Herpetology Notes 19: 83–87, published on 24 February 2026

A frog-eat-frog novelty: first record of "reverse age-class cannibalism" in the Arabian Toad, *Sclerophrys arabica* (Heyden, 1827), from King Salman Bin Abdulaziz Royal Natural Reserve, Saudi Arabia

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Amphibians, including their larvae, play important and effective roles in the food chains of ecosystems (Hopkins, 2007; Hocking and Babbit, 2014; Wickramasingha et al., 2026). While both herbivorous and omnivorous patterns among tadpoles are common, their feeding strategies vary significantly and may include carnivory (encompassing detritivory, oophagy, scavenging, predation, and cannibalism) as well as coprophagy and filter feeding (Pryor and Bjorndal, 2005; Altig et al., 2007; Pryor, 2014; Montaña et al., 2019; Fabrezi and Cruz, 2020; Gonçalves and de Almeida, 2023).

Numerous cases of frogs feeding on conspecifics have been documented (Measey et al., 2015; Souza et al., 2023). This cannibalistic behaviour is considered an important mechanism in frogs, as it can strongly influence competitive interactions between individuals of different clutches, increase survival rates, reduce tadpole abundance, and down-regulate a population (Heusser, 1970; Heyer et al., 1975; Crump, 1990; Crossland et al., 2011; Jefferson et al., 2014a, b). Tadpoles can engage in active cannibalism, by intentionally attacking and consuming living conspecifics, or passive cannibalism, by consuming incidentally encountered dead conspecifics (Heinen and Abdella, 2005), but cannibalism is more commonly performed by adult frogs that are known to sometimes feed opportunistically on tadpoles and smaller individuals (Measey et al., 2015; Kaiser et al., 2016; Plitsi et al., 2016). In addition, cannibalism is commonly related to ecological factors like increased population density and resource limitations (e.g., Crump, 1983). A potential risk of this behaviour to tadpoles is that it requires them to manage prolonged immobilization of the prey, which then takes considerable effort to ingest with rasping mouthparts (Wyatt and Forys, 2004; Altig et al., 2007). Cases have been reported in a variety of anurans, including *Rhinella marina*, *Anaxyrus americanus*, *Bombina bombina*, *Hyla pseudopuma*, *Osteopilus septentrionalis*, and *Pelophylax ridibundus* (Crump, 1986; Kuzmin, 1991; Heinen and Abdella, 2005; Pizzatto and Shine, 2008; Crossland and Shine, 2011; Crossland et al., 2022; Ivanov et al., 2024).

Quite a few studies have been conducted on the seven recorded frog species that occur in the Arabian Peninsula, and these have mainly focused on the ecology and distribution (Balletto et al., 1985; Soorae et al., 2010; Masood and Asiry, 2012; Al-Johany et al., 2014, 2025; Aloufi and Amr, 2015; Alshammari and Ibnrahim, 2018; Cowan et al., 2020; Aloufi et al., 2021, 2023; Hamdi and Fathy, 2021). Among these is the Arabian Toad, *Sclerophrys arabica*, a species endemic to the Arabian Peninsula whose range covers montane regions of the Arabian Peninsula and extends from Yemen to northwestern Saudi Arabia in the Hijaz Mountains bordered by the Red Sea in the west, the Najd Highlands in central Saudi Arabia, and the Hajar Mountains in northern Oman and the eastern United Arab Emirates (Balletto et al., 1985; Al-Qahtani and Al-Johany, 2018; Al-Johany et al., 2025). This opportunistic species is active during both day and night and can be encountered in a wide variety of microhabitats within its range wherever water is found (Balletto et al., 1985; Mashlawi and Masood, 2024).

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Tadpoles of *S. arabica* have not only been studied to understand their ecology and development (e.g., Ba-Omar et al., 2004; Barry, 2015) but a sizeable body of work exists on experimental approaches using *S. arabica* tadpoles as model organism (e.g., Barry, 2011; Al Mahrouqi et al., 2018; Seleem, 2019). However, there have not been many publications reporting on *S. arabica* tadpoles in the wild. We here contribute one such observation on these tadpoles from the Aja Mountains of the King Salman Bin Abdulaziz Royal Natural Reserve (KSRNR) in northern Saudi Arabia.

During ecological research fieldwork to survey and monitor amphibian species hotspots within KSRNR on 13 May 2025 we found tadpoles and a metamorph in a seasonal ephemeral pool in mountainous habitat near Al-Kashriya Dam (27.4947°N, 41.6200°E; Fig. 1A). This area includes natural and anthropogenic water catchments, including seasonal ephemeral pools and

Figure 1. (A) The ephemeral pool near Al-Kashriya, Saudi Arabia, where we made our observations on a metamorph and tadpoles of *Sclerophrys arabica*. (B) Two *S. arabica* tadpoles attacking a larger-sized metamorph. Note that the tadpole at left is attacking the metamorph's right, uninjured limb while its companion at right is feeding on the left leg that already shows signs of traumatic injury. (C) One tadpole is seen feeding on the metamorph's injured leg. The leg has lost a significant amount of skin and muscle, likely to tadpole feeding activity. Photos by Wael M. Shohdi (A) and Mohammad A. Abdulhakeem (B-C).

dam reservoirs, which were visited as part of planned ecological research. We observed one tadpole attached to the left hindlimb of a live metamorph of the same species, recognizable by its tail remnant (Fig. 1C). Closer inspection led us to realize that mainly two primary tadpoles, joined at times by several others, were feeding on both of the metamorph's hind limbs. In addition, numerous carnivorous insects (backswimmers; family Notonectidae) were observed to attack tadpoles as well as feed on the hind limbs of the metamorph. The metamorph's appendages exhibited clear signs of traumatic injury. We monitored this behaviour for 83 min until the metamorph was able to escape to the shoreline. Video clips to provide a clearer view of the behaviour are available via this link. A close examination of the left hindlimb revealed that parts of the limb were stripped of skin and muscle tissues entirely. We noted that the tadpoles were smaller than the metamorph (Fig. 1B, C) and had neither developed fore- nor hind limbs. Water and food sources were abundant in the environment, with no signs of shortage.

This observation is particularly interesting for several reasons. It represents the first documented evidence of cannibalism for *S. arabica* in Saudia Arabia (one other record exists, from the Hajar Mountains in Dubai; Gross and Shepley, 1994), and it is one of few reports from the northern mountains in the country. Furthermore, it is the first documentation of such a behaviour among early developmental stages of the species, with the Dubai record involving an adult swallowing a toadlet.

Cannibalism in anurans has been reported from a variety of groups, and among the many variables influencing this behaviour, body size is a factor with some significance: excluding oophagy, it is larger individuals (adults, juveniles, tadpoles) cannibalising smaller conspecifics (Polis and Myers, 1985; Measey et al., 2015). Contrary to the body of work on anuran cannibalism, our observation appears to be the first where "age-class cannibalism" (i.e., adults eating smaller conspecifics) is reversed. This "reverse age-class cannibalism" is defined by a prey (the metamorph) that is older (and larger) than the predator (the tadpoles).

This type of cannibalism is a form of active cannibalism, contrasting with passive cannibalism where feeding primarily occurs on the carcasses of conspecifics (Heinen and Abdella, 2005). Although inter-individual competitive behaviour in amphibians is often attributed to intense resource competition under challenging conditions (Heusser, 1970; Kaplan and Sherman, 1980; Crump, 1983, 1986; Ivanov et al., 2024), our observation rules this out as an explanation. The *S. arabica* tadpoles in the sampled habitat were not crowded, with an estimated population size of 3500 adults and 10,000 tadpoles in an area of 8800 m^2. The available habitat, though ephemeral, was clearly sufficient to meet the population's ecological requirements, meaning that the observed behaviour does not result from habitat limitation. While we initially thought that prior injury to the metamorph's limb may have served as the primary stimulus for tadpole attacks, we saw that an uninjured limb was also targeted (Fig. 1B). This indicates that the attraction was likely due to factors beyond physical injury, such as immobilisation, social facilitation, or stimulus enhancement in amphibians (Wyatt and Forys, 2004; Crane et al., 2012; Jefferson, 2015; Michaels et al., 2014). In addition to these behavioural cues, chemical variables potentially mediated by indirect environmental influences may play a significant role in promoting cannibalistic behaviour among amphibian larvae (Üveges, 2018). Furthermore, among some invasive toad species, one of the documented drivers for cannibalism in immature tadpoles is to adopt this behaviour to outgrow and accelerate their growth (DeVore et al., 2021), but this contrasts with our observation, which involves a species endemic to the region.

Cannibalism may in general be common and important for toads, as it may aid the survival of the fittest individuals, those most able to adapt to their environment and surrounding conditions. Such feeding behaviour of tadpoles may also facilitate faster evolution, but it raises questions about the survival of the only slightly older metamorph, which was unable to defend itself against the smaller and less developed tadpoles. These observations open the door to further questions and research on cannibalistic behaviour in anurans and the environmental factors, social or chemical stimuli that influence this behaviour.

Acknowledgements. We extend our sincere gratitude and appreciation to the Chief Executive Officer of the King Salman Bin Abdulaziz Royal Natural Reserve Development Authority and the team at the King Salman Bin Abdulaziz Royal Natural Reserve for their continuous support of our research and fieldwork. We would like to thank Pritpal Soorae (Co-Chair – West Asia, IUCN Amphibian Specialist Group) for his insightful guidance regarding the significance of this record.

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Accepted by Saeed Hosseinian Yousefkhani