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WHITEFLY SPECIES OF THE GENUS *ALEUROCHITON* TULLGREN, 1907 (HEMIPTERA: ALEYRODIDAE) RECORDED ON MAPLES *(ACER* SPP.) IN CROATIA

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Faunistic research of whitefly species of the genus *Aleurochiton* Tullgren, 1907, conducted in the period 2005-2007 on maples in Croatia resulted in the recording of 3 species. The species *Aleurochiton acerinus* Haupt, 1934 was identified on the common maple *(Acer campestre* L.) at numerous Croatian inland sites. *Aleurochiton aceris* (Modeer) 1778 was found on Norway maple *(Acer platanoides* L.*)* in the central and northern inland part. *Aleurochiton pseudoplatani* Visnya, 1936 was recorded on Montpelier maple *(Acer monspessulanum* L.) in the northern coastal region and on sycamore maple *(Acer pseudoplatanus* L.*)* in northern coastal and continental part of Croatia.

Key words: faunistic research, whiteflies, *Aleurochiton,* maples, Croatia

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Faunistička istraživanja štitastih moljaca roda *Aleurochiton* Tullgren, 1907 provedena na javorima u Hrvatskoj, u razdoblju od 2005. do 2007. godine rezultirala su nalazom 3 vrste. Vrsta *Aleurochiton acerinus* Haupt, 1934 identificirana je na poljskom javoru *(Acer campestre* L.) na brojnim lokalitetima kontinentalne Hrvatske. *Aleurochiton aceris* (Modeer) 1778 nađen je na javoru mliječu *(Acer platanoides* L.*)* u središnjem i sjevernom kontinentalnom području. *Aleurochiton pseudoplatani* Visnya, 1936 zabilježen je na sredozemnom maklenu *(Acer monspessulanum* L.) na sjevernom obalnom području i na gorskom javoru *(Acer pseudoplatanus* L.*)* u sjevernom obalnom i kontinentalnom dijelu Hrvatske.

Ključne riječi: faunistika, štitasti moljci, *Aleurochiton,* javori, Hrvatska

INTRODUCTION

Whiteflies belong to the order Hemiptera and comprise a single superfamily, Aleyrodoidea, within the suborder Sternorrhyncha. They are all placed in a single family, Aleyrodidae, and are small sap-sucking, usually inconspicuous insects. The latest updated check list of the world's extant whitefly species comprises 1556 species from 161 genera (Martin & Mound, 2007). The check list of whiteflies in Croatia contains 31 species (Šimala & Masten Milek, 2008). *Aleurochiton* Tullgren, 1907 is very distinctive and morphologically well-defined genus characterized by the uniform biology of its species (Danzig, 1966). According to Martin & Mound (2007) it includes five species. Only three species have been recorded in Europe and the Mediterranean Basin: *Aleurochiton acerinus* Haupt, 1934, *Aleurochiton aceris* (Modeer) 1778 and *Aleurochiton pseudoplatani* Visnya, 1936 (Martin *et al.*, 2000). The other two species are of non – European origin. *Aleuroc-*

hiton forbesii (Ashmead) 1893 is a Nearctic whitefly species, while *Aleurochiton orientalis* Danzig, 1966 belongs to eastern Palearctic zoogeographic region (Evans, 2006). All of the described species are only known from the maple (*Acer* spp.) (Mound & Halsey, 1978). *Acer* is a genus of trees or shrubs commonly known as maples. Maples are classified variously, either in a family of their own - the Aceraceae, or in the family Sapindaceae. There are approximately 125 species, most of which are native to Asia, but several species also occur in Europe, northern Africa and North America. Eight *Acer* wild and cultivated species are represented in the Croatian flora (Domac, 1994) .

The faunistics of the whiteflies on trees and shrubs in Croatia have been poorly researched in the past. Takahashi (1940) described *Trialeurodes klemmi* Takahashi, 1940 collected from *Laurus nobilis* L. on the island of Rab in Croatia as a new species for Yugoslavia. Zahradnik (1963; 1991) published a faunistic entry of the same species on the same host plant in Split and Opatija, but under the valid name *Trialeurodes lauri* Signoret, 1882. Matošević (2004) and Matošević *et al.* (2006) investigated whiteflies on trees and shrubs as part of research into harmful entomofauna in urban horticulture in Zagreb. Žanić (2004) stated that the species *Aleurotrachelus rhamnicola* Goux, 1940 feeds on the evergreen bush *Arbutus unedo* L. that is often a component of the Croatian coastal maquis.

The aim of this faunistic investigation was for the first time to identify which whitefly species of the genus *Aleurochiton* are present on the maples in Croatia, as well as to define their distribution.

MATERIALS AND METHODS

Faunistic investigations of whitefly species from the genus *Aleurochiton* on maples *(Acer* spp.) in Croatia were conducted in the period 2005-2007. They were focused on the northern continental part of the country, which is the area of the natural occurrence of the common maple *(Acer campestre* L.), Tatar maple *(Acer tataricum* L.), Italian maple *(Acer opalus* Miller), sycamore maple *(Acer pseudoplatanus* L.*)* and Norway maple *(Acer platanoides* L.*),* as well as on the northern coastal region, where a sub-Mediterranean species, Montpelier maple *(Acer monspessulanum* L.), grows. Whiteflies were collected using a visual survey of maple leaves, with the help of a magnifying lens of 10 x magnification, for the presence of their puparia or pupal cases. Maple species were identified according to Domac (1967; 1994) and Šilić (1988). Leaf samples with preimaginal whitefly stages were placed and stored by the dry method in an envelope until whitefly preparation (Martin, 1987; 1999).

All whiteflies collected in the leaf samples were identified to the species level on the basis of morphological characters of puparium and/or pupal case, using the classical identification method according to relevant morphological keys. Whitefly puparia and pupal cases were slide-mounted in Canada balsam as permanent microscopic slides and labelled with all data relevant for a faunistic entry (sample number, whitefly species, host plant, locality, county and country, sampling date, mounting medium, collector's and identifier's name) according to a modified Watson & Chandler (1999) method.

For identification, the key according to Martin *et al.* (2000) was used. The nomenclature used follows Martin & Mound (2007). For an accurate identification, a stereomicroscope (Nikon SMZ 800) and a compound microscope (Olympus BX 50) were used. Verification of all identifications of whitefly species recorded on maples by faunistic investigations was done by M.G.M. Jansen (Plant Protection Service, Wageningen, The

Netherlands). Slide-mounted specimens were deposited in the zoology laboratory of the Institute for Plant Protection (CCAFRA) and the Croatian Natural History Museum.

The localities of the findings of recorded whitefly species were marked according to the Universal Transverse Mercator coordinate system (Horvat *et al.*, 2003). For each sampling site, the UTM-grid code was given (Fig. 1).

Brief descriptions and photographs of puparia/pupal cases of recorded species are presented to aid detection on the maples in the field. However, formal identification requires microscopic examination of slide-mounted puparia/pupal cases, for which photographs are also presented.

RESULTS AND DISCUSSION

During the faunistic research (2005-2007), a total of three *Aleurochiton* species were recorded on maples in Croatia, i.e. *A. acerinus, A. aceris* and *A. pseudoplatani.*

Aleurochiton acerinus Haupt, 1934

The species *A. acerinus* is distributed in many European and Mediterranean countries. According to Martin *et al.* (2000), it is more common in southern parts of Europe than in the north, in contrast to *A. aceris* which is a more northerly species. Faunistic investigations of the whiteflies in the former Yugoslavia, carried out by Zahradnik (1963) resulted in findings of the species *A. acerinus* at a few localities in Serbia on *A. campestre*, but not in Croatia. Zahradnik (1991) published a study about whiteflies in the former Yugoslavia, including the present territory of Croatia. Apart from anything else, the study was also a reference for a check-list of the European and the Mediterranean whiteflies, the former Yugoslavia included, published by Martin *et al.* (2000). However, based on Zahradnik's data, it is not clear whether the species *A. acerinus* was recorded in Croatia or not, since it does not specify data important for faunistic entry, such as locality and date. Although possibly native, the presence of *A. acerinus* in Croatia was not confirmed until 2005 (Šimala & Masten Milek, 2008). Faunistic investigations carried out by the authors have shown that the whitefly *A. acerinus* is restricted to the single species of maple as the host plant - *A. campestre,* which coincides with the data given by Danzig (1964), Huldén (1986) and Martin *et al.* (2000) and is widely distributed in continental part of Croatia.

Collection data: Carevdar (XM 2703), 8 October 2005; Suhopolje (XL 9475), 23 September 2005; Hudovo (XL 0487), 15 October 2005; Kostel (WM 5614), 5 October 2005; Hum na Sutli (WM 5318), 5 October 2005; Končanica (XL 6856), 21 October 2005; Vrbovec (XL 0982), 1 August 2005; Rastoke (WK 4696), 26 July 2006; Rastovača (WK 4973), 26 July 2006; Lonjsko Polje (XL 3132), 1 August 2006; Božjakovina (WL 9974), 2 August 2006; Samobor (WL 5571), 17 August 2006; Lazina Čička (WL 8764), 18 August 2006; Dugo Selo (WL 9673), 19 August 2006; Lupoglav (XL 0472), 19 August 2006; Prečec (XL 0468), 19 August 2006; Gradec (XL 1485), 21 August 2006; Kutina (XL 3838), 2 September 2006; Rugvica (WL 9567), 6 September 2006; Šašinovečki Lug (WL 9078), 13 October 2006; Laktec (WL 9579), 13 September 2006; Mala Buna (WL 8254), 15 September 2006; Okuje (WL 8358), 15 September 2006; Ključić Brdo (WL 8152), 15 September 2006; Šiljakovečka Dubrava (WL 7954), 15 September 2006; Prvonožina (WL 7449), 20 September 2006; Dubranec (WL 7551), 20 September 2006; Cerovski Vrh (WL 7347), 20 September 2006; Lijevi Štefanki (WL 7240), 20 September 2006; Gustelnica (WL 7650), 20 September 2006; Donji Vukojevac (WL 8951), 1 August 2006; Budančevica (XL 6694), 02 August 2006; Prugovac (XL 6492), 2 August 2006; Lužan Biškupečki (XM 0419), 3 August 2006; Paka

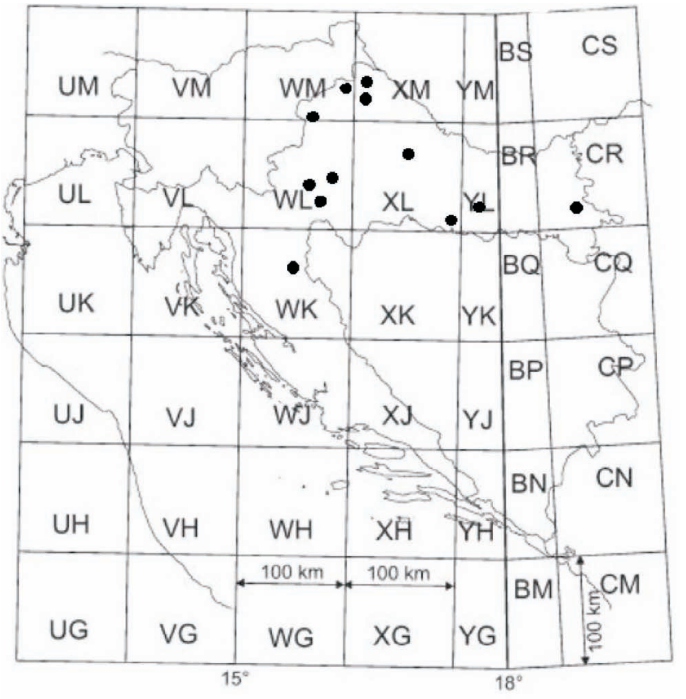

Fig. 1. UTM grid of Republic of Croatia and distribution of *Aleurochiton aceris* (Modeer) 1778 as an example

(XM 0209), 3 August 2006; Županja (CQ 1893), 8 August 2006; Šemovci (XL 5499), 13 August 2006; Kupinovac (XL 4690), 21 August 2006; Predavac (XL 3788), 31 August 2006; Velika Dapčevica (XL 7665), 2 September 2006; Dapčevački Brđani (XL 7565), 2 September 2006; Novaki (YL 0475), 2 September 2006; Novi Senkovac (YL1569), 2 September 2006; Podravska Moslavina (YL 3274), 2 September 2006; Garešnica (XL 5148), 5 September 2006; Štefanec (XM 1536), 6 September 2006; Petrijanec (WM 9433), 6 September 2006;

Fig. 2. Winter puparia of *Aleurochiton aceri-nus* Haupt, 1934 on *Acer campestre* L. leaf (photo: M. Šimala)

Fig. 3. Summer puparium of *Aleurochiton acerinus* Haupt, 1934 with a parasitoid emergence hole on *Acer campestre* L. leaf (photo: M. Šimala)

Busnovi (XL 9723), 8 September 2006; Baćindol (XL 9019), 8 September 2006; Velika (YL 0836), 8 September 2006; Veliki Zdenci (XL 6257), 12 September 2006; Donji Vukojevac (WL 8951), 21 September 2006; Gornji Vukojevac (WL 8650), 21 September 2006; Podvornica (WL 8351), 21 September 2006; Pregrada (WM 5812), 22 September 2006; Rugvica (WL 9567), 27 September 2006; Tomašica (XL 5652), 5 September 2006; Ježevo (XL 0165), 6 September 2006; Lukinić Brdo (WL 7444), 20 September 2006; Cvetković Brdo (WL 7646), 20 September 2006; Velika Buna (WL 8253), 20 September 2006; Velika Buna (WL 8253) 21 September 2006; Pustine (WL 8449), 21 September 2006; Odra (WL 7764), 27 September 2006; Velika Gorica (WL 8362), 27 September 2006; Novaki Oborovski (WL 9464), 28 September 2006; Oborovo (WL 9759), 28 September 2006; Lipnica (WL 7253), 3 October 2006; Gornji Dragonožec (WL 7355), 3 October 2006; Donji Dragonožec (WL

Fig. 4. Winter puparium of *Aleurochiton acerinus* Haupt, 1934 on *Acer campestre* L. leaf (photo: M. Šimala)

7456), 3 October 2006; Havidići (WL 7252), 3 October 2006; Zdihovo (WL 1730), 5 October 2006; Bapča (WL 8566), 11 October 2006; Črnkovec (WL 8666), 11 October 2006; Donje Podotočje (WL 8860), 14 October 2006; Ribnica (WL 8963), 14 October 2006; Novo Čiče (WL 8761), 14 October 2006; Pleso (WL 8364), 15 October 2006; Zagreb (WL 7772), 10 August 2006; Zagreb (WL 7772), 20 August 2006; Zagreb (WL 7772), 15 October 2006; Pokupsko (WL 7737), 18 October 2006; Petrovac (WL 5109), 19 October 2006; Križevci (XL 1998), 20 October 2006; Daruvar (XL 7352), 28 October 2006; Kumrovec (WM 5202), 4 November 2006.

Host plant: *A. campestre* **(Fig. 2)**.

Puparia of *A. acerinus* exhibit distinct seasonal dimorphism. Summer puparia are straw-yellow in colour, flat, 0.8-1,4 mm long and 0.5-0.9 mm wide (Fig. 3). Winter puparia are distinctly oval, elevated and chestnut brown coloured, often covered in full with white wax on the dorsal surface (Fig. 4). They attain a length of 1.0-1.6 mm and a width of 0.6-1.2 mm (Rapisarda, 1982). According to Martin *et al.* (2000) the main microscopic morphological characteristics of puparia from the genus *Aleurochiton* are as follows: operculum almost fully occupying vasiform orifice, lingula usually slightly overlapping posterior margin of orifice and transverse moulting sutures reaching puparial margin. Summer puparia of the species *A. acerinus* have a submarginal row of normally 12 pairs of long, stout setae in outer submargin (Fig. 5). Winter puparia have a submedian zone of venter delineated by an irregular fold, which is best defined cephalically and near the posterior abdominal spiracles (Fig. 6).

A. acerinus has two generations per year (Zahradnik, 1963; Danzig, 1964; 1966).

Aleurochiton aceris (Modeer) 1778

This whitefly species is widely distributed across Europe, but is usually found in areas with a continental climate, where its main host, *A. platanoides,* commonly grows (Martin *et al.,* 2000). In the former Yugoslavia it was recorded only in Serbia and published under the name *Aleurochiton complanatus* Baerensprung, 1918 (Zahradnik, 1963). In Croatia, Matošević (2004) and Matošević *et al.* (2006) recorded the species *A. aceris* under the name *A. complanatus* on *A. platanoides* in green areas of the city of Zagreb. During faunistic investigations of whiteflies on maples, *A. aceris* was identified only on *A. platanoides* at twelve localities in the central and northern inland part of Croatia (Fig. 1). Although Martin *et al.,* (2000) state that *A. tataricum* could be a plant host of *A. aceris,* its puparia were not found on this maple species.

Collection data: Zagreb (WL 7772), 19 August 2005; Zagreb (WL 7772), 31 July 2005; Zagreb (WL 7772), 10 August 2005; Zagreb (WL 7772), 24 August 2005; Zagreb (WL 7772), 30 September 2005; Bjelovar (XL 4384), 23 August 2005; Vinica (WM 8832), 21 September 2005; Vinkovci (CR 2717), 6 October 2005; Varaždin (XM 0329), 13 September 2005; Čakovec (XM 1038), 21 September 2005; Plitvička Jezera (WK 4970), 26 July 2006; Božjakovina (WL 9974), 2 August 2006; Vinkovci (CR 2717), 8 August 2006; Velika Gorica (WL 8362), 14 August 2006; Okučani (XL 7214), 8 September 2006; Trenkovo (YL 0831), 8 September 2006; Velika Gorica (WL 8362), 27 September 2006; Kumrovec (WM 5202), 14 November, 2006; Zagreb (WL 7772), 30 September 2006; Zagreb (WL 7772), 4 October 2006.

Host plant: *A. platanoides.*

Puparia of the species *A. aceris,* like those of *A. acerinus,* exhibit seasonal dimorphism. According to Malumphy *et al.* (2009), summer puparia have pale and translucent cuticle,

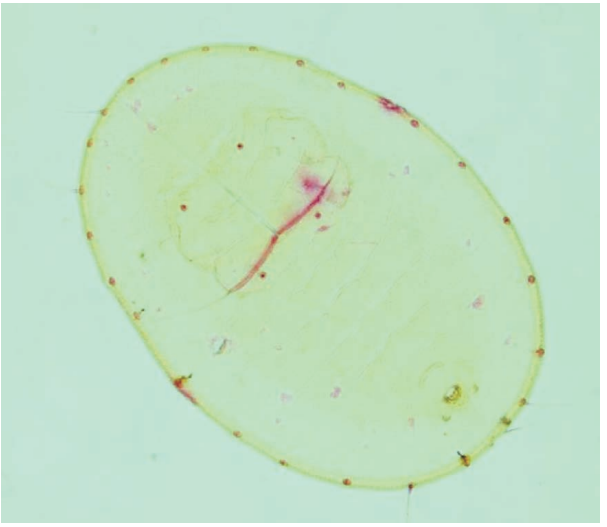

Fig. 5. Permanent microscopic slide of *Aleurochiton acerinus* Haupt, 1934 summer puparium (photo: M. Šimala)

whereas mature overwintering puparia are dark, heavily sclerotised (especially around the margins) and often secrete a dense coating of white wax on the dorsal surface (Fig. 7). Total length of winter puparia ranges from 1.5 to 1.85 mm (Iaccarino & Tremblay, 1977). The summer pupal case is fragile and the dorsal anterior part often breaks off as the adult emerges (Fig. 8). Slide-mounted summer puparia of *A. aceris* have short submarginal setae, often difficult to detect, while winter puparia (Fig. 9) do not have a defined submedian zone.

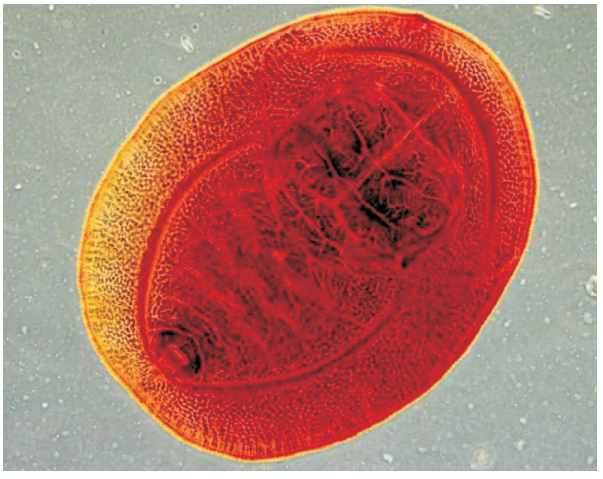

Fig. 6. Permanent microscopic slide of *Aleurochiton acerinus* Haupt, 1934 winter puparium (photo: M. Šimala)

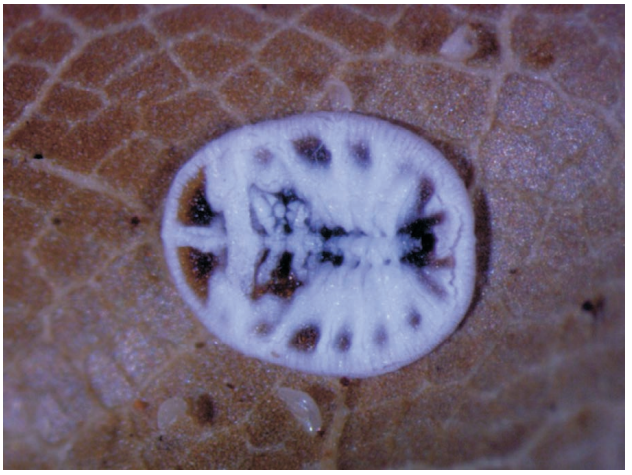

Fig. 7. Winter puparium of *Aleurochiton aceris* (Modeer) 1778 on *Acer platanoides* L. leaf (photo: M. Šimala)

This species is also sexually dimorphic, with male puparia consistently smaller than the female. Teneral winter puparia overwinter on fallen dead leaves. Occasionally both summer and winter puparia occur together on the same leaves (Malumphy *et al.*, 2009). *A. aceris* has two generations annually (Malumphy, 2010; Danzig, 1964; 1966).

Aleurochiton pseudoplatani Visnya, 1936

This species bears closer resemblance to the sole North American species *A. forbesii* than to the other two European species from the genus *Aleurochiton*. It is distributed in many European countries. Although usually developing on *A. pseudoplatanus, A. pseudoplatani*

Fig. 8. Summer pupal case of *Aleurochiton aceris* (Modeer) 1778 on *Acer platanoides* L. leaf (photo: M. Šimala)

Fig. 9. Permanent microscopic slide of *Aleurochiton aceris* (Modeer) 1778 winter puparium (photo: M. Šimala)

Fig. 10. Puparium of *Aleurochiton pseudoplatani* Visnya, 1936 on *Acer pseudoplatanus* L. leaf (photo: M. Šimala)

has also been noted in Europe on *A. monspessulanum* and *A. opalus* (Martin *et al.*, 2000). In Croatia it was recorded on *A. monspessulanum* and *A. pseudoplatanus*, but not on *A. opalus.*

Collection data: Senj (VK 9282), 13 August 2006; Selce (VL 7801), 11 July 2007.

Host plant: *A. monspessulanum.*

Collection data: Poreč (UL 9009), 1 September 2005; Suhopolje (XL 9475), 23 September 2005; Petrijevci (CR 0853), 31 August 2005; Bizovac (CR 0151), 31 August 2005; Zagreb

Fig. 11. Permanent microscopic slide of *Aleurochiton pseudoplatani* Visnya, 1936 puparium (photo: M. Šimala)

(WL 7772), 30 September 2005; Zagreb (WL 7772), 4 October 2005; Hum na Sutli (WM 5318), 5 October 2005; Rastoke (WK 4696), 26 July 2006; Rastovača (WK 4973), 26 July 2006; Slatina (YL 1064), 7 September 2006; Suhopolje (XL 9475), 7 September 2006; Požega (YL 0923), 8 September 2006; Trenkovo (YL 0831), 8 September 2006; Pregrada (WM 5812), 22 September 2006; Fužine (VL 7717), 5 October 2006; Lokve (VL 8023), 5 October 2006; Delnice (VL 8427), 5 October 2006; Buje (UL 9529), 6 October 2006; Budinjak (WL 3870), 8 August 2007.

Host plant: *A.pseudoplatanus.*

In contrast to previous *Aleurochiton* species, *A. pseudoplatani* does not exhibit puparial seasonal dimorphism. Puparia are ochre and pear-shaped, 1.0-1.5 mm in length and 0.7-1.1 mm in width (Fig. 10). The important microscopic characteristic of *A. pseudoplatani* puparium is the presence of a total of 15 pairs of subcircular submedian abdominal depressions on the thorax (3 pairs on prothorax and mesothorax and 2 pairs on metathorax) and one pair on each abdominal segment I-VII (Fig. 11) (Rapisarda, 1982).

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SAŽETAK

Vrste štitastih moljaca roda *Aleurochiton* Tullgren, 1907 (Hemiptera: Aleyrodidae) zabilježene na javorima (*Acer* spp.) u Hrvatskoj

M. Šimala & T. Masten Milek

Cilj ovog rada bio je na osnovi faunističkih istraživanja štitastih moljaca provedenih u razdoblju od 2005. do 2007. godine, objaviti popis i proširenost vrsta roda *Aleurochiton* zabi-

lježenih na javorima *(Acer* spp.) u Hrvatskoj. Vizualnim pregledom listova javora *(A. campestre, A. tataricum, A. opalus, A. pseudoplatanus, A. platanoides, A. monspessulanum)* nađeni štitasti moljci identificirani su klasičnom entomološkom metodom na osnovi morfoloških obilježja puparija i/ili egzuvija, a lokaliteti nalaza vrsta označeni su prema UTM sustavu.

Tijekom faunističkih istraživanja zabilježene su 3 vrste roda *Aleurochiton.* Vrsta *Aleurochiton acerinus* identificirana je na *A. campestre* u kontinentalnoj Hrvatskoj. *Aleurochiton aceris* nađen je na *A. platanoides* u središnjem i sjevernom kontinentalnom području. *Aleurochiton pseudoplatani* zabilježen je na *A. monspessulanum* na sjevenom obalnom području i na *A. pseudoplatanus* u sjevernom obalnom i kontinentalnom dijelu Hrvatske.