

DIVERSITY OF REPTILES IN THE SETTLEMENT MAREZA (MONTENEGRO)

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Diversity of reptile fauna, as well as threat factors were investigated during April and May 2019 in the settlement Mareza. Field methodology included active searching and visual observation of species along defined transects. In total, 20 reptile species were recorded, what comprises about 55 % of reptile fauna known for Montenegro. According to obtained results, area of Mareza can be considered as important reptile diversity hotspot in Montenegro. First finding of *Xerotyphlops vermicularis* in this area contribute to knowledge of its distribution range. Three identified species (*Emys orbicularis*, *Testudo hermanni* and *Elaphe quatuorlineata*) are listed on Annex II of the Habitat Directive. None of identified species are vulnerable, endangered or critically endangered, upon the IUCN Red List. Almost all identified species are protected on national level. Main threat factors for reptile fauna in the area of Mareza are: urbanization, habitat fragmentation and destruction, fires, illegal landfills, direct killing by locals and road killing.

Key words: reptile fauna, biodiversity hotspot, Mareza, threat factors

INTRODUCTION

Settlement Mareza is situated in the central part of Montenegro (municipality of Podgorica). It is situated on north-west part of Podgorica, about 5 km far away from the town centre, at app. 40 m above sea level. The site is a complex of freshwater, terrestrial and karst habitats and

includes flooded and occasionally flooded meadows, canals, streams and springs which together support a number of endemic or otherwise notable species considered unique in the central region of Montenegro (Evans *et al.* 2019). In the foot of the hill called Velje brdo, numerous perennial and intermittent springs are present which form river Mareza, which flow is partly channelled. In the vicinity of river Mareza is also river Matica. Areas of river Mareza and river Matica are localities where preserved stands of vegetation of aquatic and wet habitats are still present (Stešević *et al.* 2017). The peripheral part consists of limestone hills, with vegetation of shrubs and semi-shrubs (mainly associations *Paliuretum adriaticum* and *Rusco-carpinetum*) (Stešević *et al.* 2017). This areas are potentially Natura 2000 sites, since some important Natura 2000 habitats (e.g. 3260 and 6420) are present here (Stešević *et al.* 2017). In 2019, areas of river Mareza and river Matica were protected as Nature Park (Nature Park valley of river Zeta) (AZPŽS 2019).

Both, the aquatic/semi-aquatic habitats and the drier karst/meadow areas, are considered as ecologically important with the Karst elevations (not exposed to flooding) and considered to be particularly important wintering places for amphibians and reptiles (Evans *et al.* 2019).

Although areas of river Mareza and river Matica are in the vicinity of the capital city and are easily accessible with developed road infrastructure, they have been poorly and partially herpetologically explored (Iković *et al.* 2016, Stešević *et al.* 2017, AZPŽS 2019, Evans *et al.* 2019).

The main goal of this paper is to present reptile diversity and list of main threat factors to reptile populations in the settlement Mareza, including areas of river Mareza and river Matica.

MATERIAL AND METHODS

Data about diversity of reptiles in the settlement Mareza were collected during field survey in the period April-May 2019. Study area covered 15.8 km² (Fig. 1). Field survey lasted ten days. Each day, eight hours were spent in the field, mainly by one person. Additionally, due to the ecology of some species (e.g. *Hemidactylus turcicus* and *Telescopus fallax*), field survey were conducted during two nights (from 9 pm to 11 pm). Methodology included active searching and visual observation of species along defined transects as well as observation of road killed specimens. For aquatic species (i.e. turtles), traps – *hoop-nets* were used (Mali *et al.* 2014). Traps were baited with hot dogs, and checked on the end of each day. With bait, plastic bottles were placed inside the traps to ensure that they are on the surface of water body, so turtles caught in traps can breathe. Species identi-

fication was done according to standard herpetological literature (Arnold & Ovenden 2002). Taxonomy and nomenclature were given according to Speybroek *et al.* (2020). *Anguis fragilis* and *A. graeca* were threatened as complex (i.e. *Anguis fragilis* complex), because further research regarding taxa distinction are required (Siellero *et al.* 2014, Jablonski *et al.* 2016). Additionally, *Lacerta viridis-bilineata* complex which occur in the Western Balkans including Montenegro, were threatened as *Lacerta viridis* complex because further taxonomy evaluation is required (Marzahn *et al.* 2016).

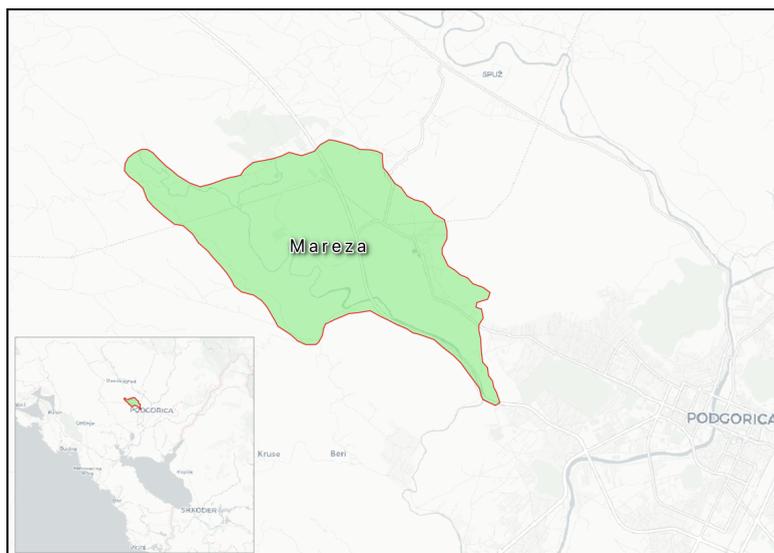


Fig. 1. – Study area

RESULTS AND DISCUSSION

Analysis of taxa and specimens

TESTUDINES

Fam. Emydidae

Emys orbicularis (Linnaeus, 1758) – in total, 9 individuals, as well as four road killed were found in and near freshwater habitats: river Matica, river Mareaza, wetlands, canals and ponds.

Fam. Testudinidae

Testudo hermanni Gmelin 1789 – in total, 78 individuals, as well as one road killed and two dead (empty shells) were found in all terrestrial habitats: bushes, meadows, human settlements, road edges, river valleys and degraded forests.

SQUAMATA

Fam. Gekkonidae

Hemidactylus turcicus (Linnaeus, 1758) – only two individuals were found in human settlements on house walls.

Fam. Anguidae

Anguis fragilis complex – just two individuals, as well as two road killed were found on wet habitats, bellow stones, and on wood pallets.

Pseudopus apodus (Pallas, 1755) – in total, 47 individuals, as well as five road killed were found in all terrestrial habitats: bushes, rocky walls, meadows, human settlements, road edges, river valleys and degraded forests.

Fam. Lacertidae

Dalmatolacerta oxycephala Duméril and Bibron, 1839 – 12 individuals were found on karst stones, aggregation of rocks and on house walls.

Lacerta trilineata Bedriaga, 1886 – in total, about 40 individuals were found, as well as three road killed in all terrestrial habitats: bushes, rocky walls, meadows, human settlements, road edges, river valleys and degraded forests.

Lacerta viridis complex – only two individuals were found on rocky habitats in degraded forests.

Podarcis muralis (Laurenti, 1768) – in total, 14 individuals were found on rocky habitats, rocky walls, human settlements, on waste and construction landfills, as well as road edges.

Podarcis melisellensis (Braun, 1877) – in total, about 40 individuals, as well as one road killed were found on rocky habitats, rocky walls, human settlements, on waste and construction landfills, road edges, meadow edges.

Fam. Colubridae

Dolichopsis caspius (Gmelin, 1789) – in total, six individuals, as well as one road killed were found on open dry habitat, meadows, road edges, as well as on construction landfills.

Elaphe quatuorlineata (Bonnaterre, 1790) – three individuals were found among wet habitats in area of river Mareza, as well as in degraded forests.

Hierophis gemonensis (Laurenti, 1768) – eight individuals were found on rocky walls with dense vegetation.

Platyceps najadum (Eichwald, 1831) – three individuals, as well as one shedded skin were found on rocky habitats with dense vegetation.

Telescopus fallax (Fleischmann, 1831) – only one road killed individual was found in human settlement.

Fam. **Psammophiidae**

Malpolon insignitus (Geoffroy Saint-Hilaire, 1827) – one individual was found on open rocky habitat, while one road killed individual was found in human settlement.

Fam. **Natricidae**

Natrix natrix (Linnaeus, 1758) – in total, 13 individuals were found in and near freshwater habitats (canals, rivers, ponds, wetlands), in bushes, on meadows and among abandoned houses far away from aquatic habitats.

Natrix tessellata (Laurenti, 1768) – in total, 21 individuals, as well as six road killed were found in freshwater habitats (canals, rivers, ponds, wetlands), as well as near freshwater habitats in dense bushes.

Fam. **Viperidae**

Vipera ammodytes (Linnaeus, 1758) – three individuals were found on rocky habitats covered with dense vegetation.

Fam. **Typhlopidae**

Xerotyphlops vermicularis (Merrem, 1820) – only two individuals were found bellow stone on open habitat near road edge, which is actually part of human settlement.

According to results of ten days field survey, 20 reptile species were recorded in the study area, what comprises about 55 % of reptile fauna in Montenegro (Jovanović 2009, Polović & Ljubisavljević 2010, Jelić *et al.* 2013, Žagar *et al.* 2013, Gvozdrenović & Čavor 2015, Gvozdrenović *et al.* 2016, Iković *et al.* 2016, Verligov *et al.* 2016, Džukić *et al.* 2017, Crnobrnja-Isalović *et al.* 2018, Iković 2018, Iković & Gvozdrenović 2018, Ljubisavljević *et al.* 2018). Upon literature sources, 37 reptile species are officially confirmed for Montenegro. In this list, three potentially present species (*Tarentola mauritanica*, *Mediodactylus kotschy* and *Podarcis tauricus*) are not included (Polović & Ljubisavljević 2010, Ljubisavljević *et al.* 2018).

Having in mind that study area is small (including areas of river Mareza and river Matica) and that 20 reptile species are recorded here, area of Mareza should be considered among three areas of the highest reptile diversity in Montenegro, together with Skadar Lake region and Bjelopavlići region (Tomović *et al.* 2004, Jovanović 2009, Polović & Ljubisavljević 2010, Polović & Čadenović 2013, 2014a, 2014b, Iković *et al.* 2016, Crnobrnja-Isalović *et al.* 2018, Iković 2018). Reviewing of literature data

(Stešević *et al.* 2017) showed that two additional species were recorded in area of Mareza, *Algyroides nigropunctatus* and *Zamenis situla*. With 22 officially confirmed species, area of Mareza should be considered as reptile diversity hot spot in Montenegro.

All recorded species belong to two orders (Testudines and Squamata) and ten families (two Testudines, three Lacertilia and five Serpentes). In total, 334 specimens were found. From that number, 217 specimens (65 %) belonged to four species (*Testudo hermanni*, *Pseudopus apodus*, *Lacerta trilineata* and *Podarcis melisellensis*). Nine species had low contribution, in range of 0.3 to 1.2 % which correspond to 1-4 specimens records. Only one species had just one record, *Telescopus fallax*. According to Stešević *et al.* (2017) population of this species is widely represented in area of Mareza. This disagreement is most probably due to the fact that species is active during late afternoon and night, while field work for this study were most often conducted during the day time.

Finding of *Xerotyphlops vermicularis* in this area contribute to the knowledge of its distribution range. *X. vermicularis* is Eurasian species, occurs from Tajikistan, Uzbekistan, Afghanistan and Turkmenistan on east up to Albania, Macedonia and Montenegro on the west (IUCN 2020). In Montenegro, *X. vermicularis* occurs in its southern and south-eastern part (Crnobrnja-Isalović i Džukić 1995, Mrdak 2006, Polović & Ljubisavljević 2010, Džukić *et al.* 2017, Crnobrnja-Isalović *et al.* 2018, IUCN 2020). Although, Grillitsch *et al.* (1999) published a record of *X. vermicularis* on Dugi Otok island in Croatia, Jelić *et al.* (2015) consider this record as highly questionable. Additionally, recent field research failed to confirm presence of this species in the Croatia (Štih *et al.* 2013, Schmidt *et al.* 2020), what indicate that the occurrence of this species is very unlikely in Croatia. Also, according IUCN (2020) presence of the species is uncertain for Bosnia and Herzegovina. Having in mind all of facts mentioned above, record of *X. vermicularis* in the area of Mareza is actually on the western boundary of the species distribution range.

Among 334 specimens, 25 specimens were road killed, and two were found dead (two empty shells of *Testudo hermanni*). The highest number of road killed specimens belong to *Natrix tessellata* (6 specimens) and *Pseudopus apodus* (5 specimens). Having in mind that road infrastructure is near river Mareza and surrounding wet habitats, it is not surprising that the highest road killed specimens belong to *Natrix tessellata*. Road traffic is one of the human activity which, more than ever, leads to decrease of reptile populations (Iković *et al.* 2012) as it cause habitat fragmentation. Iković *et al.* (2012) indicated that in the Bjelopavlići region (central Montenegro) most affected reptile species by road infrastructure are *Testudo hermanni* and *Podarcis melisellensis*. Evans *et al.* (2019) also pointed that in area of

Mareza *Testudo hermanni* is the most affected reptile species by road infrastructure.

Four out of 20 recorded species belong to Balkan endemic species: *Dalmatolacerta oxycephala*, *Lacerta trilineata*, *Podarcis melisellensis* and *Hierophis gemonensis*.

Species conservation status

Most of reptile species (15 species), recorded in the area of Mareza are protected by law in Montenegro (Official Gazette of the Republic of Montenegro 76/06) (Table 1). List of protected species is adopted in 2006 and needs revision in context of consistency, as well as concerning taxonomy and nomenclature. In total, 12 out of 20 recorded species are included in Annexes (II and/or IV) of the Habitat Directive (Table 1). All identified species are included in Appendixes (II and III) of the Bern Convention, while only one species (*Testudo hermanni*) is included in Appendix II of the CITES list (Table 1).

According to European IUCN Red List (Cox & Temple, 2009) most of recorded species in area of Mareza are considered as least concerned (LC), while only three species (*Emys orbicularis*, *Testudo hermanni* and *Elaphe quatuorlineata*) are considered as near threatened (NT) (Table 1). These species should be carefully monitored in the future, since their distribution ranges and/or quality of habitats are already impacted by threatening factors in Montenegro (Crnobrnja-Isalović *et al.* 2018).

Threat factors

During field survey in the area of Mareza different threat factors for reptile populations were identified: urbanization, habitat fragmentation and destruction, road constructions and road killings, fires, illegal landfills, as well as direct killing by local inhabitants.

Intensive urbanisation and road infrastructure cause habitat fragmentations and habitat destructions, which lead to decrease of reptile populations and diversity loss (Irwin *et al.* 2010, Iković *et al.* 2012, French *et al.* 2018). Roads are often constructed through reptile habitats and specimens are forced to cross them for migrations among habitats (for mating, egg laying, feeding, hibernation). It is well-known that road mortality is globally high in turtle and snake populations (Aresco 2003, Gibbs & Steen 2005, Andrews & Gibbons 2008, Iković 2012, Iković *et al.* 2012, Vujović *et al.* 2015). Road infrastructures in area of Mareza do not have technical solutions e.g. eco-tunnels below road, through which specimens can move freely among habitats, or traffic signs and information tables. According to

Iković (2012) and Iković *et al.* (2012) eco-tunnels bellow road, as one of the important technical solutions, have to be implemented at appropriate locations at road M18 which passing near the settlement Mareza.

Table 1. – The list of reptile species identified during field work in the study area, national/international protection and conservation status.

Scientific name	Protection on national level ¹	Protection on international level ²			IUCN (Europe) ³
		Habitat directive	Bern convention	CITES	
<i>Emys orbicularis</i>	+	Annex II, IV	Appendix II	-	NT
<i>Testudo hermanni</i>	+	Annex II, IV	Appendix II	Appendix II	NT
<i>Hemidactylus turcicus</i>	-	-	Appendix III	-	LC
<i>Anguis fragilis</i> complex	+	-	Appendix III	-	LC
<i>Pseudopus apodus</i>	+	Annex IV	Appendix II	-	LC
<i>Dalmatolacerta oxycephala</i>	+	-	Appendix III	-	LC
<i>Lacerta trilineata</i>	+	Annex IV	Appendix II	-	LC
<i>Lacerta viridis</i> complex	+	Annex IV	Appendix II	-	LC
<i>Podarcis muralis</i>	+	-	Appendix II	-	LC
<i>Podarcis melisellensis</i>	+	Annex IV	Appendix II	-	LC
<i>Dolichopsis caspius</i>	-	Annex IV	Appendix III	-	LC
<i>Elaphe quatuorlineata</i>	+	Annex II, IV	Appendix II	-	NT
<i>Hierophis gemonensis</i>	+	-	Appendix II	-	LC
<i>Malpolon insignitus</i>	+	-	Appendix III	-	LC
<i>Natrix natrix</i>	+	-	Appendix III	-	LC
<i>Natrix tessellata</i>	+	Annex IV	Appendix II	-	LC
<i>Platyceps najadum</i>	+	Annex IV	Appendix II	-	LC
<i>Telescopus fallax</i>	-	Annex IV	Appendix II	-	LC
<i>Vipera ammodytes</i>	-	Annex IV	Appendix II	-	LC
<i>Xerotyphlops vermicularis</i>	-	-	Appendix III	-	LC

¹**Protection on national level:** Official Gazette of the Republic of Montenegro 76/06, 12 December 2006;

²**Protection on international level:** *Habitat directive* – Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wildlife and flora Habitats Directive - 92/43/EEC, Annex II – animal and plant species of community interest whose conservation requires the designation of special areas of conservation, Annex IV – animal and plant species of community interest in need of strict protection; *Bern convention* – Convention on the conservation of European wildlife and natural habitats, 1979, Bern, Switzerland, Appendix II – strictly protected fauna species, Appendix III – protected fauna species; *CITES* – The convention on international trade in endangered species of wild fauna and flora, Appendix II – species that should be under the control of trade to avoid the threat of extinction;

³**IUCN (Europe):** Europe Red List of Reptiles (Cox & Temple 2009), LC – least concern, NT – near threatened

In the study area, there is huge number of illegal landfills (different types of waste). Some of freshwater canals and meadows are covered by

solid waste. Also huge number of construction, as well as plastic waste was identified. Landfills cause degradation of habitats, and according to Gibbson *et al.* (2000) and Brennan & Kuvlesky (2005) degradation, or alteration of habitats are leading causes of loss of biodiversity. In Montenegro illegal landfills are result of negligent behaviour of humans, and lack of legislations which address waste issue.

On the surrounding hills, fires are common, especially during dry, summer season. Fires are also caused by locals due to the clearing of their properties. Fires are important threat factor to reptiles, especially for slow moving species such as *Testudo hermanni*. Vujović *et al.* (2015) found high mortality rate of *Testudo hermanni*, especially in juveniles, caused by fires in area of town Danilovgrad. According to Cheyland (1984), several large-scale fires can eliminate up to 85 % of the population of tortoises in a single year.

In area of Mareza locals often cause destruction of bushes and other vegetation in and around human settlements which are important habitats for numerous reptile species such as *Testudo hermanni*, *Pseudopus apodus*, *Lacerta trilineata*, *Lacerta viridis*, *Hierophis gemonensis*, *Vipera ammodytes*. Killing of reptiles (mainly snakes) is usual because of fear which is caused by ignorance. For locals, all snakes are dangerous/poisonous and should be killed. It is known that killing of snakes by locals contributes to loss of biodiversity (Pandey *et al.* 2016).

Džukić (1995) listed general measures which should be implemented in term of reptile diversity protection: field surveys in order to collect data about populations, their status and threat factors; protection of natural habitats, especially sensitive ecosystems; law legislations and their application especially in protected areas; revision of law legislation in accordance to science results; separation of special protected zones; restrictions in biocide use; control of fires, urbanization, and pasture; education of locals; control of hunting, illegal collection and trade.

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Online Appendices:

Appendix 1. – Unpublished records.

ДИВЕРЗИТЕТ ГМИЗАВАЦА НА ПОДРУЧЈУ НАСЕЉА МАРЕЗА (ЦРНА ГОРА)

ГВОЗДЕНОВИЋ СЛАЂАНА

РЕЗИМЕ

Диверзитет гмизаваца и фактори угрожавања њихових популација истраживани су током априла и маја 2019. године у широј области насеља Мареза. Методологија је била заснована на активном тражењу и визуелном бележењу врста дуж дефинисаних трансеката. Укупно је забележено 20 врста гмизаваца, што представља удио од 55 % у укупном броју до сада забележених врста гмизаваца у Црној Гори. У литератури је забележено присуство још две врсте на овом подручју. На основу добијених резултата, са укупно 22 забележене врсте, област Марезе се може сматрати „врхом тачком“ диверзитета гмизаваца у Црној Гори. Први налаз врсте *Xerotyphlops vermicularis* у овом подручју доприноси познавању дистрибуције ове врсте. Три забележене врсте (*Emys orbicularis*, *Testudo hermanni* и *Elaphe quatuorlineata*) су на Анексу II Директиве о стаништима. Ниједна од забележених врста не спада у групу рањивих, угрожених или критично угрожених врста. Готово све забележене врсте су заштићене националним законодавством. Главни фактори угрожавања популација гмизаваца у области Марезе су: урбанизација, фрагментација и уништавање станишта, пожари, дивље депоније, убијање од стране локалног становништва, као и страдање на путевима.