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Fahimi's racerunner, a new species of the genus *Eremias* Fitzinger, 1834 (Sauria: Lacertidae) from Iran

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Abstract

We describe a new species of Lacertid lizard of the genus *Eremias* from the border of the northeastern side of Markazi Province to the western side of Tehran Province in Iran. *Eremias fahimii* **sp. nov.** is part of the *Eremias* subgenus (or morphotype) by virtue of lacking lateral fringes on the fourth toe, having movable eyelids, a lower nasal shield that rests on two supralabials, and ventral plates arranged in oblique longitudinal rows. It can be further differentiated from previously described species assigned to this morphotype by the absence of distinctly keeled upper caudal scales, gular scales that do not extend to the second inframaxiallary scales, shape and relative size of frontoparietals, parietal and parietals, scale counts and absence of lateral color ocellus. In addition, the molecular phylogeny of the most common Iranian racerunners including *Eremias fahimii* **sp. nov.** was studied using mitochondrial Cytochrome b (Cyt *b*) and 12S ribosomal RNA (12S) genes. Our results support the validation of the new species which depicts a sister group relationship to *E. persica*. Of the 20 species of *Eremias* known from Iran, *E. fahimii* **sp. nov.** is the seventh endemic species along with *E. andersoni*, *E. isfahanica*, *E. lalezharica*, *E. kavirensis*, *E. montana and E. papenfussi*. Despite the fact that up to now *E. fahimii* **sp. nov.** is only known from the type locality, it is highly probable that it also occurs in Tehran, Alborz, Qom, Qazvin and Zanjan Provinces due to topological characteristics and habitat similarities in these areas.

Key words: Reptilia, Iran, Markazi, Tehran, Endemic, *Eremias fahimii* **sp. nov.**

Institutional abbreviations: ZFMK, Zoologisches Forschungsmuseum Alexander Koenig (Bonn, Germany).

Introduction

Eremias Fitzinger, 1834 generally known as racerunner lizards, belongs to the family Lacertidae (Arnold *et al.*, 2007). The genus consists of 38 species that inhabit steppes and deserts of the Near East, Middle and Central Asia (Anderson, 1999; Uetz & Hallermann, 2020). They originated at about 9.9 million years ago and diversified between the Late Miocene and the Pleistocene (Guo *et al.,* 2011). Szczerbak (1974) considered *Eremias velox* the type species of genus *Eremias*, and the genus was subdivided into five distinct subgenera: *Eremias* Fitzinger in Wiegmann, 1834 (group *E. velox*), *Rhabderemias* Lantz, 1928 (group *Eremias scripta–Eremias lineolata*), *Ommateremias* Lantz, 1928 (group *Eremias arguta*), *Scapteira* Fitzinger in Wiegmann, 1834 (group *Eremias grammica*), and *Pareremias* Szczerbak, 1973 (group *Eremias multiocellata*). These five subgenera were supported by Arnold (1986) on the basis of the hemipenial characters. Among these five recognized subgenera, Iranian *Eremias* can be assigned to four of them (Szczerbak, 1974; Anderson, 1999): *Scapteira*, *Ommateremias*, *Rhabderemias*, and *Eremias*. Members of *Ommateremias* subgenus are medium to large size lizards with an average snout-vent length (SVL) of about 80 mm. Both juveniles and adults have dark edged light spots on the back; but rarely they fused together and shape bars in adults. Their single large subocural scale is in contact with supralabial scale(s). They share this character only with the subgenus *Scapteira*. Members of *Rhabderemias* subgenus are small lacertid lizards with the maximum SVL of about 60 mm. Both juveniles and adults have dark longitudinal stripes on the back. Their single large subocural scale is always in contact with the mouth. They share this character only with the subgenus *Eremias*. Members of *Eremias* subgenus are medium to large size lizards with an average SVL of about 80 mm. Juveniles have dark longitudinal stripes on the back, the same as the subgenus *Rhabderemias*. But these stripes will be broken down into dark spots or even disappear in adults. They have no digital fringes and their single large subocural scale is always in contact with the mouth. Members of the subgenus *Scapteira* are relatively large lacertids with a SVL of up to 100 mm. Both juveniles and adults have wavy dark transverse bars or reticulum on the back. They live in loose sands and due to adaptation to such environment, they all have large fringes in their toes, remarkable in both lateral and medial sides of the fourth toe. Guo *et al.* (2011) showed that these subgenera seem not to be monophyletic. Nineteen species of *Eremias* are known from Iran, six of which are endemic to the country (Mozaffari *et al*., 2016; Rastegar-Pouyani *et al*., 2016; Uetz & Hallermann, 2020). In this study, we report and describe a seventh endemic species of *Eremias* from Iran, using both morphological and molecular approaches to validate the new species.

Materials and methods

Two specimens (ZFMK102757(♀), ZFMK102758(♀)) of new population were collected from the border of the northeastern side of Markazi Province of Iran (around Jaroo Mountain), 35° 40' 08" N, 50° 42' 24" E at an elevation of 1,173 m a.s.l by senior author (Fig. 1). The specimens were subjected to hibernation at 4°C for 10 hours and preserved in 80% ethanol solution for further morphological examinations. For phylogenetic analysis, blood samples were taken from each specimen, and then kept in a freezer at -20°C for long term maintenance.

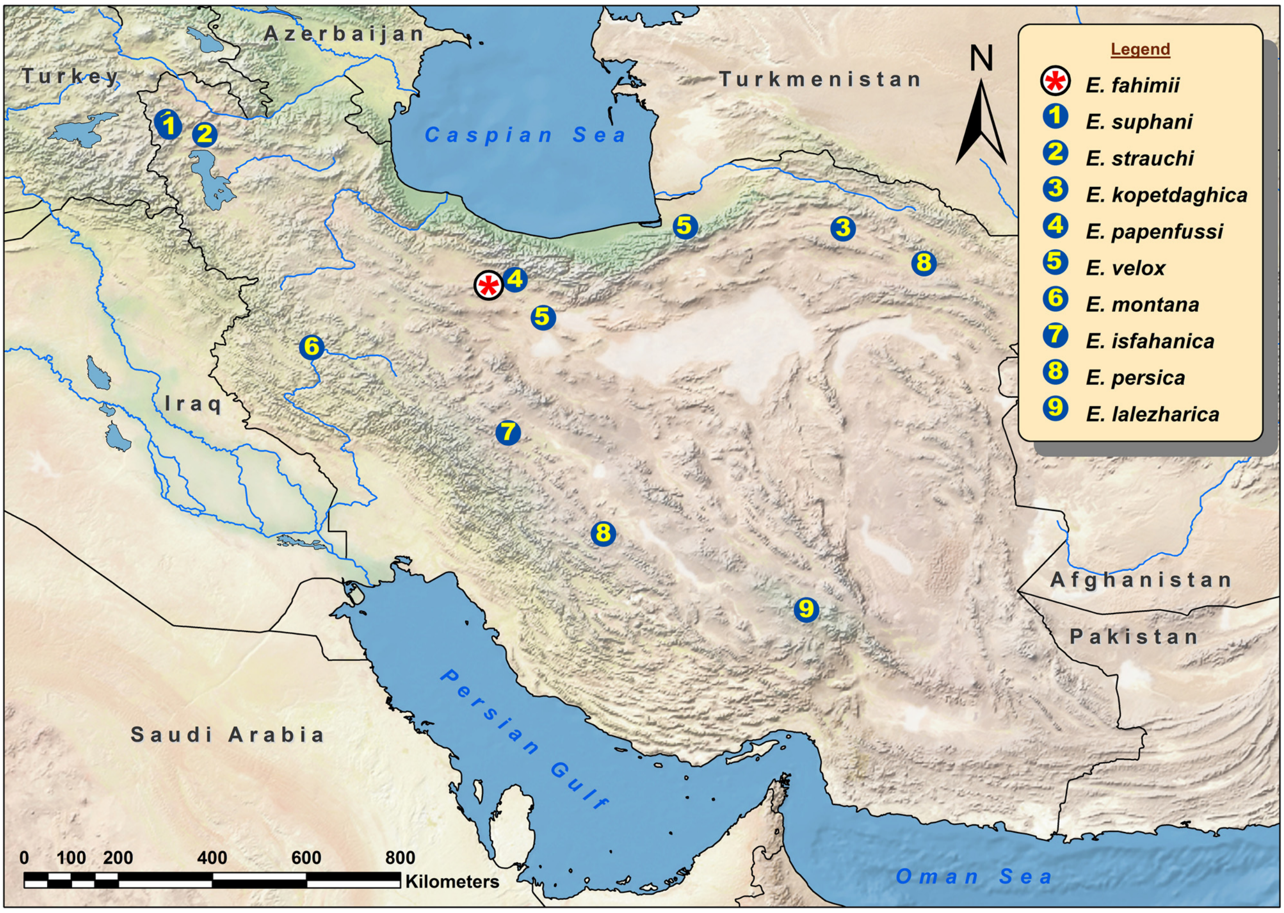

FIGURE 1. Type locality of *Eremias fahimii* **sp. nov.** along with localities of all nine other *Eremias* species used in this study. For more details, see Table 1.

TABLE 1. Data set of ten species of *Eremias* and outgroup were used in this study including museum number, locality, coordinates and GenBank accession numbers for the Cyt *b* and 12S genes.

Species	Museum number	Locality	Coordinates	GenBank accession numbers		**Reference**
				Cyt *b*	**12S**	
Eremias fahimii **sp. nov.**	ZFMK102757	Iran, around Jaroo Mountain	35° 40’ 08” N, 50° 42’ 24” E	MT249277	MT233383	This study
Eremias fahimii **sp. nov.**	ZFMK102758	Iran, around Jaroo Mountain	35° 40’ 08” N, 50° 42’ 24” E	MT249278	MT233382	This study
Eremias isfahanica	SUHC 3009	Iran, 45 km NW Isfahan	32°52’ 12.2” N; 51°06’ 41.2” E	KP317958	KP317970	Rastegar-Pouyani *et al.* (2016)
Eremias isfahanica	SUHC 3011	Iran, 45 km NW Isfahan	32°52’ 12.2” N; 51°06’ 41.2” E	KP317959	KP317971	Rastegar-Pouyani *et al.* (2016)
Eremias isfahanica	SUHC 3012	Iran, 45 km NW Isfahan	32°52’ 12.2” N; 51°06’ 41.2” E	KP317957	KP317969	Rastegar-Pouyani *et al.* (2016)
Eremias isfahanica	SUHC 3014	Iran, 45 km NW Isfahan	32°52’ 12.2” N; 51°06’ 41.2” E	KP317961	KP317973	Rastegar-Pouyani *et al.* (2016)
Eremias isfahanica	SUHC 3017	Iran, 45 km NW Isfahan	32°52’ 12.2” N; 51°06’ 41.2” E	KP317960	KP317972	Rastegar-Pouyani *et al.* (2016)
Eremias papenfussi	SUHC 1127	Iran, North of Tehran	35° 47’ 44.9” N; 51° 14’ 20.2” E	KP317962	KP317974	Rastegar-Pouyani *et al.* (2016)
Eremias papenfussi	SUHC 1128	Iran, North of Tehran	35° 47’ 44.9” N; 51° 14’ 20.2” E	KP317963	KP317975	Rastegar-Pouyani *et al.* (2016)
Eremias lalezharica	SUHC 151	Iran, Lalehzar Mountain	29°29’ 27.9” N; 56°48’ 58.3” E	KJ468077	KJ468089	Rastegar-Pouyani *et al*. (2015)
Eremias lalezharica	SUHC 153	Iran, Lalehzar Mountain	29°29’ 27.9” N; 56°48’ 58.3” E	KJ468078	KJ468090	Rastegar-Pouyani *et al*. (2015)
Eremias lalezharica	SUHC 158	Iran, Lalehzar Mountain	29°29’ 27.9” N; 56°48’ 58.3” E	KJ468079	KJ468091	Rastegar-Pouyani *et al*. (2015)
Eremias lalezharica	SUHC 159	Iran, Lalehzar Mountain	29°29’ 27.9” N; 56°48’ 58.3” E	KJ468080	KJ468092	Rastegar-Pouyani *et al*. (2015)
Eremias suphani	SUHC 301	Iran, Chaldoran	38°42’ 58.2” N; 44°37’ 55.6” E	KP317965	KP317977	Rastegar-Pouyani *et al*. (2016)
Eremias suphani	SUHC 302	Iran, Chaldoran	38°42’ 58.2” N; 44°37’ 55.6” E	KP317964	KP317976	Rastegar-Pouyani *et al*. (2016)
Eremias montana	SUHC 216	Iran, NE of Kermanshah	34°30’ 08.5” N; 47°21’ 12.3” E	FJ 416293	FJ445366	Rastegar-Pouyani *et al*. (2010)
Eremias montana	SUHC 217	Iran, NE of Kermanshah	34°30’ 08.5” N; 47°21’ 12.3” E	FJ 416294	FJ445367	Rastegar-Pouyani *et al*. (2010)
Eremias montana	SUHC 218	Iran, NE of Kermanshah	34°30’ 08.5” N; 47°21’ 12.3” E	FJ 416295	FJ445368	Rastegar-Pouyani *et al*. (2010)
Eremias montana	SUHC 219	Iran, NE of Kermanshah	34°30’ 08.5” N; 47°21’ 12.3” E	FJ 416296	FJ445369	Rastegar-Pouyani *et al*. (2010)
Eremias strauchi	SUHC 315	Iran, 44 km NW Marand	38°33’ 59.3” N; 45°18’ 37.2” E	KJ468070	KJ468082	Rastegar-Pouyani *et al*. (2015)
Eremias strauchi	SUHC 317	Iran, 44 km NW Marand	38°33’ 59.3” N; 45°18’ 37.2” E	JQ690099	JQ690168	Rastegar-Pouyani *et al*. (2012)

......*continued on the next page*

TABLE 1. (Continued)

Species	Museum number	Locality	Coordinates	GenBank accession numbers		**Reference**
				Cyt *b*	**12S**	
Eremias strauchi	SUHC 318	Iran, 44 km NW Marand	38°33’ 59.3” N; 45°18’ 37.2” E	KJ468072	KJ468084	Rastegar-Pouyani *et al*. (2015)
Eremias strauchi	SUHC 316	Iran, 44 km NW Marand	38°33’ 59.3” N; 45°18’ 37.2” E	KP317966	KP317978	Rastegar-Pouyani *et al*. (2016)
Eremias kopetdaghica	SUHC 351	Iran, Yengeje, Neyshabur, Khorasan	36°46’ 10.2” N; 57°31’ 0.2” E	KJ468076	KJ468088	Rastegar-Pouyani *et al*. (2015)
Eremias kopetdaghica	SUHC 352	Iran, Yengeje, Neyshabur, Khorasan	36°46’ 10.2” N; 57°31’ 0.2” E	KJ468075	KJ468087	Rastegar-Pouyani *et al*. (2015)
Eremias kopetdaghica	SUHC 353	Iran, Yengeje, Neyshabur, Khorasan	36°46’ 10.2” N; 57°31’ 0.2” E	KJ468073	KJ468085	Rastegar-Pouyani *et al*. (2015)
Eremias kopetdaghica	SUHC 354	Iran, Yengeje, Neyshabur, Khorasan	36°46’ 10.2” N; 57°31’ 0.2” E	KJ468074	KJ468086	Rastegar-Pouyani *et al*. (2015)
Eremias persica	SUHC 172	Iran, Near Abadeh, North of Shiraz	30°56’ 37.7” N; 52°55’ 58.2” E	FJ416246	FJ445324	Rastegar-Pouyani *et al*. (2010)
Eremias persica	SUHC 173	Iran, Near Abadeh, North of Shiraz	30°56’ 37.7” N; 52°55’ 58.2” E	FJ416250	FJ445325	Rastegar-Pouyani *et al*. (2010)
Eremias persica	SUHC 174	Iran, Near Abadeh, North of Shiraz	30°56’ 37.7” N; 52°55’ 58.2” E	FJ416252	FJ445326	Rastegar-Pouyani *et al*. (2010)
Eremias persica	SUHC 196	Iran, South of Neyshaboor, Khorasan	36°06’ 15.6” N; 59°03’ 45.1” E	FJ416243	FJ445320	Rastegar-Pouyani *et al*. (2010)
Eremias persica	SUHC 197	Iran, South of Neyshaboor, Khorasan	36°06’ 15.6” N; 59°03’ 45.1” E	FJ416245	FJ445321	Rastegar-Pouyani *et al*. (2010)
Eremias velox	SUHC 268	Iran, South of Tehran	35°04’ 06.9” N; 51°46’ 57.5” E	JQ690195	JQ690127	Rastegar-Pouyani *et al*. (2012)
Eremias velox	SUHC 269	Iran, South of Tehran	35°04’ 06.9” N; 51°46’ 57.5” E	JQ690196	JQ690128	Rastegar-Pouyani *et al*. (2012)
Eremias velox	SUHC 359	Iran, Around Gorgan	36°48’ 25.8”N; 54°29’ 58.7” E	JQ690194	JQ690126	Rastegar-Pouyani *et al*. (2012)
Mesalina watsonana	VAZ10	Iran	-	MH040049	MH039959	Sindaco *et al*. (2018)

Morphological characters. Morphometric characters including total length (TL) and snout to vent length (SVL) measured by using a 500-192 Mitutoyo digital caliper to the nearest 0.1 mm and 14 meristic characters including number of scales across mid-dorsum, number of longitudinal rows of ventral plates, number of transverse rows of ventral plates, total number of submaxillary shields, number of submaxillary shields that are in contact, total number of supralabials, number of supralabials anterior to subocular, number of supraocular, number of supraciliaris, number of gulars, number of collars, number of scales in the 10th caudal annulus, number of femoral pores and number of scales between femoral pores examined by using an Aomekie 20X/40X Stereo Microscope.

Genetic study. Genomic DNA was extracted with the high-salt method (Sambrook & Russell, 2001). Two mitochondrial genes fragments including Cytochrome *b* (Cyt *b*) (primers: Mtanew /Mtfsh) (Rastegar-Pouyani *et al.*, 2013) and 12S ribosomal RNA (12S) (primers: 12Sa /12Sb) (Kocher *et al.*, 1989) were used for PCR amplifications. The PCR mix contained 12.5 µl of Mastermix Red (Ampliqon, Copenhagen, Denmark), 0.5 µl of each primer (10 pmol/µl), 10.5 µl of ddH$_2$O, and 1 µl of DNA template (50-100 ng) in a total volume of 25 µl. PCRs were performed under the following conditions, for Cyt *b*: initial denaturation at 94°C for 5 min, followed by 30 cycles of 94°C for 40 s, 48°C for 45 s, 72°C for 2 min, and finally, a further single step extension of 72°C for 10 min, for 12S: initial denaturation at 92°C for 2 min, followed by 35 cycles of 92°C for 30s, 50°C for 40 s, 72°C for 45 s, and finally, final extension of 72°C for 10 min. Subsequently, PCR products were visualized on a 1% agarose gel stained with Safe-Red™. The proper amplicons were then purified and sequenced by Macrogene (Macrogene, Seoul, South Korea). Sequences were edited using CodonCode aligner V.9.0.1.X program (CodonCode Corporation, Dedham, MA, USA). Afterwards, sequences were submitted to GenBank.

Phylogenetic analyses. To clarify the phylogenetic assignment of the new species from Markazi Province, other nine species of *Eremias* were added to our dataset (Rastegar-Pouyani *et al.*, 2010; Rastegar-Pouyani *et al.*, 2012; Rastegar-Pouyani *et al.*, 2015; Rastegar-Pouyani *et al.*, 2016) (Table 1). *Mesalina watsonana* was used as outgroup. Datasets were aligned using MAFFT V.6 (Katoh *et al.*, 2002). MrModeltest 2.3 (Nylander, 2004) was used to determine the best nucleotide substitution model based on Akaike's Information Criterion (Akaike, 1974). The most appropriate model for the Cyt *b* and 12S genes was the GTR+G (G= 0.223 and G= 0.276, respectively). Maximum Likelihood (ML) and Bayesian Inference (BI) analyses were inferred for the concatenated dataset (Cyt *b* and 12S), including 940 bp comprising 35 individuals (33 specimens from nine *Eremias* species and two samples from the new species from Markazi Province). The ML tree was inferred using RAxML V.7.2 (Stamatakis, 2006) with 1,000 bootstrap pseudoreplications under the GTR + G model. BI was performed using MrBayes V.3.2 (Huelsenbeck & Ronquist, 2001) using five independent runs, four chains with for 5 million generations. Subsampling parameters and trees were saved every 100 generation, which generated an output of 5×10^4 trees. Eventually, 10% burn-in, equal to 5,000 trees, were discarded from the 50,001 samples subsampled during the analysis. Tracer V.1.7.1 (Rambaut *et al.*, 2018) was used to assess convergence.

Uncorrected genetic distances between the *Eremias* species and the new species from Markazi Province were calculated based on Cyt *b* and 12S genes with Mega X (Kumar *et al.,* 2018).

Results

Morphological characters. Morphological investigation demonstrated that the examined specimens had movable eyelids, a lower nasal shield that rests on two supralabials, and ventral plates arranged in oblique longitudinal rows. Variations in 16 morphological characters between two specimens were shown in Table 2.

Molecular analyses. The phylogenetic trees (ML and BI) show that all the species are recovered monophyletic and the new species from Markazi Province described herein branches as a sister taxon to *Eremias persica* with high support values (PP = 1 and BS = 100) (Fig. 2). Uncorrected genetic distances show high divergences among the *Eremias* species were examined in the study, and the minimum genetic distances were 10.1 % (Cyt *b*) and 5 % (12S) between the new species from Markazi Province described herein and *E. persica* (Table 3).

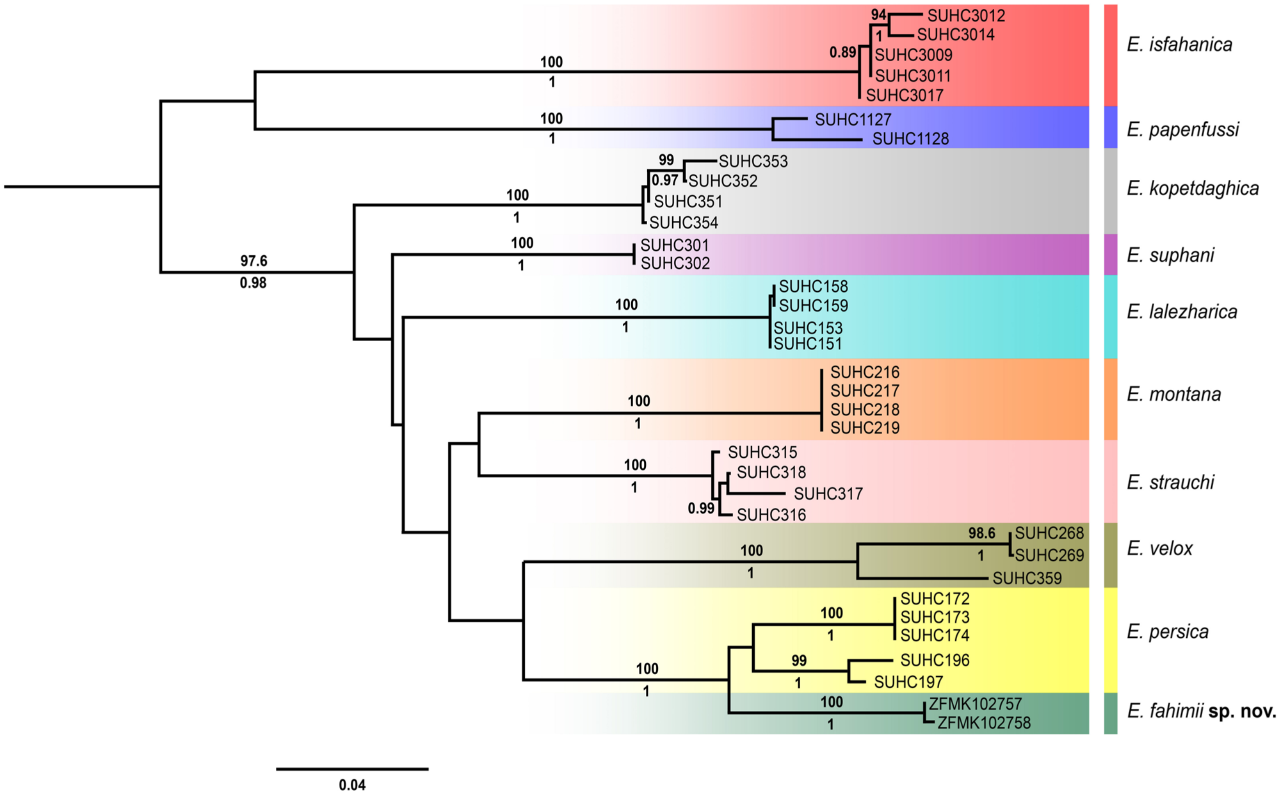

FIGURE 2. The phylogenetic tree of ten species of *Eremias* with the combined genes (Cyt *b* and 12S). The topology of BI and ML trees is the same, therefore only ML tree is shown and values above and below branches indicate bootstrap supports for ML and posterior probabilities for the Bayesian analyses, respectively.

TABLE 2. Variation among the type series.

Characteristic	ZFMK102757	ZFMK102758
Snout to vent length (SVL) (mm)	54.5	56.0
Total length (TL) (mm)	147.0	149.7
Scales across middle of dorsum	60	63
Longitudinal rows of ventral plates	15	15
Transverse rows of ventral plates	32	32
Submaxillary shields	5	5
In contact submaxillary shields	3	3
Supralabials	10/9	9/9
Supralabials anterior to subocular	7/6	6/6
Supraocular	3	3
Supraciliaris	5/6	5/5
Gulars	30	31
Collar	12	12
Scales in 10th caudal annulus	31	31
Femoral pores	19/20	20/21
Scales between femoral pores	1	1

Systematics

Family Lacertidae Oppel, 1811

Genus *Eremias* Fitzinger, 1834

Eremias persica and similar species

Blanford described *Eremias persica* in 1875 but the type locality is not exact and limited to just "near Esfahan". In 1974 Szczerbak designated the lectotype, but did not give a register number. Therefore there isn't any certain specimen from the type series. Since there are many specimens identified as *Eremias persica* (Anderson, 1999; Leviton *et al.*, 1992; Mozaffari *et al.*, 2006) from all over Iran's central and eastern plateau and the new population of *Eremias* from Markazi Province of Iran shows some morphological similarities to the *E. persica*, two groups of datasets where added to the phylogenetic analyses; one group from around the type locality and the other from north easternmost known population of this species due to this possibility that the recent new population of *Eremias* could be the north westernmost population of *E. persica.* According to combined morphological and genetic evidence, the new population of *Eremias* from Markazi Province of Iran is considered as undescribed species.

Eremias fahimii sp. nov.

(Figs. 3 and 4)

Eremias persica Anderson, 1999: 221 (part.); Leviton, Anderson, Adler and Minton, 1992: 57 (part.); Mozaffari, Kamali and Fahimi, 2006: 176 (part.).

Diagnosis. An *Eremias* species with three nasals; lower nasal resting on two supralabials; subocular bordering mouth; lateral scales of forth toe not forming distinct fringes; forth toe with single complete row of subdigital scales; the two series of femoral pores separated by a single scale; collar scales distinctly larger than adjacent gulars; 30–31 gulars in straight median series; 60–63 dorsals; 31 scales in the tenth caudal annulus; upper caudal scales smooth and without distinct keels.

Comparisons. Whether the subgenera represent monophyletic groups or not, as morphologically-defined taxa they are useful bins for comparing and diagnosing our new species. *Eremias fahimii* **sp. nov.** can be excluded from the subgenus *Scapteira* by lacking the lateral fringes on the fourth toe (Fig. 3D) and by a subocular scale that is in contact with the edge of mouth (Fig. 3C). The latter character also excludes it from the subgenus *Ommateremias*. It can be excluded from the subgenus *Rhabderemias* by its large size and by having longitudinal dorsal stripes that are broken into a spotted pattern (Anderson, 1999). Within the Iranian members of the subgenus *Eremias, E. fahimii* **sp. nov.** can be differentiated from *E. isfahanica* by having more supralabial scales (9–10 *vs*. 6–8) 6–7 of them located anterior to subocular (*vs*. 5), smaller gap between femoral pores (1 scale *vs*. 3) (Fig. 3E), fewer supraciliary scales (5–6 *vs*. 7) and fewer subdigital lamella under the 4th toe (20–21 *vs*. 22–26). It can be distinguished from *Eremias kopetdaghica* Szczerbak, 1972 by having more mid-dorsum scales (60-63 vs. 48-59), more scales in the 10th caudal annulus (31 *vs*. 20–26), more gular scales (30–31 *vs*. 19–28) (Fig. 3A) and the absence distinctly keeled upper caudal scales (Fig. 3F). With the latter character, it can be distinguished from *Eremias strauchi* Kessler, 1878. It can be distinguished from *E. lalezharica* by having more mid-dorsum scales (60–63 *vs*. 54–59), more pairs of submaxillary shields (5 *vs*.4) (Fig. 3A), fewer gular scales (30–31 *vs*. 33–40), fewer collar scales (12 *vs*. 13–15), more femoral pores (19–21 *vs*. 16–18) and a smaller gap between the femoral pores (1 scale *vs*. 3–5). It can be distinguished from *E. montana* by having more transverse rows of ventral plates (31–32 *vs*. 27–28), more scales in the 10th caudal annulus (31 *vs*. 27–28), more gular scales (30–31 *vs*. 23–25), more collar scales (12 *vs*. 9–11) and more supralabials anterior to subocular (6–7 *vs*. 4–5) (Fig. 3C). It can be distinguished from *E. papenfussi* by having more supralabial scales (9–10 *vs*. 8), 6–7 of them located anterior to the subocular (*vs*. 5), more gular scales (30–31 *vs*. 24–28) and more scales in the 10th caudal annulus (31 *vs*. 23–28). There are also very obvious differences in the shape and size of the parietals, interparietal and frontoparietals. *E. fahimii* **sp. nov.** has a relatively large quadrilateral interparietal (*vs*. small oval in *E. papenfussi*) and the length of this scale is almost as long as the parietals' junction and a little bit shorter than the frontoparietals' junction; While this length is about half of the parietals' junction and a third of the frontoparietals' junction in *E. papenfussi*. Quadrilateral shape of interparietal in *E. fahimii* **sp. nov.** has led frontoparietals to grow trapezoidal and parietals to grow almost rectangular. But in *E. papenfussi* that is opposite. Frontoparietals are rectangular and parietals are trapezoidal (Figs. 3B and 6). *Eremias fahimii* **sp. nov.** can be distinguished from *Eremias suphani* Basoglu and Hellmich, 1968 by lacking the extension of gular scales to the second inframaxiallary scales (Franzen & Heckes, 1999) (the second and third pair of submaxillary shields are in contact) (Fig. 3A). It can be distinguished from *Eremias velox* Pallas, 1771 by having more mid-dorsum scales (60–63 *vs*. 46–56) and more gular scales (30–31 *vs*. 23–25). Regarding to its color pattern in adult form, it can also distinguish from *E. kopetdaghica*, *E. strauchi*, *E. lalezharica* and *E. velox* by absence of lateral color ocellus (Fig. 4) (Mozaffari *et al*., 2016).

Description of Holotype (ZFMK102757). Size: A medium-sized *Eremias* with a SVL of 54.5 mm and TL of 147 mm.

Scalation (Fig. 3): Subocular bordering mouth; 9/10 supralabials, six/seven anterior to subocular; lower nasal rests on first and second supralabials as well as the frontonasal; three (two large and one small) supraocular scales; lateral scales of the fourth toe do not form distinct fringes and 20/21 subdigital lamella under the toe; two rows of 19/20 femoral pores separated by a single scale that reach the knee; five submaxillary shields, first three pairs in contact; 30 gular scales between submaxillary shields and collar; collar made up of 12 scales; 60 scales across mid-dorsum; 15 longitudinal and 32 transverse rows of ventral plates; 31 scales in the 10th caudal annulus; upper caudal scales smooth and without distinct keels.

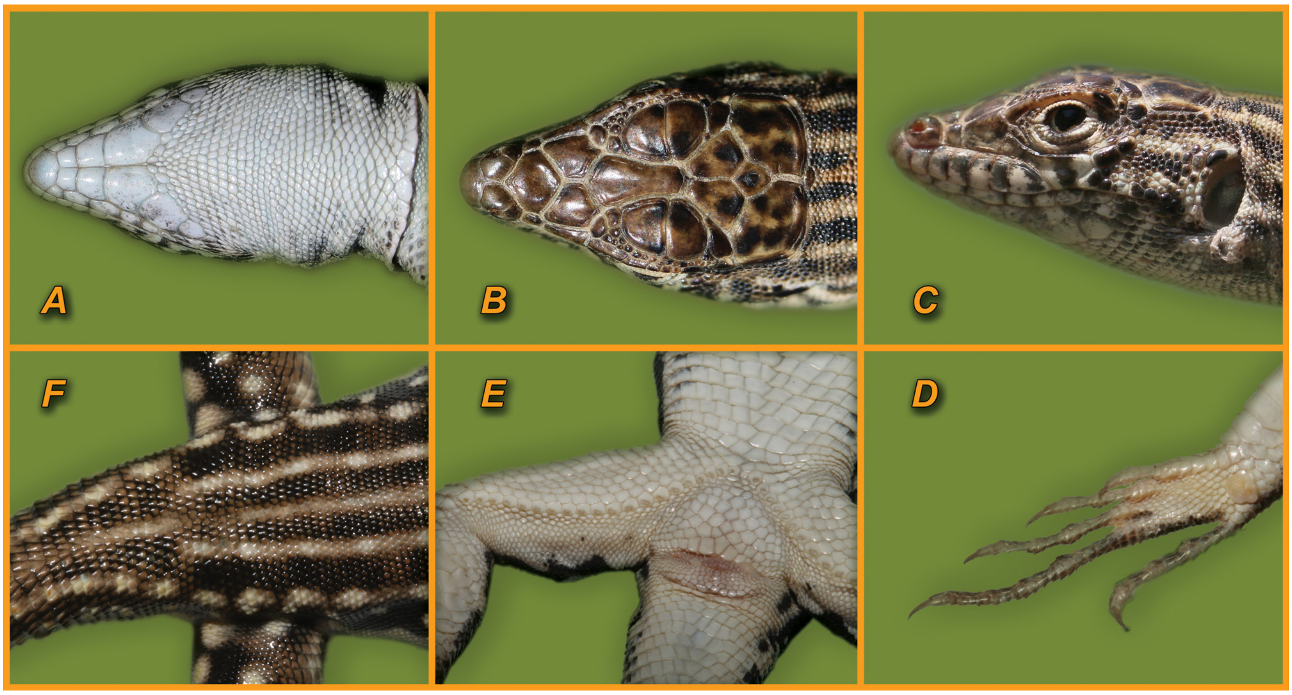

FIGURE 3. Morphology of *Eremias fahimii* **sp. nov.** (ZFMK102757). A: Ventral view of head; B: Dorsal view of head; C: Lateral view of head; D: Ventral view of hind foot; E: Ventral view of hind limb and femoral pores; F: Caudal scales in the 10th annulus.

Description of Paratype (ZFMK102758). Size: SVL of 56 mm and TL of 149.7 mm.

Scalation: Subocular bordering mouth; 9 supralabials, six anterior to subocular; lower nasal rests on first and second supralabials as well as the frontonasal; three (two large and one small) supraocular scales; lateral scales of the fourth toe do not form distinct fringes and 20 subdigital lamella under the toe; two rows of 20/21 femoral pores separated by a single scale that reach the knees; five submaxillary shields, first three pairs in contact; 31 gular scales between submaxillary shields and collar; collar made up of 12 scales; 63 scales across mid-dorsum; 15 longitudinal and 32 transverse rows of ventral plates; 31 scales in the 10th caudal annulus; upper caudal scales smooth and without distinct keels. Table 1 shows the variation between the holotype and the paratype.

Coloration. In life, the dorsum is dark brown to black with a series of five longitudinal light cream or milky white stripes. The medial stripe starts anteriorly at the posterior margin of the parietals. But four other stripes start from the anterior margin of parietals, passing through them. The inner stripe pair connect with each other in the pelvic region; but the outer pair extends to at least the anterior third of the tail. Sometimes the black or dark brown space between light stripes breaks up and makes dark irregular spots in a light brown or sandy background. Another two pairs of light lateral stripes on each side of body, one starts at the upper and the other starts about the lower edge of the ear opening. Both stripes may break up into small light spots on flanks. Head is sandy to light brown with irregular black spots. Dorsal side of the limbs is light brown with black irregular cloudy patterns and light spots. Dorsal side of the tail light brown, dark brown or black with previous mentioned light stripes (Fig. 4). The venter and ventral side of tail milky white.

FIGURE 4. *Eremias fahimii* **sp. nov.** in its natural habitat (Photo by Omid Mozaffari).

Etymology. According to Arnold *et al.* (2007), "*Eremias* is a Greek noun meaning solitary devotee, and is related to *Eremia*, signifying an isolated place or desert." (Arnold *et al.*, 2007; Mozaffari & Parham, 2007) The epithet *fahimii* is for Hadi Fahimi (1980-2018), a great young ecologist, environmentalist, herpetologist, mammalogist, co-author of the Atlas of Reptiles of Iran (Mozaffari *et al*., 2016) and friend of the authors, who passed away too soon in a plane crash.

Remarks. Habitat in type locality consists of mild slopes and covered with highly weathered rocky materials. The dominant vegetation is *Atriphaxis*, *Artemisia*, *Peganum* and annual grass (Fig. 5).

Examining fecal materials shows that like almost all *Eremias* species, they feed on small arthropods. The main ingested food of the two specimens were *coleopterans*, because of their availability due to the beginning of the dispersal season of these insects.

The other reptile species syntopic with *Eremias fahimii* **sp. nov.** are *Eumeces schneiderii* Daudin, 1802, *Malpolon insignitus* Geoffroy St. Hilaire, 1809, *Mesalina watsonana* Stoliczka, 1872, *Ophisops elegans* Menetries, 1832, *Psammophis schokari* Forskal, 1775 and *Trapelus agilis* Olivier, 1807.

FIGURE 5. Habitat at the type locality of *Eremias fahimii* **sp. nov.**

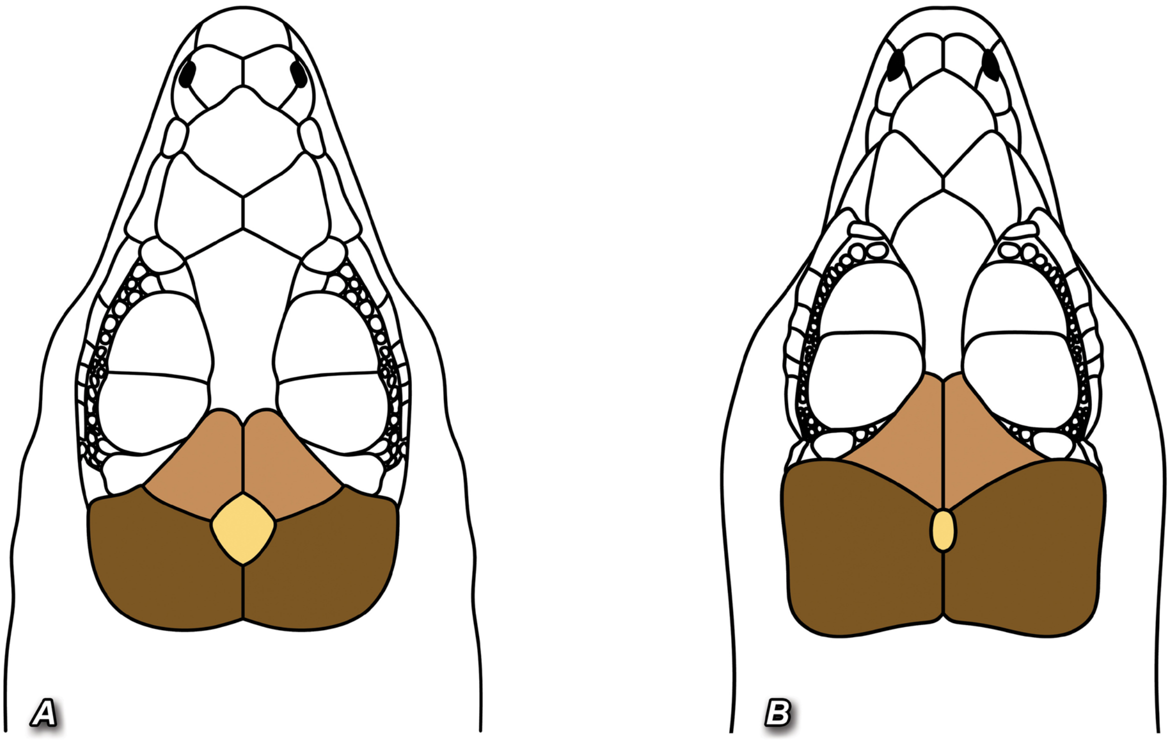

FIGURE 6. Differences in shape and size of parietals, interparietal and frontoparietals between *E. fahimii* **sp. nov.** (A) and *E. papenfussi* (B).

TABLE 3. Uncorrected genetic distances (*p*-distances) between ten species of *Eremias* based on Cyt *b* (below matrix) and 12S (above matrix).

	E. fahimii **sp. nov.**	*E. persica*	*E. montana*	*E. strauchi*	*E. velox*	*E. kopetdaghica*	*E. lalezharica*	*E. isfahanica*	*E. papenfussi*	*E. suphani*
E. fahimii **sp. nov.**		0.050	0.094	0.065	0.070	0.063	0.080	0.087	0.061	0.063
E. persica	0.101		0.098	0.079	0.088	0.083	0.105	0.090	0.079	0.079
E. montana	0.163	0.160		0.070	0.098	0.071	0.086	0.040	0.067	0.074
E. strauchi	0.158	0.150	0.138		0.079	0.060	0.085	0.072	0.068	0.069
E. velox	0.181	0.180	0.174	0.169		0.072	0.090	0.090	0.078	0.079
E. kopetdaghica	0.173	0.163	0.168	0.160	0.187		0.083	0.073	0.070	0.063
E. lalezharica	0.183	0.164	0.157	0.153	0.188	0.164		0.084	0.070	0.083
E. isfahanica	0.268	0.245	0.252	0.238	0.267	0.232	0.236		0.049	0.067
E. papenfussi	0.232	0.234	0.246	0.231	0.242	0.242	0.229	0.248		0.050
E. suphani	0.159	0.140	0.147	0.147	0.179	0.139	0.141	0.235	0.234	

Discussion

The results of the integrative study revealed that there are apparent morphological and molecular differences between *E. fahimii* **sp. nov.** and other *Eremias* species examined in this study. The results clarified the validation of the new species (*E. fahimii* **sp. nov.**) based on both molecular and morphological data. Although there are only two females available for morphological examination, *E. fahimii* **sp. nov.** is separated from the other Iranian members of the subgenus *Eremias* species with different diagnostic characters as represented in the taxonomy section (also see Table 2). The key characters to identify *E. fahimii* are lacking lateral fringes on the fourth toe and 20-21 subdigital lamella under that, a lower nasal shield that rests on two of its 9-10 supralabials, ventral plates arranged in 15 oblique longitudinal and 32 transverse rows, 19-21 femoral pores that separates by only one scale, 30-31 gular and 12 collar scales, 31 smooth scales in the 10th caudal annulus, five to six supraciliary scales and 60-63 scales around the mid-body.

According to the phylogenetic analyses, *E. fahimii* **sp. nov.** represents a distinct lineage with high support value (Fig. 2), which is a sister taxon to *E. persica*. The genetic distances based on Cyt *b* indicated that Iranian *Eremias* are highly divergent from each other (Table 3), but the new species had lower genetic divergence (~10%) with the Persian racerunner, *E. persica* Blanford 1875, a species complex which is distributed in the whole central plateau, south of the Alborz and the foothills of Zagros Mountain range (Anderson, 1999; Rastegar-Pouyani *et al*., 2010; Ahmadzadeh *et al*., 2017). Morphological examination of more specimens and using suitable nuclear markers is necessary in order to obtain more robust evidence to assess the taxonomy and phylogeny of the species.

Along with *Eremias andersoni* Darevsky & Szczerbak, 1978, *Eremias isfahanica* Rastegar-Pouyani *et al.*, 2016, *Eremias kavirensis* Mozaffari & Parham, 2007, *Eremias lalezharica* Moravec, 1994, *Eremias montana* Rastegar-Pouyani & Rastegar-Pouyani, 2001 and *Eremias papenfussi* Mozaffari *et al.*, 2011, the description of this new species represents the seventh species of *Eremias* endemic to Iran. Although *E. fahimii* **sp. nov.** is only known from its type locality, it is highly probable that it is distributed in Tehran, Alborz, Qom, Qazvin and Zanjan Provinces due to topological characteristics and habitat similarities of these areas to the type locality.

Overall, in spite of the extensive studies, the Iranian lizard fauna is poorly known. The country comprises over 150 lizard species, which inhabit a variety of habitats (Mozaffari *et al*., 2016; Uetz & Hallermann, 2020). Recently, many cryptic species of lizards were described and reported from Iran, for instance, some species of *Asaccus* and *Dareveskia* (Torki *et al*., 2011; Ahmadzadeh *et al.,* 2013). A similar pattern was also suggested for *Eremias*. It is assumed that *Eremias* is a highly diverse genus with many species still pending to be discovered and described (Mozaffari & Parham, 2007; Mozaffari *et al.*, 2011; Rastegar-Pouyani *et al.*, 2016). Applying integrated approaches in such cases is useful as it allows the identification and description of new species, which also have important implications for conservation and natural resource management.

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Literature cited

Ahmadzadeh, F., Flecks, M., Carretero, M.A., Mozaffari, O., Böhme, W., Harris, D.J., Freitas, S. & Rödder, D. (2013) Cryptic speciation patterns in Iranian rock lizards uncovered by integrative taxonomy. *PLoS One*, 8 (12), e80563. https://doi.org/10.1371/journal.pone.0080563

Ahmadzadeh, F., Lymberakis, P., Saberi-Pirooz, R. & Kapli, P. (2017) The evolutionary history of two lizards (Squamata: Lacertidae) is linked to the geological development of Iran. *Zoologischer Anzeiger*, 270, 49–56. https://doi.org/10.1016/j.jcz.2017.09.003

Akaike, H. (1974) A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 19 (6), 716–723. https://doi.org/10.1109/TAC.1974.1100705

Anderson, S.C. (1999) *The Lizards of Iran*. Society for the Study of Amphibians and Reptiles, Ithaca, New York, 442 pp.

Arnold, E.N. (1989) Towards the phylogeny and biogeography of the Lacertidae: relationships within an Old-World family of lizards derived from morphology. *Bulletin of the British Museum (Natural History) Zoology*, 55, 209–257.

Arnold, E.N., Arribas, O. & Carranza, S. (2007) Systematics of the Palearctic and Oriental lizard Tribe Lacertini (Squamata: Lacertidae: Lacertinae), with descriptions of eight new genera. *Zootaxa*, 1430 (1), 1–86.
https://doi.org/10.11646/zootaxa.1430.1.1

Franzen, M. & Heckes, U. (1999) *Eremia susphani* Basoglu & Hellmich, 1968 und *Eremias strauchi* Kessler, 1878 in der östlichen Türkei: Diagnostische Merkmale, Verbreitung und Lebensräume (Sauria: Lacertidae). *Salamandra*, 35 (4), 255–266.

Guo, X., Dai, X., Chen, D., Papenfuss, T.J., Ananjeva, N., Melnikov, D. & Wang, Y. (2011) Phylogeny and divergence times of some racerunner lizards (Lacertidae: *Eremias*) inferred from mitochondrial 16S rRNA gene segments. *Molecular Phylogenetics and Evolution*, 61, 400–412.
https://doi.org/10.1016/j.ympev.2011.06.022

Huelsenbeck, J.P. & Ronquist, F. (2001) MRBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics*, 17 (8), 754–755.
https://doi.org/10.1093/bioinformatics/17.8.754

Katoh, K., Misawa, K., Kuma, K. & Miyata, T. (2002) MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. *Nucleic Acids Research*, 30 (14), 3059–3066.
https://doi.org/10.1093/nar/gkf436

Kocher, T.D., Thomas, W.K., Meyer, A., Edwards, S.V., Pääbo, S., Villablanca, F.X. & Wilson, A.C. (1989) Dynamics of mitochondrial DNA evolution in animals: amplification and sequencing with conserved primers. *Proceedings of the National Academy of Sciences*, 86 (16), 6196–6200.
https://doi.org/10.1073/pnas.86.16.6196

Kumar, S., Stecher, G., Li, M., Knyaz, C. & Tamura, K. (2018) MEGA X: molecular evolutionary genetics analysis across computing platforms. *Molecular Biology and Evolution*, 35 (6), 1547–1549.
https://doi.org/10.1093/molbev/msy096

Leviton, A.E., Anderson, S.C., Adler, K. & Minton, S.A. (1992) *Handbook to Middle East Amphibians and Reptiles*. Society for the Study of Amphibians and Reptiles, Ithaca, New York, 252 pp.

Moravec, J. (1994) A new lizard from Iran, *Eremias* (*Eremias*) *lalezharica* sp. n. (Reptilia: Lacertilia: Lacertidae). *Bonner Zoologische Beiträge*, 45, 61–66.

Mozaffari, O., Ahmadzadeh, F. & Parham, J. (2011) *Eremias papenfussi* sp. nov., a new lacertid lizard (Sauria: Lacertidae) from Tehran Province, Iran. *Zootaxa*, 3114 (1), 57–62.
https://doi.org/10.11646/zootaxa.3114.1.6

Mozaffari, O., Kamali, K. & Fahimi, H. (2016) *Atlas of Reptiles of Iran*. Iran department of the environment, Tehran, 361 pp.

Mozaffari, O. & Parham, J.F. (2007) A new species of racerunner lizard (Lacertidae: *Eremias*) from Iran. *Proceedings of the California Academy of Sciences*, 58, 569–574.

Nylander, J. (2004) MrModeltest 2.2. Distributed by the Author. [program]

Rambaut, A., Drummond, A.J., Xie, D., Baele, G. & Suchard, M.A. (2018) Posterior summarisation in Bayesian phylogenetics using Tracer 1.7.1. *Systematic Biology*, 67, 901–904.
https://doi.org/10.1093/sysbio/syy032

Rastegar-Pouyani, E., Avci, A., Kumlutaş, Y., Ilgaz, Ç. & Hosseinian-Yousefkhani, S.S. (2013) New country record and range extension of *Eremias suphani* Baþoðlu & Hellmich, 1968 from Iran. *Amphibian & Reptile Conservation*, 6 (2), 35–39.

Rastegar-Pouyani, E., Hosseinian-Yousefkhani, S.S., Rafiee, S., Kami, H.G., Rajabizadeh, M. & Wink, M. (2016) A new species of the genus *Eremias* Fitzinger, 1834 (Squamata: Lacertidae) from Central Iran, supported by mtDNA sequences and morphology. *Zootaxa*, 4132 (2), 207–220.
https://doi.org/10.11646/zootaxa.4132.2.2

Rastegar-Pouyani, E., Hosseinian-Yousefkhani, S.S. & Wink, M. (2015) Taxonomic reevaluation of *Eremias strauchi strauchi* Kessler, 1878 and *Eremias strauchi kopetdaghica* Szczerbak, 1972, based on nuclear and mitochondrial DNA sequences (Reptilia: Lacertidae). *Zoology in the Middle East*, 61 (2), 118–124.
https://doi.org/10.1080/09397140.2015.1020615

Rastegar-Pouyani, E., Noureini, S.K., Rastegar-Pouyani, N., Joger, U. & Wink, M. (2012) Molecular phylogeny and intraspecific differentiation of the *Eremias velox* complex of the Iranian Plateau and Central Asia (Sauria, Lacertidae). *Journal of Zoological Systematics and Evolutionary Research*, 50 (3), 220–229.
https://doi.org/10.1111/j.1439-0469.2012.00662.x

Rastegar-Pouyani, E., Rastegar-Pouyani, N., Noureini, S.K., Joger, U. & Wink, M. (2010) Molecular phylogeny of the *Eremias persica* complex of the Iranian plateau (Reptilia: Lacertidae), based on mtDNA sequences. *Zoological Journal of the Linnean Society*, 158 (3), 641–660.
https://doi.org/10.1111/j.1096-3642.2009.00553.x

Rastegar-Pouyani, N. & Rastegar-Pouyani, E. (2001) A new species of *Eremias* (Sauria: Lacertidae) from highlands of Kermanshah Province, Western Iran. *Asiatic Herpetological Research*, 9, 107–112.
https://doi.org/10.5962/bhl.part.15563

Sambrook, J. & Russell, D.W. (2001) *Molecular cloning: a laboratory manual*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York, 2100 pp.

Sindaco, R., Simo-Riudalbas, M., Sacchi, R. & Carranza, S. (2018). Systematics of the *Mesalina guttulata* species complex

(Squamata: Lacertidae) from Arabia with the description of two new species. *Zootaxa*, 4429 (3), 513–547. https://doi.org/10.11646/zootaxa.4429.3.4

Stamatakis, A. (2006) RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics, 22 (21), 2688–2690. https://doi.org/10.1093/bioinformatics/btl446

Szczerbak, N.N. (1972) New subspecies of *Eremias strauchi*-*Eremias strauchi kopetdaghica* ssp. nova (Sauria, Reptilia) from Turkmenia. *Vestnik Zoologii*, 6, 83–86.

Szczerbak, N.N. (1974) *Yashchurki Palearktiki (Eremias lizards of the Palearctic)*. Axadeimiya Nauk Ukrainskoi USSR Institut Zoologii, Naukova Dumka, Kiev, 296 pp.

Torki, F., Ahmadzadeh, F., Ilgaz, Ç., Avci, A. & Kumlutacs, Y. (2011) Description of four new *Asaccus* Dixon and Anderson, 1973 (Reptilia: Phyllodactylidae) from Iran and Turkey. *Amphibia-Reptilia*, 32, 185–202. https://doi.org/10.1163/017353711X556998

Uetz, P. & Hallermann, J. (2020) The Reptile Database. Zoological Museum, Hamburg. Available from: http://reptile-database.reptarium.cz/ (accessed 27 Mar 2020)