

The Distribution, Habitat and Colour Forms Frequency of the Invasive *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) in Bosnia and Herzegovina

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Harmonia axyridis (Pallas, 1773) (Coleoptera, Coccinellidae) is an invasive alien coccinellid species that has rapidly spread over Europe in the last 25 years. The first report from Bosnia and Herzegovina was a record of several overwintering adults from January 2010. The species distribution was mapped on the basis of field surveys conducted from 2010 to 2015. *H. axyridis* was recorded at 87 localities in altitudes ranging from 1 to 2,030 m a.s.l.. The species was found to be established and widespread in the country and present in various habitats, particularly urban, ruderal and marshland habitats. It was most frequently observed on *Tilia* sp., *Salix* sp., *Typha* sp., *Phragmites australis*, *Urtica dioica* and *Humulus lupulus*. The non-melanic colour form (f. *succinea*) was the most dominant. The frequency of colour forms among the 496 adults was: f. *succinea* – 85.50%, f. *spectabilis* – 9.88%, f. *conspicua* – 4.44% and f. *axyridis* – 0.20%.

Key words: biological invasion, harlequin ladybird, *Harmonia axyridis axyridis*, *Harmonia axyridis conspicua*, *Harmonia axyridis spectabilis*, *Harmonia axyridis succinea*, invasive alien species, multicolour Asian ladybeetle

INTRODUCTION

The multicoloured Asian ladybeetle or harlequin ladybird, *Harmonia axyridis* (Pallas, 1773) (Coleoptera, Coccinellidae), is an invasive coccinellid native to East and Central Asia: China, Japan, Korea, Mongolia, eastern Russia and Kazakhstan (Dobzhansky, 1933; Brown et al., 2011). It was deliberately introduced to Europe, North America, South America and Africa as a biological control agent for aphids and coccids (Koch et al., 2006). The harlequin ladybird is probably the most infamous coccinellid used as a biocontrol agent. The species has spread to large areas of the world where it has become a predator on many native arthropods, household invader and pest in fruit production (Koch, 2003; Majerus et al., 2006). It is a large and aggressive polyphagous coccinellid with a very wide prey range that includes aphids, coccids, adelgids, psyllids, eggs and larvae of many insects, including other Coleoptera and Lepidoptera (Koch, 2003; Ware and Majerus, 2008).

Four main forms of this highly variable species are found in Europe. The f. *succinea* is orange or red with 0 to 21 black spots which can sometimes be fused; f. *axyridis* has a grid-like black pattern on the elytra; f. *spectabilis* is black/melanic and has four yellow, orange, or red spots or other shaped markings, which sometimes contain a central black spot; f. *conspicua* is the same as the latter, but with only two spots (Majerus et al., 2006; Brown et al., 2008b). The *succinea* complex that is dominant in Europe (e.g. Brown et al., 2011) can be divided into many subforms (e.g. *siccoma*—0 spots; *frigida*—6 spots; *novemdecimsignata*—19 spots) (Dobzhansky, 1933).

Lombaert et al. (2010) gave a detailed overview of the invasion routes at the global level and suggested that the main source of colonists are populations of *H. axyridis* from the eastern United States, originating from two independent introductions from the species' native range. Invaders from the eastern United States were also the source of European populations that were additionally mixed with individuals from the species' native range. In Europe *H. axyridis* was first reported in the wild in France in 1991. During the 1990's and especially after 2002 the harlequin ladybird spread rapidly throughout Europe and by 2011 was already reported from 26 countries (Brown et al., 2008a, 2011).

In the Western Balkans the harlequin ladybird was first found in Croatia and Serbia in 2008 (Thalji and Stojanović, 2008; Stanković et al., 2010) and recently also in Macedonia (Kulijer, 2016), Montenegro (Gligorović et al., 2016), Albania (Ibrahimi et al., 2016) and Kosovo (Ibrahimi et al., 2017). The first record in Bosnia and Herzegovina was in 2010 (Kulijer, 2010), but at the time only a few adult specimens were found overwintering in the buildings of the National Museum of Bosnia and Herzegovina in Sarajevo and there was no evidence of its establishment.

The aim of this study is to summarize all known records of *H. axyridis* collected over the period 2010 - 2015 and document the distribution, frequency of colour forms and plant hosts of the species in the early years of its establishment in Bosnia and Herzegovina.

MATERIAL AND METHODS

Bosnia and Herzegovina is predominantly a mountainous country situated in the western part of the Balkans peninsula (Fig.1a). Its climate and geomorphology are highly variable, with a Mediterranean climate dominating in the southern, an alpine climate in the areas of high mountains and a continental climate in the northern, lowland part of the country. The study area covers most of the country territory within three biogeographical regions: Continental, Alpine and Mediterranean (EEA, 2016).

Distribution records are mainly the result of the author's personal observations, while some were submitted by other contributors. Between 24 March 2010 and 16 July 2015, 87 localities were surveyed (Tab.1). The sampling was carried out by visual search and collecting by hand or using an entomological hand net to sweep through vegetation. The proportion of colour forms of the imagoes was counted. A variety of different habitats were sampled randomly, with the highest research effort made in wetland habitats and urban areas. The specimens collected were preserved in 70% ethyl alcohol and housed in the entomological collections of the National Museum of Bosnia and Herzegovina.

RESULTS

During the study the harlequin ladybird was found at 87 localities in Bosnia and Herzegovina. It was observed throughout the country in a wide range of climatic zones and habitats in all three biogeographical regions (Fig.1b) (Tab.1). The altitude ranges from 1 m a. s. l. in the Neretva River valley (loc. 16 and 46) to 2.030 m a.s.l. at Lupoglav peak on Mt. Prenj (loc. 54). The southernmost locality in Bosnia and Herzegovina is Trebinje (loc. 24).

All four main colour forms of *H. axyridis* were observed in the country. A total of 496 recorded specimens had information on the form type; among them f. *succinea* was by far the most dominant (85.50%), followed by f. *spectabilis* (9.88%) and f. *conspicua* (4.44%). Only one individual of f. *axyridis* was recorded (0.20%) (Tab.1). The presence of f. *axyridis* is interesting as this form is rare in Europe (e. g. Brown, 2010).

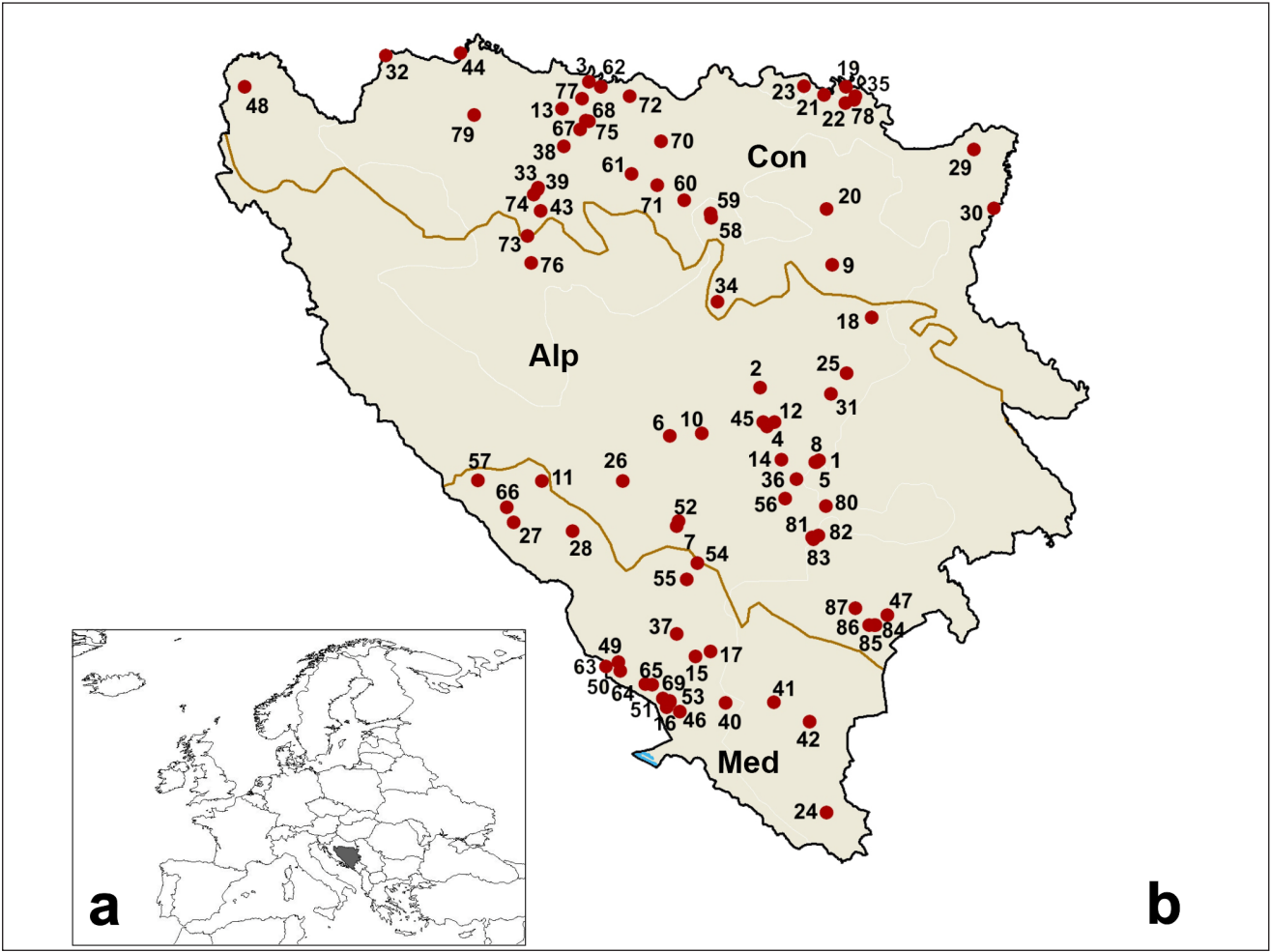


Figure 1. Geographical position of Bosnia and Herzegovina (a) and the distribution of finding sites of *Harmonia axyridis* (Pallas, 1773) within the different biogeographical regions of the country (Con – Continental, Alp – Alpine, Med – Mediterranean) (b)

Table 1. Summary of the collected data on *H. axyridis* in Bosnia and Herzegovina with a list of localities, survey dates, colour forms, life stages and host plants (suc – f. *succinea*, spc – f. *spectabilis*, con – f. *conspicua*, axy – f. *axyridis*, A – adult, L – larva, P – pupa, E – egg, Con – Continental, Alp – Alpine, Med – Mediterranean).

	Locality	Date	Form (imago)				Life stage	Host plant	Biogeographical region	N	E
			suc	spc	con	axy					
1	Sarajevo, Botanical garden of the National Museum of Bosnia and Herzegovina	24.03.2010.	1				A		Alp	43°51'16"	18°24'10"
		27.04.2010.	1				A	<i>Ligustrum vulgare</i>			
		06.05.2010.	1				A	<i>Euonymus</i> sp.			
		10.05.2010.	1				A	<i>Euonymus</i> sp.			
		11.05.2010.		1			A	<i>Euonymus</i> sp.			
		13.05.2011.		1			A				
		27.08.2014.			1		A				
2	Haljinići ponds	14.05.2010.	3				A	<i>Rumex</i> sp., <i>Rosa</i> sp., <i>Euonymus</i> sp.	Alp	44°06'08"	18°09'50"
		05.10.2010.	1				A				

	Locality	Date	Form (imago)				Life stage	Host plant	Biogeographical region	N	E
			suc	spc	con	axy					
3	Bardača wetland	27.05.2010.	2	1			A		Con	45°06'33"	17°26'16"
4	Visoko, fields in the vicinity	06.06.2010.	9	2			A,L,P	<i>Humulus lupulus</i> , <i>Acer campestre</i>	Alp	43°58'31"	18°11'22"
		29.03.2014.	4				A				
5	Sarajevo, lime tree avenue in the city centre	11.06.2010.	1				A	<i>Tilia</i> sp.	Alp	43°51'14"	18°23'57"
		29.06.2010.	1				A	<i>Tilia</i> sp.			
		26.07.2010.	1				A	<i>Artemisia vulgaris</i>			
		03.08.2010.	36	8	5		A,L,P	<i>Tilia</i> sp.			
		04.08.2010.	23	5	1	1	A,L,P	<i>Tilia</i> sp.			
		06.08.2010.	43	2	5		A,L,P	<i>Tilia</i> sp.			
6	Prokoško jezero	20.07.2010.	1				A		Alp	43°57'24"	17°45'13"
7	Jablanica city	23.07.2010.	1				A		Alp	43°39'52"	17°46'08"
8	Sarajevo, city park	04.08.2010.	29	8			A,L,P	<i>Tilia</i> sp.	Alp	43°51'36"	18°24'58"
9	Modrac jezero	05.08.2010.	10	4			A	<i>Typha</i> sp., <i>Heracleum</i> sp., <i>Sparganium erectum</i> , <i>Carum carvi</i>	Con	44°29'22"	18°30'43"
		03.09.2010.	1				A				
		01.06.2011.	11		1		A,L	<i>Humulus lupulus</i> , <i>Urtica dioica</i> , <i>Salix</i> sp.			
10	Fojnica, Franciscan Monastery	09.08.2010.	1				A	<i>Tilia</i> sp.	Alp	43°57'40"	17°53'49"
11	Šuičko polje	12.08.2010.	1				A		Alp	43°49'21"	17°10'29"
12	Ilijaš, Lješevo	18.08.2010.	1				A		Alp	43°59'17"	18°13'26"
13	Vilusi	30.10.2010.	6		1		A		Con	45°01'32"	17°18'38"
14	Vlakovo	30.10.2010.	1				A		Alp	43°52'01"	18°14'48"
15	Buna	16.05.2011.	2				A	<i>Rumex</i> sp.	Med	43°14'25"	17°50'04"
16	Gabela	16.05.2011.					L	<i>Typha</i> sp., <i>Umbeliferae</i>	Med	43°04'47"	17°41'55"
17	Blagaj	29.05.2011.					L	<i>Juglans regia</i>	Med	43°15'22"	17°54'08"
18	Gostelja River, Stupari	01.06.2011.	1				A		Alp	44°18'49"	18°40'44"
19	Domaljevac	02.06.2011.					L	<i>Salix</i> sp., <i>Typha</i> sp.	Con	45°03'45"	18°36'30"
20	Tinja River	02.06.2011.					A	<i>Urtica dioica</i>	Con	44°40'16"	18°29'44"
21	Velika Tišina wetland	02.06.2011.	16	2			A,L	<i>Urtica dioica</i> , <i>Stenactis annua</i>	Con	45°02'21"	18°30'26"
22	Oštra Luka	02.06.2011.	1				A,L	<i>Urtica dioica</i>	Con	45°00'39"	18°36'09"
		04.06.2015.	7				A	<i>Medicago sativa</i> , <i>Poaceae</i>			
23	Vojskova	03.06.2011.					L,P		Con	45°04'12"	18°25'04"
24	Trebinje	09.06.2011.	1				A	<i>Rosa</i> sp.	Med	42°43'12"	18°23'03"
25	Boganovići, Krivaja River, Olovo	13.06.2011.	1				A,L	<i>Salix</i> sp.	Alp	44°08'13"	18°33'16"
26	Ramsko jezero	16.06.2011.	1				A		Alp	43°48'54"	17°32'11"
27	Buško jezero	23.06.2011.					L		Med	43°41'27"	17°02'35"
28	Boričani, Duvanjsko polje	25.06.2011.					A,P	<i>Populus nigra</i>	Med	43°39'31"	17°18'21"
29	Crnjelovo	07.07.2011.	1				A		Con	44°50'24"	19°10'42"
30	Janja	07.07.2011.	1				A		Con	44°38'52"	19°15'10"

	Locality	Date	Form (imago)				Life stage	Host plant	Biogeographical region	N	E
			suc	spc	con	axy					
31	Nišići	08.07.2011.	1				A		Alp	44°04'25"	18°28'50"
32	Bosanska Kostajnica	07.08.2011.	2				A	<i>Heracleum</i> sp.	Con	45°12'40"	16°30'43"
33	Banja Luka, city centre	10.09.2011.	1				A		Con	44°46'18"	17°11'33"
		15.10.2011.	1				A				
34	Donja Golubinja	01.10.2011.	1				A		Alp	44°23'05"	17°59'16"
35	Tolisa	15.10.2011.	50	7	3		A		Con	45°01'53"	18°39'02"
36	Hrasnica	14.05.2012.	1				A		Alp	43°48'06"	18°18'45"
37	Krenica, Mostarsko blato	18.05.2012.					A	<i>Arthemisia</i> sp.	Med	43°18'59"	17°45'17"
		08.06.2012.					L,P	<i>Arthemisia</i> sp.			
38	Laktaši, oxbow	27.05.2012.	30	3			A,L	<i>Stenactis annua</i> , <i>Humulus lupulus</i>	Con	44°54'16"	17°18'57"
		13.06.2014.	8	1	1		A				
		11.06.2015.	1				A				
39	Kastel, Banja Luka	28.05.2012.					L		Con	44°45'56"	17°11'21"
40	Stolac	07.06.2012.	1				A		Med	43°05'11"	17°57'37"
41	Dabarsko polje, south of Berkovići	14.06.2012.	1				A		Med	43°05'01"	18°10'24"
42	Hum, Fatničko polje	14.06.2012.					L		Med	43°01'01"	18°19'39"
43	Karanovac	22.06.2012.	1	1			A		Con	44°41'46"	17°12'09"
		25.04.2015.	1				A				
44	Draksenić, Kozarska Dubica	23.06.2012.	2				A,L	<i>Salix</i> sp., <i>Stachys</i> sp.	Con	45°12'55"	16°51'19"
45	Visoko, town	25.06.2012.	1				A		Alp	43°59'26"	18°10'21"
46	Karaotok, Hutovo blato	08.07.2012.					L	<i>Phragmites australis</i>	Med	43°03'53"	17°45'24"
47	Tjentište	10.07.2012.	3				A		Alp	43°21'02"	18°41'18"
		28.06.2015.	3				A	<i>Salix</i> sp., <i>Poaceae</i>			
48	Mala Kladuša	19.08.2012.	1				A	<i>Sparganium erectum</i>	Con	45°06'57"	15°51'57"
49	Krči, Ljubuško polje	11.05.2013.					L,P		Med	43°13'46"	17°29'32"
50	Mlade River, Ljubuško polje	11.05.2013.					L		Med	43°12'09"	17°29'53"
51	Grabovine, Čapljina	14.05.2013.					L,P	<i>Iris pseudacorus</i>	Med	43°06'31"	17°41'04"
52	Donje Paprasko	27.06.2013.	1				A		Alp	43°40'51"	17°46'49"
53	Otoke, Klepci, Čapljina	29.06.2013.					L	<i>Phragmites australis</i>	Med	43°05'41"	17°42'52"
54	Lupoglav, Prenj Mts.	14.07.2013.	16	1			A		Med	43°32'33"	17°51'24"
55	Bijela, Neretva River canyon	14.07.2013.	1				A	<i>Epilobium angustifolium</i>	Med	43°29'24"	17°48'25"
56	Naplavci, Igman Mts.	16.07.2013.	1				A	<i>Urtica dioica</i>	Alp	43°44'24"	18°15'28"
57	Table, Livanjsko polje	24.07.2013.	5				A		Med	43°49'50"	16°53'16"
58	Jelah, fishpond	31.08.2013.	1				A	<i>Salix</i> sp.	Con	44°39'24"	17°58'21"
59	Tokići	31.08.2013.	1				A	<i>Salix</i> sp.	Con	44°40'15"	17°58'12"
60	Cerovica	31.08.2013.	1				A		Con	44°42'59"	17°51'09"
61	Drenova	31.08.2013.	1				A	<i>Arthemisia vulgaris</i>	Con	44°48'31"	17°37'09"

	Locality	Date	Form (imago)				Life stage	Host plant	Biogeographical region	N	E
			suc	spc	con	axy					
62	Trnjačani, Srbac	01.09.2013.	1				A	<i>Salix</i> sp.	Con	45°05'34"	17°29'29"
		15.06.2015.	2				A				
63	Muratovac, Ljubuško polje	28.04.2014.	1				A		Med	43°13'00"	17°26'10"
64	Kravice	29.04.2014.	2				A	<i>Populus nigra</i>	Med	43°09'22"	17°36'29"
65	Studenčica, mouth to Trebižat River	29.04.2014.	2				A	<i>Humulus lupulus</i>	Med	43°09'16"	17°38'22"
66	Mandek	01.05.2014.	3				A		Med	43°44'28"	17°00'49"
67	Gornje Kosjerevo	13.06.2014.	1				A		Con	44°57'25"	17°23'27"
68	Gornja Ada, Kukulje	13.06.2014.	1				A		Con	44°59'08"	17°25'07"
69	Bregava, mouth to Neretva River	20.06.2014.	2				A	<i>Phragmites australis</i>	Med	43°05'55"	17°42'54"
70	Prnjavor ribnjak	02.08.2014.	4				A		Con	44°54'39"	17°45'26"
71	Ukrina River	02.08.2014.	1				A		Con	44°46'09"	17°43'59"
72	Motajica Mts.	04.08.2014.	1				A	<i>Eupatorium cannabinum</i>	Con	45°03'30"	17°37'21"
73	Krupa na Vrbasu	25.04.2015.	3	1	1		A	<i>Salix</i> sp.	Con	44°37'01"	17°08'16"
74	Sitari, Banja Luka	17.05.2015.	5				A,L,P	<i>Reynoutria japonica</i> , <i>Acer campestre</i> , <i>Juglans regia</i>	Con	44°45'04"	17°10'22"
75	Stari Martinac	19.05.2015.	2				A,L	<i>Salix</i> sp.	Con	44°58'54"	17°25'52"
76	Bočac	20.05.2015.	1				A		Alp	44°31'47"	17°09'13"
77	Vrškalo, Kladari	02.06.2015.	1		1		A		Con	45°03'23"	17°24'16"
78	Tolisa-Bok	04.06.2015.	1				A	<i>Vicia cracca</i>	Con	45°01'11"	18°38'33"
79	Mrakovica, Kozara Mts.	13.06.2015.					L	<i>Tilia</i> sp.	Con	45°00'49"	16°54'35"
80	Bošćići	04.07.2015.	1				A		Alp	43°42'36"	18°26'13"
81	Crno jezero, Treskavica Mts.	11.07.2015.	1				A		Alp	43°36'43"	18°22'12"
82	Palež, Treskavica Mts.	11.07.2015.	1				A		Alp	43°37'04"	18°23'53"
83	Veliko jezero, Treskavica Mts.	11.07.2015.	1				A		Alp	43°36'21"	18°22'32"
84	Suha jezerina, Donje Bare, Zelengora Mts.	14.07.2015.	1				A		Alp	43°19'12"	18°38'02"
85	Donje Bare, Zelengora Mts.	14.07.2015.	2		1		A		Alp	43°19'07"	18°37'49"
86	Gornje Bare, Zelengora Mts.	14.07.2015.	20	1			A		Alp	43°19'11"	18°36'29"
87	Orlovačko jezero, Zelengora Mts.	16.07.2015.	2		1		A		Alp	43°22'38"	18°32'56"
			424	49	22	1					
			85,5%	9,9%	4,4%	0,2%					

DISCUSSION

There is no indication that *H. axyridis* was ever intentionally released in Bosnia and Herzegovina. It probably invaded the country from the neighbouring regions of Croatia and Serbia in the north, where it was found earlier (Thalji and Stojanović, 2008; Stanković et al., 2010). As its first recording in Bosnia and Herzegovina involved several overwintering individuals found in early 2010 in the central part of the country (Kulijer, 2010) it is almost certain that the harlequin ladybird was

present in the country in 2009. The discovery of several hundred larvae, pupae and adults in August 2010 in downtown Sarajevo was final proof that *H. axyridis* was established in Bosnia and Herzegovina.

H. axyridis is a habitat generalist (Brown et al. 2011, Vandereycken et al. 2012). In Europe it is reported from many different habitats: meadows, forests, wetlands, heathlands, urban areas, reed beds, crop fields, fruit trees, ruderal areas (Adriaens et al., 2008; Steenberg and Harding, 2009; Vandereycken et al.,

2012). According to Koch et al. (2006), f. *succinea* is generally associated with boreal forests, temperate broadleaf and mixed forests, temperate coniferous forests and tropical-subtropical moist broadleaf forests. In Great Britain *H. axyridis* is reported from 75 families of flowering plants (Brown et al., 2011) and in Belgium it has been recorded on 159 plant species (Adriaens et al., 2008). Most records are associated with deciduous tree and shrub species, particularly *Tilia* sp., *Salix* sp., *Acer* sp., *Quercus* sp. and *Betula* sp. (e.g. Adriaens et al., 2008; Brown, 2010).

In Bosnia and Herzegovina the largest number of records originates from lime trees (*Tilia* sp.). At multiple localities the harlequin ladybird was also found on *Salix* sp., *Phragmites australis* (Cav.) Trin. ex Steud., *Typha* sp., *Urtica dioica* L., *Humulus lupulus* L. During this investigation the harlequin ladybird was found in karst poljes, specific habitats characteristic of the Western Balkans karst area with many rare and endemic plant associations and species. Records from Bosnia and Herzegovina indicate its major presence in urban, ruderal and marshland habitats, but these results partly also reflect the higher research effort in these habitats and not only the species distribution and habitat preference. Although *H. axyridis* was not the primary target of the field research it was recorded at the majority of surveyed localities and was by far the most recorded coccinellid species. It was observed in greater numbers at several locations in urban area of Sarajevo and also at two sites in the northern part of the country. Records from the northern part of the country originate mainly from marshland and ruderal areas close to Modrac Lake and areas along the Sava River, both from early June 2011. In Sarajevo, large numbers of larvae, pupa and imagoes were observed in early August 2010 on lime trees in a downtown park and also in the lime tree avenue near the National Museum of Bosnia and Herzegovina.

In most European countries a mix of the three main colour forms is present: f. *succinea*, f. *spectabilis* and f. *conspicua*, with f. *succinea* dominating in all European populations. The ratio of forms recorded in Bosnia and Herzegovina (f. *succinea* - 85.50%, f. *spectabilis* - 9.88%, f. *conspicua* - 4.44%, f. *axyridis* - 0.20%) is similar to that reported in other countries in Europe (e.g. Adriaens et al., 2008; Brown et al., 2008a; Burgio et al., 2008; Bozsyk, 2009; Markó and Pozsgai, 2009).

The typical form (f. *axyridis*) that is predominant in Central Asia was not found in Europe before 2007 (Brown et al. 2008a; Brown 2010). From 2007 onwards f. *axyridis* was discovered in several European countries: Bulgaria, Czech Republic, Denmark, Serbia and Slovakia, but in all countries is extremely rare (Brown, 2010). During this investigation one specimen of nominate f. *axyridis* was found in the urban area of Sarajevo on a lime tree on 4th August 2010.

Poutsma et al. (2008) used the CLIMEX simulation software to develop a climate scenario in order to predict the

further spread and possibility of establishment of *H. axyridis* in new areas. The species distribution model developed by Bidinger et al. (2012) also yielded the species' potential distribution based on bioclim parameters. Although both models identified the Mediterranean region as suitable for establishment, the harlequin ladybird has been recorded only in small numbers and still has limited distribution in South Europe (e.g. Brown et al., 2011).

It is possible that the populations that invaded Europe were not adapted to the specific ecological conditions of the Mediterranean and that these conditions prevented their wider establishment. This was probably the reason for delayed invasion in the Mediterranean Europe, as the harlequin ladybird needed time to adapt to the local environment.

The presence of the species in the Mediterranean region of the eastern Adriatic coast of Croatia was first reported by Stanković et al. (2010) but with no evidence of its establishment. The adult specimens were found only in the bordering area between the coastal and highland areas. Recently it was reported from the Pelješac Peninsula in south Croatia (Cernygier et al., 2013). The results presented here also confirm the establishment of *H. axyridis* in the Mediterranean area of the eastern Adriatic coast in Croatia and Bosnia and Herzegovina even earlier. During this study the harlequin ladybird was recorded at four localities in the Mediterranean region of Bosnia and Herzegovina and at two localities numerous larvae were found. Additionally, the species was also recorded at two localities in the coastal area of South Dalmatia, Croatia. The adults and the larvae were found in Klek (personal data) and the adult specimens in the area of Dubrovnik city (Dubravko Dender, pers. comm.). In Klek adults were regularly observed on the lights in the evenings from 2010 to 2015 (July to October), while larvae were observed on grapevine in May. Although not widely present as in other biogeographical regions, these results show that *H. axyridis* is clearly established in the Mediterranean region.

Biological invasions are an important segment of global environmental change and a major concern in nature conservation. As *H. axyridis* is a highly invasive coccinellid that can seriously affect many native species (Adriaens et al., 2003; Koch et al., 2006; Roy and Wajnberg, 2008; Roy et al., 2012) future research should focus on the impact on native biodiversity, especially in areas of high biodiversity value.

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SAŽETAK

Distribucija, stanište i frekvencija formi invazivne vrste *Harmonia axyridis* (Pallas, 1773) (Coleoptera: Coccinellidae) u Bosni i Hercegovini

Harmonia axyridis (Pallas, 1773) (Coleoptera, Coccinellidae) je strana invazivna vrsta bubamare koja se u posljednjih 25 godina brzo proširila Evropom. Prvi podatak o prisustvu vrste u Bosni i Hercegovini bio je pronalazak nekoliko primjeraka u januaru 2010. godine u Sarajevu. Od 2010. do 2015. godine provedena su terenska istraživanja u cilju utvrđivanja prisustva i raširenosti ove vrste u Bosni i Hercegovini. Na temelju terenskih istraživanja utvrđeno je prisustvo *H. axyridis* na 87 lokaliteta širom BiH, u visinskom u rasponu od 1 do 2.030 m nadmorske visine. Utvrđeno je da je *H. axyridis* brojna i široko rasprostranjena vrsta, kao i da je prisutna u velikom broju različitih tipova staništa, posebno u urbanim, ruderalnim i močvarnim tipovima staništa. Biljne vrste na kojima je *H. axyridis* najčešće bilježena su: *Tilia* sp., *Salix* sp., *Typha* sp., *Phragmites australis*, *Urtica dioica* i *Humulus lupulus*. U prikupljenom uzorku f. *succinea* je bila najdominantnija. Među 496 zabilježenih primjeraka odnos formi je bio sljedeći: f. *succinea* - 85,50%, f. *spectabilis* - 9,88%, f. *conspicua* - 4,44%, f. *axyridis* - 0,20%.

Cljučne riječi: biološka invazija, harlekinska bubamara, *Harmonia axyridis axyridis*, *Harmonia axyridis conspicua*, *Harmonia axyridis spectabilis*, *Harmonia axyridis succinea*, strana invazivna vrsta, višebojna azijska bubamara