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Butterfly fauna (Lepidoptera: Rhopalocera) of Donji Emovci, Požega, Croatia

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Abstract. An example of a photographic faunistic study of butterflies implemented in Croatia is presented herewith. The survey was conducted in the near surroundings of Donji Emovci village, near Požega, Slavonia, between 2009 and 2013. The surveyed area consists mostly of a mosaic of different kinds of monocultures, scattered grasslands and forest fragments. Seventy-nine butterfly species could have been reliably identified from the photographs, several of which are rare or interesting records for Croatia (e.g. *Colias erate*, *Parnassius mnemosyne* and *Cupido decoloratus*). This study shows that butterfly photography can indeed be a useful tool for faunistic studies, although additional methods should be used to gain complete species lists.

Key words: photography, Lepidoptera, diversity, interesting records, Požega, Croatia

Izvleček. Favna dnevnih metuljev (Lepidoptera: Rhopalocera) Donjih Emovcev, Požega, Hrvatska

– V članku predstavljamo primer favnistične raziskave metuljev na Hrvaškem na podlagi njihovih fotografij. Raziskava je bila opravljena v bližini vasi Donji Emovci blizu mesta Požega v Slavoniji med letoma 2009 in 2013. Preiskano območje je mozaik različnih tipov monokultur, travnišč in zaplat gozda. Na podlagi fotografij smo lahko zanesljivo določili 79 vrst metuljev, med katerimi jih je veliko redkih ali zanimivih najdb za Hrvatsko (npr. *Colias erate*, *Parnassius mnemosyne* in *Cupido decoloratus*). Ta raziskava dokazuje, da je fotografiranje metuljev lahko uporaben način v favnističnih raziskavah, vendar pa bi za pridobitev celotnega seznama vrst določenih območij morali uporabiti še dodatne metode.

Ključne besede: fotografija, Lepidoptera, pestrost, zanimive najdbe, Požega, Hrvatska

Introduction

Butterflies are one of the most beautiful and charismatic groups of insects, regularly observed by both amateurs and professional entomologists, as they are, in most cases, large, colourful, and easy to recognize (e.g. Tolman & Lewington 2008). This is especially true in Europe where 482 species of butterflies are known to occur (Van Swaay et al. 2010). In Croatia, 197 species have been recorded so far (Šašić & Mihoci 2011, Koren & Štiš 2013, Koren et al. 2013a, b), of which 43 (22%) are listed in the Croatian Red Butterfly List (Šašić et al. 2013). The largest number of those species have a Near Threatened status (17), followed by Data Deficient (8), Critically Endangered (8), Vulnerable (6) and Endangered (4) (Šašić et al. 2013).

Most species of butterflies occurring in Europe are generally easily identified in the field just by observing their external morphological characteristics, without the need to kill them. With this in mind, modern butterfly identification guides are based on the principle of visual identification of specimens (Lafranchis 2004, Tolman & Lewington 2008). Still, this method implies that the observer needs to have considerable knowledge on the local butterfly fauna to easily and correctly identify most species encountered. While such data are very valuable from the conservation point of view, in particularly due to non-invasive sampling, some problems are linked within such records. The greatest among them is the non-existent possibility of re-evaluation of the identification, due to the lack of a collected and preserved specimen. Another way to collect valuable data regarding butterfly diversity without the need to kill specimens is butterfly photography. In this way, a specimen is preserved in the picture which, when paired with the correct coordinates, locality name, date and observer, become valuable and useful data in any study or research paper. The power of photography, especially the ones shared by social media, is nowadays immense, resulting even in description of species new to science in collaboration with the scientists (Winterton et al. 2012). And what is very important, anybody can nowadays take pictures of a butterfly and send them to a researcher for correct identification. However, complete butterfly surveys (or surveys of other insect species) done with this method are very rare, and actually non-existent in Croatia. Although not all butterfly species can be identified by just observing or photographing, the vast majority of species occurring in Croatia can be correctly assigned to the species level by entomologists from good quality pictures, without the need of removing the specimen from nature. However, it is important to emphasize that not all butterfly species can be easily photographed, especially strong and fast fliers like the genus *Colias*, or the Hesperidae genera *Pyrgus* and *Spialia*.

We present the first photographic survey of butterfly diversity in Croatia, based exclusively on the identification of specimens on the photographs taken in the surveyed area. The main aim of this study is to present the butterfly fauna of a previously unsurveyed area in eastern Croatia, Slavonia region. This region has traditionally been an agricultural part of Croatia and is still mostly covered with agricultural fields and plantations, which contain a total of about 45% of agricultural land in Croatia (DZS 2003). Natural and semi-natural habitats in the region can mostly be found scattered around river valleys, forest edges or rare mountainous regions (e.g. Papuk, Bansko Brdo). It is difficult to find suitable habitats to monitor butterfly diversity in such landscape. In the past century, several regions of Slavonia were surveyed in terms of

butterfly distribution. Probably the first overview was done by Bohatsch (1891), citing most records as »Slavonia«. After him, further records can be found in several papers (e.g. Grund 1913, Steiner 1916, Koča 1900, 1901, Mihoci et al. 2012). Most species records for the region are depicted in the provisional distribution maps of the butterflies of Yugoslavia (Jakšić 1988). According to the maps, about 126 species have been recorded for Slavonia (Jakšić 1988), however, a critical and modern update to the butterfly fauna of the region is needed, as several species records are probably erroneous, and some species may have even disappeared from the region. With that in mind, faunistic surveys of different parts of the region are needed to gain a more recent knowledge about the butterfly fauna of Slavonia.

Materials and methods

We conducted the photographic survey between 2009 and 2013, each year from spring to autumn, in the near surroundings of Donji Emovci village, in the vicinity of Požega, Croatia. The survey took place in a radius of one kilometre around the village (Fig. 1). The habitats present in the area include wet and dry grasslands (Fig. 2), agricultural land, forest edges, forests and river banks. The terrain around the village is mostly flat with small valleys. The village is located close to one of the few mountains in Slavonia – Mt. Papuk. The river Orlava flows pass the village nearby.

Each species was photographed at least once on different occasions in order to maximize the potential number of photographed species. Butterflies were photographed using Olympus μ 840 and Pentax optio I-100 digital cameras throughout the entire adult flight season by the second author. To identify the photographs, standard determination literature was used (Lafranchis 2004, Tolman & Lewington 2008). Systematics follows Van Swaay et al. (2010).

Results

More than 3,500 photos taken during this survey yielded 79 butterfly species, which could be reliably identified (Tab. 1). Most species belong to the Nymphalidae family (35), followed by Lycaenidae (19), Pieridae (10), Hesperidae (10), Papilionidae (4), and Riodinidae (with a single species).

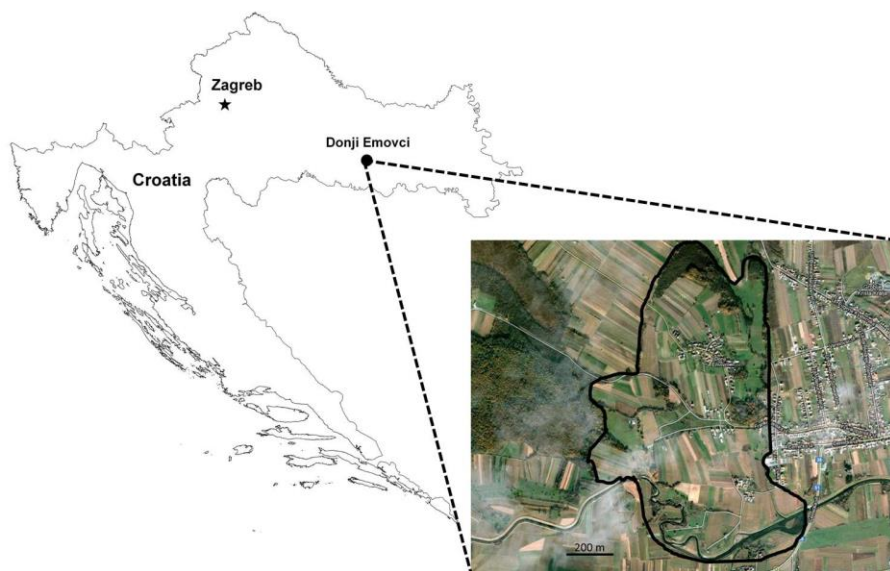


Figure 1. Location of the surveyed locality at Donji Emovci near Požega, Croatia.

Slika 1. Položaj raziskovanega območja v kraju Donji Emovci, blizu Požege, Hrvaška.



Figure 2. Dry meadow on the northern side of the study area, on which most butterfly species were recorded.

Slika 2. Suhi travnik na severnem delu raziskovanega območja, na katerem smo zabeležili največje število metuljev.

Table 1. List of recorded butterfly species in the study area near Donji Emovci (Požega), observation dates, Red List category (according to Šašić et al. 2013) and confirmed presence of each species in nearby Mt. Papuk (after Koča 1900, 1901, Lorković 1927, Mladinov 1973, Lorković et al. 1992, Lorković 2009, Mihoci et al. 2012; marked with +). Red List categories: VU – Vulnerable, DD – Data Deficient, NT – Near Threatened.

Tabela 1. Vrstni seznam metuljev območja študije v bližini Donjih Emovcev (Požega), datumi opažanja, kategorija rdečega seznama (po Šašić et al. 2013) in potrjeno pojavljanje vsake od vrst v bližini gore Papuk (po Koča 1900, 1901, Lorković 1927, Mladinov 1973, Lorković et al. 1992, Lorković 2009, Mihoci et al. 2012; oznaka +). Kategorije rdečega seznama: VU – ranljiva vrsta, DD – premalo podatkov, NT – potencialno ogrožena vrsta.

Species	Observation dates	Red List category	Presence in Mt. Papuk.
Fam. HesperIIDae			
1. <i>Erynnis tages</i> Linnaeus, 1758	21.4.2010, 5.5.2010, 10.7.2011, 7.8.2011		+
2. <i>Carcharodus alceae</i> (Esper, 1780)	13.4.2009, 7.7.2011, 19.8.2011, 25.9.2011		+
3. <i>Carcharodus floccifera</i> (Zeller, 1847)	21.5.2011, 20.7.2011, 29.7.2011, 8.8.2011		+
4. <i>Heteropterus morpheus</i> (Pallas, 1771)	12.7.2013		
5. <i>Carterocephalus palaemon</i> (Pallas, 1771)	7.5.2013		+
6. <i>Pyrgus armoricanus</i> (Oberthür, 1910)	12.5.2010, 1.6.2010, 4.7.2011, 20.8.2012		
7. <i>Pyrgus malvae</i> (Linnaeus, 1758)	27.4.2010, 5.5.2010, 13.5.2011, 15.8.2012		+
8. <i>Thymelicus lineola</i> (Ochsenheimer, 1808)	17.6.2009, 19.6.2009, 27.8.2011, 3.9.2012		+
9. <i>Thymelicus sylvestris</i> (Poda, 1761)	11.6.2010, 13.6.2011, 14.8.2011, 20.8.2011		+
10. <i>Ochlodes sylvanus</i> (Esper 1777)	6.5.2009, 14.6.2010, 7.8.2010, 10.8.2012		+
Fam. Papilionidae			
11. <i>Iphiclides podalirius</i> (Linnaeus, 1758)	6.5.2009, 15.7.2009, 27.8.2011, 6.9.2011		+
12. <i>Papilio machaon</i> (Linnaeus, 1758)	9.4.2009, 12.6.2012, 8.7.2012, 29.8.2012	NT	+
13. <i>Zerynthia polyxena</i> (Dennis & Schiffermüller, 1775)	15.4.2009, 23.4.2011, 1.5.2012, 11.5.2011	NT	+
14. <i>Parnassius mnemosyne</i> (Linnaeus, 1758)	18.5.2013	NT	+
Fam. Pieridae			
15. <i>Anthocharis cardamines</i> (Linnaeus, 1758)	3.4.2009, 17.4.2011, 23.4.2011, 1.5.2012		+
16. <i>Pieris brassicae</i> (Linnaeus, 1758)	23.4.2011, 3.5.2011, 18.9.2012, 25.10.2012	DD	+
17. <i>Pieris rapae</i> (Linnaeus, 1758)	11.4.2009, 10.6.2011, 10.9.2011, 22.10.2011		+
18. <i>Pieris napi</i> (Linnaeus, 1758)	3.4.2009, 8.7.2009, 19.9.2011, 26.10.2011		+
19. <i>Pontia edusa</i> (Fabricius, 1777)	10.6.2008, 9.7.2009, 19.8.2011, 27.8.2013		+
20. <i>Colias erate</i> (Esper, 1805)	13.6.2009, 21.7.2009, 28.9.2011, 10.10.2012		

Species	Observation dates	Red List category	Presence in Mt. Papuk.
21. <i>Colias croceus</i> (Fourcroy 1785)	9.6.2009, 2.7.2009, 16.10.2010, 26.10.2012		+
22. <i>Colias hyale</i> (Linnaeus, 1758)	1.7.2009, 12.7.2009, 13.9.2012, 24.9.2012		+
23. <i>Gonepteryx rhamni</i> (Linnaeus, 1758)	27.3.2009, 23.6.2009, 30.9.2012, 22.10.2012		+
24. <i>Leptidea sinapis/juvernica</i>	30.3.2009, 29.6.2009, 14.7.2012, 28.8.2012		+
Fam. Riodinidae			
25. <i>Hamearis lucina</i> Linnaeus, 1758	2.5.2011, 15.5.2011, 12.7.2012, 13.7.2012		+
Fam. Lycaenidae			
26. <i>Lycaena phlaeas</i> (Linnaeus, 1761)	17.5.2011, 22.8.2011, 20.9.2012, 20.10.2012		+
27. <i>Lycaena dispar</i> (Haworth, 1802)	13.5.2011, 9.6.2011, 29.7.2011, 25.9.2013	NT	+
28. <i>Lycaena tityrus</i> (Poda, 1761)	3.5.2011, 17.8.2011, 27.8.2011, 21.9.2011		+
29. <i>Lycaena hippothoe</i> (Linnaeus, 1761)	20.5.2009, 1.6.2010, 5.8.2011, 17.9.2012	NT	
30. <i>Callophrys rubi</i> (Linnaeus, 1758)	10.5.2011		+
31. <i>Satyrrium w-album</i> (Knoch, 1782)	12.6.2012, 25.6.2012, 7.6.2012, 5.7.2012		+
32. <i>Satyrrium acaciae</i> (Fabricius, 1787)	6.6.2011, 17.6.2011, 20.6.2012, 2.7.2012		+
33. <i>Celastrina argiolus</i> (Linnaeus, 1758)	10.6.2009, 16.6.2009, 17.7.2011, 26.7.2012		+
34. <i>Glauopsyche alexis</i> (Poda, 1761)	29.4.2011	NT	+
35. <i>Phengaris arion</i> (Linnaeus, 1758)	20.7.2012, 26.7.2012, 1.8.2012, 22.8.2012	VU	+
36. <i>Aricia agestis</i> (Dennis & Schiffermüller, 1775)	15.5.2009, 20.5.2011, 18.9.2011, 20.9.2012		+
37. <i>Cyaniris semiargus</i> (Rottemburg, 1775)	12.5.2009, 12.7.2011, 20.9.2012, 23.9.2012		+
38. <i>Cupido alceas</i> (Hoffmannsegg, 1804)	28.4.2010, 12.7.2012, 14.8.2011, 28.8.2012		
39. <i>Cupido argiades</i> (Pallas, 1771)	6.5.2011, 15.7.2011, 3.8.2011, 20.8.2012		
40. <i>Cupido decolorata</i> (Staudinger, 1886)	22.5.2011, 7.8.2012, 21.8.2012, 29.8.2012		
41. <i>Plebejus argus</i> (Linnaeus, 1758)	3.5.2009, 12.5.2011, 15.5.2010, 23.5.2012		+
42. <i>Plebejus argyrognomon</i> (Bergsträsser, 1779)	3.5.2010, 31.5.2011, 2.6.2011, 12.8.2012		
43. <i>Plebejus idas</i> (Linnaeus, 1761)	18.7.2010, 21.7.2011, 16.9.2011, 20.9.2011		
44. <i>Polyommatus icarus</i> (Rottemburg, 1775)	8.5.2011, 25.8.2011, 21.9.2012, 27.10.2012		+

Species	Observation dates	Red List category	Presence in Mt. Papuk.
Fam. Nymphalidae			
45. <i>Argynnis paphia</i> (Linnaeus, 1758)	21.6.2009, 18.7.2010, 23.8.2011, 7.9.2012		+
46. <i>Issoria lathonia</i> (Linnaeus 1758)	21.7.2010, 7.9.2010, 1.10.2012, 22.10.2012		+
47. <i>Brenthis ino</i> (Rottemburg, 1775)	1.6.2010, 16.6.2010, 19.6.2012, 26.6.2012		
48. <i>Brenthis daphne</i> (Bergsträsser, 1780)	27.5.2010, 10.6.2010, 14.6.2012, 13.8.2012		+
49. <i>Brenthis hecate</i> (Dennis & Schiffermüller, 1775)	7.6.2010, 14.6.2010, 2.7.2012, 8.7.2012		+
50. <i>Boloria dia</i> (Linnaeus, 1767)	5.7.2013, 9.7.2013, 19.7.2013, 25.7.2013		+
51. <i>Boloria euphrosyne</i> (Linnaeus, 1758)	28.9.2011		+
52. <i>Vanessa atalanta</i> (Linnaeus, 1758)	13.7.2009, 21.8.2010, 17.9.2010, 1.11.2011		+
53. <i>Vanessa cardui</i> (Linnaeus, 1758)	13.5.2011, 12.7.2011, 2.9.2011, 18.11.2012		+
54. <i>Aglais io</i> (Linnaeus, 1758)	16.3.2011, 26.6.2011, 2.9.2011, 27.10.2011		+
55. <i>Aglais urticae</i> (Linnaeus, 1758)	23.3.2011		+
56. <i>Polygonia c-album</i> (Linnaeus, 1758)	5.4.2011, 27.6.2011, 18.7.2012, 23.10.2012		+
57. <i>Araschnia levana</i> (Linnaeus, 1758)	25.3.2011, 11.4.2011, 19.5.2011, 10.7.2012		+
58. <i>Nymphalis antiopa</i> (Linnaeus, 1758)	23.3.2011, 1.4.2011, 19.10.2011, 22.10.2012		+
59. <i>Nymphalis polychloros</i> (Linnaeus, 1758)	25.6.2011, 1.7.2011, 15.9.2011, 29.10.2012		+
60. <i>Euphydryas aurinia</i> (Rottemburg, 1775)	3.5.2011	NT	+
61. <i>Melitaea phoebe</i> (Dennis & Schiffermüller, 1775)	8.5.2011, 15.7.2011, 25.9.2011, 26.10.2012		+
62. <i>Melitaea didyma</i> (Esper, 1778)	22.6.2009, 5.7.2010, 8.7.2011, 29.8.2011		+
63. <i>Melitaea diamina</i> (Lang, 1789)	31.5.2011, 26.7.2011		
64. <i>Melitaea athalia</i> (Rottemburg, 1775)	10.5.2011, 2.6.2011, 19.8.2011, 28.8.2011		+
65. <i>Neptis sappho</i> (Pallas, 1771)	7.5.2011, 21.7.2011, 29.7.2011, 28.8.2011		+
66. <i>Neptis rivularis</i> (Scopoli, 1763)	14.6.2011, 18.6.2011, 18.7.2011, 1.8.2011		+
67. <i>Apatura ilia</i> (Dennis & Schiffermüller, 1775)	25.6.2011, 1.7.2011, 7.8.2011, 20.8.2011	NT	+
68. <i>Apatura iris</i> (Linnaeus, 1758)	16.6.2011, 18.6.2011, 12.8.2011, 19.8.2011	NT	+

	Species	Observation dates	Red List category	Presence in Mt. Papuk.
69.	<i>Pararge aegeria</i> (Linnaeus, 1758)	14.4.2011, 19.7.2011, 3.9.2011, 4.10.2011		+
70.	<i>Lasiommata megera</i> (Linnaeus, 1767)	22.4.2010, 5.5.2011, 15.7.2011, 5.10.2011		+
71.	<i>Coenonympha arcania</i> (Linnaeus, 1761)	15.6.2011		+
72.	<i>Coenonympha glycerion</i> (Borkhausen, 1788)	24.5.2011, 19.7.2012, 13.8.2012, 17.9.2012		+
73.	<i>Coenonympha pamphilus</i> (Linnaeus, 1758)	1.5.2011, 15.6.2011, 16.9.2011, 27.10.2011		+
74.	<i>Pyronia tithonus</i> (Linnaeus, 1767)	19.7.2011, 29.7.2011, 12.8.2011, 29.8.2011		+
75.	<i>Aphantopus hyperantus</i> (Linnaeus, 1758)	10.7.2011, 12.7.2011, 13.7.2011, 3.8.2011		+
76.	<i>Maniola jurtina</i> (Linnaeus, 1758)	1.6.2011, 9.7.2011, 6.8.2011, 13.9.2011		+
77.	<i>Melanargia galathea</i> (Linnaeus, 1758)	11.6.2011, 26.6.2011, 4.7.2011, 20.9.2011		+
78.	<i>Minois dryas</i> (Scopoli, 1763)	29.7.2011, 1.8.2011, 6.8.2011, 13.8.2011		+
79.	<i>Brintesia circe</i> (Fabricius, 1775)	17.6.2011, 20.6.2011, 29.8.2011, 22.9.2011		

Discussion

The 79 species recorded in this study constitute 40% of all the butterfly species known from Croatia (Šašić & Mihoci 2011, Koren & Štih 2013, Koren et al. 2013a, b). Twelve of them are listed in the Red List of Butterflies of Croatia (Šašić et al. 2013): 1 species as Vulnerable, 1 as Data Deficient and 10 as Near Threatened. The species listed as Vulnerable is *Phengaris arion* (Linnaeus, 1758). This myrmecophilus species has a scattered distribution in Croatia (Lorković 2009). It has even disappeared from some areas, like central Istria (Koren & Ladavac 2010). The species listed as Data Deficient is *Pieris brassicae* (Linnaeus, 1758), a widespread and locally common species (Lorković 2009), photographed several times in the surveyed area.

Another interesting species is *Colias erate* (Esper, 1805), which has been a part of Croatia's butterfly fauna for only a few decades (Lorković et al. 1992). It has been recorded several times during our survey. Observations of *C. erate* perfectly fit into the known range of this species in Croatia and show that it is still present in Slavonia (Lorković et al. 1992). For example, in nearby Slovenia, it occurs only occasionally and does not have a permanent population (Verovnik et al. 2012).

One of the most interesting records concerns *Parnassius mnemosyne* (Linnaeus, 1758), one of the last species noted during this photo-survey, with a single specimen photographed. This species is present in two ecotypes in Croatia: the mountain form, found mostly at higher altitudes in the mountains, and the lowland form found in northern Croatia. The closest known record of this species is from the village of Duboka in Slavonia, on the slopes of Mt. Papuk (Koča 1901), located about 20 kilometres from the study site. However, no recent records from that area exist. It is possible that the specimen observed on our site may just be a record of a vagrant individual from Mt. Papuk. On the other hand, it is also possible that a population of *P. mnemosyne* inhabits the surveyed area. To confirm that, distribution of its larval host plant, *Corydalis solida* (L.), in the surveyed area should be mapped and checked for larval stages. How little we know about the lowland populations of *P. mnemosyne* is shown by the fact that a population was discovered in the eastern part of the country, on Bansko Hill, just a few years ago (Koren et al. 2012).

Regarding the Lycaenidae family it is important to note the record of *Cupido decolorata* (Staudinger, 1886), a rare and local species in Croatia. It is mostly known from its northern parts (Lorković 2009), but has also been recorded on Krk Island (Habeler 2003). In nearby Slovenia, which represents the southwestern distribution border of this species, it is extremely rare and known only from several records (Verovnik et al. 2012). It was photographed several times in the study area.

From the genera represented in this study area, only two could not be reliably identified from the pictures. The first is the genus *Leptidea* Billberg, 1820, with two similar species possibly occurring in the area: *Leptidea sinapis* (Linnaeus, 1758) and *Leptidea juvernica* Williams, 1946, and can be correctly identified only by the examination of the genital structures (Dincă et al. 2011). The other problematic group is the genus *Melitaea*, and the species complex that includes *Melitaea athalia* (Rottemburg, 1775), *Melitaea aurelia* (Nickerl, 1850) and *Melitaea britomartis* Assmann, 1847. To check whether some or all species of this complex occur in the study area, additional surveys will need to be done in the future.

Mt. Papuk is the closest location to Donji Emovci with historical records, therefore useful for the faunal comparison. Major work was done by Koča (1900, 1901), but additional records can be found in many other papers (e.g. Lorković 1927, Mladinov 1973, Lorković et al. 1992, Lorković 2009, Mihoci et al. 2012). Direct comparison between the two sites is not applicable due to large difference in size, altitudinal span, habitat diversity and the fact that Mt. Papuk was surveyed almost a century ago. However, a rough comparison, in terms of species diversity and recorded species, can be useful. Based on literature records, 92 butterfly species are known from the area of Mt. Papuk. In total, there are 23 species recorded in Mt. Papuk, but not in the area of Donji Emovci: *Hesperia comma* (Linnaeus, 1758), *Pyrgus alveus* (Hübner, 1803), *Spialia sertorius* (Hoffmannsegg, 1804), *Leptidea morsei* (Fenton, 1881), *Thecla betulae* (Linnaeus, 1758), *Favonius quercus* (Linnaeus, 1758), *Satyrium pruni* (Linnaeus, 1758), *Satyrium ilicis* (Esper, 1779), *Pseudophilotes vicrama* (Moore, 1865), *Polyommatus amandus* (Schneider, 1792), *Polyommatus bellargus* (Rottemburg, 1775), *Polyommatus coridon* (Poda, 1761), *Argynnis aglaja* (Linnaeus, 1758), *Argynnis adippe* (Dennis & Schiffermüller, 1775), *Argynnis niobe* (Linnaeus, 1758), *Nymphalis vaualbum* (Denis & Schiffermüller, 1775), *Melitaea cinxia* (Linnaeus, 1758), *Melitaea aurelia* (Nickerl, 1850), *Limenitis populi* (Linnaeus, 1758), *Lopinga achine* (Scopoli, 1763), *Erebia aethiops* (Esper, 1777) and *Hipparchia fagi* (Scopoli, 1763), *Hipparchia semele* (Linnaeus, 1758). Some

differences are probably the result of different methodologies (photography versus classical net hunting). This is especially true for large and fast flying nymphalids, like members of the genus *Argynnis* Fabricius, 1807, from which only *Argynnis paphia* (Linnaeus, 1758) was recorded during this survey, while three additional species are known from Mt. Papuk. The differences also arise from the habitat preferences of some species. Some strictly woodland species such as *Erebia aethiops* (Esper, 1777), *Limenitis populi* (Linnaeus, 1758) or *Lopinga achine* (Scopoli, 1763), which were recorded in Mt. Papuk, can hardly be expected at the study site. Even if they are present there, some species like *L. achine* can hardly be observed, as well as photographed. With additional surveys of both localities, the differences in the composition of recorded species could probably be reduced, and more species recorded for both areas.

It is important to emphasize the importance of such data gathering as each photograph, containing correct time and locality, is an important contribution to the knowledge of the butterfly fauna of Croatia. What we are missing in Croatia is a website on which such photographs could be easily posted, correctly identified by entomologists and eventually incorporated in the also non-existent national database. Such web sites already exist in Europe (e.g. www.observado.org), but are not generally visited by nature enthusiasts from Croatia. In this country, photographs usually end up on web sites dedicated to photography itself, usually with no correct locality, making them less valuable, and more time consuming to find the correct data from the photograph's authors. The creation of a national database, with a web site on which users could upload photographs and request the correct identification, not only for butterflies or even insects, but wider, could greatly contribute to our knowledge of the flora and fauna of the country.

Butterfly photography is useful for the research of butterfly diversity at the local scale. Rare species can usually be recorded as well, raising the importance and value of such surveys. However, for one to gain a complete picture about the butterfly fauna of a selected area, additional methods, such as the collection of specimens and the preparation of genitalia are needed. Compared to the classical net hunting, this method always comes second, since not all species and their diagnostic characteristics can always be photographed.

The 79 recorded butterfly species is a high number, especially if one has in mind that Slavonia is one of the regions in Croatia with the strongest and most intensive anthropogenic impact. On the other hand, this is also one of the less surveyed regions in Croatia, especially considering the published data (e.g. Jakšić 1988). Recent surveys of Slavonia are almost non-existing, so this survey represents an important insight into the current butterfly fauna of the region. Even though the survey area was relatively small, such a high number of recorded species indicates that many butterfly species are still present in Slavonia, and more systematic surveys of larger areas are needed.

Povzetek

Slavonija obsega severovzhodni del Hrvaške, ki je danes pod močnim antropogenim vplivom. Tu se razteza kar 45 % vseh kmetijskih površin Hrvaške. Raziskave dnevnih metuljev Slavonije potekajo že od konca 19. stoletja, vendar so nesistematične. Tako je večji del regije še vedno favnistično neraziskan, večina podatkov pa je starejša od 100 let. V raziskavi smo naredili favnistični popis dnevnih metuljev okolice vasi Donji Emovci pri Požegi med letoma 2009 in 2013. Metulje smo beležili s fotografiranjem. Skupno smo zabeležili 79 vrst oziroma 40 % favne Hrvaške (Šašić & Mihoci 2011, Koren & Štih 2013, Koren et al. 2013b). Najzanimivejše najdbe so vrste *Colias erate*, *Parnassius mnemosyne* in *Cupido decoloratus*, ki so redke ali lokalno razširjene na Hrvaškem. Na raziskovanem območju je bilo večino vrst dnevnih metuljev možno določiti na podlagi fotografij, medtem ko je bila za rodova *Melitaea* in *Leptidea* potrebna dodatna analiza spolnega aparata. Fotografiranje metuljev je ena izmed metod za pridobivanje novih najdb metuljev in kljub temu, da vseh vrst ni možno določiti na ta način, je ta metoda primerna za zbiranje podatkov. Kar na Hrvaškem pogrešamo, obstaja pa v drugih državah Evrope, je spletni portal, na katerega bi ljubitelji narave lahko naložili fotografije, entomologi pa pravilno določili in dodali v nacionalno podatkovno bazo.

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Checklist of Croatian amphibians and reptiles with bibliography of 250 years of research

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Abstract. An updated checklist is presented for the amphibian and reptile fauna of Croatia. According to historical and recent literature sources, 20 amphibian and 41 reptile species have been recorded so far. Two reptile species, *Blanus strauchi* and *Typhlops vermicularis*, are considered doubtful, although there are individual museum vouchers for the country. Presence of a total of 59 species can be considered valid, with two additional considered doubtful. This paper summarizes data from 700 scientific and popular publications, which is the first attempt to publish a complete Croatian herpetological bibliography. Full bibliography is also given for all occurring species and constitutes a basis for future publications.

Key words: amphibians, reptiles, checklist, bibliography, Croatia

Izvleček. Pregled dvoživk in plazilcev Hrvaške z bibliografijo 250 let raziskav – V članku je podan posodobljen seznam dvoživk in plazilcev Hrvaške. Po zgodovinskih in recentnih literarnih virih je bilo doslej v državi zabeleženih 20 vrst dvoživk in 41 vrst plazilcev. Za dve vrsti plazilcev, *Blanus strauchi* in *Typhlops vermicularis*, je pojavljanje v državi vprašljivo, čeprav obstajajo njuni muzejski primerki. Tako je bilo skupaj najdenih 59 vrst, medtem ko sta dve vprašljivi. V članku je povzetih 700 strokovnih in poljudnih publikacij, kar je prvi poskus objave celotne bibliografije o herpetološki favni Hrvaške. Podana je tudi celotna bibliografija za vse vrste, ki je hkrati izhodišče za prihodnje objave.

Ključne besede: dvoživke, plazilci, seznam vrst, bibliografija, Hrvaška

Introduction

Croatia is a small sized country with a total surface of 56,538 km². With its bow-like shape, it stretches from the Danubian Plains in the north-east, over the Drava and Sava River floodplains and central mountain areas (Gorski kotar) to the Istrian Peninsula in the west and to Boka Kotorska in the south. Croatia, as other parts of Europe, belongs to the Palearctic region and it can be divided into four main biogeographical regions: Pannonian, Continental, Alpine and Mediterranean. The present-day flora and fauna of these regions is a result of numerous geological, geographical, climatic and biological influences occurring during their formation. The Alpine and Mediterranean regions are especially rich with flora and fauna species, as they constituted glacial and interglacial refuges in different times, and are declared part of the Mediterranean biodiversity hotspot (Médail & Quézel 1999, Mayers et al. 2000, Mayers 2003, Cox et al. 2006). The area is also characterized by a very high level of endemism.

The first sporadic insights into the fauna of amphibians and reptiles of Croatia date back to the beginning of the 18th century. In 1768, J.N. Laurenti described *Natrix tessellata* as *Coronella tessellata*, based on a specimen from »In Japidia, vulgo Cars« as Terra typica. Jelić & Lelo (2011) discuss that this individual probably originated from Croatia or western Bosnia, as this was the historical land of the Illyrian tribe called »Japodi«. In 1771, when travelling through Dalmatia, Alberto Fortis reported on some reptiles (for example describing the »*Vipera*«, probably referring to *Vipera ammodytes*), but did not use any scientific names for reference (Fortis 1771, 1778). In 1780, Pietro Nutrizio Grisogono published his comprehensive book »Notizie per servire alla Storia Naturale della Dalmazia«, in which he describes the geographical, cultural and natural heritage of Dalmatia, with several notes on the amphibians and reptiles present in the area (Grisogono 1780). These data, together with just a few museum collection specimens (like *Proteus anguinus* from 1807 in NHMW) represent some of the first data about Croatian herpetofauna. In the first part of the 19th century, a couple of new authors contributed a few articles (Germar 1817, Configliachi & Rusconi 1821, Carrara 1846, Frauenfeld 1853, Bedriaga 1879) with their, mainly, localized data. More serious data have been collected during the second part of the 19th century (Erber 1864, Braun 1877, Brusina 1878, 1880, Stossich 1880, Bedriaga 1886, Jurinac 1887a, Werner 1891, Kolombatović 1893, 1894, 1895a, b, Werner 1897, Katuriċ 1898, Werner 1899) with even some publications summarizing the current knowledge (Kolombatović 1882, Katuriċ 1883). Full or partial list of the Croatian amphibian and reptile species were made by a number of authors during the 19th and 20th centuries (e.g. Kolombatović, Werner, Bolkey, Karaman, Rössler, Radovanović, Pavletić, Brelih, Džukić). The Croatian Natural History Museum in Zagreb also keeps a large collection of preserved herpetological material collected by the already mentioned renowned herpetologists. An overview of this collection was first published in Rössler (1904), and later also Karaman (1921) also reviewed the collection and eventually used it to complete one of the most comprehensive works on Croatian herpetofauna (as part of work on herpetofauna of the entire ex Yugoslavia). Pavletić (1964) published the last review of the collection with records of 2,616 animals from Croatia and its neighbouring countries. During the 1990s, Croatia was involved in major war activities that prevented any herpetological research, and this period was marked by a serious stagnation in the production of new scientific publications. After the war, the number of publications significantly increased and in 2006 Croatia got its first Red book of endangered amphibians

and reptiles (Janev Hutinec et al. 2006). In 2012, the second national Red book of endangered amphibians and reptiles was published by Jelić et al. (2012c). The book contains description and bibliography of 23 endangered species, indicating that Croatia is inhabited by a total of 19 amphibian and 39 reptile species.

Despite these more than 200 years of herpetological research, a full checklist of Croatian herpetofauna has never been made due to various political and social reasons. This also means that complete herpetological bibliography has never been gathered in one place. The aim of this publication is to critically evaluate all of the published literature and to produce a checklist of Croatian herpetofauna. Recently, several smaller popular publications were produced, presenting general herpetofauna of local areas (Schneider-Jacoby & Ern 1993, Marguš 2008, 2009, Janev-Hutinec & Karaica 2010, Janev-Hutinec et al. 2013).

Material and methods

Material sources

The present checklist of the amphibian and reptile fauna of Croatia is compiled from

- (i) previous faunistic surveys,
- (ii) survey of the available scientific publications (some including data from museum collections),
- (iii) data received from museum collections of the Hungarian National History Museum, Budapest (HNHM), Museo Civico di Storia Naturale di Milano (MSNM), Muséum national d'Histoire naturelle, Paris (MNHN), Naturhistorisches Museum Wien (NHMW), Swedish Natural History Museum (SNHM).

Orders and families were arranged according to Speybroeck et al. (2010). Within each family, genera were listed in alphabetic order. Only species, which were documented in scientific literature or represented in museum collections with voucher specimens, were taken into consideration. Species not meeting these requirements are discussed but not included in the checklist.

Latin names of each species are followed by vernacular name in Croatian (followed by HR) and Slovenian (followed by SI).

Results

Species account of the amphibians and reptiles of Croatia.

CLASS: AMPHIBIA

ORDER: URODELA

Salamandridae

1. *Ichthyosaura alpestris* (Laurenti, 1768) – planinski vodenjak (HR), planinski pupek (SI)

Synonyms: *Triturus alpestris* (Laurenti, 1768), *Mesotriton alpestris* (Laurenti, 1768)

Depoli 1900, Hirc 1900a, Scherer 1902, Rössler 1904, Kolombatović 1907, Katuriđ 1907, Kolombatović 1908, Hirtz 1911, Karaman 1921, Bolkay 1922, Poljak 1924, Bolkay 1928a, Karaman 1928, Wettstein 1928, Karaman 1939, Pavletić 1964, Švob & Selimić 1965, Rucner & Rucner 1971, Dolce 1977, Schmidler & Schmidler 1983, Šolaja 1984, Tvrtković 1984, Strijbosch et al. 1986, Schmidler 1988, De Luca et al. 1990, Kalezić et al. 1990a, Džukić et al. 1990, Kalezić et al. 1992, Tvrtković & Kletečki 1993a, Klipa et al. 1994, Tvrtković 1994, Kletečki 1995, Böhme et al. 1999, Denoël et al. 2001, Kobašić 2002, Grossenbacher & Thiesmeier 2003, Džukić & Kalezić 2004, Janev-Hutinec et al. 2006, Treer 2006, Sotiropoulos et al. 2007, Dumbović et al. 2009, Jelić & Marchand 2009a, Jeran et al. 2011, Janev Hutinec & Karaica 2010, Jelić et al. 2012c, NHM, NHMW

2. *Lissotriton vulgaris* (Linnaeus, 1758) – mali vodenjak (HR), navadni pupek (SI)

Synonym: *Triturus vulgaris* (Linnaeus, 1758)

Šloser 1870, Kolombatović 1882, Katuriđ 1883, Kolombatović 1888, Werner 1897, Scherer 1902, Zimmermann 1902, Rössler 1904, Méhely 1905, Wolterstorff 1905, Knoblauch 1907, Kolombatović 1907, Brusina 1908, Kolombatović 1908, Werner 1908a, Bolkay 1911a, Hirtz 1911, Karaman 1921, Bolkay 1922, 1924a, 1928c, 1928c, Wettstein 1928, Bolkay 1929, Pavletić 1964, Diesner 1966, Radovanović 1964, Pozzi 1966, Rucner & Rucner 1971, Bruno 1980, Henle 1980, Schmidler & Schmidler 1983, Tvrtković 1984, Strijbosch et al. 1985, Strijbosch et al. 1986, Burlin & Dolce 1986, Franzen 1987, Bruno 1988, De Luca et al. 1990, Džukić et al. 1990, Kalezić et al. 1990a, Gonzales-Candelas et al. 1992, Kalezić et al. 1992, Schneider-Jacoby & Ern 1993, Tvrtković & Kletečki 1993a, b, Klipa et al. 1994, Tvrtković 1994, Kletečki 1995, Krizmanić et al. 1997, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Kobašić 2002, Grossenbacher & Thiesmeier 2003, Džukić & Kalezić 2004, Schmidler & Franzen 2004, Babik et al. 2005, Šalamon et al. 2005, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Treer et al. 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Trócsányi & Schäffer 2008, Jelić & Marchand 2009a, Jelić et al. 2012c, MSNM, NHMW

3. *Triturus carnifex* (Laurenti, 1768) – veliki vodenjak (HR), veliki pupek (SI)

Šloser 1870, Kolombatović 1882, Katuriđ 1883, Werner 1897, Depoli 1898, 1900, Rössler 1904, Mähely 1905, Knoblauch 1907, Kolombatović 1908, Hirtz 1911, Karaman 1921, Bolkay 1922, 1924a, Wettstein 1928, Pavletić 1964, Radovanović 1964, Pozzi 1966, Kalezić & Stevanović 1980, Schmidler & Schmidler 1983, Tvrtković 1984, Burlin & Dolce 1986, Meštrov 1986, Strijbosch et al. 1986, Crnobrnja et al. 1989, Džukić 1989, Crnobrnja & Kalezić 1990, Kalezić et al. 1990b, 1992, Tvrtković & Kletečki 1993a, Tvrtković 1994, Klipa et al. 1994, Kletečki 1995, Crnobrnja-Isalović et al. 1997, Cvetković et al. 1997, Kalezić et al. 1997, Kobašić 2002, Grossenbacher & Thiesmeier 2003, Džukić & Kalezić 2004, Janev-Hutinec et al. 2006, Tvrtković & Veen 2006, Kuljerić et al. 2007, Jelić & Marchand 2009a, Jelić et al. 2012c, NHMW

4. *Triturus dobrogicus* (Kiritzescu, 1903) – dunavski vodenjak (HR), panonski pupek (SI)

Karaman 1921, Pavletić 1964, Radovanović 1964, Pozzi 1966, Matošić 1986, Meštrov et al. 1986, Crnobrnja et al. 1989, Džukić 1989, Crnobrnja & Kalezić 1990, Kalezić et al. 1990b, 1992, Arntzen et al. 1997, Crnobrnja-Isalović et al. 1997, Kalezić et al. 1997, Kobašić 2002, Grossenbacher & Thiesmeier 2003, Janev-Hutinec et al. 2006, Kuljerić et al. 2007, Vörös & Arntzen 2010, Jelić et al. 2012c, NHMW

5. *Salamandra atra* Laurenti, 1768 – crni daždevnjak (HR), planinski močerad (SI)

Jurinac 1887a, Hirc 1900b, Rössler 1904, Honigmann 1906, Mähely 1905, Karaman 1921, Bolkay 1922, 1924a, Wettstein 1928, Pavletić 1964, Radovanović 1964, Pozzi 1966, Mikšić 1969, Kletečki 1990, Tvrtković 1994, Riberon et al. 2001, Kobašić 2002, Böhme et al. 2003, Džukić & Kalezić 2004, Grbac et al. 2006, Janev-Hutinec et al. 2006, Jeran et al. 2011, Jelić et al. 2012c, NHMW

6. *Salamandra salamandra* (Linnaeus, 1758) – pjegavi daždevnjak (HR), navadni močerad (SI)

Šloser 1870, Kolombatović 1882, Katuriđ 1883, Jurinac 1887a, Kolombatović 1888, Werner 1897, Depoli 1898, Katuriđ 1898, Werner 1898, Depoli 1900, Largaiolli 1904, Rössler 1904, Mähely 1905, Katuriđ 1907, Brusina 1908, Werner 1908a, b, Hirtz 1911, Šećerov 1920, Karaman 1921, Bolkay 1922, Karaman 1928, Bolkay 1928b, 1928c, Wettstein 1928, Karaman 1939, Buresch & Zonkov 1941, Cyren 1941, Radovanović 1941, Ehrlich 1955a, b, Štrkanec-Bečejac 1959, Krpan 1962, Pavletić 1964, Dely 1966, Rucner & Rucner 1971, Schmidler 1977, Schmidler & Schmidler 1983, Saraćini 1984, Tvrtković 1984, Henle 1985, Strijbosch et al. 1985, Burlin & Dolce 1986, Matošić 1986, Strijbosch et al. 1986, De Luca et al. 1990, Tvrtković & Kletečki 1993a, b, Tvrtković 1994, Kletečki 1995, Steinfartz et al. 2000, Janev-Hutinec 2001, Kobašić 2002, Böhme et al. 2003, Džukić & Kalezić 2004, Šalamon et al. 2005, Treer 2006, Dragobratović 2007, Dumbović et al. 2009, Jelić & Marchand 2009a, Jeran et al. 2011, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, HNHM, NHMW

Proteidae

7. *Proteus anguinus* Laurenti, 1768 – čovječja ribica (HR), človeška ribica, močeril (SI)

Configliachi & Rusconi 1821, Schreiber 1875, Brusina 1880, Kolombatović 1882, 1883, Katurić 1883, Marchesetti 1885, Jurinac 1887a, Kolombatović 1888, Depoli 1898, Boegan 1908, Brusina 1908, Langhoffer 1912, Karaman 1921, Bolkay 1922, Dolivo-Dobrovolsky 1923, Hadži 1928, Boegan 1931a, b, Buresch & Zonkov 1941, Fitzinger 1850, Radovanović 1951, Redenšek 1955, Matus 1957, Vivat & Matus 1959, Ledić 1961, Krpan 1962, Pretner 1962, Pavletić 1964, Radovanović 1964, Pozzi 1966, Gluščević 1969, Garašić 1975, Rađa 1980a, 1980b, Cvitković 1985, De Luca et al. 1990, De Luca et al. 1990, Parzefali et al. 1993, Tvrtković & Kletečki 1993a, Grillitsch & Tiedemann 1994, Jurić 1995, Arntzen & Sket 1996, Kletečki et al. 1996, Sket 1997, Vrcan 2000, Gottstein Matočec et al. 2002, Kobašić 2002, Grossenbacher & Thiesmeier 2003, Sket 2003, Trontelj & Gorički 2003, Džukić & Kalezić 2004, Gorički & Trontelj 2006, Janev-Hutinec et al. 2006, Ozimec et al. 2009, Tvrtković & Veen 2006, Dragobratović 2007, Ozimec et al. 2009, Jelić et al. 2012c, HNHM, NHMW

ORDER: ANURA

Bombinatoridae

8. *Bombina bombina* (Linnaeus, 1761) – crveni mukač (HR), nižinski urh (SI)

Šloser 1870, Jurinac 1887a, Mojsisovics 1887, Méhely 1905, Hirtz 1911, Karaman 1921, Bolkay 1922, Cyren 1941, Radovanović 1941, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Strijbosch et al. 1986, Schneider-Jacoby & Ern 1993, MacCallum et al. 1998, Kobašić 2002, Janev-Hutinec et al. 2006, Kuljerić et al. 2007, Dumbović et al. 2009, Grossenbacher 2012, Jelić et al. 2012c, MSNM, HNHM, NHMW

9. *Bombina variegata* (Linnaeus, 1758) – žuti mukač (HR), hribski urh (SI)

Kolombatović 1882, 1888, Boulenger 1897, Werner 1897, Hirc 1902a, Rössler 1904, Méhely 1905, Werner 1908a, b, Hirtz 1911, Bolkay 1919, Karaman 1921, Bolkay 1922, Karaman 1922, Bolkay 1924a, 1928c, Wettstein 1928, Bolkay 1929, Radovanović 1951, Krpan 1962, Pavletić 1964, Diesner 1966, Pozzi 1966, Rucner & Rucner 1971, Džukić 1972, Schmidtler 1977, Bruno 1980, Schmidtler & Schmidtler 1983, Tvrtković 1984, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Bruno 1988, De Luca et al. 1990, Tvrtković & Kletečki 1993a, 1993b, Tvrtković 1994, Kletečki 1995, Vogrin 1997, Schimmenti & Fabris 2000, Kobašić 2002, Džukić & Kalezić 2004, Šalamon et al. 2005, Janev-Hutinec et al. 2006, Tóth et al. 2006, Treer et al. 2006, Tvrtković & Veen 2006, Vukov et al. 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Kuljerić et al. 2007, Jelić & Marchand 2009a, Jeran et al. 2011, Vörös & Jelić 2011, Janev-Hutinec & Karaica 2010, Grossenbacher 2012, Jelić et al. 2012c, NHMW

Bufonidae

10. *Bufo bufo* (Linnaeus, 1758) – smeđa krastača (HR), navadna krastača (SI)

Erber 1864, Šloser 1870, KaturiĆ 1883, Kolombatović 1888, Depoli 1898, Boulenger 1897, Werner 1898, Depoli 1900, Galvagni 1902, Werner 1902, Zimmermann 1902, Rössler 1904, Brusina 1908, Werner 1908a, b, Karaman 1921, Bolkay 1922, 1928c, Karaman 1928, Wettstein 1928, Hirtz 1937a, Karaman 1939, Buresch & Zonkov 1942, Krpan 1962, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Dolce 1977, Bruno 1980, Henle 1980, Schmidler & Schmidler 1983, Tvrtković 1984, Henle 1985, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Bruno 1988, Schmidler 1988, De Luca et al. 1990, Schneider-Jacoby & Ern 1993, Tvrtković & Kletečki 1993a, b, Tvrtković 1994, Kletečki 1995, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Gottstein Matočec et al. 2002, Kobašić 2002, Džukić & Kalezić 2004, Tóth et al. 2006, Treer et al. 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Grossenbacher 2009, Jelić & Marchand 2009a, Šalamon et al. 2009, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, HHNM, NHMW

11. *Bufo viridis* (Laurenti, 1768) – zelena krastača (HR), zelena krastača (SI)

Synonym *Pseudepidalea viridis* (Laurenti, 1768)

Küster 1842a, b, Frauenfeld 1853, Erber 1864, Brusina 1874, Kolombatović 1881, 1882, KaturiĆ 1883, Kolombatović 1888, Boulenger 1897, Werner 1897, Depoli 1898, 1900, Galvagni 1902, Werner 1902, Zimmermann 1902, Kolombatović 1904, Rössler 1904, Brusina 1908, Werner 1908a, b, c, Bolkay 1909, Hirtz 1911, Hirc 1914, Bolkay 1919, Sajović 1920, Karaman 1921, Bolkay 1922, Koch 1926, Bolkay 1928c, d, Hirtz 1930a, Radovanović 1951, Krpan 1962, Pavletić 1962, 1964, Pozzi 1966, Bruno 1980, Cvitanić 1984, Tvrtković 1984, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Bruno 1988, De Luca et al. 1990, Tvrtković & Kletečki 1993a, b, Tvrtković 1994, Škvarč 1999a, Waitzbauer et al. 1999, Schimmenti & Fabris 2000, Šalamon 2000, Škvarč 2000, Krofel 2002, Kobašić 2002, Planinc 2002, Rathbauer 2002, Cafuta 2003, Moravec 2003, Džukić & Kalezić 2004, Cafuta 2005, Šalamon et al. 2005, Schweiger 2005a, Konte et al. 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Lucić 2007, Dragobratović 2007, Lucić et al. 2008, Grossenbacher 2009, Šalamon et al. 2009, Tóth et al. 2009a, b, Vervust et al. 2009, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012b, c, MSNM, NHMW

Pelobatidae

12. *Pelobates fuscus* (Laurenti, 1768) – češnjača (HR), navadna češnovka (SI)

Kolombatović 1886a, b, Depoli 1898, 1900, Karaman 1921, Bolkay 1922, Pavletić 1964, Pozzi 1966, Strijbosch et al. 1986, Kobašić 2002, Džukić & Kalezić 2004, Džukić et al. 2005, Janev-Hutinec et al. 2006, Džukić et al. 2008, Šalamon et al. 2009, Grossenbacher 2012, Jelić et al. 2012c.

Hylidae

13. *Hyla arborea* (Linnaeus, 1758) – gatalinka (HR), zelena rega (SI)

Frauenfeld 1853, Erber 1864, Šloser 1870, Brusina 1874, Kolombatović 1882, Katuriđ 1883, Kolombatović 1888, Werner 1897, Depoli 1898, 1900, Zimmermann 1902, Kolombatović 1904, Rössler 1904, Méhely 1905, Brusina 1908, Werner 1908a, b, Bolkay 1909, Hirc 1914, Karaman 1921, Bolkay 1922, Wettstein 1928, Bolkay 1928c, Hirtz 1930a, Krpan 1962, Pavletić 1962, 1964, Pozzi 1966, Rucner & Rucner 1971, Dolce 1977, Schmidler 1977, Bruno 1980, Henle 1980, Enzeroth 1982, Tvrtković 1984, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Franzen 1987, Bruno 1988, De Luca et al. 1990, Tvrtković & Kletečki 1993a, Tvrtković 1994, Kletečki 1995, Škvarč 1999b, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Krofel 2002, Gottstein Matočec et al. 2002, Kobašić 2002, Planinc 2002, Rathbauer 2002, Moravec 2003, Džukić & Kalezić 2004, Cafuta 2005, Schweiger 2005b, c, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Treer et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Grossenbacher 2009, Jelić & Marchand 2009a, Šalamon et al. 2009, Barun et al. 2010, Janev-Hutinec & Karaica 2010, Koren & Jelić 2011, Jelić et al. 2012c, NHMW

Ranidae

14. *Pelophylax* kl. *esculentus* (Linnaeus, 1758) – jestiva zelena žaba (HR), zelena žaba (SI)

Synonym *Rana esculenta* Linnaeus, 1758

This taxon has »kl.« inserted into the name since is not considered as truly biological species, but hemiclone of *P. lessonae* and *P. ridibundus*, with »kl.« referring to the Greek word »klepton«, meaning thief (Speybroeck et al. 2010).

Erber 1864, Šloser 1870, Boulenger 1882, Kolombatović 1882, Katuriđ 1883, Jurinac 1886, Jurinac 1887b, Depoli 1898, 1900, Zimmermann 1902, Kolombatović 1904, Largaioli 1904, Rössler 1904, Brusina 1908, Hirtz 1911, Karaman 1921, Bolkay 1922, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Strijbosch et al. 1985, 1986, Tvrtković 1994, Kobašić 2002, Džukić & Kalezić 2004, Cafuta 2005, Treer et al. 2006, Dragobratović 2007, Trócsányi & Schäffer 2008, Jelić et al. 2012c, NHMW

15. *Pelophylax lessonae* (Camerano, 1882) – mala zelena žaba (HR), pisana žaba (SI)

Synonym *Rana lessonae* Camerano, 1882

Karaman 1921, Pavletić 1964, Schneider-Jacoby & Ern 1993, Tvrtković 1994, Kobašić 2002, Kuljerić et al. 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Jelić et al. 2012c, NHMW

16. *Pelophylax ridibundus* (Pallas, 1771) – velika zelena žaba (HR), debeloglavka (SI)

Synonym *Rana ridibunda* Pallas, 1771

Partsch 1826, Erber 1864, Mojsisovics 1897, Kolombatović 1888, Boulenger 1898, Werner 1897, Galvagni 1902, Werner 1902, Scherer 1902, Bolkay 1907, Werner 1908a, b, c, Hirtz 1911, Karaman 1921, Bolkay 1922, 1926, 1928c, Karaman 1928, Wettstein 1928, Karaman 1939, Radovanović 1941, Krpan 1962, Pavletić 1962, 1964, Diesner 1966, Pozzi 1966, Schmidler 1977, Bruno 1980, Enzeroth 1982, Schmidler & Schmidler 1983, Tvrtković 1984, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Gabriel 1987, Franzen 1987, Pracht 1987, Bruno 1988, De Luca et al. 1990, Schneider & Sinsch 1992, Tvrtković & Kletečki 1993a, Tvrtković 1994, Vogrin 1997, Škvarč 1999b, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Kobašilić 2002, Rathbauer 2002, Moravec 2003, Džukić & Kalezić 2004, Šalamon et al. 2005, Cafuta 2005, Schweiger 2005a, Konte et al. 2006, Tóth et al. 2006, Treer et al. 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Kuljerić et al. 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Jelić & Marchand 2009b, Barun et al. 2010, Jelić et al. 2012b, c, NHMW

17. *Rana arvalis* Nilsson, 1842 – močvarna smeđa žaba (HR), barska žaba (SI)

Hirc 1903, Rössler 1904, Méhely 1905, Fejérváry-Láng 1921, Karaman 1921, Bolkay 1922, Pavletić 1964, Radovanović 1964, Pozzi 1966, Strijbosch et al. 1985, 1986, Kiš 1988, Schneider-Jacoby & Ern 1993, Obradović & Janev 1997, Kobašilić 2002, Džukić & Kalezić 2004, Treer et al. 2006, Glandt 2008, Tvrtković & Kletečki 2008, Dumbović et al. 2009, Jelić et al. 2012c, NHMW

18. *Rana dalmatina* Fitzinger in: Bonaparte, 1838 – šumska smeđa žaba (HR), rosnica (SI)

Bonaparte 1838, Boulenger 1882, Kolombatović 1882, 1886b, 1888, Wolterstorff 1895, Depoli 1900, Hirc 1903, Šmid 1903, Méhely 1905, Bolkay 1909, 1920a, Fejérváry 1920, Karaman 1921, Bolkay 1922, 1924a, 1928c, Radovanović 1941, 1951, Krpan 1962, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Schmidler 1977, Bruno 1980, Henle 1980, Tvrtković 1984, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Bruno 1988, Kiš 1988, De Luca et al. 1990, Tvrtković & Kletečki 1993a, Tvrtković 1994, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Gottstein Matočec et al. 2002, Kobašilić 2002, Džukić & Kalezić 2004, Janev-Hutinec et al. 2006, Tóth et al. 2006, Treer et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Dragobratović 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Jelić & Marchand 2009a, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, NHNM, NHMW

19. *Rana latastei* Boulenger, 1879 – talijanska smeđa žaba (HR), laška žaba (SI)

Schmidler 1977, Strijbosch et al. 1985, Burlin & Dolce 1986, Strijbosch et al. 1986, Gasc et al. 1997, Kobašilić 2002, Garner et al. 2004, Janev-Hutinec et al. 2006, Kuljerić 2007, Kuljerić & Strišković 2011, Jelić et al. 2012c.

20. *Rana temporaria* Linnaeus, 1758 – livadna smeđa žaba (HR), sekulja (SI)

Šloser 1870, Katurić 1883, Depoli 1898, Kosić 1898, Depoli 1900, Rössler 1904, Méhely 1905, Bolkay 1909, Karaman 1921, Bolkay 1922, Wettstein 1928, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Stribosch et al. 1985, 1986, Kiš 1988, Tvrtković & Kletečki 1993a, Tvrtković 1994, Kletečki 1995, Obradović & Janev 1997, Kobašić 2002, Džukić & Kalezić 2004, Treer et al. 2006, Dumbović et al. 2009, Jelić & Marchand 2009a, Šalamon et al. 2009, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, NHMW

CLASS: REPTILIA
ORDER: TESTUDINES

Testudinidae

21. *Testudo hermanni* Gmelin, 1789 – kopnena kornjača, čančara (HR), grška kornjača (SI)

Frauenfeld 1853, Erber 1864, Šloser 1870, Brusina 1874, Kolombatović 1883, 1884, 1885, 1886a, b, c, 1888, Boettger 1893, Werner 1897, Rössler 1904, Werner 1908a, b, Bolkay 1911c, Hirtz 1911, Krumbach 1917, Bolkay 1924a, 1928a, Hirtz 1933a, Radovanović 1941, 1951, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Diesner 1966, Pozzi 1966, Tolnai 1969, Brelj & Džukić 1974, Mršić 1978, Bruno 1980, Henle 1980, Glavičić & Radić 1981, Meek & Inskip 1981, Mattison 1982, Lapini 1984, Meek 1984, Tvrtković 1984, Meek 1985, Stribosch et al. 1985, 1986, Mršić 1987, Pracht 1987, Bruno 1988, Meek 1988, 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Grillitsch et al. 1995, Zuffi 1995, Vogrin 1997, Schmidler 1999, Sehnal & Schuster, 1999, Schimmenti & Fabris 2000, Fritz 2001, Pistotnik 2001, Herz 2002, Rathbauer 2002, Moravec 2003, Blanck & Esser 2004, Cafuta 2003, Džukić & Kalezić 2004, Cafuta 2005, Lončar 2005, Schweiger 2005a, Fritz et al. 2006, Janev-Hutinec et al. 2006, Konte et al. 2006, Schweiger 2006, Tóth et al. 2006, Kryštufek & Kletečki 2007, Meek 2007, Schweiger 2008, Tóth et al. 2009a, Vervust et al. 2009, Barun et al. 2010, Lauš 2010, Meek 2010, Koren et al. 2011, Jelić et al. 2012b, c, MSNM, NHMW

Emydidae

22. *Emys orbicularis* (Linnaeus, 1758) – barska kornjača (HR), močirska sklednica (SI)

Erber 1864, Šloser 1870, Möllendorff 1873, Kolombatović 1888, Sebišanović 1888, Boettger 1893, Werner 1897, Galvagni 1902, Werner 1902, Scherer 1902, Zimmermann 1902, Kolombatović 1904, Rössler 1904, Brusina 1908, Werner 1908a, b, Hirtz 1911, Krumbach 1917, Karaman 1921, Bolkay 1924a, 1928c, Hirtz 1930a, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Diesner 1966, Pozzi 1966, Brelj & Džukić 1974, Bruno 1980, Henle 1980, Mattison 1982, Stribosch et al. 1985, 1986, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Fritz 1992, Schneider-Jacoby & Ern 1993, Fritz & Obst 1995, Grillitsch et al. 1995, Vogrin 1997, Mihaljević & Martinčić 1999, Schmidler 1999, Sehnal & Schuster 1999, Schimmenti & Fabris 2000, Fritz 2001, Pistotnik 2001, Pahor 2002, Rathbauer 2002, Moravec 2003, Džukić & Kalezić 2004, Koren 2004, Lončar 2005, Schweiger 2005a, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Kryštufek & Kletečki 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Barun et al. 2010, Koren et al. 2011, Jelić et al. 2012b, c, NHMW

Geomydidae

23. *Mauremys rivulata* (Valenciennes, 1833) – riječna kornjača (HR), rečna sklednica (SI)

Erber 1864, Kolombatović 1888, Tomasini 1889, Boettger 1893, Werner 1898, Rössler 1904, Karaman 1921, Radovanović 1941, 1951, Pavletić 1964, Radovanović 1964, Diesner 1966, Pozzi 1966, Brelih & Džukić 1974, Pracht 1987, Fritz & Wischuf 1997, Fritz 2001, Mantziou et al. 2004, Lončar 2005, Tvrtković & Veen 2006, Janev-Hutinec et al. 2006, Šalamon & Šilić 2007, Fritz et al. 2008, Strišćević et al. 2009, Jelić et al. 2012c, NHMW

24. *Trachemys scripta* (Schoepff, 1792) – crvenouha kornjača (HR), popisana sklednica (SI)

Janev-Hutinec et al. 2006, Schweiger 2008, Jelić et al. 2012c.

Dermochelyidae

25. *Dermochelys coriacea* (Vandelli, 1761) – sedmopruga usminjača (HR), orjaška usnjača (SI)

Kosić 1896, 1899, 1910, Babić 1920a, b, Wettstein 1928, Cvitanić 1956, Crnković 1957, Pavletić 1964, Bruno 1978, Mršić 1987, Kletečki & Lazar 1993, Lazar 1993, Lazar & Tvrtković 1995, Lazar & Tvrtković 2002, Džukić & Kalezić 2004, Fritz 2005, Tóth et al. 2006, Janev-Hutinec et al. 2006, Lazar et al. 2008a, b, Jelić et al. 2012c.

Cheloniidae

26. *Caretta caretta* (Linnaeus, 1758) – glavata želva (HR), glavata kareta (SI)

Frauenfeld 1853, Erber 1864, Cubich 1875, Brusina 1878, Stossich 1880, Kolombatović 1881, 1882, 1883, Faber 1883, Kolombatović 1884, 1885, 1886a, b, c, 1888, Boettger 1893, Kolombatović 1895a, b, Rössler 1904, Brusina 1908, Bolkay 1911b, Puschig 1914, Krumbach 1917, Bolkay 1924a, Vatova 1928, Hirtz 1932, Karaman 1939, Gaston 1960, Riedl 1963, Pavletić 1964, Pozzi 1966, Petrović 1970, Bussani 1972, Džukić 1972, Marcuzzi 1972, Bruno 1978, Henle 1980, Glavičić & Radić 1981, Čepe 1983, Riedl 1983, Lipej et al. 1987, Mršić 1987, Cocco et al. 1988, Cetinić 1989, De Luca et al. 1990, Argano et al. 1992, Kletečki & Lazar 1993, Lazar 1993, Šolić & Jukić 1993, Lazar 1995, Lazar & Tvrtković 1995, Schmidtler 1999, Lazar & Tvrtković 2002, Krofel 2002, Lazar & Tvrtković 2002, Planinc 2002, Džukić & Kalezić 2004, Lazar et al. 2004a, Fritz 2005, Lončar 2005, Casale et al. 2006, Janev-Hutinec et al. 2006, Lazar et al. 2008a, b, Lucić et al. 2008, Vervust et al. 2009, Tóth et al. 2009b, Lazar et al. 2011a, b, Lazar & Gračan 2011, Gračan et al. 2012, Jelić et al. 2012c.

27. *Chelonia mydas* (Linnaeus, 1758) – golema želva (HR), orjaška črepaha (SI)

Stossich 1880, Damin 1889, 1900, Hirtz 1927a, Pavletić 1964, Bruno 1978, Mršić 1987, Lazar 1993, Kletečki & Lazar 1993, Šolić & Jukić 1993, Lazar & Tvrtković 2002, Džukić & Kalezić 2004, Lazar et al. 2004b, Fritz 2005, Janev-Hutinec et al. 2006, Lazar et al. 2010, Jelić et al. 2012c.

ORDER: SQUAMATA**Lacertidae**

28. *Algyroides nigropunctatus* (Duméril & Bibron, 1839) – mrki ljuskavi gušter (HR),
črnopikčasta kuščarica (SI)

Kolombatović 1886b, 1888, Boettger 1893, Werner 1897, Scherer 1902, Kammerer 1903, Kolombatović 1904, Brusina 1908, Werner 1908a, b, Lampe 1909, Karaman 1921, Bolkay 1924a, Mosauer & Wallis 1924, Kammerer & Wettstein 1926, Radovanović 1941, 1951, Pavletić 1964, Dimovski 1967, Pozzi 1966, Peaker & Peaker 1968, Lovrić 1969, Džukić 1970, Rucner & Rucner 1971, Brelih & Džukić 1974, Mršić 1978, Džukić & Pasuljević 1979, Bruno 1980, Henle 1980, Böhme 1981, Enzeroth 1982, Tvrtković 1984, Strijbosch et al. 1985, 1986, Arnold 1987, Mršić 1987, Schulz & Philippen 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, Grbac et al. 1998a, Bressi 1999, Harris et al. 1999, Schmidler 1999, Sehnal & Schuster 1999, Škvarč 1999b, Schimmenti & Fabris 2000, Mayer & Podnar 2002a, b, c, Rathbauer 2002, Mayer & Podnar 2003a, Dieckmann 2004, Džukić & Kalezić 2004, Koren 2004, Lončar 2005, Šalamon et al. 2005, Podnar & Mayer 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Tóth et al. 2009a, Jelić et al. 2012c, MSNM, HNHM, NHMW

29. *Iberolacerta horvathi* (Méhely, 1904) – velebitska gušterica (HR), velebitska kuščarica (SI)
Synonym *Lacerta horvathi* Méhely, 1904

Méhely 1904a (description, terra typica: Jasenak, Kapela, Croatia), 1904b, 1905, Boulenger 1905, Knoblauch 1907, Werner 1906, Karaman 1921, Bolkay 1923, Wettstein 1928, Bolkay 1924a, Mertens 1937, Kramer & Mertens 1938a, b, Cyren 1941, Radovanović 1951, Brelih 1954, Radovanović 1957a, b, Pavletić 1964, Radovanović 1964, Pozzi 1966, Rucner & Rucner 1971, Brelih & Džukić 1974, Mršić 1978, Böhme 1984, Tvrtković 1984, Arnold 1987, De Luca & Đulić 1988, De Luca 1989, 1990, 1992, Crochet et al. 2004, Džukić & Kalezić 2004, Lončar 2005, Tvrtković & Veen 2006, Janev-Hutinec et al. 2006, Jelić et al. 2012c, HNHM, NHMW

30. *Dalmatolacerta oxycephala* Duméril & Bibron, 1839 – oštroglava gušterica (HR),
šiloglavka (SI)
Synonym *Lacerta oxycephala* Duméril & Bibron, 1839

Duméril & Bibron 1839 (description, terrae typicae: Dalmatia, Croatia), Kolombatović 1886a, b, c, 1888, Boettger 1893, Werner 1897, Depoli 1898, Werner 1898, 1899, Galvagni 1902, Werner 1902, Gugler 1903, Kammerer 1903, Kolombatović 1904, Méhely 1904b, Werner 1905, Brusina 1908, Rogenhofer 1908a, b, Werner 1908a, b, c, Rössler 1919, 1920, Karaman 1921, Bolkay 1924a, Kammerer & Wettstein 1926, Koch 1926, Bolkay 1928c, d, Mertens 1934, Cyren 1941, Radovanović 1941, 1951, 1954, 1957a, b, 1960, Krpan 1962, Frommhold 1963a, b, Pavletić 1964, Radovanović 1964, Diesner 1966, Pozzi 1966, Cvitanić 1968, Džukić 1972, Brelih & Džukić 1974, Gorman et al. 1975, Böhme 1984, Lapini 1984, Arnold 1987, Pracht 1987, Raynor 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, Vogrin 1997, Grbac et al. 1998b, Bressi 1999, Schmidler 1999, Škvarč 1999a, b, Planinc 2000, Janev-Hutinec 2001, Pistotnik 2001, Scheers & Van Damme 2002, Mayer & Podnar 2002a, b, c, Cafuta 2003, Mayer & Podnar 2003a, Cafuta 2005, Lončar 2005, Podnar & Mayer 2006, Šalamon et al. 2005, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Huyghe et al. 2007, Kryštufek & Kletečki 2007, Lucić 2007, Lucić et al. 2008, Vervust et al. 2009, Barun et al. 2010, Jelić et al. 2012b, c, MSNM, HNHM, NHMW, MNHN

31. *Dinarolacerta mosorensis* Kolombatović, 1886 – mosorska gušterica (HR), mosorska kuščarica (SI)

Synonym *Lacerta mosorensis* Kolombatović, 1886

Kolombatović 1886b (description, terra typica: Mosor mountain, Dalmatia, Croatia), 1886c, 1888, Steindachner 1892, Werner 1897, Méhely 1903, 1904b, Rössler 1904, Werner 1904, Werner 1905, Karaman 1921, Bolkay 1924a, 1928d, Radovanović 1941, 1951, 1957a, b, Krpan 1962, Pavletić 1964, Radovanović 1964, Pozzi 1966, Džukić 1972, Brelih & Džukić 1974, Böhme 1984, Mršić 1987, De Luca & Đulić 1988, De Luca 1989, Džukić 1989, Maurušchat et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, 1999, Schmidtler 1999, Lončar 2005, Šalamon et al. 2005, Janev-Hutinec et al. 2006, Tvrtković & Veen 2006, Jelić et al. 2012c, NHMW

32. *Lacerta agilis* Linnaeus, 1758 – livadna gušterica (HR), martinček (SI)

Šloser 1870, Brusina 1874, Jurinac 1886, 1887b, Boettger 1893, Werner 1897, 1898, 1899, Hirc 1901a, Rössler 1904, Werner 1904, Méhely 1905, Werner 1905, Hirtz 1911, Karaman 1921, Bolkay 1924a, Wettstein 1928, Radovanović 1964, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Džukić 1972, Brelih & Džukić 1974, Street 1976, Mršić 1978, Böhme 1984, Tvrtković 1984, Strijbosch et al. 1986, Arnold 1987, Tvrtković 1994, De Luca et al. 1990, Bressi 1995, 1999, Mihaljević & Martinčić 1999, Džukić & Kalezić 2004, Koren 2004, Lončar 2005, Tvrtković & Veen 2006, Jelić 2010a, Jelić et al. 2012c, HNHN, NHMW

33. *Lacerta bilineata* Daudin, 1802 – zapadno mediteranski zelembać (HR), zahodnoevropski zelenec (SI)

Frauenfeld 1853, Erber 1864, Peters 1962, Bruno 1980, Bressi 1995, Mavrović 1997, Tvrtković et al. 1998, Bressi 1999, Sehnal & Schuster 1999, Waitzbauer et al. 1999, Pahor 2002, Rathbauer 2002, Dieckmann 2004, Džukić & Kalezić 2004, Lončar 2005, Janev-Hutinec et al. 2006, Tóth et al. 2006, Kuljerić et al. 2007, Tóth et al. 2009b, Jelić et al. 2012c.

34. *Lacerta viridis* (Laurenti, 1768) – obični zelembać (HR), zelenec (SI)

Erber 1864, Šloser 1870, Brusina 1874, Kolombatović 1886b, Jurinac 1887a, Kolombatović 1888, Depoli 1898, Galvagni 1902, Werner 1902, Zimmermann 1902, Gugler 1903, Kolombatović 1904, Rössler 1904, Méhely 1905, Brusina 1908, Werner 1908a, b, Hirtz 1911, Karaman 1921, Hirtz 1923, Mosauer & Wallis 1924, Bolkay 1927, Wettstein 1928, Bolkay & Čurčić 1930, Houba 1957, Koen 1960, Krpan 1962, Peters 1962, Brelih 1963, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Džukić 1972, Lilge & Wicker 1972, Street 1976, Mršić 1978, Bruno 1980, Henle 1980, Böhme 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Mršić 1987, Bruno 1988, Tvrtković & Kletečki 1993b, Tvrtković 1994, Bressi 1995, Kletečki 1995, Tvrtković et al. 1998, Bressi 1999, Mihaljević & Martinčić 1999, Schmidtler 1999, Škvarč 1999b, Koren 2004, Lončar 2005, Šalamon et al. 2005, Treer et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Kuljerić et al. 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, MSNM, NHMW

35. *Lacerta trilineata* Bedriaga, 1886 – veliki zelembać (HR), veliki zelenec (SI)

Frauenfeld 1853, Erber 1864, Boettger 1893, Katurić 1898, Scherer 1902, Bolkay 1919, Karaman 1921, Bolkay 1924a, 1928c, d, Wettstein 1928, Houba 1957, Pavletić 1962, Peters 1962, Frommhold 1963a, b, Pavletić 1964, Pozzi 1966, Džukić 1972, Sinke 1973, Mršić 1978, Bruno 1980, Enzeroth 1982, Mattison 1982, Böhme 1984, Cvitanić 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Arnold 1987, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Bressi 1995, 1999, Tvrtković & Kletečki 1993b, Cvitanić 1995, Vogrin 1997, Tvrtković et al. 1998, Schmidler 1999, Planinc 2000, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Cafuta 2003, Džukić & Kalezić 2004, Cafuta 2005, Lončar 2005, Schweiger 2005b, Šalamon et al. 2005, Konte et al. 2006, Tóth et al. 2006, Kryštufek & Kletečki 2007, Barun et al. 2010, MSNM, NHMW

36. *Podarcis melisellensis* (Braun, 1877) – krška gušterica (HR), kraška kuščarica (SI)

Braun 1877 (description, terra typica: Insel Melisello = Brusnik Island by St. Andrea = Svetac), Erber 1864, Braun 1886, Kolombatović 1888, Boettger 1893, Galvagni 1902, Werner 1902, Lehrs 1902, Scherer 1902, Gugler 1903, Kammerer 1903, Rössler 1904, Boulenger 1905, Werner 1905, 1908a, b, Kammerer 1910, Boulenger 1913A, Rössler 1919, 1920, Karaman 1921, Bolkay 1924a, b, Mosauer & Wallis 1924, Kammerer & Wettstein 1926, Wettstein 1926, Bolkay 1928a, b, c, Wettstein 1928, Hirtz 1930a, Mertens 1934, Kramer & Mertens 1938a, b, Cyren 1941, Radovanović 1941, Wettstein 1949, Radovanović 1951, 1954, 1955a, b, 1957a, b, Cvitanić 1959b, Radovanović 1959a, b, Krpan 1962, Pavletić 1962, Brelih 1963, Frommhold 1963a, b, Gelineo & Gelineo 1963, Pavletić 1964, Diesner 1966, Pozzi 1966, Gorman et al. 1975, Radovanović 1970, Rucner & Rucner 1971, Džukić 1972, Nevo et al. 1972, Brelih & Džukić 1974, Gorman et al. 1975, Mršić 1978, Clover 1979, Bruno 1980, Henle 1980, Mattison 1982, Cvitanić 1984, Lapini 1984, Tvrtković 1984, Strijbosch et al. 1985, Böhme 1986, Strijbosch et al. 1986, Tiedemann & Henle 1986, Arnold 1987, Mršić 1987, Bruno 1988, Schwammer & Baurecht 1988, Mršić et al. 1989, Raynor 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, Cvitanić 1995, Grbac et al. 1998a, b, Tvrtković & Kletečki 1998, Vranković 1998, Bressi 1999, Schmidler 1999, Sehnal 1999a, b, Sehnal & Schuster 1999, Škvarč 1999a, Schimmenti & Fabris 2000, Škvarč 2000, Grbac & Bauwens 2001, Janev-Hutinec 2001, Pistotnik 2001, Krofel 2002, Mayer & Podnar 2002a, b, c, Pahor 2002, Planinc 2002, Rathbauer 2002, Scheers & Van Damme 2002, Cafuta 2003, Mayer & Podnar 2003b, Moravec 2003, Dieckmann 2004, Džukić & Kalezić 2004, Podnar et al. 2004, Cafuta 2005, Lončar 2005, Podnar et al. 2005, Poulakakis et al. 2005, Schweiger 2005b, Šalamon et al. 2005, Grbac & Brnin 2006, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Huyghe et al. 2007, Kryštufek & Kletečki 2007, Kuljerić et al. 2007, Lucić 2007, Brecko et al. 2008, Herrel et al. 2008, Lucić et al. 2008, Huyghe 2009a, b, c, Tóth et al. 2009a, Vervust et al. 2009, Koren et al. 2011, Barun et al. 2010, Huyghe et al. 2010, Lauš 2010, Huyghe et al. 2012, Jelić et al. 2012b, c, Lailvaux et al. 2012, MSNM, NHNM, NHMW

37. *Podarcis muralis* (Laurenti, 1768) – zidna gušterica (HR), pozidna kuščarica (SI)

Erber 1864, Šloser 1870, Brusina 1874, Braun 1886, Jurinac 1886, Kolombatović 1886a, b, c, Boulenger 1887, Kolombatović 1888, Boettger 1893, Werner 1897, 1898, Depoli 1898, Werner 1899, Galvagni 1902, Werner 1902, Lehrs 1902, Scherer 1902, Zimmermann 1902, Gugler 1903, Kammerer 1903, Kolombatović 1904, Mähely 1904b, Rössler 1904, Boulenger 1905, Mähely 1905, Werner 1905, Brusina 1908, Kammerer 1910, Hirtz 1911, Boulenger 1913a, Hirc 1914, Boulenger 1916, 1920, 1921, Karaman 1921, Bolkay 1924a, Mosauer & Wallis 1924, Wettstein 1926, 1928, Mertens 1937, Kramer & Mertens 1938a, b, Wettstein 1949, Taddei 1950, Krpan 1962, Breljih 1963, Radovanović 1964, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Džukić 1972, Breljih & Džukić 1974, Street 1976, Schmidler 1977, Mršić 1978, Bruno 1980, Henle 1980, Tvrtković 1984, Strijbosch et al. 1985, Böhme 1986, Strijbosch et al. 1986, Arnold 1987, Mršić 1987, Bruno 1988, Tvrtković & Kletečki 1993b, Tvrtković 1994, Bressi 1995, De Luca & Grbac 1995, De Luca et al. 1998, Grbac et al. 1998a, Bressi 1999, Schmidler 1999, Grbac & Bauwens 2001, Dieckmann 2004, Džukić & Kalezić 2004, Koren 2004, Lončar 2005, Šalamon et al. 2005, Treer et al. 2006, Podnar & Mayer 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Hill 2008, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Tóth et al. 2009a, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, MSNM, NHMW, MNHN

38. *Podarcis siculus* (Rafinesque, 1810) – primorska gušterica (HR), primorska kuščarica (SI)

Synonym *Podarcis sicula* (Rafinesque, 1810)

Erber 1864, Boettger 1893, Lehrs 1902, Scherer 1902, Gugler 1903, Boulenger 1905, Werner 1905, 1908a, b, Lampe 1909, Boulenger 1913a, Rössler 1919, 1920, Karaman 1921, Bolkay 1924a, Mosauer & Wallis 1924, Kammerer & Wettstein 1926, Wettstein 1926, Hirtz 1930a, Wettstein 1931, Mertens 1934, 1937, Kramer & Mertens 1938a, b, Cyren 1941, Radovanović 1941, Wettstein 1949, Taddei 1950, Radovanović 1951, 1954, 1955a, b, 1956, 1957a, b, Sochurek 1956, Cvitanić 1959b, Radovanović 1959a, b, Cvitanić 1960, Radovanović 1960, Breljih 1961, 1963, Krpan 1962, Pavletić 1962, 1964, Witte 1965, Pozzi 1966, Cvitanić 1968, Peaker & Peaker 1968, Gorman et al. 1975, Radovanović 1970, Rucner & Rucner 1971, Džukić 1972, Lilge & Wicker 1972, Nevo et al. 1972, Verbeek 1972, Breljih & Džukić 1974, Cvitanić 1974, Gorman et al. 1975, Cvitanić 1976, Schmidler 1977, Mršić 1978, Clover 1979, Bruno 1980, Henle 1980, Bank et al. 1982, Enzeroth 1982, Mattison 1982, Strohmaier 1984, Strijbosch et al. 1985, Böhme 1986, Strijbosch et al. 1986, Arnold 1987, Mršić 1987, Bruno 1988, Henle 1988, Mršić et al. 1989, Raynor 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, Tome 1995, Vogrin 1997, Podnar et al. 1998, Tome 1998, Tvrtković & Kletečki 1998, Bressi 1999, Schmidler 1999, Schimmenti & Fabris 2000, Škvarč 2000, Krofel 2002, Mayer & Podnar 2002a, b, c, Pahor 2002, Planinc 2002, Mayer & Podnar 2003a, b, Moravec 2003, Džukić & Kalezić 2004, Koren 2004, Podnar et al. 2004, Podnar et al. 2005, Lončar 2005, Grbac & Brnin 2006, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Kryštufek & Kletečki 2007, Kuljerić et al. 2007, Vervust et al. 2007, 2008a, b, Herrel et al. 2008, Tóth et al. 2009b, Vervust et al. 2009, Koren et al. 2011, Radočaj et al. 2011, Urošević et al. 2012, Jelić et al. 2012c, MSNM, HNHN, NHMW

39. *Zootoca vivipara* (Lichtenstein, 1823) – živorodna gušterica (HR), živorodna kuščarica (SI)
Synonym *Lacerta vivipara* Jacquin, 1787

Frauenfeld 1854, Kolombatović 1888, Méhely 1905, Karaman 1921, Radovanović 1951, Pavletić 1964, Pozzi 1966, Mršić 1978, Böhme 1984, Tvrtković 1984, Tvrtković 1994, Schmidler 1999, Heulin et al. 2000, Džukić & Kalezić 2004, Lončar 2005, Jelić & Bogdanović 2011, Jelić et al. 2012c, Horváthová et al. 2013, NHMW

Gekkonidae

40. *Hemidactylus turcicus* (Linnaeus, 1758) – kućni macaklin (HR), turški gekon (SI)

Partsch 1826, Frauenfeld 1853, Erber 1864, Brusina 1874, Kolombatović 1888, Werner 1897, Galvagni 1902, Werner 1902, Kolombatović 1904, Werner 1904, Rössler 1904, Werner 1905, Brusina 1908, Rogenhofer 1908a, Werner 1908a, b, Hirtz 1911, Rössler 1913, Bolkay 1919, Rössler 1919, Karaman 1921, Bolkay 1924a, Koch 1926, Bolkay 1928c, d, Hirtz 1930a, Radovanović 1941, Radovanović 1951, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Pozzi 1966, Cvitanic 1968, Tolnai 1969, Kattinger 1972, Brelih & Džukić 1974, Mršić 1978, Bruno 1980, Böhme 1981, Cvitanic 1984, Tvrtković 1984, Mršić 1987, Bruno 1988, Raynor 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, 1999, Cvitanic 1995, Schmidler 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Krofel 2002, Planinc 2002, Čafuta 2003, Moravec 2003, Džukić & Kalezić 2004, Čafuta 2005, Lončar 2005, Schweiger 2005b, Šalamon et al. 2005, Konte et al. 2006, Tóth et al. 2006, Kryštufek & Kletečki 2007, Lucić 2007, Lucić et al. 2008, Vervust et al. 2009, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012b, c, Lisičić et al. 2012, NHMW

41. *Tarentola mauritanica* (Linnaeus, 1758) – zidni macaklin (HR), pozidni gekon (SI)

Frauenfeld 1853, Kolombatović 1888, Werner 1897, Galvagni 1902, Werner 1902, 1905, Brusina 1908, Karaman 1921, Radovanović 1951, Koen 1960, Frommhold 1963a, b, Pavletić 1964, Pozzi 1966, Brelih & Džukić 1974, Bruno 1980, Böhme 1981, Bruno 1988, De Luca et al. 1990, Bressi 1995, 1999, Schimmenti & Fabris 2000, Džukić & Kalezić 2004, Tóth et al. 2006, Kryštufek & Kletečki 2007, Barun et al. 2010, Jelić et al. 2012c, Lisičić et al. 2012, MSNM, HNHN, NHMW

Anguidae

42. *Anguis fragilis* Linnaeus, 1758 – sljepić (HR), slepec (SI)

Erber 1864, Šloser 1870, Brusina 1874, Mojsisovics 1883, Boettger 1886, Mojsisovics 1886, Jurinac 1887a, Katuri 1887, Kolombatović 1888, Boettger 1893, Depoli 1898, Katuri 1898, Scherer 1902, Zimmermann 1902, Méhely 1905, Hirtz 1911, Karaman 1921, Mosauer & Wallis 1924, Bolkay 1928c, d, Wettstein 1928, Fejérváry-Lágh 1943, Koen 1960, Gelenčir 1963, Pavletić 1964, Radovanović 1964, Pozzi 1966, Rucner & Rucner 1971, Džukić 1972, Brelih & Džukić 1974, Mršić 1978, Bruno 1980, Henle 1980, Böhme 1981, Enzeroth 1982, Mattison 1982, Tvrtković 1984, Strijbosch et al. 1985, 1986, Džukić 1987, Mršić 1987, Bruno 1988, Henle 1988, Mršić et al. 1989, Tvrtković 1994, Bressi 1995, 1999, Mihaljević & Martinčić 1999, Sehnal & Schuster 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Rathbauer 2002, Džukić & Kalezić 2004, Koren 2004, Lončar 2005, Konte et al. 2006, Tóth et al. 2006, Treer et al. 2006, Kryštufek & Kletečki 2007, Dumbović et al. 2009, Janev-Hutinec & Karaica 2010, Jeran et al. 2011, Jelić et al. 2012c, NHMW

43. *Pseudopus apodus* (Pallas, 1775) – blavor (HR), blavor (SI)

Synonym *Ophisaurus apodus* (Pallas, 1775)

Frauenfeld 1853, Erber 1864, Brusina 1874, Kolombatović 1888, Boettger 1893, Werner 1897, Depoli 1898, Galvagni 1902, Werner 1902, Scherer 1902, Kolombatović 1904, Rössler 1904, Werner 1905, Brusina 1908, Werner 1908a, b, Bolkay 1911c, Hirc 1912, Rössler 1919, Karaman 1921, Bolkay 1925a, Koch 1926, Bolkay 1928c, d, Hirtz 1930a, Tonković 1934, Radovanović 1941, Radovanović 1951, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Radovanović 1964, Igalfy et al. 1965, Diesner 1966, Pozzi 1966, Cvitanić 1968, Peaker & Peaker 1968, Tolnai 1969, Rucner & Rucner 1971, Džukić 1972, Brelih & Džukić 1974, Lovrić 1976, Mršić 1978, Obst 1978, Bruno 1980, Henle 1980, Böhme 1981, Enzeroth 1982, Mattison 1982, Lapini 1984, Meek 1986a, b, Strijbosch et al. 1986, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Bressi 1995, Grillitsch et al. 1995, Vogrin 1997, Sehnal & Schuster 1999, Bressi 1999, Schmidler 1999, Škvarč 1999a, b, Planinc 2000, Schimmenti & Fabris 2000, Škvarč 2000, Janev-Hutinec 2001, Pistotnik 2001, Krofel 2002, Planinc 2002, Rathbauer 2002, Cafuta 2003, Moravec 2003, Džukić & Kalezić 2004, Cafuta 2005, Lončar 2005, Schweiger 2005b, Šalamon et al. 2005, Konte et al. 2006, Tóth et al. 2006, Huyghe et al. 2007, Kryštufek & Kletečki 2007, Lucić et al. 2008, Tóth et al. 2009a, b, Vervust et al. 2009, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012b, c, MSNM, NHMW, MNHN

Scincidae

44. *Ablepharus kitaibelii* Bibron & Bory de Saint-Vincent, 1833 – ivanjski rovaš (HR), ivanja kuščarica (SI)

Lončar 2005, Janev-Hutinec et al. 2006, Szövényi & Jelić 2011, Jelić et al. 2012c

Amphisbaenidae

45. *Blanus strauchi* (Bedriaga, 1884) – turski dvoplaz (HR), turški mrežoril (SI)

Karaman 1921, Wettstein 1928, Pavletić 1964, Delfino 1997, Janev-Hutinec et al. 2006, Jelić et al. 2012c

Typhlopidae

46. *Typhlops vermicularis* Merrem, 1820 – zmijolika sljeparica (HR), črvasta slepica (SI)

Grillitsch et al. 1999, Janev-Hutinec & Lupret-Obradović 2005, Janev-Hutinec et al. 2006, Jelić et al. 2012c, NHMW

Colubridae

47. *Coronella austriaca* Laurenti, 1768 – smukulja (HR), smokulja (SI)

Erber 1864, Šloser 1870, Möllendorff 1873, Jurinac 1887b, Katuriĉ 1887, Kolombatović 1888, Katuriĉ 1895, Werner 1897, Depoli 1898, Werner 1898, 1899, Hirc 1901b, Galvagni 1902, Werner 1902, Rössler 1904, Hirtz 1911, Boulenger 1913b, Karaman 1921, Bolkay 1928c, Hirtz 1928, Wettstein 1928, Buresch & Zonkow 1934, Hirtz 1937c, 1940a, b, Radovanović & Martino 1950, Sochurek 1958, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1964, Pozzi 1966, Mikačić 1967, Džukić 1972, Brelj & Džukić 1974, Street 1976, Mršić 1978, Bruno 1980, Lapini 1984, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Lipej et al. 1987, Mršić 1987, Bruno 1988, Schneider-Jacoby & Ern 1993, Tvrtković & Kletečki 1993b, Tvrtković 1994, Kranjčev 1997, Mihaljević & Martinčić 1999, Schmidler 1999, Schimmenti & Fabris 2000, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Šalamon et al. 2005, Džukić & Kalezić 2004, Treer et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Hill 2008, Barun et al. 2010, Janev-Hutinec & Karaica 2010, Jelić 2010b, Jelić & Vilaj 2011, Jelić et al. 2012b, c, HHNM, HHMW

48. *Dolichophis caspius* (Gmelin, 1789) – žuta poljarica (HR), velika poljarica (SI)

Synonym *Coluber caspius* Gmelin, 1789

Galvagni 1902, Werner 1902, 1904, Rössler 1919, Radovanović 1964, Janev-Hutinec & Lupret-Obradović 2005, Ozimec et al. 2005, Janev-Hutinec et al. 2006, Krčmar et al. 2007, Huyghe et al. 2007, Kreiner 2007, Kryštufek & Kletečki 2007, Lucić et al. 2008, Trócsányi & Schäffer 2008, Kletečki et al. 2009, Vervust et al. 2009, Barun et al. 2010, Jelić et al. 2012c

49. *Elaphe quatuorlineata* (Lacepède, 1789) – četveroprugi kravosas (HR), progasti gož (SI)

Erber 1864, Kolombatović 1881, 1882, 1883, 1888, Boulenger 1894, Werner 1897, Boettger 1898, Depoli 1898, Kosić 1898, Galvagni 1902, Werner 1902, Zimmermann 1902, Gugler 1903, Kolombatović 1904, Rössler 1904, Brusina 1908, Rogenhofer 1908c, Werner 1908a, b, Kosić 1910, Boulenger 1913b, Rössler 1919, Karaman 1921, Bolkay 1924a, 1928a, Buresch & Zonkow 1934, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1958, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1964, Radovanović 1964, Pozzi 1966, Mikačić 1967, Bruno 1968, Cvitanić 1968, Džukić 1972, Brelj & Džukić 1974, Lovrić 1976, Mezzena & Dolce 1977, Bruno 1980, Mattison 1982, Lapini 1984, Sochurek 1984, Strohmaier 1986, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Böhme 1993, Burlin & Dolce 1993, Tvrtković & Kletečki 1993b, Schulz 1996, Vogrin 1997, Schmidler 1999, Sehnal & Schuster 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Pahor 2002, Rathbauer 2002, Cafuta 2003, Džukić & Kalezić 2004, Koren 2004, Janev-Hutinec & Lupret-Obradović 2005, Kranjčev 2005, Lončar 2005, Prpić 2005, Schweiger 2005b, Konte et al. 2006, Tóth et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Lucić 2007, Schweiger 2008, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012c, MSNM, HHMW, MNHN

50. *Hierophis gemonensis* (Laurenti, 1768) – šara poljarica (HR), belica (SI)

Synonym *Coluber gemonensis*

Frauenfeld 1853, Erber 1864, Kolombatović 1881, 1882, Werner 1897, Boettger 1898, Galvagni 1902, Werner 1902, Gugler 1903, Kolombatović 1904, Rössler 1904, Brusina 1908, Werner 1908a, b, Lampe 1909, Veith 1909, Boulenger 1913b, Rössler 1919, Karaman 1921, Bolkay 1924a, Koch 1926, Bolkay 1928c, Wettstein 1928, Hirtz 1930a, 1937d, e, Cyren 1941, Radovanović 1941, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1953, 1958, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Radovanović 1964, Diesner 1966, Pozzi 1966, Mikačić 1967, Bruno 1968, Cvitanić 1968, Džukić 1972, Lilge & Wicker 1972, Brelih & Džukić 1974, Lovrić 1976, Mršić 1978, Dolce 1979, Fottner 1979, Bruno 1980, Enzeroth 1982, Mattison 1982, Lapini 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Mršić 1987, Bruno 1988, Schätti 1988, Mršić et al. 1989, De Luca et al. 1990, Böhme 1993, Tvrtković & Kletečki 1993b, Grillitsch et al. 1995, Mavrović 1997, Vogrin 1997, Škvarč 1999b, Schimmenti & Fabris 2000, Schmidler 1999, Sehnal & Schuster 1999, Janev-Hutinec 2000, 2001, Škvarč 2000, Krofel 2002, Planinc 2002, Cafuta 2003, Moravec 2003, Nagy et al. 2003, Džukić & Kalezić 2004, Koren 2004, Cafuta 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Schweiger 2005b, Šalamon et al. 2005, Konte et al. 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Lucić 2007, Tóth et al. 2009b, Barun et al. 2010, Lauš 2010, Strunjak-Perović et al. 2010, Čož-Rakovac et al. 2011, Jelić & Lauš 2011, Koren et al. 2011, Jelić et al. 2012b, c, MSNM, NHNM, NHMW, MNHN

51. *Hierophis viridiflavus* (Lacépède, 1789) – crna poljarica (HR), črnica (SI)

Synonym *Coluber viridi-flavus* Lacépède, 1789

Frauenfeld 1853, 1854, Erber 1864, Kolombatović 1882, Braun 1886, Depoli 1898, Godez 1899, Galvagni 1902, Werner 1902, Scherer 1902, Rössler 1913, Hirc 1914, Mosauer & Wallis 1924, Radovanović 1941, Radovanović & Martino 1950, Sochurek 1958, Krpan 1962, Pavletić 1962, 1964, Radovanović 1964, Pozzi 1966, Lilge & Wicker 1972, Brelih & Džukić 1974, Lovrić 1976, Mršić 1978, Dolce 1979, Fottner 1979, Bruno 1980, Henle 1980, Mattison 1982, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1985, Schätti & Vanni 1986, Strijbosch et al. 1986, Bruno 1988, Henle 1988, Schätti 1988, Mršić et al. 1989, Böhme 1993, Grillitsch et al. 1995, Schimmenti & Fabris 2000, Nagy et al. 2002, Džukić & Kalezić 2004, Koren 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Kreiner 2007, Kryštufek & Kletečki 2007, Jelić et al. 2012c, NHMW

52. *Natrix natrix* (Linnaeus, 1758) – bjelouška (HR), belouška (SI)

Erber 1864, Šloser 1870, Brusina 1874, Kolombatović 1881, 1882, Katuriđ 1883, Mojsisovics 1883, Boettger 1886, Jurinac 1887a, Kolombatović 1888, Werner 1897, Boettger 1898, Depoli 1898, Kosić 1898, Werner 1898, Zimmermann 1902, Kolombatović 1904, Rössler 1904, Brusina 1908, Werner 1908a, b, Lampe 1909, Hirtz 1911, Boulenger 1913b, Karaman 1921, Bolkay 1924a, 1928c, Wettstein 1928, Hirtz 1930a, b, Buresch & Zonkow 1934, Tonković 1934, Hirtz 1940b, Cyren 1941, Radovanović & Martino 1950, Sochurek 1958, Cvitanić 1959a, c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Gelenčir 1963, Pavletić 1964, Cvitanić 1965, Diesner 1966, Pozzi 1966, Bruno 1968, Keler 1971, Rucner & Rucner 1971, Džukić 1972, Brelih & Džukić 1974, Lovrić 1976, Street 1976, Schmidler 1977, Mršić 1978, Fottner 1979, Bruno 1980, Henle 1980, Enzeroth 1982, Mattison 1982, Cvitanić 1984, Lapini 1984, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Franzen 1987, Mršić 1987, Pracht 1987, Bruno 1988, Henle 1988, Mršić et al. 1989, De Luca et al. 1990, Schneider-Jacoby & Ern 1993, Tvrtković & Kletečki 1993b, Tvrtković 1994, Janev &

Obradović 1994, Kletečki 1995, Janev & Obradović 1997, Kranjčev 1997, Vogrin 1997, Mihaljević & Martinčić 1999, Schmidtler 1999, Sehnal & Schuster 1999, Schimmenti & Fabris 2000, Šalamun 2000, Janev-Hutinec 2000, 2001, Pahor 2002, Cafuta 2003, Moravec 2003, Springer et al. 2003, Džukić & Kalezić 2004, Koren 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Schweiger 2005b, Šalamun et al. 2005, Konte et al. 2006, Mikuška et al. 2006, Tóth et al. 2006, Treer et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Barun et al. 2010, Janev-Hutinec & Karaica 2010, Jelić & Vilaj 2011, Jelić et al. 2012c, MSNM, HNHN, NHMW, MNHN, SMNH

53. *Natrix tessellata* (Laurenti, 1768) – ribarica (HR), kobranka (SI)

Synonym: *Coronella tessellata* Laurenti, 1768

Laurenti 1768 (description, terrae typicae: »In Japidia, vulgo Cars« = probably Croatia or west Bosnia), Erber 1864, Kolombatović 1882, Mojsisovics 1883, Boettger 1886, Mojsisovics 1886, Kolombatović 1888, Werner 1897, Boettger 1898, Depoli 1898, Scherer 1902, Zimmermann 1902, Largaiolli 1904, Rössler 1904, Hirtz 1911, Boulenger 1913b, Karaman 1921, Bolkaý 1928c, Buresch & Zonkow 1934, Hirtz 1940b, Cyren 1941, Radovanović & Martino 1950, Sochurek 1958, Cvitanić 1959a, c, Gelenčir 1963, Pavletić 1964, Pozzi 1966, Brelih & Džukić 1974, Bruno 1980, Mattison 1982, Sochurek 1984, Strijbosch et al. 1985, 1986, Franzen 1987, Bruno 1988, De Luca et al. 1990, Schneider-Jacoby & Ern 1993, Tvrtković 1994, Vogrin 1997, Böhme 1999, Mihaljević & Martinčić 1999, Schmidtler 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Džukić & Kalezić 2004, Koren 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Treer et al. 2006, Tvrtković & Veen 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Schweiger 2008, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Jelić 2011, Jelić & Lauš 2011, Jelić & Lelo 2011, Jelić & Vilaj 2011, Jelić et al. 2012c, MSNM, NHMW, MNHN, SMNH

54. *Platyceps najadum* (Eichwald, 1831) – šilac, plavetna poljarica (HR), vitka poljarica (SI)

Synonym *Coluber najadum* Schmidt, 1939

Erber 1864, Kolombatović 1881, 1882, 1888, Werner 1897, Boettger 1898, Lampe 1909, Gugler 1903, Brusina 1908, Bolkaý 1928c, Buresch & Zonkow 1934, Cyren 1941, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1958, Cvitanić 1959c, Koen 1960, Radovanović 1960, Krpan 1962, Pavletić 1964, Diesner 1966, Pozzi 1966, Mikačić 1967, Bruno 1968, Džukić 1972, Brelih & Džukić 1974, Mršić 1978, Dolce 1979, Fottner 1979, Bruno 1980, Mattison 1982, Lapini 1984, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1986, Bruno 1988, De Luca et al. 1990, Böhme 1993, Tvrtković & Kletečki 1993b, Vogrin 1997, Schmidtler 1999, Planinc 2000, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Vuković 2001, Džukić & Kalezić 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Schweiger 2005b, Šalamun et al. 2005, Konte et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Jelić et al. 2012c, MSNM, HNHN, NHMW, MNHN

55. *Telescopus fallax* (Fleischmann, 1831) – ljuta crnokrpica (HR), mačjeoka kača, črnostrel (SI)

Frauenfeld 1853, Erber 1864, Kolombatović 1881, 1882, Katuriđ 1887, Kolombatović 1888, Werner 1897, Boettger 1898, Depoli 1898, Galvagni 1902, Werner 1902, Hirc 1902b, Kolombatović 1904, Rössler 1904, Brusina 1908, Lampe 1909, Bol kay 1911c, Rössler 1919, Karaman 1921, Bol kay 1924a, 1928c, Hirtz 1930a, b, Radovanović & Martino 1950, Sochurek 1953, 1958, Cvitanović 1959c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Radovanović 1964, Pozzi 1966, Mikačić 1967, Cvitanović 1968, Džukić 1972, Brel ih & Džukić 1974, Lovrić 1976, Tadić 1976, Mršić 1978, Dolce 1979, Bruno 1980, Henle 1980, Cvitanović 1984, Lapini 1984, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1986, Lipej et al. 1987, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Grillitsch et al. 1995, Vogrin 1997, Böhme 1999, Schmid tler 1999, Grillitsch & Grillitsch 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Grillitsch & Grillitsch 2002, Krofel 2002, Planinc 2002, Džukić & Kalezić 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Schweiger 2005b, Konte et al. 2006, Tóth et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012c, MSNM, NHNM, NHMW

56. *Zamenis longissimus* (Laurenti, 1768) – bjelica, Eskulapova zmija (HR), navadni gož (SI)
Synonym *Elaphe longissima* (Laurenti, 1768)

Erber 1864, Šloser 1870, Brusina 1874, Mojsisovics 1883, Jurinac 1886, Mojsisovics 1886, Kolombatović 1888, Werner 1897, Depoli 1898, Zimmermann 1902, Kolombatović 1904, Rössler 1904, Werner 1908a, b, Hirtz 1911, Boulenger 1913b, Karaman 1921, Bol kay 1928c, Hirtz 1930b, Buresch & Zonk ow 1934, Radovanović & Martino 1950, Müller 1952, Sochurek 1958, Cvitanović 1959c, Koen 1960, Krpan 1962, Frommhold 1963a, b, Gelenčir 1963, Pavletić 1964, Pozzi 1966, Džukić 1972, Brel ih & Džukić 1974, Street 1976, Mršić 1978, Bruno 1980, Henle 1980, Mattison 1982, Cvitanović 1984, Lapini 1984, Sochurek 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Mršić 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Böhme 1993, Tvrtković & Kletečki 1993b, Schulz 1996, Kranjčev 1997, Vogrin 1997, Mihaljević & Martinčić 1999, Schmid tler 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2001, Rathbauer 2002, Cafuta 2003, Džukić & Kalezić 2004, Koren 2004, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Schweiger 2005b, Šalamon et al. 2005, Cafuta 2005, Prpić 2005, Tóth et al. 2006, Treer et al. 2006, Tvrtković & Veen 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Hill 2008, Schweiger 2008, Trócsányi & Schäffer 2008, Dumbović et al. 2009, Barun et al. 2010, Janev-Hutinec & Karaica 2010, Jelić et al. 2012c, MSNM, NHNM, NHMW

57. *Zamenis situla* (Linnaeus, 1758) – pjegava crvenkrpica (HR), leopardovka (SI)
Synonym *Elaphe situla* (Linnaeus, 1758)

Erber 1864, Brusina 1874, Kolombatović 1888, Boulenger 1894, Werner 1897, Boettger 1898, Hirc 1902b, Lampe 1909, Gugler 1903, Kolombatović 1904, Rössler 1904, Boulenger 1913b, Rössler 1919, Karaman 1921, Poljak 1924, Bol kay 1928c, Hirtz 1928, 1930a, b, d, Buresch & Zonk ow 1934, Lederer 1936, Hirtz 1939c, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1953, 1958, Cvitanović 1959c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Canadija 1965, Diesner 1966, Pozzi 1966, Mikačić 1967, Bruno 1968, Džukić 1972, Brel ih & Džukić 1974, Lovrić 1976, Mršić 1978, Bruno 1980, Mattison 1982, Pozio 1983, Lapini 1984, Sochurek 1984, Tvrtković 1984, Mršić 1987, Bruno 1988, De Luca et al. 1990, Durbešić 1990, Böhme 1993, Tvrtković & Kletečki 1993b, Farkas & Tóth 1999, Schmid tler 1999, Sehnal & Schuster 1999, Škvarč

1999b, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Škvarč 2000, Krofel 2002, Planinc 2002, Rathbauer 2002, Džukić & Kalezić 2004, Cafuta 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Schweiger 2005b, Šalamon et al. 2005, Janev-Hutinec et al. 2006, Konte et al. 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012c, MSNM, HNHN, NHMW, MNHN

Lamprophiidae

58. *Malpolon insignitus* (Geoffroy Saint-Hilaire, 1827) – zmajur (HR), zrna (SI)

Synonym *Malpolon monspessulanus* Hermann, 1804

Botteri 1853, Frauenfeld 1853, Erber 1864, Bruno 1968, Kolombatović 1881, 1882, 1888, Katurić 1887, Werner 1897, Galvagni 1902, Werner 1902, Scherer 1902, Lampe 1902, Kolombatović 1904, Rössler 1904, Brusina 1908, Werner 1908a, b, c, Veith 1909, Bolkay 1911c, Rössler 1919, Karaman 1921, Bolkay 1924a, 1928c, Hirtz 1930a, Buresch & Zonkow 1934, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1958, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1964, Radovanović 1964, Diesner 1966, Pozzi 1966, Mikačić 1967, Bruno 1968, Kušan 1971, Džukić 1972, Brelih & Džukić 1974, Lovrić 1976, Bruno 1980, Cvitanić 1984, Lapini 1984, Sochurek 1984, Strijbosch et al. 1986, Mršić 1987, Bruno 1988, De Luca et al. 1990, Tvrtković & Kletečki 1993b, Sehnal & Schuster 1999, Böhme 1999, Schmidtler 1999, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Pistotnik 2001, Krofel 2002, Planinc 2002, Rathbauer 2002, Cafuta 2003, Moravec 2003, Džukić & Kalezić 2004, Grbac 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Schweiger 2005b, Šalamon et al. 2005, Tóth et al. 2006, Kreiner 2007, Kryštufek & Kletečki 2007, Schweiger 2008, Barun et al. 2010, Lauš 2010, Koren et al. 2011, Jelić et al. 2012b, c, MSNM, HNHN, NHMW

Viperiidae

59. *Vipera ammodytes* (Linnaeus, 1758) – poskok (HR), modras (SI)

Lalich 1840, Frauenfeld 1853, Erber 1864, Šloser 1870, Möllendorff 1873, Brusina 1874, Kolombatović 1881, 1882, Katurić 1883, Jurinac 1886, Kolombatović 1888, Werner 1897, Depoli 1898, Kosić 1898, Sebišanović 1898, Galvagni 1902, Werner 1902, Hirc 1902b, Gugler 1903, Kosić 1904, Rössler 1904, Brusina 1908, Lampe 1909, Kosić 1910, Veith 1910, Hirtz 1911, Bolkay 1917, Rössler 1919, Bolkay 1920b, c, Karaman 1921, Bolkay & Ćurčić 1920, Bolkay 1924a, Poljak 1924, Bolkay 1925b, Hirtz 1925, 1927b, c, d, Marčić 1927, Reuss 1927b, Bolkay 1928c, Crkvenac 1928, Bolkay & Ćurčić 1930, Hirtz 1930b, c, Radovanović 1932, Bolkay & Ćurčić 1933, Hirtz 1933b, Buresch & Zonkow 1934, Stipančić 1934, Tonković 1934, Hirtz 1937b, 1939b, 1940d, Cyren 1941, Hirtz 1941, Radovanović & Martino 1950, Sochurek 1953, 1958, Vivat 1958, Cvitanić 1959c, Koen 1960, Krpan 1962, Pavletić 1962, Frommhold 1963a, b, Pavletić 1964, Radovanović 1964, Pozzi 1966, Mikačić 1967, Bruno 1968, Tolnai 1969, Rucner & Rucner 1971, Džukić 1972, Brelih & Džukić 1974, Lovrić 1976, Tadić 1976, Mršić 1978, Dolce 1979, Sochurek 1979, Bruno 1980, Filipović & Ostojić-Bakotin 1981, Sochurek 1981, Mattison 1982, Tvrtković 1982, Biella 1983a, b, Cvitanić 1984, Tvrtković 1984, Strijbosch et al. 1985, 1986, Burlin & Dolce 1986, Mršić 1987, Pracht 1987, Bruno 1988, Mršić et al. 1989, De Luca et al. 1990, Burlin & Dolce 1993, Tvrtković & Kletečki 1993b, Tvrtković 1994, Kranjčev 1997, Schmidtler 1999, Planinc 2000, Schimmenti & Fabris 2000, Janev-Hutinec 2000, 2001, Cafuta 2003, Prpić 2003, Tomović & Džukić 2003, Džukić & Kalezić 2004, Böhme 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Schweiger 2005b,

Šalamon et al. 2005, Škrobonja & Muzur 2005, Konte et al. 2006, Lukšić et al. 2006, Tomović 2006, Tóth et al. 2006, Tvrtković & Veen 2006, Kryštufek & Kletečki 2007, Kreiner 2007, Schweiger 2008, Ursenbacher et al. 2008, Dumbović et al. 2009, Schweiger 2009, Barun et al. 2010, Janev-Hutinec & Karaica 2010, Lukšić et al. 2010, Mader 2010, Tomović et al. 2010, Jelić et al. 2012a, b, c, 2013, MSNM, HNHN, NHMW, MNHN, SMNH

60. *Vipera berus* (Linnaeus, 1758) – ričovka (HR), navadni gad (SI)

Lalich 1840, Šloser 1870, Möllendorff 1873, Schreiber 1875, Jurinac 1887a, Boettger 1889, Werner 1893, 1897, Depoli 1898, Hirc 1902b, Rössler 1904, Méhely 1905, Hirtz 1911, Krumbach 1917, Bolkay 1920b, c, Karaman 1921, Hirtz 1924, 1925, Reuss 1927a, b, Wettstein 1928, Hirtz 1929a, b, Bolkay & Čurčić 1930, Praunsperger 1930, Buresch & Zonkow 1932, Radovanović 1932, Bolkay & Čurčić 1933, Hirtz 1933b, Buresch & Zonkow 1934, Horvat 1935, Bieling et al. 1936, Hirtz 1937b, 1938, 1939a, Vidović 1939, Hirtz 1940c, Radovanović & Martino 1950, Sochurek 1953, 1958, Frommhold 1964, Pavletić 1964, Pozzi 1966, Rucner & Rucner 1971, Brelih & Džukić 1974, Theakston & Reid 1976, Sochurek 1979, 1981, Schiemenz 1985, Tvrtković 1994, Kranjčev 1995, Mihailević & Martinčić 1999, Džukić & Kalezić 2004, Böhme 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Prpić 2005, Kreiner 2007, Jelić et al. 2009, Malina et al. 2011, Jelić et al. 2012a, c, 2013, NHMW, SMNH

61. *Vipera ursinii* (Bonaparte, 1835) – planinski žutokrug (HR), mali gad (SI)

Méhely 1894, Werner 1894, 1898, Kolombatović 1899, 1900, Méhely 1911, Fejérváry 1915a, b, Karaman 1921, Reuss 1927b, Bolkay & Čurčić 1933, Buresch & Zonkow 1934, Tonković 1934, Schwarz 1936, Hirtz 1939a, Radovanović & Martino 1950, Radovanović 1951, Sochurek 1953, Knoepffler & Sochurek 1955, Frommhold 1959, Kramer 1961, Radovanović 1964, Pozzi 1966, Brelih & Džukić 1974, Bruno 1980, Sochurek 1985, Dely 1986, Bruno 1988, Dely & Stohl 1989, Schimmenti & Fabris 2000, Nilson & Andrén 2001, Džukić & Kalezić 2004, Böhme 2005, Janev-Hutinec & Lupret-Obradović 2005, Lončar 2005, Janev-Hutinec et al. 2006, Jelić et al. 2007, Kreiner 2007, Ferchaud et al. 2012, Jelić et al. 2012a, c, 2013, MSNM, HNHN, NHMW

Other species

One male specimen of *Vipera aspis francisciredi* Laurenti, 1768, is deposited in the Natural History Museum of Milano (MSNM In. No. 1594) and labelled »Croazia, Istria, 1960, Morto allo Zoo di Torino« [died in Torino ZOO] (Stefano Scali, pers. comm.). This individual was obviously held in the Torino Zoological Garden for some time and died in 1960. Original collector of this specimen is not mentioned and it is questionable whether the location of specimen collection was labelled correctly after living for such a long time in captivity. This is currently the only finding or mentioning of *V. aspis* in Croatian or Slovenian part of Istria. The eastern border of *V. aspis* distribution in Slovenia is the Vipava River (Dolce 1979, Tome 2003, Torkar 2003).

There are also two preserved specimens of *Chalcides chalcides* (Linnaeus, 1758) in the Natural History Museum in Vienna (NHMW In. No. 10529/1 and 31244/), both collected by Otto Tomasini and labelled »Zara« [Zadar]. The sample was checked by Schreiber in 1915 and declared »fälschlich Zara angegeben« [Zadar falsely stated].

Neither of these species was included in the list due to the reasons listed above. *T. vermicularis* and *B. strauchi* were, on the other hand, included due to papers published about their findings in Croatia. Author finds it highly unlikely that these species are naturally occurring in Croatia.

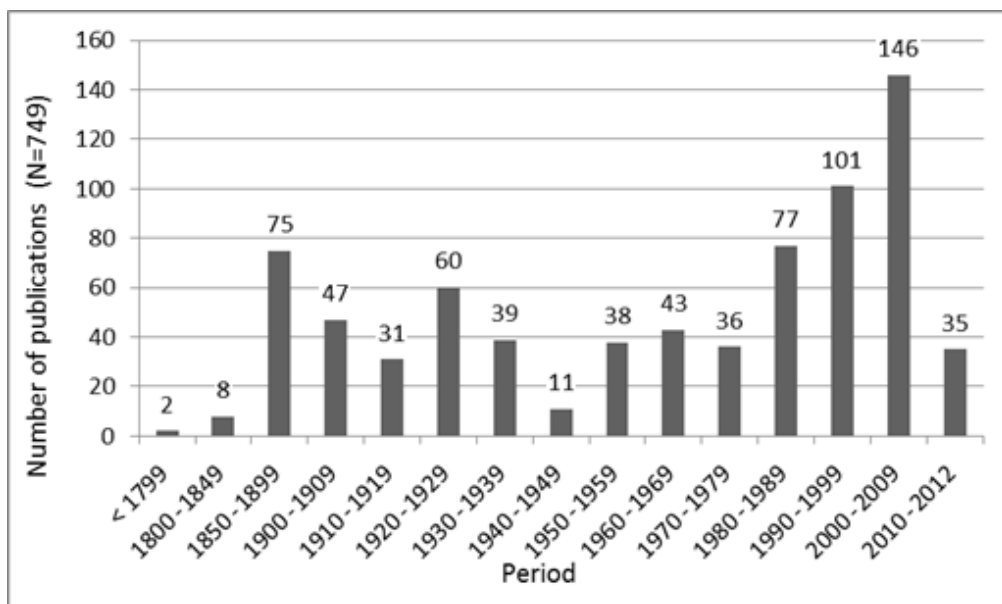


Figure 1. Fluctuation of the number of herpetological publications in Croatia in the last 200 years.

Slika 1. Spreminjanje števila herpetoloških objav na Hrvaškem v zadnjih 200 letih.

Figure 1 shows a very steep decline of the number of publications during the time of the two world wars 1914–1918 (First World War) and 1939–1945 (Second World War). During the war activities the scientific research was stopped and it needed some time to recover. Recent war activities in Croatia (1990–1999) did not leave such a devastating effect on research, but definitely slowed down the process. After that, in the 2000–2009 period, the average number of publications rose to the maximum of 14.6 per year.

Only five species had more than 100 publications (Fig. 2), *V. ammodytes* and *P. melisellensis* being the most frequently mentioned species with 147 and 141 publications respectively (20% of total number). On the other side of the scale, same number of species had less than 10 publications, i.e. *P. lessonae*, *B. strauchi*, *A. kitaibelii*, *T. vermicularis* and *T. scripta*.

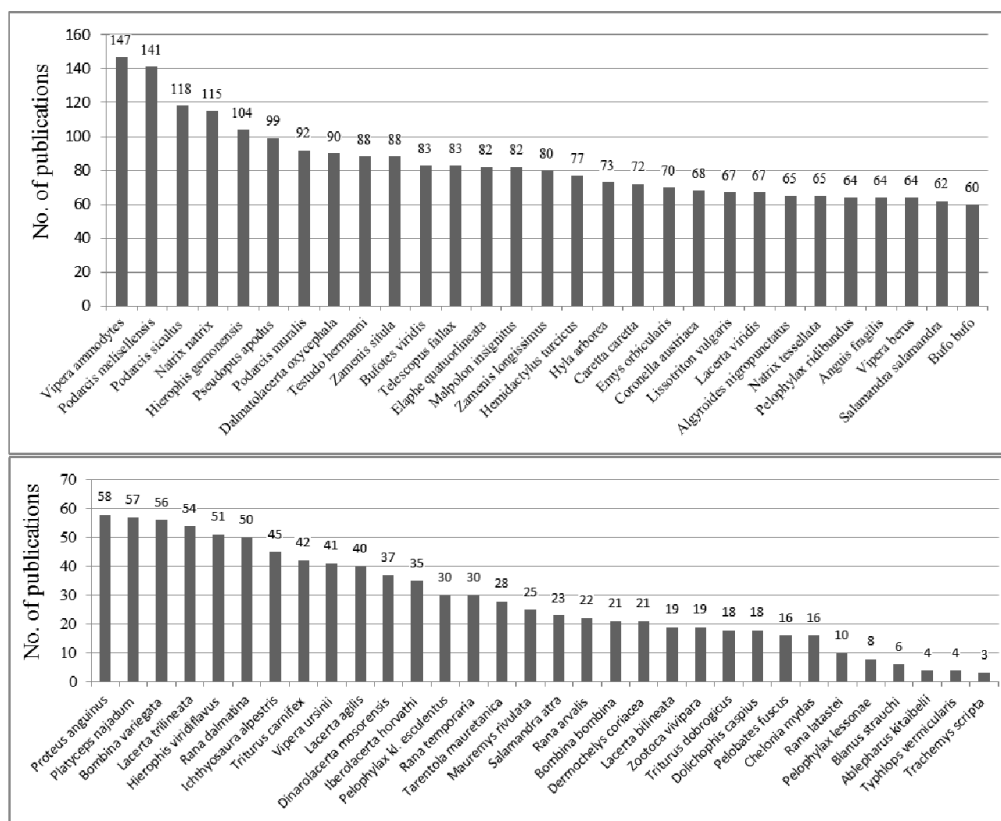


Figure 2. Number of publications per species of Croatian herpetofauna.

Slika 2. Število objav na posamično vrsto hrvaške herpetofavne.

Discussion

According to all historical and recent sources gathered from scientific literature, 20 amphibian and 41 reptile species have been recorded in Croatia up to date. Two species, *Blanus strauchi* (Squamata, Amphisbaenidae), *Typhlops vermicularis* (Squamata, Typhlopidae), are considered doubtful, although individual museum vouchers are at hand. Altogether, the number can be summarized as 59 + 2 doubtful species, which represents an increase of Croatian herpetofauna compared to Rössler (1904), Pavletić (1964) and Janev-Hutinec et al. (2006). The amphibian fauna is represented by 2 orders (Caudata and Anura) and 7 families (Bufonidae, Discoglossidae, Hylidae, Pelobatidae, Proteidae, Ranidae, Salamandridae). The reptile fauna is also represented by 2 orders (Testudines and Squamata), but with 13 families (Amphisbaenidae, Anguidae, Chelonidae, Colubridae, Dermochelyidae, Emydidae, Gekkonidae, Geoemydidae, Lacertidae, Scincidae, Testudinidae, Typhlopidae, Viperidae). Regarding the number of species, the two largest families of reptiles are

Lacertidae (12; 20%) and Colubridae (12; 20%). Among amphibians, two of the largest families are Ranidae (7; 12%) and Salamandridae (6; 10%). Altogether, 7 families are represented by just one species.

Two more species have been recorded historically, *Vipera aspis* (Squamata, Viperidae) and *Chalcides chalcides* (Squamata, Scincidae), but the possibility for their presence in Croatia is discarded and therefore not included in the list. *Rana catesbeiana* is another species that was mentioned for Croatia only once in a species list by Janev-Hutinec et al. (2006), but without any explanation on the origin of the data. There are no other published data in literature or records known to the author, so this species cannot be included in the list of Croatian herpetofauna. *R. catesbeiana* would be the first introduced amphibian species in Croatia, if found here. Currently, only the Red-eared Slider (*T. scripta*) is being widely introduced in Croatia and can be found in the wild. This species is represented by two subspecies, *T. scripta scripta* and *T. scripta elegans*, which are illegally sold as pets all over the country. Two more native species have been actively introduced to new environments: *P. siculus* was introduced from the Adriatic coast to the mainland (Zagreb, Karlovac), where it has established a viable population; *T. hermanni* was introduced from the Adriatic coast to several locations on the mainland (surroundings of Velika Gorica, Virovitica and Ilok), but the author assumes that they do not breed there. Also, the presence of *D. caspius* on Olib Island is thought to be the result of recent introduction.

Analysis of the number of publications per species shows strong research preference of reptiles over amphibians. This is visible from the fact that the first 10 species are all reptiles and that only two amphibians (*B. viridis* and *H. arborea*) are found among top 20 most published species. Even stronger preference is shown towards Mediterranean species versus montane and continental ones. Least published species are mostly the ones that are considered not present (*B. strauchi* and *T. vermicularis*), recently discovered (*A. kitaibelii*) and recently introduced (*T. scripta*). It is somewhat surprising that *P. lessonae* is found among five least published species, but this is due to the lack of good experts that can distinguish species of the genera *Pelophylax* with certainty. Very often these species are recorded as *Pelophylax* sp. or not recorded at all.

Due to the geographical position of Croatia, many of the listed species are regional endemics of different geographical areas. *R. latastei* is regionally endemic to the Padano-Veneto Valley and Istrian Peninsula (Po River Valley: Italy, Switzerland, Slovenia and Croatia), *T. dobrogicus* is distributed through the great Pannonian Plains of Central and eastern Europe, *P. anguinus* is endemic to karst underground waters from Trieste (Italy) through Slovenia, Croatia and Bosnia and Herzegovina to the border with Montenegro, *S. atra*, *T. carnifex* and *I. horvathi* are regionally endemic to the Alps and Dinaric mountain chain. *M. rivulata*, *A. nigropunctatus*, *D. oxycephala*, *D. mosorensis*, *P. melisellensis*, *E. quatuorlineata* and *H. gemonensis* are generally endemic to the Balkan Peninsula.

This paper summarizes data from 700 scientific and non-scientific publications, which is the first attempt to publish complete Croatian herpetological bibliography.

Povzetek

Iz pregleda zgodovinskih in recentnih literaturnih virov je bilo doslej na Hrvaškem zabeleženih 20 vrst dvoživk in 41 vrst plazilcev. Pojavljanje dveh vrst plazilcev, *Blanus strauchi* (Squamata, Amphisbaenidae) in *Typhlops vermicularis* (Squamata, Typhlopidae), je vprašljiva, čeprav obstajajo njuni muzejski primerki. Tako je skupno število vrst 59, medtem ko sta dve vrsti vprašljivi. Dvoživke so zastopane z dvema redoma in sedmimi družinami, plazilci pa z dvema redoma in 13 družinami. Po številu vrst sta največji družini plazilcev Lacertidae (12,2 % vrst) in Colubridae (12, 2 % vrst). Med dvoživkami sta največji družini Ranidae (7,1 % vrst) in Salamandridae (6,1 % vrst). Sedem družin je zastopanih s po eno samo vrsto. Splošno razširjena v naravi je vrsta vodnih želv *Trachemys scripta*; zastopana je z dvema podvrstama, *T. scripta scripta* in *T. scripta elegans*, ki se prodajata za domače ljubljence. Dve avtohtoni vrsti sta bili naseljeni na nova območja: *Podarcis siculus* je bil prinesen z jadranske obale v notranjost (Zagreb, Karlovac), kjer so se vzpostavile viabilne populacije; *Testudo hermanni* je bila prinesena z jadranske obale na več območij na celini (okolica Velike Gorice, Virovitice in Iloka), vendar avtor predpostavlja, da se tam ne razmnožujejo. Analiza števila objav na posamezno vrsto kaže, da je več raziskovalne pozornosti dane plazilcem kot dvoživkam. Po številu objav na vrsto je prvih deset plazilcev, med 20 vrstami z največ objavami pa sta le dve dvoživki, *Bombina viridis* in *Hyla arborea*. Bolje so raziskane sredozemske vrste kot vrste v goratih in celinskih območjih. Zaradi geografske lege Hrvaške je mnogo naštetih vrst regionalnih endemitov različnih geografskih območij. *Rana latastei* je regionalni endemit doline Padano - Veneto in Istre (Padška dolina: Italija, Švica, Slovenija in Hrvaška). *Triturus dobrogicus* je razširjen po velikih panonskih nižinah srednje in vzhodne Evrope, *Proteus anguinus* je endemit kraških podzemnih voda od Trsta (Italija), prek Slovenije, Hrvaške ter Bosne in Hercegovine do meje s Črno goro, *Salamandra atra*, *Triturus carnifex* in *Iberolacerta horvathi* so regionalni endemiti Alpske in Dinarske gorske verige. *Mauremys rivulata*, *Algyroides nigropunctatus*, *Dalmatolacerta oxycephala*, *Dinarolacerta mosorensis*, *Podarcis melisellensis*, *Elaphe quatuorlineata* in *Hierophis gemonensis* so endemiti Balkanskega polotoka. V članku je povzetih 700 strokovnih in poljudnih publikacij, kar je prvi poskus objave celotne bibliografije o herpetološki favni Hrvaške.

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Distribution and population size estimation of the moor frog *Rana arvalis* Nilsson, 1842 in Ljubljansko barje Nature Park, central Slovenia

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Abstract. Until recently, the moor frog *Rana arvalis* has been recorded only from the Pannonian and Sava Basins of north-eastern and south-eastern Slovenia, respectively. Here we report on the occurrence of the species at Ljubljansko barje, central Slovenia, and give estimates of the species' abundance and distribution. In addition, we present some morphological characteristics of this population and offer insights into the present threats and the status of its habitats. The overall population size was estimated through egg mass count and is calculated to be more than 19,000 adults. All findings were distributed in two separate clusters. The northern cluster hosted more than 96% of all findings, while the smaller cluster in the south-eastern part of Ljubljansko barje accounted for only a fraction of the records. Even though the habitats in the northern cluster are relatively well preserved, the possibility of local extinction remains high owing to the immediate proximity of the capital and the municipal landfill site, which is planned for expansion in the near future.

Key words: moor frog, *Rana arvalis*, egg mass counts, population size, Ljubljansko barje Nature Park

Izvleček. Razširjenost in ocena velikosti populacije barske žabe *Rana arvalis* Nilsson, 1842 v Krajinskem parku Ljubljansko barje, osrednja Slovenija – Barska žaba (*Rana arvalis*) je evrazijska vrsta, za katero je do nedavnega veljalo, da živi zgolj v nižinah severovzhodne in jugovzhodne Slovenije. V prispevku poročamo o pojavljanju te vrste na Ljubljanskem barju, o njeni razširjenosti in o velikosti tamkajšnje populacije. Poleg tega podajamo še vpogled v stanje in ogroženost te populacije in predstavljamo nekaj njenih morfoloških značilnosti. Velikost populacije smo ocenili s štetjem mrestov na mrestiščih. Na Ljubljanskem barju živi več kot 19.000 odraslih barskih žab, ki so geografsko razporejeni v dve večji območji. Več kot 96 % vseh najdb prihaja iz večjega, severnega območja, medtem ko preostale najdbe prihajajo iz jugovzhodnega dela Barja. Čeprav so gozdni habitati na severnem območju razmeroma dobro ohranjeni, neposredna bližina mesta in deponije, ki se bo predvidoma širila, barske žabe močno ogrožata. Uničenje primernih habitatov in prekinitev povezav med mrestišči in kopenskimi habitati namreč vodi v lokalno izumrtje vrste.

Ključne besede: barska žaba, *Rana arvalis*, ocena velikosti populacije, štetje mrestov, KP Ljubljansko barje

Introduction

Borders of species distribution and identification of isolated populations have recently received considerable attention mostly due to the reappraisal of their conservation values. They possibly contain the gene pool that is best suited for colonisation of new habitats or recolonisation of adjunct areas where they have become extinct (Hamilton & Eckert 2007). Thus it is important and urgent to document the fine-scale distribution, habitat, life history and demography of peripheral populations. In the European Union, a great deal of new data on the borders of species distribution was collected during various activities related to implementations of Natura 2000 networks, especially in countries that have been under-explored in terms of recording and researching biodiversity (Jovanović 2009, Jelić et al. 2012, Bonk et al. 2012). This also applies to Slovenia, where knowledge of the border distribution of some amphibian species has increased significantly in recent years (Krofel 2005, Stanković & Delić 2012, Stanković & Pobljšaj 2013, Stanković et al. 2014).

The moor frog *Rana arvalis* is a Euroasiatic lowland species distributed through a vast area spreading all the way from northern France to Lake Baikal and beyond (Glandt 2008). Its distribution is continuous over most of its range, except in the western part, where a number of isolated populations occur. In most cases, fragmentation can be explained by recent human activities; however, fossil records from western Europe, the Balkans, southern Russia and the Caucasus, and an isolated population in southern Norway and by the Sea of Azov indicate an even broader species distribution at the end of the Pleistocene (Roček & Šandera 2008, Kuzmin et al. 2009). In Europe, two regions of species distribution can be distinguished. The larger area (i) spreads from above the Arctic Circle in Scandinavia over the European lowlands of central, western and eastern Europe and all the way to the coast of the Black Sea in Ukraine. The smaller area (ii) extends like a pocket from the central European lowlands into the Pannonian Basin along the River Danube. These two areas correspond with the two recognized geographic subspecies, whose status, however, is partly disputed by morphological and molecular data (Babik & Rafinski 2000, Babik et al. 2004): *R. a. wolterstorffi* inhabits the Pannonian Basin, whereas *R. a. arvalis* is found in the remainder of the distribution range. The species shows a great variety in the dorsal colouration pattern, which does not correspond to its taxonomic division, but is described as different colour morphs or varieties. The three most common morphs are *striata*, *maculata* and *unicolor*. While the *maculata* morph occurs practically everywhere, the *unicolor* and *striata* morphs have limited geographical distributions. In general, the *unicolor* morph is rare in the northern and north-western border of the species distribution and is commonest to the south and to the east – it is the most dominant in Croatia and in south-eastern Hungary, but is probably rare in Austria. On the other hand, the *striata* morph is more common towards the border areas of the species distribution range, including Austria and most of Hungary, but is rare in the central and south-eastern areas of the range. In addition, this form is absent in the Sava Basin (Fog 2008a, b).

In Slovenia, *R. arvalis* reaches its south-eastern distribution limit. Until recently, it was believed to be limited to the Pannonian and Sava Basins in the north-eastern and south-eastern parts of the country, respectively (Pobljšaj et al. 2008). In the spring of 2010, however, the authors confirmed the species presence at Ljubljansko barje, central Slovenia (Stanković & Cipot 2013). Among the neighbouring countries, this species can be found in

Croatia, Austria and Hungary (Tvrtković & Kletečki 2008, Grillitsch & Cabela 2008, Puky & Schad 2008). Except for the populations along the River Kupa in Croatia and the River Drava in Austria, all other populations are continuous across the national borders of the adjacent countries.

Although *R. arvalis* is listed as a species of least concern (LC) by the IUCN (Kuzmin et al. 2009), it is strictly protected under the Bern Convention (Appendix II) and protected by the EU Habitats Directive 92/43/EEC (listed in Annex IV). In Slovenia, it is legally protected by the Decree on Protected Wild Animal Species (Ur. l. RS 2004a) and listed as an endangered species (E) in the »Slovenian Red Data List« (Ur. l. RS 2002).

The aim of this contribution is to give a precise description of the first indisputable record of *R. arvalis* in central Slovenia, to present data on the size and distribution of the sub-populations at Ljubljansko barje and to assess the status of the population and its habitat along with possible threats. By having extensively surveyed potential *R. arvalis* habitats over an area of 135 km² we have significantly expanded the knowledge of the distribution and abundance of this species in the south-eastern border of its range. In addition, we offer insights into the terrestrial and aquatic habitat selection and provide observations on some morphological characteristics of the populations studied. We conclude by placing these populations in the context of the known distribution in adjacent regions and countries and suggest two scenarios for the origin of this well isolated population.

Material and methods

Records of *R. arvalis* at Ljubljansko barje were compiled from a large-scale survey in 2011 (Cipot 2011), other herpetological surveys (Govedič et al. 2009) and unpublished data. All surveys were restricted to Ljubljansko barje Nature Park.

Study area

Ljubljansko barje is some 160 km² large lowland area located in central Slovenia south of the capital city of Ljubljana. This is one of the southernmost regions in Europe where raised bogs can be found. In the second half of the 18th century, large-scale draining operations were put in motion. By the turn of the 20th century, the marshes were drained to an extent that made the land exploitable for extensive farming (Brenčič 2008).

Despite the intensive degradation and urbanisation, Ljubljansko barje still hosts a few larger complexes of wet meadows, traces of lowland raised bogs and fragments of wet woodlands. Even though less than 10% of the area is covered by woodlands (Kotarac & Grobelnik 1999), some fragments are still in good condition and could present suitable habitats for *R. arvalis*.

Potential breeding sites of *R. arvalis* were preselected based on the species' ecological characteristics and breeding demands, taking all confirmed and possible sightings into account. The timing of the surveys coincided with the species breeding season in Slovenia (March through April) and was carried out in 2011. However, some sites were visited outside this timespan. Twelve areas were selected for the survey, including all larger lowland woodlands and marshes found in the region (Fig. 1). The surface of the preselected areas extended from 3.0 to 186.0 ha with an average of 64.2 ha, while the total combined surface area added up to 770.3 ha (Tab. 1). Most of the preselected areas are characterised by a relatively large proportion of woodlands (44% on average), followed by extensive agricultural land (24.9% on average) and finally by marshes (13.5% on average).

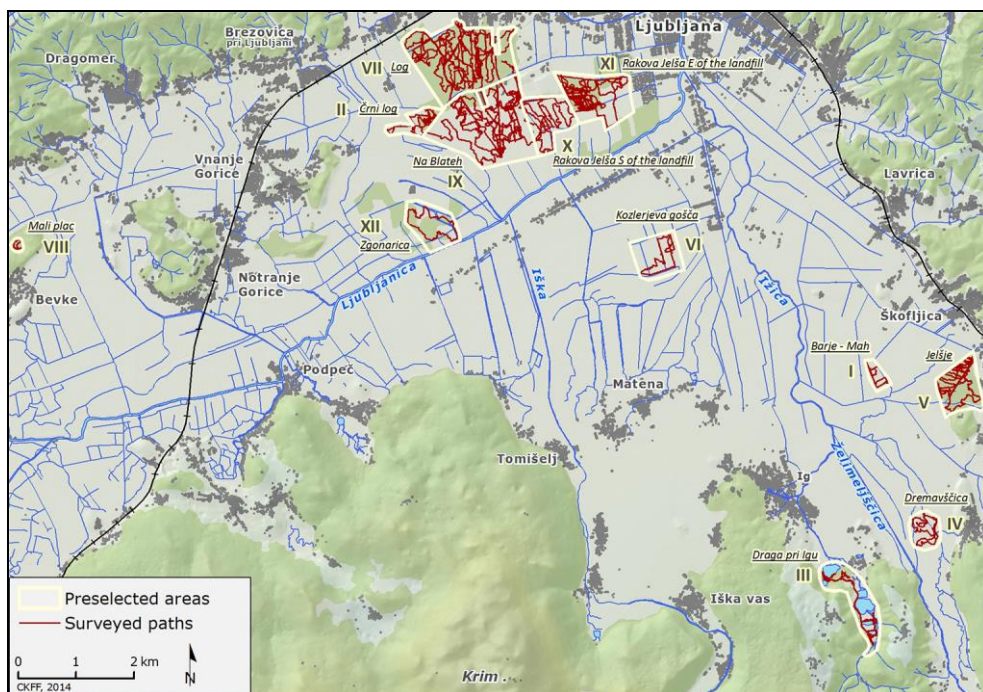


Figure 1. All preselected areas were checked on foot and all potential breeding grounds and habitats of *R. arvalis* were inspected.

Slika 1. Preglednost izbranih območij. V vseh vnaprej izbranih območjih so bila potencialna mrestišča in bivališča barskih žab prehojena in pregledana.

Table 1. Land use and habitat characteristics in the preselected areas to be examined for *R. arvalis* breeding sites (after Kotarac & Grobelnik 1999). Each area is marked by a roman numeral. Areas where *R. arvalis* breeding was confirmed are in bold. The forest in Rakova Jelša E of the landfill (*) was completely cut down a few years prior to the 2011 survey.

Tabela 1. Pokritost pregledanih območij s skupinami habitatnih tipov v odstotkih glede na rabo pomembno za barske žabe (povzeto po Kotarac & Grobelnik 1999). Pregledana območja so označena z rimskimi številkami. Območja, kjer je bilo razmnoževanje barske žabe potrjeno, so odebeljena. Gozd v Rakovi Jelši vzhodno od deponije (*) je bil popolnoma posekan nekaj let pred inventarizacijo barskih žab v letu 2011.

PRESELECTED AREAS	Surface area [ha]	Urban area [%]	Intensive agriculture areas [%]	Extensive agriculture areas [%]	Woodlands [%]	Swamps [%]	Water bodies [%]
I Barje – Mah	9.4	11.3	0.9	42.3	34.0	7.6	3.9
II Crni Log	19.9	11.2	1.4	40.8	46.4	0	0.2
III Draga pri Igu	64.1	3.6	1.3	12.7	52.9	8.9	20.6
IV Dremavščica	26.3	9.2	19	33.3	33.8	0.5	4.2
V Jelšje	55.8	6.0	1.8	6.9	84.2	0.4	0.7
VI Kozlarjeva gošča	44.7	2.7	14.2	30.9	0.6	49.2	2.4
VII Log	172.7	1.4	0.1	11.0	86.7	0	0.8
VIII Mali plac	3.0	0	0	0	20.6	79.4	0
IX Na blateh	186.0	2.7	14.6	37.8	41.9	2.6	0.4
X Rakova Jelša S of the landfill	58.9	2.9	10.9	40.0	35.6	9.6	1.0
XI Rakova Jelša E of the landfill*	80.5	16.9	6.2	29.8	*42.0	3.7	1.4
XII Zgonarica	49.0	5.5	31.9	13.6	45.2	0.2	3.6
Areas combined	770.3	4.9	8.8	24.7	52.9	5.8	2.8
Average values	64.2	6.1	8.5	24.9	43.7	13.5	3.3

Species detection and estimation of census population size

During the survey, all wet meadows, flood-meadows, marshes and swamps, ponds and ditches in the preselected areas were inspected, searching for both egg clutches and adults. During the breeding season, adult *R. arvalis* males were visually identified by their blue colouration. Otherwise, adults were identified based on the colouration of the belly, head mask pattern, the shape of the metatarsal tubercle and other morphological characters or by vocalisation. All caught specimens were released at the site of capture. Egg clutches were identified by the characteristic manner of egg deposition. Females of both *R. arvalis* and the common frog *Rana temporaria* deposit their eggs in aggregations in shallow water. By way of comparison, *R. temporaria* deposits somewhat larger egg clutches containing more eggs, while the clutches of *R. arvalis* are smaller and have a more compact globular shape (Nöllert & Nöllert 1992). An accurate distinction between the clutches of both species is possible only when they are relatively fresh. Therefore, our sightings were classified in two separate categories. The first category contained sightings of egg clutches that belonged to *R. arvalis* beyond doubt. On the other hand, clutches that were not indisputably identified and could belong to either of the two species were placed in the category *R. arvalis/temporaria* group.

Although by no means representative of the true census population size, the number of clutches can give a rough indication of the number of breeding females and some idea on the abundance of frogs in a given area (Glandt 2008). To get a good estimate of the census size, egg clutches were counted in two independent runs, both conducted when most of the clutches had already been laid but were still fresh enough to allow reliable identification. Only the count with more clutches per locality was considered. The available data on the sex ratio in *R. arvalis* varies quite extensively. Some researchers report the ratio to be in favour of females (Günther & Nabrowsky 1996), while others claim the opposite (Hellbernd 1987). Because of these discrepancies, the proposition given by Glandt (2008) was followed, and 1:1 sex ratio for the estimation of the minimum number of males based on egg mass count was used.

Besides counts of egg mass, the census size was also estimated by counting adult blue males on the breeding sites. If possible, the males were counted from distance with the help of binoculars and camera. Because adult males can be very timid during breeding, the observer had to wait for the animals to habituate to his/her presence, which could last up to half an hour or even more. Preselected areas with no indisputable records of *R. arvalis* were processed as areas where this species is only probably present.

Morphometric analysis and analysis of colour pattern

A total of 33 adult males were collected at three Ljubljansko barje localities: the Jelšje (V), Log (VII) and Na blateh (IX) areas. Two morphometric measurements were taken on live individuals using callipers with an accuracy of 0.1 mm: snout-vent length (SVL) and tibia length (TL). The frogs were captured at their breeding sites during the mating season in April 2011, with males mostly in their blue colouration. The SVL/TL ratio was calculated.

For colouration analysis, a total of 35 adults from the Log (VII) area were inspected. Based on their colouration pattern and the distribution of skin tubercles, individuals were assigned to either striata, maculata, unicolor or the hemistriata morph as suggested by Fog (2008a, b). Hemistriata morph is a transitional form and can be conceived as a variant of other morphs. The main reason for defining it is to avoid specimens to be falsely classified as striata. Frogs were captured in August and September 2012. The prevalence of colour morphs was compared to that from the alluvial forest in Rački ribniki Nature Park in north-eastern Slovenia, where 20 adults were collected in July of 2013.

Results

Distribution of *R. arvalis* in the Ljubljansko barje area

On 25. 3. 2010, the authors confirmed the presence of *R. arvalis* at Ljubljansko barje. A small group of about twenty individuals, including blue males, was found on a flooded fallow land south of Ljubljana in an area known under the name of Na blateh (IX). A few days later another confirmation of the species presence in the area known as Log (VII) came from Davorin Tome. The closest known population at that time was located about 100 km SE in Krakovski gozd near Novo mesto.

During the spring of 2011, *R. arvalis* breeding sites were confirmed in five out of the twelve preselected areas, with altogether 6,112 egg clutches recorded, while additional 3,669 clutches could also belong to *R. temporaria*. Therefore, based on egg clutch counts, Ljubljansko barje hosts at least 12,224 *R. arvalis* adults and 7,338 adults that may alternatively belong to *R. temporaria*. This sums to 19,562 adults, when considering all *R. arvalis*/*temporaria* clutches as in fact belonging to *R. arvalis*. This conclusion can be drawn on the basis of the rareness or even absence of *R. temporaria* in preselected areas and generally in this lowland region. In fact, less than 3% of all our findings (egg clutches or adults) were assigned to *R. temporaria* beyond doubt.

Breeding of *R. arvalis* was confirmed in the following preselected areas - Črni Log (II), Log (VII), Na blateh (IX), Rakova Jelša south of the municipal landfill site (X) and Rakova Jelša east of the municipal landfill site (XI), while the Dremavščica (IV) and Jelšje (V) areas contained only clutches that could belong to either of the two species (Tab. 2). On the other hand, *R. arvalis* adults were observed at the following five preselected sites: Črni Log (II), Jelšje (V), Log (VII), Na blateh (IX) and Rakova Jelša east of the municipal landfill site (XI).

The inspected breeding sites can be divided into two clusters. Of a total of 18 breeding aggregations with >100 *R. arvalis* egg clutches of recorded at Ljubljansko barje, all but one belong to the northern cluster (A) (Figs. 2–3). This cluster spans four preselected areas, which are spread in the close vicinity of the municipal landfill site. In the Log area (VII) alone, four breeding-aggregation sites with >500 clutches and four with >200 *R. arvalis* clutches were registered, while three breeding aggregations with a high density of clutches (>200) were also recorded in the neighbouring Črni Log (II) and Na blateh areas (IX). On the other hand, Rakova Jelša east and south of the municipal landfill site (X, XI) holds fewer small breeding sites. In other words, the northern cluster includes more than 96% of all findings and has the highest ecological densities (Tab. 3). On the other hand, the smaller cluster (B) is comprised of only one or possibly two preselected areas, as Dremavščica (IV) contains only *R. arvalis*/*temporaria* group (Fig. 2). During the survey, 2,019 clutches of *R. dalmatina* and 334 clutches that belong to *R. temporaria* frog beyond doubt were also recorded (Tab. 2).

Table 2. Adult brown frogs and egg clutches counted in preselected areas during the survey in 2011.**Tabela 2.** Število prešteti odraslih osebkov in mrestov rjavih žab na posameznem pregledanem območju v letu 2011.

PRESELECTED AREAS	<i>R. arvalis</i>		<i>R. arvalis/temporaria</i>		<i>R. dalmatina</i>		<i>R. temporaria</i>		<i>R. sp.</i>	(combined)	
	No. clutches	No. adults	No. clutches	No. adults	No. clutches	No. adults	No. clutches	No. adults	No. adults	No. clutches	No. adults
I Barje – Mah	0	0	0	0	13	0	0	0	0	13	0
II Črni Log	258	180	254	0	56	0	0	0	0	568	180
III Draga pri Igu	0	0	0	0	96	0	192	633	8	288	641
IV Dremavščica	0	0	59	0	19	0	0	0	0	78	0
V Jelšje	0	8	277	0	949	64	8	0	0	1234	72
VI Kozlarjeva gošča	0	0	0	0	2	0	0	0	0	2	0
VII Log	1923	4347	2245	0	165	1	5	11	1	4338	4360
VIII Mali plac	0	0	0	0	178	4	16	0	2	194	6
IX Na blateh	1984	321	482	0	245	0	0	0	4	2711	325
X Rakova Jelša S of the landfill	12	0	10	0	46	0	0	0	0	68	0
XI Rakova Jelša E of the landfill	1935	19	342	0	239	0	113	0	2	2629	21
XII Zgonarica	0	0	0	0	11	0	0	0	0	11	0
All together	6112	4875	3669	0	2019	69	334	644	17	12134	5605

Table 3. Population and ecological density of *R. arvalis* in preselected areas at Ljubljansko barje. Number of adults was estimated by egg counts and considering 1:1 sex ratio (Glandt 2008b). Preselected areas marked with an asterisk (*) belong to the southern cluster (B).**Tabela 3.** Gostota in ekološka gostota odraslih osebkov barskih žab in skupine *R. arvalis/temporaria* v letu 2011, izračunana iz prešteti mrestov obeh taksonov na podlagi razmerja med spoloma 1:1 (Glandt 2008b) na posameznem raziskovalnem območju. Območja označena z zvezdico (*) so del južne zgoščitve (B).

PRESELECTED AREAS	Surface area [ha]	Density	Ecological density
II Črni Log	19.9	51.46	58.94
IV Dremavščica*	26.3	4.48	6.63
V Jelšje*	55.8	9.92	10.85
VII Log	172.7	48.27	49.44
IX Na blateh	186.0	26.52	32.221
X Rakova Jelša S of the landfill	58.9	0.75	0.88
XI Rakova Jelša E of the landfill	80.5	56.57	74.94

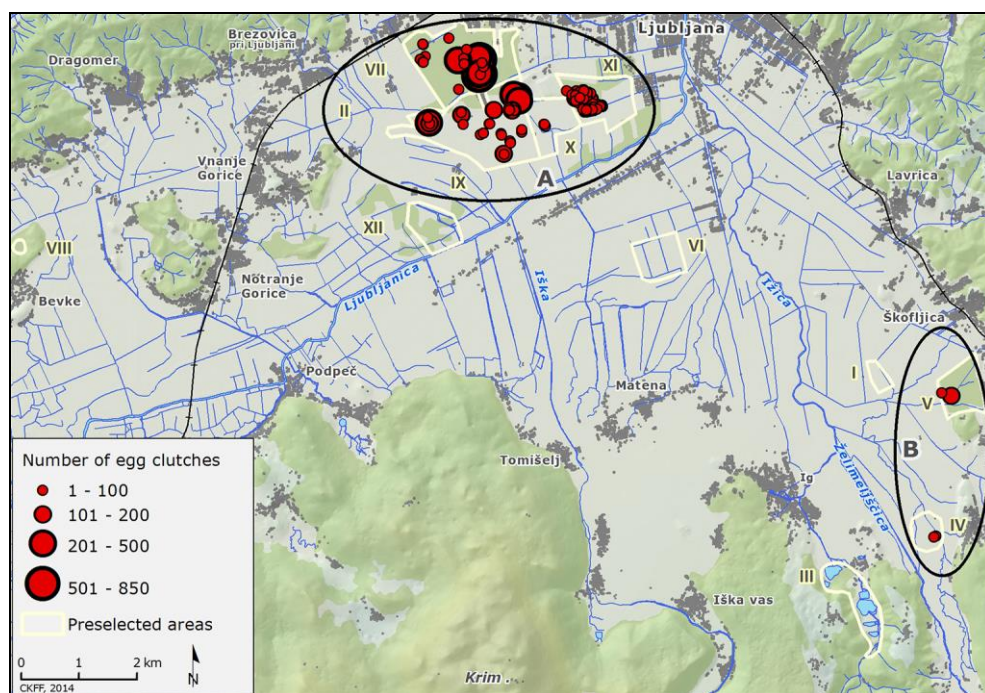


Figure 2. Distribution and abundance of *R. arvalis* breeding grounds as recorded in 2011. All clutches that could belong to *R. arvalis* were considered, including those that could not be identified beyond any doubt and were assigned to the *R. arvalis/temporaria* group. Dots represent either individual clutches or aggregations thereof rather than separate breeding grounds; a single breeding ground could thus be represented by more than one dot.

Sljka 2. Razporejenost in razpršenost seštevka mrestov barskih žab in nadrejene skupine *Rana arvalis/temporaria* na Ljubljanskem barju v letu 2011. Pike ponazarjajo najdišča skupine (blazine) mrestov ali posameznih mrestov in ne posameznega mrestišča (eno mrestišče lahko ponazarja več pik).

Morphometric analysis and colour pattern morphs

The mean body length of inspected males (SVL) was 70.2 mm, while the overall SVL/TL ratio was 1.65 (Tab. 4).

Table 4. Mean body length values (X) of 33 *R. arvalis* males from Ljubljansko barje, with standard deviations (SD) and minimum (MIN) and maximum (MAX) values for snout-vent length (SVL), tibia length (TL) and for the ratio between snout-vent and tibia length (SVL/TL).

Tabela 4. Povprečni podatki morfometrijskih meritev (X) 33 samcev barske žabe z Ljubljanskega barja, standardne deviacije (SD) ter najnižja (MIN) in najvišja (MAX) vrednost za dolžino telesa (SVL), dolžino goleni (TL) in izračunano razmerje med dolžino telesa in dolžino goleni (SVL/TL).

	SVL [mm]	TL [mm]	SVL/TL
X	70.2	42.5	1.65
MIN	54.1	31.4	1.47
MAX	79.3	47.7	1.84
SD	6.3	3.6	0.09

The analysis of colour patterns revealed that 25 of the 35 specimens (71.4%) belonged to the unicolor morph, only three specimens (8.6%) to the striata morph, while the rest (20.0%) belonged to the transitional hemistriata morph and none was assigned to the maculata morph. The prevalence of the unicolor morph is even more striking when compared to colour morph distribution of a *R. arvalis* population from the alluvial forest in Rački ribniki Nature Park in north-eastern Slovenia (River Drava watershed). Of 20 inspected specimens only four (20%) belonged to the unicolor morph, while 9 belonged to the striata morph (45%) and six to the transitional hemistriata morph (30%). In addition, one specimen was recognised to belong to the maculata morph (5%).

Discussion

Distribution of *R. arvalis* in the Ljubljansko barje area

During the short time frame since the first indisputable records of *R. arvalis* at Ljubljansko barje in 2010, our knowledge of its distribution has increased extensively. This survey confirms that it is not limited only to the Na blateh (IX) and Log (VII) areas, but is also present in adjunct woodlands in the northern part of Ljubljansko barje and in two isolated areas approximately 10 km away in the eastern and south-eastern part of Ljubljansko Barje – Jelšje (V) and Dremavščica (IV).

Based on egg clutch counts, Ljubljansko barje could hold more than 19,500 *R. arvalis* adults. For comparison, the entire Ecologically important area Mura - Radmožanci (EPO Mura – ID. Nr. 42100) (185 km²) contains only five large breeding areas with more than 500 clutches: Polanski log (~1,800), Muriša (~700), Bobri – Spodnja Bistrica (~600), Bunčani (~800) and Petanjci. The latter location used to hold the biggest *R. arvalis* population in north-eastern Slovenia – in 2006, more than 1,700 and in 2008 more than 2,800 clutches had been counted there, while herpetological surveys in 2013 and 2014 reported no more than 50 clutches counted here (unpublished data). As follows, Ljubljansko barje holds the largest and best preserved *R. arvalis* population in Slovenia. However, data presented here can serve only as a rough guide, as the majority of the River Mura floodplain has never been systematically investigated for amphibians and could still hold some yet unrecorded larger populations of *R. arvalis*. Our field work has revealed that *R. arvalis* distribution in central Slovenia is also closely related to the alluvial alder forest fragments at Ljubljansko barje. Indeed, all the findings were located no more than 500 m from the closest woodland. *R. arvalis* is nearly always associated with deciduous forest in Slovenia and adjunct countries, and usually chooses its breeding sites within or adjacent to the woodland (Poboljšaj et al. 2008). Of all the breeding aggregations, the Log alder forest (VII), within the northern cluster (A), represents the most important breeding area for *R. arvalis* at the national scale, which can be ascribed to the large number of man-made water bodies in this relatively extensive woodland habitat. These depressions of different sizes and depths used to be part of a clay pit. Today, they represent the only larger system of permanent lentic waters in the wider area of the northern part of Ljubljansko barje. While the area east of the municipal landfill site contains many small breeding sites with a couple of clutches in each, the southern area contains only two such sites. Even though the area south of the municipal landfill site contains a favourable share of

woodlands, it is not an appropriate breeding ground for *R. arvalis*, as its forest is more fragmented by meadows and intensive agricultural land. In addition, this area is somewhat elevated and contains only a few scarcely distributed smaller depressions, which hold water for a limited period of time. The area east of the landfill site depicts a special situation. It used to be covered with a rather large share of woodland, which was completely cut down a few years before the survey. As most of the depressions are filled with refuse, only smaller breeding sites were recorded. In general, Ljubljansko barje holds only a few forest habitats outside the northern cluster (A) suitable and large enough to sustain *R. arvalis*.

The entire *R. arvalis* distribution lies within the borders of Ljubljansko barje Nature Park and, furthermore, the majority of findings fall within SCI SI3000271 Ljubljansko barje Natura 2000 site. However, fragmentation and habitat destruction due to urbanization still present a major threat to *R. arvalis* in this area. Even though the forest habitats in the northern cluster (A) can be qualified as good, the possibility of local extinction remains high, as there are no other suitable habitats in the vicinity (Fig. 3). Moreover, the northern cluster lies in the immediate proximity of the capital city and the municipal landfill site. The planned expansion of the landfill will most probably separate the eastern and western breeding sites and seriously affect this sub-population. In addition, this area is under strong influence of human recreational activities. Numerous visitors frequent this site, especially during the spawning time, when they come to observe the »blue frogs«; they often approach the animals up close and frighten them.

The origin of *R. arvalis* in central Slovenia

Extensive search of historical literature on natural history and faunistics of Ljubljansko barje revealed only one vague record that could be related to *R. arvalis* presence of in this part of Slovenia. In his description of Slovenian batrachofauna, Bevk (1951) stated that inhabitants of Ljubljansko barje know this species under the common name »playček«, meaning the blue one; while in other parts of Slovenia this species was at that time known under the common name »barska žaba«, meaning the moor frog. However, Bevk does not clarify any further whether this species was indeed present here. Nevertheless, the high ecological densities and the presence of at least two clusters separated by almost ten kilometres of inappropriate habitats contradict the hypothesis of man-mediated origin. For such a scenario to be plausible, it is at least highly unlikely that the translocation was mediated in recent decades. In addition, some unconfirmed and possible sightings of *R. arvalis* have been made at Ljubljansko barje in previous decades.

The presence of *R. arvalis* at Ljubljansko barje is more likely a result of natural colonization. Assuming the origin of *R. arvalis* in central Slovenia is not man-mediated, two mutually non-exclusive hypotheses can be put forward to explain the presence of this species in central Slovenia. Isolated populations from southern Norway and by the Sea of Azov and fossil records bear witness to the species' broader historical distribution at the end of the Pleistocene (Roček & Šandera 2008, Kuzmin et al. 2009). A similar course of events can also explain the presence of this amphibian at Ljubljansko barje. *R. arvalis* probably colonized central Slovenia after the last glacial maximum (about 14,000 years ago). This amphibian could have reached central Slovenia from its putative source population in south-eastern

Slovenia (i) from the east along the River Sava and/or (ii) from the south over flooded karst poljes (Radensko polje, Dobropolje) and along the River Krka. Both scenarios predict an existence of a period when potential habitats in southern Slovenia were more abundant and the species had a more extensive distribution along at least one of these two possible routes.

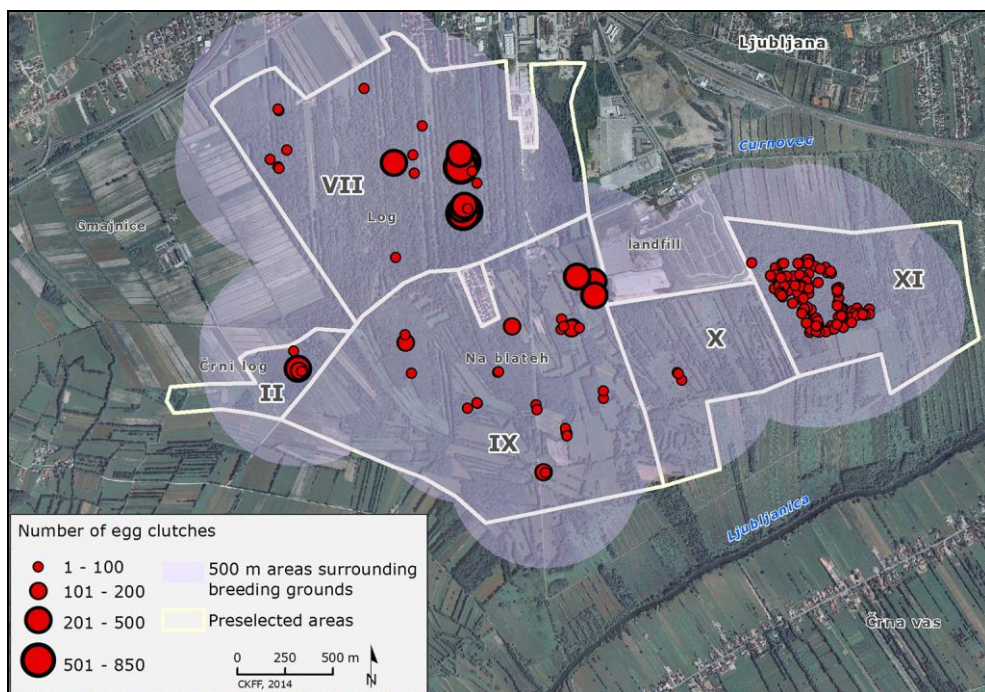


Figure 3. Distribution and abundance of *R. arvalis* breeding grounds in the immediate vicinity of Ljubljana. All clutches that could belong to *R. arvalis* were considered, including those that could not be identified beyond any doubt and were assigned to the *R. arvalis/temporaria* group. Dots represent either individual clutches or aggregations thereof rather than separate breeding grounds; a single breeding ground could thus be represented by more than one dot. Shaded area represents *R. arvalis* home range, if we take into the consideration that adults migrate less than 500 m (Günther & Nabrowsky 1996).

Slika 3. Razporejenost in razpršenost seštevka mrestov barskih žab in nadrejene skupine *R. arvalis/temporaria* v neposredni bližini mesta Ljubljana. Pike ponazarjajo najdišča skupine (blazine) mrestov ali posameznih mrestov in ne posameznega mrestišča (eno mrestišče lahko ponazarja več pik). Osenceni pas okoli mrestišč ponazarja predvideni domači okoliš barskih žab, če upoštevamo, da se odrasli osebki ne selijo več kot 500 m (Günther & Nabrowsky 1996).

Because variation of colour morphs is due to genetic rather than environmental factors, the occurrence of forms can also shed some light on the origin of *R. arvalis* in central Slovenia. Prevalence of the unicolor morph indicates a connection with the populations from the River Sava, as this is the most dominant form in Croatia (Fog 2008a). Unfortunately, no data are available for populations from south-eastern Slovenia, while based on the photographs deposited at the Centre for Cartography of Fauna and Flora database (CKFF 2014), striata morph is also common elsewhere in north-eastern Slovenia and not just in Rački ribniki Nature Park.

Nevertheless, variation in distribution of forms is not only due to non-selective forces, but is also connected with adaptations to different habitats. For example, non-striata morphs thrive better in woody habitats, while the striata morph is better suited for sandy soil and less eutrophic habitats in general. This inclination towards more oligotrophic habitats is probably also related to higher sensitivity for competition from other arvalis tadpoles in striata morph, as more tadpoles in a breeding ground inevitably leads to eutrophication of water (Fog 2008a, b). As follows, intraspecific competition could also explain lower local densities of *R. arvalis* in north-eastern Slovenia, where striata form is common.

Furthermore, the individuals from Ljubljansko barje are in general bigger and have relatively longer legs, when compared to those from north-eastern Slovenia, Hungary, Romania, Czech Republic, Poland and Germany (Dély 1964, Günther & Nabrowsky 1996, Babik & Rafinski 2000, Poboljšaj et al. 2008). On the basis of their relatively longer legs and larger bodies, frogs from the Pannonian and Sava Basins were traditionally described as the *R. a. wolterstorffi* subspecies, which is supposed to have the SVL/TL ratio below 1.75 (Dély 1964); at Ljubljansko barje, the ratio is 1.65. However, Babik & Rafinski (2000) found that morphometric characters, including SVL/TL ratio, are not reliable for discriminating between the subspecies, while Babik et al. (2004) even showed that molecular data do not reflect the partition into two subspecies.

The case of *R. arvalis* at Ljubljansko barje is a good example that this species can be overlooked in nature or mistaken for other brown frog species if one is not careful. Even though chances of finding possible relic populations of *R. arvalis* in the remaining suitable habitats along the two suggested corridors are small at best, future field surveys should not neglect these areas. Other potential areas that could hold yet unrecorded *R. arvalis* populations in Slovenia are along the Drava and Sotla Rivers. The contribution of the outlined scenarios could also be elucidated through the application of quickly evolving molecular markers such as microsatellites.

Povzetek

Barska žaba (*Rana arvalis*) je evrazijska nižinska vrsta, za katero je do nedavnega veljalo, da je razširjena zgolj v severovzhodni in jugovzhodni Sloveniji. Pojavljanje vrste na Ljubljanskem barju je bilo prvič zanesljivo potrjeno spomladi leta 2010, ko sta avtorja 25. marca na območju »Na blateh« našla nekaj deset barskih žab, vključno z modro obarvanimi samci. Le nekaj dni kasneje je Davorin Tome odkril veliko mrestišče barskih žab v poplavnem jelševem gozdu »Log« na severnem delu Barja. Za boljši vpogled v razširjenost te vrste je Krajinski park Ljubljansko barje pri Centru za kartografijo favne in flore naročil obširno raziskavo, katere glavni namen je bil opredelitev najpomembnejših območij za varstvo barske žabe na območju parka.

Na podlagi terenskih raziskav iz marca in aprila 2011 in drugih raziskav podajamo karto razširjenosti in oceno številčnosti te vrste na Ljubljanskem barju. Barske žabe smo z gotovostjo potrdili na šestih raziskovalnih območjih (Črni Log, Jelšje, Log, Na blateh, Rakova Jelša južno od odlagališča in Rakova Jelša vzhodno od odlagališča), medtem ko smo na območju »Dremavščice« zabeležili le najdbe, ki jih nismo mogli določiti do nivoja vrste. Iz tega razloga »Dremavščico« obravnavamo zgolj kot potencialno območje za barsko žabo. Pred začetkom terenskega dela smo na podlagi kartiranih habitatnih tipov izbrali dvanajst

območij, ki bi lahko gostile to dvoživko. Velikost populacije smo ocenili s štetjem mrestov na mrestišču. Ocenili smo, da na Ljubljanskem barju živi več kot 19.000 odraslih barskih žab, ki se geografsko razporejajo v dve območji. Na širšem območju gozdnega kompleksa Log, v neposredni bližini mesta in deponije, živi in se razmnožuje več kot 96 % barskih žab v osrednji Sloveniji, medtem ko preostale najdbe prihajajo iz jugovzhodnega dela barja, predvsem iz območja Jelšje, morda pa tudi iz območja Dremavščice. Med terenskimi raziskavami v letu 2011 smo poleg mrestov barskih žab prešteli še 2.019 mrestov rosnice (*Rana dalmatina*) in 334 mrestov sekulj (*Rana temporaria*).

Vsa območja z barskimi žabami so v celoti del Krajinskega parka Ljubljansko barje in večina jih je del SCI-območja Ljubljansko barje (SI3000271). Barska žaba je kot strogo zavarovana vrsta uvrščena na Prilogo IV Direktive o habitatih in je tako varstvo vrste in njenih habitatov z Naturo 2000 možno vsaj posredno. Dolgoročni obstoj vrste na Ljubljanskem barju je odvisen predvsem od načina upravljanja območij barske žabe v prihodnje, pri čemer je največja nevarnost načrtovana širitev deponije.

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