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New records of *Darevskia praticola* at the northern limit of its distribution range in Romania

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Abstract

In the summer of 2021 we identified three new distribution localities of *Darevskia praticola* north of the Mureș River, and one locality south of the river. The habitats populated by *D. praticola* (broad-leaved forest with wet areas) and the altitude (175–245 m) of the new records are typical for this species. Nevertheless, *D. praticola* had not been recorded in 12 other localities with similar conditions from an area previously considered suitable for this species. Thus, *D. praticola* may be slowly expanding from a bridgehead north of the Mureș River, occupying new favorable habitats. Probably, *D. praticola* recently crossed the Mureș River, possibly on a bridge, or with the timber trucks which exploit the woods from both sides of the river.

Key Words

barrier, distribution, introduction, range limit, suitability, water course

Species range limits are very dynamic, but their evolution is not properly studied in nature, despite their importance (for a review see Sexton et al. 2009). In this context, understanding range limits can offer information on species evolution (Bridle and Vines 2007; Gaston 2009). *Darevskia praticola* (Eversmann, 1834) reaches its northern distribution limit in Romania (Agasyan et al. 2009). Generally, this species has a very fragmented distribution range, as it is rather rare in central and southern Europe (Agasyan et al. 2009). In Romania *D. praticola* is rare with records from southern and western Romania (Sos et al. 2012; Cogălniceanu et al. 2013). Although western Romania seems suitable for *D. praticola* (Ćorović et al. 2018), the species had not been mentioned until recently north of the Mureș River (Gaceu and Josan 2013). Previously, the Mureș River seemed to be the northernmost barrier which *D. praticola* had managed to reach (Bogdan et al. 2011; Gaceu and Josan 2013), and only two locations from this area were known from the literature (Cogălniceanu et al. 2013). But in recent years, this species had been recorded north of the Mureș River in two new localities (Toc and Ilteu) (Gaceu and Josan 2013), in an area that seems to be most suitable for this species in Romania (Ćorović et al. 2018), as it prefers broad-leaf forests with wet habitats (Fuhn and Vancea 1961). Thus, we hypothesized that this species is actually better represented north of the Mureș River, but the region had simply not been sufficiently studied. This assumption is supported by the recent identification of new distribution records of *D. praticola* in the country (Iftime and Iftime 2019; Sucea 2019; Covaciu-Marcov et al. 2020) including some that filled large gaps in its distribution (Sos et al. 2012; Maier and Cadar 2021). Also, recent studies have identified new distribution localities at the range limit of other lizard species (Crnobrnja-Isailović et al. 2020).

We obtained data from our own fieldwork performed in the year 2021 (three days: June 30th, July 4th and 11th). We investigated the region surrounding the two localities where *D. praticola* was recorded north of the Mureș River (Toc and Ilteu), a region with favorable habitats for this species (Gaceu and Josan 2013). We also studied some areas south of the Mureș River, on the other side

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Figure 1. Representative picture of *Darevskia praticola* from Săvârșin N-E, Romania.

of the river from the previously known localities (Gaceu and Josan 2013). Totally we investigated 16 localities on both sides of the Mureș River. The lizards were directly observed, and the individuals were not disturbed. We walked transects of different lengths through habitats considered characteristic for this species, namely broad-leaved forests with wet areas (e.g., Fuhn and Vancea 1961; Covaciu-Marcov et al. 2009; Gherghel et al. 2011; Gaceu and Josan 2013) as well as through less typical habitats. We spent approximately half an hour in each location, depending on the habitats. Observations were documented with photographs of individuals (when possible) and surrounding habitats. We recorded coordinates and altitudes for all observations.

Darevskia praticola (Fig. 1) was identified in three new locations north of the Mureș River (Cuiaș, Săvârșin S-E, Săvârșin N-E), and one new location south of the river (Căprioara) (Table 1, Fig. 2). We searched for *D. praticola* in 12 other localities north of the Mures River, but did not encounter it (Zam, Micănești, Petriș, Temerești, Troaș, Pârnești, Hălăliș, Stejar, Selište E, Selište V, Săvârșin V, Săvârșin railroad station). All the new *D. praticola* distribution records are located in Arad County, at altitudes between 175 and 245 m. They are wooded areas (Fig. 3), covered by beech, oak, and hornbeam forests, in varying proportions depending on the habitat.

The habitats north of Mureș River are wetter, as they border with small brooks. South of Mureș River the habitat is drier – a forest edge on a hilltop. In all cases *D. praticola* was observed in areas with abundant herbaceous vegetation, usually wet, with fallen logs and thick leaf litter layer. At Cuiaș and Săvârșin N-E, *D. praticola* was the only lizard species present, while at Savârșin S-E it was identified alongside *Lacerta viridis* (Laurenti, 1768) and *Podarcis muralis* (Laurenti, 1768), and at Căprioara alongside *L. viridis*.

Table 1. The new distribution records of *Darevskia praticola* in western Romania.

Locality	Position	Geographic coordinates	Altitude	No. individuals
Cuiaș	North of Mureș	46.010555, 22.296112	233	12
Săvârșin S-E	North of Mureș	46.016111, 22.24	175	3
Săvârșin N-E	North of Mureș	46.028611, 22.260833	245	2
Căprioara	South of Mureș	46.028611, 22.260833	210	3

The three new distribution records north of the Mureș River are located at a maximum distance of 7 km to the west of the two previously known localities (Gaceu and Josan 2013), but they all belong to the same mountain ridge. The ridge is surrounded to the west and to the east by two narrow valleys with open areas and agricultural fields, which are unfavorable habitats for this species related with forests (Fuhn and Vancea 1961; Agasyan et al. 2009; Gherghel et al. 2011). Nowadays *D. praticola* is likely limited to this ridge. *Darevskia praticola* does not appear to be advancing north even in its occupied areas north of the Mures River, as it was only recorded in a small strip of a few kilometers wide parallel to the

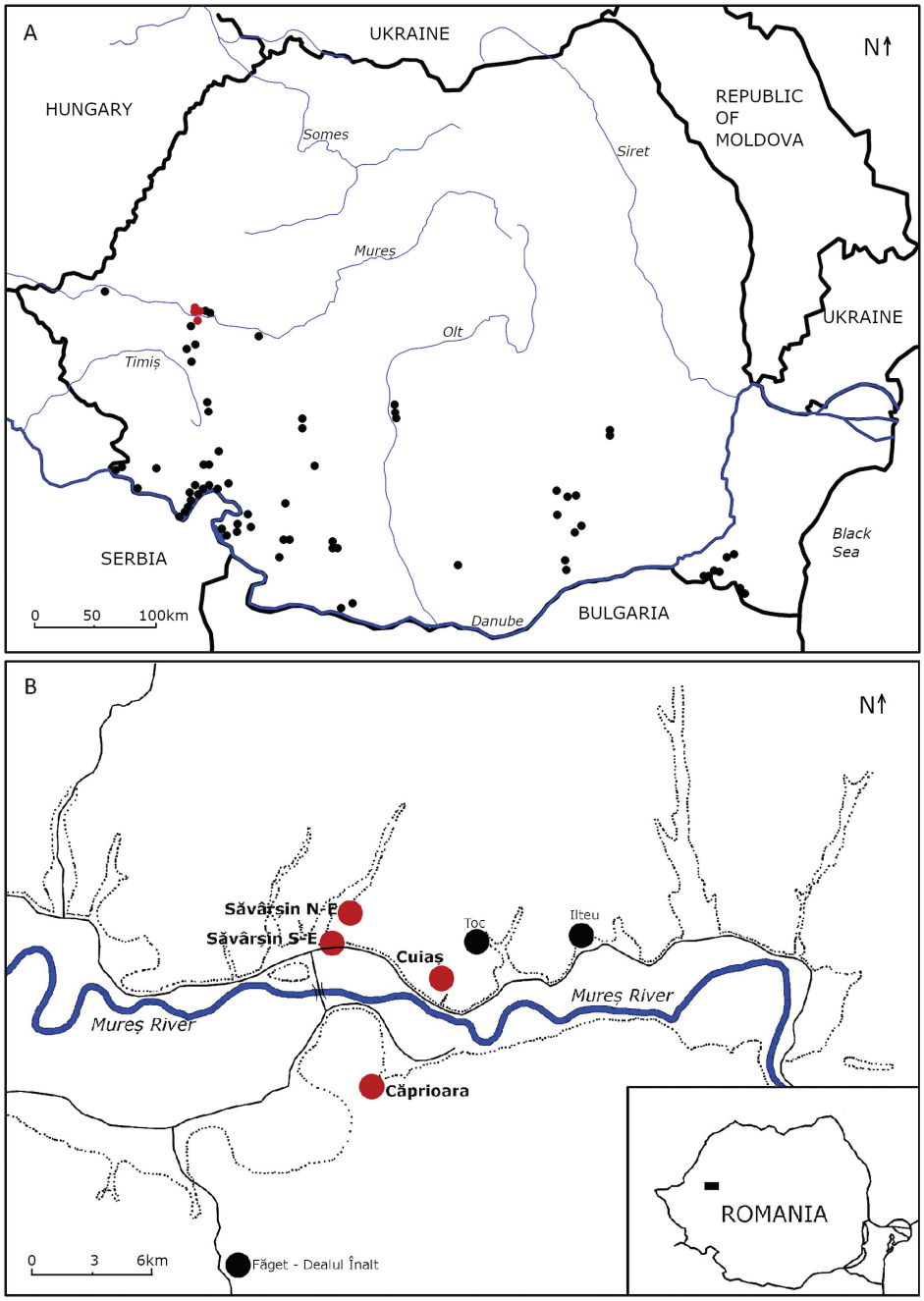

Figure 2. Distribution of *Darevskia praticola* north of Mureș River, Romania. **A.** New distribution records (red circles) related to the previous distribution records (black circles) in Romania (after Bogdan et al. 2011, 2014; Cogălniceanu et al. 2013; Gaceu and Josan 2013; Covaciu-Marcov et al. 2020; Maier and Cadar 2021) (continuous black line – country border); **B.** Detailed map of the new distribution records north of Mureș River, Romania (black circle – previous records (Gaceu and Josan 2013; Bogdan et al. 2014), red circle – new distribution records, continuous black lines – roads, dotted lines – forest limits).

river. Moreover, the highest number of individuals was observed in the southernmost one of the localities north of the Mureș River (Cuiaș). As the distance from the Mureș increases, the number of individuals decreases, although the region further north seems equally suitable (Ćorović et al. 2018). This raises questions not only about how, but also about when *D. praticola* reached the area north of the Mureș River. Our new data suggest two possible scenarios to explain *D. praticola`s* presence north of the Mureș River: 1. it arrived recently in the region and now expands its range, 2. the populations north of Mureș River are relicts of a wider distribution range from the past.

Range limit populations could also represent relicts of a larger distribution in the past, restricted only to islands of favorable habitats (Hampe and Petit 2005; Cassel-Lundhagen 2010). This could be true for *D. praticola* populations in western Romania as well, as they were previously considered to have reached the area in the warmer period of the postglacial (Bogdan et al. 2011; Gaceu and Josan 2013). Other reptile species such

Figure 3. Habitat of *Darevskia praticola* from Săvârșin N-E, Romania.

as *Vipera ammodytes* (Linnaeus, 1758) reached their northern range limit in this area, but their distribution in the area seems limited by climatic factors (Ghira 2016). Nevertheless, the suitability of the region populated by *D. praticola* (Ćorović et al. 2018) advocates against this point of view, supporting its status as a recent immigrant to the region. Moreover, *V. ammodytes* is distributed some tens of km north (Cogălniceanu et al. 2013; Ghira 2016). Thus, nowadays *D. praticola* occupies only a small bridgehead north of the Mureș River, from where it slowly spreads to the west, east, and north, following the forests` boundaries. This assumption is supported also by earlier studies on the region`s herpetofauna (e.g., Ghira et al. 2002; Covaciu-Marcov et al. 2005), which did not mention *D. praticola* north of the Mureș River. Thus, it is possible that the species recently occupied this bridgehead north of the river. This also disproves the hypothesis that the isolated populations from Poiana Ruscă Mountains are relicts of a former larger distribution in the warmer period of the postglacial (Bogdan et al. 2011). This apparent isolation rather may be the result of insufficient studies.

The new locality south of the Mureș River (Căprioara) represents a connection between the area occupied by *D. praticola* north of the river and the area south of the river, in Lipova Hills (Bogdan et al. 2014). Located within a few km of the Mures River, Căprioara is less than 5 km away from one of the populations north of the river, and approximately 10 km away from the nearest southern population in Făget – Dealul Înalt. This population offers insights as to how the species reached the Mureș River, proving the existence of a continuous range in the region, but does not explain how it passed the river. Obviously, there are other larger hydrographic barriers in the distribution range of this species (even the Danube), and nevertheless, *D. praticola* has passed them. Thus, it is quite possible that in a dry year the species crossed to the north of the river in an area where the forests from both sides of the river are very close to each other, as it was suggested previously (Gaceu and Josan 2013). At the same time, a passage mediated by human activity cannot be ruled out, because in the region there is a bridge over Mureș River, at Săvârșin. The bridge could have been used both directly and indirectly, as there are numerous timber deposits and wood logging platforms on both sides of the river. It is possible that the trucks transporting logs from the southern shore of Mureș River populated by *D. praticola* have brought along some individuals, which continued to spread from the timber deposits. Lizard species introduced by human activity are known to exist in both Romania (Covaciu-Marcov et al. 2006; Strugariu et al. 2008; Gherghel et al. 2009; Iftime and Iftime 2021) and other regions (e.g., Oliveira et al. 2018; Santos et al. 2019; Deimezis-Tsikoutas et al. 2020; Oskyrko et al. 2020). If this supposition is real, this will be a case when a forest species would benefit exactly from those activities which reduced its habitats. Nevertheless, the answer is probably the simpler one and *D. praticola* has passed the Mureș River on its own, as it had previously done with other larger rivers.

In conclusion, the bridgehead that *D. praticola* occupies north of Mureș River seems to be expanding, or at least our understanding of its size is increasing. The fact that it was identified in only a small part of its suitable area (Ćorović et al. 2018) while neighboring localities consist of similar habitats (perhaps even identical), indicates that the species has very recently arrived in the region. Thus, nowadays *D. praticola* may be at the beginning (or during) of an expansion in the region, which seems to be facing anthropogenic barriers (at least at the moment). The region north of the Mures River is the extreme north-western distribution range limit of *D. praticola*, regardless of its time of arrival to the region. Thus, any new information about *D. praticola* in the region is useful, not only because this is a protected species (Anonymous 2007), but also to advance our understanding of range limit dynamics in a changing world, both climatically and on the verge of a biodiversity catastrophe (see Schrödl 2019).

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