

Does size matter? Reports of cannibalism in scorpions (Scorpiones: Buthidae) from Turkey

Cannibalism is a phenomenon where one individual kills and consumes another of its own species, often arising during conflicts related to survival or reproduction (e.g., Persson et al. 2000, DeVore et al. 2021). Early authors have suggested that this mechanism regulates and controls the predator population size, facilitating their survival during prey scarcity (Elgar & Crespi 1992, Wise 2006, Oliveira et al. 2022). As potential competition decreases, resources such as food, shelter, and territory become more readily available. Therefore, cannibalism may result from high population density and/or strong intraspecific competition for prey resources (Davison et al. 2020).

This type of ecological interaction can be classified into four different categories: I) sexual cannibalism, where the female consumes the male during or after mating (e.g., O'Hara & Brown 2021, Martínez Villar et al. 2024); II) intrauterine cannibalism, where more developed embryos feed on other embryos in the mother's uterus (e.g., Shimada et al. 2020, Rincon et al. 2023); III) matrophagy, where the mother offers herself as food for her offspring, ensuring the survival of the brood (e.g., Tizo-Pedroso & Del-Claro 2005, Dias et al. 2021); and IV) predatory cannibalism, where larger individuals consume juveniles individuals of their own species, especially in environments where resources are

limited (e.g., Golobinek et al. 2021, Chedad et al. 2022).

Scorpions are primordial and generalist-feeding terrestrial arachnids distributed mostly in tropical and subtropical regions across various habitats worldwide (Polis 1990). Although they prey on various animals, the diet of scorpions primarily consists of insects, spiders, and occasionally lizards (Dupré 2015, Dionisio-da-Silva et al. 2024). Both intraguild predation and cannibalism are important regulatory mechanisms to control the population density in these animals (Polis 1980, Lighton et al. 2001). Overall, larger scorpion individuals prey on smaller ones in antagonistic interactions (e.g., Moreira et al. 2022, Toprak et al. 2022, Martins et al. 2024). Despite this, ecological studies reporting cannibalism have generally been conducted in the Americas. Only a small number of cannibalism records in nature have been reported for Old World scorpions (Probst 1972, Chedad et al. 2022, Sánchez-Piñero et al. 2025). Therefore, aiming to fill this gap in knowledge about this ecological interaction in the Asian scorpion assemblage, in the present work, we provide records of cannibalism among different species of these arachnids in Turkey.

The cannibalism events here were observed during a nocturnal field study (22:00-02:30 h) between 2014 and 2022 in different sites across Turkey (Fig. 1). After photographing the interactions between the scorpions, the animals were collected for later identification through pertinent literature (Cain et al. 2021, Fet et al. 2018, Kovařík 2019, Kovařík et al. 2022, Yağmur 2021). Voucher specimens were deposited in the Zoology Museum of Alaşehir Vocational School, Manisa Celal Bayar University, Manisa, Turkey (AZMM)



Figure 1. Scorpion sampling sites across Turkey country. Circle: *Buthacus tadmorensis* (Simon, 1892); star: *Aegaobuthus gibbosus*; square: *Mesobuthus eupeus*; triangle: *Olivierus caucasicus*; inverted triangle: *Androctonus turkiyensis*.

We recorded six cannibalism events for five scorpion species, all belonging to the family Buthidae. Our first record (26 July 2014) was observing a *Buthacus tadmorensis* (Simon, 1892) adult female in Şanlıurfa Province, Birecik District, Mezra Village (36°57'39"N 38°00'51"E, 395 m a.s.l.) predating a conspecific adult male (Fig. 2A). In the second record (01 July 2022), an *Aegaobuthus gibbosus* (Brulle, 1832) adult male was found eating an adult female (Fig. 2B) in Konya Province, Seydişehir District, Taraşçı Village, Geyik Mountains

(37°27'49"N 31°43'00"E, 1781 m a.s.l.). In the third record (16 July 2022), an adult female *Mesobuthus eupeus* (C.L. Koch, 1839) was found eating a second instar juvenile (Fig. 2C) in Iğdır Province, Karakoyunlu District, Fatih Village (39°57'31"N, 44°08'42"E, 865 m a.s.l.). In the same locality, another *M. eupeus* female was found predating a conspecific subadult (Fig. 2D). In the fifth record (17 July 2022), an adult *Olivierus caucasicus* (Nordmann, 1840) female was found eating another adult specimen (Fig. 2E) in Iğdır Province, Central

District, Suveren Village (39°48'04"N, 44°03'34"E, 1215 m a.s.l.). Our last record (25 August 2022) documented an *Androctonus turkiyensis* Yagmur, 2021 adult male feeding on a juvenile (Fig. 2F) in Şırnak Province, Central District, Koçbeyi Village (37°25'18"N, 42°10'59"E, 598 m a.s.l.). When we found them, the adult specimen had killed the juvenile, and it immediately began to run away. We placed it in a plastic box for photography, but the adult specimen did not leave the juvenile that it was eating.

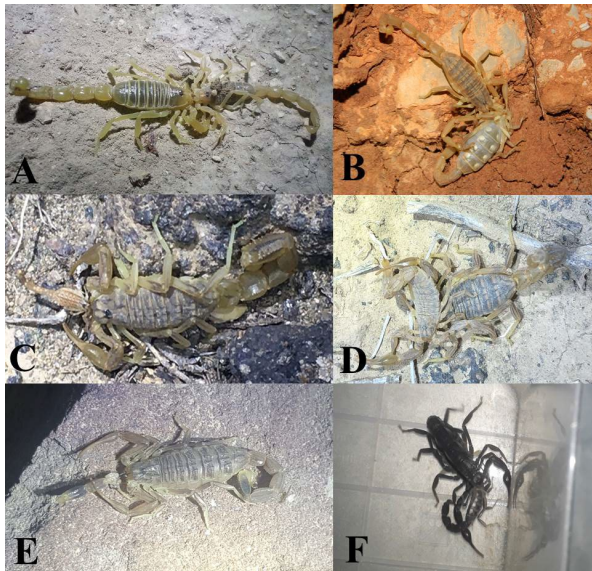


Figure 2. Cannibalism records in Turkish scorpions: (A) *Buthus tadmorensis* (Simon, 1892) adult female eating an adult male; (B) *Aegaeobuthus gibbosus* (Brullé, 1832) adult male eating an adult female; (C) *Mesobuthus eupeus* (C.L. Koch, 1839) adult female eating a second instar juvenile; (D) *M. eupeus* female was found eating a subadult; (E) *Oligoeris caucasicus* (Nordmann, 1840) adult female eating another adult specimen; (F) *Androctonus turkiyensis* Yagmur, 2021 adult male feeding on a juvenile.

Our study reported six cannibalism events involving five species of Turkish scorpions from different regions of the country. Cannibalism in scorpions may be an important ecological interaction in arid areas of the world, comprising 25-30% of the biomass ingested by these arachnids (Polis 1979, 1980, 1981, Sánchez-Piñero et al. 2025). For example, in an arid open shrub-steppe in Spain, cannibalism was a major component of *Buthus montanus* Lourenço and Vachon, 2004 diet, especially in large individuals (Sánchez-Piñero et al. 2025). Body size and foraging behavior have been recognized as important factors in interactions between scorpion species; larger species behave as predators of their juveniles or smaller species (e.g., Lira et al. 2017, Polis & McCormick 1987, Toprak et al. 2022). Similarly, in our observations, *A. turkiyensis* and *M. eupeus* fed on their juveniles. However, cannibalism may occur among individuals of similar sizes, as recorded for *O. caucasicus*. Considering the similarity of climatic conditions in the sampled areas of Turkey, it is plausible to think that cannibalism is a common and important food resource for scorpion species. Therefore, this behavior highlights the adaptability of scorpions to their environments, where competition for resources can lead to such practices as a means of sustenance.

Despite this instance of predatory cannibalism, we also recorded cases of sexual cannibalism in *B. tadmorensis*, where an adult female preyed upon an adult male. We interpreted this as sexual cannibalism because they were in a mating position. Previous studies have indicated that female scorpions generally react aggressively to male reproductive attempts (Chantall-Rocha & Japyassú 2017, Oviedo-Diego et al. 2024). To mitigate this aggressive behavior, males employ specific behavioral actions such as juddering and tail wagging (e.g., Lira et al. 2018, 2021, Foerster et al. 2021). A failure in any of these strategies may signal the female's rejection, leading to the interpretation that the male is considered food. This aligns with the mate choice hypothesis (Eberhard 1996, Prenter et al. 2006), which postulates that males are consumed because they lack certain phenotypic traits preferred by females, ensuring that only the highest-quality males succeed in mating.

Unlike our other cases, we recorded an instance of reverse cannibalism, in which a male *A. gibbosus* was found preying on a pregnant female. Reverse sexual cannibalism is uncommon in nature but has been reported in various groups of arthropods, such as isopods, crabs, and spiders (e.g., Haddon 1995, Tsai & Dai 2003, Aisenberg et al. 2011). Scorpions are typically generalist predators (Polis 1990), so the reverse cannibalism observed here may result from a combination of voracity and opportunistic behaviour (Arnqvist & Henriksson 1997). Additionally, in environments with low prey availability, the animal may benefit from consuming a conspecific (Fox 1975, Polis 1981). This case highlights the complexity of predatory behaviours in scorpions and underscores the adaptability of these species in response to ecological pressures.

In conclusion, our findings highlight that cannibalism may play a significant role as a predatory behavior and a survival strategy among Turkish scorpions. The documented instances of cannibalism, including both traditional and reverse forms, illustrate the complex ecological dynamics at play in arid environments where competition is intense. The adaptability of scorpions to exploit conspecifics as a food source highlights their opportunistic feeding strategies and underscores the evolutionary pressures that shape their behaviors. Furthermore, the interplay between sexual and predatory cannibalism reveals the intricate balance between reproduction and survival in these arachnids. Understanding these interactions is crucial for comprehending the ecological roles of scorpions and their responses to environmental challenges.

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