

Dangerous Invasive Harlequin Ladybird *Harmonia axyridis* (Pallas, 1773) (Coleoptera, Coccinellidae) in the European Russia

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Abstract—The harlequin ladybird (*Harmonia axyridis*) is recorded in Belgorod oblast. This species has established itself in 38 countries of North America, South America, Europe, and Africa in the last 24 years. Mass propagation of this beetle in a number of regions has led to the decline of local ladybird species and other insects. The harlequin ladybird is a significant pest of fruit and wine production. *H. axyridis* is a nuisance that infests houses in large numbers when searching for overwintering sites. Hungry beetles bite people. The fluid excreted by these beetles has a foul odor, stains furniture and walls, and causes an allergy. The harlequin ladybird should be included in the list of quarantine species of the Federal Service for Veterinary and Phytosanitary Supervision of Russia.

Keywords: *Harmonia axyridis*, harlequin ladybird, Coleoptera, Coccinellidae, pest, invasive species, allergen, European Russia, Belgorod oblast

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HISTORY OF EXPANSION

The multicolored Asian lady beetle or harlequin ladybird, *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) is one of the most rapidly spreading beetle species. It is included in the list of 100 most dangerous invasive insects of the world (Branquart and Koch, 2010).

This ladybird has been successfully raised and used for fighting against aphids and coccids, which are agricultural and forest pests. In the United States, the harlequin ladybird was first released in 1916; in the Soviet Union, in 1927 (Georgia, Ukraine, Belarus, Kazakhstan); and in Western Europe, in 1982 (Brown et al., 2011). Breeding beetles has been regarded as both an efficient and safe way of biological control. After having been released, the beetles ate pests inhabiting cultivated and forest lands and died. Nevertheless, it was 20 years ago when the whole situation changed. The ladybirds began to adapt in the natural environment and formed stable and rapidly growing populations.

In 1988, the first population of *H. axyridis* was found in the United States (Chapin and Brou, 1991). The beetle began to rapidly spread over the country from that time. It has adapted itself in 24 states and moved across the border of Canada and Mexico (Koch et al., 2006). The harlequin ladybird has also penetrated into South America (Argentina, Brazil, Chile, Peru, Paraguay, and Uruguay) and Africa (Egypt, Republic of South Africa, and Lesotho) (Brown et al., 2011).

Multicolored Asian lady beetles have been caught in Western Europe since 1991. Individual findings were first registered in France, Germany, Belgium, and the Netherlands. Mass propagation and colonization of Europe started in 2002. Currently, the harlequin ladybird has established itself in the following 26 countries: France, Greece, Germany, Belgium, Netherlands, Great Britain, Switzerland, Luxemburg, Italy, Czech Republic, Denmark, Austria, Norway, Poland, Lichtenstein, Scotland, Sweden, Croatia, Hungary, Serbia, Slovakia, Slovenia, Ukraine, Bulgaria, Latvia, and Romania (Brown et al., 2011). There are data on the Internet that *H. axyridis* was found in Georgia on July 16, 2012 (Schlüter, 2012), but this finding was not verified by specialists.

The harlequin ladybird approached the western borders of Russia three years ago. It was registered in Latvia (Barsevskis, 2009) and Ukraine (in Kyiv and Zakarpattia oblast) (Nekrasova and Titar, 2009). It is interesting is that *H. axyridis* is penetrating into Eastern Europe from the west, despite the fact that its original habitat is in Asia (Altai, South Siberia, Far East, Mongolia, China, Korean Peninsula, Japan, Taiwan, and particular districts of the Oriental region) (Kovjū, 2007). Some other pests also exhibit this type of invasion. For example, it was found recently that the scarlet lily beetle *Lilioceris lili* (Scopoli, 1763) (Coleoptera, Chrysomelidae) was first brought from Siberia to Western Europe, and then it gradually spread eastward. Currently, it has adapted itself in a

major part of European Russia (Orlova-Bienkowskaja, 2012a).

The harlequin ladybird spreads like an avalanche and can colonize vast territories within several years. The habitat increases at a rate of 100–500 km per year (Brown et al., 2011). In addition, the abundance of ladybird in the colonized areas grows in an exponential manner. According to the leading European specialists, this ladybird species is going to become the most abundant all over the continent or even worldwide (Brown et al., 2011). Ecological modeling demonstrates that the potential habitat of the species encompasses North America and the temperate zone of Europe, as well as vast areas of the Mediterranean, South America, Africa, Australia, and New Zealand (Poutsma et al., 2008). This species was found in Kenya last summer (Nedvĕd et al., 2011). This finding can be evidence that *H. axyridis* is capable of surviving even in a tropical climate.

For now, no method of stopping habitat expansion of the harlequin ladybird has been found, because this beetle is extremely prolific, good at flying, and easily adapts to a new environment. In 2007, Ireland issued an “ecological alarm.” The harlequin ladybird was qualified as the most undesirable invasive species. Nevertheless, it was not possible to prevent the beetle from penetrating into the country. In 2007 and 2009, individual specimens were registered. In 2010 and 2011, ecologists detected stable populations of this species (National Invasive Species Database (Ireland), 2012).

HARMFULNESS

Unfortunately, the bright beautiful beetles released to fight against aphids were far from being harmless. Firstly, their propagation leads to the decline of other local insect species. Secondly, it causes a significant problem in fruit and wine production. Thirdly, harlequin ladybirds are a nuisance to people and can cause allergic reactions (Branquart and Koch, 2010).

Researchers working in different countries have found that the harlequin ladybird causes a significant decrease in the abundance of aphids, including the harmless ones, in both cultivated and natural cenoses. In addition, the abundance of local ladybird species also becomes lower (Roy et al., 2012). Multicolored Asian lady beetles displace local ladybirds. The species is called a “six-legged alligator.” One specimen can eat up to 5000 aphids during its life (Nedvĕd et al., 2010). The alien beetles dominate over the local ones on the basis of other characteristics: they propagate more intensely and have up to four generations per year. What is more, the larvae of the harlequin ladybird feed on eggs and larvae of other ladybird species. They excrete a fluid on plants that prevents egg laying of other species (Pell et al., 2008). As a result, *H. axyridis* has now become the dominant ladybird species in

many regions of North America and Europe (Branquart and Koch, 2010).

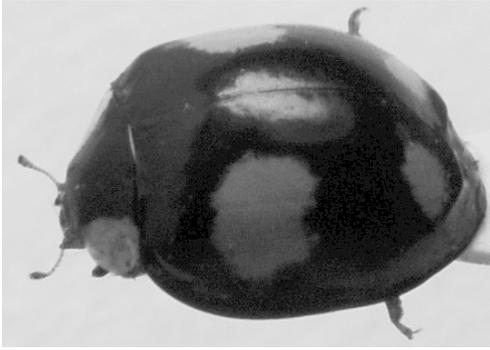
Besides ladybirds, *H. axyridis* affects other arthropods, including rare and beneficial species. The beetle eats psyllids, ticks, and coccids, as well as larvae of leaf-cutting beetles, weevils, and butterflies (Koch, 2003). It was established that the invasion of *H. axyridis* reduces the abundance of the American butterfly *Danaus plexippus* (Linnaeus, 1785) and the leaf-cutting beetle *Galerucella californiensis* (Linnaeus, 1767). Parasitic species of hymenopterans feeding on aphids are also affected (Sebolt and Landis, 2004; Koch and Galvan, 2008).

H. axyridis is a significant pest of fruit production. It damages apples, pears, citrus plants, and even potatoes. Wine production is particularly affected by the harlequin ladybird. It is often impossible to clean bunches of grapes, because they are covered by beetles. If they get into the wine, the beverage acquires an unpleasant taste (Branquart and Koch, 2010).

The harlequin ladybird is a nuisance to people, because it infests houses in large numbers (up to several thousand specimens) for overwintering (Koch and Galvan, 2008). The fluid excreted by these beetles has a foul odor and stains furniture, carpets, curtains, and walls. There are cases where invasion of harlequin ladybirds disturbed the normal operation of public eating facilities, manufacturing enterprises, and research institutions. If the ladybirds are hungry, they will sometimes bite humans. After a bite, a small amount of digestive enzymes gets into the skin. As a result, one can feel a burning pain or suffer from swelling similar to that from a mosquito bite.

Medical professionals are also concerned about the biological invasion of harlequin ladybirds. In the United States, the harlequin ladybird is considered a dangerous seasonal allergen. The fluid excreted by harlequin ladybirds can cause dermatitis, coughing, rhinoconjunctivitis, and even asthma (Branquart and Koch, 2010).

What did the species, which is harmless to humans in its natural habitat, propagate in mass and cause damage in other regions? There may be several reasons. Firstly, it is well known that invasive species often propagate in an avalanche manner, because they have no natural enemies. Secondly, the genetic investigations have demonstrated that breeding harlequin ladybirds before releasing them into the natural environment resulted in a gene rearrangement (Brown et al., 2008). The beetles were raised on food which was significantly different from their natural ration. In addition, the aim was to breed as many beetles for sale as possible. As a result, the most fecund specimens able to feed on a wide range of food objects were selected unintentionally.



Immature female of *Harmonia axyridis* found near the village of Borisovka, Belgorod oblast, in July 2012.

FINDINGS OF *H. axyridis* IN BELGOROD OBLAST

One specimen of *H. axyridis* (figure) was found among the samples collected near the village of Borisovka (Belgorod oblast) in July 2012. It was found by students of the Faculty of Biology and Soil Science, St. Petersburg State University. The insects were sampled during field entomological training. Thus, it is not possible to find out what student on what date and in what biotope made the finding.

The specimen detected was an immature female with soft and weak coverings. Only one specimen was found, but it is still an alarming signal. The harlequin ladybird propagates rapidly. For example, in Norway, the first specimen of the multicolored Asian lady beetle was registered in 2002. By 2004, the species had spread over the whole country.

The species was identified on the basis of the Identification Guide of Insects of the Russian Far East (Kuznetsov, 1992). The correctness was verified through comparing the samples of *H. axyridis* found in Primorsky krai, Jewish autonomous oblast, and Germany.

The online context-based search of Russian dissertations demonstrated that this was not the only finding of *H. axyridis* in European Russia. The ladybird species was first detected in Belgorod oblast in 2004 (Bin'kovskaya, 2004). Obviously, this finding was not given the proper significance. The data were published by neither Russian nor foreign researchers. There is also no indication that *H. axyridis* was found in European Russia either in the full description of its habitat compiled by European authoritative specialists (Brown et al., 2011) or in the catalog of Palaearctic beetles (Kovjū, 2007). *H. axyridis* was not mentioned in the catalog of invasive herbivorous insects published last year (Maslyakov and Izhevskii, 2011). O.V. Binkovskaja pointed out in the abstract of her dissertation that the harlequin ladybird was found in Russia for the first time. However, this fact was not emphasized, but listed among other findings. The species was not characterized as an invasive one.

Therefore, specimens of the harlequin ladybird were found in Belgorod oblast twice: in 2004 and 2012. Where did they come from? Three variants are possible. Firstly, individual specimens could have been brought from western areas, i.e., from Ukraine, which borders with Belgorod oblast. The distance from Borisovka to the nearest area of finding in Ukraine (Kyiv) is about 400 km. Secondly, the repeated detection of this species in Belgorod oblast can be evidence that the habitat border of the harlequin ladybird has moved eastward and has already crossed the Russian border, and a stable population has formed in Belgorod oblast. Finally, it is hardly possible but still cannot be excluded that harlequin beetles naturalized in Belgorod oblast as long ago as the 1960s when these beetles were released in Ukraine for fighting aphids (Voroniin, 1968).

DISCUSSION

The example of the harlequin ladybird demonstrates that breeding and releasing insects into the natural environment can have unpredictable consequences. Even species which have been successfully used over decades for the biological struggle against pests can get out of control and become harmful.

The first finding of such a dangerous invasive species as *Harmonia axyridis* was not noticed by researchers for 8 years. This fact illustrates that faunistic lists as a way of storing zoogeographical data are not really efficient (Orlova-Bienkowskaja, 2012b). The modern alternative is online databases on habitats of animals and plants. These databases are actively being developed in Germany (<http://naturgucker.de/natur.dll/EXEC>), Denmark (<http://www.fugleognatur.dk>), the Netherlands (<http://waarneming.nl/index.php>), Belgium (<http://waarnemingen.be/index.php>), and other countries.

Currently, *H. axyridis* is not included in the list of quarantine species of the Federal Service for Veterinary and Phytosanitary Supervision of Russia (*A List of Quarantine Objects...*, 2007). At the same time, it is clear that this ladybird can propagate in European Russia and cause damage to the local natural communities, agriculture, and even human health. The harlequin ladybird should be included in the list of quarantine species as soon as possible. It is necessary to perform monitoring and register all findings in the territory of European Russia, as is done in Western Europe and Ukraine.

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