

The first record of age structure and body size of the Suphan Racerunner, *Eremias suphani* Başoğlu & Hellmich, 1968

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Abstract: The age structure of *Eremias suphani* was studied from a high-altitude (2180 m a.s.l.) locality in eastern Turkey. A total of 24 preserved (16♂♂, 7♀♀, and 1 juvenile) specimens were used in this study. According to the skeletochronological analysis, ages ranged from 6 to 9 years (mean: 7.38 ± 0.22 years) in males and from 6 to 10 years (mean: 7.86 ± 0.51 years) in females. Age at maturity was estimated to be 5–6 years for both males and females. The mean snout–vent length was calculated as 60.88 ± 2.61 mm in males and 58.85 ± 2.44 in females. The sexual dimorphism index was calculated as -0.03 . The difference between the sexes for both age and size was not statistically significant.

Key words: Age structure, body size, *Eremias suphani*, Lacertidae, sexual dimorphism, Turkey

1. Introduction

The genus *Eremias* Fitzinger, 1834, which includes 35 lizard species, is a widespread lacertid genus and is known from northern China, Mongolia, Korea, Central and Southwest Asia, and Southeast Europe (Šmíd et al., 2014). Three species of *Eremias* occur in Turkey (*E. strauchi* Kessler, 1878; *E. pleskei* Nikolsky, 1905; and *E. suphani* Başoğlu & Hellmich, 1968) (Baran and Atatür, 1998; Baran et al., 2012). *E. suphani*, Suphan Racerunner, is known from eastern Anatolia (the provinces of Van, Bitlis, and Ağrı) and western Iran (Firozagh, in the west of the province of Azarbaijan) (Baran et al., 2012; Rastegar-Pouyani et al., 2013). *E. suphani* is a medium-sized lizard with a total length of up to 20 cm. It inhabits desert-like, dry, open places with sandy, pebbly substrates and little vegetation (Baran et al., 2012). This lizard generally hides in depressions and cracks in soil, and it can burrow when disturbed. Its distribution can be up to 2400 m a.s.l (Franzen and Heckes, 1999; Baran et al., 2012). The dorsum is greenish or brownish gray and the venter is whitish (Baran and Atatür, 1998; Baran et al., 2012). *E. suphani* is categorized as being of Least Concern (LC) (IUCN, 2014).

Although abundant studies on different subjects about the genus *Eremias* exist in the literature (e.g., sexual size dimorphism, Li et al., 2006; phylogeny, Guo et al., 2011; genetics, Chen et al., 2012; behavior, Kim et al., 2012; monitoring and population size, Song et al., 2013), there

are little data available on life history characteristics such as body size, age at maturity, and longevity. Kim et al. (2010) studied the physical characteristics and age structure of *E. argus* Peters, 1869, while Altunışık et al. (2013) studied the age and body size of *E. strauchi*. However, there has not been a study conducted on the age structure of the Suphan Racerunner *E. suphani* until now.

A population's age structure is directly related to the life history of individuals (Gül et al., 2014); the modern method for determining age is skeletochronology, which is based on counting the lines of arrested growth (LAGs) in the bone tissue (Castanet and Smirina, 1990). Many studies have shown that this method can be applied successfully to different lizard species for age determination (e.g., Noura, 1987; El Mouden et al., 1999; Arakelyan, 2002; Roitberg and Smirina, 2006; Guarino et al., 2010; Kim et al., 2010; Tomašević et al., 2010; Altunışık et al., 2013; Arakelyan et al., 2013; Ergül et al., 2014; Gül et al., 2014; Üzümlü et al., 2014).

In view of this, the aim of this study is to present the first data on the age structure, body size, and longevity of a breeding population of *E. suphani* located in eastern Turkey. We also investigated eventual intersexual differences in terms of the characteristics mentioned above.

2. Materials and methods

This study is based on a total of 24 specimens of *E. suphani* (16♂♂, 7♀♀, and 1 juvenile) collected between

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Güzelsu and Başkale, 10 km, Van, Turkey (38°15'16.5"N, 43°52'28.4"E), at an altitude of 2180 m a.s.l. on 10.06.2003. The samples were collected from sandy, pebbly habitat with sparse vegetation. The animals were treated in accordance with the guidelines of the local ethics committee (B.30.2 .DEÜ.0.00.00.00/050.03/10/2003). The specimens were fixed according to the method described by Başoğlu and Baran (1977): they were first anesthetized with ether, then fixed with a 1:1 mixture of 5% formalin and 70% ethanol, and later kept in 70% ethanol for permanent conservation. They were incorporated into the collection of ZDEU (Zoology Department of Ege University, Turkey; ZDEU 64/2003) and stored in the zoology lab of the Department of Biology, Faculty of Science, Dokuz Eylül University. The syntopic reptile and amphibian species with *E. suphani* specimens were *Testudo graeca* Linnaeus, 1758; *Trapelus ruderatus* (De Filippi, 1865); *Ophisops elegans* Ménétries, 1832; and *Bufo variabilis* (Laurenti 1768).

Males and females were identified according to the presence of a hemipenis in the cloacal opening; the snout-vent length (SVL) of each individual was measured by using a digital caliper with an accuracy of 0.02 mm. This character was used to determine whether there was any sexual size dimorphism (SSD) between the sexes and to test the relationship between age and size. The use of a size dimorphism index (SDI) has been proposed by numerous authors to quantify the degree of SSD exhibited by a species or population (Lovich and Gibbons, 1992). In this study, sexual size dimorphism based on the SVL was calculated according to the SDI introduced by Lovich and Gibbons (1992):

$$SDI = (\text{mean length of the larger sex} / \text{mean length of the smaller sex}) \pm 1.$$

In this formula, +1 is used if males are larger than females and defined as negative, and -1 is used if females are larger than males and defined as positive arbitrarily.

Individual age was determined by using skeletochronology applied to the longest finger of the forelimb. This method followed procedures mentioned in the literature (e.g., Castanet and Smirina, 1990; Miaud, 1991; Üzümlü et al., 2014): conserved phalanx samples in 70% ethanol were first washed in tap water for approximately 24 h and subsequently decalcified in 5% nitric acid for 2 h. They were later washed again in tap water for about 12 h. By using a cryostat microtome, cross-sections (18 µm) from the middle part of the diaphysis were obtained, and they were stained with Ehrlich's hematoxylin. The sections were placed in glycerin in order to be observed with a light microscope and were photographed at the same magnification. All section photos belonging to each individual were examined, and LAGs in the cross-sections were counted to determine the age, as each of them corresponds to 1 year. We assessed the rate of endosteal

resorption by comparing the diameters of eroded marrow cavities from adults with the diameters of noneroded marrow cavities in the section from the juvenile.

Because all data were normally distributed (Kolmogorov-Smirnov D-test, all $P > 0.05$), age and size were compared using parametric tests (t-test). The significance level used in all tests was $P < 0.05$. Pearson's correlation coefficient was calculated to understand the relationship between age and SVL. The most suitable regression model was chosen according to R^2 values. All tests were processed with STATISTICA 7.0 (StatSoft Inc., USA) and Excel (Microsoft).

3. Results

3.1. Bone histology and growth marks

Cross-sections from the juvenile and adult phalanges exhibited a series of thin, intensely stained, and approximately concentric layers, which were separated from each other by wide, lightly stained bone tissue (Figure 1). These thin dark-stained lines (layers) were noted as LAGs, and the broader pale ones as marks of skeletal growth (Castanet et al., 1977). Endosteal resorption was determined in all cross-sections from the adult individuals. The section from the juvenile had no endosteal resorption and exhibited a noneroded marrow cavity. When the section from the juvenile was compared with the sections from adults, it was determined that the first LAG had completely resorbed in 86.95% of the individuals. In 13.05% of the specimens, the first 2 (4.35%), 3 (4.35%), and 4 (4.35%) LAGs were completely destroyed by endosteal resorption. Endosteal bone deposition was also observed in some sections (Figure 1). It was possible to estimate age for 100% ($n = 24$) of the available phalanges.

3.2. Body size and age

SVL ranged from 52.10 to 95.39 mm in males and 52.32 to 70.86 mm in females. The mean SVL of males was larger than that of females (Table), but this difference was not found to be statistically significant ($t = -0.473$, $df = 21$, $P\text{-value} = 0.641$). The juvenile individual had a SVL of 37.45 mm. SDI was calculated as -0.03, indicating a male bias.

The mean age was determined as 7.38 ± 0.22 years for males and 7.86 ± 0.51 years for females. The age distribution of the population is given in Figure 2. The difference in age between males and females was not significant ($t = 1.025$, $df = 21$, $P\text{-value} = 0.317$). The age at which a significant decrease in growth occurred, based on the thickness of the growth rings, was taken as the age of sexual maturity (Ryser, 1988). We estimated that individuals of this population reach sexual maturity at the age of 5 or 6. The observed maximum age or longevity was detected as 9 years for males and 10 years for females; these individuals had the highest SVL values (95.39 mm for males and 70.86 mm for females).

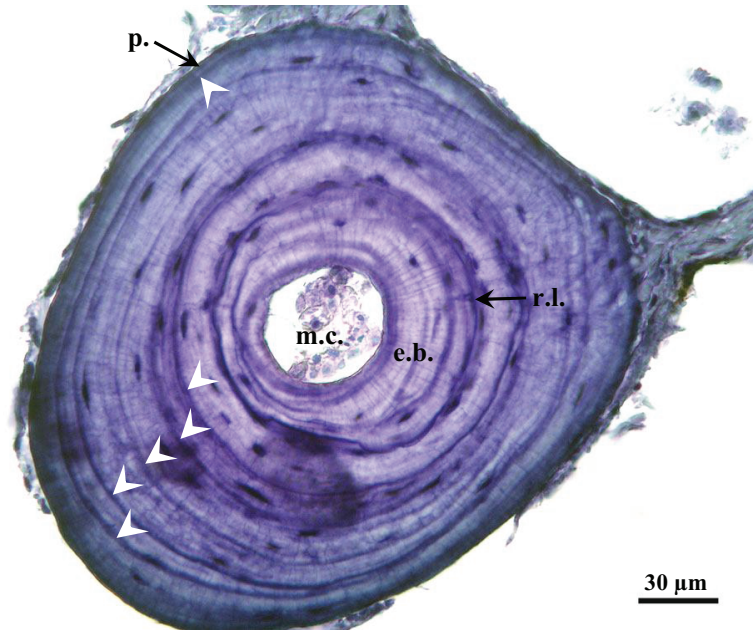


Figure 1. Cross-section (18 μm thick) at the diaphysis level of a phalanx of male *E. suphani*, 60.52 mm SVL, 7 years old. Six LAGs were observed in the periosteal bone. The first LAG was destroyed by endosteal resorption and endosteal bone was present. Periphery was not regarded as a LAG. Arrows indicate endosteal resorption and periphery, and arrowheads indicate LAGs. e.b. = endosteal bone, m.c. = marrow cavity, r.l. = reversal line, p = periphery.

Age and size were strongly correlated in males ($r = 0.790$, $P < 0.05$) as well as in females ($r = 0.959$, $P < 0.05$) according to Pearson's correlation coefficients. The exponential regression fit the correlation between SVL and age in males ($y = 22.627e^{0.1325x}$, $R^2 = 0.730$, $P < 0.05$) while the polynomial regression fit in females ($y = -0.0381x^2 + 5.5393x + 17.508$, $R^2 = 0.920$, $P < 0.05$) (Figure 3) according to R^2 values.

4. Discussion

In this study, the skeletochronological method has been used successfully for age determination of an *E. suphani*

population from eastern Turkey. The same conclusion was also reached previously in the studies performed on the species *E. argus* (Kim et al., 2010) and *E. strauchi strauchi* (Altunışık et al., 2013). While determining the individuals' ages, we faced the problem of endosteal resorption. In this problem, the periosteal bone and endosteal bone replace (Hemelaar, 1985) and resorption completely or partially destroys the inner LAGs (Leclair, 1990; Guarino et al., 1995; Kyriakopoulou-Sklavounou et al., 2008). In our *E. suphani* samples, all sections from adult individuals exhibited endosteal resorption. According to some authors, this phenomenon may be linked to environmental conditions (Smirina, 1972) and changes related to altitude; e.g., populations living at high altitudes exhibited less resorption than lowland populations (Esteban et al., 1999), or conversely, less resorption was observed in lowland populations than in highland ones (Caetano and Castanet, 1993).

In this study, we also revealed the age distribution of an *E. suphani* population from a high-altitude (2180 m) locality in eastern Turkey for the first time. Maximum age was determined as 9 years for males and 10 years for females. These results are relatively concordant with the results (8 years and 11 years, respectively) reported for *E. argus* by Kim et al. (2010). However, Altunışık et al. (2013) found lower maximum longevity for males (7 years) and

Table. Descriptive statistics on snout–vent length (SVL, mm) and age (years) of *E. suphani* (n: number of individuals; SE: standard error).

	Males (n = 16)	Females (n = 7)	Juvenile (n = 1)
SVL (mm)			
Mean ± SE	60.88 ± 2.61	58.85 ± 2.44	37.45 ± 0.00
Range	52.10–95.39	(52.32–70.86)	-
Age (years)			
Mean ± SE	7.38 ± 0.22	7.86 ± 0.51	4 ± 0.00
Range	(6–9)	(6–10)	-

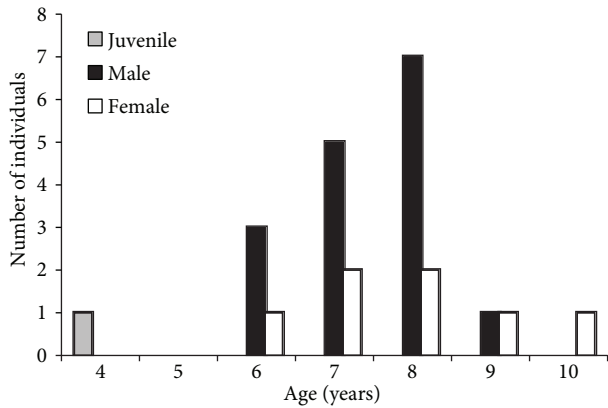


Figure 2. Age structure of the population of Suphan Racerunner *E. suphani* from eastern Turkey.

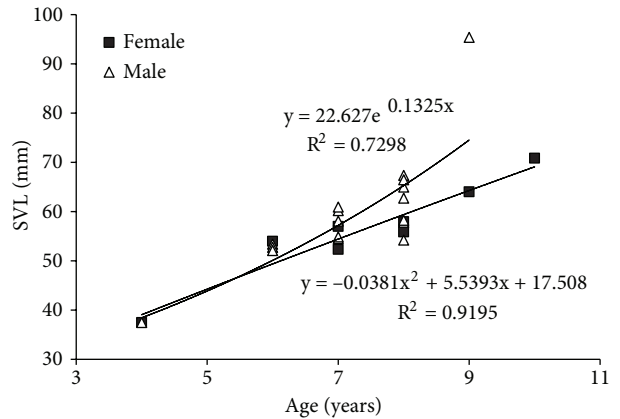


Figure 3. Regression of SVL on age in male and female *E. suphani*.

females (5 years) in *E. strauchi strauchi*. The mean ages, ages at sexual maturity, and longevity of the males and females were similar to each other in our population, and the difference in age between the sexes was not found to be statistically significant. Both sexes of *E. suphani* reached sexual maturity during the fifth or sixth year of their lives. Variation in age at sexual maturity has been recorded for *Eremias* spp. in the literature. Kim et al. (2010) reported that the age at sexual maturity was 2 years in *E. argus*, while Rastegar-Pouyani (2009) mentioned it as being 1 year for *E. velox*. These interspecific differences in age of sexual maturity and longevity can be explained by species-specific life history characteristics affected by environmental variation. Guarino et al. (2010) also reported that life history traits such as age at sexual maturity, longevity, and growth rates in reptiles can differ greatly between populations (even populations from the same species), especially depending on altitude and latitude. Moreover, as a general rule, individuals from northern latitudes and high altitudes have longer lifespans than individuals from southern latitudes and low altitudes (Wapstra et al., 2001; Roitberg and Smirina, 2006; Guarino et al., 2010).

In contrast to other lizard species in which females evidence longer SVLs than males (e.g., Haenel and John-Alder, 2002; Liu et al., 2008; Ahmadzadeh et al., 2009), the mean SVL of males was larger than females in *E. suphani*, but this difference was not found to be statistically significant. This result is concordant with the studies of *Agama impalearis* Boettger, 1874 (El Mouden et al., 1999); *Lacerta agilis boemica* Suchow, 1929 (Roitberg and

Smirina, 2006); and *Acanthodactylus boskianus* (Daudin, 1802) (Üzüm et al., 2014). Fitch (1981) also indicated that males are larger than females in most lizards. However, some authors did not find any significant difference between the sexes in terms of body length for some lizard species [e.g., *E. multiocellata* Günther, 1872 (Li et al., 2006); *Lacerta agilis* Linnaeus, 1758 (Guarino et al., 2010); *E. argus* Peters, 1869 (Kim et al., 2010); *Dinarolacerta mosorensis* (Kolombatovic, 1886) (Tomašević et al., 2010); and *E. strauchi strauchi* (Altunışık et al., 2013)].

E. suphani showed a low level of male-biased SSD. This result is concordant with the results of some studies of other lizards as well [e.g., *Lacerta agilis* (Roitberg and Smirina, 2006); *Eremias strauchi strauchi* (Altunışık et al., 2013); *Acanthodactylus boskianus* (Üzüm et al., 2014)]. According to some authors, sexual dimorphism in lizards generally results from sexual selection, especially mediated by male–male competition for mates (Vitt and Cooper, 1985; Shine, 1989; Hews, 1990; Vincent and Herrel, 2007), whereas others have indicated that the cause of this dimorphism is natural selection caused by factors such as food competition (Best and Gennaro, 1984).

To conclude, we obtained the preliminary results of some life history characteristics of *E. suphani* such as body size, age at maturity, and longevity. In addition, our study serves as an important contribution to the related literature. However, further studies with larger numbers of individuals are also needed to reflect results for the entire population living in nature.

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