To take the risk: feeding on scorpions by lizards (Sauria: Lacertidae, Scincidae) – first documented cases from Bulgaria

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Resumen: Los escorpiones constituyen una de las presas más difícilmente consumibles por lagartos de pequeño tamaño, pudiendo calificarse como presas peligrosas por su comportamiento defensivo cuando son atacados. Aquí se presenta casos de alimentación de escorpiones por dos especies de lacértidos y una de escíncido de Bulgaria, basados en el análisis de muestras fecales. La alimentación de escorpiones rara vez se observa en lagartos europeos, especialmente en poblaciones continentales, y en opinión de la autora estos son los primeros casos documentados en Bulgaria. A partir de estos resultados se sugiere que el uso de presas potencialmente peligrosas podría deberse a una posible competencia inter e intraespecífica, lo que podría ser más evidente en verano cuando los recursos tróficos son escasos.

European lizards feed mainly on small arthropods, and among them insects and spiders are more preferred (Capula & Luiselli, 1994; Carretero, 2004; Vacheva & Naumov, 2020, 2022). Consumption of highly dangerous animals, such as stinging insects, scorpions and centipedes are rarely observed in small lizards, and in some cases, lizards can become victim of scorpions (Castilla, 1995; Castilla & Herrel, 2009a) or centipedes (Zimić & Jelić, 2014; De Luna *et al.*, 2016). Although this type of behavior has been documented in some lacertids: for example, Pianka *et al.* (1979) noted the presence of scorpions in over 50% of cases in *Nucras tessellata* (Smith, 1838) (Huey & Pianka, 1981), but the research of Van der Meer *et al.* (2010) and Edwards *et al.* (2013) do not demonstrate the importance of scorpions as a main food component in other populations of the same species. The presence of scorpions in the diet of lizards has been documented in only few studies from Europe and the Mediterranean (Castilla *et al.*, 2008; Castilla & Herrel, 2009b; Žagar *et al.*, 2011), and Castilla *et al.* (2008) showed experimentally that lizards from island populations are more prone to eat scorpions than those from continental populations. In conditions with limited natural resources, such as small islands (the case with *Podarcis* spp.) or desert areas (the case with *Nucras tessellata*), lizards are more likely to resort to the use of unprofitable food sources, including potentially dangerous ones. In addition, there is pronounced gender dependence: in all reported cases adult males are more likely to use such food sources, which could be the result of male's larger head size and greater bite force, compared to females (Verwaijen *et al.*, 2002). To my knowledge, this is the first information about the presence of scorpions in the diet of small lizards from Bulgaria.

The study area is situated in Sredna Gora Mts., near Gabrovitsa Village (N 42.2602º, E 23.9208º, 430-570 masl) in Western Bulgaria. The climate is temperate-continental with an average annual air temperature of -4.2º C in January and 16.1º C in July. The main precipitation maximum occurs at the end of spring - May and the beginning of June, and the minimums are in February, March and between August and Septem-

ber. More detailed descriptions of the studied sites are given by Vacheva *et al.* (2020). During dietary research conducted in 2017 and 2018, I visited the study area for 8 days in 2017 and 17 days in 2018 to collect faecal pellets from four syntopic lizard species: the Eastern Green lizard *Lacerta viridis* (Laurenti, 1768), the Common Wall lizard *Podarcis muralis* (Laurenti, 1768), the Meadow lizard *Darevskia praticola* (Eversmann, 1834) and the Snake-eyed skink *Ablepharus kitaibelii* (Bibron & Bory de Saint-Vincent, 1833) (Figure 1).

Figure 1: The three lizard species: a) *Podarcis muralis*, b) *Darevskia praticola* and c) *Ablepharus kitaibelii*.
Figura 1: Las tres especies de lagartos: a) *Podarcis muralis*, b) *Darevskia praticola* y c) *Ablepharus kitaibelii*.

A total of 49 samples from *L. viridis*, 137 from *P. muralis*, 149 from *D. praticola* and 66 from *A. kitaibelii* were collected. Scorpion remnants were found in faecal pellets from three of the studied species: *P. muralis*: in 4 adult males (Snout-vent length or SVL between 56 and 63mm), one subadult male (SVL 43 mm), 3 adult females (SVL 53-56 mm) and one juvenile female (SVL 33 mm); *D. praticola*: only in one male (SVL 45 mm); *A. kitaibelii*: one male (SVL 40 mm) and one female (SVL 48 mm).

For *D. praticola* scorpions represent only 0.19% of the total prey composition in the diet (Vacheva & Naumov, 2022), while in *A. kitaibelii* and *P. muralis* were 1.03% and 1.80%, respectively. The remnants belong to one scorpion species, *Euscorpius solegladi* Fet, Graham, Webber & Blagoev, 2014 (Euscorpiidae) (Figure 2). *Euscorpius solegladii* is medium sized scorpion species (34-35 mm), known from south-western Bulgaria and north-eastern Greece (Fet *et al.*, 2014).

While scorpions were present with low numbers in *D. praticola* and *A. kitaibelii*, it seems to be more common prey for *P. muralis* and was observed almost equally between sexes, as well as in juvenile and subadult individuals. It seems that *P. muralis* is more capable of dealing with such dangerous prey, probably because of its wide trophic niche (Mou, 1987; Capula *et al.*, 1993; Scali *et al.*, 2015; author's unpublished data) and better ability to handle prey, related to head morphology and bite force (Herrel *et al.*, 2001; Verwaijen *et al.*, 2002). Scorpions were absolutely absent from the samples of *L. viridis*, and this could be because of its relatively larger body and head size in adults, which could not be attracted from that size of prey, or because of the smaller sample size in comparison to other species. The case with the *A. kitaibelii* presents an interesting observation, in relation to its smaller head and body size – the Snake-eyed skink is small-sized scincid

Figure 2: *Euscorpius solegladii* found under stone at the study site.
Figura 2: *Euscorpius solegladii* encontrado bajo una piedra en el lugar de estudio.

which can reach up to 80 mm SVL. Diet of the Snake-eyed skink consist of various insects and arachnids, including spiders and pseudoscorpions (Herczeg *et al.*, 2007; pers. data), but this is the first documentation for relatively dangerous prey such as scorpions.

Remains of *E. solegladi* were registered in faecal samples from *P. muralis* in both years, and in all months from April to August, but more often in August, while in *A. kitaibelii* and *D. praticola* were registered only for 2018: in June and August for the Snake-eyed skink and in August for the Meadow lizard. Poor trophic availability is observed more often in summer (Adamopoulou *et al.*, 1999; Mamou *et al.*, 2019), which could explain why lizards resort to dangerous prey more frequently then.

The presence of scorpions is interested not only because of the higher risk of dealing with, but also with finding them: although lizards are diurnal and scorpions nocturnal, the probability of lizards to encounter scorpions could be under rocks or in burrows used as diurnal refuges. Most of the European lizards are active foragers (Arnold, 1987; Werner *et al.*, 1990; Verwaijen & Van Damme, 2008) and their diet is dominated by low-mobile invertebrates or those with cryptic coloration (Huey & Pianka, 1981; Vanhooydonck *et al.*, 2007). In most of the active foragers, different types of prey are recognized by the olfaction and vomerolfaction (Baeckens *et al.*, 2017) which gives them opportunity to find hidden prey. In the recognition of scorpions, vision is probably also involved to recognize the morphological traits of the dangerous prey, similar to the ecologically related teiid lizards which recognize scorpions and fallow different strategy for handling it (O'Connell & Formanowicz, 1998). Further research is needed to elucidate the ways in which dangerous prey is recognized by lacertid lizards.

The cases reported here show the ability of small lizards to modulate their foraging behaviour, utilizing different food sources in favour to reduce possible inter- and intraspecific competition, and especially in summer when prey is less abundant.

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