

**INITIAL ASSESSMENTS OF THE MULTICOLOURED ASIAN LADYBIRD *Harmonia axyridis* P a l l a s, 1773 (Coleoptera: Coccinellidae) IN THE WESTERN SERBIAN REGION**

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**Abstract.** The first record of *Harmonia axyridis* in Serbia was reported in 2008 from the Vorovo locality within the Fruska Gora National Park. During the late autumn of 2009, the first and mass occurrence of the species was noted at 19 sites in residential areas in the vicinity of the towns of Cacak and Gornji Milanovac, western Serbia. Additionally, the imagoes of *H. axyridis* were recorded in late October in the said areas on the balconies of residential buildings. This is the first report and at the same time the first mass finding of the invasive species in the Western Serbian region. No allergic reactions in humans to *H. axyridis* were reported.

**Keywords:** *Harmonia axyridis*, first report, central Serbia, Moravica district.

**AIMS AND BACKGROUND**

Variously known as the multi-coloured Asian lady beetle, harlequin ladybird or Halloween beetle *Harmonia axyridis* (Coleoptera: Coccinellidae) was initially described in 1773 as *Coccinella axyridis* P a l l a s. Eight synonyms have been used for this species in the subsequent scientific literature (*Coccinella bisex-notata* H e r b s t, 1793; *Coccinella 19-sinata* F a l d e r m a n n, 1835; *Coccinella conspicua* F a l d e r m a n n, 1835; *Coccinella aulica* F a l d e r m a n n, 1835; *Harmonia spectabilis* F a l d e r m a n n, 1835; *Coccinella succinea* H o p, 1845; *Anatis circe* M u l s a n t, 1850, and *Ptychanatis yedoensis* T a k i z a w a, 1917). *H. axyridis* is a holometabolous species. It is generally considered bivoltine<sup>1</sup>. However, it produces up to 4 to 5 generations per year<sup>2</sup>. The egg, larval and pupal stages last 3 to 5, 12 to 14 and 5 to 6 days, respectively. Development from egg to adult requires 20–25 days. Under cool spring weather conditions, development can take 36 days or longer<sup>3</sup>. *H. axyridis* is an aphidophagous ladybird beetle native to northern and

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temperate parts of Asia, including Japan<sup>1</sup>. The species was introduced into North America as early as the 20th century (1916) and released again in the mid-1980's as an efficient aphid control agent. The first established population was reported in 1988. Thereafter, *H. axyridis* spread throughout the USA (Ref. 4).

In Europe, *H. axyridis* was brought into France from China in 1982 to control aphids on different crops<sup>5</sup>. INRA (Institut scientifique de recherche agronomique) conducted a series of *in vivo* trials (strawberry) in the 1990's and initiated a multiplication programme for the predator in 1992. The species spread throughout France in 2004. During 1994, the stock culture of *H. axyridis* raised in France was introduced into Greece to control aphids on a variety of crops (including citrus, vegetables, beans and maize)<sup>5</sup>. Belgium introduced the species from Japan in 1997 and the 1st established populations were documented as early as 2001 (Ref. 6). During 1997 and 1998, the Asian ladybird was released in Germany in an attempt to control high levels of aphid infestation on roses. The 1st established populations were discovered in 1999, and the species spread widely in 2006 (Ref. 5). During 1996–2003, the species was used as a biological control agent in the Netherlands. More than 2000 reports over the 5-year period (2002–2007) suggest that the species is widely spread in this country<sup>5</sup>. The flightless strain of *H. axyridis* was introduced into the Czech Republic in 2003 to control aphids in hop gardens, and 4 years later, the spread of the species was evident throughout the country<sup>5</sup>.

The predator was introduced into Portugal, Spain and Italy as well, but no massive numbers of the insect have been established within the ecosystems of these countries<sup>5</sup>.

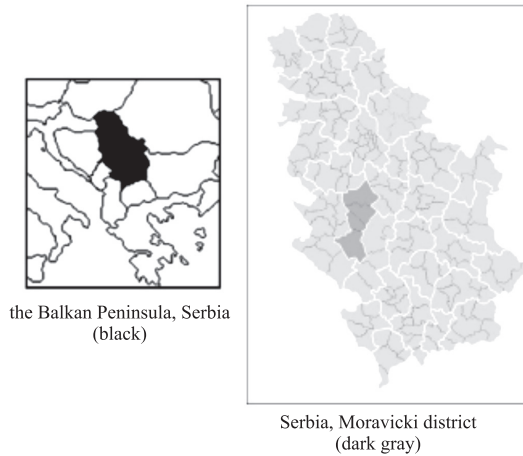
Due to its predatory and competitive abilities, the ladybird concerned can have adverse effects on the indigenous entomofauna of some regions, including the populations of ladybirds and other aphidophagous insects. The adverse impacts of *H. axyridis* also include fruit damage in late autumn and tainting the flavour of wine when accidentally harvested and processed along with grapes<sup>7–9</sup>. Moreover, *H. axyridis* has been reported to increasingly search for overwintering sites in residential buildings within new geographic regions. Exposure to the species may also affect humans by triggering allergic reactions<sup>10</sup>.

The first record of the invader in Serbia was reported in 2008 from the Vorovo locality within the Fruška Gora National Park<sup>11,12</sup>, in the north part of country. The aim of this work was to confirm presence of this invasive species in the Western Serbian region.

## EXPERIMENTAL

The Moravica district is located in central Serbia, encompassing the municipalities of Gornji Milanovac, Cacak, Lucani and Ivanjica. The Republic of Serbia (88 361 km<sup>2</sup>) covers the central and south-eastern parts of Europe and the central regions

of the Balkan Peninsula (Fig. 1), lying between 41°52' and 46°11' N latitudes and 18°06' and 23°01' E longitudes. Lowlands are typical of the north – Vojvodina province, and highlands cover 3/4 of the whole country area<sup>13</sup>.



**Fig. 1.** Locations of study sites

Several collection methods were used depending on the type of habitat. The specimens were collected by shaking them off the host plants and structures, using an aspirator or by hand-picking individual specimens. The collected specimens were transferred from flacons into ‘self-lock’ cuvettes to allow easy manipulation and, then, they were refrigerated.

The material was sampled from 15 rural sites in the municipalities of Cacak and Gornji Milanovac as well as from a few urban sites. The location of each site where the species had been detected was pinpointed by a GPS device (EtrexLegend, Garmin).

Determination of the specimens was conducted using the method described by Kuznetsov<sup>14</sup>.

## RESULTS AND DISCUSSION

Large aggregations of small-sized beetles were observed in late autumn 2009 in the residential areas of the municipalities of Cacak and Gornji Milanovac in the Moravica District (Fig. 1).

Sampling was conducted at 15 rural and 4 urban sites during October and November 2009 (Fig. 2).

The invasive species *H. axyridis* were first reported in Serbia in August 2008 from the Fruska Gora National Park<sup>11</sup>, located in the northern part of the country. This species was detected in 2009 in the villages of Vranici, Milicevci, Gornja Gor-

evnica, Miokovci, Trbusani, Srezojevci, Bersici, Leusici, Brezna, Teocin, Prijedor, Rosci, Jancici, Brdani and Premeca. The insect was also detected in the 4 urban locations (Cacak: Avenija I, Avenija II and Vinara, G. Milanovac – downtown). All locations lie between 43–44° N latitude and 20–21° E longitude at an altitude of 264–547 m a.s.l., in the western part of the state.



**Fig. 2.** Sampling sites of the collected *Harmonia axyridis* (P a l l a s, 1773)

The identification of the specimens collected (Fig. 3) suggested that all 3 forms of the invasive ladybird *H. axyridis* – *succinea*, *spectabilis* and *conspicua* – were found within the study area.



**Fig. 3.** Variations in colour forms of the collected *Harmonia axyridis* (P a l l a s, 1773)

Cases of insect aggregations on the sun-facing exposure of the buildings – usually a southern or south-western exposure, and on the light-coloured surfaces of residential buildings were notified at the end of October (20–25 October 2009)

and in mid-November (14–17 November 2009). The common feature of the above dates is a stronger increase in daily temperatures over a few days subsequent to the previously recorded lower temperatures approaching 0°C. During the period, peak daily temperatures during the warmest part of the day ranged from 13 to 25°C (Cacak Fruit Research Institute Weather Station database). It was during the warmest time of the day that massive aggregations were recorded, mostly on the sun-facing and brightly lit exposures of the doors, windows, balconies, balusters, parts of roof structures and building façades. The above occurrence is in agreement with the autumn flights of the insect in Ohio, USA (Ref. 10). Infamous autumn migrations are characteristic of the species<sup>15</sup>. The migrations include the insects flying towards specific target points on the horizon, generally including isolated and brightly sunlit buildings. These locations of the buildings, mostly houses or cottages, served as the largest aggregation sites of the insect, as determined during the collection process.

The above findings are the first record of *H. axyridis* in this part of Serbia. The insects formed dense aggregations at the respective sites and showed a tendency to move towards the interior of residential buildings. Insufficient knowledge of the species caused problems in the interior of houses or flats due to the mechanical methods of insect elimination employed, resulting in the smearing of walls, curtains, wallpapers and furniture.

During the period, no disturbances in the human population were reported, as expected in view of earlier investigation<sup>16</sup>. Interestingly, the rate of allergic responses in humans declined from an average of 30% in the rural population to as low as 16% in the urban population<sup>16</sup>. The ladybird is the leading allergen in the invaded regions causing conjunctivitis, asthma and urticaria<sup>16</sup>. This fact indicates that there is a great risk of allergic reactions in the rural population exposed to *H. axyridis* in Serbia, considering the above 15 sites in the western Serbia.

The above findings suggest an extremely high capacity and broad phenotypic plasticity of *H. axyridis* as well as its likely further spread into new geographic regions. This hypothesis is strengthened by the fact that the species has been recorded in the northern parts of the USA and in the south Canada<sup>4</sup>, i. e. in regions where minimum daily temperatures tend to drop to the freezing point that may be lethal to *H. axyridis*. However, the species has sought out suitable overwintering sites that provide absolute protection against extremely low temperatures and ensure its further spread throughout the geographic region in question. There are no such temperature extremes in Serbia, but temperature fluctuations are evidently quite an insufficient indicator of the potential spread or occurrence of *H. axyridis* within a geographic region. Basically, they can not be considered a factor constraining the further spread of the species range.

## CONCLUSIONS

Given the fact that ladybirds as members of the Serbian entomofauna have not been sufficiently investigated<sup>17-21</sup>, monitoring of this insect group should be conducted, particularly in view of the current records of the invasive multicoloured Asian ladybird *H. axyridis* from a number of locations in Serbia. Also, this monitoring system should be developed according to modern and practical geographical information system – GIS (Ref. 22). Implementation at the same time of GIS+monitoring gives us the opportunity to develop applications using maps and represent spatial distribution of this species in the region studied.

This paper represents the first evidence of mass aggregations of this non-native invasive species in the western part of Serbia. We should explore establishment of this coccinellid in this region of Serbia, potential interactions with native species and presence and undesirable effects on fruits in this leading productions area. Adequate control measures should be explored and developed in the light of its harmful effects on exposed ecosystems and potential health risks for the human population. The measures should particularly focus on indoor insect control, considering the potentially deleterious effects of biocides on humans.

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