Hyla *VOL. 2012., No. 2, Str.3 - 17*
ISSN: 1848-2007
Original Scientific Paper

Distribution and Conservation of Batrachofauna and Herpetofauna of the Zrmanja River catchment area

Distribucija i zaštita faune vodozemaca i gmazova slivnog područja rijeke Zrmanje

BORIS LAUŠ[1], DUŠAN JELIĆ[1], IVONA BURIĆ[1], ANA KOLARIĆ[1], TONI KOREN[2]

[1]Croatian Institute for Biodiversity, Croatian Herpetological Society HYLA, Prva Breznička 5a, 10 000 Zagreb
[2]Univerza na Primorskem, Znanstveno–raziskovalno središče Koper, Inštitut za biodiverzitetne študije, Garibaldijeva 1, SI-6000 Koper, Slovenija

Corresponding author*:* BORIS LAUŠ, Croatian Institute for Biodiversity and Croatian Herpetological Society HYLA, Prva Breznička 5a, 10000 Zagreb, boris.laus.pmf@gmail.com

Abstract

Over the four year period (2007–2010), the authors conducted a field study aimed at drawing up an inventory of batrachofauna and herpetofauna of the Zrmanja river catchment area. Eight species of amphibians and twenty one species of reptiles were detected; through the available literature overview two more reptilian and one amphibian species were added to the list. Therefore, we proved the presence of thirty two species in total. High diversity of amphibians and reptiles indicates great significance of this area and imposes the need to ensure survival of these species through long-term populations monitoring and conservation measures.

Key words: Amphibians, Reptiles, Zrmanja, Conservation

Sažetak

Kroz period od četiri godine (2007–2010), autori su proveli terenska istraživanja u cilju inventariziranja batrahofaune i herpetofaune slivnog područja rijeke Zrmanje. Zabilježeno je osam vrsta vodozemaca i dvadeset i jedna vrsta gmazova, dok su pregledom dostupne literature za ovo područje zabilježene još dvije vrste gmazova i jedna vrsta vodozemaca, čime je dokazana prisutnost ukupno trideset i dvije vrste. Velika raznolikost vodozemaca i gmazova upućuje na izniman značaj ovog područja i nameće potrebu za osiguranjem opstanka ovih vrsta kroz dugoročno praćenje stanja njihovih populacija i provođenje neophodnih mjera zaštite.

Ključne riječi: vodozemci, gmazovi, Zrmanja, zaštita

INTRODUCTION

Zrmanja is a 69 kilometres long river in southern Croatia. Its spring is located at 395 m a.s.l. beneath the Mount Poštak in the southern part of Lika, and flows into the Novigrad sea, 12 kilometres from the city of Obrovac. Its most important tributaries are Krnjeza and Krupa rivers, but also rivers from the Lika region: Ričica and Otuča (Crkvenčić et al. 1974). From its spring, Zrmanja flows to the south, passes through the Mokro polje area, then turns westwards, passes through the Ervenik area, and through the Žegar field; after this point Zrmanja forms a canyon, passes through the city of Obrovac and finally flows into the Novigrad sea. The entire area we surveyed during the present research belongs to the region of the southern Hrvatsko Primorje (or North Dalmatia), i.e. Zadar region, except for the mere area of the Zrmanja spring beneath the Mount Poštak, which belongs to the Lika region (Crkvenčić et al. 1974). Along its course towards the Novigrad sea, Zrmanja passes through larger area of Bukovica and Ravni Kotari. Rock composition of the entire area of Ravni Kotari belongs to the Upper Cretaceous and Tertiary calcareous rocks, that extend in Dinaric direction (northwest–southeast), while in the opposite direction (southwest–northeast) we have rotation of calcareous convex folds (anticlines) and downward folds (synclines). The area of Bukovice is a higher and more open calcareous plateau which is surmounted by calcareous Velebit mountain range. Prevailing substrates are Tertiary calcareous rocks (Promina deposits), calcareous breccias and conglomerates with intercalations of softer and more fertile marlstone and bauxite deposits (Crkvenčić et al. 1974).

The result of such relief is a broad spectrum of microclimatic conditions. Climatic differentiation in the Zadar region is the most obvious in diversity of plant communities: true Mediterranean vegetation (evergreen macchia) is present along the Adriatic sea coast and in the islands, Sub-Mediterranean plants (oak and hornbeam) dominate in Ravni Kotari, and in Bukovica these are replaced by more mountainous plant communities (Crkvenčić et al. 1974). Detailed list of vegetation types and plant communities in the Zrmanja river catchment area and their endangerment status is discussed in Matoničkin & Pavletić (1964), Lovrić & Rac (1989), Razlog-Grlica (1993), Lovrić et al. (1989) and Topić (2010).

Major part of the Zrmanja river basin, according to the Köppen climate classification, is under the Cfa class, the humid subtropical climate. A humid subtropical climate is characterized by hot, humid summers and generally mild to cool winters (Tab. 2).

Table 2. Climatic data for the city of Knin (44°2.4′N, 16°11.6′E, 220 m a.s.l.), representing climatic conditions of the North Dalmatian hinterland (according to Croatian Meteorological and Hydrological Service, 2010)

Tablica 2. Klimatski podaci za grad Knin (44°2.4′N, 16°11.6′E, 220 m n.v.), koji predstavljaju klimatske uvjete sjevernodalmatinskog zaleđa (prema Državnom hidrometeorološkom Zavodu, 2010)

Month	Average air temperature (°C)	Insolation (h)	Precipitation (mm)
January	3,2	110,9	179,2
February	5,2	79,8	129,4
March	7,7	157,4	73,9
April	12,9	190,7	123,1
May	16,2	196,4	145,7
June	20,9	265,2	88,2
July	24,4	339,5	62,5
August	22,7	332,1	48,9
September	17,6	211,3	117,7
October	11,9	151,2	54,6
November	10,8	89,1	223,8
December	4,6	100,8	169,0
x / ∑	x=13,2	∑=2.224,4	∑=1.416,0

Towards the coastline, this type of climate transforms into the Csa class, Mediterranean or dry subtropical climate, and from the Zrmanja spring towards the continent it changes into the Cfb class, marine west coast climate (Šegota & Filipčić, 2003). The present study summarizes current knowledge about batrachofauna and herpetofauna of the wider surroundings of the river Zrmanja. In this

paper we present former literature data and recent unpublished findings of the authors and their associates. Localities for 9 species of amphibians and 23 species of reptiles are given on maps, and authors also provide guidelines for conservation of these species.

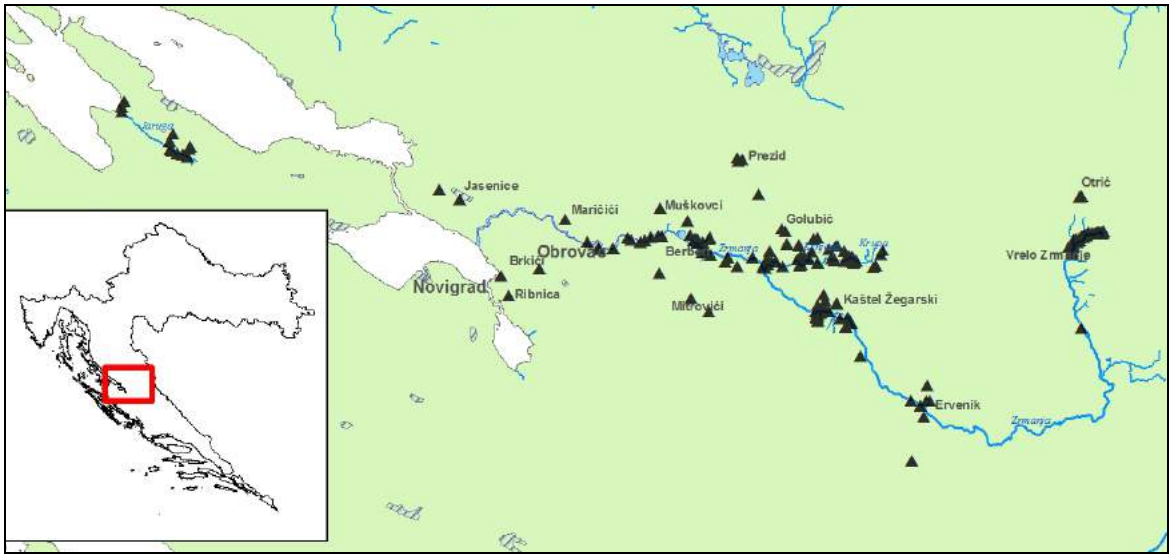

Figure 1. Surveyed localities (▲) in the Zrmanja river catchment area
Slika 1. Istraživani lokaliteti (▲) na slivnom području rijeke Zrmanje

MATERIAL AND METHODS

In the majority of older publications (Kolombatović 1908, Karaman 1921, Poljak 1924, Pavletić 1964) findings from the wider surroundings of Zrmanja are often listed without precise locality, i.e. merely as ”Zrmanja” or ”Obrovac”. With the data presented herein authors wanted to fill in the blanks in knowledge of batrachofauna and herpetofauna by gathering all available data about the accurate species presence and distribution. Field research was carried out in numerous localities (Fig. 1) on several occasions during 2007 (a total of ten days from May to August, average of 3 persons), 2008 (six days in August, 2 persons), 2009 (four days in April, 1 person), and 2010 (nine days, end of April / beginning of May, and ten days through August/September, average of 5 persons). Target research was conducted in order to gather new information about rare species, and also to evaluate the level of endangerment of the encountered species. As a research area we selected wider surroundings of the river Zrmanja, from its spring to the river mouth, also including southern slopes of the Mount Poštak and the Mount Velebit (Prezid), and part of the Ravni Kotari area. Formerly published data concerning the target groups in the selected area were gathered from available literature (Kolombatović 1908, Karaman 1921, Poljak 1924, Cvitanić 1959, Koen 1960, Pavletić 1964 Mršić 1978, Đukić & Pasuljević 1979, Strijbosch et al. 1985, Strijbosch et al. 1986, De Luca 1989, De Luca 1990, Tvrtković & Kletečki 1993, Krizmanić et al. 1997, Bressi 1999, Denoel et al. 2001, Sotiropoulos et al. 2001, Lončar 2005).

RESULTS

From 2007 to 2010, extensive research of amphibian and reptilian fauna was carried out in wider surroundings of the river Zrmanja, and presence of a total of twenty nine species was recorded (Tab. 1). This number includes eight species of amphibians and twenty one species of reptiles. The occurrence of several additional species (one amphibian and two reptiles) was confirmed through the existing published data, but these species were not recorded during our field work.

Table 1. List of amphibian and reptilian species recorded in literature and/or through the current research
Tablica 1. Popis vrsta vodozemaca i gmazova zabilježenih u literaturi i/ili provedenim istraživanjem.

Class	Species	Confirmed by authors	Literature data
Amphibia	*Ichthyosaura alpestris* (Laurenti, 1768)	✓	✓
	Lissotriton vulgaris (Linnaeus, 1758)	✓	✓
	Salamandra salamandra (Linnaeus, 1758)	✓	✓
	Bombina variegata (Linnaeus, 1758)	✗	✓
	Bufo bufo (Linnaeus, 1758)	✓	✓
	Pseudepidalea viridis (Laurenti, 1768)	✓	✗
	Hyla arborea (Linnaeus, 1758)	✓	✓
	Rana dalmatina Fitzinger in Bonaparte, 1838	✓	✓
	Pelophylax ridibundus (Pallas, 1771)	✓	✓
Reptilia	*Emys orbicularis* (Linnaeus, 1758)	✓	✓
	Testudo hermanni Gmelin, 1789	✓	✓
	Anguis fragilis Linnaeus, 1758	✓	✗
	Pseudopus apodus (Pallas, 1775)	✓	✓
	Algyroides nigropunctatus (Duméril & Bibron, 1839)	✓	✓
	Iberolacerta horvathi (Méhely, 1904)	✗	✓
	Lacerta agilis Linnaeus, 1758	✓	✗
	Lacerta trilineata Bedriaga, 1886	✓	✓
	Lacerta viridis (Laurenti, 1768)	✓	✓
	Podarcis melisellensis (Braun, 1877)	✓	✓
	Podarcis muralis (Laurenti, 1768)	✓	✓
	Podarcis siculus (Rafinesque, 1810)	✓	✓
	Coronella austriaca Laurenti, 1768	✓	✓
	Natrix natrix (Linnaeus, 1758)	✓	✓
	Natrix tessellata (Laurenti, 1768)	✓	✓
	Platyceps najadum (Eichwald, 1831)	✓	✗
	Hierophis gemonensis (Laurenti, 1768)	✓	✓
	Elaphe quatuorlineata (Lacépède, 1789)	✓	✓
	Zamenis longissimus (Laurenti, 1768)	✓	✓
	Zamenis situla (Linnaeus, 1758)	✓	✗
	Malpolon insignitus (Geoffroy Saint-Hilaire, 1827)	✓	✓
	Telescopus fallax (Fleischmann, 1831)	✗	✓
	Vipera ammodytes (Linnaeus, 1758)	✓	✓
	SUM	29	27

Species overview

Class Amphibia

Ichthyosaura (Triturus) alpestris (Laurenti, 1768) – Alpine Newt

Through the most part of investigated area, Alpine newts were found in karstic ponds which are still used in traditional outdoor livestock farming, or in neglected ponds that gradually became overgrown, but can still hold water for a longer period of the year. Natural retentions in karstic environment are rare and mostly ephemeral, and as such are less suitable habitats, which is confirmed through our research. Along the river Zrmanja and its tributaries several flooded areas exist, but *I. alpestris* was not found in these water retentions.

According to published data, Alpine newt is present on Prezid Pass, Veselinovići settlement near Golubić, and Urukulovac locality, Velebit (Tvrtković & Kletečki 1993); additional previously known localities are along the road Karin–Obrovac (Kobašlić 2002), and settlement Ušljebrke near Kaštel Žegarski (Sotiropoulos et al. 2007). We also found this species at Prezid Pass, on new localities near Golubić (three different ponds), and near Otrić (Begovac pond).

Lissotriton vulgaris (Linnaeus, 1758) – Smooth Newt

Literature data for this species provided only one locality (Prezid Pass, Velebit), but it wasn't confirmed through our research. We found it on new localities near the village Brkići (pond Sekina lokva), and near Otrić (Begovac pond). As for the Alpine newt, the most suitable habitats for *T. vulgaris* are karstic ponds that can hold water for longer periods of time.

Salamandra salamandra (Linnaeus, 1758) – Fire Salamander

Considering preferable habitats for this species, i.e. humid and shady areas with water bodies necessary for reproduction, only few suitable areas exist along the river Zrmanja and its tributaries. A single literature datum on Fire salamander distribution is unclear and states only "Zrmanja".. We found this species on two localities, around the Zrmanja spring and at the Begovac pond near Otrić.

Bombina variegata (Linnaeus, 1758) – Yellow-bellied Toad

The only published locality for the Yellow-bellied toad is the Prezid Pass on the southern slopes of the Mount Velebit (Karaman 1921). During the present research we couldn't confirm the presence of this species, but we do not exclude the possibility of suitable habitats existence in the river Zrmanja catchment area where Yellow-bellied toad could still be present, especially considering other findings of this species in Dalmatia (Janev-Hutinec et al. 2006).

Bufo bufo (Linnaeus, 1758) – Common Toad

The two previously published localities from Tvrtković & Kletečki (1993) are stated only as "Zrmanja", without detailed descriptions. During our recent research this species was recorded on several locations along the river Zrmanja and its tributaries Krnjeza and Krupa: the Zrmanja spring, Kaštel Žegarski, Krupa spring, Manastir na Krupi, Golubić, Berberi, Muškovci and the vicinity of the city of Obrovac.

Pseudepidalea (Bufo) viridis (Laurenti, 1768) – Green Toad

Until our research of the river Zrmanja catchment area, there wasn't a single literature datum mentioning this species. During our field work we recorded Green toads on several localities: the vicinity of Karin, Ribnica area, Berberi, Muškovci, Maričići, Golubić and Kaštel Žegarski.

Hyla arborea (Linnaeus, 1758) – European Tree Frog

In older publications this species was mentioned on two localities: Prezid Pass on the southern slopes of the Mount Velebit, and the village Nadvode near Kaštel Žegarski (Tvrtković & Kletečki 1993). Our field work

brought out two more localities, Kaštel Žegarski and the vicinity of Berberi.

Rana dalmatina Fitzinger in: Bonaparte, 1838 – Agile Frog

This is the only species from the group of Brown frogs (genus *Rana*) distributed in the river Zrmanja catchment area. Although it was mentioned only twice in the literature (Krnjeza river mouth: Kobašlić 2002, and Krupa river mouth: Tvrtković & Kletečki 1993), Agile frog was one of the most common and the most numerous amphibians of the explored area. It was found along the entire watercourse of Zrmanja and also along the entire river courses of Krupa and Krnjeza, and along the Jaruga stream towards the gulf of Ljubački.

Pelophylax ridibundus (Pallas, 1771) – Marsh Frog

Green frogs are well adaptable aquatic or semi-aquatic animals that inhabit various water bodies. Because of this fact it is not surprizing that these are indeed the most numerous and the most common amphibians in the investigated area. This species is confirmed both through literature (Pavletić 1964, Karaman 1921, Strijbosch et al. 1985), and through our research, along the entire Zrmanja, Krupa and Krnjeza river courses, and along the Jaruga stream towards the gulf of Ljubački.

Class Reptilia

Emys orbicularis (Linnaeus, 1758) – European Pond Turtle

One previous finding puts the European pond turtle on the Zrmanja river near the city of Obrovac (Jablonski D., pers. comm. 2010), and it was also recorded during our research on the Krupa river (two ponds at Manastir na Krupi).

Testudo hermanni Gmelin, 1789 – Hermann's Tortoise

Herman's tortoise is well known in this area for decades, and was previously mentioned for Kaštel Žegarski, Krupa River, and the city of Obrovac (Strijbosch et al. 1985). Our research confirmed all of the previously known localities, and revealed several new ones: the vicinity of Berberi, the vicinity of Manastir na Krupi and the area of the Jaruga stream towards the gulf of Ljubački.

Anguis fragilis Linnaeus, 1758 – Slow Worm

This species prefers humid and shady habitats with dense vegetation, so in Dalmatia it can be found in the limited number of locations compared to the continental Croatia. The findings in Dalmatia are mostly associated with higher altitudes of mountain ranges of the Dinara, Troglav, Kamešnica and Svilaja (Jelić D., pers. comm. 2010), while the lack of findings at lower altitudes, particularly in river valleys of Krka and Cetina, is quite surprizing. There are no previous literature data for the area of the river Zrmanja; however, during recent field work we recorded this species on several localities. Slow worm was found in the vicinity of Ervenik settlement, Kaštel Žegarski, meadows along the Krupa River, in the vicinity of Berberi, near the Dobarnica river mouth, and in the area of Jaruga stream towards the gulf of Ljubački.

Pseudopus apodus (Pallas, 1775) – European Glass Lizard

In the review of the Croatian National Zoological Museum collection of amphibians and reptiles in Zagreb, Pavletić (1964) mentions a sample of European Glass Lizard collected from the area of the Zrmanja river in 1909. However, except that specimen, there is no other published information for this area. Authors of the present paper recorded *P. apodus* in the vicinity of Kaštel Žegarski, Manastir na Krupi, canyon of the river Krupa, the vicinity of Obrovac and the area of Jaruga stream.

Algyroides nigropunctatus (Duméril & Bibron, 1839) – Dalmatian Algyroides

The first information about this species in the surveyed area was provided by Đukić & Pasuljević (1979), from the Prezid Pass on the southern slopes of Velebit, and later it was also found in the river Krupa canyon

(Strijbosch et al. 1985), and the Krupa river mouth (Strijbosch et al. 1986). Most of the specimens observed during this study were recorded around the Zrmanja spring, and a smaller number of individuals were noted from Prezid Pass to Golubići.

Iberolacerta horvathi (Méhely, 1904) – Horvath's Rock Lizard

Although there are several published findings of this species in the area of the river Zrmanja (Karaman, 1921; Pavletić, 1964; De Luca, 1989), the authors of the present survey could not confirm the presence of this species during field work. Previously, this species was considered to be exclusively mountainous (De Luca, 1989); however, findings from a locality at 200 m a.s.l. were published recently (Žagar, 2008). As potential habitats the most probable localities are Tulove grede and southern slopes under the Prezid Pass and Crnopac (Velebit), so future research shall be directed to this area.

Lacerta agilis Linnaeus, 1758 – Sand Lizard

Because in Dalmatia the Sand lizard is distributed only on higher altitudes of mountain ranges and prefers continental climate (Jelić, 2010), it's not surprising that authors found this species only at the Prezid Pass on Velebit, 929 m. In the previously published literature there is no mention of this species in the catchment area of the river Zrmanja.

Lacerta trilineata Bedriaga, 1886 – Balkan Green Lizard

This is the largest species of lizards in Croatia, which presents its westernmost point of distribution. Older findings confirm this species for the area of Krupa and Zrmanja (Strijbosch et al. 1985, Strijbosch et al. 1986) and Karin sea (Mihoković N., pers. comm. 2010). During the current research, the Balkan green lizard was recorded on several localities, from southern slopes of the Poštak Mountain, along the river Zrmanja and its tributaries towards the Novigrad sea, around the Karin sea, and the gulf of Ljubački. At the river Zrmanja catchment area both *Lacerta trilineata* and *Lacerta viridis* can be found. Because their distributional areas overlap, it's necessary to be particularly careful with their determination. *L. viridis* is a representative of the continental fauna and mostly inhabits higher and colder areas of southern slopes of mountains (Tremzina, Poštak, Velebit), while *L. trilineata* represents Mediterranean fauna, and is mostly distributed in lower and warmer areas (river Zrmanja canyon, Ravni Kotari).

Lacerta viridis (Laurenti, 1768) – European Green Lizard

Besides one specimen from 1909 in the Croatian Natural History Museum collection (Pavletić, 1964) from the Zrmanja territory, there were no other published data until this research. Authors confirmed the presence of the European green lizard on Prezid Pass on Velebit, in the vicinity of Begovac pond near Otrić, and along the first 10 kilometres from the Zrmanja spring downstream.

Podarcis melisellensis (Braun, 1877) – Dalmatian Wall Lizard

Literature states just a few localities for this species, which is widespread in whole Dalmatia. There is one sample from 1909 in the Croatian Natural History Museum collection (Pavletić, 1964) from the Zrmanja territory, a finding from 1978 from the Prezid Pass on Velebit (Lončar, 2005), one from the locality in the vicinity of Kaštel Žegarski (Strijbosch et al. 1985), and a report from the locality in the Krupa river valley (Strijbosch et al. 1986). During our research the Dalmatian wall lizard was recorded across the whole demarcated area, from the Zrmanja spring, along the entire river course, and along its tributaries.

Podarcis muralis (Laurenti, 1768) – Common Wall Lizard

There are just a few unspecified information about the findings of this lizard for the "Zrmanja" area (Karaman, 1921; Pavletić, 1964), and one for the Prezid Pass (Lončar, 2005). The authors confirmed the presence of

the common wall lizard at the Zrmanja spring, near the bridge Kravlja draga, and at the Prezid Pass.

Podarcis siculus (Rafinesque, 1810) – Italian Wall lizard
The first information about the Italian wall lizard mentions findings near Obrovac, Kaštel Žegarski and area around the river Krupa (Strijbosch et al. 1985, Strijbosch et al. 1986), and there is also one finding near the Karin sea (Katušić L., pers. comm. 2010). New records of this lizard were provided through our field work, at localities around the Zrmanja spring, in the vicinity of Berberi, and in the area of Jaruga stream towards the gulf of Ljubački.

Coronella austriaca Laurenti, 1768 – Smooth Snake
The first published finding of the Smooth snake from the area of the river Zrmanja dates back to 1902, and that specimen is stored in the Croatian Natural History Museum collection (Pavletić, 1964). There are some additional records with localities marked just as "Zrmanja" (Karaman, 1921). A few specimens of this snake were recorded during our research around the Zrmanja spring, and at the Prezid Pass.

Natrix natrix (Linnaeus, 1758) – Grass Snake
Although this species is the most common snake in Croatia, there is just one published record, from 1910 (Pavletić, 1964). Through our recent field work, the Grass snake was encountered at the Begovac pond near Otrić, along most of the Zrmanja, Krupa and Dobarnica river courses, and in area of Karin sea.

Natrix tessellata (Laurenti, 1768) – Dice Snake
Judging by the high number of recorded specimens during our research, the dice snake is certainly the most common snake in the studied area. The earliest findings from this region are mentioned in 1921 by Karaman, and there are later data from the area of Kaštel Žegarski (Strijbosch et al. 1985). Authors recorded this snake in the whole area along the river course of Zrmanja (from the spring downstream to the city of Obrovac), and also Krupa, Krnjeza and Dobarnica. It is interesting to mention that individuals recorded on the Zrmanja river stretch between Janković buk and the city of Obrovac live in brackish water (Jelić & Lelo, 2010) and feed, among other, on marine fishes that enter Zrmanja in large numbers.

Platyceps najadum (Eichwald, 1831) – Dahl's Whip Snake
This is one elegant and certainly fast snake, with the westernmost part of its distribution in Croatia: it can be found along the entire Adriatic coast to the Istria in the northwest (Darewskij & Ščerbak, 1993; Kreiner, 2007). Until our study, there were no records of this species in the examined area. Therefore, this is the first information of Dahl's whip snake presence in the river Zrmanja catchment area, in three different localities: the vicinity of Berberi, between Manastir na Krupi and Golubić, and the area near to the Karin sea.

Hierophis gemonensis (Laurenti, 1768) – Balkan Whip Snake
Along with the Dice snake, the Balkan whip snake was one of the most numerous snakes observed during this study. Although it is associated mainly with the warm climate of the Mediterranean area, during our research several specimens were recorded around the Zrmanja spring, which geographically belongs to the region of Lika (Crkvenčić et al. 1974), and has a somewhat colder climate, compared to the usual Mediterranean habitats. This snake was also found on several locations along the Zrmanja river: from Ervenik, over Kaštel Žegarski, to the city of Obrovac, and also along its tributary, river Krupa, from its spring to the river mouth. Besides, it was recorded near the pond Sekina lokva in the vicinity of the settlement Brkići, and in the area along the Jaruga stream towards the gulf of Ljubački. Literature also confirms this species, for the surroundings of Kaštel Žegarski (Strijbosch et al. 1986) and the city of Obrovac (Strijbosch et al. 1985); there are also some unpublished

findings in the vicinity of the Karin (Katušić L., pers. comm. 2010).

Elaphe quatuorlineata (Lacépède, 1789) – Four-lined Snake

Cvitanić (1959) stated that he had got a sample of the Four-lined snake in the spring of 1958 from the area of the city of Obrovac. The next information is a finding of this snake in the vicinity of Kaštel Žegarski (Koen, 1960). Beside these two records, our research revealed two more locations: the canyon of the river Krnjeza, and location at the village Golubići.

Zamenis longissimus (Laurenti, 1768) – Aesculapian Snake

This snake is quite common in the entire territory of Croatia. Despite that, there is just a single historical finding, for the vicinity of Kaštel Žegarski (Strijbosch et al. 1985). During our research, specimens of this snake were found on a few locations, from the Begovac pond near Otrić, the Zrmanja spring, Manastir na Krupi, to the surroundings of Obrovac (ruins of the Old city of Obrovac).

Zamenis situla (Linnaeus, 1758) – Leopard Snake

Although its distribution in Croatia stretches across the entire coast, up to the Istria peninsula, with presence on some islands (Janev-Hutinec & Lupret-Obradović, 2005; Lauš, 2010), due to its secretiveness it's not easy to confirm the presence of this snake in a certain area. There are no historical findings for Leopard snake in the researched area, so the authors recorded this species for the first time. Localities where this snake was found are: Manastir na Krupi, the river Krupa canyon, Golubići, the vicinity of Muškovci, and the vicinity of Jasenice.

Malpolon insignitus (Geoffroy Saint-Hilaire, 1827) – Eastern Montpellier Snake

There are two literature data with findings of Eastern Montpellier snake, one of which is a sample in the Croatian Natural History Museum collection from 1902 (Pavletić, 1964), and the other is from the Krupa river valley (Strijbosch et al. 1986). Authors have recorded just two specimens of this species, one at Manastir na Krupi, and another one at the pond Sekina lokva near the village Brkići.

Telescopus fallax (Fleischmann, 1831) – European Cat Snake

As this is crepuscular and nocturnal animal, conditions for study of this species are somewhat difficult. We couldn't find it during our research of the river Zrmanja catchment area, but we do not exclude the possibility of this species presence. This is based on several former findings: area of Jasenice from 1986 (Lončar, 2005), the surroundings of Obrovac (Strijbosch et al. 1986), and Golubići (Horvatić B., pers. comm. 2006).

Vipera ammodytes (Linnaeus, 1758) – Nose-horned Viper

This is the only adder in the studied range. For the area of Zrmanja there is one finding from 1910 (Pavletić, 1964). It is also confirmed for the surroundings of Kaštel Žegarski and Obrovac (Strijbosch et al. 1985). Authors recorded the Nose-horned Viper at the Begovac pond near Otrić, around the Zrmanja spring, on the slopes of Trebačnik hill near Kaštel Žegarski, and above the river Krnjeza canyon.

Discussion

During the survey of batracho- and herpetofauna of the river Zrmanja catchment area, a total of 29 species was recorded: 21 reptile species and 8 species of amphibians. Examining the literature concerning this area, another 2 species of reptiles and one amphibian were confirmed: *Iberolacerta horvathi*, *Telescopus fallax*, and *Bombina variegata*. With this additional data, total number of species confirmed to be present in this area rose to 32, which represents 53% of all amphibians and reptiles in Croatia.

High number of recorded species is surely the result of favourable climatic factors and preserved variety of habitats, as well as low anthropogenic influence.

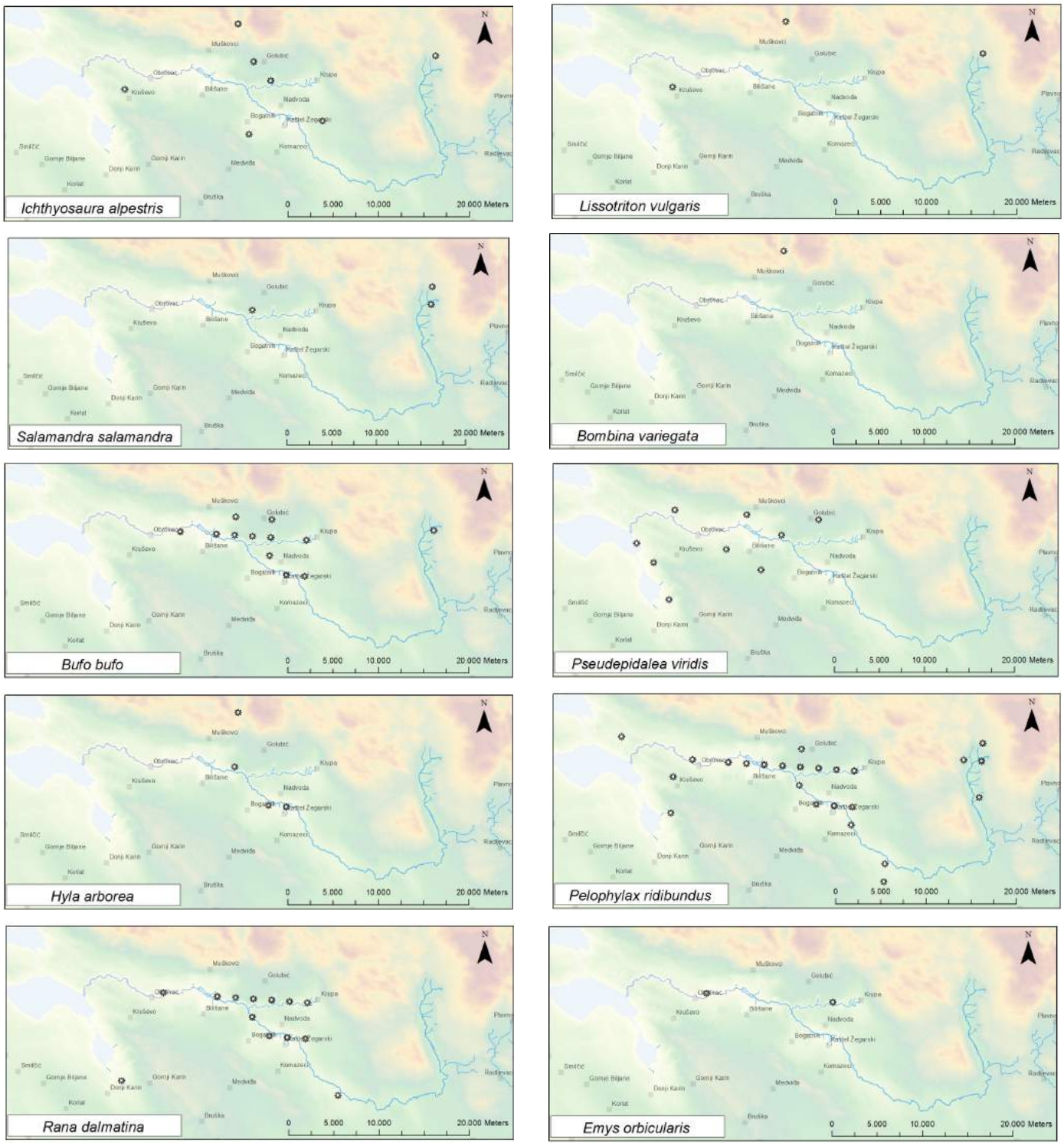

Figure 2. Recorded distribution of amphibians and reptiles in Zrmanja River area (2x2 km EEA grid)

Slika 2. Zabilježena rasprostranjenost vodozemaca I gmazova područja rijeke Zrmanje (2x2 km EEA mreža)

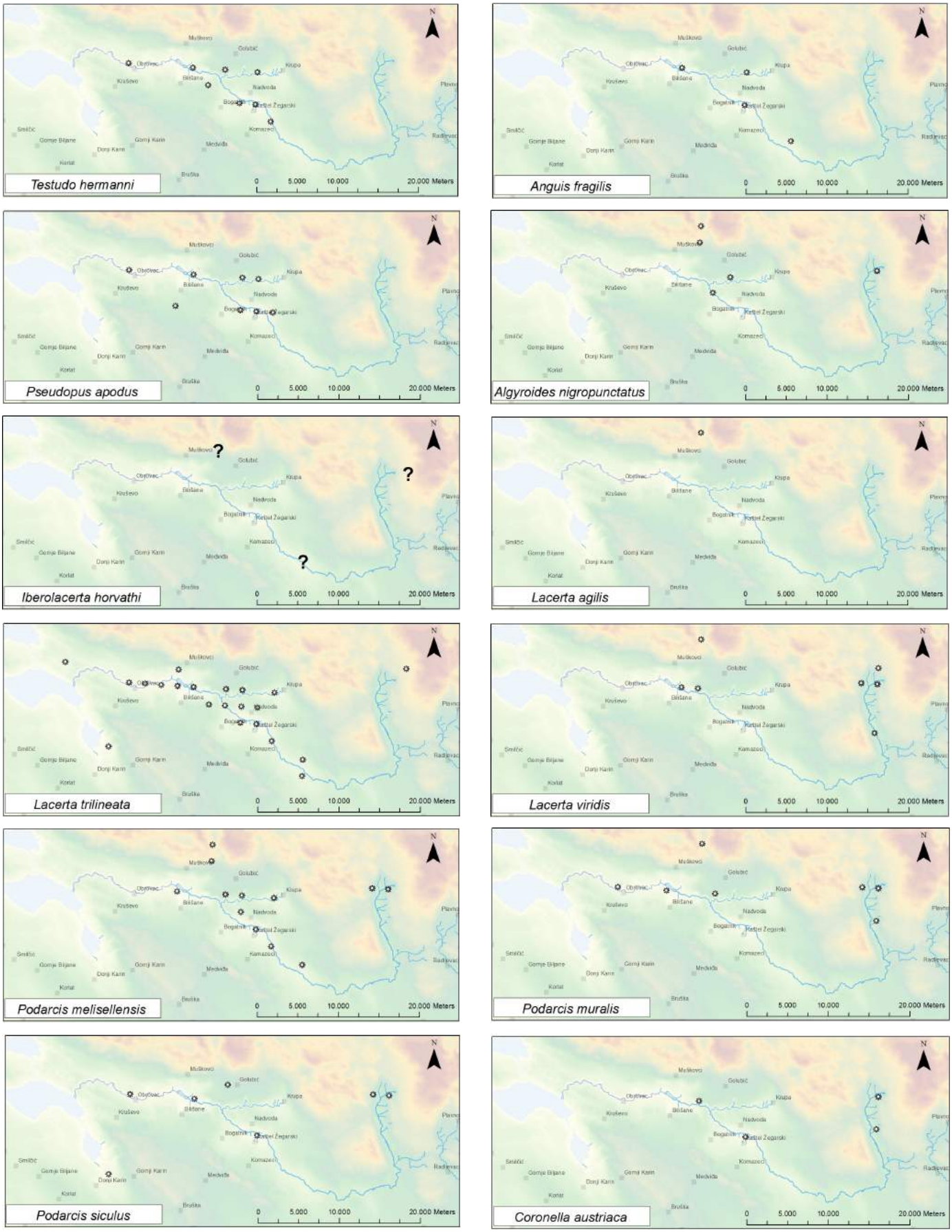

Figure 2. Recorded distribution of amphibians and reptiles in Zrmanja River area (2x2 km EEA grid)

Slika 2. Zabilježena rasprostranjenost vodozemaca I gmazova područja rijeke Zrmanje (2x2 km EEA mreža)

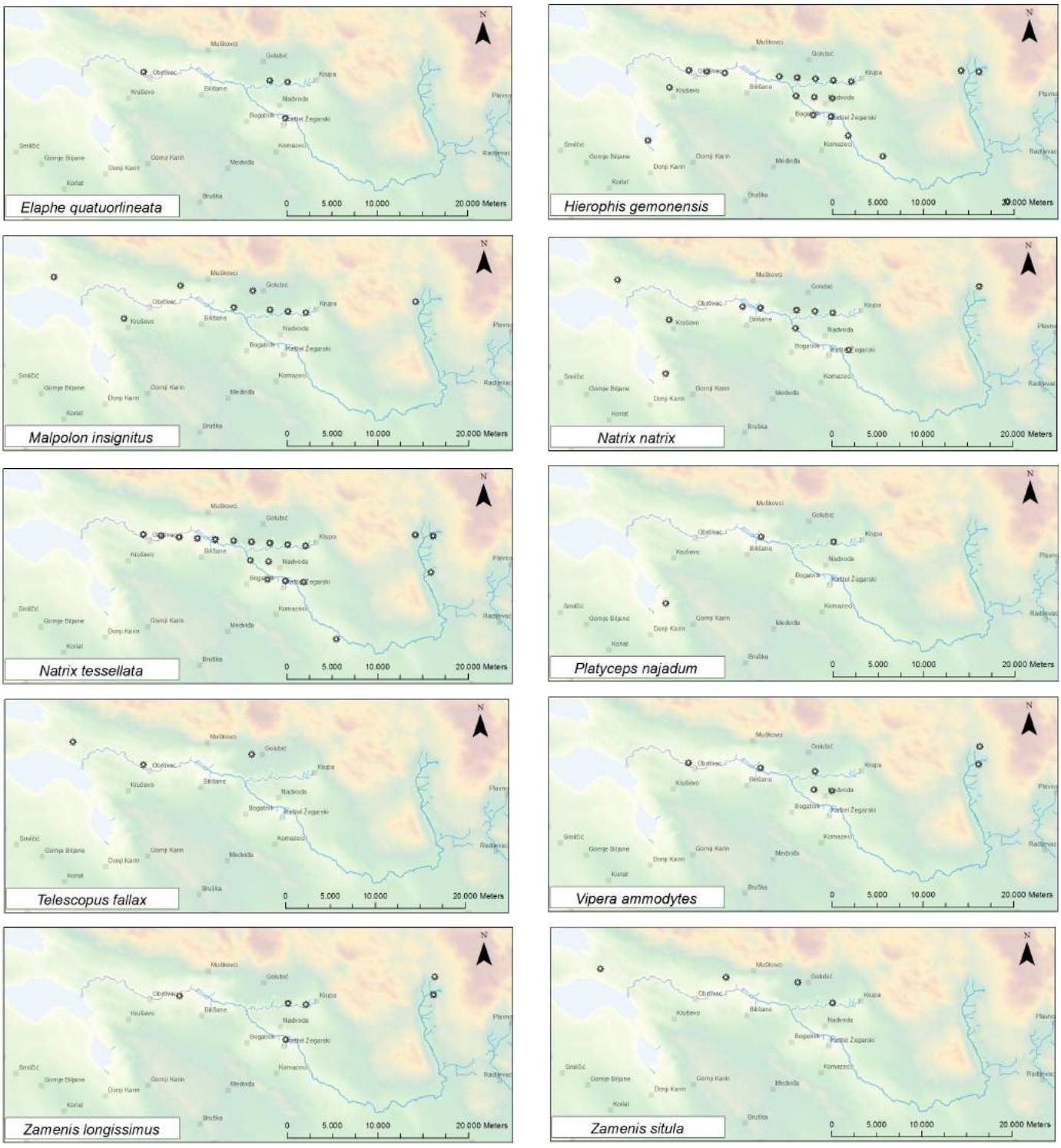

Figure 2. Recorded distribution of amphibians and reptiles in Zrmanja River area (2x2 km EEA grid)

Slika 2. Zabilježena rasprostranjenost vodozemaca I gmazova područja rijeke Zrmanje (2x2 km EEA mreža)

Because of the influence of several climatic types in this area, a mixture of different species is present: species typical for Mediterranean coast of the Balkan Peninsula, like the Eastern Montpellier snake (*Malpolon insignitus*), the Leopard snake (*Zamenis situla*), the Dahl's whip snake (*Platyceps najadum*) etc., but also species commonly present in continental parts, like the European green lizard (*Lacerta viridis*), the Smooth snake (*Coronella austriaca*), Fire salamander (*Salamandra salamandra*), etc. Due to the beneficial influence of the sea, some species normally present in coastal areas penetrated deeper into the continent. For example, few such species were recorded all the way along the Zrmanja river till the mere spring, located in colder region of Lika. These are the Balkan whip snake (*Hierophis gemonensis*), Dalmatian wall lizard (*Podarcis melisellensis*), Italian wall lizard (*Podarcis siculus*) and Dalmatian algyroides (*Algyroides nigropunctatus*).

Among the present species of amphibians and reptiles, nine are in the protected category, and twenty three species are in the strictly protected category, according to the Croatian Nature Protection Act. As well, seven species are listed in the Red Book of amphibians and reptiles of Croatia (Janev-Hutinec et al. 2006). *Lissotriton vulgaris*, *Bombina variegata*, *Hyla arborea*, *Natrix tessellata* and *Zamenis situla* are listed as data deficient species (DD), while *Emys orbicularis* and *Testudo hermanni* are listed as near threatened (NT).

The Zrmanja river basin is essential for amphibian reproduction. Great number of frog populations was recorded, primarily of Marsh frogs (*Pelophylax ridibundus*), Agile frogs (*Rana dalmatina*) and Common toads (*Bufo bufo*). These and other frog species inhabit flood plains along the Zrmanja river course, as well as flood plains alongside its tributaries. This is one of the most important centres for amphibian diversity in Dalmatia, and must be taken into consideration in every eventual project for canalizing these rivers. On the other hand, ponds are vital for other amphibians like newts. Therefore, it is necessary to revitalize traditional livestock farming, restore some of the neglected ponds, and provide better management of permanent water bodies like these.

Although traffic infrastructure is not strongly developed, and traffic itself is not too frequent, we noticed that some species tend to be more vulnerable to road kills. This particularly stands for the Leopard snake (*Zamenis situla*), of which the majority of specimens were found basking on asphalt roads. This species requires further monitoring in this area, and if potential "black spots" are revealed, further action is required towards the eliminating of negative anthropogenic factors.

Conclusion

In the catchment area of the river Zrmanja, only sporadic studies of certain localities were conducted so far; some information gathered from the literature were older than 100 years. With this paper authors tried to unite historical information with their recent research, in order to provide better knowledge and understanding of batracho- and herpetofauna of this area. From the data we provided it is evident that catchment area of the river Zrmanja is of exceptional importance to amphibian and reptilian fauna. So far we recorded 32 species, which present 53% of the total species number of amphibians and reptiles in Croatia. Water presence in a karstic area such as the terrain we surveyed results in large populations of particular species of amphibians, and favourable climate factors and preserved habitat diversity stimulate high number of reptile species. Although this area is currently under low anthropogenic impact, it is reasonable to expect economic progress and accelerated urbanisation. Therefore, it is of great importance to understand the significance of the Zrmanja river catchment area, and to ensure long-term survival and good management of the recorded populations and high numbers of amphibian and reptile diversity.

Acknowledgements

The authors wish to thank the members of Croatian Herpetological Society HYLA, Biology Students Association BIUS and management of the Public Institution Nature Park "Velebit" who contributed to the quality of this research with their support and commitment. We would especially like to thank our colleagues Mila Lončar, Ana Kobašlić, Marija Kuljerić, Berislav Horvatić, Luka Katušić and Dijana Župan for all the help during the field research and writing of this paper. Authors wish to also thank two anonymous reviewers for their helpful advices and comments.

References

Bressi, N. (1999): European sauria in the herpetological collection of the Trieste natural history museum. Natura Croatica 8: 345-366.

Crkvenčić, I., Derado, K., Friganović, M., Kalođera, A., Mirković, D., Radica, T., Riđanović, J., Rogić, V., Roglić, J., Stražičić, N., Šegota, T. (1974): Geografija SR Hrvatske 6. Južno Hrvatsko primorje. Školska knjiga, Zagreb.

Cvitanić, A. (1959): Prilog poznavanju zmija splitske okolice. Biološki glasnik 12: 127-130.

Darewskij, I. S., Ščerbak, N. N. (1993): *Coluber najadum* – Schlanknatter. Pp. 131-144. In: Böhme, W. (Ed.): Handbuch der Reptilien und Amphibien Europas. Vol. 3/I, Schlangen (Serpentes) I. Wiesbaden (Aula).

De Luca N. (1989): Taxonomic and Biogeographic Characteristics of Horvath's Rock Lizard (Lacereta horvathi MEHELY, 1904, Lacerticae, Reptilia) in Yugoslavia. Scopolia 18: 1-48.

De Luca, N. (1990): Velebitska gušterica. Ekološki glasnik 5-6: 18-20.

Denoël, M., Duguet, R., Džukić, G., Kalezić, M., Mazzotti, S. (2001): Biogeography and ecology of paedomorphosis in *Triturus alpestris* (Amphibia, Caudata). Journal of Biogeography 28: 1271-1280.

Džukić, G., Pasuljević, G. (1979): O rasprostranjenju ljuskavog guštera – Algyroides nigropunctatus (Dumeril et Bibron, 1839) Reptilia, Lacertidae. Biosistematika, Beograd 5: 61-70.

Janev-Hutinec, B., Lupret-Obradović, S. (2005): Zmije Hrvatske – Priručnik za određivanje vrsta. Izdanje HHD-Hyla, 33 pp.

Janev Hutinec, B., Kletečki, E., Lazar, B., Podnar Lešić, M., Skejić, J., Tadić, Z., Tvrtković, N. (2006): Red Book of Amphibians and Reptiles of Croatia. Ministry of Culture and State Institute for Nature Protection, Republic of Croatia.

Jelić, D. (2010): First record of the erythronotus mutant in *Lacerta agilis argus* Laurenti, 1768 from Croatia. Natura Croatica 19:119-121.

Jelić, D. & Lelo, S. (2010): Distribution data (UTM grid 10 × 10 km) and Status quo of *Natrix tessellata* (Laurenti, 1768) in Croatia and Bosnia and Herzegovina. Mertensiella 18: 217-224.

Karaman, S. (1921): Beiträge zur Herpetologie von Jugoslawien. Glasnik Hrvatskog Prirodoslovnog Društva 33: 194-209.

Kobašlić, A. (2002): Rasprostranjenost vodozemaca Hrvatske prema podacima Hrvatskog prirodoslovnog muzeja u Zagrebu. Diplomski rad. PMF, Zagreb.

Koen G. (1960): Herpetološka ispitivanja u okolici Zadra. Pismeni domaći rad za stručni (profesorski) ispit (Biologija) u jesenskom roku 1960 godine. Zadar.

Kolombatović, P. (1908): Sui Trittoni della Dalmazia. Glasnik Hrvatskog Naravoslovnog Društva 20: 240-251.

Kreiner, G. (2007): Snakes of Europe, All Species from West of the Caucasus Mountains. Edition Chimaira, Frankfurt am Main. 317 pp.

Krizmanić, I., Mesaroš, G., Džukić, G., Kalezić, M.L. (1997): Morphology of the Smooth Newt (*Triturus vulgaris*) in former Yugoslavia: taxonomical implications and distrubution patterns. Acta Zoologica Academiae Scientiarum Hungaricae, 43: 345-357.

Lauš, B. (2010): A contribution to the herpetofauna of Žirje Island (Dalmatia, Croatia). Natura Sloveniae 12: 61–63.

Lončar, M. (2005): Rasprostranjenost gmazova Hrvatske, zbirka Hrvatskog prirodoslovnog muzeja. Diplomski rad. PMF Biološki odsjek, Zagreb.

Lovrić, A. Ž. & Rac, M. (1989): Florističke osobitosti i zaštita fitocenoza u rječnim kanjonima Dalmacije (Cetina, Krka i Zrmanja). Acta Biokovica, Radovi o prirodi biokovskog područja 5: 105-120.

Lovrić, A.Ž., Rac, M. & Vukelić, J. (1989): Fitocenološka tipologija pejzažnih ekosistema NP "Krka" i susjednog sliva Zrmanje. Zbornik sažetaka i priopćenja (Simpozij NP "Krka": stanje istraženosti i problemi zaštite ekosistema, Šibenik, 37.

Matoničkin, I. & Pavletić, Z. (1964): Faktori razvoja biocenoza u slatkovodnom dijelu rijeke Zrmanje i njene pritoke Krupe. Krš Jugoslavije(4): 47-63.

Mršić, N. (1978): Prispevek k poznavanju taksonomije, zoogeografije in ekologije plazilcev Velebita. Razprave IV razreda SAZU, XXI: 4-43.

Pavletić J. (1964): Amphibia i Reptilia zbirke Hrvatskog narodnog zoološkog muzeja u Zagrebu. Hrvatski narodni zoološki muzej 4: 1-37.

Poljak, J. (1924): Velebit (Fauna Velebita). Priroda XIV: 159-176.

Razlog-Grlica, J. (1993): Fitocenološke i ekološke značajke makrofita rijeke Zrmanje u području utjecaja RHE Obrovac. Magistarski rad, JAZU, Globus nakladni zavod, Zagreb.

Sotiropoulos, K., Eleftherakosa, K., Džukić, G., Kalezić, M. L., Legakisd, A., Polymeni, R. M. (2007): Phylogeny and biogeography of the alpine newt *Mesotriton alpestris* (Salamandridae, Caudata), inferred from mtDNA sequences. Molecular Phylogenetics and Evolution 45: 211-226.

Strijbosch, H., Creemers, R. C. M, Lamberts, J., Martens, J. G. W., Mulder, J., Muster, J. C. M., Rijst, J. van der, Spaargaren, J. J., Zollinger, R. (1986): Verslag excursion N. W. Joegoslavie 1986 (Izvještaj sa istraživanja Sjevero-zapadne Jugoslavije 1986 godine). Katholieke Universiteit Nijmegen, 41 pp.

Strijbosch, H., Pouwels, W. Th. G., Bellink, P. J., Bugter, R. J. F., Creemers, R. C. M., Erftemeyer, P. L. A., Foppen, R. P. B., Hagemeyer, E. J. M., Laan, R. M., Marijnissen, J. W. N., Moonen, M. P. H. M., Peeters, S. A. M., Schelwald, R. A., Swaay, C. A. M. van, Teunis, H., Vergeer, L. H. T., Verouden, F. H., Wynhoff, I. (1985): Verslag excursion N. W. Joegoslavie 1985 (Izvještaj sa istraživanja Sjevero-zapadne Jugoslavije 1985 godine). Katholieke Universiteit Nijmegen, 37 pp.

Šegota, T., Filipčić, A. (2003): Köppenova podjela klima i hrvatsko nazivlje. Geoadria VIII/1: 17-37

Topić, J. (2010): Zrmanja - Muškovci. U: Nikolić, T. Topić, J. Vuković: Botanički važna područja Hrvatske. Školska knjiga d.d. i Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu: pp. 480-483.

Tvrtković, N., Kletečki, E. (1993): Vertebrates of the Velebit mountain (Croatia). Part I: Amphibians. Natura Croatica 2 : 27-46.

Žagar A. (2008): The lowest altitudinal record of Horvath's Rock Lizard (*Iberolacerta horvathi*) in Slovenia. Natura Sloveniae 10: 59-62.