Environmental and Experimental Biology (2020) 18: 1–6
http://doi.org/10.22364/eeb.18.01

Original Paper

New species of three monophagous arthropods (Acari & Hemiptera) associated with common walnut (*Juglans regia*) in Latvia

ISSN 2255-9582

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Abstract

Three arthropods, including one eriophyoid mite species, *Aceria erinea*, and two aphid species, *Chromaphis juglandicola* and *Panaphis juglandis*, were recorded in Latvia for the first time. These species are monophages and all are associated with common walnut, *Juglans regia*. All three species were recorded from several localities in Kurzeme and Zemgale region in Latvia, and one species, *P. juglandis* was found also in Sigulda (Vidzeme region), reaching the northernmost confirmed distribution in eastern Baltic region. *P. juglandis* was the most abundant species and was recorded from all localities inspected, but these aphids did not occur on all trees in each locality.

Key words: *Aceria erinea,* alien species, aphids, *Chromaphis juglandicola*, mites, *Panaphis juglandis.*

Introduction

Common walnut, *Juglans regia* L., is widely cultivated worldwide. This species originates in central Asia, but due to intensive use of this crop plant as well as due to deforestation, accurate determination of its native range is impossible (Leslie, McGranahan 1998). Pollen records indicate that presence and spread of *J. regia* in Europe coincided with Greek settlements, suggesting that in Europe *J. regia* is of alien origin (Leslie, McGranahan 1998). Presently the species is widely naturalised throughout Europe (Alford 2007). As in the rest of Europe, also in Latvia *J. regia* was introduced, but cultivated rarely (Mauriņš, Zvirgzds 2006). During park and greenery inventories, *J. regia* was documented only from 40 sites (Laiviņš et al. 2009). Cultivation of *J. regia* in Latvia is difficult, and plants can strongly suffer during winter or even die off (Mauriņš, Zvirgzds 2006). Attempts to cultivate *J. regia* have been carried out since the 19th century, but its cultivation has not always been successful due to low winter hardiness, as trees died during harsh winters, like in winter 1927–1928, and especially in 1939–1940, 1955–1956 and 1978–1979 (Saliņš, Zukovska 1985).

The first collections of *J. regia* and other *Juglans* species have been planted since 1952, but since 1957 several forest cultures with different walnut species have been established (Zukovska 1968). Notwithstanding to these growing problems in the past *J. regia* has been selected by horticulturists Alfrēds Ozols, Pēteris Upītis and Viktors Vārna, who used seeds collected in mountain regions (Saliņš, Zukovska 1985; Mauriņš, Zvirgzds 2006). Walnuts were also studied by Zelma Zukovska (Saliņš, Zukovska 1985; Āboliņa 2016). Alfrēds Ozols obtained hybrids of *Juglans mandshurica* and *J. regia*, which still grow in plant collections and parks (Saliņš, Zukovska 1985; Mauriņš, Zvirgzds 2006). Plants grown by A. Ozols are still present in the collection of the National Botanic Gardens of Latvia. Growth of *J. regia* in Latvia has been limited due to unsuitable climatic conditions, but in this study we found that in some places new *J. regia* has been planted during the last decade, as in Ventspils in the Kurzeme region, where the climate is more appropriate for the species.

Alford (2007) lists 27 arthropod species associated with *J. regia*, which all are found in Europe. This list included some highly monophagous species, e. g. two gall forming eriophyoid mites: *Aceria erinea, Aceria tristriata*; two aphids: *Chromaphis juglandicola, Panaphis juglandis*; and one fly, *Rhagoletis completa*. Besides the two eriophyoid mites, also several other eriophyoid mites have been found in Europe, all of them being non-gall-inducing (vagrant) species associated with *J. regia*: *Aculus arzakanensis, Aculus fascigrans, Aculus juglandis, Aculus pulaviensis, Aculus unguiculatus* and *Anthocoptes striatus* (Flechtmann et al. 2002; Skoracka et al. 2005). According to the latest faunal reviews dedicated to particular arthropod groups (Rupais 1989; Karpa 2008; Stalažs, Turka 2019), none of the previously mentioned arthropod species occurred in Latvia in the past.

The aim of the present study was to search for new arthropod species associated with *J. regia* in Latvia. As a result, three species were documented for the first time in Latvia:*A. erinea, C. juglandicola* and *P. juglandis*.

Methods

In August 2018 on one *J. regia* plant in Jelgava city galls were observed, which were typical damage caused by *A. erinea*. For that reason, walnut, *Juglans* species were monitored with attention to potential pests in several localities, mainly in the Kurzeme and Zemgale region, as well as in one park in Vidzeme region (Sigulda), from July to September, 2019. The visited localities are listed in Table 1.

Results

Among the monitored walnut species, leaf damage made by pests was found only on *J. regia* plants, not on the other *Juglans* species inspected. In some cases, only leaves damaged by insects were found, but it was impossible to determine the source of damage, as no adults or larvae were found.

All identified and confirmed arthropod species were found only on *J. regia*. These all were species found in Latvia for the first time: walnut leaf erineum mite (*Aceria erinea*), small walnut aphid (*Chromaphis juglandicola*) and large walnut aphid (*Panaphis juglandis*). More detailed information on the *A. erinea, C. juglandicola* and *P. juglandis* records is outlined below.

Table 1. Localities visited for studies of common walnut (*Juglans regia*) pests

Locality	Locality address and coordinates	Dates visited	Habitat	Number of observed trees
Dobele 1	Brīvības Street 46, Dobele, Dobele Municipality; N 56.626490, E 23.292699	Several times since July 1, 2019; August 5, 2019	Home garden	3
Dobele 2	Robežu Street 17, Dobele, Dobele Parish; N 56.631343, E 23.290946	August 5, 2019	Home garden	1
Dobele 3	Robežu Street 39, Dobele, Dobele Municipality; N 56.632143, E 23.293455	August 6, 2019	Home garden	1
Dobele 4	Pavasara Street, Dobele, Dobele Municipality; N 56.613979, E 23.277299	August 27, 2019	Home garden	1
Dobele 5	Kooperācijas Street, Dobele, Dobele Municipality; N 56.628672, E 23.289996	August 29, 2019	Home garden	1
Jaundubeņi 1	Jaundubeņi (Pirmie Dubeņi), Ceriņu Street, N 56.484602, E 21.179229	August 10, 2019	Home garden	1
Jaundubeņi 2	Jaundubeņi (Pirmie Dubeņi), Ziedu Street, N 56.484715, E 21.178457	September 7, 2019	Home garden	1
Jaundubeņi 3	Jaundubeņi (Pirmie Dubeņi), Ziedu Street, N 56.484528, E 21.178516	August 10, 2019; September 7, 2019	Home garden	1
Jelgava	Pasta Street, Jelgava, N 56.644197, E 23.728134	August 3, 2019	Park-like greenery	1
Krimūnas	Krimūnas, Krimūnu Parish, Dobeles Municipality, N 56.569461, E 23.378092	August 12, 2019	City park	1
Liepāja 1	Vaļņu Street, Liepāja, N 56.496988, E 21.009371	July 21, 2019; August 11, 2019; August 24, 2019	Home garden	1
Liepāja 2	Kārļa Zāles Street, Liepāja, N 56.511522, E 21.016366	August 24, 2019	Park-like greenery	2
Miltiņi	"Dailes", Miltiņi, Dobeles Municipality, N 56.632574, E 23.342410	August 13, 2019	Home garden	1
Rīga	Botanic Gardens, University of Latvia, Rīga, N 56.948874, E 24.058321	August 13, 2019	Plant collection	5
Sigulda	Spieķu Park, Sigulda, Sigulda Municipality, N 57.161770, E 24.849553	August 14, 2019	City park	6
Ventspils	Ventspils, several home gardens at localities Kurpniekciems, Gāliņciems, Zāžciems, coordinates not registered	July 16 to 18, 2019	Home gardens	5
Zaļenieki	Zaļenieki, Zaļenieku Parish, Jelgavas Municipality, N 56.521143, E 23.519014	August 12, 2019	Private plant nursery park	1

Table 2. Summarised information on records of new arthropods associated with common walnut (*Juglans regia*)

Locality	Number of inspected trees	Number of trees infested with mites and aphids		
		Aceria erinea	*Chromaphis juglandicola*	*Panaphis juglandis*
Dobele 1	3	3	–	2
Dobele 2	1	–	–	1
Dobele 3	1	–	–	1
Dobele 4	1	–	–	1
Dobele 5	1	–	–	1
Jaundubeņi 1	1	1	1	–
Jaundubeņi 2	1	–	–	1
Jaundubeņi 3	1	1	–	1
Jelgava	1	1	–	1
Krimūnas	1	1	–	1
Liepāja 1	1	1	1	1
Liepāja 2	2	2	–	2
Miltiņi	1	–	1	–
Rīga	5	4	–	1
Sigulda	6	–	–	4
Ventspils	5	5	not searched	not searched
Zaļenieki	1	–	–	1

Aceria erinea *(Nalepa, 1891) [Acari: Eriophyidae] – walnut leaf erineum mite*

The species was found in almost all inspected localities (Table 2). For the first time, typical leaf galls (Figure 1) induced by *A. erinea* were found on one *J. regia* tree in August 2018 (in Jelgava), where mites were repeatedly found on the same plant in 2019. In 2019, *A. erinea* was confirmed in the following localities: Dobele 1 – on all trees, but the number of galls on leaves differed among trees, from a few galls on one tree to numerous on others (Fig. 2); Jaundubeņi; Jelgava – number of galls on leaves (Fig. 1) in 2019 was noticeably lower than in 2018; Krimūnas; Liepāja 1; Liepāja 2; Rīga and Ventspils – on all trees inspected.

If galls were numerous, then sometimes damaged leaflets became twisted, especially at locality Dobele 1.

Chromaphis juglandicola *(Kaltenbach, 1843) [Aphididae] – small walnut aphid*

This aphid species was found for the first time on one *J. regia* tree in the Liepāja 1 locality. Later the species was confirmed in two other localities: Jaundubeņi 1 and Miltiņi. In the Miltiņi site on two leaves collected by Edīte Kaufmane, one nymph and six mummies with parasitoids were found. Aphid mummies parasited by parasitoids were found also at locality Liepāja 1. Aphids always fed on the underside of *J. regia* leaves. At locality Liepāja 1, late in the growing season, this species was found together with *P. juglandis*, when colonies of *C. juglandicola* had decreased, and *P. juglandis* had established initial colonies (August 24, 2019) on leaves without *C. juglandicola*.

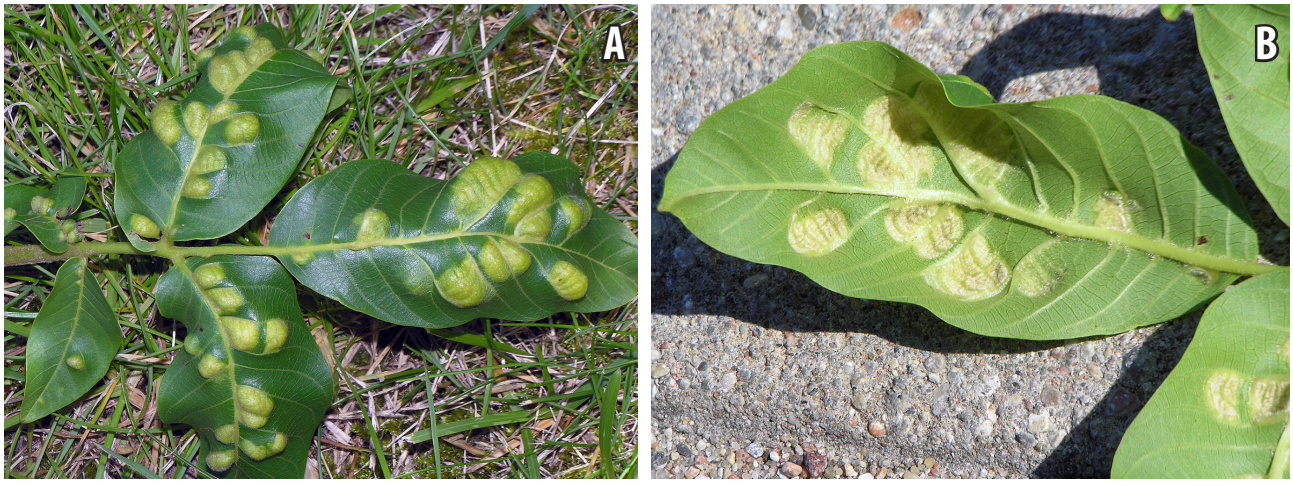

Fig. 1. *Juglans regia* leaf with galls induced by *Aceria erinea* (Ventspils, 18 July 2019). A, leaf with galls from upper side; B, leaf with galls from under side. Photo: Arturs Stalažs.

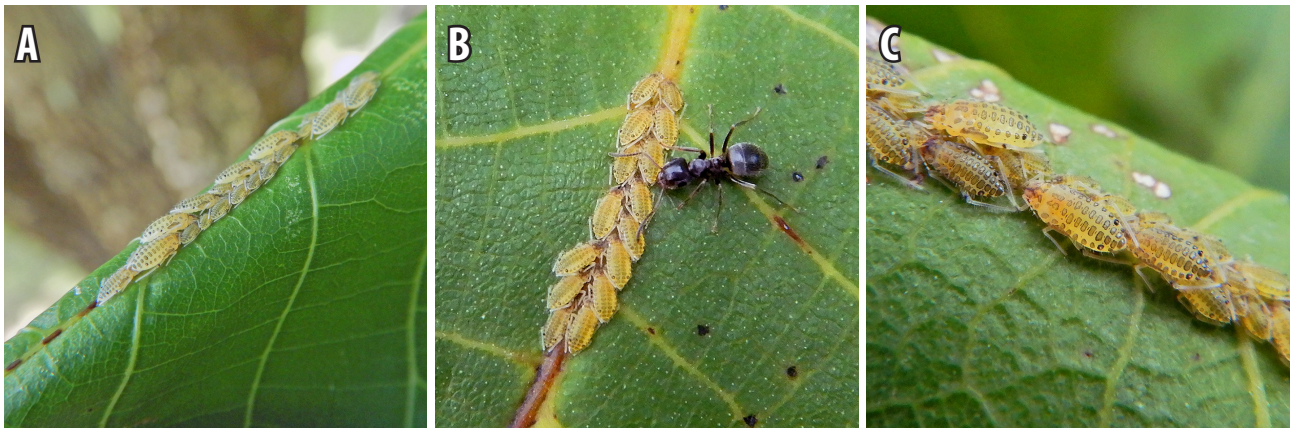

Fig. 2. *Panaphis juglandis* colonies on *Juglans regia* (Sigulda, 14 August 2019). A, an overview of colony; B, *P. juglandis* colony attended by ants; C, *P. juglandis* colony attacked by *Chrysopa* sp. larvae. Photo: Andrejs Svilāns.

Panaphis juglandis *(Goeze, 1778) [Aphididae] – large walnut aphid*

It seems that *P. juglandis* is a relatively common species. In most of the localities mainly young colonies of aphids were found, and in two localities ("Dobele 1" and "Liepāja 1") the species was not found earlier in the season, but was found during repeated inspections in August. In one locality ("Liepāja 1") *P. juglandis* was found together with *C. juglandicola* on the same *J. regia* tree. When colonies of *P. juglandis* occurred on this tree (August 24, 2019), the *C. juglandicola* colonies were scarce and later the species occurred in small numbers in comparison with high density of colonies observed earlier in the season (July 21, 2019). Colonies of *P. juglandis* frequently were attended by ants. Aphids always fed on the upper side of *J. regia* leaves, and always were in double lines along the main vein. *P. juglandis* was found in the following localities: Dobele 1; Dobele 2; Dobele 3; Dobele 4; Dobele 5; Jaundubeņi 2; Jaundubeņi 3; Jelgava; Krimūnas; Liepāja 1, Liepāja 2; Rīga; Sigulda and Zaļenieki. At locality Liepāja 2, on one tree in aphid colonies, two ladybird larvae was collected and reared, which were later identified as *Adalia bipunctata*. Findings of *P. juglandis* in Sigulda is the most northern locality where the species was found in Latvia.

Numerous newly established colonies of *P. juglandis* were observed in August and September, both on trees where the species was found during previous inspections and on trees where *P. juglandis* was not found early in the season.

Discussion

All three arthropod species identified and confirmed in this study were new for Latvia, as never been reported in Latvia previously (Rupais 1989; Stalažs, Turka 2019). This study showed that *P. juglandis* is a relatively common species, with the widest range reaching its northernmost distribution in Sigulda. The aphid species *C. juglandicola* seemed to be with quite limited in distribution and was found only in the south-western part of Latvia. Probably, *C. juglandicola* is not able to spread widely in conditions of Latvia. *P. juglandis*, like the ecologically related species *Appendiseta robiniae* un *Phyllaphis fagi*, can produce more than five generations per season (Borowiak-Sobkowiak, Durak 2012), and *P. juglandis* males give birth to young aphids already after 14 to 17 days (Wani, Tariq Ahmad 2014). Certainly these adaptations are associated with better dispersal ability of the species. In Poland, *P. juglandis* population dynamics vary throughout the growing season, and depend on climatic conditions in the particular year (Karczmarz 2012). Populations with relatively high number of individuals can be found late in the season during August and September.

Usually *C. juglandicola* and *P. juglandis* do not occur together, and this can be explained by honeydew secreted by *C. juglandicola* (Alford 2007). A similar observation was reported by Gull et al. (2019). When individuals of *C. juglandicola* and *P. juglandis* occur on the same individual tree, they never can be found on the same leaf (Gull et al. (2019). Each aphid species feeds on different sides of leaves, with *C. juglandicola* always feeding only on the lower side (Flint 2003; Fremlin 2016). *P. juglandis* feeds on the upper side of leaves, usually in double rows along the midrib (Alford 2007; Fremlin 2016), as observed in the present study. As *J. regia* is a rarely planted species in Latvia (Mauriņš, Zvirzgds 2006; Laiviņš et al. 2009), then for these two aphid species there is no wide opportunity to select particular trees, and aphids are forced to feed on the same trees; both monophagous species are associated with *J. regia* only. In this study noticeable honeydew production by *C. juglandicola* was observed in locality "Liepāja 1", when aphids were observed on 21 July. However, on 24 August, when newly established colonies of *P. juglandis* was noticed, *C. juglandicola* colonies were very weak in comparison with the situation one month earlier. That explains possibility of *P. juglandis* individuals to colonise particular tree. In this part of Europe it has been observed that the main

activity of *C. juglandicola* occurs during the first part of the season, mainly in May and June (Karczmarz 2010), but the activity can also differ during a growing seasons, with high individual density usually in July (Jaśkiewicz, Kmieć 2007). Therefore, decline of population density is common during the second part of the season. Although we observed only one case when both aphid species were on the same tree, it can be expected that in the future *C. juglandicola* and *P. juglandis* probably will often occur on the same trees due to deficiency of host plant species in Latvia. This assumption is based on the fact that the only known host plant, *J. regia* (Magnussen, Hansen 2014), in Latvia occurs in small numbers. Although *P. juglandis* accidentally has been documented also on other *Juglans* species (as reviewed by Juronis, Rakauskas 2004), there is no doubt that these reports demonstrate only rather exceptional cases but not normal behaviour of this species. This has been confirmed also in the present study, as no *C. juglandicola* or *P. juglandis* where found on other *Juglans* species inspected. Recently the same was found in Norway (Magnussen, Hansen 2014). However, in Korea *C. juglandicola* has been found also on other *Juglans* species, e. g. *J. mandshurica* and *J. sinensis* (Lee et al. 2018).

Presently, *C. juglandicola* and *P. juglandis* have Eurasian distribution, and both species were introduced in North America (Sluss 1967; Alford 2007; Andersen, Mills 2017; Wieczorek et al. 2019). *C. juglandicola* has also been introduced in Africa (Algeria, Canary Islands and Tunisia) and South America (Argentina and Chile) (Salas et al. 2016; CABI 2017). It seems that *C. juglandicola* is a highly economically important species, especially on young trees and nursery stock (Alford 2007; Gull et al. 2019). In the past, a specific parasitic wasp was introduced in California for control of *C. juglandicola* (van Den Bosch et al. 1979). Since introduction of this parasitic wasp species, *C. juglandicola* is no longer a major pest of *J. regia* in this region (Flint 2003). Recent findings of both aphid species in new territories in Europe (Magnussen, Hansen 2014) and in other parts of the World (Salas et al. 2016; Lee et al. 2018) indicate that these aphids will continue their spread worldwide.

Movement of *C. juglandicola* and *P. juglandis* to northernly locations in Europe and appearance of both species in Latvia was predictable. Recently expansion of the species was recorded in Scandinavia, when both aphids were found in Norway (Magnussen, Hansen 2014). One of these aphid species, *P. juglandis*, was previously reported from Lithuania (Juronis, Rakauskas 2004). The northernmost finding of *P. juglandis* in this part of Europe now has moved to Latvia, since the aphid was found also in Sigulda. In contrast to *P. juglandis*, the northernmost occurrence of *C. juglandicola* in this part of Europe was previously considered to be Poland (Krzyżanowski 2017). As previously reported (Alford 2007; Fremlin 2016), we observed that *P. juglandis* populations were frequently attended by ants.

Similarly to aphids, also *A. erinea* originates from Asia and has a large worldwide distribution in areas where *J. regi*a is cultivated (Chireceanu et al. 2015). Nowadays this eriophyoid mite species is present in Australia, Eurasia, North America and New Zealand (Boczek 1964; Skoracka et al. 2005; Alford 2007; Chireceanu et al. 2015). The two *Aceria* species, *A. erinea* and *A. tristirata* sometimes have been synonymised (Boczek 1964). These two species induce specific leaf-galls on *J. regia*, and the shape of induced galls is well distinguishable for each mite species (Skoracka et al. 2005; Alford 2007; Chireceanu et al. 2015). *A. erinea* produces large felty masses of erineum on the underside of leaves (Skoracka et al. 2005) and usually there are several galls per leaf (Alford 2007), but *A. tristirata* induces a large number of small galls up to 2 mm diameter, which usually are placed among mid and other veins, where mites live in intracellural spaces of mesophyll (Skoracka et al. 2005; Alford 2007; Chireceanu et al. 2015). *A. erinea* do not cause economically important damage (van Steenwyk, Barnett 1998; Flint 2003; Alford 2007). The nearest previous finding of *A. erinea* was in Poland (Skoracka et al. 2005), but in August 2019 heavy infested trees were also observed in Klaipēda, Lithuania (A. Svilāns, unpublished data).

Results of this study demonstrate that alien species in Europe have continued to spread in the northern direction, especially narrowly specialised ones, like these three monophagous arthropod species. There are two possible reasons for this: warming as a result of climate change or human activity due to transfer of planting material. It is highly predictable that several other narrowly specialised monophagous or oligophagous species will reach the territory of Latvia in the nearest future.

Acknowledgements

Thanks to Edīte Kaufmane (Institute of Horticulture) for *J. regia* leaf samples with aphids collected in Miltiņi village, and to Vija Bārdiņa (National Library of Latvia) for providing the older literature.

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Received 29 October 2019; received in revised form 20 December 2019; accepted 10 March 2020