Establishment of the New Alien Pest Woolly Ash Aphid, *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1979), in European Russia

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Abstract

Woolly ash aphid *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1979) is a pest of ash native to North America. After its first record in Europe in 2003 in Hungary it has spread to Ukraine (first record in 2005), Serbia (2006), Bulgaria (2007), Great Britain (2011), Spain (2011), Poland (2012) and Germany (2015). In 2016 *P.(M.) fraxinifolii* was recorded at the southwestern border of Russia. Here we report the establishment of *P.(M.) fraxinifolii* in the centre of European Russia, namely in Moscow, which is more than 700 km far from all other known localities of the species. In September 2017 five groups of trees (*Fraxinus pennsylvanica*) with colonies of *P. (M.) fraxinifolii* were found. This record indicates that the pest continues to spread quickly and can appear in other regions of European Russia and neighbouring countries including Baltic countries soon.

Keywords: *Prociphilus fraxinifolii*, *Fraxinus*, pest of ash, exotic species, invasive species, Russia

Introduction

Ash (*Fraxinus* spp.) comprises a significant part of urban plantations and forests in Europe and play an important role in biodiversity, since many animals, plants and fungi are connected with it (FRAXIGEN 2005). The most usual ash species are *Fraxinus pennsylvanica* Marsh. introduced from North America and *Fraxinus excelsior* L. native to Europe. Over the last two decades ashes in Europe are affected by new alien pests and pathogens: ash dieback fungus, *Hymenoscyphus fraxineus* Baral et al., 2014 (Ascomycota), emerald ash borer, *Agrilus planipennis* Fairmaire, 1888 (Coleoptera: Buprestidae) and woolly ash aphid, *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1879) (Hemiptera: Eriosomatidae) (Orlova-Bienkowskaja 2014, Gross et al. 2014, Hałaj and Osiadacz 2017). All these species were found in Europe less than 20 years ago, all are spreading quickly and causing significant damage to the trees. Here we report the new data on further spread of *P. (M.) fraxinifolii* to the east.

The genus *Prociphilus* Koch, 1856 includes about 45 species grouped into six subgenera (Blackman and Eastop 2016). Subgenus *Prociphilus* (*Meliarhizophagus*) Smith, 1974 consists of only one species – *Prociphilus* (*M.*) *fraxinifolii. Prociphilus (M.) fraxinifolii* is native to North America. It is a common pest of ash in the United States, Canada and Mexico and is introduced to Chile, South Africa, China, Iran and Europe (Hałaj and Osiadacz 2017). In 2003 it was for the first time recorded in Europe in Budapest (Hungary) on *Fraxinus pennsylvanica* (Remaudiere and Ripka 2003). Then it quickly spread to Ukraine (first record in 2005, host plant *F. pennsylvanica*) (Chumak et al. 2016), Serbia (2006, *F. pennsylvanica*) (Petrović-Obradović et al. 2007), Bulgaria (2007, *F. pennsylvanica*) (Trenchev and Trencheva 2009), Great Britain (2011) (Baker and Martin 2011), Spain (2011, *F. pennsylvanica*) (Pérez Hidalgo and Mier Durante 2012), Poland (2012, *Fraxinus excelsior, F. americana*) (Hałaj et al. 2016), and Germany (2015) (Hałaj and Osiadacz 2017). In 2016 *P. (M.) fraxinifolii* was first recorded at the border of Russia (Rostov Region, *F. pennsylvanica*) and Ukraine (Donetsk Region, *F. pennsylvanica*) (Martynov and Nikulina 2016). Here *P. (M.) fraxinifolii* is first recorded in the centre of European Russia, namely in Moscow Region, which is more than 700 km far from all other known localities of the species.

Materials and Methods

Collection of material

Fraxinus pennsylvanica introduced from North America is widely cultivated in European Russia since the

1950s. Now it makes up about 20% of the trees in urban plantations of Central Russia, in particular, in Moscow (Majorov et al. 2012). The outbreak of the emerald ash borer *Agrilus planipennis* on *F. pennsylvanica* prompted us to study the community of insects connected with this tree in European Russia. In 2013–2017 we surveyed more than 6000 trees in 40 localities in 20 regions of European Russia (Orlova-Bienkowskaja 2014, 2015, Orlova-Bienkowskaja and Volkovitsh 2014, Orlova-Bienkowskaja and Belokobylskij 2014, Orlova-Bienkowskaja and Bieńkowski 2016). Besides that, regular surveys of trees were carried out in Moscow and Zelenograd (Moscow Region) in 2013–2017. But in spite of these intensive surveys *P. (M.) fraxinifolii* was not recorded before 2017. In September 2017 about 500 trees in nine localities of Moscow (Mitino, Trikotazhnaya, Leninsky Prospect, Shchukino, Alekseevskaya, Park Pobedy, Volzhskaya, Tsaritsyno and Orekhovo) and about 1,000 trees in fifteen localities in Zelenograd (from the 1st to 12th districts) were examined. Aphids *P. (M.) fraxinifolii* were detected in six localities and placed to alcohol. Collected material is deposited in the collection of the first author (Zelenograd).

Identification

Slides of alatae and apterous females were prepared in Berlese fluid and examined under the microscope. The species was identified referring to Blackman and Eastop (2016). Details of adult apterous female and alatae female are shown in Figure 1. *Prociphilus* (*M.*) *fraxinifolii* can be distinguished from other species of the genus by the following characters. Alatae females have secondary rhinaria on antennomere 6 differing in shape from narrow transverse secondary rhinaria on antennomere 3. Antennomere 3 as long as 3× antennomere 2. Besides that, they differ from those of *P. bumeliae*, and *P. fraxini* in antennomere 5 with 4 secondary rhinaria, antennomere 6 with 2 irregular-rounded secondary rhinaria (1-5 rhinaria after Blackman and Eastop (2016)). Apterous mature females of *P. (M.) fraxinifolii* differ from morphologically close *P. (Pulvius) probosceus* in rostrum very short, with apical segment (really the 4th + 5th segments joined together) with 3 accessory hairs (2 hairs after Blackman and Eastop (2016)).

Mature and immature apterous viviparous females of *P. (M.) fraxinifolii* are pale green or pale yellow in colour. Nymphs are pale green with pale yellow thoraces. Alatae viviparous females have grey heads and thoraces and pale green abdomens. Ocelli and compound eyes (in alatae females and nymphs) are black. All morphs are covered by white wax, besides that, mature and immature apterous females bear thick curved white wax threads.

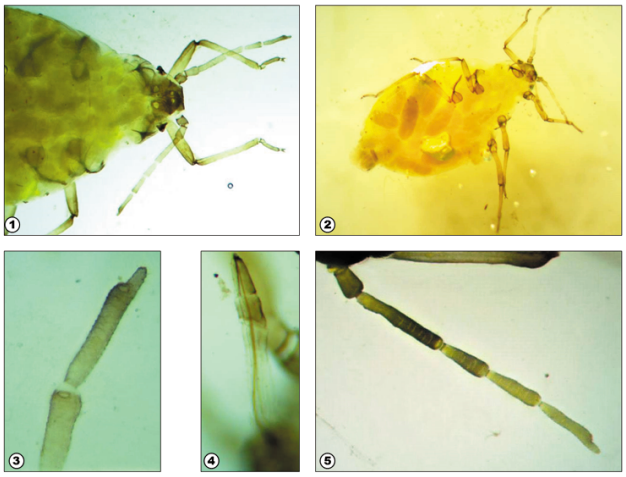

Figure 1. *Prociphilus fraxinifolii,* structural details. 1 – anterior part of the body of adult apterous female from above, 2 – apterous female with embryos from below, 3 – last antennal segment of apterous female, 4 – rostrum of apterous female, 5 – antenna of alatae female

Results

Characteristic leaf nests with colonies of *P. (M.) fraxinifolii* were detected on *F. pennsylvanica* in three localities in Moscow: Mitino (three trees), Trikotazhnaya (two trees) and Leninsky Prospect (two trees), as well as in three localities in Zelenograd: the 11th district (two trees), the 2nd district (two trees) and the 4th district (three trees). Groups of colonized trees occurred in the same plantations along the streets with the trees unaffected by the pest. All trees, where aphids were found, have emergence holes of *Agrilus planipennis,* like the most of *F. pennsylvanica* trees in Moscow Region. But the canopies of these trees were not thinned. Up to 20 leaf nests were observed on each

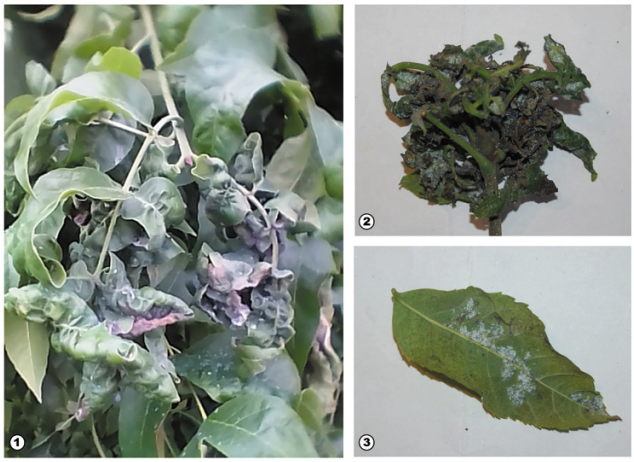

Figure 2. *Prociphilus fraxinifolii* on *Fraxinus pennsylvanica* in Moscow Region (Russia). 1,2 –Malformations or leaf nests caused by these aphids; 3 – the leaf with a colony of *P. fraxinifolii*

tree. A leaf nest is formed by a deformed shortened shoot with tightly curled leaves. It is a "nest" for aphid colony consisting of apterae and alatae viviparae (Figure 2). A colony is immersed in the thick wax produced by insects. Aphids excrete large amounts of white honeydew, which is seen on the leaves under the "nests". Since the groups of colonized trees have been detected in different localities, there is no doubt that the pest has established in the region.

Predators, in particular, ladybirds, easily penetrate to the leaf nests. It is known that the outbreak of *P. (M.) fraxinifolii* sometimes facilitates the outbreak of ladybirds (Torres-Acosta and Sịnchez-Peńa 2015). The following coccinellids have been found on *F. pennsylvanica* affected by *P. (M.) fraxinifolii* in Moscow Region: *Ądalia bipunctata* (*Linnaeus 1758*), *Psyllobora vigintiduopunctata* (Linnaeus 1758), *Exochomus quadripustulatus* (Linnaeus 1758), *Calvia decemguttata* (Linnaeus 1767) and *Halyzia sedecimguttata* (Linnaeus 1758).

Discussion

Prociphilus (M.) fraxinifolii affects both species introduced from North America *(F. pennsylvanica, F. americana*, and *F. velutina)* and *F. excelsior* native to Europe (Hałaj and Osiadacz 2017). We found *P. (M.) fraxinifolii* on *F. pennsylvanica* only, because *F. excelsior* is rare in Moscow. The opinions about the harmfulness of *P. (M.) fraxinifolii* are contradicting. Pérez Hidalgo and Mier Durante (2012) suppose that these aphids do not seem to cause any significant harm to trees. But Hałaj and Osiadacz (2017) argue that *P. (M.) fraxinifolii* can significantly damage the tree. Our observations confirm the latter point of view. First, the formation of leaf nests reduces the growth of shoots and causes their premature dieback. This has a significant negative impact, since mainly young trees are affected and up to 20 leaf nests appear on one tree. Second, the large amount of honeydew produced by *P. (M.) fraxinifolii* facilitates the development of harmful fungi. About all of the trees affected by these aphids in Moscow Region were also strongly affected by powdery mildew on the leaves.

Prociphilus (M.) fraxinifolii is spreading in Europe very quickly. The spread of *P. (M.) fraxinifolii* in the eastern part of the range has been described by Martynov and Nikulina (2016). In 2005, in only two years after the first finding in Europe in Budapest, the pest was recorded in the west of Ukraine – in Uzhgorod (Transcarpathian region). In 2012 it appeared in the centre of Ukraine: in Kyiv. Three years later it was firstly recorded in the east of the country: in Donetsk and Luhansk Regions. In summer 2016 the pest became very common in urban plantations of Donetsk and was for the first time recorded at the border of Russia and Ukraine. Now *P. (M.) fraxinifolii* is recorded much further north. The distance between Moscow and the nearest localities of *P. (M.) fraxinifolii* known before is more than 700 km. It indicates that the dispersal of the pest to the centre of European Russia was not natural, but represented an accidental introduction by human. It is not surprising that the pest was introduced just to Moscow. It is the largest city of Europe, the main transport hub of Russia, and therefore the main centre of insect invasions. Alien insects are often introduced to this city and after the establishment quickly spread to other regions (Orlova-Bienkowskaja 2017).

It seems that *P. (M.) fraxinifolii* appeared in the centre of European Russia just recently, because it was not found in 2013–2016 in spite of our intensive surveys of ashes in different regions, especially in Moscow Region. The characteristic leaf nests are easy to notice, but they were not found until the autumn 2017. Now the pest has not yet become very abundant in Moscow Region. Only some individual foci (small groups of trees affected by the pest) are found in Moscow Region. Only about 1% of surveyed trees are affected by the pest. But it is quite possible that the strong outbreak will happen for the foreseeable future as it was observed before in Donetsk (Martynov and Nikulina 2016). In the period ahead, *P. (M.) fraxinifolii* can spread to other regions of European Russia and neighbouring countries.

By now Moscow Region has become the only region where all three alien species seriously damaging ash are recorded: *Agrilus planipennis* appeared in 2003, *Hymenoscyphus fraxineus* reached Moscow by 2014 (Musolin et al. 2017, Selikhovkin et al. 2017) and *P.(M.) fraxinifolii* reached Moscow by 2017 (current communication). This makes it possible to study ecological interactions among these species.

Conclusions

1. The record of *P.(M.) fraxinifolii* 700 km far from previously known range indicates that this pest is spreading quickly and its dispersal is connected with an accidental introduction by human.

2. The record of established population of *P.(M.) fraxinifolii* in Moscow is of great importance for forestry, plant protection and plant quarantine services of Russia, Belarus, Estonia, Latvia and Lithuania, since an alien species established in this large city can quickly spread to all directions.

3. Moscow has become the only region, where ash trees are affected by *Agrilus planipennis*, *Hymenoscyphus fraxineus* and *P.(M.) fraxinifolii* and ecological interactions among these species can be studied.

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References

Baker, E.A. and Martin, J.H. 2011. *Prociphilus fraxinifolii* (Hemiptera: Aphididae), a species new to Britain. *British Journal of Entomology and Natural History* 24: 221–223.

Blackman, R.L. and Eastop, V.F. 2016. Aphids on the world's plants. An online identification and information guide. Available online at: http://www.aphidsonworldsplants.info/ (Last accessed on: 17 September, 2017)

Chumak, V.O., Zhuravlev, V.V., Migal, A.V. and Galats, V.V. 2016. Novi invaziini vydy popelyc, zareiestrovani v Ukraini [New invasive species of aphids recorded in Ukraine]. *Ukrainska Entomofaunistyka* 7(3): 97 (in Ukrainian). Available online at: https://www.google com.ua/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwiYobbEjqDfAhWB2ywKHW8lCn8QFjABegQIAhAC&url=https%3A%2F%2Fwww.researchgate.net%2Fprofile%2FViktor_Fursov%2Fpublication%2F317388661_FURSOV_KODAN_Ukrainska_Entomofaunistika_2016_vol-_7_page95-96%2Fdata%2F593856e80f7e9b32b7f4bd8a%2FFURSOV-KODAN-Ukrainska-Entomofaunistika-2016-vol-7-page95-96.pdf&usg=AOv Vaw3HLUe_j8hWzhm1Rv-_rZOk

FRAXIGEN. 2005. Ash species in Europe: biological characteristics and practical guidelines for sustainable use. Oxford Forestry Institute, University of Oxford, UK, 128 pp. Available online at: https://www.researchgate.net/publication/262765209_Ash_Species_in_Europe_Biological_Characteristics_and_Practical_Guidelines_for_Sustainable_Use. (Last accessed on: 30 January, 2016)

Gross, A., Holdenrieder, O., Pautasso, M., Queloz, V. and Sieber, T.N. 2014. *Hymenoscyphus pseudoalbidus*, the causal agent of European ash dieback. *Molecular Plant Pathology* 15(1): 5–21, DOI: 10.1111/mpp.12073.

Hałaj, R., Osiadacz, B. and Poljaković-Pajnik, L. 2016. Górny Śląsk – polski przyczółek zdobyty przez obcą mszycę *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1879). *Acta Entomologica Silesiana* 24 (online 019): 1–9. Available online at http://mgb.nazwa.pl/stronaste/wp-content/uploads/2016/07/AES-24online019.pdf

Hałaj, R. and Osiadacz, B. 2017. Woolly ash aphid – is the alien bug posing a threat to European ash trees? – a review. *Plant Protection Science* 53(3): 127–133, DOI: 10.17221/138/2016-PPS.

Majorov, S.R., Bochkin, V.D., Nasimovich, Y.A. and Shcherbakov, A.V. 2012. [Майоров, С.Р., Бочкин, В.Д., Насимович, Ю.А. и Щербаков, А.В.] Адвентивная флора Москвы и Московской области [Alien Flora of Moscow and Moscow Region]. KMK Publ. House, Moscow, 412 pp. (in Russian).

Martynov, V.V. and Nikulina, T.V. 2016. *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1979) (Hemiptera: Aphididae: Eriosomatinae) – novyi invazivnyi severoamerikanskii vid tlei na territorii Donbassa [*Prociphilus (Meliarhizophagus) fraxinifolii* (Riley, 1979) (Hemiptera: Aphididae: Eriosomatinae) is a new invasive North American species of aphids in the territory of Donbass]. In: Proceedings of International Research-to-Practice Conference of Young Researchers "Actual Problems and Prospects of Integrated Plant Protection", November 7-9, 2016, Kyiv, p. 53–54 (in Russian with English abstract). Available online at: https://www.researchgate.net/publication/309847643_Prociphilus_Meliarhizophagus_fraxinifolii_Riley_1979_Hemiptera_Aphididae_Eriosomatinae_-_a_new_invasive_North_American_species_of_aphids_in_the_territory_of_Donbass

Musolin, D.L., Selikhovkin, A.V., Shabunin, D.A., Zviaginsev, V.B. and Baranchikov, Y.N. 2017. Between ash dieback and emerald ash borer: two Asian invaders in Russia and the future of ash in Europe. *Baltic Forestry* 23 (1): 316–333.

Orlova-Bienkowskaja, M.J. 2014. Ashes in Europe are in danger: the invasive range of *Agrilus planipennis* in European Russia is expanding. *Biological Invasions* 16: 1345–1349, DOI: 10.1007/s10530-013-0579-8.

Orlova-Bienkowskaja, M.J. 2015. Cascading ecological effects caused by establishment of the emerald ash borer *Agrilus planipennis* in European Russia. *European Journal of Entomology* 112(4): 778–789, DOI: 10.14411/eje.2015.102.

Orlova-Bienkowskaja, M.J. 2017. Main Trends of Invasion Processes in Beetles (Coleoptera) of European Russia. *Russian Journal of Biological Invasions* 8(2): 143–157, DOI: 10.1134/S2075111717020060.

Orlova-Bienkowskaja, M.J. and Belokobylskij, S.A. 2014. Discovery of the first European parasitoid of the emerald ash borer *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). *European Journal of Entomology* 111(4): 594–596, DOI: 10.14411/eje.2014.061.

Orlova-Bienkowskaja, M.J. and Bieńkowski, A.O. 2016. The life cycle of the emerald ash borer *Agrilus planipennis* in European Russia and comparisons with its life cycles in Asia and North America. *Agricultural and Forest Entomology* 18(2): 182–188, DOI: 10.1111/afe.12140.

Orlova-Bienkowskaja, M.J. and Volkovitsh, M.G. 2014. Range expansion of *Agrilus convexicollis* in European Russia expedited by the invasion of emerald ash borer, *Agrilus planipennis* (Coleoptera: Buprestidae). *Biological Invasions* 17(2): 537–544, DOI: 10.1007/s10530-014-0762-6.

Pérez Hidalgo, N. and Mier Durante, M.P. 2012. First record of *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley) [Hemiptera: Aphididae] in the Iberian Peninsula. *EPPO Bulletin* 42 (1): 142–145, DOI: 10.1111/epp.2531.

Remaudiere, G. and Ripka, G. 2003. Arrivée en Europe (Budapest, Hongrie) du puceron des frenes américains, *Prociphilus (Meliarhizophagus) fraxinifolii* (Hemiptera, Aphididae, Eriosomatinae, Pemphigini). [Arrival in Europe (Budapest, Hungary) of American aphid, *Prociphilus (Meliarhizophagus) fraxinifolii* (Hemiptera, Aphididae, Eriosomatinae, Pemphigini).] *Revue franēaise d'entomologie* 25(3): 152 (in French).

Selikhovkin, A.V., Popovichev, B.G., Mandelshtam, M. Yu., Vasaitis, R. and Musolin, D.L. 2017. The Frontline of Invasion: the Current Northern Limit of the Invasive Range of Emerald Ash Borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), in European Russia. *Baltic Forestry* 23(1): 309-315.

Petrović-Obradović, O., Tomanović, Ž., Poljaković-Pajnik, L. and Vučetić, A. 2007. An invasive species of aphid, *Prociphilus fraxinifolii* (Hemiptera, Aphididae, Eriosomatinae), found in Serbia. *Archives of Biological Sciences* 59: 9–10.

Torres-Acosta, R.I. and Sánchez-Peña, S.R. 2015. Regional concurrent outbreaks of ash leaf curl aphid, *Prociphilus fraxinifolii* (Riley) (Hemiptera: Aphididae: Eriosomatinae), and the invasive predator, *Harmonia axyridis* (Pallas) (Coleoptera: Cocinellidae), in Northeastern Mexico. *Southwestern Entomologist* 40(3): 661–664.

Trenchev, G. and Trencheva, K. 2009. *Prociphilus fraxinifolii* Riley (Hemiptera, Aphididae, Eriosomatinae) a species new to the Bulgarian fauna. *Sustainable Forestry* 59–60: 79–82.