**Orchard aphids (Hemiptera: Sternorrhyncha, Aphidoidea)
of Lithuania: a century of research***

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ABSTRACT. The current state of knowledge on the composition of aphid species inhabiting horticultural crops in Lithuania is summarized, with notes on their taxonomy and the biological peculiarities of Lithuanian populations of particular species.

KEY WORDS: aphids, orchard pests, fauna, biology, Lithuania.

INTRODUCTION

The first data concerning the aphid species inhabiting horticultural crops in Lithuania appeared at the beginning of the last century (KRIŠČIŪNAS 1913, TRZEBIŃSKI 1916; for more references of that period see RAKAUSKAS et al. 1992). Results of special studies of horticultural pests, including some aphid species, were also published (MASTAUSKIS & VILKAITIS 1929, OGJEWICZ 1929, 1931). More detailed faunistic studies of dendrophilous aphids (including horticultural ones) were started in the second half of the 20th century (RUPAIS 1966, 1971, RUPAIS & JURONIS 1983a, 1983b, VENGELIAUSKAITĖ 1962, RAKAUSKAS 1978, 1980, 1981). In addition, data on host specificity, life cycles and natural enemies of Lithuanian populations of certain horticultural pest aphid species were also reported (RAKAUSKAS 1983a, 1983b, 1984, 1986, 1993, 1996, RAKAUSKAS & RUPAIS

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1983, RAKAUSKAS & ZAJANČKAUSKAS 1983, RAKAUSKAS & TURČINAVIČIENĖ 1998, TURČINAVIČIENĖ 2000, BAŠILOVA 2006). Later on, although closer attention was now being paid to taxonomic and phylogenetic studies (RAKAUSKAS 1998, 1999, 2000a, 2000b, 2003a, 2003b, 2003c, 2006, TURČINAVIČIENĖ et al. 1997, 1999, RAKAUSKAS & CICHOCKA 2005, RAKAUSKAS & TURČINAVIČIENĖ 2006, TURČINAVIČIENĖ et al. 2006, BAŠILOVA et al. 2008, 2012, TURČINAVIČIENĖ & RAKAUSKAS 2009, BAŠILOVA 2010a, BAŠILOVA 2010b, BAŠILOVA & RAKAUSKAS 2007, 2012a, 2012b, RAKAUSKAS et al. 2011, 2013, 2014a, 2014b), faunistic studies were continuing (for a broader account of faunistic references, see RAKAUSKAS 2011, 2014). At the beginning of the 21st century alien and invasive aphid species in Lithuania were studied (RAKAUSKAS 2004, 2011, BAŠILOVA & RAKAUSKAS 2012c, BAŠILOVA et al. 2012, RAKAUSKAS et al. 2015a). In all, 58 aphid species feeding on horticultural crops have been reported from Lithuania, 18 of which constitute a real threat to horticulture in the country and have been subject to detailed morphological, taxonomical, life cycle and host specificity studies.

The present report aims to summarize the current state of knowledge on the composition of aphid species inhabiting horticultural crops in Lithuania, their taxonomy and the biological peculiarities of Lithuanian populations of particular species.

RESULTS AND DISCUSSION

At present, 58 aphid species are reported as inhabiting horticultural crops in Lithuania (Table 1). Eleven of these species are associated with stone fruit crops (Prunoideae), 19 with pome fruit crops (Pyroideae), 6 with host plant species of the genus *Rubus* LINNAEUS, 1753, 15 with *Ribes* LINNAEUS, 1753 and 8 with *Rosa* LINNAEUS, 1753. A short review on the available information relating to the morphological features, biology and ecology of Lithuanian populations of orchard aphid species now follows. Particular emphasis is placed on characteristics that differing from what is commonly known about these species (BLACKMAN & EASTOP 2000).

Table 1. Taxonomic composition and incidence of aphid species on horticultural crops in Lithuania (the most common species are given in bold). A – Prunoidea, B – Pyroideae, C – *Rubus*, D – *Ribes*, E – *Rosa*.

No	Aphid species	A	B	C	D	E
1.	<i>Amphorophora idaei</i> (BÖRNER, 1939)			+		
2.	<i>A. rubi</i> (KALTENBACH, 1843)			+		
3.	<i>Anuraphis catonii</i> HILLE RIS LAMBERS, 1935		+			
4.	<i>A. farfarae</i> (KOCH, 1854)		+			

Table 1. Continued.

No	Aphid species	A	B	C	D	E
5.	<i>Anuraphis subterranea</i> (WALKER, 1849)		+			
6.	<i>Aphis craccivora</i> KOCH, 1854		+			
7.	<i>A. grossulariae</i> KALTENBACH, 1843				+	
8.	<i>A. idaei</i> VAN DER GOOT, 1912			+		
9.	<i>A. pomi</i> DE GEER, 1773		+			
10.	<i>A. ruborum</i> (BÖRNER, 1932)			+		
11.	<i>A. schneideri</i> (BÖRNER, 1940)				+	
12.	<i>A. triglochynis</i> (THEOBALD, 1936)				+	
13.	<i>A. spiraeicola</i> PATCH, 1914	+	+			
14.	<i>Brachycaudus cardui</i> (LINNAEUS, 1758)	+				
15.	<i>B. divaricatae</i> SHAPOSHNIKOV, 1956	+				
16.	<i>B. helichrysi</i> (KALTENBACH, 1843)	+				
17.	<i>Chaetosiphon tetrarhodum</i> (WALKER, 1849)					+
18.	<i>Cryptomyzus galeopsidis</i> (KALTENBACH, 1843)				+	
19.	<i>C. korschelti</i> BÖRNER, 1938				+	
20.	<i>C. maudamanti</i> GULDEMOND 1990				+	
21.	<i>C. ribis</i> (LINNAEUS, 1758)				+	
22.	<i>Dysaphis affinis</i> (MORDVILKO, 1928)		+			
23.	<i>D. anthrisci</i> BÖRNER, 1950		+			
24.	<i>D. brancoi</i> BÖRNER, 1950		+			
25.	<i>D. crataegi</i> (KALTENBACH, 1843)		+			
26.	<i>D. devector</i> (WALKER, 1849)		+			
27.	<i>D. plantaginea</i> (PASSERINI, 1860)		+			
28.	<i>D. pyri</i> (BOYER DE FONSCOLOMBE, 1841)		+			
29.	<i>D. sorbi</i> (KALTENBACH, 1843)		+			
30.	<i>Eriosoma grossulariae</i> (SCHÜLE, 1887)				+	
31.	<i>E. lanigerum</i> (HAUSSMAN, 1802)		+			
32.	<i>E. lanuginosum</i> (HARTIG, 1839)		+			
33.	<i>E. ulmi</i> (LINNAEUS, 1758)				+	
34.	<i>Hyalopterus pruni</i> (GEOFFROY, 1762)	+				
35.	<i>Hyperomyzus lactucae</i> (LINNAEUS, 1758)				+	
36.	<i>H. pallidus</i> HILLE RIS LAMBERS, 1935				+	
37.	<i>H. picridis</i> (BÖRNER & BLUNCK, 1916)				+	
38.	<i>H. rhinanthi</i> (SCHOUTEDEN, 1903)				+	
39.	<i>Longicaudus trirhodus</i> (WALKER, 1849)					+
40.	<i>Macrosiphum euphorbiae</i> (THOMAS, 1878)					+
41.	<i>M. funestum</i> (MACCHIATI, 1885)			+		
42.	<i>M. rosae</i> (LINNAEUS, 1758)					+
43.	<i>Maculolachnus submacula</i> (WALKER, 1848)					+
44.	<i>Melanaphis pyrararia</i> (PASSERINI, 1861)		+			
45.	<i>Metopolophium dirhodum</i> (WALKER, 1849)					+
46.	<i>Myzaphis bucktoni</i> JACOB, 1946					+

Table 1. Continued.

No	Aphid species	A	B	C	D	E
47.	<i>Myzaphis rosarum</i> (KALTENBACH, 1843)					+
48.	<i>Myzus cerasi</i> (FABRICIUS, 1775)	+				
49.	<i>M. lythri</i> (SCHRANK, 1801)	+				
50.	<i>M. persicae</i> (SULZER, 1776)	+				
51.	<i>Nasonovia ribisnigri</i> (MOSLEY, 1841)				+	
52.	<i>Ovatus insitus</i> (WALKER, 1849)		+			
53.	<i>Phorodon humuli</i> (SCHRANK, 1801)	+				
54.	<i>Rhopalosiphoninus ribesinus</i> (VAN DER GOOT, 1912)				+	
55.	<i>Rhopalosiphum insertum</i> (WALKER, 1849)		+			
56.	<i>R. nymphaeae</i> (LINNAEUS, 1761)	+				
57.	<i>R. padi</i> (LINNAEUS, 1758)	+				
58.	<i>Sitobion fragariae</i> (WALKER, 1848)			+		

Eight aphid species have been reported inhabiting plum trees in Lithuania: *Hyalopterus pruni*, *Phorodon humuli*, *Brachycaudus cardui*, *B. divaricatae*, *B. helichrysi*, *Rhopalosiphum nymphaeae*, *R. padi* and *Aphis spiraeicola*. The most common aphid species inhabiting plums during the last four decades were *Hyalopterus pruni*, *Brachycaudus divaricatae*, *Phorodon humuli* and *Brachycaudus cardui* (RAKAUSKAS 1978, 1980, 1983a, RAKAUSKAS et al. 2015b).

Hyalopterus pruni is the only representative of the genus *Hyalopterus* KOCH, 1854 that is present in Lithuania and the entire eastern Baltic region. The morphological features, biology and ecology of Lithuanian populations of *H. pruni* have been the subject of detailed studies. These populations of *H. pruni* are reported as being capable of living on plums throughout the season, including the production of oviparous females on winter hosts; males appear on secondary hosts (*Phragmites* ADANSON, 1763) only, however (RAKAUSKAS 1983a, 1983b, ZAREMBA 2012). Partial mitochondrial *COI* gene sequences did not reveal any specificity of Lithuanian populations of *H. pruni* when compared to those from other regions of Europe (RAKAUSKAS et al. 2013). *Brachycaudus cardui* is the most common native aphid species of the genus *Brachycaudus* VAN DER GOOT, 1913 inhabiting plums in Lithuania. The biology and ecology of this country's populations of *B. cardui* have been studied by RAKAUSKAS (1983a). From 2002 onwards, the alien species *B. divaricatae* appeared to be the most common one on cherry plums in Lithuania and the entire eastern Baltic region (RAKAUSKAS & CICHOCKA 2005). A distinctive feature of the Lithuanian populations of *B. divaricatae* is that they are monoecious holocyclic on cherry plums, avoiding migration to the principal summer host plant of this aphid species, *Silene alba* (MILLER, 1768) (RAKAUSKAS & TURČINAVIČIENĖ 2006). On the molecular level, these

populations of *B. divaricatae* appeared to be extremely monomorphic in their partial sequences of mitochondrial *COI* and nuclear *EF-1 α* genes (BAŠILOVA et al. 2012). The most recent studies have revealed that, despite population outbreaks, *B. divaricatae* did not have any distinct negative effect on the plum aphid guild structure in Lithuania (RAKAUSKAS et al. 2015b). This is partially explainable by the ability of the local ladybird species to prey on *B. divaricatae* (DANILOV & RAKAUSKAS unpublished). Life cycle studies of *Phorodon humuli* in Lithuania showed that this species was capable of living on plums during the entire season, including the production of oviparous females on winter hosts, with males appearing on secondary hosts (*Humulus* LINNAEUS, 1753) only (RAKAUSKAS 1983a). Nonetheless, recent studies have shown *P. humuli* to be extremely rare on plums in Lithuania after the end of June in 2012-2014. This is not explainable by migration to summer hosts, because in the same years *P. humuli* was also rare on its summer hosts in summer (RAKAUSKAS unpublished).

Four aphid species have been reported inhabiting species of the genus *Cerasus* MILLER, 1754 in Lithuania: *Myzus cerasi*, *M. lythri*, *M. persicae* and *Brachycaudus divaricatae*. The most common aphid species inhabiting cherries in Lithuania during the last four decades has been *Myzus cerasi*. Mahaleb cherry serves as a host for *M. lythri*, but no outbreaks of this aphid species have been recorded in this country as yet. *Brachycaudus divaricatae* and *Myzus persicae* are assumed to be occasional species, extremely rare on *Cerasus* spp. in Lithuania. Available morphological, ecological and molecular (partial mitochondrial *COI* gene sequences) data suggest the existence of two host-specific subspecies of *M. cerasi* in Lithuania (RAKAUSKAS 1984, RAKAUSKAS et al. 2014a). The country's populations of *M. cerasi* appeared capable of living on cherries throughout the season, including the production of oviparous females on winter hosts; the males emerge on secondary hosts only (RAKAUSKAS 1984).

Ten aphid species have been reported as inhabiting apple trees in Lithuania: *Aphis pomi*, *A. spiraecola*, *Dysaphis affinis*, *D. anthrisci*, *D. brancoi*, *D. devecta*, *D. plantaginea*, *Eriosoma lanigerum*, *Rhopalosiphum insertum* and *Ovatus insitus*. The most common aphid species inhabiting apple trees in Lithuania during the last four decades have been *Aphis pomi*, *Dysaphis plantaginea* and *Rhopalosiphum insertum* (RAKAUSKAS 1978, 1980, RAUDONIS et al. 2009). Detailed studies of Lithuanian populations of *Aphis pomi* (RAKAUSKAS & RUPAIS 1983) showed their biological and ecological characters to be similar to those summarized by BLACKMAN & EASTOP (2000). On the molecular level, sampled Lithuanian populations appeared identical in their partial nuclear *EF-1 α* gene sequences: most of the samples had the predominant European haplotype of the mitochondrial *COI* gene (RAKAUSKAS et al. 2015a). Molecular data also confirmed the existence of *A. spiraecola* in Lithuania. Most of the Lithuanian samples of this species had the common and widely distributed (Europe, Turkey, China) haplotypes of the

mitochondrial *COI* and nuclear *EF-1 α* genes. The length of the ultimate rostral segment appeared to be the most reliable morphological character for discriminating between *A. pomi* and *A. spiraecola* in Lithuania, enabling 100% correct identification of the former ($n = 143$) and 91.5% of the latter ($n = 94$) species in the samples used for the molecular analysis (RAKAUSKAS et al. 2015a). The coexistence between these two *Aphis* LINNAEUS, 1758 species is challenging for pest aphid management practice, because both species are similar in their morphology but differ in their ecological features and resistance to pesticides. Therefore, competitive displacement of *A. pomi* by *A. spiraecola* is reported as mediated by human activities in North America (SMIRLE et al. 2010). The life cycle and host specificity of the Lithuanian populations of *Dysaphis plantaginea* appeared to be similar to those described by BLACKMAN & EASTOP (2000). This species can thrive on apple till the end of the season in Lithuania, but gynoparous females and males emerge on summer hosts only. Experimental transfers showed *Plantago lanceolata* LINNAEUS, 1753 to be the preferred summer host of *D. plantaginea* in Lithuania (RAKAUSKAS 1983a). The life cycle and host specificity of Lithuanian populations of *Rhopalosiphum insertum* appeared similar to those described by BLACKMAN & EASTOP (2000). This species is the first of the apple aphids to hatch from overwintering eggs in Lithuania and also the first one to emigrate completely from apple to summer hosts (RAKAUSKAS 1983a). *Dysaphis anthrisci*, *D. brancoi*, *D. devector*, and *Ovatus insitus* are currently uncommon on apple trees in Lithuania. *Eriosoma lanigerum* was reported as an accidental species introduced with plant material to Lithuania (ITOMLENSKIS & BAGDONAS 1936), but there is no information on stable local populations of this species in this country at present. *Dysaphis affinis* is reported to be monoecious on *Malus* spp. in Asia (west Siberia, Turkey, Armenia, Georgia, Kazakhstan, Tajikistan, Pakistan, north-west China) (BLACKMAN & EASTOP 2000). Our data show that this species is rather common on wild apple seedlings living in red leaf galls in Lithuania (RAKAUSKAS 1983a, also more recent unpublished data).

Nine aphid species have been reported inhabiting pear trees in Lithuania: *Anuraphis catonii*, *A. farfarae*, *A. subterranea*, *Aphis craccivora*, *A. pomi*, *Dysaphis pyri*, *Eriosoma lanuginosum*, *Rhopalosiphum insertum* and *Melanaphis pyraria*. The most common aphid species inhabiting pear trees in Lithuania during the last four decades have been *Anuraphis farfarae*, *Aphis pomi* and *Dysaphis pyri* (RAKAUSKAS 1978, 1980, 2004). *Anuraphis farfarae* is present on pear trees early in the season, completing its emigration to summer hosts by the middle of June (RAKAUSKAS 1983a). *Dysaphis pyri* was reported to have population outbreaks on pear trees in Lithuania (RAKAUSKAS 2004, also more recent unpublished data), but at present there is no evidence for permanently established populations of this species in the country. The other species of those mentioned above are rare on pear trees in Lithuania, whilst *Aphis craccivora* should be regarded as an accidental one. *Eriosoma lanuginosum* has been found on the roots of pear tree in Lithuania only once

(RAKAUSKAS 1983); earlier records (just four altogether) concern its secondary host, *Ulmus* spp. (MOVŠOVIČIUS 1941, RUPAIS 1966, RUPAIS & JURONIS 1983a).

Sixteen aphid species have been reported inhabiting *Ribes* spp. in Lithuania: *Aphis grossulariae*, *A. schneideri*, *A. triglochinis*, *Cryptomyzus galeopsidis*, *C. korschelti*, *C. maudamanti*, *C. ribis*, *Eriosoma grossulariae*, *E. ulmi*, *Hyperomyzus lactucae*, *H. pallidus*, *H. picridis*, *H. rhinanthi*, *Nasonovia ribisnigri* and *Rhopalosiphoninus ribesinus*. The most common aphid species inhabiting currants and gooseberries during the last four decades were *Aphis grossulariae*, *A. schneideri*, *Cryptomyzus ribis*, *Eriosoma ulmi* and *Hyperomyzus lactucae* (RAKAUSKAS 1983, BAŠILOVA 2006, 2010a). Species of the genus *Aphis* have been the subject of detailed morphological, taxonomic, life cycle and host specificity studies (RAKAUSKAS 1983a, 1993, 2000, 2003a, TURČINAVIČIENĖ 2000, 2004, RAKAUSKAS et al. 2011). Contrary to common knowledge (BLACKMAN & EASTOP 2000), Lithuanian populations of *A. grossulariae* are associated mostly with the winter host plants of the *Ribesia* section in the *Ribesia* JANCZEWSKI, 1907 subgenus of the genus *Ribes* (redcurrants and related species) and are facultatively heteroecious (capable of completing their entire life cycle on currants). The possibility of hybridization between *A. grossulariae* and *A. schneideri* in Lithuania and Poland has been demonstrated by experimental hybridization experiments (RAKAUSKAS 1999, 2003a, TURČINAVIČIENĖ 2000). Obligatively and facultatively heteroecious lineages were reported in Lithuanian populations of *Cryptomyzus ribis*, the latter ones producing both winged and apterous males (RAKAUSKAS 1986, BAŠILOVA 2010b). Winged fundatrigeniae of facultatively heteroecious lineages of *C. ribis* are only capable of feeding on summer host plants, whilst apterous fundatrigeniae continue their life cycle on currants. Winged fundatrigeniae of facultatively heteroecious lineages of *C. galeopsidis* are capable of feeding on both currants and summer host plants (BAŠILOVA 2010b). Molecular phylogenetic studies of the genus *Cryptomyzus* OESTLUND, 1922 showed that the partial sequences of mitochondrial *COI* gene were of little discriminative value for separating the closely related species of *C. galeopsidis-maudamanti* and *C. korschelti-ribis* complexes when compared with partial sequences of the nuclear *EF-1a* gene (BAŠILOVA 2010b).

Six aphid species have been reported inhabiting *Rubus* spp. in Lithuania: *Amphorophora idaei*, *A. rubi*, *Aphis idaei*, *A. ruborum*, *Macrosiphum funestum* and *Sitobion fragariae*. The most common aphid species inhabiting *Rubus* spp. in Lithuania during the last four decades was *Aphis idaei* (RAKAUSKAS 1983a). Rearing experiments showed the existence of virgino-sexuparous females (producing viviparous and oviparous females, also males) in the country's populations of *A. idaei*.

Seven aphid species have been reported inhabiting *Rosa* spp. in Lithuania: *Chaetosiphon tetraerhodum*, *Longicaudus trirhodus*, *Macrosiphum rosae*, *M. euphorbiae*, *Maculolachnus submacula*, *Metopolophium dirhodum*, *Myzaphis bucktoni* and *M. rosarum*.

The most common aphid species inhabiting *Rosa* spp. in Lithuania during the last four decades was *Macrosiphum rosae* (RAKAUSKAS 1983a, RAKAUSKAS & ZAJANČKAUSKAS 1983, RAKAUSKAS unpublished). This species lives on wild and cultivated roses throughout the season, and is capable of completing its entire cycle by producing sexual morphs on these plants. In Lithuania the possible summer host plant of *M. rosae*, *Knautia arvensis* (LINNAEUS, 1753) COULTER, 1823, is mostly inhabited by another closely related species, *M. knautiae* HOLMAN, 1972 (RAKAUSKAS 1985, 2003a). The same holds for Belarus (BUGA et al. 2012). Molecular phylogenetic studies of the *M. rosae* species complex showed the above species to be different in their *EF1α* sequences, but nearly identical in their *COI* sequences (TURČINAVIČIENĖ & RAKAUSKAS 2009).

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