

# EXPANSION OF *HARMONIA AXYRIDIS* (PALLAS, 1773) (COLEOPTERA: COCCINELLIDAE) IN SOUTH-EASTERN EUROPE

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In this paper, we report the first records of the harlequin ladybird *Harmonia axyridis* (Pallas, 1773) from Republic of Kosovo as well as new records from Albania, Greece, Montenegro and the Republic of North Macedonia. So far, the species is reported from 25 localities in Kosovo (first record in 2013) and 13 localities all over Montenegro. *H. axyridis* was found at different habitats and elevations, from sea level up to 1700 m above sea level, frequently being associated with seven coccinellid species. Our results clearly indicate that the harlequin ladybird is well established all over South-eastern Europe. Future studies should focus on its potential impact on native ladybird fauna.

**Key words:** Balkan Peninsula, distribution, invasion, Ladybird

Ibrahimi, H., Gligorović, A., Gligorović, B., Kulijer, D., Bilalli, A., Musliu, M., Geci, D. & Bozdoğan, H.: Širenje vrste *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) u jugoistočnoj Europi. *Nat. Croat.*, Vol. 31, No. 1, 31-42, Zagreb, 2022.

U radu donosimo prve nalaze harlekinske božje ovčice *Harmonia axyridis* (Pallas, 1773) iz Republike Kosovo, kao i nove nalaze iz Albanije, Grčke, Crne Gore i Republike Sjeverne Makedonije. Dosad je vrsta zabilježena na 25 lokaliteta na Kosovu (prvi nalaz 2013.) i na 13 lokaliteta u Crnoj Gori. *H. axyridis* nađena je na različitim staništima i nadmorskim visinama, od razine mora do 1700 m n.m., često zajedno s drugih sedam vrsta božjih ovčica. Naši rezultati jasno pokazuju da je harlekinska božja ovčica naselila cijelu jugoistočnu Europu. Buduća istraživanja trebala bi se fokusirati na njen potencijalni utjecaj na domaću faunu božjih ovčica.

**Ključne riječi:** Balkanski poluotok, rasprostranjenost, invazija, božja ovčica

## INTRODUCTION

*Harmonia axyridis* (Pallas, 1773) is a polymorphic species, with three main colour morphs: red or orange with zero to many black spots (form *succinea*), black with either

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four orange spots (form *spectabilis*) or two (form *conspicua*). The native distribution of the harlequin ladybird *Harmonia axyridis* comprises the Altai Mountains in the west, the Pacific Coast in the east, then southern Siberia in the north, to southern China in the south (e.g., KUZNETSOV, 1997; SASAJI, 1971, LOMBAERT *et al.*, 2011, ORLOVA-BIENKOWSKAJA *et al.*, 2015). It has been released as a classical biological control agent in North America since 1916 and was commercially available in Europe since the 1980s (ROY *et al.*, 2006). *H. axyridis* preys on a wide variety of insects, such as aphids, psyllids, coccids and adelgids (KOCH *et al.*, 2006). Amongst the alien coccinellids in Europe, *H. axyridis* has spread most rapidly in a wide variety of habitats across the continent (ROY & MIGEON, 2010). It has high dispersive potential and survivorship ability, becoming thus very often the predominant species at the expense of native coccinellid species (e.g. ALYOKHIN & SEWELL, 2004; ROY *et al.*, 2012).

In South-eastern Europe, *Harmonia axyridis* was reported during the past years from most of the area, including Albania (IBRAHIMI *et al.*, 2016), Bosnia and Herzegovina (KULIJER, 2010), Croatia (IVEŽIĆ *et al.*, 2011; MIČEVIĆ STANKOVIĆ *et al.*, 2011), Greece (KONTODIMAS *et al.*, 2008), Montenegro (GLIGOROVIĆ *et al.*, 2015), the Republic of North Macedonia (KULIJER, 2016), Serbia (THALJI & STOJANOVIĆ, 2008) and Slovenia (KUS VEENVLIET & VEENVLIET, 2009).

Systematic data about coccinellid species in Kosovo and Montenegro are largely lacking. The only data we could trace for Kosovo is an investigation from 1966 from western Kosovo where nine species are reported: *Subcoccinella vigintiquatuorpunctata* (Linnaeus, 1758), *Scymnus apetzii* Mulsant, 1846, *H. variegata*, *A. bipunctata*, *Adalia decempunctata* (Linnaeus, 1758), *C. quatuordecimpustulata*, *P. vigintiduopunctata*, *P. quatuordecimpunctata* and *Exochomus nigromaculatus* Goeze, 1777 (PURRINI, 1966). Coccinellid fauna of Montenegro has only recently been explored, mostly from the faunistic point of view (e.g. GLIGOROVIĆ, 2011; JORDANOVA, 2002; NIKČEVIĆ, 2007; THALJI *et al.*, 2008; ZEKOVIĆ *et al.*, 2008, 2010). However, biological and ecological data are lacking in these studies.

The goal of this paper is to provide the first record of *H. axyridis* from Kosovo and new distribution data from the Balkans. We also include data about some other coccinellid species cohabiting with *H. axyridis*.

## MATERIAL AND METHODS

Specimens were observed and collected during the period 2009-2016. In total 48 localities were sampled: 29 in the Republic of Kosovo, 13 in Montenegro, 4 in Albania, 3 in the Republic of North Macedonia and 2 in Greece. The geographical coordinates of the investigated localities are given in Table 1. The localities were only casually investigated and some sites were visited several times during the research period. Sampling sites were randomly selected, in order to represent different natural and man-made habitats. Beetles were collected mostly by handpicking, but also by sweep nets and light trapping. Sometimes, the specimens were only directly visually observed in the field. Twelve of the investigated sites are urbanized areas and manmade constructions, one is a planted wheat crop, while the rest are natural habitats. Collected specimens were preserved in 96% ethyl alcohol and identified at the laboratory. Collected specimens are deposited at the Department of Biology of the Faculty of Mathematics and Natural Sciences of the University of Prishtina "Hasan Prishtina", personal collection of Aleksandra Gligorović and the National Museum of Bosnia and

Herzegovina in Sarajevo. Specimens were identified by their outer morphology by using key of NEDVĚD (2015).

## RESULTS

Tab. 1. The list of localities where *Harmonia axyridis* and associated coccinellid species were recorded in South-eastern Europe in the period 2009-2016, with the number of individuals and locality data. Abbreviations: su. – succinea; sp. – spectabilis; co. – conspicua.

Locality	Date	Species found / colour forms	No. of individuals	Type of habitat
KOSOVO				
Janjevë 42.5745°N, 21.2514°E, 776 m asl.	14.04.2013	<i>Harmonia axyridis</i> / su.	1	Natural habitat
		<i>Coccinella septempunctata</i>	1	
Klinë e Ulët, Skënderaj 42.7595°N, 20.7880°E, 617 m asl.	16.01.2013	<i>Harmonia axyridis</i> / su.	2	Natural habitat
		<i>Coccinella septempunctata</i>	1	
		<i>Psyllobora vigintiduopunctata</i>	45	
Gjinoc, Suharekë 42.3154°N, 20.8166°E, 422 m asl.	11.04.2013	<i>Harmonia axyridis</i> / su., sp., co.	11	Natural habitat
		<i>Coccinella septempunctata</i>	35	
Suharekë 42.3638°N, 20.8342°E, 409 m asl.	21.04.2013	<i>Harmonia axyridis</i> / su., sp., co.	19	Natural habitat
		<i>Coccinella septempunctata</i>	2	
		<i>Psyllobora vigintiduopunctata</i>	1	
Rahovec 42.4034°N, 20.6563°E, 454 m asl.	16.03.2013	<i>Harmonia axyridis</i> / su., sp.	5	Manmade habitat
Gjilan 42.4400°N, 21.4731°E, 534 m asl.	12.02.2013	<i>Harmonia axyridis</i> / su.	2	Manmade habitat
Orllan, Prishtinë 42.8172°N, 21.3450°E, 650 m asl.	17.03.2013	<i>Harmonia axyridis</i> / sp.	2	Natural habitat
		<i>Hippodamia variegata</i>	1	
Metehi, Podujevë 43.0138°N, 21.1482°E, 719 m asl.	02.02.2013	<i>Harmonia axyridis</i>	4	Natural habitat
		<i>Adalia bipunctata</i>	1	
Greme, Ferizaj 42.3298°N, 21.1461°E, 615 m asl.	25.03.2013	<i>Harmonia axyridis</i> / sp.	2	Natural habitat
Ferizaj 42.3710°N, 21.1493°E, 584 m asl.	24.05.2013	<i>Adalia bipunctata</i>	6	Manmade habitat
		<i>Hippodamia variegata</i>	9	
		<i>Coccinula quatuordecimpustulata</i>	1	
Pollate, Podujevë 43.0465°N, 21.1274°E, 839 m asl.	17.03.2013	<i>Harmonia axyridis</i> / su., sp.	7	Natural habitat
		<i>Coccinella septempunctata</i>	3	
		<i>Chilocorus bipustulatus</i>	1	
Xerxe, Rahovec 42.3527°N, 20.5711°E, 316 m asl.	19.04.2013	<i>Harmonia axyridis</i> / su., sp., co.	9	Natural habitat
		<i>Coccinella septempunctata</i>	2	
Ballovç, Podujevë 42.8894°N, 21.2278°E, 603 m asl.	13.05.2013	<i>Harmonia axyridis</i> / su.	6	Natural habitat
		<i>Coccinella septempunctata</i>	10	
		<i>Hippodamia variegata</i>	2	
		<i>Propylea quatuordecimpunctata</i>	1	
Lipjan 42.5256°N, 21.1238°E, 554 m asl.	23.05.2013	<i>Coccinella septempunctata</i>	5	Natural habitat
Morinë, Skënderaj 42.6788°N, 20.8271°E, 647 m asl.	01.06.2013	<i>Harmonia axyridis</i> / su.	2	Natural habitat

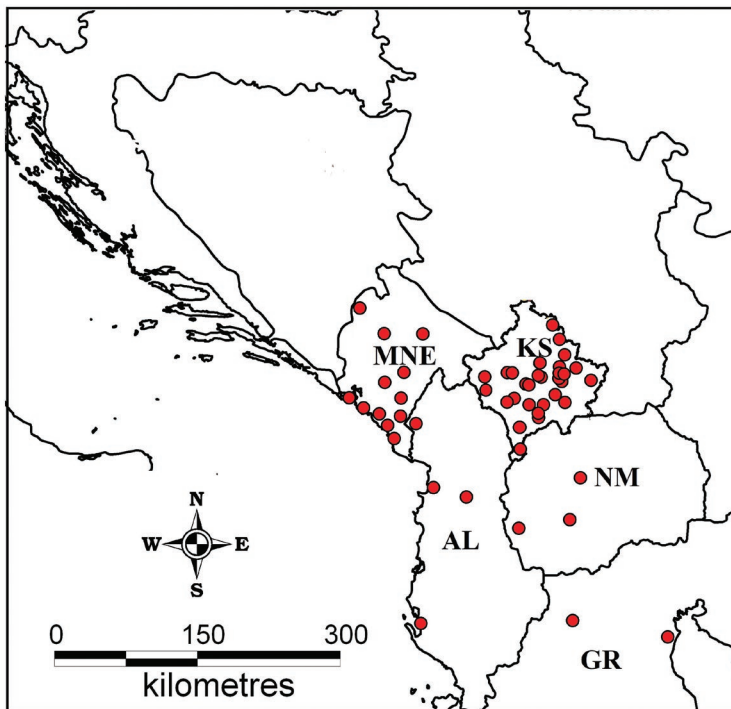
Locality	Date	Species found / colour forms	No. of individuals	Type of habitat
Prizren 42.2161°N, 20.7530°E, 496 m asl.	04.06.2013	<i>Harmonia axyridis</i> / su.	3	Manmade habitat
Bardhosh, Prishtinë 42.7196°N, 21.1415°E, 595 m asl.	15.06.2013	<i>Adalia bipunctata</i>	1	Natural habitat
Peqan, Suharekë 42.3827°N, 20.8235°E, 451 m asl.	02.06.2013	<i>Harmonia axyridis</i> / su., sp., co.	8	Natural habitat
		<i>Coccinella septempunctata</i>	4	
Brod, Dragash 41.9884°N, 20.7059°E, 1389 m asl.	19.06.2013	<i>Coccinella septempunctata</i>	3	Natural habitat
Prishtinë 42.6657°N, 21.1721°E, 615 m asl.	09.06.2013	<i>Harmonia axyridis</i> / su., sp.	2	Natural habitat
		<i>Coccinella septempunctata</i>	2	
		<i>Adalia bipunctata</i>	2	
Ratkoc, Gjakovë 42.4106°N, 20.5470°E, 369 m asl.	06.06.2013	<i>Harmonia axyridis</i> / su., sp.	6	Natural habitat
		<i>Coccinella septempunctata</i>	3	
		<i>Hippodamia variegata</i>	3	
		<i>Psyllobora vigintiduopunctata</i>	1	
Klinë 42.6195°N, 20.5890°E, 384 m asl.	03.06.2013	<i>Harmonia axyridis</i> / su., sp., co.	11	Natural habitat
		<i>Coccinella septempunctata</i>	3	
		<i>Psyllobora vigintiduopunctata</i>	1	
Dragobil, Malishevë 42.4631°N, 20.7368°E, 602 m asl.	01.06.2013	<i>Harmonia axyridis</i> / su., sp.	8	Natural habitat
		<i>Coccinella septempunctata</i>	6	
		<i>Hippodamia undecimnotata</i>	4	
Rahovec 42.3944°N, 20.9679°E, 724 m asl.	22.04.2013	<i>Coccinella septempunctata</i>	2	Natural habitat
Shtuticë, Drenas 42.6975°N, 20.8611°E, 702 m asl.	22.04.2013	<i>Harmonia axyridis</i> / su., sp., co.	More than 100	Manmade habitat
Rixhevë, Klinë 42.5774°N, 20.6473°E, 582 m asl.	20.04.2013	<i>Harmonia axyridis</i> / su.	5	Natural habitat
		<i>Psyllobora vigintiduopunctata</i>	5	
Malishevë 42.4828°N, 20.7438°E, 532 m asl.	01.04.2013	<i>Coccinella septempunctata</i>	2	Natural habitat
		<i>Psyllobora vigintiduopunctata</i>	1	
		<i>Coccinula quatuordecimpustulata</i>	1	
Prishtinë 42.6636°N, 21.1636°E, 600 m asl.	19.03.2016	<i>Coccinella septempunctata</i>	1	Manmade habitat
Pejë 42.6611°N, 20.2655°E, 543 m asl.	20.03.2016	<i>Harmonia axyridis</i> / su.	1	Manmade habitat
Deçan 42.5472°N, 20.2669°E, 660 m asl.	20.03.2016	<i>Harmonia axyridis</i> / su.	17	Manmade habitat
MONTENEGRO				
Ravnjak, Mojkovac 42.5922°N, 19.2440°E, 840 m asl.	21.06.2009	<i>Harmonia axyridis</i> / su.	2	Natural habitat
		<i>Adalia bipunctata</i>	5	
Žabljak 43.0548°N, 19.0407°E, 1724 m asl.	15.07.2010	<i>Harmonia axyridis</i> / su., sp.	16	Natural habitat
		<i>Adalia bipunctata</i>	11	
Ulcinj/Ulqin 41.5437°N, 19.1555°E, 4 m asl.	23.07.2010	<i>Harmonia axyridis</i> / su., sp., co	More than 100	Manmade habitat
		<i>Coccinella septempunctata</i>	7	
		<i>Hippodamia variegata</i>	2	
Plužine 43.0914°N, 18.5027°E, 700 m asl.	23.07.2010	<i>Harmonia axyridis</i> / su.	8	Natural habitat
		<i>Coccinella septempunctata</i>	5	
		<i>Adalia bipunctata</i>	19	

Locality	Date	Species found / colour forms	No. of individuals	Type of habitat
Podgorica 42.2655°N, 19.1423°E, 46 m asl.	05.07.2011	<i>Harmonia axyridis</i> / su., sp.	7	Manmade habitat
		<i>Coccinella septempunctata</i>	16	
		<i>Adalia bipunctata</i>	32	
	20.05-13.08.2012	<i>Harmonia axyridis</i> / su., sp.	More than 100	
	18.05.-09.08.2013	<i>Harmonia axyridis</i> / su., sp.	More than 100	
Bar 42.0519°N, 19.0641°E, 13 m asl.	12.07.2013	<i>Harmonia axyridis</i> / su., sp., co.	4	Natural habitat
		<i>Coccinella septempunctata</i>	2	
		<i>Coccinula quatuordecimpustulata</i>	1	
Bijelo Polje 43.0130°N, 19.4422°E, 578 m asl.	03.09.2012	<i>Harmonia axyridis</i> / su., sp.	More than 100	Manmade habitat
		<i>Coccinella septempunctata</i>	9	
Danilovgrad 42.3313°N, 19.0627°E, 48 m asl	21.06.2013	<i>Harmonia axyridis</i> / su., sp.	2	Natural habitat
		<i>Adalia bipunctata</i>	34	
		<i>Coccinula quatuordecimpustulata</i>	3	
Kotor 42.2528°N, 18.4616°E, 11 m asl.	15.05.2012	<i>Harmonia axyridis</i> / su., sp., co.	2	Natural habitat
		<i>Coccinella septempunctata</i>	5	
		<i>Adalia bipunctata</i>	17	
Virpazar 42.1433°N, 19.0508°E, 17 m asl.	24.06.2012	<i>Harmonia axyridis</i> / su., sp.	16	Natural habitat
		<i>Coccinella septempunctata</i>	9	
Herceg Novi 42.2712°N, 18.3302°E, 17 m asl.	15.05.2012	<i>Harmonia axyridis</i> / su.	1	Natural habitat
		<i>Adalia bipunctata</i>	1	
		<i>Coccinula quatuordecimpustulata</i>	2	
Šavnik 42.5840°N, 19.0413°E, 1023 m asl.	15.08.2012	<i>Harmonia axyridis</i> / sp.	4	Natural habitat
		<i>Adalia bipunctata</i>	53	
ALBANIA				
Shkodër 42.0310°N, 19.2937°E, 22 m asl.	13.05.2010	<i>Harmonia axyridis</i> / su.	1	Natural habitat
Vlorë 40.2937°N, 19.2825°E, 7 m asl.	17.06.2014	<i>Harmonia axyridis</i> / su., sp., co.	3	Natural habitat
Durrës 41.1849°N, 19.2603°E, 6 m asl.	17.06.2014	<i>Harmonia axyridis</i> / su., sp.	2	Natural habitat
Elbasan 41.73475°N, 20.06947°E, 168 m asl.	22.06.2014	<i>Harmonia axyridis</i> / su., sp.	5	Natural habitat
GREECE				
Florina 40.4714°N, 21.2523°E, 635 m asl.	18.06.2014	<i>Harmonia axyridis</i> / su., sp., co.	2	Natural habitat
Solun 40.3730°N, 22.5713°E, 9 m asl	20.06.2014	<i>Harmonia axyridis</i> / su.	1	Natural habitat
REPUBLIC OF NORTH MACEDONIA				
Bitola 41.0213°N, 21.1823°E, 667 m asl.	03.07.2013	<i>Harmonia axyridis</i> / su.	1	Natural habitat
Ohrid 41.0655°N, 20.4722°E, 707 m asl.	18.06.2014	<i>Harmonia axyridis</i> / su., sp., co.	7	Natural habitat
		<i>Coccinella septempunctata</i>	3	
Skoplje 41.5921°N, 21.2835°E, 233 m asl.	21.06.2014	<i>Harmonia axyridis</i> / su., sp., co.	4	Manmade habitat
		<i>Coccinella septempunctata</i>	2	

The distribution of *Harmonia axyridis* in South-eastern Europe, based on random observation during this investigation, is presented in Figure 1. Photographs of some recorded specimens of the harlequin ladybird and other species are shown in Figures 2, 3, 4 and 5. During this investigation we found *H. axyridis* in 25 localities in Kosovo, 86 % of all investigated stations in Kosovo. Seven coccinellid species were recorded together with the harlequin ladybird in Kosovo: *Adalia bipunctata* (Linnaeus, 1758), *Hippodamia undecimnotata* (Schneider, 1792), *Chilocorus bipustulatus* (Linnaeus, 1758), *Coccinella septempunctata* Linnaeus, 1758, *Coccinula quatuordecimpustulata* (Linnaeus, 1758), *Hippodamia variegata* (Goeze, 1777), *Propylea quatuordecimpunctata* (Linnaeus, 1758) and *Psyllobora vigintiduopunctata* (Linnaeus, 1758). The most widespread species besides the harlequin was *C. septempunctata* which was found in 16 localities and always, except in one locality, was associated with the harlequin ladybird. *P. vigintiduopunctata* was present in six localities, *H. variegata* and *A. bipunctata* were present at four localities each, while *C. quatuordecimpustulata* in two localities only. All other species were found at a single locality. In Montenegro, *H. axyridis* was found in all randomly selected localities for coccinellids and together with the following species: *C. septempunctata*, *H. variegata*, *A. bipunctata*, and *C. quatuordecimpustulata*.

*Harmonia axyridis* was also found in three localities in the Republic of North Macedonia, four in Albania and two in Greece, as a result of casual findings.

Large numbers of between 2000 and 2500 specimens were observed during autumn and winter inside houses in Drenica Region in Kosovo and Ulcinj/Ulqin Municipality



**Fig. 1.** Records of *Harmonia axyridis* (Pallas, 1773) in Kosovo (KS), Montenegro (MNE), Albania (AL), Greece (GR) and Republic of North Macedonia (NM) during the period 2009-2016.





**Fig. 2.** Some of the observed specimens of *Harmonia axyridis* (Pallas, 1773) during 2009-2016 in diverse localities (in clockwise direction): Kotor, Virpazar, Virpazar, Ulcinj/Ulqin (Montenegro). Photos by: A. Gligorijevic, D. Kulijer and H. Ibrahim.

in Montenegro, while in other investigated sites in Montenegro and Kosovo the number of overwintering specimens was significantly lower. The selection of observational sites during autumn and winter was random and not systematic, however. Other coccinellid species (*Coccinella septempunctata* and *Adalia bipunctata*) were found overwintering together with *H. axyridis* inside houses in several cases during this investigation (Ulcinj/Ulqin (23.07.2010) and Bijelo Polje (03.09.2012)). Thus, in Drenica Region the overwintering colony consisted only from *H. axyridis* in very high abundance.



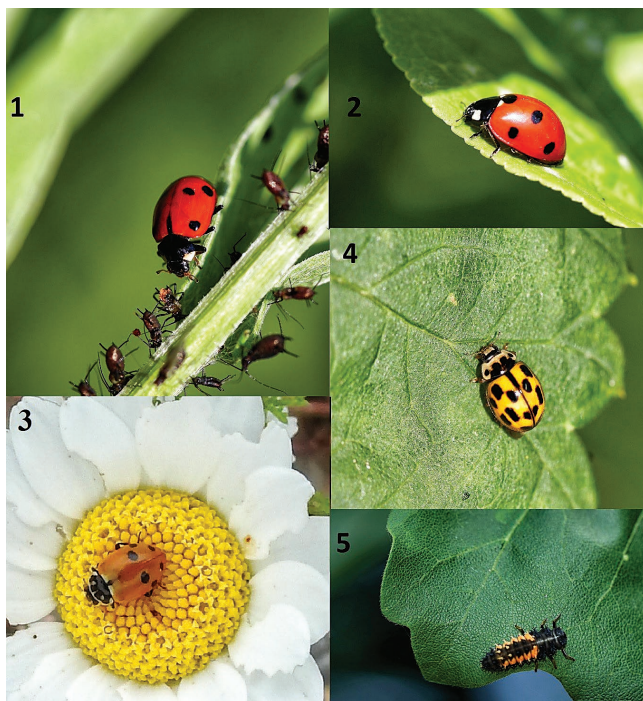
**Fig. 3.** Overwintering colony and different color morphs of *Harmonia axyridis* (Pallas, 1773): Ulcinj/Ulqin (Montenegro). Photo by A. Gligorijević.

In most of the cases, specimens of *H. axyridis* in Montenegro were associated with the following plant taxa: *Tillia* sp., *Alnus* sp., *Anethum* sp., *Chrysanthemum* sp., *Vitis* sp. and *Populus* sp. The association with a wheat crop was recorded in Bardhosh village, a Prishtina suburb in Kosovo.

The dominant colour forms of *Harmonia axyridis* were *succinea* and *spectabilis*, while *conspicua* was rare.

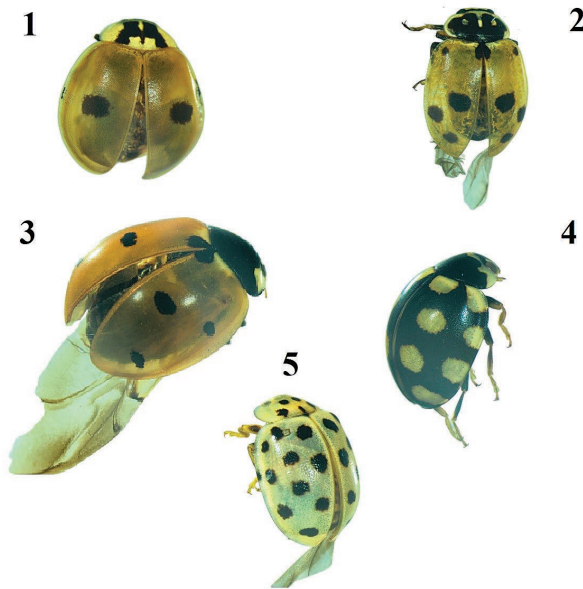
## DISCUSSION

During the last decade *Harmonia axyridis* has substantially widened its distribution range in Europe (e.g. ROY & MIGEON, 2010). Due to the high adaptability to various environmental conditions, the species is rapidly spreading all over the continent (cf. ALYOKHIN & SEWELL, 2004; KUS VEENVLIET & VEENVLIET, 2009; KULIJER, 2010; IBRAHIMI et al., 2016; IVEZIĆ et al., 2011; MIČEĆIĆ STANKOVIĆ et al., 2011; ROY & MIGEON, 2010; ROY et al., 2012). The invasion of *Harmonia axyridis* in Europe has been followed by a decline of some native species such as *Adalia bipunctata* (ROY et al., 2012) as result of its intraguild predation capacities towards other coccinellid species. During our investigation we found four species reported by PURRINI (1966) for Kosovo: *H. variegata*, *A. bipunctata*, *C. quatuordecimpustulata* and *P. vigintiduopunctata*. We also found three species not recorded in this investigation: *Coccinella septempunctata*, *C. undecimnotata* and *C. bipustulatus*. Without a previous large scale population as well as biological and ecological data it is impossible to conclude the level of impact of *Harmonia axyridis* in populations of other coccinellid species. However, based on our investigation we can conclude that *H. axyridis* has become well established and cohabits with populations of the following species: *A. bipunc-*



**Fig. 4.** Some of the observed ladybird species in the field; locality name is given in brackets: 1. *Hippodamia undecimnotata* (Malishevë, Kosovo), 2. *Coccinella septempunctata* (Malishevë, Kosovo), 3. *Hippodamia variegata* (Malishevë, Kosovo), 4. *Propylea quatuordecimpunctata* (Ballovç, Kosovo) and 5. Larvae of *Harmonia axyridis* (Ballovç, Kosovo). Photo by D. Kulijer and H. Ibrahimi





**Fig. 5.** Some of the observed specimens, photographed in the laboratory; locality name is in brackets: 1. *Adalia bipunctata* (Ferizaj, Kosovo), 2. *Hippodamia variegata* (Ballovc, Kosovo) 3. *Coccinella septempunctata* (Suharekë, Kosovo) 4. *Coccinula quatuordecimpustulata* (Malishevë, Kosovo) and 5. *Psyllobora vigintiduopunctata* (Klinë, Kosovo). Photo by D. Kulijer and H. Ibrahim

*tata*, *C. septempunctata*, *H. variegata* and *P. vigintiduopunctata*. In Podgorica during the period 2011-2013, we noticed that populations of *C. septempunctata* and *A. bipunctata* disappeared after two seasons of cohabitation. However, more detailed and repeated investigations in this area must be carried out in order to study the interaction of the harlequin ladybird and other coccinellid species.

The high invasive potential of *H. axyridis*, in both urbanized areas and natural habitats such as grasslands and bushes has already been proven worldwide, including in South-eastern Europe (ADRIAENS *et al.*, 2008; BROWN *et al.*, 2008; KULIJER, 2017; MIČEVIĆ STANKOVIĆ *et al.*, 2010; ROY *et al.*, 2006). In this regard, during our investigation, we found the harlequin ladybird in a variety of habitats, such as town parks, green areas and gardens inside the towns, as well as in wild habitats. Several investigations proved that *H. axyridis* also inhabits field crops and in some cases these are regular habitats for this species (e.g. BROWN, 2003; NAULT & KENNEDY, 2003; VANDEREYCKEN, 2013). This was observed during our investigation too, where established populations of the harlequin ladybird were found in a wheat field crop near Prishtinë in Kosovo. During our investigation, *H. axyridis* has been found from 1 m a.s.l. in Ulqin/Ulcinj (Montenegro) up to 1700 m a.s.l. in Žabljak Mountains (Montenegro). In other European countries *H. axyridis* has been also found at different elevations, e.g. in Slovakia from 100 to 1250 m a.s.l. (PANIGAJ, *et al.*, 2014) and in Bosnia and Herzegovina from 1 to 2030 m a.s.l. (KULIJER, 2017).

Based on this preliminary assessment of the distribution of the harlequin ladybird, we can conclude that *H. axyridis* has become one of the dominant coccinellid species in Kosovo and Montenegro, both in terms of presence/absence at the sites and in terms of abundance. However, this observation must be further verified and backed up with data from more diverse habitats in the area. In particular, high altitude mountains must be investigated in order to see if the harlequin ladybird has managed to establish its populations in these habitats as well.

Previous studies have found that adults of *H. axyridis* seek shelter in autumn and very often choose houses and other artificial objects as their overwintering sites (KOCH, 2003), sometimes in very abundant populations (e.g. MIČEĆIĆ STANKOVIĆ *et al.*, 2010). This was observed during our investigation as well in several places in Kosovo and Montenegro.

The long term establishment and rapid spread of *H. axyridis* seems likely in many regions across the world. Based on the CLIMEX prediction, large parts of Mediterranean Europe, South America, Africa, Australia, and New Zealand seem highly suitable for the long-term survival of *H. axyridis* (POUTSMA *et al.*, 2008). Our investigation confirms that *Harmonia axyridis* has already invaded the whole of South-eastern Europe and is currently one of the most widely diffused coccinellid species in the investigated area, possibly already affecting populations of native species.

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## SUMMARY

### Expansion of *Harmonia axyridis* (Pallas, 1773) in South-eastern Europe

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In this study, we present the first record of *Harmonia axyridis* from Republic of Kosovo and new data from Albania, Greece, Montenegro and the Republic of North Macedonia. The species is reported from 25 localities in Kosovo and 13 localities all over Montenegro. During a rapid survey in these two countries it was found that Harlequin ladybird is frequently associated with seven coccinellid species: *Adalia bipunctata*, *Hippodamia undecimnotata*, *Chilocorus bipustulatus*, *Coccinella septempunctata*, *Coccinula quatuordecimpustulata*, *Hippodamia variegata*, *Propylea quatuordecimpunctata* and *Psyllobora vigintiduopunctata*. The species was found at different habitats and altitudes, from sea level up to 1700 m.

Long term establishment and quick spread of *H. axyridis* seems likely in many regions across the world. Our investigation confirms that *Harmonia axyridis* has already invaded the whole southeastern Europe and is currently one of the most spread coccinellid species in the investigated area. Further studies must confirm if its spread is possibly affecting populations of local species.