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A NEW PERSPECTIVE ON THE DISTRIBUTION OF HORVATH'S ROCK LIZARD (*IBEROLACERTA HORVATHI*) IN UČKA NATURE PARK: NEW RECORDS FROM ĆIĆARIJA MOUNTAIN

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This study explores the distribution of Horvath's rock lizard (*Iberolacerta horvathi*) in the area of Ćićarija mountain located in the northern part of Učka Nature Park, where its presence was previously uncertain. Field surveys identified eight new sites where the species was observed, primarily on shaded limestone cliffs at around 900 meters in elevation. The discovery of adults, subadults, and juveniles suggests the presence of a healthy population in this area. These findings indicate that the lizard's distribution in the region is less fragmented than previously described, potentially linking it to the species' main range. The study suggests further genetic research and ongoing monitoring to support effective conservation efforts.

Keywords: Horvath's rock lizard, *Iberolacerta horvathi*, Učka Nature Park, Ćićarija

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U ovom radu istražena je rasprostranjenost velebitske gušterice (Iberolacerta horvathi) na području Ćićarije, smještenom u sjevernom dijelu Parka prirode Učka, gdje prisutnost ove vrste do sada nije bila istražena. Terenska istraživanja identificirala su osam novih lokacija na kojima je ova vrsta opažena, prvenstveno na zasjenjenim vapnenačkim stijenama na oko 900 metara nadmorske visine. Opažene odrasle, mlade i juvenilne jedinke ukazuju na prisutnost zdrave populacije na tom području. Ovi rezultati ukazuju da je rasprostranjenost velebitske gušterice na ovom području manje fragmentirana nego što je ranije opisano, što bi moglo povezati ovu populaciju s glavnim područjem rasprostranjenosti vrste. Rezultati ovog istraživanja ukazuju na potrebu za daljnjim genetičkim istraživanjima i kontinuiranim praćenjem ove vrste kako bi se osigurala njezina dugoročna zaštita.

Ključne riječi: velebitska gušterica, Iberolacerta horvathi, Park prirode Učka, Ćićarija

INTRODUCTION

Horvath's rock lizard (*Iberolacerta horvathi*) is a mountain lacertid species found in a relatively small range extending from the eastern Alps to the northwestern Dinarides (De Luca, 1989; Žagar *et al.*, 2014). Recent publications confirm that the species occurs in at least four countries: Italy, Austria, Slovenia, and Croatia (Cocca *et al.*, 2021).

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This petrophilic species inhabits rocky substrates with sparse vegetation, increasing in numbers with altitude. It can also be found in clearings within densely forested areas at lower elevations (Arnold, 1987; Arnold *et al.*, 2007; Cabela *et al.*, 2007; Speybroeck *et al.*, 2016; Žagar *et al.*, 2014). The species generally exhibits a relatively restricted and apparently fragmented distribution, ranging from 200 to 2,000 meters above sea level, and prefers high rainfall and snowy conditions in winter, along with cooler temperatures in summer (Arnold & Ovenden, 2004). In Croatia, the species was initially believed to inhabit areas such as Gorski Kotar and Velebit, but it has since been discovered in numerous other localities, including Učka (Mertens, 1937) and Dinara (Žagar *et al.*, 2014). This suggests that the species' distribution is still not fully understood. The Horvath's rock lizard is currently classified as Least Concern under IUCN Red List criteria (Bowles & Crnobrnja-Isailović, 2024), but it is a strictly protected species in Croatia, with the main threat believed to be the isolation of the different populations (Vogrin *et al.*, 2009.).

Učka Nature Park is situated in the northeastern part of the Istrian Peninsula, Croatia, and encompasses the Učka massif in the south and the Ćićarija plateau in the north. Unlike Učka, which is a distinctive mountain massif extending north-south, Ćićarija is a karst plateau featuring several mountain ridges oriented in the characteristic Dinaric northwest-southeast direction (Vlahović & Matoš, 2021). Previous studies have identified a small, isolated population of Horvath's rock lizard inhabiting the cliffs near Vojak Peak on Učka Mountain (De Luca, 1989). However, it has also been suggested that the species likely inhabits the cliffs of Brajkov Vrh on the Ćićarija plateau, situated along the northwestern boundary of Učka Nature Park (Grbac 2006). Additionally, prior research indicated that Ćićarija Mountain provides suitable habitats for the species and could serve as a corridor linking the Učka population with the main population areal (De Luca, 1989). Despite accumulating evidence, the distribution of Horvath's rock lizard within Ćićarija Mountain remains unclear. To address this issue, our study investigated the distribution of Horvath's rock lizard through field surveys conducted in the Ćićarija region, situated in the northern part of Učka Nature Park.

Study area

Field research was conducted between mid-June and mid-August 2024 and consisted of four three-day surveys focused on Ćićarija Mountain in the northern part of Učka Nature Park (Fig. 1). According to the literature, this area provides suitable habitats for the species (Cocca *et al.*, 2021)1904 and spans altitudes of approximately 800 to 1300 meters, where the species is most abundant (Arnold & Ovenden, 2004). Ćićarija is a mountain range extending south from the Slovenian border to the Učka Mountain range. In the eastern part of Ćićarija, the range features summits often exceeding 1,000 meters, such as Veliki Planik (1,272 meters) and Žbevnica (1,014 meters). To the west, a karst plateau rises to about 600 meters. The bedrock is predominantly limestone, with many characteristic karst formations (Vlahović & Matoš, 2021). Vegetation is well-developed and falls within the epi-Mediterranean vegetational zone (*Ostryo-Quercetum pubescentis*) and the para-Mediterranean vegetational zone (*Seslerio autumnalis-Fagetum*) (Trinajstić, 1995).

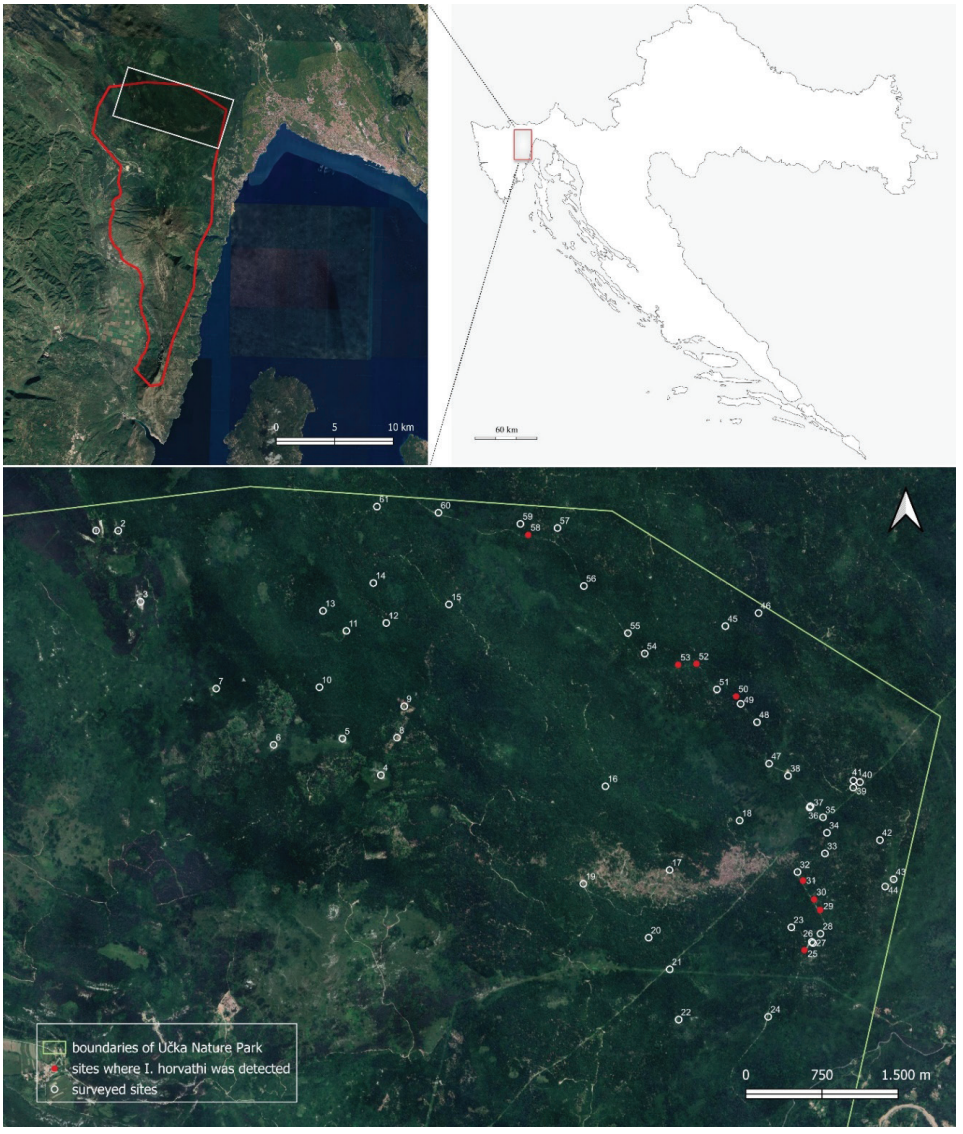

Fig. 1. Map of the area surveyed for reptile species. Numbers on the map correspond to investigated sites in Tab. 1.

Tab. 1. Overview of investigated sites (correspond to numbers on Fig. 1), numbers of *Iberolacerta horvathi* individuals and elevation recorded during *Iberolacerta horvathi* survey on Ćićarija Mountain (Croatia).

Investigated sites	Elevation/Altitude (m a.s.l.)	Number of individuals			
		Adults	Subadults	Juveniles	Total
25	835	1			1
29	840	7	2	1	10
30	848	2			2
31	842	8	1	2	11
50	993	1			1
52	924	2			2
53	1011	6	1	1	8
58	1045	3			3

Field work

Surveys for Horvath's rock lizard were conducted during the day, from approximately 7 a.m. to 6 p.m., when environmental conditions were favourable to reptile activity. The sites investigated included habitat types previously identified as preferred by the species, such as cliffs, rock piles, and boulders in open beech or mixed forests, as well as rocky outcrops, road cuttings, and habitats associated with human-made structures (Žagar *et al.*, 2023). Some of the investigated habitats are shown in Fig. 2. Furthermore, the surveyed sites were predominantly located near forest roads and pathways (a total of 61 sites were surveyed; Fig. 1), and some of these sites were visited more than once. Also, additional sites with potential habitats for the species were identified in the investigated area, but access was hindered by the difficult terrain. Individual lizards were identified through examination at very close distance and analysis of fieldwork photographs (De Marchi *et al.*, 2017), following the determination key (Arnold *et al.*, 2007;Gallotiinae and Lacertinae, the latter comprising two monophyletic tribes, the Eremiadini of Africa and arid southwest and central Asia, and the Lacertini of Europe, north-west Africa and southwest and east Asia. Relationships within the 108 species of Lacertini are explored using mtDNA (291 bp cytochrome b; 329 bp 12S rRNA for 59 nominal species, and reanalysis of the data of Harris *et al.* 1998, and Fu 2000 Arnold & Ovenden, 2004). Geographical coordinates were recorded for each Horvath's rock lizard sighting using a handheld GPS (Garmin). Precise altitude data was obtained from digital cartographic sources (Google Earth). Additionally, to gather more detailed data, several adult individuals from different localities were captured using a noose (a long stick with a cotton loop) and photographed. Standard morphometric measurements (SVL: snout-vent length) were also taken with callipers to the nearest of 1 mm. All individuals were released on site without harm. Geographical coordinates were also recorded for other reptile species observed at the study sites.

Fig. 2. Habitat of Horvath's rock lizard (*Iberolacerta horvathi*) on Ćićarija Mountain (Croatia).

RESULTS

During fieldwork, 38 individuals of Horvath's rock lizard, including subadults and juveniles, were observed at eight new sites throughout the study area at altitudes ranging from 835 to 1045 m above sea level (Tab. 1 and Fig. 3). Measurement data for six captured individuals are detailed in Suppl. Tab. 1. and the close-up photographs of captured individuals can be seen in Fig. 4. These lizards were found on limestone rocks and cliffs along a forest road, which featured numerous small crevices and partial exposure to sunlight. Most of the rocks were partially covered with vegetation, predominantly moss, although some rocks were entirely bare at the top (Fig. 2). The rocks were predominantly shaded, situated within a beech forest, and oriented primarily south or southwest. They were located along the forest road at an average elevation of approximately 900 meters above sea level (m.a.s.l.). During the survey, temperatures ranged from 20 to 28° C. Additionally, several other reptile species were observed at the surveyed sites. A list of these species and their associated investigated sites is provided in Suppl. Tab. 2.

Fig. 3. Photographs of adult (A-C), subadult (D) and juvenile (E) Horvath's rock lizard (*Iberolacerta horvathi*) individuals observed on Ćićarija Mountain (Croatia).

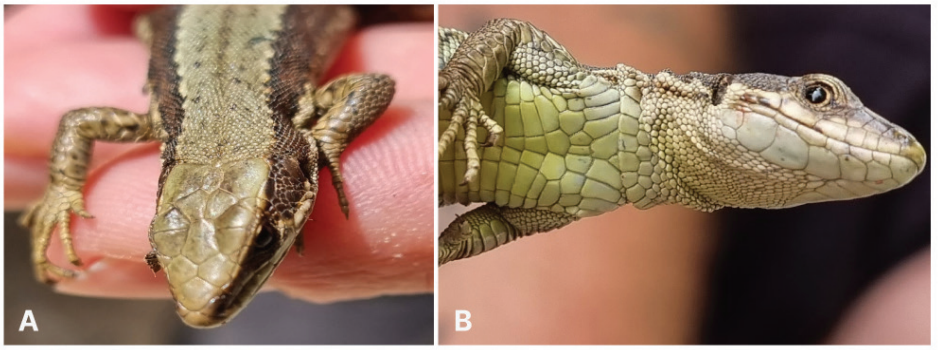

Fig. 4. Close-up photographs of the dorsal (A) and right ventral side (B) of adult Horvath's rock lizard (*Iberolacerta horvathi*) found on Ćićarija Mountain (Croatia).

DISCUSSION

Previously, it was believed that the population of Horvath's rock lizard on Mount Učka constituted an isolated enclave of the species within the Učka Nature Park (De Luca, 1998; Grbac, 2006). Although it was assumed that the species might inhabit potentially suitable habitats on Ćićarija mountain (De Luca, 1989), there were no data on its distribution in this area. Our field research has now, for the first time, confirmed the presence of the species in the northern part of the park, particularly in the Ćićarija region. We observed the species at eight sites along a

forest road in the northern part of the park. Notably, these sites were relatively close to each other, which suggests that more individuals are present in this area. Furthermore, the proximity of suitable habitats near the recorded locations supports this hypothesis. In addition, the presence of adults, subadults and juvenile Horvath's rock lizards among the observed individuals suggests a healthy, sustainable population and favourable environmental conditions within their habitat in this area (Fig. 3).

Furthermore, recent studies have confirmed that this species favours higher altitudes, moderate to high precipitation during the wettest part of the year, and low average temperatures during the driest period (Cocca *et al.*, 2021)1904. Our discovery of new localities on Ćićarija mountain is consistent with these findings. These new sites are located approximately 900 meters above sea level in an area characterized by the absence of dry periods and maximum precipitation concentrated during the colder months (Zaninović *et al.*, 2008). According to Thornthwaite's climate classification, this region falls within the perhumid (extremely humid) climate zone. In terms of temperature, the average July temperature does not exceed 22°C, while the mean January temperature remains above -3°C (Zaninović *et al.*, 2008). Also, all observed individuals of Horvath's rock lizard were found on rock faces and cliffs with steep surfaces, characterized by narrow crevices, partial vegetation cover, and limited exposure to sunlight (Fig. 2C). This observation is consistent with previous studies on microhabitat selection by the species (Žagar, 2016; Žagar *et al.*, 2023)100 m a.s.l. in the study area revealed 62 localities with populations of both or either species. At 11 of these localities (18%. Furthermore, no sites have been reported in which both Horvath's rock lizards and common wall lizards (*Podarcis muralis*) are found (Tab. 1 and Supplementary Tab. 2; Fig. 1). However, common wall lizards were frequently detected at sites in close proximity to those where Horvath's rock lizards were observed (Tab. 1 and Suppl. Tab. 2; Fig. 1). Considering that these species are generally known to occur in syntopy (Žagar *et al.*, 2013), we infer that this is likely the case in this area as well.

Additionally, despite thorough research, it is noteworthy that the species was not recorded in the Brajkov Vrh cliff area, where its presence had been anticipated. Instead, only a population of common wall lizards was found at this location. Given the information provided, it remains unclear whether Horvat's lizard is present at this location.

Recent studies have revealed that the distribution of Horvath's rock lizard is less fragmented than previously thought (Cocca *et al.*, 2021; Žagar *et al.*, 2014)Lacerta agilis, L. viridis sensu lato, Podarcis muralis, P. melissellensis, Coronella austriaca, Zamenis longissimus, and Vipera ammodytes.",",language":"en",",source":"Zotero",",title":"REPTILE SURVEY IN DINARA MOUNTAIN (CROATIA, which supports our discovery of new localities for this species. We also propose that this newly identified population reduces the distance between the known site occupied by the species on Mount Učka and its main population range (De Luca, 1989), potentially bridging gaps in population continuity. Furthermore, we recommend a genetic structure analysis of the newly discovered Horvath's rock lizard population and an investigation of potential gene flow among the known populations in the surrounding area.

In conclusion, the results of this study have enhanced our understanding of the species' distribution within Učka Nature Park and highlighted the importance of the Ćićarija mountain region as a habitat for Horvath's rock lizard. To ensure the protec-

tion of the species and its natural habitats within Učka Nature Park and other areas under the institution's management, further field research is both essential and ongoing.

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SUMMARY

A new perspective on the distribution of Horvath's rock lizard (*Iberolacerta horvathi*) in Učka Nature Park: new records from Ćićarija mountain

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This study investigates the distribution of Horvath's rock lizard (*Iberolacerta horvathi*), a mountain lacertid species classified as Near Threatened. Its presence in Učka Nature Park, specifically on Ćićarija, has been unclear. While previous research suggested that the species might inhabit this region, this had not been confirmed. Field surveys conducted from June to August 2024 across numerous sites in the area of the Ćićarija mountain, located in the northern part of Učka Nature Park, identified Horvath's rock lizards at eight new locations, primarily on shaded limestone cliffs and rocks at an average elevation of 900 meters. The discovery of adults, subadults, and juveniles suggests the presence of a healthy population in this area. The results of this study confirm the presence of Horvath's rock lizard in the northern part of Učka Nature Park, consistent with its preference for high altitudes, cool summers, and humid conditions. These findings confirm the hypothesis of a distribution of this species less fragmented than had been thought, potentially linking this population with the species' main range.

Supplementary data

Suppl. Tab. 1. Snout-vent length (SVL) measured from captured *Iberolacerta horvathi* individuals and corresponding investigated sites (correspond to numbers in Fig. 1).

Investigated sites	Individual	SVL (mm)
58	1	61
29	2	59
29	3	60
53	4	50,15
29	5	61
25	6	51

Suppl. Tab. 2. Overview of reptile species observed during the survey on Ćićarija, including investigated sites (correspond to numbers on Fig. 1) and number of adults, subadults and juvenile individuals.

Latin name of observed species	Number of individuals				Investigated sites
	Total	Adults	Subadults	Juveniles	
Algyroides nigropunctatus	2	2			24
Anguis fragilis	2	2			7, 37
Lacerta viridis sensu lato	1		1		2, 8
Podarcis melisselensis	3	3			6
Podarcis muralis	46	40	2	4	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 15, 16, 22, 24, 27, 37, 38, 40, 43, 55
Vipera ammodytes	1	1			56
Zamenis longissimus	1			1	11