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INVASION NOTE

Ashes in Europe are in danger: the invasive range of *Agrilus planipennis* in European Russia is expanding

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Abstract The emerald ash borer, *Agrilus planipennis* (Coleoptera, Buprestidae), is a pest of ash native to Asia. This major stem borer has killed millions of ash trees in North America. It was first found in Europe in 2003 in the city of Moscow. Now it is rapidly spreading in European Russia. In 2012 *A. planipennis* was found in the Tula, Kaluga, and Smolensk regions. A survey of green plantations in 22 localities in 2013 has revealed that *A. planipennis* occurs also in the Tver, Orel, Voronezh, Tambov, and Yaroslavl regions. It occurs 230 km northeast, 350 km southeast, and 460 km south from Moscow. Most ashes in the Moscow region, both alien American *Fraxinus pennsylvanica* and the indiginous European ash *Fraxinus excelsior*, are dying or already dead. Thousands of trees in other regions are seriously damaged. The pest will cross the western border of Russia soon. It represents a serious threat for ashes in other European countries.

Keywords *Agrilus planipennis* · Pest · Emerald ash borer · European Russia · *Fraxinus pennsylvanica* · *Fraxinus excelsior*

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The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, 1888, is a serious invasive pest of ashes. This beetle, native to East Asia, has killed millions of ash trees in North America (Poland 2007; Knight et al. 2013). In Europe EAB has the highest quarantine status (EPPO 2013). It was first found in Europe in 2003 in Moscow (Shankhiza 2007). Now almost all ash trees in the Russian capital and its vicinity, both introduced American ash *Fraxinus pennsylvanica* and the indiginous European ash *Fraxinus excelsior,* are killed or greatly damaged (Majorov et al. 2012). Several years after the first record the beetles were found only in Moscow and its vicinity (Baranchikov et al. 2010). But in 2012 *A. planipennis* was discovered in the Smolensk region (Baranchikov and Kurteev 2012). In addition, communications about findings of the pest in Obninsk (Kaluga region) and the Tula region appeared in the media (Communication of the information agency "Regnum" 2012; Gninenko 2012). This paper provides data on the current range of *A. planipennis* in Russia.

In spring and summer of 2013 ash trees in 22 localities of European Russia were examined for damage caused by *A. planipennis.* Characteristic D-shaped emergence holes are reliable evidence of the presence of *A. planipennis* (Poland 2007). 2,719 trees of *Fraxinus pennsylvanica* and 115 trees of *Fraxinus excelsior* were examined. Damaged trees with emergence holes have been found not only in the Moscow region, but also in Konakovo (Tver region), Michurinsk (Tambov region), Tula, Kaluga, Orel,

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Table 1 Results of examinations of ash trees in European Russia in 2013

Locality	Distance from Moscow (km)	Coordinates	Date of survey	Evidence of EAB	Number of examined trees		Percentage of trees with emergence holes (%)	
					F. pennsylvanica	*F. excelsior*	*F. pennsylvanica*	*F. excelsior*
Kaluga	145	54.52 N, 36.26E	June 3	Emergence holes	128	0	15.6	0
Klin	70	56.33 N, 36.73E	May 25	Emergence holes	88	0	98.9	0
Konakovo	100	56.71 N, 36.77E	May 20	Emergence holes	128	0	88.3	0
Michurinsk	350	52.90 N, 40.50E	June 28	Emergence holes	11	4	54.5	0
Uzunovo	135	54.55 N, 38.62E	June 29	Emergence holes	53	0	100	0
Monino	20	55.84 N, 38.20E	June 21	Emergence holes, 1 adult	112	0	98.2	0
Orel	310	52.97 N, 36.07E	June 4	Emergence holes, 1 adult	193	14	48.2	57.1
Tula	150	54.20 N, 37.62E	June 5	Emergence holes, 1 adult	124	3	10.5	100
Voronezh	460	51.68 N, 39.18E	June 12	Emergence holes, 1 adult	110	1	52.7	100
Yaroslavl	230	57.63 N, 39.87E	June 30	Emergence holes, 1 adult	219	0	21.9	0
Zelenograd	20	55.99 N, 37.20E	May–July	Emergence holes, 26 adults captured from June 8 to July 5, 20 larvae captured August 20 and 22	161	0	95.6	0
Staraya Kupavna	20	55.81 N, 38.18E	June 21	Emergence holes, 5 adults	109	0	94.5	0
Bryansk	330	53.25 N, 34.40E	June 3	No	159	0	0	0
Gryazi	380	52.49 N, 39.93E	June 27	No	40	0	0	0
Kostroma	285	57.77 N, 40.94E	July 16	No	140	0	0	0
Lipetsk	350	52.60 N, 39.59E	June 27	No	195	1	0	0
Nizhniy Novgorod	375	56.32 N, 44.00E	August 14	No	99	4	0	0
Rostov-on-Don	950	47.23 N, 39.72E	June 14	No	83	84	0	0
Ryazan	165	54.62 N, 39.74E	June 29	No	128	0	0	0
Tambov	400	52.72 N, 41.45E	June 28	No	175	3	0	0
Tver	145	56.86 N, 35.91E	May 25	No	144	0	0	0
Vladimir	160	56.14 N, 40.41E	August 15	No	120	1	0	0

Yaroslavl, and Voronezh (Table 1). Some of these records have been described in detail (Orlova-Bienkowskaja 2013).

In 2013, adults of *A. planipennis* were captured from June 8 to July 5. At the end of August larvae of the second instar and prepupae were found under the bark (identified after Chamorro et al. 2012). It may indicate that the beetle completes its life cycle in more than 1 year. In China and North America, the beetle completes its life cycle in one or 2 years depending on the climate (Wei et al. 2007; Mastro et al. 2007). *A. planipennis* has often been found infesting ash trees along with the bark beetle *Hylesinus fraxini* (Panzer 1779). (Coleoptera: Scolytidae) (Izhevskiy 2007), *Agrilus convexicollis* Redtenbacher, 1849 (Coleoptera: Buprestidae), and *Tetrops starkii* Chevrolat, 1859 (Coleoptera: Cerambycidae) (original data).

In all examined localities of the Moscow region, as well as in the city of Konakovo (Tver region), most of the ash trees have already been killed by the EAB. Most ash trees in Kaluga, Orel, Tula, Yaroslavl, Michurinsk, and Voronezh appear healthy, but groups of damaged and dying trees with characteristic emergence holes are present. No signs of *A. planipennis* were found in other 10 localities. Data on the distribution of *A. planipennis* are summarized in the map (Fig. 1) and in Table 2.

Currently, the westernmost known locality of the species is 250 km from Moscow (Baranchikov and Kurteev 2012). According to our data, the most northern locality of the species is Yaroslavl (230 km northeast from Moscow), the most eastern is Michurinsk (350 km southeast from Moscow), and the most southern is Voronezh (460 km south from Moscow). Adults of *A. planipennis* fly well, but can spread only 6–10 km per year by themselves (Mercader et al. 2009). How could the beetles spread over 460 km within only 10 years after the first record in Moscow? First, the beetle could have appeared in European Russia earlier. Second, long-distance human-assisted spread is quite possible. In America, natural spread is of minor importance compared to human-assisted movement (Poland 2007). It is interesting that *A. planipennis* was found in Michurinsk near the union railway station, while it was not found in the four nearest cities. This may indicate that the beetle was spread by transport.

The invasive range of *A. planipennis* is expanding rapidly. Within 10 years after the first record in Moscow this pest has spread to at least nine regions of the Russian Federation. The area of its invasive range is at least 150,000 km^2 (i.e., it exceeds the area of England). *Agrilus planipennis* has been found as far as 460 km from Moscow, while the distance between the most western point of known range and the western border of the Russian Federation is about 180 km. Considering that ash species occur all over Europe, there is no reason to doubt that *A. planipennis* will eventually spread to other European regions. Baranchikov and Kurteev (2012) suggested that it would cross the western border of Russia and appear in adjacent countries before 2020. The present data strongly confirm this suggestion.

The first recorded infestations of *A. planipennis* in European Russia were observed on *F. pennsylvanica* (Volkovich 2007; Mozolevskaya et al. 2008) because this ash species introduced from America largely dominates in Russian cities, with European ash *F. excelsior* being occasionally planted. It was initially unclear whether *F. excelsior* was susceptible to the pest (Baranchikov et al. 2008). Now it is understood that *F. excelsior* is indeed susceptible: almost all *Fraxinus excelsior* in Moscow and its vicinity have been killed or greatly damaged (Majorov et al. 2012), and the present survey revealed that *A. planipennis* also damages *F. excelsior* in other regions, including Orel, Voronezh, and Tula.

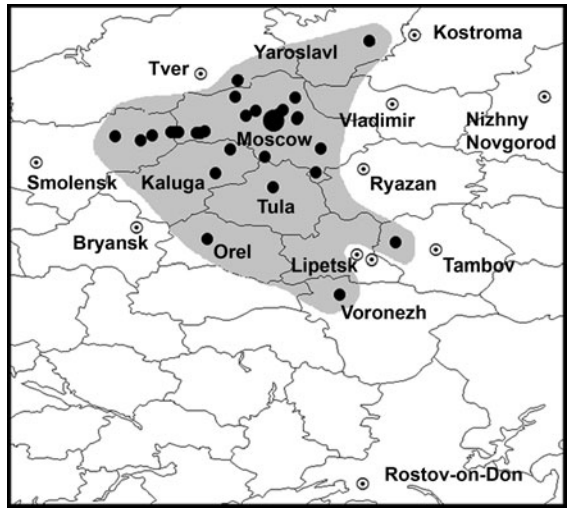

Fig. 1 The invasive range of *A. planipennis* in European Russia. *Black dots* indicate localities where *A. planipennis* has been found. *White dots* with a point are localities where examinations were performed but *A. planipennis* was not found. Sources of information are listed in Table 2

Table 2 Localities where *A. planipennis* has been found in European Russia

Region	The year of first record	Source of information
Moscow region		
Moscow	2003	(Shankhiza 2007)
Istra district: Manikhino	2006	(Volkovich 2007)
Mozhaisk district	2009	(Baranchikov et al. 2010)
Serpukhov	2009	(Baranchikov et al. 2010)
Mytistchi	2009	(Baranchikov et al. 2010)
Pushkino	2009	(Baranchikov and Kurteev 2012)
Zelenograd	2011	Original data
Sergiev Posad	2012	(Baranchikov and Kurteev 2012)
Klin	2013	Original data
Kolomna	2012	(Lifant'eva 2012)
Noginsk district: Staraya Kupavna	2013	Original data
Shchelkovo district: Monino	2013	Original data
Serebryanye Prudy district: Uzunovo	2013	Original data
Smolensk region		
Gagarin district	2012	(Baranchikov and Kurteev 2012)
Vyazma district	2012	(Baranchikov and Kurteev 2012)
Tver region		
Konakovo	2013	Original data
Kaluga region		
Obninsk	2012	(Communication of the information agency "Regnum" 2012)
Kaluga	2013	Original data
Orel region		
Orel	2013	Original data
Tula region		
Tula	2013	Original data
Voronezh region		
Voronezh	2013	Original data
Yaroslavl region		
Yaroslavl	2013	Original data
Tambov region		
Michurinsk	2013	Original data

The current situation with *A. planipennis* in European Russia is quite similar to the situation in North America. Obviously, *A. planipennis* will cross the western border of Russia and appear in other countries soon. As the pest kills both *F. pennsylvanica* and *F. excelsior*, it represents a serious threat for ashes in Europe and, indirectly, to the European economy and environment.

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