

# Systematics and distribution of the genus *Darevskia* Arribas, 1997 on the Iranian plateau: a review

## Abstract

Two hundred ninety species of lacertids are presently placed in from 24 to about 30 genera. Most of the genera that have been recognized appear to be clades on the basis of their morphology, with the exception of the paraphyletic central African *Adolfus* and *Lacerta sensu lato* of Europe, Asia and northwest Africa. Traditionally, species boundaries are only based on morphological and appearance differences, and this approach is qualitatively or quantitatively investigated. At the same time, several new and modern methods can be used for a more realistic and logical investigation in the determination of species boundaries. Molecular analysis has provided more evidence about lacertids' kinship relationships. These methods work particularly well when dealing with cryptic species or species complexes. Where there is a high general and morphological similarity between the species of a population. The rock lizards, genus *Darevskia* Arribas, 1999, are such species, as many of its members have few distinctive and diagnostic morphological features. Biodiversity and species diversity assessment allows for more precise determination of the causes of many biological processes. These processes involve complex patterns that are especially observed in areas with high species diversity. Anatolia and Caucasus regions are two important geographical regions where *Darevskia* species live, which have complex morphology and unique speciation. *Darevskia valentini* and *D. rudis* are two widely distributed species of this genus, both of which have controversial taxonomy. In this study, an attempt has been made to summarize the species available in Iran.

**Keywords:** lizards, distribution, Iranian plateau, Asia

Volume 7 Issue 2 - 2024

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**Received:** April 19, 2024 | **Published:** June 14, 2024

## Introduction

Systematic knowledge is a field and biological science that deals with the distribution, evolutionary patterns and processes related to the biodiversity of life,<sup>1,2</sup> one of the main goals of which is to discover and describe new species and investigate phylogenetic and evolutionary relationships among them.<sup>3</sup> Lizards classified in the family Lacertidae are widely distributed in most regions of Eurasia and the entire African continent. The distribution range of this family continues to the east to Malaysia and Indonesia. These lizards do not exist in New Guinea and Australia. These lizards are not present in Madagascar either. Currently, about 259 species of lacertid lizards have been classified into 24 genera.<sup>4-9</sup> Despite this wealth of knowledge and the efforts of scientists, the phylogenetic and evolutionary relationships of these genera are still not precisely known.<sup>10</sup> At the family level, these lizards are morphologically well-studied, and the clades seem to be relatively well-studied.<sup>11</sup> Lacertids are small or medium sized lizards. The size of most species is less than 9 cm, except for the tail. Although the largest living species, *Gallotia stehlini*, reached 46 cm in length, some extinct forms were larger still. They are mainly insectivorous.<sup>12</sup> Species of lacertids found in Europe and the Mediterranean region mainly live in forest and scrub habitats.<sup>12</sup> *Eremias* and *Ophisops* species have replaced the mentioned species in the grassland and desert habitats of Asia. African species live in dry areas. *Holaspis* species are among the few arboreal lacertids, and two of them, *Holaspis guentheri* and *Holaspis laevis*, although they have a weak appearance, they use their wide tail and wide body as an aerofoil.<sup>13</sup> *Merole anchietae* is one of the few wall lizards that eat seeds regularly - the perfect food for the geckos of the harsh Namib Desert. Lacertids are remarkably similar - slender bodies and long tails - but have a wide variety of patterns and colors, even within the same species. The scales on their heads are large, often containing osteoderms. These scales are small and grainy

on the back and rectangular on the bottom. Most species are sexually dimorphic, with males and females having different patterns.<sup>12</sup> Lacertids are thought to have originated in Europe because their earliest fossils have been found in this region, alongside fossils of their sister group, the extinct Eolacertidae.<sup>14</sup> Fossils possibly attributed to lacertids are known from the Paleocene. Although the oldest definitive lacertid is known from the early Eocene (Ypresian) of Mutigny, around Paris.<sup>15</sup> Lacertids dispersed in Asia in the early Oligocene.<sup>16</sup> The time of colonization of Africa is uncertain, ranging from Eocene to Miocene.<sup>17</sup> *Darevskia* is a genus of wall lizards in the Lacertidae family. The species of this genus are native to the Caucasus, Iran and Turkey and live in forest and grassland habitats with numerous rocky outcrops. *Darevskia* is a genus of small lizards that live in a variety of habitats from rocks to grasslands and include 27 introduced species so far.<sup>18</sup> The most widespread species is *Darevskia praticola*,<sup>19</sup> which has a disjunct distribution and is found throughout the Caucasus, from the coast of the Black Sea to northwestern Iran and the eastern Balkans. Unlike many species of this genus, *D. praticola* is mainly terrestrial and is restricted to areas with lush vegetation, pastures, and meadows in broad-leaved forests.<sup>20</sup> The rock lizard genus *Darevskia* Arribas, 1997 was the first group of terrestrial vertebrates in which obligate parthenogenesis was discovered.<sup>21</sup>

The species of *Darevskia* in the Iranian Plateau are listed in Table 1.

## Systematic account

Order Squamata Opper, 1811

Family Lacertidae Opper, 1811

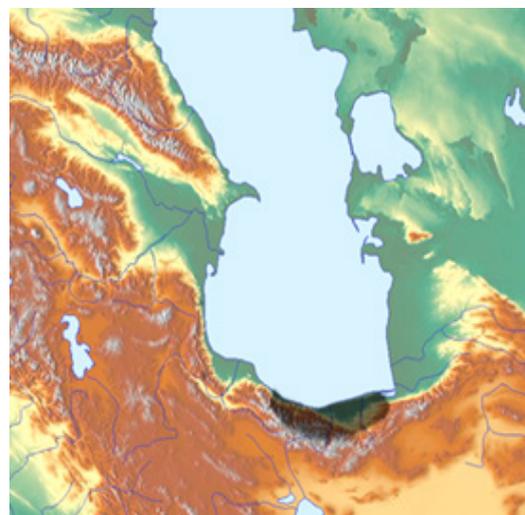
Genus *Darevskia* Arribas, 1997

**Table 1** Checklist of genus *Darevskia* Arribas, 1999 in the Iranian plateau (Safaei-Mahroo et al, 2015)<sup>30</sup>

Species	Distribution
<i>Darevskia caspica</i> Ahmadzadeh et al, 2013 <sup>22</sup>	Mazandaran
<i>Darevskia chlorogaster</i> (Boulenger, 1908)	Ardabil, Gilan and Mazandaran
<i>Darevskia defilippii</i> (Camerano, 1877)	Tehran, Alborz, Mazandaran and Gilan
<i>Darevskia kamii</i> Ahmadzadeh et al, 2013 <sup>22</sup>	Golestan
<i>Darevskia kopetdaghica</i> Ahmadzadeh et al, 2013 <sup>22</sup>	North Khorasan
<i>Darevskia raddei</i> (Boettger, 1892) <sup>25</sup>	
<i>D. r. raddei</i> (Boettger, 1892) <sup>26</sup>	East Azarbaijan and Ardabil
<i>D. r. chaldoranensis</i> Rastegar-Pouyani et al, 2012 <sup>25</sup>	West Azarbaijan
<i>D. r. vanensis</i> (Eiselt et al, 1993) <sup>26</sup>	West Azarbaijan
<i>Darevskia schaeckeli</i> Ahmadzadeh et al, 2013 <sup>22</sup>	Tehran, Mazandaran and Golestan
<i>Darevskia steineri</i> (Eiselt, 1995) <sup>26</sup>	Golestan
<i>Darevskia praticola</i> (Boettger, 1892) <sup>25</sup>	
<i>D. p. praticola</i> (Eversmann, 1834) <sup>19</sup>	
<i>D. p. hyrcanica</i> Tuniyev et al, 2011 <sup>27</sup>	Ardabil and Gilan
<i>D. p. loriensis</i> Tuniyev et al, 2013 <sup>31</sup>	
<i>Darevskia valentini</i> (Eversmann, 1834) <sup>19</sup>	West Azarbaijan

### *Darevskia caspica* 2013<sup>22</sup>

The length of the snout to the denominator of this lizard is about 60 mm, and the length of its tail is 120 mm. The shape of the head is compact. The rostral scale is touching the nostril. The rostral scale is tangential to the frontonasal. The length of the frontonasal scale is less than its width. The slits between the prefrontal and frontal scales are somewhat straight. The postnasal scales are fragmented and separate. The supranasal scale is separated from the anterior loreal scale. A set of granules is incompletely present between the scales of the supraoculars and supraciliars (11 on each side of the body). There are 4 supralabial scales on each side of the body. The first supratemporal scale is large, and there are 3 small posttemporal scales on each side. 1-2 (on the left and right sides of the body, respectively) small scales between the masseteric and tympanic shields. 3 fine scales can be seen between the masseteric and supratemporal shields on each side. There are 45 dorsal scales transversely in the middle of the body. The back scales of this lizard are keeled. These scales are larger and sharper towards the tail. There are 7 collar sequins. There are 21 gular scales. 32 small scales can be seen between the ears and along them. The ventral plates are arranged in 26 transverse rows. 2 large symmetrical preanal scales can be seen. There are 15 femoral pores on each side. 29 scales can be seen under the fourth finger. The sides are light whitish with a black border.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 1 and 2. Based on valid data, the conservation status of this species is NE (Iacerta.de).

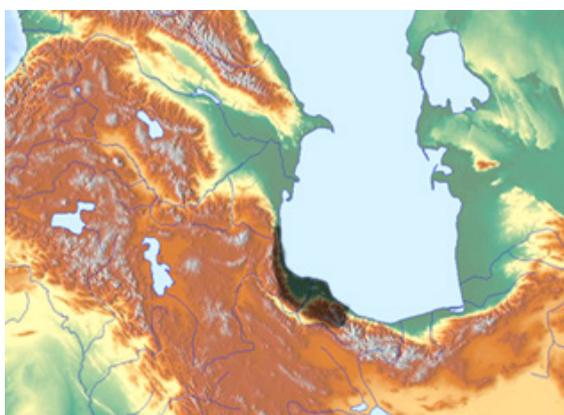
**Figure 1** *Darevskia caspica* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).**Figure 2** Distribution of *D. caspica* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).

### *Darevskia chlorogaster* (Boulenger, 1908)

Boulenger (1908) described this species of lizard with a serrated collar consisting of 7 to 9 scales. Back scales are hexagonal and strong. These scales are smoother and slightly smaller on the ventral side. 20-27 gular scales are seen. 3 or 4 numbers correspond to the length of the ventral plate and are located in 6 longitudinal series on the ventral surface. There are 44-50 scales in the middle of the body. 27-30 lamellar scales are seen under the fourth toe and there are 14-18 femoral pores. 43-51 scales are seen in the back area, which are located in the middle of the back area. 6 to 10 collar scales are seen. 20-25 gular scales can be seen between collar and maxillary scales. 27-37 small scales fill the space between the ears. 4-8 superciliary scales are seen. There are 3-16 supraciliary granules. 1-3 scales are seen between the masseteric and supratemporal shields. There are 2-4 scales between the masseteric and tympanic shields. 2-3 large preanal scales are seen. The rostral scale has reached the nostril. The maximum length of the snout in males is about 64 mm and in females 66.0 mm.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 3 and 4. Based on valid data, the conservation status of this species is LC (Iacerta.de).



**Figure 3** *Darevskia chlorogaster* (Boulenger, 1908) (reptile-database.reptarium.cz).



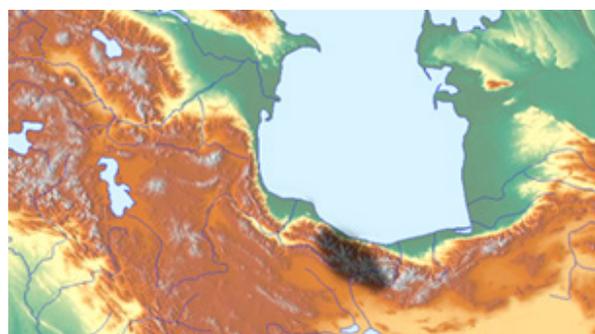
**Figure 4** Distribution of *D. chlorogaster* (Boulenger, 1908) (Lacerta.de/AS/Home.php).

### ***Darevskia defilippii* (Camerano, 1877)**

Camerano (1877) distinguishes this species from *Podarcis muralis* with a flatter and relatively shorter head. The marginal plates are narrower and the outer sides are divided and bordered by a number of small horizontal plates. The temporal region is covered by numerous small scales. The masseteric shield is sometimes absent and is usually closer to the tympanum than the posterior corner of the eye. There are 6 to 8 very small and short supralabial scales. The tympanum is relatively small. The back scales are sharp and round without edges, in other words, they are flat. The abdominal plates of this lizard are arranged in 6 longitudinal rows. There are 44 to 55 posterior scales in the middle of the back area. There are 7 to 14 collar scales. 30 to 42 small scales can be seen in the gap between the ears. 21 to 30 gular scales can be seen between maxillar and collar scales. There are 14 to 20 femoral pores. 25 to 30 scales can be seen under the fourth toe. 5 to 7 supraciliar scales are seen. There are 6 to 19 supraciliary granules. Up to 4 scales are seen between the masseteric and supratemporal shields. 1 to 6 scales are seen between the masseteric and tympanic shields. There are 2 large preanal scales in this lizard. The rostral scale is separate from the nostril. The maximum length of the muzzle in males is about 55 mm and in females about 54 mm.<sup>22</sup> A distribution map and an image of this species are shown below (Figure 5 and 6). Based on valid data, the conservation status of this species is LC (lacerta.de).



**Figure 5** *D. defilippii* (Camerano, 1877) (Lacerta.de/AS/Home.php).



**Figure 6** Distribution of *D. defilippii* (Camerano, 1877) (Lacerta.de/AS/Home.php).

### ***Darevskia kamii* 2013<sup>22</sup>**

The length of the muzzle to the denominator is about 70 mm. The tail was reconstructed and the head is seen as compact. The rostral scale is connected to the nostril. The rostral scale is separate from the frontonasal scale. The length of the frontonasal scale is less than its width. The gap between prefrontal and frontal is curved. On the left side, the supranasal is connected to the anterior loreal. A set of granules between the supraocular and supraciliary is incompletely present (6 on the right and 7 on the left). 4 supralabial scales can be seen on each side of the body. On each side of the body there is the first large supratemporal and 3 small posttemporals. There is a large masseteric shield on both sides of the body. 1-2 (right and left sides of the body, respectively) small scales between the masseteric and tympanic shields. 2 small scales are seen between the masseteric and supratemporal shields on each side. 45 dorsal scales can be seen transversely in the middle of the body. The dorsal scales are pointed and these scales become larger and more pointed toward the tail. There are 9 collar scales. 23 gular scales are seen. There are 33 small scales along the length between the ears. The ventral plates are arranged in 25 transverse rows. There are 2 large symmetrical preanal scales. 16 femoral pores can be seen on each side of the body. There are 28 scales under the fourth toe. The flanks are dark gray with a distinct whitish median row. The background color is olive gray.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 7 and 8. Based on valid data, the conservation status of this species is NE (lacerta.de).



**Figure 7** *D. kamii* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).



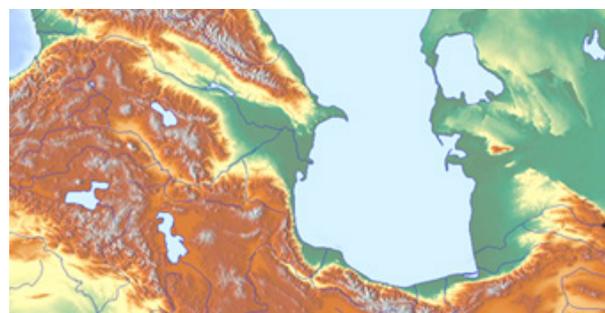
**Figure 8** Distribution of *D. kamii* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).

### ***Darevskia kopetdaghica* 2013<sup>22</sup>**

The length of the muzzle to the denominator is about 57 mm. The tail has been restored and the flat head is somewhat flat. The rostral scale is separate from the nostril. The rostral scale is separate from the frontonasal scale. The length of the frontonasal lobe is less than its width. The gap between prefrontal and frontal is somewhat smooth and straight. The supranasal scale is attached to the anterior loreal on the right side. There are a number of granules between the supraocular and supraciliary (10 can be seen on each side of the body). 4 supralabial scales can be seen on each side of the body. The first supratemporal is large and 3 small posttemporals are seen on each side of the body. A small masseteric shield is distinct on both sides of the body. There are 2 small scales between the masseteric and tympanic shields on each side of the body. There are 6 small scales between the masseteric and supratemporal shields on each side of this lizard's body. There are 46 dorsal scales along the length of the body. The dorsal scales are granular, round and smooth and become larger towards the tail. There are 10 collar scales. There are 26 gular scales. 34 small scales can be seen between the ears. Abdominal plates are located in 27 transverse rows. There are 2 large symmetrical preanal scales. 19 femoral pores can be seen on each side of the body. There are 29 scales under the fourth finger. The sides are brown.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 9 and 10. Based on valid data, the conservation status of this species is EN (lacerta.de).



**Figure 9** *D. kopetdaghica* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).



**Figure 10** Distribution of *D. kopetdaghica* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).

### ***Darevskia raddei*<sup>25</sup>**

The classification of the genus *Darevskia* and especially the species of the *D. raddei* complex is very complex and difficult, and the history of their analysis, review and classification proves this claim. In the first studies, all stone lizard populations of the Caucasus and Asia Minor were classified into a single species, *Lacerta saxicola*. This classification included many subspecies including *L. saxicola raddei*. By collecting more data, many of these subspecies were classified as separate species (including their own subspecies). Of course, there are still some differences of opinion. After further studies, some populations were renamed or assigned to another species or subspecies.<sup>21</sup> From a literary point of view, the specific name *raddei* is in honor of the German naturalist Gustav Radde.<sup>23</sup> *D. raddei* is found in the regions of Armenia, Azerbaijan, Georgia, Iran and Turkey (Reptarium.cz Reptile Database). *D. raddei* is found at elevations of 2,500–600 m (2,000–8,200 ft) in a variety of habitats, including forest, scrub, pasture, and rocky areas.<sup>24</sup> The following three subspecies of this species are recognized (Reptarium.cz Reptile Database). A distribution map and an image of this species are shown below, Figure 11 and 12. Based on valid data, the conservation status of this species is LC (lacerta.de).

*D. r. chaldoranensis* Rastegar-Pouyani et al, 2012

*D. r. raddei* (Boettger, 1892)

*D. r. vanensis* (Eiselt et al, 1993)



Figure 11 *D. raddei* (Boettger, 1892)<sup>25</sup> (Reptarium.cz Reptile Database).

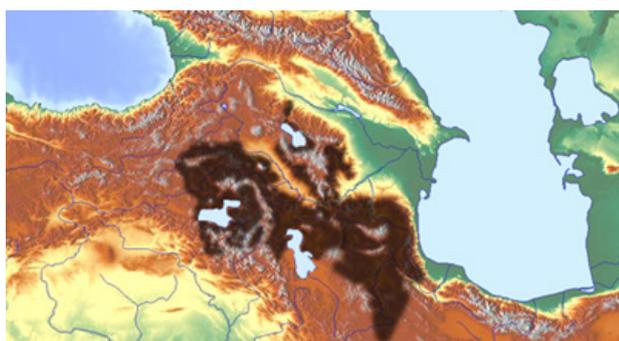


Figure 12 Distribution of *D. raddei* (Boettger, 1892 (Lacerta.de/AS/Home.php)).<sup>25</sup>

### *Darevskia schaeckeli* 2013<sup>22</sup>

The length of the muzzle to the denominator is about 55 mm. The tail is reconstructed and the head is somewhat widened. The rostral scale is separated from the nostril. The rostral scale is separate from the frontonasal scale. The length of the frontonasal is less than its width. The gaps between prefrontal and frontal are more or less straight and smooth. The supranasal is separated from the anterior loreal scales. A number of granules between supraoculars and supraciliars complete (11 on each side of the body). 4 supralabials are seen on each side of the body. There is the first large supratemporal and 4 small posttemporals on each side of the body. The masseteric shield is present in fragments on both sides of the body. 4 small scales between the largest scale in the mastic region and the tympanic shield on each side. There are 3 small scales between the largest scale in the masseteric region and the tympanic shield on each side of the body. There are 54 dorsal scales along the middle of the body. The dorsal scales are smooth and rounded and granular and become larger towards the tail. 10 collar scales are seen. There are 25 gular scales. 41 small scales can be seen along the gap between the ears. The ventral plates are arranged in 26 transverse rows. There are 2 large symmetrical preanal scales. There are 17 femoral openings on each side of the body. There are 28 scales under the fourth toe. The flanks are seen with a broad but indistinct grey-brown dorsal stripe. These bands become lighter towards the ventral plates. Bands are scattered and seen with small irregular bright spots. Abdomen is bluish white, the outermost plate in the ventral region changes color to reddish orange. Orange color is also present on the ventral surfaces of the limbs and the base of the tail.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 13 and 14. Based on valid data, the conservation status of this species is NE (lacerta.de).



Figure 13 *D. schaeckeli* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).

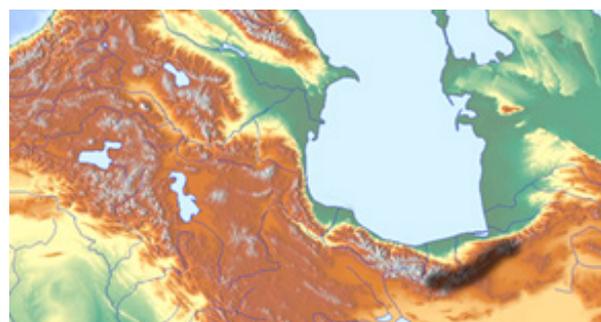


Figure 14 Distribution of *D. schaeckeli* Ahmadzadeh et al, 2013<sup>22</sup> (Lacerta.de/AS/Home.php).

### *Darevskia steineri*<sup>26</sup>

This species is actually a member of the *D. defilippii* complex with collar scales without teeth and smooth dorsal scales. The size of the massetericum is very small. There are small tibials and small temporals between the masseteric and tympanic/supratemporal shields. Fewer femoralia and marginalia are present compared to *D. defilippii*. There are 50 to 60 dorsal scales in the middle of the dorsal area. There are 7 to 10 collar scales. There are 36 to 49 small scales along the length between the ears. 23 to 30 gular scales are present from the corner between the maxillar scales to the collar. 15 to 21 femoral pores are present. There are 28 to 33 scales under the fourth toe. 5 to 6 supraciliar scales are seen. 10 to 12 supraciliary granules are present. There are 2 to 3 scales between the masseteric and supratemporal shields. There are 2 to 4 scales between the masseteric and tympanic shields. 2 large preanal scales are seen. The rostral scale is separate from the nostril. The maximum length of the muzzle to the denominator is 56.6 mm in males and about 61 mm in females.<sup>22</sup> A distribution map and an image of this species are shown below, Figure 15 and 16. Based on valid data, the conservation status of this species is DD (lacerta.de).



Figure 15 *D. steineri* (Eiselt, 1995)<sup>26</sup> (Lacerta.de/AS/Home.php).

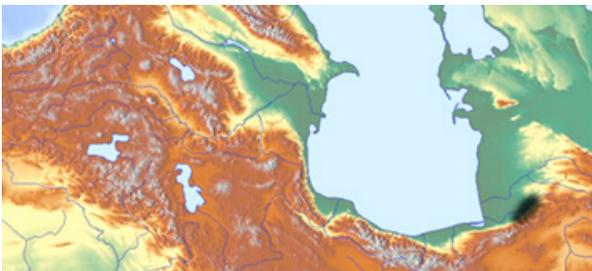


Figure 16 Distribution of *D. steineri* (Eiselt, 1995)<sup>26</sup> (Lacerta.de/AS/Home.php).

### *Darevskia praticola*<sup>25</sup>

The size of this species is small and different from other samples. The size of the width and height of the head is more. A decrease in the number of scales can be seen between the rows of femoral pores. These species are chocolate brown lizards. There is a bright stripe on each side of the body.<sup>27</sup> In this species, three valid subspecies are known (lacerta.de):

*D. p. praticola* (EVERSMANN, 1834)

*D. p. hyrcanica* TUNIYEV et al, 2011

*D. p. loriensis* TUNIYEV et al, 2013

A distribution map and an image of this species are shown below, Figure 17 and 18. Based on valid data, the conservation status of this species is NT (lacerta.de).



Figure 17 *D. praticola* (Boettger, 1892)<sup>26</sup> (Lacerta.de/AS/Home.php).

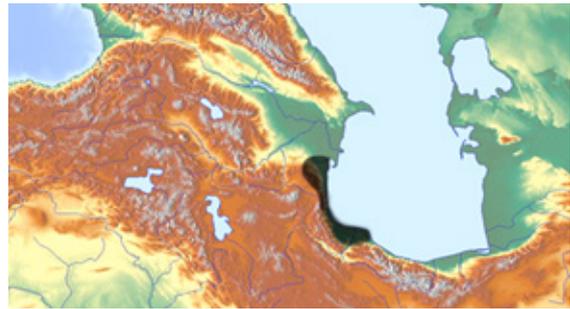


Figure 18 Distribution of *D. praticola* (Boettger, 1892)<sup>26</sup> (Lacerta.de/AS/Home.php).

### *Darevskia valentini*<sup>19</sup>

This species is known as Valentin's rock lizard and is a rock lizard that lives mainly in grasslands at altitudes between 1900 and 3110 meters. It is found in the Little Caucasus region, especially in northern Armenia, southern Georgia, northern Iran, and eastern Turkey.<sup>28</sup> This species is of interest due to its evolutionary role in the origin of several parthenogens.<sup>29</sup> The mating season of *D. valentini* started just after leaving hibernation shelters in early April and continued until early June, (NCBI data-base). A distribution map and an image of this species are shown below, Figure 19 and 20. Based on valid data, the conservation status of this species is LC (lacerta.de).



Figure 19 *D. valentini* (Eversmann, 1834)<sup>19</sup> (Lacerta.de/AS/Home.php).

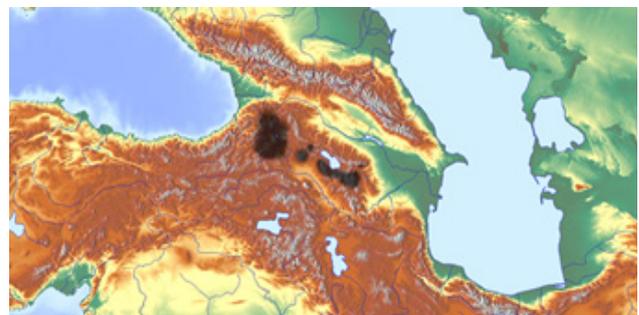


Figure 20 Distribution of *D. valentini* (Eversmann, 1834)<sup>19</sup> (Lacerta.de/AS/Home.php).

## Conclusion

According to the articles and sites used, *Darevskia* is a European and Caucasian genus of lizards. There are some species of this genus

in Iran. The presence of these species in the northern and northwestern regions of Iran is significant. But this genus in Iran has not yet been fully investigated and analyzed, and they should be investigated in order to know more precisely. Some species of this genus that have been reported from other countries may also exist in Iran. It is likely that the molecular investigations of the members of this genus will lead to the introduction of new species. It seems that the conducted studies are not complete and molecular and morphological studies should be done together to determine the status of this family. The distribution map of this genus should be drawn, and in my opinion, the distribution map of this genus is important for environmental and ecological investigations of this genus.<sup>30,31</sup>

## Acknowledgments

None.

## Funding

None.

## Conflicts of interest

The authors declare that there are no conflicts of interest.

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