NAT. CROAT. | VOL. 32 | No 1 | 121-126 | ZAGREB | June 30, 2023

original scientific paper / izvorni znanstveni rad
DOI 10.20302/NC.2023.32.7

EXPANSION OF THE SHARP-SNOUTED ROCK LIZARD (*DALMATOLACERTA OXYCEPHALA*) IN THE SOUTHERN PART OF THE ISLAND OF CRES

Tamás Tóth*[1,4], Nikolett Varga[4], János Gál[1] & Borbála Kocsis[2,3,4]

[1]University of Veterinary Medicine Budapest, Department of Exotic Animal and Wildlife Medicine, 1078 Budapest, István u. 2., Hungary

[2]Behavioural Ecology Research Group, Center for Natural Sciences, University of Pannonia, Veszprém, H-8210, Hungary

[3]ELKH-PE Evolutionary Ecology Research Group, University of Pannonia, Pf. 1158., H-8210 Veszprém, Hungary

[4]Budapest Zoo and Botanical Garden, P.O. Box 469, 1371 Budapest, Hungary

Tóth, T., Varga, N., Gál, J. & Kocsis, B.: Expansion of the sharp-snouted rock lizard (*Dalmatolacerta oxycephala*) in the southern part of the island of Cres. Nat. Croat., Vol. 32, No. 1, _____, 2023, Zagreb.

In 2005, a new lizard species, the sharp-snouted rock lizard (*Dalmatolacerta oxycephala*) appeared on the island of Cres, probably due to anthropogenic transfer. Before that, only the Dalmatian wall lizard (*Podarcis melisellensis*) had inhabited the town of Osor, where the new species was discovered. In areas where the two species live sympatrically, *P. melisellensis* is competitively superior to *D. oxycephala*; however, in Osor, *D. oxycephala* appeared in parts of the town where *P. melisellensis* had been present before. Since 2005, there has been no systematic survey to assess how the distribution of the two species has changed in Osor and, the aim of this study is to investigate how far *D. oxycephala* has spread and what happened to the distribution of the native *P. melisellensis* after the new species appeared. Here we show that in 16 years, the native Dalmatian wall lizard was outcompeted by the sharp-snouted rock lizard, and there was no observation of the two species together at the same locations. Despite the new species preferring high stone walls, specimens were also found on shorter stone walls alongside the road towards Lošinj. According to our findings, the further spread of the sharp-snouted rock lizard cannot be excluded in the upcoming years in Cres, which could negatively affect the native Dalmatian wall lizard, but further research is needed to reveal the causes of our observations and to monitor the changes in the distribution of the two species.

Keywords: Croatia, Cres, *Dalmatolacerta oxycephala*, expansion, *Podarcis melisellensis*

Tóth, T., Varga, N., Gál, J. & Kocsis, B.: Širenje oštroglave gušterice **(*Dalmatolacerta oxycephala*) na južnom dijelu otoka Cresa. Nat. Croat., Vol. 32, No. 1, _____, 2023, Zagreb.**

Tijekom 2005. na Cresu se pojavila za otok nova vrsta gušterice, oštroglava gušterica (*Dalmatolacerta oxycephala*), vjerojatno kao posljedica antropogenog prijenosa. Nova vrsta otkrivena je u gradu Osoru, kojeg je dotad naseljavala jedino krška gušetrica (*Podarcis melisellensis*). U područjima gdje obje vrste žive simpatrički, *P. melisellensis* je kompetitivno superiorna u odnosu na *D. oxycephala*; no u Osoru se *D. oxycephala* pojavila u dijelovima grada gdje je otprije bila prisutna *P. melisellensis*. Od 2005. nije bilo sustavnih istraživanja promjena u rasprostranjenosti obaju vrsta u Osoru; cilj ovog rada je stoga istražiti koliko daleko se raširila *D. oxycephala* i što se dogodilo s rasprostranjenošću domaće vrste *P. melisellensis* nakon pojave nove vrste. Pokazalo se da je nakon 16 godina oštroglava gušterica istis-

* corresponding author's e-mail: toth.tamas@univet.hu

nula domaću kršku guštericu, a dvije vrste nisu viđene zajedno na istim lokalitetima. Iako novopridošla vrsta preferira visoke kamene zidove, primjerci su također nađeni na nižim kamenim zidovima duž ceste prema Lošinju. Prema našim opažanjima ne može se isključiti daljnje širenje oštroglave gušetrice po Cresu, što bi moglo negativno utjecati na kršku guštericu, no potrebna su daljnja istraživanja koja bi obrazložila naše nalaze i kojima bi se dalje pratile promjene u rasprostranjenju obaju vrsta.

Ključne riječi: Hrvatska, Cres, *Dalmatolacerta oxycephala*, ekspanzija, *Podarcis melisellensis*

INTRODUCTION

The range of the sharp-snouted rock lizard, also called the sharp-headed lizard (*Dalmatolacerta oxycephala*), is limited to the eastern Adriatic coast from the southern part of the Croatian coast, through southern Bosnia, Herzegovina and Montenegro to northern Albania (Bischoff, 1981; Crnobrnja-Isailović & Džukić, 1997; Šunje *et al*., 2014). The northwesterly-most occurrence data of the species come from the vicinity of Zadar (Boulenger, 1916, 1920); however, according to Bischoff (1981), these reports were not confirmed. The closest reliable information concerning the northwesterly-most occurrence of this lizard species comes from around the Krka River (Bedriaga, 1886; Schreiber, 1912) and Sebenico (Šibenik) (Méhely, 1909). In addition to the indigenous distribution area of the species, there is also an introduced occurrence on the island of Cres in the northern Adriatic. Here, the species was first observed on the 26th of April 2005 in Osor, in the southern part of the island, where a total of three specimens were discovered on the high embankment walls of a small sea canal separating the islands of Cres and Lošinj (Tóth *et al*., 2006). At that time, Tóth *et al*. (2006) only observed this reptile on a small section of the high stone walls. In contrast, they only encountered the Dalmatian wall lizard (*Podarcis melisellensis*) on the rest of the wall and other parts of the settlement (previously unpublished data, Fig. 1). It is suggested that the sharp-snouted rock lizard was likely transported to the island by boat through a small harbour near the site at which it occurred (Sämann & Zauner, 2010; Dieckmann, 2017). Sämann & Zauner (2010), in 2009 and 2010, were able only to detect a total of 6–7 adult specimens on the harbour walls, while some young individuals could be seen in the periphery of the wall but could not be found in any other part of the town. According to Martina Podnar Lešić, Zagreb, pers. comm. in Šunje *et al*. (2014), in 2014, *D. oxycephala* was present just on the old town walls of Osor, without any evidence of further dispersal being found. But by 2016 Bringsøe (2019) had encountered the sharp-snouted rock lizard in several areas of the settlement, observing 25–30 specimens. In 2018, Geissler & Grabert (2019) found that the species was already occurring on a 200 m stretch of the old city wall, between the sea canal and the ruins of St. Peter's Church, where approximately 30 adult and subadult animals could be seen. The authors above also saw two juvenile individuals in Osor marketplace. In addition, according to Sämann & Zauner (2010) and Geissler & Grabert (2019), *D. oxycephala* and *P. melisellensis* occur syntopically in Osor, while Bringsøe (2019) stated that the former species was not found outside the walls of the settlement, and beyond that, just the latter taxon occurred everywhere. The aim of this study was to investigate systematically how far *D. oxycephala* has spread in Osor since its introduction and how the distribution of the native *P. melisellensis* changed since the presence of *D. oxycephala*.

METHODS

The entire settlement of Osor in Croatia, ranging 350 meters to the north-south and 250 meters to the east-west, was systematically searched for reptile species in two dif-

ferent years; first in 2005, when the first observation of *D. oxycephala* was recorded on the 26th and on the 31st of April (Tóth *et al*., 2006) and on the 26th and 27th of April 2021, when the survey focused just on *D. oxycephala* and *P. melisellensis*. In both years, the species of lizard and the location of the encounters were noted on a paper map. The number of individuals was not recorded. Data for the second survey were collected on two sunny days between 14:00–18:00 when both species were expected to be active (Scheers & Van Damme, 2002). All data were digitalized with QGIS Geographic Information System software (QGIS version 3.22.7; QGIS Development Team, 2022).

RESULTS AND DISCUSSION

In 2005, when *D. oxycephala* appeared in Osor for the first time, it was only present at the harbour at 3 locations, while *P. melisellensis* was present everywhere else in Osor at 44 locations (Fig. 1). In contrast, in 2021, except for the northern and eastern edges of the town, we could observe only *D. oxycephala* at 41 locations, sometimes three individuals in an area of 1 m^2 (Fig. 3), while *P. melisellensis* was observed at just 11 locations (Fig. 2). No evidence of a mixed occurrence of the two species was found anywhere, and the distributions of the two species were well separated. As the maps presenting the observations show, *D. oxycephala* has populated the entire settlement in 16 years and outcompeted *P. melisellensis*. These results contradict the pattern, which shows that where the two species live sympatrically, *P. melisellensis* is competitively superior to *D. oxycephala* (Arnold, 1987; Lailvaux *et al*., 2012; Vervust *et al*., 2009). In their field experiment on the Lastovo Archipelago, Croatia, Lailvaux *et al*. (2012) experienced interspecific aggression between the two sympatric species. *P. melisellensis* males behaved more aggressively towards *D. oxycephala* males when the latter were introduced to their territory, and this

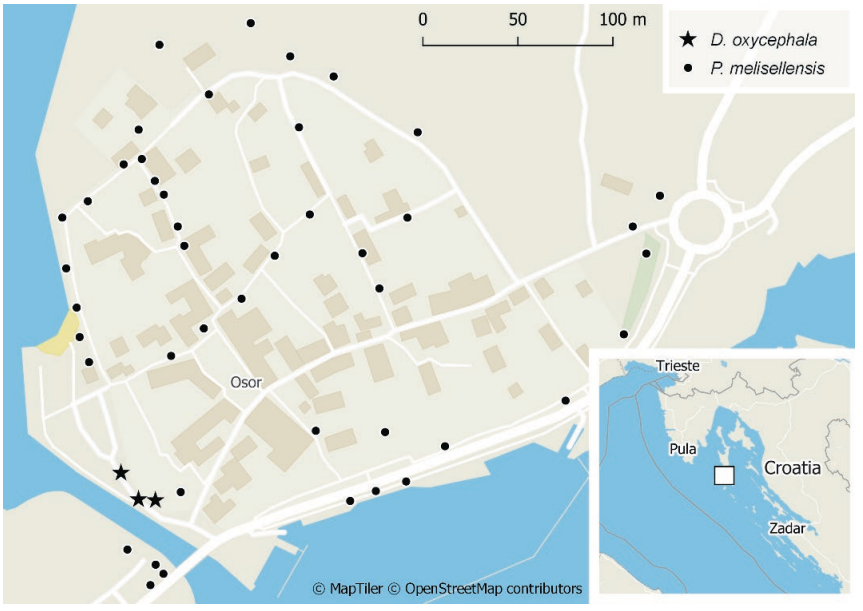

Fig. 1. Observations of the sharp-snouted rock lizard (*Dalmatolacerta oxycephala*) (black star) and the Dalmatian wall lizard (*Podarcis melisellensis*) (black dot) in Osor, 2005.

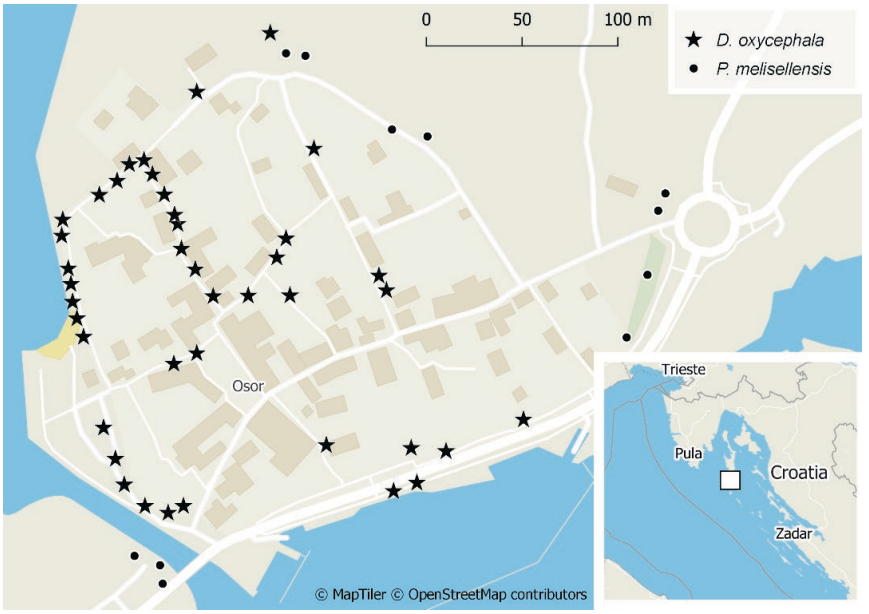

Fig. 2. Observations of the sharp-snouted rock lizard (*Dalmatolacerta oxycephala*) (black star) and the Dalmatian wall lizard (*Podarcis melisellensis*) (black dot) in Osor, 2021.

Fig. 3. In Osor, more than one sharp-snouted rock lizard (*Dalmatolacerta oxycephala*) can be observed in an area of 1 m^2 at a time (Photo: N. Varga).

was also true when they reversed the situation and introduced *P. melisellensis* males into the territory of *D. oxycephala* males. Interestingly, they also found that the Dalmatian wall lizards were significantly more aggressive to sharp-snouted rock lizards than to their male conspecifics. Their result showed that aggression could occur even when no breeding competition existed (Lailvaux *et al*., 2012). Vervust *et al*. (2009) found a similar pattern in their Lastovo Archipelago Nature Park survey. Here, the two species occur syntopically, and the sharp-snouted rock lizard is competitively inferior to the Dalmatian wall lizard. They revealed that *D. oxycephala* lives on the periphery in areas where the two species occur together. On small islands, *D. oxycephala* prefers barren, rocky, harsh

habitats in order to avoid competition with *P. melisellensis*. Even here, the authors observed that individuals were being chased by Dalmatian wall lizards and Italian wall lizards (*Podarcis sicula*). Vervust *et al*. (2009) also noted that the sharp-snouted rock lizards live in high density on two small and rocky islands where Dalmatian wall lizards are absent. They concluded that there is an interspecific competition between the two species, with the *Podarcis* species being more successful. It is important to note that none of the authors referenced (Lailvaux *et al*., 2012; Vervust *et al*., 2009) mentioned whether their work was conducted in a natural habitat or in an urbanised area; the only mention was from the field study of Lailvaux *et al*. (2012), who performed their experiment on the roadside, in the territory of the lizard species being investigated. In their work, Kolodziej & Prokosch (2018) cited the remark of M. Schweiger, according to whom the sharp-snouted rock lizard was expanding mainly along the stone wall of the quay in the city. This statement is aligned with other authors' opinions (Arnold, 1987; Hill 2009; Sämann & Zauner, 2010), who believed that this reptile used only vertical stone walls, while *P. melisellensis* is mostly ground-dwelling, preferring areas with vegetation. Much of the available literature reported that perhaps the sharp-snouted rock lizard was best adapted to the climbing lifestyle of European lizard species that live on rocks, stone walls and vertical places with little vegetation (Bischoff, 1984; Dieckmann & Dieckmann, 2010; Dieckmann, 2017; Šunje *et al*., 2014). This adaptation can be the outcome of competition with lacertid lizards in the Mediterranean area, which results in the dominant species occupying the more preferable, vegetated, horizontal microhabitats, while the subordinate species is forced to live on vertical, rocky, barren and less vegetated microhabitats (Arnold, 1987; Hardin, 1960). By contrast, Arnold (1987) pointed out that, in communities of small lacertid lizards in the Mediterranean part of the Balkan peninsula, species spatial distribution is primarily shaped by the structure of the microhabitats. Moreover, Capula & Luiselli (1994) analysed niche partitioning among three Mediterranean lacertid lizard species. They concluded that the qualitative composition of the Mediterranean lizard community is shaped by the ecological requirements of species rather than by their interspecific interactions, in this case, their competition. Our results showed that *D. oxycephala* is spreading in the settlement where artificial walls and vertical surfaces dominate the landscape. This environment could be more advantageous for *D. oxycephala* than for *P. melisellensis*. Bringsøe (2019) called it questionable whether the sharp-snouted rock lizard could reach the surrounding natural habitats or the island of Lošinj through the canal. Although the lack of high stone walls may make it difficult for the species to expand further, we have also found some specimens on the 30–50 centimetre tall rocky retaining wall along the main road between Cres and Lošinj on the southern edge of Osor, proving the adaptability of this reptile. According to Šunje *et al*. (2014), *D. oxycephala* is able to maintain high genetic and morphological variation, which can help the species spread to new niches in the event of the absence of other species.Thus in our opinion, it is possible, that *D. oxycephala* will expand further in the area over time, although future research is needed to reveal the process, its extent and cause.

ACKNOWLEDGEMENTS

We would like to acknowledge the financial help of the Budapest Zoo & Botanical Garden to support the field trip to Osor. Furthermore, we are grateful to Péter Kertész for his help in creating the maps. We would also like to thank the anonymous reviewers for helping improve the manuscript.

Received September 3, 2023

REFERENCES

Arnold, E.N., 1987: Resource partition among lacertid lizards in southern Europe. Journal of Zoology **1**, 739–782. https://doi.org/10.1111/J.1096-3642.1987.TB00753.X

Bedriaga, J., 1886: Beiträge zur Kenntnis der Lacertiden-Familie (Lacerta, Algiroides, Tropidosaura, Zerzumia und Bettaia). Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft, Frankfurt am Main **14**, 1–427.

Bischoff, W., 1981b: *Lacerta oxycephala* Duméril and Bibron, 1839 – Spitzkopfeidechse. In: Böhme, W. (Ed.): Handbuch der Reptilien und Amphibien Europas. Band 1. Echsen (Sauria) II. Aula-Verlag Wiesbaden. 301–317.

Bischoff, W., 1984: *Lacerta oxycephala* Duméril und Bibron 1839 –Spitzkopfeidechse. In: Böhme, W. (Hrsg.): Handbuch der Reptilien und Amphibien Europas; Band 2/I, Echsen II (*Lacerta*). Aula-Verlag Wiesbaden, S. 301–317.

Boulenger, G.A., 1916: On the lizards allied to Lacerta muralis, with an account of Lacerta agilis and Lacerta parva. Transactions of the Zoological Society of London **21**, 1–105.

Boulenger, G.A., 1920: Monograph of the Lacertidae. Trustees British Museum, London, **1**, 352.

Bringsøe, H., 2019: Dalmatolacerta oxycephala eating a stink bug on the island of Cres, Croatia, along with other ecological notes. Pod@rcis **10**, 35–38.

Capula, M. & Luiselli, L., 1994: Resource partitioning in a Mediterranean lizard community. Bolletino di Zoologia **61**, 173–177.

Crnobrnja-Isailović, J. & Džukić, G., 1997: *Lacerta oxycephala* Dumeril & Bibron 1839. In Gasc J-P, Cabella A, Crnobrnja-Isailovic J, Dolmen D, Grossenbacher K, Haffner P, Lescure J, Martens H, Martínez-Rica JP, Maurin H, Oliveira ME, Sofianidou TS, Veith M & Zuiderwijk A (eds): Atlas of Amphibians and Reptiles in Europe. Societs Europaea Herpetologica & Muséum National d' Histoire Naturelle (IEGB/SPN), Paris, 252–253.

Dieckmann, M., 2017: Die Kvarner-Bucht. Eine Schnittstelle zwischen den Ökosystemen Europas. Elaphe **26**, 26–33.

Dieckmann, M. & Dieckmann, K., 2010: Die mythischen Inseln: Cres und Lošinj. Draco **11**, 40–53.

Geissler, P. & Grabert, M., 2019: New herpetofaunal data from Cres Island, Croatia. Natura Croatica **28**, 161–165. https://doi.org/10.20302/NC.2019.28.14

Hardin, G., 1960: The competitive exclusion principle. Science 131,1292–1297. https://doi.org/10.1126/science.131.3409.1292

Lailvaux, S.P., Huyghe, K. & Van Damme, R., 2012: Why can't we all just get along? Interspecific aggression in resident and non-resident Podarcis melisellensis lizards. Journal of Zoology **288**, 207–213. https://doi.org/10.1111/j.1469-7998.2012.00943.x

Kolodziej, K. & Prokosch, P., 2018: Nord-Kroatien – Eine feldherpetologische Fotosafari. Elaphe **27**, 40–49

Méhely, L., 1909: Materialien zu einer Systematik und Phylogenie der Muralis-ähnlichen Lacerten. Annales historico-naturales Musei nationalis Hungarici **7**, 409–621.

QGIS Development Team, 2022: QGIS geographic information system. Open Source Geospatial Foundation Project. http://qgis.osgeo.org

Sämann, J. & Zauner. J., 2010: Über eine eingeschleppte Population der Dalmatinischen Spitzkopfeidechse, *Dalmatolacerta oxycephala* (Duméril and Bibron, 1839) auf Cres (Kroatien). Die Eidechsen **21**, 81–83.

Scheers, H. & Van Damme, R., 2002: Micro-scale differences in thermal habitat quality and a possible case of evolutionary flexibility in the thermal physiology of lacertid lizards. Oecologia **132**, 323–331. https://doi.org/10.1007/S00442-002-0970-0

Schreiber, E., 1912: Herpetologia europaea (2. Aufl.). Jena (Fischer), pp 960.

Šunje, E., Bird, D.R. & Jelić, D., 2014: Distribution and conservation of *Dalmatolacerta oxycephala* (Duméril and Bibron, 1839) in Croatia and Bosnia and Herzegovina. Hyla **2**, 20–33.

Tóth, T., Grillitsch, H., Farkas, B., Gál, J. & Sušić, G., 2006: Herpetofaunal data from Cres Island, Croatia. Herpetozoa **19**, 27–58.

Vervust, B., Grbac, I., Brecko, J., Tvrtković, N. & Van Damme, R., 2009: Distribution of reptiles and amphibians in the nature park Lastovo archipelago: possible underlying biotic and abiotic causes. Natura Croatica **18**, 113–127.