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## Age and growth of the red-bellied lizard, *Darevskia parvula*

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Submitted: August 18, 2015. Final revision received: December 18, 2015.

Accepted: January 20, 2016

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### Abstract

In the present study, we investigated potential effects of some environmental climatic factors on life-history traits of two *Darevskia parvula* populations located at different elevation sites and evaluated age, body size, SSD and growth rate results in these lizards. The age at maturity and longevity were found to be similar in both populations. Males of the highland population had significantly larger snout-vent length and older age than those of the lowland population. Although the mean ages of females were not significantly different between the two populations, the highland population had significantly larger snout-vent length than the lowland population. Considering all individuals (both males and females), we found that specimens from the population in the higher-elevation site had significantly larger snout-vent length and older age than those of the lower-elevation site. A low level of male-biased sexual size dimorphism was observed in both populations. The growth coefficient was lower in the high-elevation site than the lower elevation site. Growth rates were not significantly different between the populations. Our preliminary results indicate that although our studied populations were located at different elevation sites and had distinct climate, longevity, age at sexual maturity and growth rate results were similar. This may be a reason of the lower male-biased sexual size dimorphism in both populations.

### Keywords

Growth rate; longevity; sexual size dimorphism; skeletochronology; SVL; von Bertalanffy

### Introduction

Many ecological studies are performed to learn about the lifespan of reptilian species (Tinkle, 1967; Davbin, 1982; Gibbons & Semlitsch, 1982; Hutton, 1986; Barbault & Mou, 1988; Frazer et al., 1991). These studies generally focused on age structure. The mark-recapture and skeletochronology are only two techniques to calculate ages of terrestrial animals (Halliday & Verrell, 1988; Gül et al., 2014).

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Skeletochronology, which is known as a very effective and reliable method, is used to calculate age by using presence of growth layers in the bone tissue and counting the lines of arrested growth (LAGs) in reptilian species ([Castanet, 1994](#); [Nayak et al., 2008](#); [Guarino et al., 2010](#); [Kim et al., 2010](#); [Kolarov et al., 2010](#); [Arakelyan et al., 2013](#); [Kurita & Toda, 2013](#)). For age determination of Turkish reptiles, a growing number of studies has been recently performed ([Altunışık et al., 2013](#); [Arakelyan et al., 2013](#); [Tok et al., 2013](#); [Gül et al., 2014, 2015](#); [Üzüm et al., 2014, 2015](#); [Kanat & Tok, 2015](#); [Yakın & Tok, 2015](#)).

Environmental factors such as elevation, drought, and climate in the habitats of lizards affect their longevity and life history ([Gül et al., 2014](#)). As a rule, individuals from high-elevation sites and northern latitude live longer than those from low-elevation sites and southern latitudes ([Wapstra et al., 2001](#); [Roitberg & Smirina, 2006](#); [Guarino et al., 2010](#)). Thermal constraints may provide a possible explanation for this trend ([Guarino et al., 2010](#)).

Growth rates are dependent on food availability and the thermal environment ([Adolph & Porter, 1993](#)). Previous examples of growth rate variation along bioclimatic gradients support the hypothesis that populations living at cooler sites should either grow faster ([Merilä et al., 2000](#); [Caley & Schwarzkopf, 2004](#); [Conover et al., 2009](#)) or compensate their slower growth rate with larger eggs and hatchlings and delayed maturity ([Berven, 1982](#); [Liao & Lu, 2010a, 2012](#)). Lizards will grow faster at the high elevation site because of the better growth environment driven by higher precipitation levels, associated types of vegetation (e.g., deciduous forests) and, ultimately, higher productivity ([Iraeta et al., 2006](#)).

The red-bellied lizard, *Darevskia parvula* ([Lantz & Cyren, 1913](#)), is distributed in the Eastern Black Sea and Eastern Anatolia regions of Turkey and the Adjara autonomous region of Georgia ([Baran & Atatür, 1998](#); [İlgaz, 2009](#); [IUCN, 2014](#)). It has been classified at the LC (Least Concern) category in the IUCN Red List of Threatened Animals since 2009. Although *Darevskia parvula* lives in a large area (Trabzon, Rize, Artvin, Ardahan and Kars provinces) in Turkey ([Darevsky & Eiselt, 1980](#); [İlgaz, 2009](#)), there is no detailed study based on population dynamics (age structure, size, longevity, age at maturation and growth rate) on the species. Therefore, the present study aimed to assess i) the effects of some conditions (e.g., temperature and altitude) on age structure, longevity and body length, ii) the relationships in longevity and age at sexual maturity with sexual size dimorphism (SSD) and growth rates, in two *Darevskia parvula* populations located at different elevation sites in Turkey, for the first time by using skeletochronology.

## Material and methods

Lizards were collected from two populations (Pirnallı and Kemalpaşa populations located in Artvin Province of Turkey) at different altitudes during the breeding season (number of permission to capture: 72784983-488.04-113808). The Pirnallı population (41°29'30"N, 42°02'92"E) is located in a highland area at an altitude of

1484 m a.s.l. The habitat of the population occurs in woodland. The specimens were caught in a stony place on the edge of a forest road. *D. parvula* lives in sympatry with *D. derjugini* and *Lacerta media* in this population. The Kemalpaşa population (41°29'23"N, 41°31'23"E) is located in a lowland area at an altitude of 17 m a.s.l. The specimens were caught from a rocky slope on the edge of the Hopa-Sarp highway.

The active period for lizards changes from early April to early October in Pırnallı and from early April to late October in Kemalpaşa. The average air temperatures in daytime were recorded as 31°C and 28°C, respectively, during the sampling period (between 20-25 July 2015 for Pırnallı and 5-10 August 2015 for Kemalpaşa). The mean annual temperature, precipitation, and humidity of the Pırnallı site were 10.6°C, 60.33 mm, and 71.65%, respectively. During the active period of the lizards, the mean temperature, precipitation, and humidity were 16.3°C, 78.22 mm, 69.55%, respectively. The mean annual temperature, precipitation, and humidity of the Kemalpaşa site were 16.3°C, 128.80 mm, and 70.81%, respectively. During the active period of the lizards, the mean temperature, precipitation, and humidity were 19.8°C, 108.17 mm, 76.57%, respectively.

Within each site, the lizards were caught by hand and sexed by direct examination of sexual organs and the secondary sex characteristics (e.g., dark blue spots on the margins of ventral plates and more conspicuously red-belly in the males). Snout-vent length (SVL) was measured to the nearest 0.01 mm using a digital caliper. We quantified Sexual Size Dimorphism (SSD) with the Lovich & Gibbons (1992) index according to the following formula:

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

In this formula, +1 is used if males are larger than females and defined as negative, or -1 is used if females are larger than males and defined as positive arbitrarily (Üzüm et al., 2014).

For each lizard, the second phalange from the longest finger of the hind limb was clipped and preserved in 10% formalin solution for subsequent histologic analyses. After registration and toe-clipping, the lizards were released back into their natural habitats. The animals were treated in accordance with the guidelines of the local ethics committee (KTÜ.53488718-649/2014/54).

A total of 92 specimens (50 ♂♂, 39 ♀♀ and 3 subadults) were caught [46 specimens (22 ♂♂, 22 ♀♀ and 2 subadults) from Pırnallı and 46 ones (28 ♂♂, 17 ♀♀ and 1 subadult) from Kemalpaşa]. The procedure of skeletochronology is based on calculation of the lines of arrested growth (LAGs) in transverse sections of the middle part of phalangeal diaphyses using a portion of the second phalanx from the third toe (Gül et al., 2014). However, the phalangeal LAGs could not be real age of individuals. The phalangeal LAGs are generally 1-2 years lower especially in older individuals. The LAGs in older individuals can be obscured by replacement of periosteal bone with endosteal bone (Hemelaar, 1985; Sagor et al., 1998). In phalanges in which first LAG has been completely destroyed by endosteal resorption,

the innermost visible LAG was actually deposited during the second, rather than the first (Sagor et al., 1998). In the cross-sections of the present study, it was observed that the resorption zone was not reached the first LAG in all specimens.

After skins of the toes preserved in 10% solution of formaldehyde were peeled, they were left for 2.5 hours in 5% nitric acid solution for decalcification of bone tissue. Afterwards, all samples of the toes were loaded tissue processing system (Tissue processor with Leica brand). Then, all tissue samples were embedded to paraffin with tissue embedding device (Thermo brand). The cross-sections (15  $\mu\text{m}$ ) were obtained from embedded phalanges with a rotary microtome, after which they were stained using the haematoxylin procedure. The stained cross-sections, which were put on the microscope slides, were closed using entellan. Finally, the cross-sections were observed under a light microscope.

Age determination was estimated using skeletochronology analysis (Castanet & Smirina, 1990; Smirina, 1994). The numbers of LAGs on the cross-sections were independently calculated by three observers (U. Bülbul, A.İ. Eroğlu & M. Kurnaz) and results were compared. The observed double lines were not taken into account for age determination. As previously stated in the study of Özdemir et al. (2012), we assessed endosteal resorption of the first LAG by comparing the diameters of eroded marrow cavities with the diameters of non-eroded marrow cavities in sections from the youngest specimens. The distance between two adjoining LAGs is a good indicator of individual growth in a given year (Kleinenberg & Smirina, 1969; Özdemir et al., 2012). Where we observed an obvious decrease in spacing between two subsequent LAGs, we took it to mark the age when sexual maturity was achieved (Ryser, 1998; Yılmaz et al., 2005; Özdemir et al., 2012). Uncountable cross-section samples were not incorporated into our study. Any serious problems depend on age estimation was not caused by the endosteal resorption.

Because age classes and body measurements (SVL) were normally distributed (One-Sample Kolmogorov-Smirnov Test,  $P > 0.05$ ) we used parametric test for comparison of means (Independent Sample t-test,  $P < 0.05$ ) and for correlation (Spearman's correlation,  $P < 0.01$ ). All statistic tests were processed with IBM SPSS 21.0 for Windows and the level of significance chosen was  $P < 0.05$ .

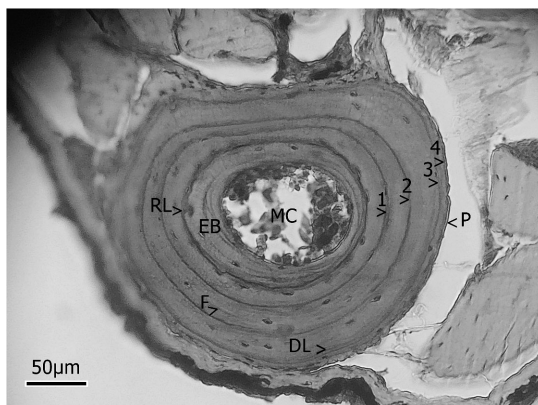
The growth patterns were estimated according to the von Bertalanffy growth model, which previous studies have shown to be the model that better fits the relation between body size and age (James, 1991; Wapstra et al., 2001; Roitberg & Smirina, 2006; Guarino et al., 2010). The general form of the von Bertalanffy growth equation used is  $L_t = L_\infty(1 - e^{-k(t-t_0)})$ , where  $L_t$  is length at age  $t$ ,  $L_\infty$  is a parameter depicting asymptotic maximum length,  $e$  is the base of the natural logarithm,  $k$  is a growth coefficient, and  $t_0$  is the age at hatching, which is the starting point of the growth interval under the present study. As applied in the study of Guarino et al. (2010), we assumed as size at hatching ( $L_{t_0} = 25.5$  mm) the mean value provided by In den Bosh & Bout (1998) because of the lack of incontrovertible data on the size at hatching of the studied populations, due to lack of young lizards collected during the field studies. The parameters  $L_\infty$  (asymptotic SVL) and

$k$ , and their asymptotic confidence intervals ( $CI$ ), were estimated using a non-linear regression procedure by means of the IBM SPSS 21.0 software program. Then, the growth rates were calculated as  $R = k(L_{\infty} - L_t)$ . Growth curves were considered to be significantly different if the 95% confidence intervals did not overlap (James, 1991; Wapstra et al., 2001).

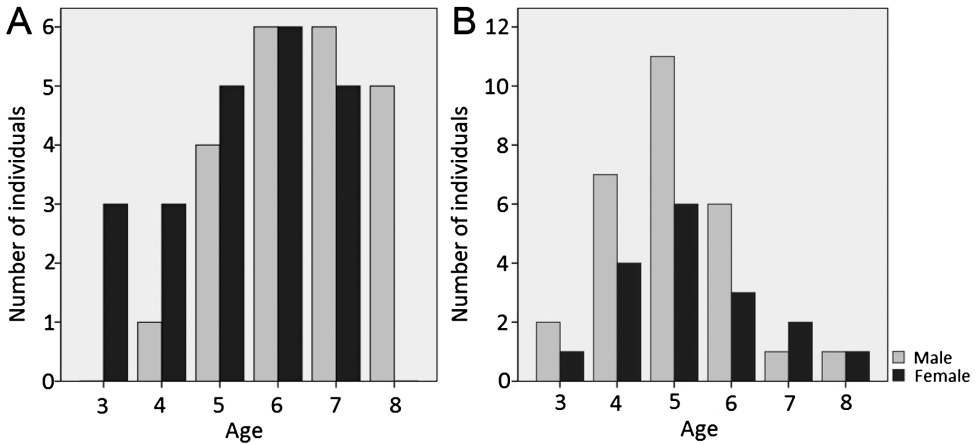
## Results

The lizards in both populations have different ecological, but similar anthropogenic conditions. The Pınallı and Kemalpaşa sites are not highly populated and agricultural activity is not intensive in both habitats of the lizards. But ecological conditions of both populations are different. Although the Pınallı population is located in woodland and specimens were caught in a stony place on the edge of forest road, individuals of the Kemalpaşa population were caught from an area consisting of a rocky slope on the edge of highway.

A growth zone and thin hematoxylinophilic outer line corresponding to a winter line of arrested growth were present in cross-sections of the phalanges in 100% of adult individuals of both the Pınallı ( $N = 44$ ) and Kemalpaşa ( $N = 45$ ) populations (fig. 1). The resorption zone did not reach the first LAG in all specimens. The resorption zone clearly seemed out of endosteal bone in all preparations for both populations, and never created difficulty for age determination. We observed double lines in 24 (54.50%) specimens of the Pınallı population and in 26 (57.80%) of the Kemalpaşa population. The oldest females and males were 7 and 8 years old, respectively, in the Pınallı population while the maximum age for both sexes in the Kemalpaşa population was 8 years (fig. 2). The age at maturation was 2 years for both sexes in the Pınallı population while it was 1-2 years for both sexes in the



**Figure 1.** A cross-section (15  $\mu\text{m}$  thick) through a phalange of a four-year-old male (49.77 mm SVL) *D. parvula* from the Pınallı population. Abbreviations: DL, Double line; EB, Endosteal bone; F, False line; MC, Marrow cavity; P, Periphery; RL, Resorption line; see also text. Periphery was not regarded as a line of arrested growth (LAG).



**Figure 2.** Age distributions for male and female *D. parvula* from the Pirnallı (A) and Kemalpaşa (B) populations.

Kemalpaşa population. The age at maturity was 2 years (100%) in all specimens of the Pirnallı population while it was 1 year in 1 (4.26%) specimen and 2 years in 44 (95.74%) specimens of the Kemalpaşa population.

The means of SVL and age values were  $54.23 \pm 0.45$  mm and  $5.89 \pm 0.21$  years for the Pirnallı population ( $55.21 \pm 0.58$  mm;  $6.46 \pm 0.25$  years in male specimens and  $53.27 \pm 0.63$  mm;  $5.32 \pm 0.29$  years in female specimens), respectively. In the Kemalpaşa population, means of SVL and age values were  $51.87 \pm 0.51$  mm and  $5.03 \pm 0.18$  years ( $52.85 \pm 0.63$  mm;  $5.00 \pm 0.21$  years in male specimens and  $50.30 \pm 0.72$  mm;  $5.24 \pm 0.32$  years; in female specimens), respectively. Descriptive statistics of both populations are given in Table 1.

#### *Age, body length and growth between sexes in the Pirnallı population*

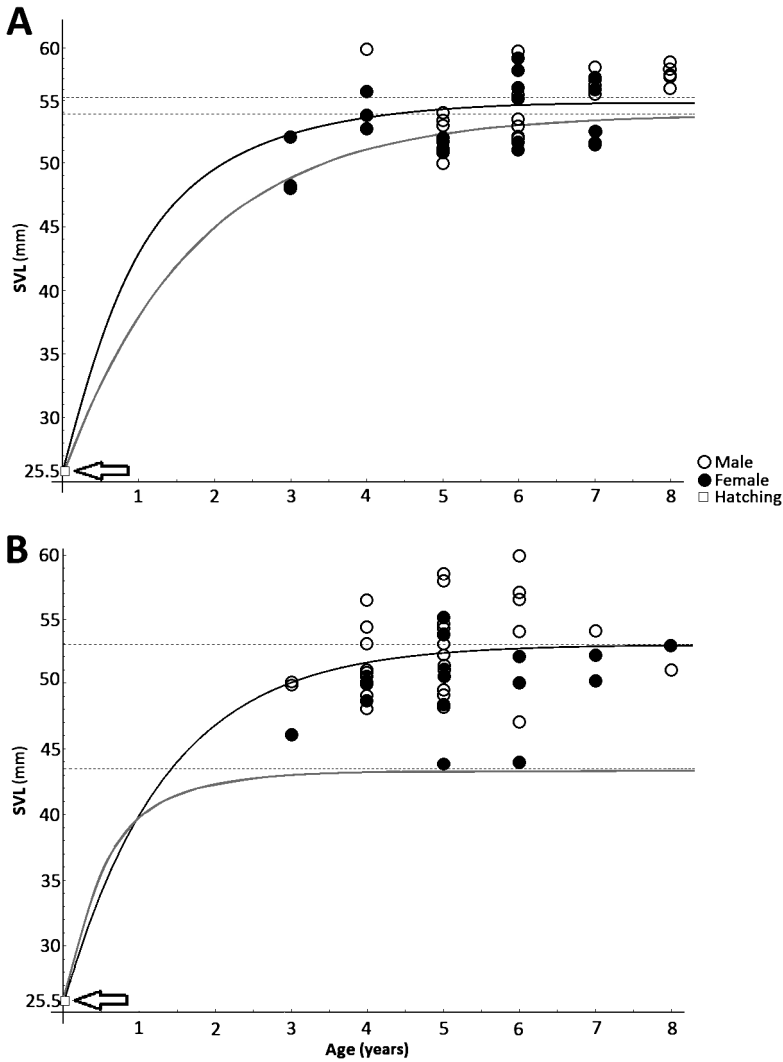
Age ranged from 3–7 years in females and 4–8 years for males. The mean age of the specimens was found to be significantly different between the sexes (Independent Sample t-test;  $t = 2.957$ ,  $df = 42$ ,  $P = 0.005$ ). Intersexual differences in body size (length) was male-biased (SDI =  $-0.04$ ). The mean SVL ( $t = 2.259$ ,  $df = 42$ ,  $P = 0.029$ ) differed significantly between sexes. There was no correlation between SVL and age for both males (Spearman's correlation  $r = 0.256$ ,  $P = 0.250$ ) and females ( $r = 0.334$ ,  $P = 0.129$ ). Growth pattern estimated by von Bertalanffy showed a good fit to the relation between age and SVL (fig. 3). For both sexes, the estimated asymptotic SVL was slightly smaller than the maximum SVL recorded ( $SVL_{asym} \pm CI$ , males:  $55.13 \pm 11.1$  mm; females:  $53.85 \pm 9.56$  mm). The growth coefficient was higher in males than in females ( $k \pm CI$ , males:  $0.98 \pm 0.20$ ; females:  $0.58 \pm 0.18$ ). The growth curve of males was significantly different from that of females. Growth rates of the males and females were not significantly different within the population (Independent Sample t-test;  $t = -2.183$ ,  $df = 4.37$ ,  $P = 0.089$ ). Descriptive statistics of the growth rates are given in Table 1.

**Table 1.**

Descriptive statistics of age, snout-vent length (SVL in mm) and growth rate (mm per year) in both populations. Abbreviations: *N*, number of samples; Range, maximum and minimum values; SD, standard deviation; SE, standard error.

Descriptive statistics	♂♂			♀♀			♀♀ + ♂♂		
	SVL	Age	Growth rate	SVL	Age	Growth rate	SVL	Age	Growth rate
<b>Pırmallı</b>									
<i>N</i>	22	22	5	22	22	5	44	44	6
Mean	55.21	6.46	0.33	53.27	5.32	2.31	54.24	5.89	2.05
Range	50.14-59.90	4-8	0.02-1.05	47.94-59.40	3-7	0.52-5.43	47.94-59.90	3-8	0.31-5.57
SE	0.58	0.25	0.19	0.63	0.29	0.89	0.45	0.21	0.82
SD	2.72	1.84	0.43	2.97	1.36	1.98	2.98	1.39	2.00
<b>Kemalpaşa</b>									
<i>N</i>	28	28	6	17	17	6	45	45	6
Mean	52.83	5.00	1.29	50.30	5.24	0.04	51.88	5.09	1.01
Range	47.38-59.92	3-8	0.09-4.15	44.51-54.95	3-8	0.00-0.19	44.51-59.92	3-8	0.05-3.48
SE	0.64	0.21	0.63	0.72	0.32	0.03	0.51	0.18	0.54
SD	3.34	1.12	1.56	2.96	1.30	0.08	3.40	1.18	1.32





**Figure 3.** The von Bertalanffy growth curves for males (open circle, solid line) and females (solid circle, grey line) of *D. parvula* from the Pınallı (A) and Kemalpaşa (B) populations. The open square and arrow show SVL mean of the lizards at hatching as reported by In den Bosch & Bout (1998). Growth parameters are given in the text.

#### *Age, body length and growth between sexes in the Kemalpaşa population*

Age ranged from 3–8 years in both females and males. The mean age did not differ significantly between males and females (Independent Sample t-test;  $t = -0.642$ ,  $df = 43$ ,  $P = 0.524$ ). Intersexual differences in body size (length) was male-biased (SDI =  $-0.05$ ). The mean SVL differed significantly between the sexes ( $t = 2.566$ ,  $df = 43$ ,  $P = 0.014$ ). There was no correlation between age and SVL for both males (Spearman's correlation  $r = 0.216$ ,  $P = 0.269$ ) and females ( $r = 0.339$ ,  $P =$

0.183). The growth pattern estimated by von Bertalanffy showed a good fit to the relation between age and SVL (fig. 3). For both sexes, the estimated asymptotic SVL was slightly smaller than the maximum SVL recorded ( $SVL_{asym} \pm CI$ , males:  $52.94 \pm 7.82$  mm; females:  $43.99 \pm 0.81$  mm). The growth coefficient was lower in males than in females ( $k \pm CI$ , males:  $0.75 \pm 0.15$ ; females:  $2.05 \pm 0.02$ ). The growth curve of males was significantly different from that of females. Growth rates of the males and females were not significantly different within the population (Independent Sample t-test;  $t = 1.972$ ,  $df = 5.02$ ,  $P = 0.105$ ). Descriptive statistics of the growth rates are given in Table 1.

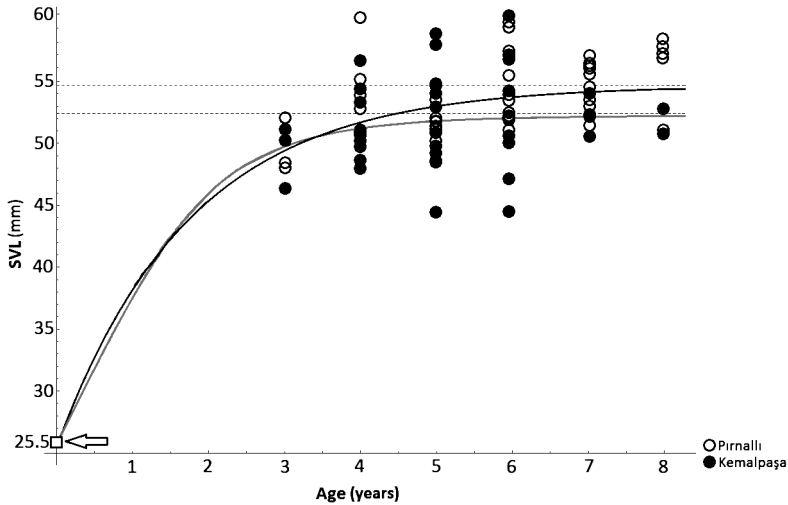
#### *Comparison of age, SVL and growth between populations*

Males of the Pırnallı population had significantly larger SVL ( $t = 4.440$ ,  $df = 48$ ,  $P < 0.05$ ) and older age ( $t = 2.709$ ,  $df = 48$ ,  $P < 0.05$ ) than males of the Kemalpaşa population. As in males, females of the Pırnallı population were significantly ( $t = 3.095$ ,  $df = 37$ ,  $P < 0.05$ ) bigger than females of the Kemalpaşa population. However, there were no significant differences in females between the two populations for the mean age ( $t = 0.192$ ,  $df = 37$ ,  $P = 0.848$ ). Considering all individuals (both males and females), it was found that the specimens of the Pırnallı population had significantly larger SVL ( $t = 0.738$ ,  $df = 87$ ,  $P < 0.05$ ) and older age ( $t = 0.198$ ,  $df = 87$ ,  $P < 0.05$ ) than those of the Kemalpaşa population. For all individuals in both populations, the estimated asymptotic SVL was slightly smaller than the maximum SVL recorded ( $SVL_{asym} \pm CI$ , Pırnallı population:  $54.69 \pm 6.67$  mm; Kemalpaşa population:  $52.10 \pm 2.75$  mm). The growth coefficient was lower in the high-elevation site than the lower elevation site ( $k \pm CI$ , Pırnallı population:  $0.57 \pm 0.12$ ; Kemalpaşa population:  $0.84 \pm 0.43$ ). Growth rates were not significantly different between the populations (Independent Sample t-test;  $t = -1.057$ ,  $df = 10$ ,  $P = 0.315$ ). Growth curves of both populations were significantly different (fig. 4). Descriptive statistics of the growth rates are given in Table 1.

#### **Discussion**

We observed double lines in 24 (54.50%) specimens of the Pırnallı population and in 26 (57.80%) ones of the Kemalpaşa population. Double lines are irregularities in bone deposition caused by unpredictable ecological factors, such as a dry period, hot climate, food availability and other conditions (Jakob et al., 2002; Guarino & Erişmiş, 2008; Özdemir et al., 2012).

Endosteal resorption in bone specimens also may be related to environmental conditions (Smirina, 1972). For example, Caetano & Castanet (1993) reported that fewer resorptions were observed in lowland populations than in populations living at high altitudes. A converse trend is reported in other lizard species (Arakelyan et al., 2013; Gül et al., 2014). However, we found no differences in the percentage of endosteal resorption in both populations (the resorption zone did not reach the first



**Figure 4.** The von Bertalanffy growth curves for all individuals of the Pırnallı (open circle, solid line) and Kemalpaşa (solid circle, grey line) populations of *D. parvula*. The open square and arrow show SVL mean of the lizards at hatching as reported by In den Bosch & Bout (1998). Growth parameters are given in the text.

LAG in all specimens). On the other hand, daily and annual activity and climate conditions probably have a strong effect on the intensity of bone resorption of long bones in animals (Hemelaar, 1988; Esteban, 1990; Leclair, 1990; Augert, 1992; Esteban et al., 1999).

A different climatic condition might affect population demography by generating differences in age structure and longevity (Özdemir et al., 2012). In colder environments, an increase in mean age with higher altitude has been reported for various lizard species (Roitberg & Smirina, 2006). Differences in average temperature and rainfall in both populations may be a reason for the higher mean age of the highland population in the present study. Although we found higher mean age in the highland population of *Darevskia parvula*, Gül et al. (2014) studied another rock lizard species (*Darevskia rudis*) and reported that the mean age of a highland population (2137 m a.s.l.) was lower than two lowland populations (700 and 1277 m a.s.l., respectively). Similar results were found for Agile Lizard (*Lacerta agilis*) and Striated Lizard (*Lacerta strigiata*) in the study of Roitberg & Smirina (2006).

Contrary to common prediction stating that animals live longer in higher elevation sites, we found maximum longevity 8 years in both populations. It may be the result of the similar length of the active periods of the lizards in both populations (6 months in the Pırnallı population and 6.5 months in the Kemalpaşa population). The longevity is not only dependent on the active period, but also related to altitude, latitude and other climatic and environmental factors. Although the climatic conditions were not similar between the Pırnallı and Kemalpaşa populations, we found similar maximum longevity in both populations. Also, Tarkhnishvili &

Gokhelashvili (1996) suggested that longevity might be related to the type of locality rather than climate, but while the types of the localities in our study were distinct we found similar maximum longevity. Similar to our results, the maximum longevity was found to be 8 years in *D. armeniaca*, *D. unisexualis* (Arakelyan et al., 2013) and *D. rudis* (Gül et al., 2014), but, 6 years in *D. sapphrina* and *D. uzzelli* (Arakelyan et al., 2013).

The pattern that many ectotherms have smaller body sizes in cold environments follows the converse to Bergmann's rule and is most frequently found in lizards (Jin & Liao, 2015). Smaller body size for lizards in colder climates may be the result of selection towards more rapid heating abilities (Pianka & Vitt, 2003). In contrast to this explanation, we found higher SVL in the highland population (having colder climate) for both sexes. When compared to body length between the sexes, the mean SVL of males was significantly greater than that of females in both populations. Contrary to our results, Gül et al. (2014) found a significant difference between the sexes in terms of SVL only in the highland population of *D. rudis*, while there were not significant differences in two lowland populations.

In our study, a low level of male-biased sexual size dimorphism (SSD) was observed in both populations. In contrast to our results, Gül et al. (2014) reported strong female-biased SSD in the highland population of *D. rudis* whereas SSD appeared male-biased, however, not statistically significant, in the lowland populations. They explained the higher level of SSD in the highland population as a result of colder environmental temperatures at the higher elevation site of the population. Although the higher elevation site had colder climate than the lower one in our study, we did not observe higher level of SSD differences. Further, the patterns of SSD variation may occur as a result of abiotic and biotic environmental factors. Therefore, SSD in lizards may be explained by differences in the SVL and climate (e.g., temperature and precipitation) between females and males (Roitberg, 2007). Although the lower elevation site had more rainfall than the higher one in our study, we did not observe higher level of SSD differences in both populations. On the other hand, longevity and age at first reproduction have been identified as the main determinants of SSD at an intra-specific or inter-specific level (Liao & Lu, 2010b; Lyapkov et al., 2010; Liao et al., 2013, 2015). Congruently, longevity and age at sexual maturation were found similar between both populations in the present study. Moreover, SSD in many adult lizards arises due to sexual differences in the growth rates, and the larger sex grows faster than the smaller sex (John-Adler & Cox, 2007; Tomašević et al., 2010; Üzümlü et al., 2014). Conformably, we found no significant difference between growth rates of both sexes in two populations and the observed male-biased SSD was very low in both populations. Although the prediction suggesting that lizards grow faster at the high elevation site is common, our growth rate results were not congruent with this expectation.

In the present study, the age of both sexes is not correlated with their body size (SVL) in both populations. Contrary to our findings, Gül et al. (2014) found a significant correlation between SVL and age in males of *D. rudis* while there was no

significant correlation in females. Based on relationships between SVL and each age class in the four parthenogenetic species, Arakelyan et al. (2013) found significant differences only between 4 years-old *D. uzzelli* and *D. unisexualis* and between 4 years-old *D. uzzelli* and *D. armeniaca*. The adult body size depends on many factors including age at maturity and longevity (Özdemir et al., 2012). According to the studies of Beebee & Griffiths (2000) and Olsson & Madsen (2001), male lizards mature earlier than females in some species. However; age at maturity in both populations was found similar for both sexes (2 years in Pirnallı and 1-2 years in Kemalpaşa) in our study. But, SVL was found to be significantly different between the sexes of both populations. Conformably, Olgun et al. (2005) also reported that age at maturity was greatly influenced by local conditions (e.g., reduction of the length of the active period).

In conclusion, our presented data on body size, longevity, age structure, and growth rate of *D. parvula* may contribute to life history traits of this species. Our preliminary results show similar growth rates between both populations (having similar longevity and age at sexual maturity) inhabiting different altitudes. Further long-term and detailed studies including different populations, under various environmental conditions, may reveal more comprehensive data.

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