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THREE REPTILE SPECIES NEWLY RECORDED IN UČKA NATURE PARK, CROATIA

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Učka Nature Park in northeastern Istria represents an important habitat for herpetofauna, yet knowledge of certain reptile occurrences within the park has been limited. Field surveys conducted in 2024 and 2025 at selected peripheral sites confirmed, for the first time, the presence of three reptile species previously undocumented in the park: the four-lined snake *Elaphe quatuorlineata* Lacepède, 1789, European glass lizard *Pseudopus apodus* (Pallas 1775), and Mediterranean house gecko *Hemidactylus turcicus* (Linnaeus, 1758). These findings expand the known reptile fauna of Učka Nature Park and provide a valuable baseline for future research, monitoring, and conservation efforts.

Keywords: reptile fauna, *Elaphe quatuorlineata, Pseudopus apodus, Hemidactylus turcicus*, protected area, Istria

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Park prirode Učka u sjeveroistočnoj Istri predstavlja važno stanište za herpetofaunu, no dosadašnje spoznaje o prisutnosti pojedinih vrsta gmazova unutar Parka bile su ograničene. Terenska istraživanja provedena 2024. i 2025. godine na odabranim rubnim lokalitetima prvi su put potvrdila prisutnost vrsta gmazova koje ranije nisu bile zabilježene na području Parka: četveroprugastog kravosasa, *Elaphe quatuorlineata* Lacepède, 1789, blavora, *Pseudopus apodus* (Pallas, 1775) i mediteranskog kućnog macaklina, *Hemidactylus turcicus* (Linnaeus, 1758). Ovi nalazi proširuju dosadašnje spoznaje o fauni gmazova Parka prirode Učka i predstavljaju vrijednu osnovu za buduća istraživanja, praćenje populacija te planiranje mjera očuvanja.

Ključne riječi: fauna gmazova, *Elaphe quatuorlineata, Pseudopus apodus, Hemidactylus turcicus,* zaštićeno područje, Istra

INTRODUCTION

Učka Nature Park, is located in western Croatia, covers 160 km² and encompasses the Učka massif in the south and the Ćićarija plateau in the north. The park is situated in the northeastern Istrian Peninsula within the northern Mediterranean biogeographical region. The Učka massif forms a relatively homogeneous north-south ridge with steep coastal and inland - facing slopes. Coastal slopes are dominated by well-preserved forests of European hop-hornbeam (*Ostrya carpinifolia* Scop.) (PARK PRIRODE UČKA, 2023). Forests of Downy Oak (*Quercus pubescens* Willd.) are found in the lowest and warmest parts of the coastal slope,

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whereas forests of Sweet Chestnut (*Castanea sativa* Mill.) are less common and occupy only small areas within this area (MINISTARSTVO ZAŠTITE OKOLIŠA, PROSTORNOG UREĐENJA I GRADITELJSTVA, 2006). Common beech (*Fagus sylvatica* L.) forms thermophilus forests in a continuous belt between approximately 800 and 1150 m a.s.l. on the coastal slope, while beech forests of subalpine character are largely restricted to the summit areas of Mt Učka (FRANJIĆ et al., 2012). Furthermore, inland-facing slopes are characterized by a more fragmented forest cover (PARK PRIRODE UČKA, 2023). In contrast, the Ćićarija plateau comprises several ridges along the Dinaric northwest-southeast axis, mainly covered by *F. sylvatica* forests, with some black pine (*Pinus nigra* Arnold) and Norway spruce (*Picea abies* (L.) Karst.) plantations. Elevations up to ~900 m a.s.l. are dominated by mixed *O. carpinifolia* and *Q. pubescens* stands. The park boundary along the coastal slope of Učka generally lies at ~500 m a.s.l., whereas the inland-facing slope extends to lower elevations, typically between 50 and 400 m a.s.l. (MINISTARSTVO ZAŠTITE OKOLIŠA, PROSTORNOG UREĐENJA I GRADITELJSTVA, 2006). Along the Ćićarija range, the park boundary is situated at approximately 800-1000 m a.s.l. in the north, around 800 m a.s.l. in the east, and about 700 m a.s.l. in the west, descending locally to nearly 300 m a.s.l. in the southwestern part.

In the context of herpetological research, Učka has been mentioned as a study locality as early as the 1920s by MOSAUER & WALLIS (1924), and in the 1930s by MERTENS (1937), primarily in investigations focusing on lizards (GRBAC, 2006). During the 1970s and 1980s, the area was further referenced by Italian authors Dolce and Burlin in the framework of broader herpetofaunal surveys of Istria (GRBAC, 2006). Furthermore, a targeted survey conducted between 2002 and 2006 identified a total of eleven reptile species, including five species of the order Serpentes and six of the order Sauria (GRBAC, 2006). Recorded species included the blue-throated keeled lizard *Algyroides nigropunctatus* (Dumeril & Bibron, 1839), common slow worm *Anguis fragilis* Linnaeus, 1758, Horvath's rock lizard *Iberolacerta horvathi* (Mehely, 1904), European green lizard *Lacerta viridis* (Laurenti, 1768), Dalmatian wall lizard *Podarcis melisellensis* (Braun, 1877), common wall lizard *Podarcis muralis* (Laurenti, 1768), Aesculapian snake *Zamenis longissimus* (Laurenti, 1768), grass snake *Natrix natrix* (Laurenti, 1768), Balkan whip snake *Hierophis gemonensis* (Laurenti, 1768), western whip snake *Hierophis viridiflavus carbonarius* (Bonaparte, 1833), and horned viper *Vipera ammodytes* (Linnaeus, 1758). Although comprehensive, the survey primarily focused on ponds and other aquatic habitats within the park and its surroundings, leaving opportunities for further herpetological investigations in other habitat types suitable for reptiles. In the following years,

additional surveys were conducted, primarily focusing on amphibians (HYLA, 2009; BUDINSKI & ČULINA, 2010). More recent amphibian-focused surveys carried out in 2024 and 2025 (KOLLER ŠARIĆ *et al*., 2024; HYLA, 2025), together with a targeted survey of *I. horvathi* (ROŽMANIĆ *et al*., 2025), systematically recorded all observed reptile species within the surveyed sites. However, all species documented during these efforts had already been previously reported in the area, indicating consistency with earlier records and confirming the established reptile species composition of the park.

Furthermore, several other reptile species are known to occur on the Istrian Peninsula (SPEYBROECK *et al*., 2016), but they have not yet been recorded within the park. Among the documented species, the four-lined Snake (*Elaphe quatuorlineata* Lacepède, 1789), a widespread species on the Istrian Peninsula (MINISTARSTVO GOSPODARSTVA I ODRŽIVOG RAZVOJA, 2023), has also been recorded near the park's southwestern (GRBAC, 2009) and southern boundaries (KLETEČKI, 2009). Moreover, suitable habitat types for this species (SPEYBROECK *et al*., 2016) are particularly frequent in peripheral areas along the park's western and eastern boundaries, extending northwards at least to the zone of *F. sylvatica* forest (PARK PRIRODE UČKA, 2023; MINISTARSTVO ZAŠTITE OKOLIŠA, PROSTORNOG UREĐENJA I GRADITELJSTVA, 2006). Based on these findings and the presence of suitable habitats for the species in the peripheral areas of the park, we hypothesized that *E. quatuorlineata* may also occur within the park boundaries, particularly in its peripheral zones in the southwestern part of the park. Accordingly, the main objective of this study was to conduct the initial assessment of the potential occurrence of *E. quatuorlineata* at 13 sites located along the peripheral areas of the park, from its southern limit northwards to Brest pod Učkom in the west and Lovranska Draga in the east.

MATERIALS AND METHODS

Field surveys were conducted at 13 previously selected sites within the park between April and July 2024 and 2025 (Fig. 1, Tab. 1). Sites were selected based on previous records of the species along the park boundary and the presence of suitable habitats in the peripheral areas of the park, including karst grasslands, scrublands, rocky slopes, forest edges, areas adjacent to aquatic habitats, and appropriate anthropogenic environments (ARNOLD & OVENDEN, 2004). They were located from the southern boundary of the park, following the boundary eastwards to Lovranska Draga and westwards to Brest pod Učkom (Fig. 1). Elevations at the surveyed sites ranged approximately from 60 to 700 m a.s.l. The fieldwork encompassed a total of 20

survey days. Given that *E. quatuorlineata* is active during the day and at dusk (ARNOLD & OVENDEN, 2004), field surveys were carried out during daylight and early evening hours, when environmental conditions were favourable for reptile activity. The survey method employed in the field included random visual searches for active individuals within suitable microhabitats, as well as the inspection of potential refuges, such as loose stones, logs, and anthropogenic objects, at each site. This procedure involved carefully turning suitable objects and returning them to their original positions. At least two researchers participated in the surveys at each site. Other observed reptile species were also recorded during the surveys. Individuals were identified through close-range visual examination and/or analysis of in situ photographs, following standard identification keys (ARNOLD & OVENDEN, 2004). Geographical coordinates for each observation were recorded using a handheld GPS device (Garmin), and precise elevation data were obtained from digital cartographic sources (Google Earth) (Tab. 2).

Tab. 1. List of surveyed areas in Učka Nature Park, Croatia. Letters correspond to surveyed areas indicated on the map in Fig. 1.

Letter of surveyed area	Surveyed area
A	Brest pod Učkom
B	Vela Draga
C	Kras, Ševčevi dvori
D	Unukovica
E	foothill area below Krvave stijene
F	Zagrad – Kožljak castle ruin
G	Kunfin, Škalameri
H	area above Katun village
I	coastal slopes of Učka mountain below Sisol peak
J	Prodol
K	Kalac
L	Potoki
M	Lovranska draga

Tab. 2. Summary of previously unrecorded reptile species documented in Učka Nature Park, Croatia, including the number of individuals, corresponding observation sites, coordinates given in WGS84and elevation (m a.s.l.).

Latin name of observed species	Number of individuals	Reptile observation sites	Coordinates (WGS84))		Elevation (m a.s.l.)
			X	Y	
Elaphe quatuorlineata Lacepède, 1789	2	1	45.322611	14.180003	617
		5	45.175096	14.190242	276
Hemidactylus turcicus Linnaeus, 1758	1	2	45.278951	14.244567	355
Pseudopus apodus Pallas, 1775	2	3	45.219133	14.177911	127
		4	45.218966	14.177970	127

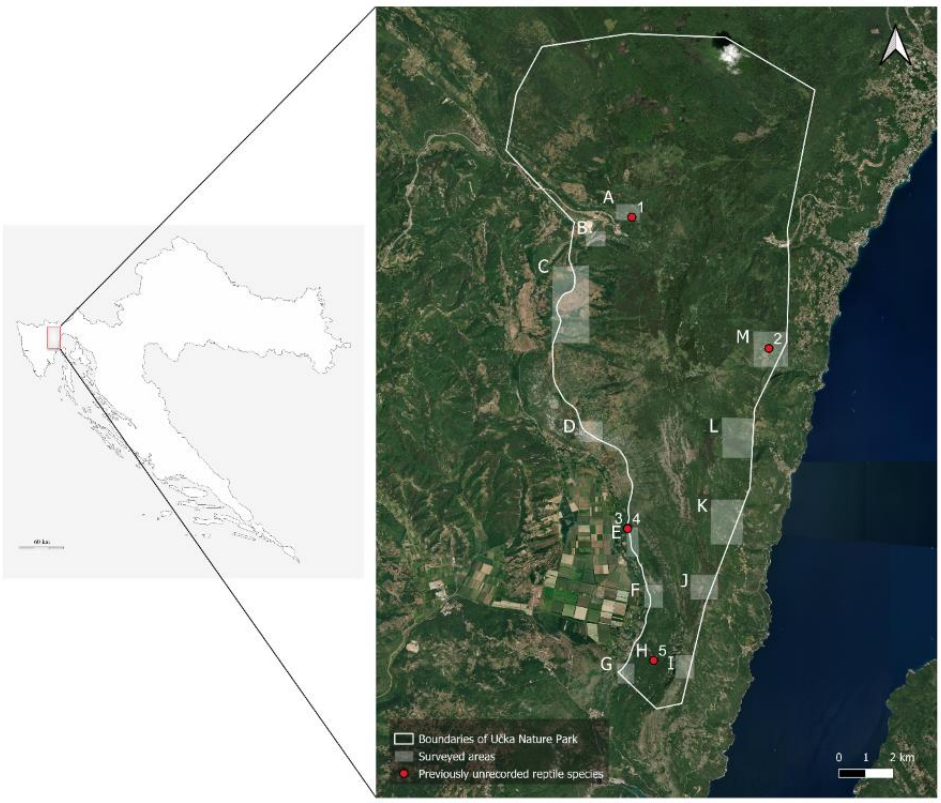

Fig. 1. Map of surveyed areas and sites of previously unrecorded reptile species in Učka Nature Park, Croatia. Letters on the map correspond to the surveyed areas for reptile species listed in Tab. 1 and numbers correspond to reptile observation sites indicated in Tab. 2.

RESULTS AND DISCUSSION

In the course of field surveys conducted at 13 sites within Učka Nature Park, *E. quatuorlineata* was recorded in the park for the first time (Figs. 1 and 2A, Tab. 2). In addition, two reptile species not previously reported from the park were also observed during the surveys, namely *Pseudopus apodus* (Pallas, 1775) and *Hemidactylus turcicus* (Linnaeus, 1758) (Figs. 1, 2B and 2C, Tab. 2). These findings expand the currently known reptile species composition of the area and provide valuable baseline information on the occurrence of these species within the park. The surveys also confirmed the presence of ten additional reptile species previously documented from the park (data for the remaining species are not shown), thereby providing further insight into their current distribution and occurrence.

E. quatuorlineata is strictly protected in Croatia and is classified as Near Threatened in the national conservation status category on the Red List of reptiles and amphibians of the Republic of Croatia (JELIĆ *et al.*, 2015). In Croatia, it is broadly distributed across the Mediterranean biogeographic region, extending from northern Istria along the Adriatic coast to the southernmost areas, including several offshore islands (BARUN *et al.*, 2011; LONČAR, 2005;

LUCIĆ, 2007; KOREN *et al*., 2011; SCHMIDT *et al*., 2020; TÓTH *et al*., 2006). Furthermore, *E. quatuorlineata* has been recorded across the Istrian Peninsula (MINISTARSTVO GOSPODARSTVA I ODRŽIVOG RAZVOJA, 2023). During the present field surveys, two adult individuals of *E. quatuorlineata* were recorded: one in the southernmost section of the Istrian-facing slope of the park and the other at the northernmost surveyed locality along the park's western boundary, near Brest pod Učkom (Fig. 1, Tab. 2). The record from the southernmost part of the Istrian-facing slope (Fig. 1, Tab. 2) is consistent with earlier findings from areas in vicinity to the southwestern boundary of the park (GRBAC, 2009; KLETEČKI, 2009) and corroborates our hypothesis regarding the species' occurrence within the park at suitable habitats. In contrast, the observation of a second individual at the northernmost surveyed site along the western boundary of the park, near Brest pod Učkom (Fig. 1, Tab. 2), was only partially anticipated, as earlier records of *E. quatuorlineata* along the park boundary originated from locations further south. Both individuals were observed in mixed forest and scrub habitat dominated by *Q. pubescens* and *O. carpinifolia* (Figs. 3A and B). These results suggest the potential presence of *E. quatuorlineata* in suitable habitats at the surveyed sites along the western boundary of the park, extending from the Brest pod Učkom area southwards, and provide additional insight into its occurrence within the eastern part of the Istrian Peninsula.

Fig. 2. *In situ* photographs of adult individuals of (A) four-lined snake (*Elaphe quatuorlineata* Lacepède, 1789), (B) European glass lizard (*Pseudopus apodus* Pallas, 1775) (photographic documentation of the second individual in situ was not feasible) and (C) Mediterranean house gecko (*Hemidactylus turcicus* Linnaeus, 1758) recorded in Učka Nature Park, Croatia.

Fig. 3. Habitats of previously unrecorded reptile species in Učka Nature Park, Croatia. (A and B) Habitat of the four-lined snake (*Elaphe quatuorlineata* Lacepède, 1789); (C and D) Habitat of the European glass lizard (*Pseudopus apodus* Pallas, 1775).

In Croatia, *P. apodus* is strictly protected and is classified as Least Concern on the Red List of reptiles and amphibians of the Republic of Croatia (JELIĆ *et al*., 2015). It is widely distributed in Croatia's Mediterranean biogeographic region (SCHMIDT *et al*., 2020; TÓTH *et al*., 2006) and has been documented at several localities across the Istrian Peninsula, from the southern areas west to Rovinj and east to the lower Raša River (JELIĆ & BURIĆ, 2012; GRBAC, 2009). During field surveys, two adult individuals were recorded at a short distance from each other at the surveyed site in the southwestern part of the park, situated on the Istrian-facing slope (Figs. 1 and 2B, Tab. 2). Specimens were recorded in a habitat characterized by abundant rocky substrate and scrubland vegetation (Figs. 3C and D). This finding was unexpected, given the absence of previously documented records of the species in the vicinity of the park's boundaries. In addition, these observations indicate the presence of a local population of *P. apodus* in suitable microhabitats in the surveyed southwestern area of the park and further document the species' occurrence in the eastern part of the Istrian Peninsula.

The third species recorded within the park boundaries for the first time during the field surveys was *H. turcicus*. *H. turcicus* is classified as Least Concern on the IUCN Red List (AGHASYAN *et al*., 2009) and is not strictly protected in Croatia. A single adult individual was observed in the settlement of Lovranska Draga, located on the coastal slope of the park (Figs. 1 and 2C,

Tab. 2). This record was not entirely unexpected, as *H. turcicus* is widely distributed along the Adriatic coast (LISIČIĆ *et al*., 2012; SCHMIDT *et al*., 2020) and is commonly observed in coastal settlements of western Istria, including Opatija and Lovran (personal observations by the corresponding author), as well as at other localities throughout the Istrian Peninsula (ŽIVANOVIĆ *et al*., 2019; BREZAK *et al*., 2025). Nevertheless, despite comprehensive surveys, no additional individuals were detected. Therefore, it remains uncertain whether a resident population exists in this area or if the observation reflects an anthropogenic introduction.

Several limitations of this study should be acknowledged. First, the surveyed method employed in this study can generally be applied to all reptile species within the park, provided that the biological and ecological characteristics of each species are considered. However, there are certain inherent limitations to this approach. For instance, *E. quatuorlineata* is highly secretive and cryptically coloured, inhabiting mosaic type of habitats that often include dense shrub cover, which complicates field surveys. Consequently, this method may have contributed to the reduced detection of *E. quatuorlineata* at the surveyed sites. A similar pattern applies to *P. apodus*, which exhibits comparable ecological preferences to *E. quatuorlineata*. Moreover, the detectability of *E. quatuorlineata* during field surveys may have been limited, as its dusk activity (ARNOLD & OVENDEN, 2004) can reduce observation efficiency due to low-light conditions. Similarly, *H. turcicus*, recorded during the survey, may have exhibited reduced detectability, given that its crepuscular and nocturnal activity also reduces survey efficiency under low-light conditions. Second, the study primarily focused on assessing the presence of *E. quatuorlineata* within the park, at sites along the eastern and western boundaries of the central and southern parts of the park (northernmost to Brest pod Učkom in the west and Lovranska Draga in the east). These sites were selected based on previously documented records of the species along the southwestern boundary of the park and the presence of suitable habitats in the peripheral areas of the park. Given these considerations, future research will be necessary to investigate the occurrence of all three newly recorded species at additional sites within the park where suitable habitat conditions for these species exist.

In conclusion, this study reports, for the first time, the presence of three reptile species previously undocumented in Učka Nature Park, *E. quatuorlineata, P. apodus*, and *H. turcicus*. These records not only complement the existing species inventory of reptiles in the park, but also provide an initial insight into their occurrence within the park. Furthermore, they may serve as a basis for future monitoring efforts, as well as for the development and implementation of targeted conservation measures for newly documented species such as *E. quatuorlineata*, given

its degree of endangerment and legal protection in Croatia. The need for such measures is further underscored by the pronounced vegetation succession observed both within the surveyed localities and across other parts of the park. This process, largely driven by the abandonment of traditional agricultural practices and grazing, leads to a gradual decline in habitat heterogeneity, a key requirement for the persistence of these species in the park. Finally, in the context of conservation planning and management, particular attention should be directed towards mitigating potential anthropogenic pressures, especially those associated with the increasing intensity of tourism activities throughout the park.

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SUMMARY

Three reptile species newly recorded in Učka Nature Park, Croatia

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Učka Nature Park covers 160 km² and encompasses the Učka massif and the Ćićarija plateau, an area characterized by diverse habitats within the northern Mediterranean biogeographical region. Previous herpetological research conducted in the area documented a total of 11 reptile species. Several additional reptile species are known to occur on the Istrian Peninsula but have not yet been recorded within the park boundaries. Among them is the four-lined snake (*Elaphe quatuorlineata* Lacepède, 1789), a strictly protected species in Croatia that is widely distributed across the Mediterranean region of the country and has been previously recorded near the southwestern and southern boundaries of the park. Given the presence of suitable habitats in the peripheral areas of the park, it was hypothesized that the species may occur within the park boundaries. Therefore, the primary objective of this study was to assess the potential occurrence of *E. quatuorlineata* within the park. Field surveys were conducted at 13 selected sites along the peripheral areas of the park between April and July in 2024 and 2025. Sites were chosen based on previously documented records in the vicinity of the park and the presence of suitable habitats. During the surveys, *E. quatuorlineata* was recorded within the park for the first time, confirming its presence in suitable habitats along the park's peripheral areas. In addition, two reptile species not previously documented in the park were recorded as well: the European glass lizard (*Pseudopus apodus* Pallas, 1775) and the Mediterranean house gecko (*Hemidactylus turcicus* Linnaeus, 1758). These findings expand the known reptile fauna of Učka Nature Park and provide valuable baseline data on the occurrence and distribution of these species. The results may also serve as a basis for future monitoring efforts, as well as for the development and implementation of targeted conservation measures for newly documented species such as *E. quatuorlineata*, given its degree of endangerment and legal protection in Croatia.