

First Observation of Tail Bifurcation in the Clark's Lizard, *Darevskia clarkorum* (Darevsky & Vedmederja, 1977) and the Spiny-Tailed Lizard, *Darevskia rudis* (Bedriaga, 1886) (Squamata: Lacertidae)

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Abstract: Tail anomalies, such as bifurcation and trifurcation, are observed in different species of Lacertid lizards. In the present study, bilateral tail bifurcation was observed in male specimens belonging to *Darevskia clarkorum* and *Darevskia rudis* in the Eastern Black Sea Region of Türkiye. In the specimen of *D. clarkorum*, SVL and TL are 55.37 mm and 66.43 mm, respectively. Bifurcation from the base of the tail occurred at 42.82 mm. The regenerated tail is 8.45 mm. SVL and TL are 83.56 mm and 128.93 mm, respectively in the specimen of *D. rudis*. Bifurcation from the base of the tail occurred at 33.38 mm. The length of the regenerated tail is 46.77 mm.

Keywords: Tail bifurcation, regeneration, anomalies, Black Sea Region, Türkiye.

Klark Kertenkelesi, *Darevskia clarkorum* (Darevsky & Vedmederja, 1977) ve Trabzon Kertenkelesi, *Darevskia rudis* (Bedriaga, 1886) (Squamata: Lacertidae)'te İlk Kuyruk Çatallanması Gözlemi

Öz: İkili ve üçlü çatallanma gibi kuyruk anomalileri farklı Lacertid türlerinde gözlenmektedir. Bu çalışmada, Türkiye'nin Doğu Karadeniz Bölgesi'nde *Darevskia clarkorum* ve *Darevskia rudis* türlerine ait erkek bireylerde ikili kuyruk çatallanması gözlenmiştir. *D. clarkorum* örneğinde, SVL ve TL sırasıyla 55,37 ve 66,43 mm'dir. Kuyruk tabanından çatallanma 42,82 mm'de meydana gelmiştir. Rejenere kuyruk 8,45 mm uzunluğundadır. *D. rudis* örneğinde, SVL ve TL sırasıyla 83,56 ve 128,93 mm'dir. Kuyruk tabanından çatallanma 33,38 mm'de meydana gelmiştir. Rejenere kuyruk ise 46,77 mm uzunluğundadır.

Anahtar kelimeler: Kuyruk çatallanması, rejenerasyon, anomaliler, Karadeniz Bölgesi, Türkiye.

Many lizard species use caudal autotomy, a special anatomical structure that separates their tails to escape from wild animals (Bateman & Fleming, 2009; Zani, 1996). The severed tail distracts predators and gives the lizards a chance to escape from its predator (Clause & Capaldi, 2006). It is not only a predation prevention strategy but it can also occur during social interactions such as intraspecific competition, mating, and threatening rivals in the living areas of the lizards (Iverson et al., 2004; Koleska et al., 2017). Tail loss occurs when the vertebrae (intravertebral) or between the vertebrae (intervertebral) are broken by contraction along the fracture planes and the veins in that area are occluded (Arnold, 1984). In a few weeks, a new cartilaginous bone is formed in place of the severed tail and it does not separate again (Zani, 1996; Clause & Capaldi, 2006; Alibardi, 2010).

In some cases, complications occur with incomplete autotomy. An additional tail grows in that part and two tails, called bifurcation, and related malformations develop (Tamar et al., 2013a). The presence of more than one tail in a lizard can adversely affect its adaptability because the tail can affect activities such as the balance in movement, foraging, mating, and escaping from predators (Passos et al., 2014).

In the present study, we report the first observation of tail bifurcation for the Clark's Lizard, *Darevskia*

clarkorum (Darevsky & Vedmederja, 1977) and the Spiny-Tailed Lizard, *D. rudis* (Bedriaga, 1886) from eastern Black Sea Region of Türkiye.

Darevskia clarkorum is a medium sized lizard. It is currently known from southwest Georgia (Adzharia) and part of northeastern Türkiye, from Artvin to Giresun (Arribas et al., 2021). The number of the known populations of *D. clarkorum* is decreasing. The species is classified as Endangered (EN) according to the IUCN Red List of the Threatened Species and the number of the mature individuals is continuing to decline in its known populations (Tuniyev et al., 2009).

Darevskia rudis lives in the northeastern and central Anatolia; southern, southeastern, and western Georgia; northern slope of the central Caucasus; Dagestan Russia and northwestern Azerbaijan at elevation up to 2000 m (Arribas et al., 2013). The species is classified as Least Concern (LC) according to the IUCN Red List of the Threatened Species (Tok et al., 2009).

During the field research on 16 May 2021, tail bifurcation was observed in a male specimen of *Darevskia clarkorum* captured from Çayırcı Village, Tonya, Trabzon Province, (GPS Data, N: 40° 49' 44.5'' and E: 39° 18' 03.54'', 960 m a.s.l.). The specimen was caught by hand and anaesthetized with a MS-222 solution. Sex was identified by the absence/presence of palpable hemipenis pockets.

This is the characteristic feature used for sex determination in Squamates (Budak & Göçmen, 2008). After measurements, the lizard was released back into its habitat. SVL [(snout-vent length), tip of snout to anal cleft] and TL [(tail length), anal cleft to the tip of tail] were measured using a digital caliper with an accuracy of 0.01 mm. Bifurcation from the base of the tail occurred at 42.82 mm. The regenerated tail is 8.45 mm (Fig. 1).



Figure 1. Tail bifurcation in a male specimen of *Darevskia clarkorum*

On May 23, 2020, tail bifurcation was observed in a male specimen of *Darevskia rudis* during the field research between the Murgul and Borçka districts of Artvin Province in Türkiye (GPS Data, N: 41° 18' 40.7" and E: 41° 37' 40.3", 302 m a.s.l.). The specimen was caught by hand and anaesthetized with a MS-222 solution. Sex was identified by the absence/presence of palpable hemipenis pockets. After measurements, the lizard was released back into its habitat. SVL and TL are 83.56 mm and 128.93 mm, respectively. Bifurcation from the base of the tail occurred at 33.38 mm. The length of the regenerated tail is 46.77 mm (Fig. 2).



Figure 2. Tail bifurcation in a male specimen of *Darevskia rudis*

Tail bifurcation was recorded in the different lacertids [*Acanthodactylus aegyptius* Baha El Din, 2007 (Stark et al., 2018), *Algyroides nigropunctatus* Dumeril & Bibron, 1839 (Koleska & Jablonski, 2015), *Lacerta agilis* Linnaeus, 1758 (Dudek & Ekner-Grzyb, 2014; Kolenda et al., 2017; Ramadanović & Zimić, 2019), *Lacerta viridis* Laurenti, 1768 (Stojanov et al., 2011), *Ophisops elegans* Ménétries, 1832 (Tamar et al., 2013b), *Podarcis erhardii* Bedriaga, 1882 (Brock et al., 2014), *Podarcis muralis* Laurenti, 1768 (Pola & Koleska, 2017; Badiane, 2017; Sorlin et al., 2019), *Teira dugesii* Milne-Edwards, 1829 (Koleska et al., 2017), and *Zootoca vivipara* Lichtenstein, 1823 (Dudek & Ekner-Grzyb, 2014; Kolenda et al., 2017)].

This study indicates that tail bifurcation is present in *Darevskia* Arribas, 1997 species as well as in species from other lacertid genera. The status of other species in the genus *Darevskia* may be revealed in future studies.

Ethics committee approval: Ethics committee approval is not required for this study.

Conflict of interest: The authors declare that there is no conflict of interest.

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References

- Alibardi, L. (2010). Morphological and cellular aspects of tail and limb regeneration in lizards: A model system with implications for tissue regeneration in mammals. *Advances in Anatomy, Embryology and Cell Biology*, 207, iii, 1-109.
- Arnold, E.N. (1984). Evolutionary aspects of tail shedding in lizards and their relatives. *Journal of Natural History*, 18(1), 127-169. <https://doi.org/10.1080/00222938400770131>
- Arribas, O., Ilgaz, Ç., Kumlutaş, Y., Durmuş, S.H., Avcı, A., & Üzümlü, N. (2013). External morphology and osteology of *Darevskia rudis* (Bedriaga, 1886), with a taxonomic revision of the Pontic and Small-Caucasus populations (Squamata: Lacertidae). *Zootaxa*, 3626(4), 401-428. <https://doi.org/10.11646/zootaxa.3626.4.1>
- Arribas, O., Candan, K., Kumlutaş, Y., & Ilgaz, Ç. (2021). Multivariate analysis of the geographic variation in *Darevskia clarkorum* (Darevsky & Vermederja, 1977), its relation with geographic and climatic parameters, and the true status of *D. dryada* (Darevsky & Tuniyev, 1997). *Zootaxa*, 4990, 1-22. <https://doi.org/10.11646/zootaxa.4990.1.1>
- Badiane, A. (2017). Trifurcation caudale chez le lézard des murailles *Podarcis muralis* (Laurenti, 1768) (Squamata : Lacertidae). *Bulletin de la Société Herpétologique de France*, 163, 106-107.
- Bateman, P.W., & Fleming, P.A. (2009). To cut a long tail short: A review of lizard caudal autotomy studies carried out over the last 20 years. *Journal of Zoology*, 277, 1-14. <https://doi.org/10.1111/j.1469-7998.2008.00484.x>
- Brock, K.M., Belasen, A., & Fofopoulos, J. (2014). *Podarcis erhardii* (Erhard's wall lizard) bifurcated tail, post-autotomy. *Herpetological Review*, 45(2), 332.
- Budak, A., & Göçmen, B. (2008). Herpetoloji. 2. Baskı. İzmir, Ege Üniversitesi Yayınları, Fen Fakültesi Yayın No.194. 230 pp.
- Clause, A.R., & Capaldi, E.A. (2006). Caudal autotomy and regeneration in lizards. *Journal of Experimental Zoology*, 305A, 965-973. <https://doi.org/10.1002/jez.a.346>
- Dudek, K., & Ekner-Grzyb, A. (2014). Field observation of two-tailed sand lizard *Lacerta agilis* Linnaeus, 1758 and a common lizard *Zootoca vivipara* (Jacquin, 1787) in Poland. *Natura Sloveniae*, 16(1), 65-66.
- Iverson, J.B., Smith, G.R., & Pieper, L. 2004 Factors affecting long-term growth of the Allen Cays rock iguana in the Bahamas. In: Alberts A.C., Carter R.L., Hayes W.K., & Martins E.P. (eds) *Iguanas: Biology and conservation*. University of California Press, Berkeley, USA, 176-192.
- Kolenda, K., Wiczorek, M., Najbar, A., Najbar, B., & Skawiński, T. (2017). Limb malformation and tail bifurcation in sand lizards (*Lacerta agilis*)

- and common lizards (*Zootaca vivipara*) from Poland. *Herpetology Notes*, 10, 713-716.
- Koleska, D., Kulma, M., & Vrabec, V. (2017). *Teira dugesii* (Madeiran wall lizard). Tail bifurcation. *Herpetological Review*, 48(2), 440-441.
- Koleska, D., & Jablonski, D. (2015). Tail bifurcation in *Algyroides nigropunctatus* (Duméril & Bibron, 1839). *Ecologica Montenegrina*, 3, 26-28. <https://doi.org/10.37828/em.2015.3.4>
- Passos, D.C., Pinheiro, L.T., Galdino, C.A.B., & Rocha, C.F.D. (2014). *Tropidurus semitaeniatus* (Calango de Lagedo). Tail bifurcation. *Herpetological Review*, 45(1), 138. <https://doi.org/10.17161/randa.v27i2>
- Pola, L., & Koleska, D. (2017) Tail bifurcation in Common Wall lizard (*Podarcis muralis Laurenti, 1768*) from Liguria, Italy. 9th Workshop on Biodiversity, July 8-9 2017, Proceedings of the 9th Workshop on Biodiversity pp. 93-97, Jevany, Czech Republic.
- Ramadanović, D., & Zimić, A. (2019). Record of a *Lacerta agilis* Linnaeus, 1758 with *erythronotus* colour morph and tail bifurcation. *Herpetology Notes*, 12, 779-781.
- Sorlin, M.V., Gangloff, E., Kouyoumdjian, L., Cordero, G., Darnet, E., & Aubret, F. (2019). *Podarcis muralis* (Common wall lizard). Tail bifurcation. *Herpetological Review*, 50(2), 377-378.
- Stark, G., David, D., Lewin, A., & Meiri, S. (2018). Natural history notes: *Acanthodactylus aegyptius* (Egyptian fringed-fingered lizard). Tail bifurcation. *Herpetological Review*, 49(2), 324-325.
- Stojanov, A., Tzankov, N.D., & Naumov, B. (2011). Die Amphibien und Reptilien Bulgariens. Frankfurt am Main, Chimaira, 582 pp.
- Tamar, K., Maza, E., & Meiri, S. (2013a). *Acanthodactylus boskianus* (Bosk's fringe-fingered lizard) bifurcation. *Herpetological Review*, 44, 135-136.
- Tamar, K., Maza, E., & Meiri, S. (2013b). *Ophisops elegans* (Snake-eyed lizard): Bifurcation. *Herpetological Review*, 44, 146.
- Tok, V., Uğurtaş, İ., Sevinç, M., Böhme, W., Crochet P.A, Tuniyev, B., & Kaya, U. (2009). *Darevskia rudis*. IUCN Red List of Threatened Species. Retrieved from <https://www.iucnredlist.org/species/164633/5913665>
- Tuniyev, B., Ananjeva, N.B., Agasyan, A., Orlov, N.L., & Tuniyev, S. (2009). *Darevskia clarkorum*. The IUCN Red List of Threatened Species. Retrieved from <https://www.iucnredlist.org/species/11117/114549398>
- Zani, P.A. (1996). Patterns of caudal-autotomy evolution in lizards. *Journal of Zoology*, 240, 201-220. <https://doi.org/10.1086/673875>
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