

## Expansion of *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae) to European Russia and adjacent regions

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**Abstract** An invasive alien species, the harlequin ladybird *Harmonia axyridis* (Pallas, 1773), has quickly expanded its distribution in Eastern Europe. Records of *H. axyridis* from 31 localities in Lithuania, Latvia, the Ukraine, European Russia, and the Northern Caucasus are summarized and mapped. Within the last few years this species has established in south Latvia, on the Baltic Sea shore (Kaliningrad oblast and Lithuania), in the western and central Ukraine, Crimea, and in the Northern Caucasus. Besides that, individual specimens have been found in 4 more localities in European Russia. The species is recorded from Lipetsk oblast (European Russia), Crimea, and Nikolaev oblast (the Ukraine) for the first time.

**Keywords** Harlequin ladybird · Pest · Range expansion · European Russia · New records · *Harmonia axyridis*

*Harmonia axyridis* (Pallas, 1773) has perhaps become the most infamous of invasive alien insects in the twenty-first century (Roy and Majerus 2010). Native to Asia, since 1916 *H. axyridis* has been released as a biological control agent of aphids and coccids in various parts of the world (Brown et al. 2011; Belyakova and Polikarpova 2012). In 1988 the species began to establish and propagate in the wild (Chapin and Brou 1991). *H. axyridis* causes negative ecological and economic consequences: (1) its spread caused the decline of populations of native ladybird species (Roy et al. 2012); (2) it has become a significant pest of fruit production and wine production (Koch and Galvan 2008); (3) it is a nuisance that infests houses and other buildings in large numbers when searching for overwintering sites (Koch and Galvan 2008).

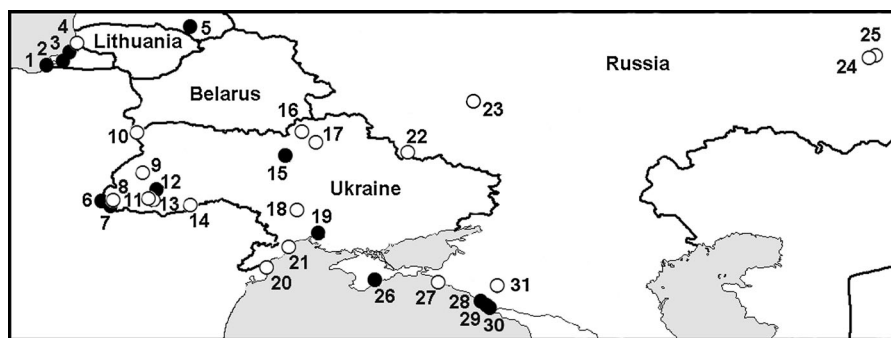
In the last 25 years *H. axyridis* has established in Europe, North America, South America, and Africa (Brown et al. 2011). In Europe this ladybird was first recorded in the wild in the late 1990s in France and Germany, and since 2002 its range has rapidly expanded (Brown et al. 2008). Between 2006 and 2010 it established in at least 12 countries of Eastern Europe (Brown et al. 2011). According to our data, the European part of the range is continuing to expand eastwards. Here, a review of records of *H. axyridis* from European Russia, Northern Caucasus, Lithuania, Latvia, and the Ukraine is given (Fig. 1, Table 1).

*Harmonia axyridis* has become established in the Baltic region. First, in August 2009, adults and larvae of this species were observed in great numbers in the

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**Fig. 1** Distribution of *H. axyridis* in Latvia, Lithuania, the Ukraine, European Russia, and the Northern Caucasus. Black dots indicate localities where the species has established, white

dots localities, where individual specimens have been found. Numbers of localities correspond to the table below

south of Latvia (Barševskis 2009). Then, in 2010, many specimens were recorded in the city of Kaliningrad (Russia) (Zakharov et al. 2011), with many more found in different parts of Kaliningrad in August and September 2011 (Alekseev et al. 2012). In summer 2012 *H. axyridis* was recorded not only in Kaliningrad, but also in Russian parts of Vistula Spit and Curonian Spit. The species was also found in the Lithuanian part of Curonian Spit (Nagrockaitė et al. 2011). Adults of *H. axyridis* occur in the Baltic region from April to October (Alekseev, personal communication), so they successfully overwinter there.

From 1964 *H. axyridis* was released in the western Ukraine (Chernovtsy oblast) as an agent of biological control, but it did not become established (Voronin 1971). In 2003 a few specimens of *H. axyridis* var. *spectabilis* were collected in the Ukraine, in the city of Kiev (Verizhnikova and Shylova 2013). At that time other documented parts of the European range were very far from the Ukraine: the species was found only in France, Greece, Germany, Belgium, the Netherlands, and England (Brown et al. 2011). It is likely that the specimens found in the wild in the Ukraine in 2003 were descended from the beetles released in this country.

The oldest known established population in the Ukraine exists in the village of Martusovka, near Kiev. *H. axyridis* has been recorded there since 2007 (Verizhnikova and Shylova 2013). Recently *H. axyridis* has become a common species in the center of the country. About 3,500 specimens of this species were recorded in 49 localities in the vicinity of Kiev (Tytar and Nekrasova 2012). Spread of *H. axyridis* in this region has caused the dramatic decline of populations

of native ladybird species *Coccinella septempunctata* Linnaeus, 1758 and *Propylea quatuordecimpunctata* (Linnaeus, 1758) (Verizhnikova 2011). *H. axyridis* has established in at least 10 oblasts of the Ukraine (see Table 1). In summer 2011 an established population was found in the vicinity of Nikolaev, where several specimens were captured in light traps (V. V. Strenado, personal communication). Additionally, in July 2013 an established population was found in Crimea, in the vicinity of Alushta, where many specimens were captured on the leaves of *Mimosa pudica* (E. V. Rybalchenko, personal communication). These are the first records of *H. axyridis* from Nikolaev oblast and Crimea (the Ukraine).

From the 1930s to 2010 *H. axyridis* was released in the Caucasus (Belyakova and Polikarpova 2012), but there was no evidence of establishment until recently. In 2006 the first specimen of *H. axyridis* was found in the Northern Caucasus, namely in Adyghe Republic (Ukrainsky and Shapovalov 2010). In 2011 the species appeared in Krasnodar Territory (Ukrainsky 2013), then in 2012 an established population was found in the vicinity of Sochi (T. A. Mogilevich, personal communication; Belyakova and Polikarpova 2012). According to our own observations, in 2013 *H. axyridis* not only established in the vicinity of Sochi, but also became the most abundant species of coccinellid there.

Two specimens of *H. axyridis* were found in Iglino district in Bashkir Republic (14.10.1981 and 14.7.2007), far from both secondary and native areas (Khabibullin et al. 2004, 2009, and personal communication by Khabibullin). The specimens belong to the colour form *H. axyridis* var. *axyridis*, which occurs

**Table 1** Localities where *H. axyridis* was found in the eastern part of its European range

Number	Locality	Years of records in the wild	Biotopes	Colour forms of adults	Found specimens	References
1	Russia, Kaliningrad oblast, Vistula Spit	2012	Leaves of shrubs	<i>succinea</i>	Many adults	Alekseev, personal communication
2	Russia, Kaliningrad oblast, Kaliningrad	2010–2013	Leaves and stems of <i>Acer pseudoplatanus</i> and <i>Spiraea</i> sp.	<i>succinea</i> , <i>spectabilis</i>	Many adults, larvae and pupae	Zakharov et al. (2011), Alekseev et al. (2012), Alekseev, personal communication
3	Russia, Kaliningrad oblast, Curonian Spit	2012	Leaves of shrubs	<i>succinea</i>	Many adults	Alekseev, personal communication
4	Lithuania, Juodkrante	2011	Grass in the wood lot	<i>succinea</i>	1 adult	Nagrockaitė et al. (2011)
5	Latvia, Līvāni municipality, Jersika	2009	Young shoots of <i>Prunus cerasifera</i>	<i>succinea</i> , <i>spectabilis</i>	Many adults, larvae and pupae	Barševskis (2009)
6	Ukraine, Transcarpathian oblast, Chop	2009	Unknown	<i>succinea</i> , <i>conspicua</i> , <i>spectabilis</i>	Many adults and larvae	Markó and Pozsgai (2009), Verizhnikova (2011)
7	Ukraine, Transcarpathian oblast, Beregovo	2009	Unknown	<i>succinea</i> , <i>conspicua</i> , <i>spectabilis</i>	Many adults larvae and pupae	Markó and Pozsgai (2009), Verizhnikova (2011)
8	Ukraine, Transcarpathian oblast, Mukachevo	2010	Unknown	Unknown	Unknown	Nekrasova and Tytar (2012)
9	Ukraine, Lvov oblast, Lvov	2011	Unknown	Unknown	Unknown	Tytar and Nekrasova (2012)
10	Ukraine, Volyn oblast, Shatsk National Natural Park	2011	Unknown	Unknown	Unknown	Tytar and Nekrasova (2012)
11	Ukraine, Ivano-Frankovsk oblast, Zelionaya	2010	Unknown	Unknown	2 adults	Zamoroka et al. (2011)
12	Ukraine, Ivano-Frankovsk oblast, Ivano-Frankovsk	2009	Unknown	Unknown	11 adults	Zamoroka et al. (2011)
13	Ukraine, Ivano-Frankovsk oblast, Yarechma	2010	Unknown	Unknown	1 adult	Zamoroka et al. (2011)
14	Ukraine, Chernovtsy oblast	2011	Unknown	Unknown	Unknown	Nekrasova and Tytar (2012)
15	Ukraine, Kiev oblast, left bank of the Dnieper River	2003	Unknown	<i>spectabilis</i>	Several adults	Verizhnikova and Shylova (2013)

**Table 1** continued

Number	Locality	Years of records in the wild	Biotopes	Colour forms of adults	Found specimens	References
	Ukraine, Kiev oblast, Martusovka	2007–2012	<i>Rosa</i> sp., <i>Capsicum annuum</i> , <i>Viburnum opulus</i>	<i>spectabilis</i> , <i>conspicua</i> , <i>succinea</i>	127 adults were captured in 2007. The population exists up to now	Verizhnikova (2011), Verizhnikova and Shylova (2013)
	Ukraine, Kiev oblast, Kiev, different districts of the city	2009–2012	Leaves of <i>Swida sanguinea</i> , <i>Acer</i> sp., <i>Tilia cordata</i> , <i>Aesculus hippocastanum</i> , <i>Urtica</i> sp. and <i>Lythrum salicaria</i> .	<i>spectabilis</i> , <i>conspicua</i> , <i>succinea</i> , <i>axyridis</i>	More than 3500 adults, many larvae, and pupae	Nekrasova and Tytar (2009), (2012), Verizhnikova and Shylova (2013)
16	Ukraine, Chernigov oblast, Chernigov	2011	Unknown	Unknown	1 adult	Sheshurak, personal communication
17	Ukraine, Chernigov oblast, Nezhin	2010	The specimen was captured on the wall	Unknown	1 adult	Zamoroka et al. (2011)
18	Ukraine, Nikolaev oblast, Kuripchino	2012	Unknown	Unknown	1 adult	Sheshurak, personal communication
19	Ukraine, Nikolaev oblast, Nikolaev	2011	The specimens were captured in light trap	Unknown	Several adults	Own data
20	Ukraine, Odessa oblast, the Danube Delta, the island Ptichij	2011	Unknown	Unknown	Unknown	Tytar and Nekrasova (2012)
21	Ukraine, Odessa oblast, Sukhoj Liman	2011	Unknown	Unknown	Unknown	Tytar and Nekrasova (2012)
22	Russia, Belgorod oblast, Borisovka	2012	Unknown	<i>spectabilis</i>	1 adult	Orlova-Bienkowskaja (2013)
23	Russia, Lipetsk oblast, Leski	2012	The specimen was captured in light trap	<i>succinea</i>	1 adult	Own data
24	Russia, Bashkir Republic, Iglino district, Urman	2007	Unknown	<i>axyridis</i>	1 adult	Khabibullin et al. (2009)
25	Russia, Bashkir Republic, Iglino district near Asha	1981	Unknown	<i>axyridis</i>	1 adult	Khabibullin et al. (2004)
26	Ukraine, Crimea, Solnechnogorskoe	2013	Leaves of <i>Mimosa pudica</i>	<i>succinea</i>	Many adults	Own data
27	Russia, Krasnodar Territory, Bolshoi Utrish	2011	Leaves of shrubs	<i>succinea</i>	1 adult	Ukrainsky (2013)
28	Russia, Krasnodar Territory, Lazarevskoe	2012	<i>Tilia</i> sp., <i>Hibiscus syriacus</i> , <i>Catalpa</i> sp.	<i>succinea</i>	8 adults, 13 larvae and 26 pupae	Belyakova and Polikarpova (2012)

**Table 1** continued

Number	Locality	Years of records in the wild	Biotopes	Colour forms of adults	Found specimens	References
29	Russia, Krasnodar Territory, Loo	2012	<i>Artemisia</i> sp., <i>Rosa</i> sp.	<i>succinea</i>	More than 10 adults, several larvae, and 39 pupae	T. A. Mogilevich, personal communication; Belyakova and Polikarpova (2012)
30	Russia, Krasnodar Territory, Sochi	2012, 2013	<i>Catalpa</i> sp., <i>Corylus maxima</i> , <i>Populus tremula</i> , other trees and shrubs	<i>succinea</i>	More than 100 adults and more than 100 larvae and pupae	Belyakova and Polikarpova (2012) and own data
31	Russia, Adyghe Republic, Rodnikovyi	2006	<i>Crataegus</i> sp.	<i>spectabilis</i>	1 adult	Ukrainisky and Shapovalov (2010)

very rarely in European populations. There is still no evidence of an established population there, and probably, individual beetles arrived in this region with produce. Transport of *H. axyridis* with fruit, vegetables and flowers was documented in various European countries (Brown et al. 2011).

In 2004 one specimen identified as *H. axyridis* was found near the railway station of Shebekino in Belgorod oblast (Binkovskaya 2004 and personal communication by Binkovskaya). However, the specimen was lost, so it is impossible to confirm the identification. In August 2012 one female of *H. axyridis* was found in Borisovka district of Belgorod oblast (Orlova-Bienkowskaja 2013), quite close to the Ukrainian border; and in October 2012 one female was captured in Lipetsk oblast. [*H. axyridis* var. *succinea*, with elytral ridge, captured by light trap on the bank of Don river near the village of Leski, Krasnoe district, Lipetsk oblast, 17.10.2012, leg. S. G. Mazurov. This specimen is deposited in the Zoological Museum of Moscow State University]. The latter locality is situated 300 km northeast of the former and is the first record of *H. axyridis* from Lipetsk oblast (European Russia).

The spread of *H. axyridis* to Eastern Europe was predicted by an ecological model (Poutsma et al. 2008) and this prognosis is quickly being realized. The established populations appeared in the Baltic region (Lithuania, Latvia, Kaliningrad oblast), the Northern Caucasus, and the Ukraine. Excluding the enclave of Russia in the Baltic region, only individual specimens

of *H. axyridis* have been collected in European Russia. Thus there is still no evidence of established populations in the main part of European Russia. However, the ecological model and recent eastward expansion of the range of this species indicate that *H. axyridis* will become common in the south of European Russia. There are still no records of *H. axyridis* from Moldova and Belarus, but it is likely that this invader will soon be found there, since it occurs in all adjacent countries.

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