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OVERWINTERING AND NEW RECORDS OF INVASIVE HARLEQUIN LADYBIRD *HARMONIA AXYRIDIS* (PALLAS, 1773) (COLEOPTERA: COCCINELLIDAE) AFTER MASS EXPANSION TO EUROPEAN PART OF RUSSIA IN 2018–2019

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Abstract. The data on the first record of harlequin ladybird (*Harmonia axyridis*) in Ryazan, Tula, Tver, Oryol, Orenburg regions and the Udmurt Republic are presented. On the studied parts of invasive distribution area of *H. axyridis*, the development of two generations is recorded. *H. axyridis* winters during imaginal diapause, gathering in large groups. The date of the migratory flight varies from early September to mid-October. Many bugs die of starvation during the postwintering period. Overwintering specimens of *Harmonia axyridis* (after mass expansion to European part of Russia in 2018–2019) were recorded in many regions in 2020: Kursk, Penza, Samara, Saratov, Volgograd, Astrakhan regionns, the Republic of Mordovia, Tatarstan and Chuvash Republic.

Key words: *Harmonia axyridis*, harlequin ladybird, multicolored Asian ladybird, invasive species, fauna, new records.

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ЗИМОВКА И НОВЫЕ НАХОДКИ ИНВАЗИОННОЙ КОРОВКИ *HARMONIA AXYRIDIS* (PALLAS, 1773) (COLEOPTERA, COCCINELLIDAE) ПОСЛЕ МАССОВОЙ ЭКСПАНСИИ НА ТЕРРИТОРИИ ЕВРОПЕЙСКОЙ ЧАСТИ РОССИИ В 2018–2019 ГОДАХ

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Аннотация. Впервые данные по азиатской божьей коровке (*Harmonia axyridis*) приводятся для Рязанской, Тульской, Тверской, Орловской, Оренбургской областей и территории Республики Удмуртия. На исследованных участках инвазионного ареала *H. axyridis* зарегистрировано развитие двух поколений. В период имагинальной диапаузы *H. axyridis* зимуют, собираясь большими группами. Сроки перелета на зимовку варьируют от начала сентября до середины октября. Многие жуки погибают от голода после зимовки. Перезимовавшие (после массовой экспансии в Европейской части России в 2018–2019 гг.) особи *Harmonia axyridis* отмечены в 2020 г. для Курской, Пензенской, Самарской, Саратовской, Волгоградской, Астраханской областей, а также Республики Мордовия, Татарстана и Чувашии.

Ключевые слова: *Harmonia axyridis*, азиатская божья коровка, божья коровка-арлекин, инвазионный вид, фауна, новые находки.

Introduction

The harlequin ladybird *Harmonia axyridis* (Pallas, 1773) is one of the most rapidly spreading beetle species, its range is increasing at a rate of 100–500 km per year [1]. The original area of *H. axyridis* is Asia including particular districts of the Oriental Region [2, 3], where distribution of this species is restricted by tropical climates. The most northwestern finding native point of *H. axyridis* is Tyukalinsk, Omsk oblast [3]. The Asian (initial) distribution area of this species is continuous and comprises a wide variety of ecological conditions [3]. In the last 25 years *H. axyridis* has established in Europe, North America, South America, and Africa [1]. In European part of Russia this ladybird was firstly recorded in the 2004 year in Belgorod oblast [4], and now it is widely distributed through the European Russia, where it is known from Kaliningrad, Belgorod, Lipetsk, Moscow, Bryansk, Voronezh and Rostov-on-Don oblasts, Krasnodar and Stavropol Kray, Adygea, Dagestan, Kabardino-Balkaria, North Ossetia, Crimea and Bashkir Republics [5–14]. The mass reproduction of *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) was recorded in many Russian regions (Republics of Tatarstan and Mordovia, Chuvash Republic, Nizhny Novgorod, Pskov, Kursk, Tambov, Penza, Ulyanovsk, Samara, Saratov, Volgograd, Astrakhan oblasts and the Chechen Republic) in 2018–2019 [15–17]. Monitoring an invasive species remains relevant, and the opportunity of the species (as *Harmonia axyridis*) to assimilate and gain a foothold in a new territory requires a detailed study. This determined the purpose of this research.

Material and methods

The material has been collected by authors and colleagues during investigation of the complex expedition in 2020 year. Specimens of *H. axyridis* were collected using UV-light trap and manual collecting. The part of the observations was made

thanks to the online project www.inaturalist.org. Names of morphs are given according to Andrianov et al. [18]. Total over 1000 specimens of *H. axyridis* have been examined (2018–2020).

Map was created in SimpleMappr online service (www.simplemappr.net).

Results and discussion

Harmonia axyridis (Pallas, 1773)

Material examined. *Orenburg oblast*: Ilek distr., Ilek vill., 10.10.2019, 1 ex. (f. *succinea*), unknown collector. *Oryol oblast*: Oryol, 8.10.2018, 2 exs. (f. *succinea*), unknown collector. *Ryazan oblast*: Rayzan distr., Murmino vill., 7.05.2020, 1 ex. (f. *spectabilis*), unknown collector; Rayzan, 11.05.2020, 1 ex. (f. *succinea*), unknown collector. *Saratov oblast*: Khvalynsk distr., Khvalynsk, facility of Saratov State University, 52.4861°N, 48.0439°E, UV-light, 23–27.06.2020, 7 exs. (5 – f. *succinea*, 1 – f. *conspicua*, 1 – f. *spectabilis*), V. V. Anikin leg.; Saratovsky district, Raslovka-2 vill., 51.7777°N, 46.2339°E, holiday village, in the garden, at day, 28.06.2020, 2 exs. (f. *succinea*), O. V. Sinichkina leg.; Saratov, B. Sadovaya str., 51.5217°N, 45.9837°E, apartment, on the UV-light, 6–13.08.2019, 1 ex. (f. *succinea*), V. V. Anikin leg.; same locality, on the UV-light, 20.08.2019, 2 exs. (f. *succinea*), V. V. Anikin leg.; same locality, on the UV-light, 20–25.08.2019, 12 exs. (10 – f. *succinea*, 2 – f. *spectabilis*), V. V. Anikin leg.; same locality, on the UV-light, 27.08.2019, 5 exs. (f. *succinea*), V. V. Anikin leg.; Novouzensk distr., Novouzensk, 23.08.2020, 1 ex. (f. *succinea*), unknown collector. *Tula oblast*: Shekino distr., Shekino vill., 3.05.2020, 1 ex. (f. *succinea*), unknown collector. *Tver oblast*: Konakovo, 5.10.2020, 1 ex. (f. *succinea*) N. Larionov leg.; *Udmurt Republic*: Glazov distr., Glazov, 24.09.2019, 1 ex. (f. *spectabilis*), unknown collector.

It is the first records of harlequin ladybird for Tula, Tver, Rayzan, Oryol, Orenburg oblasts and the Udmurt Republic (Fig. 1).

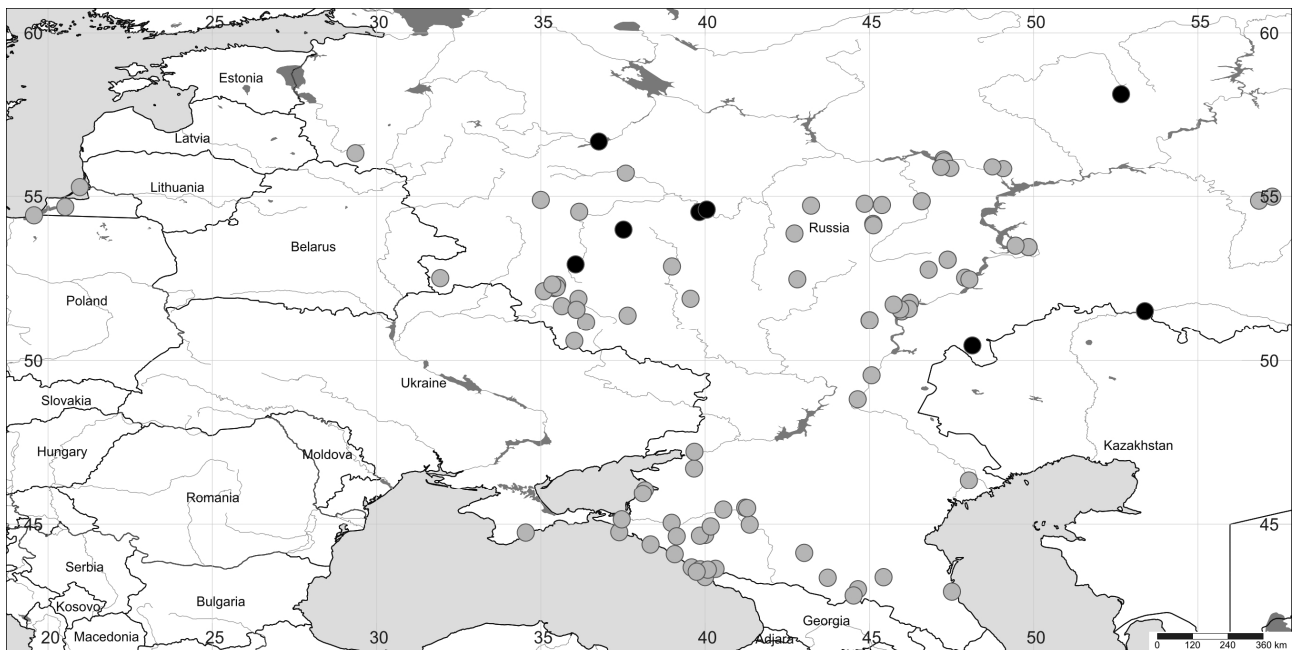


Fig. 1. Records of *Harmonia axyridis* from European Russia: gray circles – literature data, black circles – new records

One to four generations of *H. axyridis* develop during an active season, depending on the duration of the warm period [3], on the studied parts of areas recorded two generations develop (as on the biggest part of the area).

H. axyridis winters during imaginal diapause, gathering in large groups in cracks at southern slopes of mounds and hills, as well as in houses, within a major part of both the native and invasive distribution area [3, 19, 20], this is also observed in the studied populations. Overwintering specimens of *Harmonia axyridis* were recorded in many regions of European part of Russia in 2020: Kursk, Penza, Samara, Saratov, Volgograd, Astrakhan oblasts, the Republic of Mordovia, Tatarstan and Chuvash Republic [17, and orig.]. The date of the migratory flight varies from early September to mid-October, and depends on climatic conditions [3, 21].

Postwintering migration occurs as the temperature rises in late February to early May, depending on climatic conditions [3, 20]. Many beetles die of starvation during this period, when humidity is low and food is absent [3]. On the territory of the national park «Khvalynsky», where in the fall of 2019 there was a mass outbreak of the species [15], the species overwintered, but «lost» most of the adults who went to winter. The number of dead adults in shelters (forest floor, clumps of trees, attics, etc.) to the number of survivors was at the end of May – mid-June 2020 as 1:500–600!

Harmonia axyridis is a very polymorphic species with variations in the coloration pattern within a fairly broad range [22, 23]. It has long been an object of geneticists' study [1, 3, 23–25]. New records (2020) in European part of Russia presented two coloration form: f. *succinea* and f. *spectabilis* (Fig. 2).

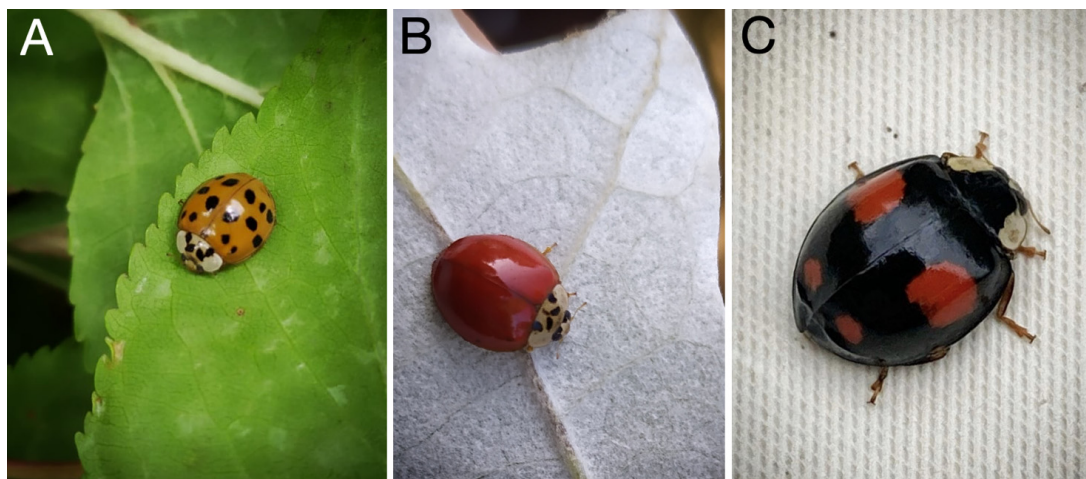


Fig. 2. Coloration form of *Harmonia axyridis* from Saratov oblast: A–B – f. *succinea*; C – f. *spectabilis*. Photo by O. V. Sinichkina

Apparently, the settlement of the European part of Russia is a spontaneous expansion of the species range both from the West, which is confirmed by the findings of *H. axyridis* f. *axyridis* in the Kursk oblast [17], and from the south of Russia, where the «strong point» represented by local populations of *H. axyridis* introduced to the Caucasus [12] plays a significant role in the colonization of the species (primarily in the Volga region) [10].

A similar rapid penetration along the Volga River line is known for other invasive species, for example horse-chestnut leaf miner – *Cameraria ohridella* Deschka & Dimić, 1986 [26] or emerald ash borer – *Agrilus planipennis* Fairmaire, 1888 [27].

Conclusion

The species *Harmonia axyridis* once again expresses itself as a dangerous and aggressive

invader. In a single year, this invasive harlequin ladybird spread itself more than 500 km along the Volga River to the north. In our opinion, in the future we should expect the closure of the native (from Kazakhstan) and the adventive ranges of *H. axyridis*.

On the studied parts of invasive distribution area of *H. axyridis* recorded, two generations develop. *H. axyridis* winters during imaginal diapause, gathering in large groups in cracks of buildings (more often), at southern slopes of mounds, less often in between stones, under bark and in leaf litter. The date of the migratory flight varies from early September to mid-October. Many beetles die of starvation during postwintering period (the number of dead adult specimens to the number of survivors is 1:500–600).

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