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Research Article/Araştırma Makalesi

Age and Body Size of the Mediterranean Chameleon, *Chamaeleo chamaeleon* (Linnaeus, 1758) (Lacertilia: Chamaeleonidae) Specimens Collected from Adana, Türkiye

Elif YILDIRIM[1,4]*, Nurettin BEŞER[2], Can YILMAZ[3], Kamil CANDAN[1,4], Yusuf KUMLUTAŞ[1,4], Çetin ILGAZ[1,4], Elnaz NAJAFİ MAJD[5]

[1]*Dokuz Eylül University Faculty of Science, Department of Biology, Buca-İzmir, TÜRKIYE*
[2]*Aydın Adnan Menderes University, Department of Biology, Faculty of Science and Arts, Aydın, TÜRKIYE*
[3]*Hakkari University, Vocational School of Health Services, Medical Laboratory Techniques, 30000, Hakkari, TÜRKIYE*
[4]*Dokuz Eylül University Fauna and Flora Research Centre, 35610, Buca-İzmir, TÜRKIYE*
[5]*Ege Üniversity, Faculty of Science, Department of Biology, Bornova-İzmir, TÜRKIYE*
ORCID ID: Elif YILDIRIM: https://orcid.org/0000-0001-9614-5754; Nurettin BEŞER: https://orcid.org/0000-0002-0143-8915; Can YILMAZ: https://orcid.org/0000-0002-5994-508X; Kamil CANDAN: https://orcid.org/0000-0002-6934-3971; Yusuf KUMLUTAŞ: https://orcid.org/0000-0003-1154-6757; Çetin ILGAZ: https://orcid.org/0000-0001-7862-9106; Elnaz NAJAFİ MAJD: https://orcid.org/0000-0001-7710-1625

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Abstract: Age structure and body size of the Mediterranean Chameleon, *Chamaeleo chamaeleon* (Linnaeus, 1758) specimens collected from Akyatan, Adana Province (Türkiye) were investigated using the skeletochronology method and the demographic structure was revealed. The mean age was 3.07 years in females and 2.93 years in males. Derived from the LAG configuration, the age at sexual maturity was 1 year in males and 2 years in females. There was no significant correlation between the SVL and age. Moreover, the mean age and SVL were not statistically different between sexes. Results obtained here indicate that *C. chamaeleon* is one of the short-living lizard species when compared to other lizards.

Keywords: Lizard, skeletochronology, longevity, Türkiye.

Adana (Türkiye)'dan Toplanan *Chamaeleo chamaeleon* (Linnaeus, 1758) (Lacertilia: Chamaeleonidae) Örneklerinin Yaş ve Vücut Büyüklüğü

Öz: Akyatan (Adana, Türkiye)'dan toplanan *Chamaeleo chamaeleon* (Linnaeus, 1758)'nin yaş yapısı ve vücut ölçüleri iskelet kronolojisi yöntemi ile araştırılmış ve demografik yapısı ortaya çıkarılmıştır. Ortalama yaş dişilerde 3.07, erkeklerde 2.93 yıldır. Cinsel olgunluk yaşı erkeklerde 1 ve dişilerde ise 2 yıl olarak belirlenmiştir. SVL ile yaş arasında anlamlı bir ilişki mevcut değildir. Ayrıca, ortalama yaş ve SVL cinsiyetler arasında istatistiksel olarak farklılık göstermemektedir. Elde edilen sonuçlar, *C. chamaeleon* türünün diğer kertenkelelere göre kısa ömürlü bir tür olduğunu göstermektedir.

Anahtar kelimeler: Kertenkele, iskelet kronolojisi, ömür uzunluğu, Türkiye.

1. Introduction

The family Chamaeleonidae constitutes 213 recognized species (Glaw, 2015; Uetz et al., 2021). Due to the independently moving eyes, prehensile tail, ballistic tongue, and gripping feet, the chameleons, which differ in life style and morphology, are among the most remarkable lizards. The Mediterranean Chameleon, *Chamaeleo chamaeleon* (Linnaeus, 1758) is known from southern Europe, northern Africa, and southwestern Asia including Algeria, Cyprus, Egypt, Greece, Israel, Italy, Jordan, Lebanon, Libya, Malta, Morocco, Portugal, Saudi Arabia, Spain, Syria, Tunisia, Türkiye, and Yemen (Vogrin et al., 2012). Its distribution in Türkiye ranges from İzmir to Birecik along the Aegean and Mediterranean coasts in Anatolia (Baran et al., 1988; Baran et al., 2021). The Mediterranean chameleon is a diurnal species. It is an oviparous arboreal lizard with summer courtship, autumn oviposition, and a protracted incubation time (Cuadrado & Loman, 1999). It is listed as Least Concern (LC) by the IUCN Red List of Threatened Animals due to its wide distribution, tolerance to a degree of habitat modification, presumed large population and because it is unlikely to be declining fast enough to qualify for listing in a threatened category (Vogrin et al., 2012).

The number of studies have been carried out on different species of chameleons that are related with the distribution range, the ecology and behavior, life history and conservation, tail growth, the population density, the reproduction, the blood sample collection, phylogeny, systematics and zoogeography, the habitat preference, and the mating behavior of chameleons (Burrage, 1973; Moody & Rocek, 1980; Klaver, 1981; Hebrard & Madsen, 1984; Blasco et al., 1985; Burmeister, 1989; Werner, 1902; Engelmann et al., 1985; Baran et al., 1988; Raxworthy & Nussbaum, 1995; Cuadrado & Loman, 1997; Hódar et al., 2000; Akani et al., 2001; Diaz-Paniagua et al., 2002; Bergmann et al., 2003; Cuadrado et al., 2003; Matthee et al., 2004; Andreone et al., 2005; Herrmann & Herrmann, 2005; Keren-Rotem et al., 2006; Karsten et al., 2009; Keren-Rotem et al., 2016; Reaney et al., 2012; Tolley & Menegon, 2013; Dimaki et al., 2015; Tessa et al., 2017; Cumhuriyet et al., 2018; Tolley et al., 2018).

Age determination in animals provides useful

*Corresponding author: yildirim.elif@deu.edu.tr

information to understand several evolutionary and ecological processes (Roff, 2002). Skeletochronology is one of the most common methods to determine age and has been successfully applied to different lizard species (e.g. Guarino et al., 2010; Bülbül et al., 2016; Eroğlu et al., 2018). In contrast to many other lizards, the age determination of chameleons has limited data (Cuadrado & Loman, 1999).

Here, we present data on the age structure and body size of the Mediterranean Chamalaon for the first time in Türkiye. In the present study, the data obtained from the specimens of *Chamaeleo chamaeleon* is analyzed not only in relation to life history traits but also in order to evaluate the demographic status of the population.

2. Material and Methods

The study site is located at sea level in Akyatan, Adana (36° 36'53"N, 35° 17'58"E), in the mid-south part of Türkiye, and has Mediterranean climate regime (hot and dry summer periods followed by warm and rainy winter periods). According to the data from the meteorological station nearest to the study area, the annual average temperature is 18.7°C and the annual total precipitation is 769.9 mm. Akyatan lagoon and the surrounding area, which serve as chameleon habitat, consist of sandy coastal areas.

A total of 29 museum specimens (15 males and 14 females) were used for this study. Specimens were stored in the Fauna Flora Applied and Research Center (FAMER) of Dokuz Eylül University. The snout–vent length (SVL) of the specimens was measured with a digital calliper with an accuracy of 0.01 mm. The sex of each individual was determined by observing the presence of hemipenis in the cloacal opening (Baran et al., 2021). Skeletochronology was performed following Castanet & Smirina (1990) and Andreone & Guarino (2003): after removal of the muscles, femur was decalcified in 5% nitric acid solution for approximately 7 hours depending on the bone size, rinsed in tap water, and processed according to the routine histological protocol. Series of 16 µm diaphyseal cross sections were obtained by using a rotary microtome and stained with Ehrlich's haematoxylin for 20 minutes. Then, all the sections were examined under a stereomicroscope. The good sections were placed in glycerin in order to be observable through a light microscope (Olympus CX21). Bone sections from each individual lizard were photographed by a camera connected to light microscope (Zeiss A1 AX10). Periosteal lines of arrested growth (LAGs) were counted using a light microscope by the two observers. An obvious decrease in the distance of two subsequent LAGs was assumed as the beginning of sexual maturity (Ryser, 1998; Özdemir et al., 2012). In the present study, endosteal resorption was determined by comparing the diameters of eroded marrow cavities with the diameters of non-eroded marrow cavities in sections from the youngest specimens as previously described in the study of Özdemir et al. (2012). Sexual size dimorphism was quantified by the sexual dimorphism index (SDI) as described by the formula: SDI = (mean SVL of the larger sex/mean SVL of the smaller sex) ± 1 (Lovich & Gibbons, 1992). The value +1 is used if males are larger than females and -1 if the opposite is true. SDI was defined as positive if females were larger and negative if males were larger.

All data were tested for normality (Kolmogrov-Smirnov test) and for homogeneity of variances (Levene test). Since the data were not distributed normally ($p \leq 0.05$), we used the non-parametric Mann-Whitney U test to compare sexual differences in body size and age of *Chamaeleo chamaeleon*. The Spearman correlation was used to analyze the relationship between the variables. The chosen level of statistical significance was $p \leq 0.05$. All numerical data were analyzed by using STASTICA 12 (Stat Soft Inc., USA).

3. Results and Discussion

The femur had a layer (cortex) of compact bone, delimiting the marrow cavity in all specimens. The endosteal bone was observed around the marrow cavity (Fig. 1) and was seen in 18 (62%) individuals where the first line of arrested growth was partly destroyed. The mean SVL of the individuals sampled was 85.34 (59.71-106.84±13.18 mm) while the mean age was 3.00 (2-4±0.76). The mean SVL and age of females were larger than males (Fig. 2).

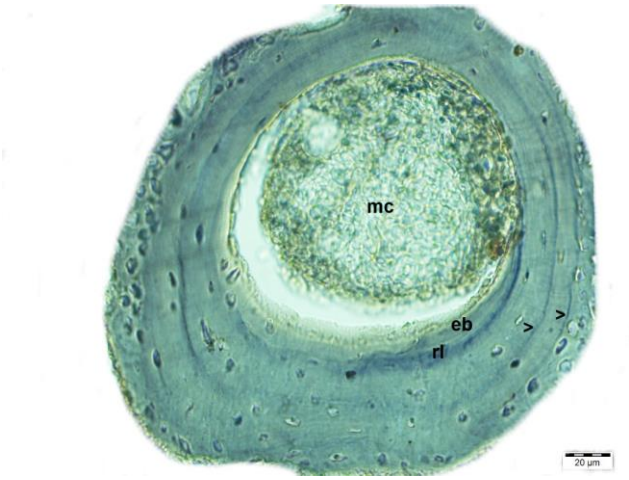

Figure 1. A cross-section at the diaphysis level of femur of *Chamaeleo chamaeleon* (2 years). eb, endosteal bone; mc, marrow cavity; rl, resorption line.

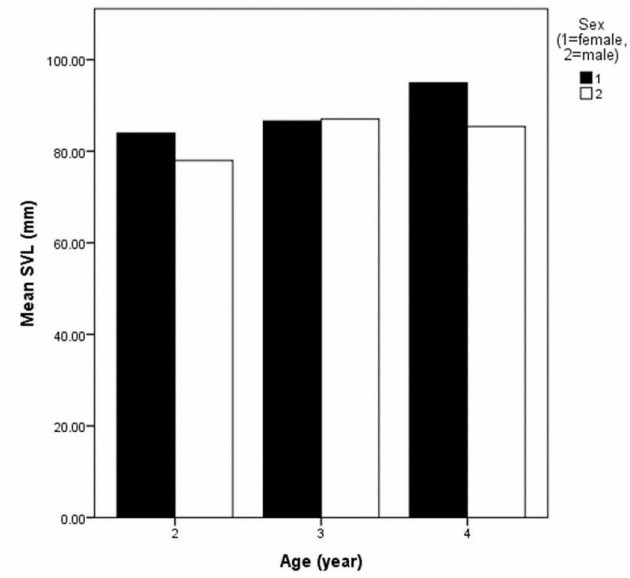

Figure 2. Relationships between SVL and age of *Chamaeleo chamaeleon*.

Our study revealed that the longevity ranging from 2 to 4 years, with the body size ranging from 59.71 mm and 106.84 mm. The oldest individual presented the largest body size. There was no statistically significant difference

between sexes in age (Mann-Whitney U test; U=29, z=-0.462, p=0.623) and SVL (Mann-Whitney U test; U=29, z=-0.960, p=0.337). Body size and age were not correlated in both males and females (Spearman correlation: r=0.242, p=0.20 for males; r=0.315, p=0.27 for females). A female-biased sexual size dimorphism, regarding to mean SVLs, was calculated (SDI=0.06). Males reached sexual maturity after the first hibernation whereas females attained maturity after the second year of their life.

4. Discussion

Studies on life history traits of chameleons, including body size, age, body size at maturity, and longevity in breeding populations are scarce (Andreone et al., 2005; Karsten et al., 2008; Tolley et al., 2010). In the present study, skeletochronology was successfully applied for the first time on the age and growth parameters of *Chamaeleo chamaeleon* population in Akyatan, Türkiye.

İbrahim (2013) reported mean SVL of 99.6 mm and 105.2 mm for males and females, respectively, in an Egyptian population. In another study, a Spanish population showed different mean SVL distribution for females (as 117 mm; ranging from 75 to 130 mm) (Diaz-Paniague et al., 2002). The mean SVL of Akyatan population is smaller than those of the Spanish and Egyptian populations. According to Guarino et al. (2010), growth rate of the body size varies widely among the different populations of the same species. Yet, it appears that the variations in body size of the lizards can depend on more than one factor such as age at maturity and longevity (Özdemir et al., 2012; Gül et al., 2014). In most lizards, males represent the larger sex (Fitch, 1981; Cox et al., 2007) and Andreone et al. (2005) reported that male *Furcifer pardalis* specimens were larger and heavier than females which is in contrast to our results. According to Stamps (1983), larger males have physical advantages that are important for territorial defense and mating success. In addition, being a smaller male during fighting would put the animal in a higher risk (Cooper & Witt, 1987). As the survival is important during combats, some different strategies such as avoiding fights can be observed among species. Lanuza et al. (2013) stated that small *Podarcis* males protected themselves from larger ones by changing body color to resemble females. However, such evidence is not available for females (Olsson & Madsen, 1995) because coloration in females is scarce (Cooper & Greenberg, 1992).

Among reptiles, lizards exhibit the shortest life spans (Shine & Charnov, 1992; Eckhardt et al. 2019). The longevity of the lizards generally varies roughly between 5 to 20 years (Castanet, 1994). It substantially could be affected by many environmental conditions as the most prominent beings are the climatic features, food availability, active period, altitude, latitude, and the risk of hunted (Jenssen & Andrews, 1984; Smith & Ballinger, 1994; Roitberg & Smirina, 2006; Bülbül et al., 2016; Altunışık & Eksilmez, 2018). The maximum longevity was ascertained to be 4 years for both males and females. Additionally, the maximum longevity was recorded as 6 years for *Chamaeleo chamaeleon* under captivity (Necas, 1999). The varieties in longevity were observed in previous studies among chameleons. It was reported as 2 years for *Furcifer pardalis* (Andreone et al., 2005). A shorter life span from the same genus was reported for *Furcifer labordi* from southwest of Madagascar as 4-5 months (Karsten et al., 2008) and for *F. labordi* from Morondava, northern Madagascar as 6-9 months (Eckhardt et al., 2017). Additionally, the longevity of *Trioceros hoehnelii* was reported as 4.5 years (Measey et al., 2014). The results obtained from the present study indicate that the *C. chamaeleon*'s lifespan is short just like other chameleons. However, longer lifespan has been determined in *Calumma parsonii* specimens [the highest minimum age was nine years for one male and eight years for one female (Tessa et al., 2017)]. Long-lived specimens and populations are characterized by delayed sexual maturity and low reproduction rates (Gadsden & Castaneda, 2013).

In the present study, the age at maturity was found as 1 year in males and 2 years in females. In general, the tendency of male lizards is to mature earlier than females (Olsson & Madsen, 1995; Beebee & Griffiths, 2000). Thus, variations for age at maturity were recorded within Chamaeleonidae family: e.g. it was reported as a year for *Furcifer campani*, *F. lateralis* and *F. antimena* (Raselimanan & Rakotomalala, 2003) while 2 months for *F. labordi* (Karsten et al., 2008) and 8.5 months for *Trioceros hoehnelii* (Measey et al., 2014).

Endosteal resorption is widely reported from lizard species (Arakelyan et al., 2013; Gül et al., 2014; Bülbül et al., 2016; Kurnaz et al., 2018). Previous studies documented that the resorptions were more frequently observed in highland populations than lowland ones (Caetano & Castanet, 1993; Arakelyan et al., 2013; Gül et al., 2014). In the present study, considerably lower endosteal resorption was observed. Yet, these initial animals inhabited a rather low elevation site.

In conclusion, one of the main highlights of this study should be Akyatan population's being comprised of short-living specimens. This feature puts animals in a vulnerable situation against rapid environmental changes. Our presented data here provides some insights on the basic demographic features of *Chamaeleo chamaeleon* and may help future studies that would go further on biology of this species. As of short life span of Adana population, further studies are needed and essential for effective conservation and management measures.

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