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Age structure and body size of the Strauch's racerunner, *Eremias strauchi strauchi* Kessler, 1878

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Abstract: We studied, for the first time, the age structure of *Eremias strauchi strauchi* (Kessler, 1878) from a sample (18 adults) of a population living in the vicinity of Iğdır (eastern Turkey) using the skeletochronological method. The maximum observed longevity was 7 years for males and 5 years for females. The age of males ranged from 4 to 7 years (mean 4.91, n = 12), while that of females ranged from 4 to 5 years (mean 4.66, n = 6). The average snout–vent length (SVL) was 61.10 mm in males and 60.82 mm in females. The differences in mean age and SVL between sexes were not statistically significant. Intersexual differences in body size were male-biased, but this state was not statistically significant. Age and SVL were positively correlated in both sexes.

Key words: Lacertidae, *Eremias strauchi strauchi*, age, sexual dimorphism, Turkey

1. Introduction

The Strauch's racerunner (*Eremias strauchi*) is a small-size lizard species belonging to the family Lacertidae, Reptilia. *Eremias strauchi* has 2 subspecies. The nominative subspecies (*Eremias strauchi strauchi* Kessler, 1878) ranges from South Armenia and Azerbaijan (in Zuvand, Nakhichevan, and southwestern Azerbaijan) into northwestern Iran and Turkey (eastern Anatolia region in the vicinities of Iğdır and Tuzluca). The second subspecies (*Eremias strauchi kopetdaghica* Szczerbak, 1972) is present in the Kopet Dagh of northwestern Iran (northern Khorasan and eastern Mazanderan) and southern Turkmenistan (Agasyan et al., 2009). In Iran, the species has been recorded from silty soil, red sandstone, slopes, ridges, and alluvial valleys and the vegetation at the known sites is generally sparse, overgrazed dry shrubs and steppe (Anderson, 1999). In Turkey, the species is found in desert-like, dry open places with pebbly substrates and little vegetation. They feed on insects and some plant material. The total body length is up to approximately 200 mm. The dorsal surface of the body is greenish brown-gray, spotless, and there are dark and light maculations on the ventral region. The lizard hides in cracks and crevices and can also burrow. The female lays 2 clutches of 3–7 eggs annually (Baran and Atatür, 1998).

Many studies have been conducted about genus *Eremias.* Some of these studies concern mating behavior (Kim et al., 2012a), sexual size dimorphism (SSD) (Li et al., 2006), reproduction (Tang et al., 2012; Yue et al., 2012), phylogeny (Guo et al., 2011), home range (Kim et al., 2012b), and genetics (Chen et al., 2012). The only demographic study about this genus is on the species *Eremias argus* (Kim et al., 2010). Although the morphological features of *Eremias strauchi strauchi* (Ahmadzadeh et al., 2009) have been studied, there are no data available about the age structure of this subspecies.

Skeletochronology is a method for estimating age using the presence of growth layers in bone tissue and counting the lines of arrested growth (LAGs) (Castanet and Smirina, 1990). This method has been used to determine ages of many amphibian and reptile species (Yılmaz et al., 2005; Üzüm, 2009; Kim et al., 2010; Tomašević et al., 2010). Although it has been stated that age determination by skeletochronology in lizards deviates by 1 or 2 years from ages calculated via the mark–recapture method (Smirina and Tsellarius, 1996), skeletochronology has been preferred to other methods because of its time-saving feature.

In this study, we describe for the first time the age structure, body size, and sexual dimorphism of an *Eremias strauchi strauchi* sample population located in Iğdır, in eastern Turkey.

2. Materials and methods

We used 18 preserved (12 ♂♂ and 6 ♀♀) *Eremias strauchi strauchi* specimens stored in the herpetological collection

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of the Department of Biology Zoology Section at Çanakkale Onsekiz Mart University, Turkey (Collection number: 84/2008). The specimens were randomly collected by hand from Melekli village (39°58′N, 44°13′E, 838 m above sea level), in the vicinity of Iğdır (in the east of Turkey, neighbor to Armenia, Iran, and Nakhichevan) in 2008. *Testudo graeca*, *Phrynocephalus horvathi*, *Eremias pleskei*, *Trachylepis aurata*, *Malpolon monspessulanus*, and *Eryx jaculus* are the other reptile species located sympatrically with *Eremias strauchi* specimens within the area. The specimens were obtained from the surface of rocky and dune areas. The dominant plant cover in the localities is composed of the species *Tribulus terrestris*, *Euphorbia* sp., *Eryngium* sp., *Artemisia* sp., *Xeranthemum annuum*, *Petrosimonia squarrosa*, *Alhagi* sp., *Astragallus* sp., *Thymus pabescens*, *Aeluropus* sp., *Stipa* sp., *Taeniatherum* sp., *Eremopyrum* sp., *Ziziphora* sp., and *Achillea* sp. (Tosunoğlu et al., 2011).

The specimens were captured between 0500 and 0900 in June and were fixed in 95% ethyl alcohol and preserved in glass jars with 70% ethyl alcohol. The annual mean relative humidity in the region is around 63%. Throughout the year, the level of relative humidity reaches a maximum value in December (73%) and a minimum value in July (53%).

For each individual, we determined sex based on the presence of a hemipenis, measured snout–vent length (SVL) to the nearest 0.01 mm using digital calipers (Mitutoyo Corp., Kawasaki, Japan), and clipped the longest toe of the right hindlimb, including the first and second phalanges. Toe samples were stored in 70% ethanol and successively used in histological analysis.

We estimated age using skeletochronology (Castanet and Smirina, 1990). After the digits were dissected, the phalanges were washed in running tap water for 24 h, decalcified in 5% nitric acid for 2 h, and then washed again under running tap water for 12 h and embedded in cryomatrix (Thermo). Cross-sections (16 µm) of the diaphyseal part of each phalanx were obtained using a freezing microtome and stained in Ehrlich's hematoxylin. The sections were submerged in glycerol for observation under a light microscope. We assessed the endosteal resorption of the first LAG by comparing the diameters of eroded marrow cavities with the diameters of noneroded marrow cavities in sections from the youngest (4-year-old) specimens. The number of LAGs was assessed independently by 2 observers (A. Altunışık and T. Ergül) and the results were compared.

Both SVL and age showed normal distribution (Kolmogorov–Smirnov test, $P > 0.05$) and homogeneity of variance (Levene test, $P > 0.05$). We used the independent sample t test to compare variables between sexes and Pearson's correlation coefficient was computed to infer the pattern of relationships between SVL and age. The best regression model was selected according to R^2 values. Data analysis was performed using SPSS 18.

We quantified SSD with the Lovich and Gibbons (1992) index: sexual dimorphism index (SDI) = (size of larger sex / size of smaller sex) ± 1, where the result is arbitrarily defined as positive (minus one) when females are larger and negative (plus one) in the opposite case.

3. Results

Descriptive statistics of age and body length are summarized in the Table. The average SVL of males was 61.10 ± 4.76 mm (range 52.01–71.38) and in females it was 60.82 ± 3.53 mm (range 55.13–63.65). LAGs were clearly marked and relatively easy to count in all phalangeal cross-sections as can be seen in Figure 1. The first LAG was partially eroded in 57% of the individuals and completely eroded in 20% because of endosteal resorption, which creates partial erosion of the periosteal bone on the edge of the marrow cavity. In addition, we observed double lines in 66% of the individuals.

The minimum age for adult lizards was found to be 4 years for both males and females. The maximum observed lifespan was 7 years in males and 5 years in females. The age of males ranged from 4 to 7 years (mean 4.91 ± 0.99, n = 12), whereas those of females were 4 and 5 years (mean 4.66 ± 0.51, n = 6) (Figure 2). There was no significant difference in terms of mean age between the sexes ($t = -0.57$, $df = 16$, $P > 0.05$).

SVL did not significantly differ between females and males ($t = 0.13$, $df = 16$, $P > 0.05$). Intersexual differences in body size were male-biased (SDI: –0.004), but this state was not statistically significant. A significant positive correlation was found between age and SVL in males ($r = 0.90$, $P < 0.01$) and in females ($r = 0.97$, $P < 0.01$). Considering the small sample size of females, we

Table. Age and SVL of an *Eremias strauchi strauchi* sample population.

		Age (years)		SVL (mm)	
Sex	N	Mean ± SD	Range	Mean ± SD	Range
Males	12	4.91 ± 0.99	4–7	61.10 ± 4.76	52.01–71.38
Females	6	4.66 ± 0.51	4–5	60.82 ± 3.53	55.13–63.65

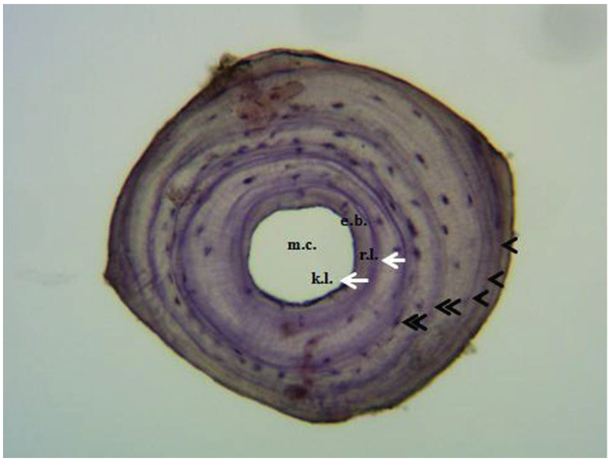

Figure 1. A cross-section (16 µm in thickness) at the diaphysis level of a phalanx of a female *Eremias strauchi strauchi* individual (m.c. = marrow cavity, r.l. = resorption line, k.l. = Kastschenko line, and e.b. = endosteal bone). The 5 LAGs are indicated by black arrows (double LAGs with double arrows).

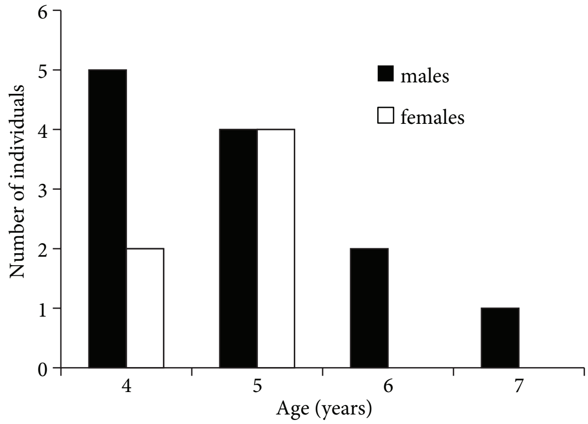

Figure 2. Age frequency distributions for males and females of an *Eremias strauchi strauchi* sample population.

performed regression analysis only for males and a simple linear regression fitted between age (x-axis = years) and body size (y-axis = mm) ($y = 39.97 + 4.29x$, $R^2 = 0.809$).

4. Discussion

We provide here the first data on age and body size of an *Eremias strauchi strauchi* sample population in Iğdır, eastern Turkey. In our study, we found the maximum observed longevity to be 7 years for males and 5 years for females. For *Eremias argus* females and males, it has been reported as 11 years and 8 years, respectively (Kim et al., 2010).

In our study, the SVL mean of females did not significantly differ from that of males, although the latter were bigger on average. Similar to our results, no statistically significant difference between the sexes was reported in the studies of *Eremias multiocellata* (Li et al., 2006), *Phymaturus patagonicus* (Piantoni et al., 2006), *Lacerta agilis* (Guarino et al., 2010), and *Eremias argus* (Kim et al., 2010). In contrast to our study, the SVL mean of females was significantly larger than that of males in *Sceleporus undulatus* (Haenel and John-Alder, 2002) and *Lacerta vivipara* (Liu et al., 2008). Although Ahmadzadeh et al. (2009), who studied the morphological features of the same subspecies, *Eremias strauchi strauchi*, with ecological and biological observations, found that the SVL mean of females (64.96 mm) was larger than that of males (64.01 mm), they did not support this finding with any statistics. Our results resemble that study for not having any statistically significant differences in terms of SVL.

Sexual dimorphism in body size, coloration, and a variety of morphological characteristics is well known in amphibians and reptiles. In lizards, aggressive interactions among males appear to result in sexual dimorphism, and males are larger than females regardless of whether or not the lizards are territorial (Vitt and Caldwell, 2009). Males are the larger sex in most lizards (Fitch, 1981). Some authors have suggested that this sexual dimorphism has evolved as a result of competition between the sexes for a limited resource, usually food (Best and Gennaro, 1984). Others have proposed that sexual selection, mediated by male–male competition for mates, is the primary cause (Vitt and Cooper, 1985; Hews, 1990). Because of sufficient food availability in Melekli village (pers. obs.), the latter cause may be more important to explain our results.

In the present study, this lizard exhibited a very low level of male-biased SSD in adult animals based on the SVL. This result is in agreement with surveys of *Agama impalearis* (El Mouden et al., 1999), *Lacerta agilis boemica* (Roitberg and Smirina, 2006), and *Dinarolacerta mosorensis* (Tomašević et al., 2010). However, no sexual dimorphism was indicated between sexes based on the SVL in the study of *Eremias argus* (Kim et al., 2010).

Lizards exhibit indeterminate growth, implying that body size increases with age (Bauwens, 1999). In the studied population, the relationship between age and SVL is statistically significant. Similar results have been recently reported for some other lizard species (*P. patagonicus*, Piantoni et al., 2006; *D. mosorensis,* Tomašević et al., 2010; *L. agilis*, Guarino et al., 2010; *E. argus*, Kim et al., 2010).

In our skeletochronological samples, we observed a consistent number of double LAGs appear as very closely adjacent lines (Castanet et al., 1993). These double LAGs are caused by unpredictable ecological factors such as very high temperatures, very dry conditions, variations in food availability, and other occasional environmental changes (Jakob et al., 2002; Guarino and Erismis, 2008). Iğdır has a semiarid continental climate with hot dry summers, and cold snowy winters, and is the driest city in Turkey (total yearly precipitation of 260.3 mm) close to the borderline of the arid climate that nevertheless does not exist in Turkey (www.dmi.gov.tr, Iğdır Observation Station, 1970–2011). In Iğdır, a possible effect on growth of the arid period in summer (mean temperature of 24.43 °C and maximum of 41.8 °C in August) and/or the cold period in winter (mean of 1.43 °C and minimum of –30.3 °C in December) may be the cause of the high percentage of double lines.

In conclusion, the results of our skeletochronological analysis show that the specimens reached 7 years longevity and intersexual differences in body size were male-biased, which was not statistically significant. However, further studies on a larger scale (i.e. more samples) or on the other subspecies, *Eremias strauchi kopetdaghica,* would give us more comprehensive data about the body size and age structure of the species.

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