)	Australia	2015, Čibača (N 42°37'41.78" E 18°10'48.12"), Dubrovnik-Neretva county	<i>Acacia dealbata</i> Link	-
<i>Acizzia acaciaebaileyanae</i> (Froggatt, 1901)	Australia	2020, Kaštel Sućurac (N 43°32'40.59" E 16°27'21.44"), Split-Dalmatia county	<i>Acacia dealbata</i> Link	-

### ***Albizia* psyllid *Acizzia jamatonica***

*A. jamatonica* is a widely spread and well-established species on *A. julibrissin* in Croatia. It is present along the Croatian coast, including some very remote islands, and was also found on several localities in the continental region. First record of *A. jamatonica* in Croatia dates to September 2002, when the psyllid was found on several localities in Istria on *A. julibrissin* (Seljak, 2003; Seljak et al., 2004). During 2004 and 2005 first survey of this psyllid in Croatia was conducted, using yellow sticky traps, and resulted in establishing its presence all along the Adriatic coast (Šimala et al., 2006). Newly generated data show the species is well established in Croatia and is inhabiting virtually all areas where its host is present. Very high population densities were often recorded, with overlapping generations usually present on the shoots. In some coastal localities damages had been recorded, with yellowing of the leaves, defoliation and absence of flowering clearly visible.

*A. jamatonica* is a species of eastern Asian origin, with Japan, Korea and China considered as its native range (Seljak et al., 2004; Wheeler and Hoebeker, 2009). It was recorded for the first time in Europe in Northern Italy in 2001 (Alma et al., 2002) and has so far been reported from most countries of the Mediterranean basin, several central European countries (EPPO GD, 2021) and since 2006 from United States (Ulyshen and Miller, 2007). It overwinters as adult on conifers (Lauterer et al., 2011) and in favourable climatic conditions breeds through most of the year (Malumphy et al., 2013), producing numerous overlapping generations.

*A. jamatonica* is highly host specific and feeds only on *Albizia* species, in particular *A. julibrissin* (EPPO, 2006; Ouvrard, 2021), commonly named Persian silk tree, a very common woody ornamental tree introduced from Asia into Europe in the mid-18<sup>th</sup> century (Vétek and Rédei, 2009). Popular for its unique appearance, with decorative leaf texture, flowers and broad crown, it is often present in private and public gardens and parks (Vétek and Rédei, 2009). Until 2002, it was considered a pest-free ornamental both in Europe and America (Lauterer et al., 2011).

Adults of *A. jamatonica* are the largest among the species of genus *Acizzia* occurring in Europe (Lauterer et al., 2011) and are easily distinguished from other species within genus by the nearly uniformly pale, yellowish forewings, with only small and faint dark spots at the apical margins of cells  $r_2$ ,  $m_1$ ,  $m_2$  and  $cu_1$  (Vétek and Rédei, 2009).

### ***Acacia* psyllid *Acizzia uncatoides***

Heavily infested shoots covered with nymphs, adults and sticky film of honeydew were discovered on April 23<sup>rd</sup> 2015 on a single *Acacia dealbata* Link tree in a garden of a plant nursery located in a small town of Čibača, in the southernmost region of Croatia. Collected specimens were subsequently identified as *A. uncatoides*, a new species for Croatian fauna. The *Acacia* tree seems to have been long planted, so the origin of this infestation is unknown. The tree has since been cut down, after freezing in 2017. The species was additionally identified from a sample collected in 2016 on imported *Acacia* spp. seedlings of unknown origin, in a commercial garden centre in Šibenska Dubrava (N 43°44'7.77" E 15°56'49.25"). These plants were presumably sold to the public, facilitating probable spread of the insect.

No damages to host plants other than large amounts of honeydew sticky film were visible at the time of collecting on either locality. Although these remain the only records of this species in Croatia to date, it is likely that its real distribution is wider than the presented data suggest.

For a definite identification, following descriptions and illustrations of morphological characters available in Hodkinson and Hollis (1987) were used: general body colour orange, with paler markings on dorsum of thorax; forewing oblong-oval, with well-developed pterostigma and costal break, cell  $m_1$  elongate, cell  $cu_{1a}$  high and strongly arched towards the wing base, membrane pale yellow to pale amber with orange-brown maculation, veins concolorous with membrane but appearing slightly darker (Figure 2); metatibia with 4 or 5 thick black spurs; basal metatarsus with 1 black spur; male genital terminalia (Figure 3); proctiger with long tubular apical portion and

a rounded posterior lobe bearing a subsidiary finger-like projection, paramere broad, with apex deflexed posteriorly, aedeagus with harpoon-shaped apex.

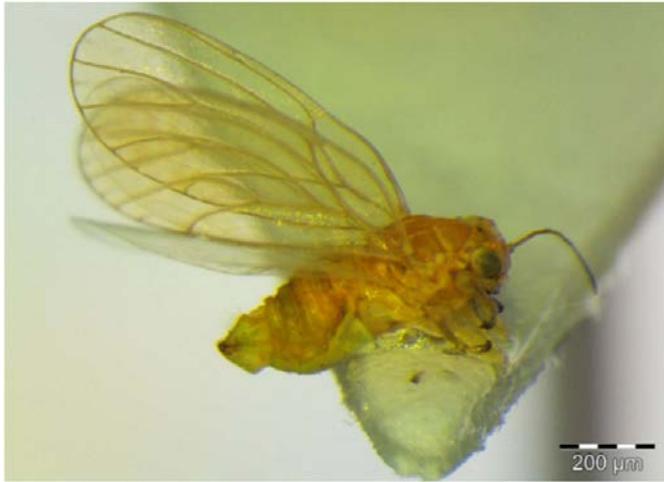


Figure 2. Adult female of *A. uncatoides* (photo: M. Pintar)

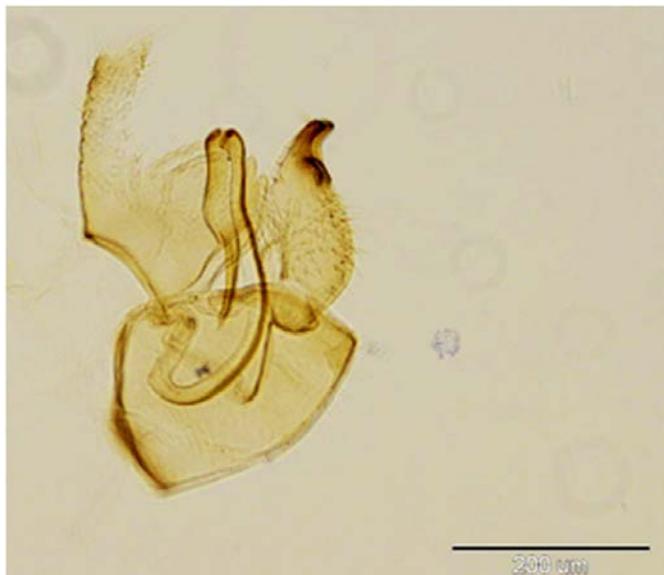


Figure 3. Permanent microscopic slide of *A. uncatoides* male genital terminalia (photo M. Pintar)

*A. uncatoides* is a species native to Australia (Hodkinson and Hollis, 1987), but has spread into new regions, including Europe, where it has been reported from France, Great Britain, Greece, Italy, Malta, Montenegro, Portugal, and Spanish Canary Islands (Mifsud et al., 2010; Malumphy and Luker, 2014; Ouvrard, 2021). Although Fauna Europaea includes former Yugoslavia on the list of distribution areas of *A. uncatoides* (Burckhardt, 2013), its presence has so far been confirmed only from Montenegro (Lauterer, 1993; Ouvrard, 2021). Therefore,

our findings should be considered as first records of the species in Croatia.

*A. uncatoides* is an oligophagous psyllid that feeds on many *Acacia* and some *Albizia* species (Malumphy and Luker, 2014; Ouvrard, 2021). It is a polyvoltine species, with an almost continuous development during the whole year (Rapisarda and Belcari, 1999), producing at least 8 overlapping generations in coastal central California and between 6 and 8 in northern Italy (DEFRA, 2021). A seasonal dimorphism with a larger winter form and a smaller summer form is observed (Burckhardt, 1994). Temperature tolerance might be a limiting factor for the establishment of this species in some areas, as development is incomplete at 30 °C and at 45 °C the adults die before any eggs get laid (DEFRA, 2021). Under experimental conditions, the optimum survival of immature stages occurred at 20 °C and optimum longevity was achieved with an upper temperature limit of 25-30 °C (DEFRA, 2021). Warmer, drier climate, such as present in the Mediterranean and California, is suitable for the establishment of *A. uncatoides* (DEFRA, 2021).

#### *Cootamundra wattle psyllid Acizzia acaciaebaileyanae*

Heavy infestation of *A. dealbata* imported from Italy was observed in a commercial garden centre in Kaštel Sućurac, located in the middle of the Croatian Adriatic coast, on May 27<sup>th</sup> 2020. In a subsequent laboratory analysis, collected specimens were identified as *A. acaciaebaileyanae*, a new psyllid for Croatian fauna. So far this remains the only record of *A. acaciaebaileyanae* in Croatia and its possible spread and establishment are to be determined.

For a definite identification, the following descriptions and illustrations of morphological characters available in Hodkinson and Hollis (1987) were used: general coloration of head and thorax dull orange-yellow, with darker yellowish brown markings, abdominal sclerites yellowish brown; forewing oblong oval, with well-developed pterostigma and costal break, transparent, with small irregular pale brown maculations, veins pale, yellowish brown, cell m1 elongate, cell cu1 high and

strongly arched towards the wing base (Figure 1 & Figure 4); metatibia with 4 or 5 thick black apical spurs, basal metatarsus with 1 black spur; male genital terminalia (Figure 5): proctiger with short and broad tubular apical projection and with rounded posterior lobe bearing a subsidiary finger-like projection, paramere simple, broad basally, gradually tapering to rounded apex, with a small posteriorly directed subapical denticle on inner posterior margin, aedeagus with a bulbous apex.



Figure 4. Adult *A. acaciaebaileyanae* on *A. dealbata* (photo: M. Pintar)



Figure 5. Permanent microscopic slide of *A. acaciaebaileyanae* male genital terminalia (photo M. Pintar)

*A. acaciaebaileyanae* is a species of Australian origin (Hodkinson and Hollis, 1987). Its presence in the Palearctic region was first reported from Italy (Rapisarda, 1985), where the psyllid was introduced on ornamental *Acacia* trees (Hodkinson and Hollis, 1987). To date, records from France (Malausa et al., 1997), Germany (Burckhardt and Mühlethaler, 2003; Malumphy and Luker, 2014), Great Britain (Malumphy and Luker, 2014) and Slovenia (Seljak et al., 2004) have been reported. *A. acaciaebaileyanae* favours *Acacia baileyana* F. Muell. as its host, but feeds also on several other *Acacia* and *Albizia* species, such as *A. dealbata*, *Acacia decurrens* Willd., *Acacia podalyriifolia* G. Don and *Albizia saman* (Jacq.) Merr. (Malumphy and Luker, 2014; Percy et al., 2012). *A. acaciaebaileyanae* is a polyvoltine species, with an almost continuous development during the whole year, with highest population density in the spring (Rapisarda and Belcari, 1999).

#### **Pests' significance for Croatian flora**

Although *Acizzia* is considered as a predominantly legume-feeding genus, particularly on *Acacia* and *Albizia* genera (Hodkinson and Hollis, 1987; Hollis, 2004), host records also include species from non-legume plant families of Capparidaceae, Sapindaceae, Loranthaceae, Proteaceae (Hollis, 2004) and Solanaceae (Kent and Taylor, 2010). At least 46 species from genus *Acizzia* have been documented from family Fabaceae, 30 of which from various hosts within the large *Acacia* genus, showing a strong bond between this host family and the psyllid genus (Martoni and Armstrong, 2019). The plant genus *Acacia* is widely distributed, occurring naturally on all continents except Europe. More than 1500 species are known worldwide, with around 1200 endemic to Australia (Old et al., 2003). As members of the genus *Acizzia* present in Croatia are monophagous or oligophagous on Mimosoideae, it is unlikely they will present risk to native plant species.

Serious damages, such as severe defoliation caused by *A. jamatonica* recorded on *A. julibrissin* trees in Istria, come as a result of a rapid build-up of high population densities of *Acizzia* species on host plants. Psyllids'

feeding also causes chlorosis, deformation and damage to meristematic tissue that can result in plants having poor form (Lauterer et al., 2011; Malumphy and Luker, 2014). Nymphs' feeding on the growing tips results in die-back of the new growth. Both nymphs and adults excrete honeydew (Ossiannilsson, 1992), sugary viscous liquid suitable for development of fungi, i.e. black sooty moulds that decrease aesthetic value of ornamental plants and cause reduction of photosynthetic activity of affected leaves (Malumphy et al., 2013).

## CONCLUSION

As horticultural trends change and many exotic plants now enrich European flora, introduction of their accompanying pests into non-native habitats seems inevitable. Species from order Hemiptera seem to be well adapted for such spread, which was the reason for intensification of faunistic research on species from suborder Sternorrhyncha, e.g., superfamily Psylloidea in Croatia.

According to literature, five alien species from superfamily Psylloidea were already reported from Croatia: *A. jamatonica* (Seljak, 2003; Seljak et al., 2004), *Cacopsylla fulguralis* (Kuwayama, 1908) (Šimala and Masten, 2003; Šimala et al., 2006), *Cacopsylla pulchella* (Löw, 1877) (Pintar et al., 2018; Pernek et al., 2020), *Ctenarytaina eucalypti* (Maskell, 1890) (Šimala et al., 2006) and *Glycaspis brimblecombei* Moore, 1964 (Pintar et al. 2020; Kolar et al., 2021). Two previously unrecorded species were identified during this survey: *A. uncatoides* and *A. acaciaebaileyanae*. Both native to Australia, they feed on Australian ornamental trees from *Acacia* and *Albizia* genera, popular on the Croatian Adriatic coast. Warm and dry climate in the coastal part of Croatia provides suitable environment for these species, so their establishment and spread are expected. However, as both species are oligophagous on *Acacia* and *Albizia* genera, they are not likely to pose a risk to native Mediterranean flora.

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