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Predatory interactions between lacertid lizards (Lacertidae) and scorpions (Scorpiones), including the first report of predation by an Italian Wall Lizard *Podarcis siculus* (Rafinesque-Schmaltz, 1810) on a Balearic Small Wood-Scorpion *Euscorpius balearicus* Caporiacco, 1950 in Menorca, Spain

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RESUMEN: Los escorpiones pueden considerarse depredadores oportunistas que cazan principalmente invertebrados, pero las presas vertebradas no son infrecuentes en la dieta de algunos escorpiones. Este fenómeno se denomina depredación cruzada y describe la situación en la que dos especies pueden convertirse en presas la una de la otra. Presentamos aquí una nueva observación de depredación por parte del lagartija italiana (*Podarcis siculus*) sobre el escorpión balear (*Euscorpius balearicus*), así como un resumen de los casos documentados de depredación por parte de Lacertidae sobre escorpiones. El caso que describimos no solo es una nueva observación de depredación, sino también un ejemplo de una especie introducida que representa una amenaza potencial para una especie endémica.

Scorpions (Arachnida: Scorpiones) can be regarded as opportunistic predators that mainly hunt invertebrates (insects, arachnids, other scorpions; e.g. Polis, 1979; Polis & McCormick, 1986; McReynolds, 2020; Rodríguez-Cabrera *et al.*, 2020), but vertebrate prey are not rare in the diet of

some scorpions (e.g. Anderson, 1956; McCormick & Polis, 1982). Infrequent predation by scorpions on lizards has been observed in both laboratory and experimental studies (Hardy, 1947; Banta, 1957; Garcia-Cardenete, 2003; Castilla *et al.*, 2008), and during *in situ* observations (Rodríguez-Mu-

ñoz *et al.*, 2017; Bringsøe *et al.*, 2022; Silva-Júnior *et al.*, 2023). On the other hand, many lizards, including those in the family Lacertidae, can feed on large and dangerous prey. In some populations of *Nucras tessellata*, scorpions were the primary food source in 50% of cases (Pianka *et al.*, 1979). Interactions between lizards and scorpions can be complex and depend on numerous factors (e.g. food base and its availability, overlapping ecological niches, and adaptations in both groups for hunting each other). In contrast to the data presented by Pianka *et al.* (1979), it has been demonstrated that in different regions, *N. tessellata* can have a diet that excludes scorpions altogether, even though scorpions are

present in these areas (van der Meer *et al.*, 2010). Thus, food availability in environments shapes intraspecific interactions. Similarly, mainland populations of *P. liolepis* (*P. hispanica atrata* therein) do not feed on *Buthus occitanus*, whereas island populations of *P. hispanica* very often hunt for them and vice versa (Castilla *et al.*, 2008). Such a phenomenon is called cross-predation – it describes the situation where two species can fall prey to each other. It has also been documented in different lizard and arthropod species (e.g. *Anolis sagrei* and *Heteroctenus junceus*, Rodríguez-Cabrera *et al.*, 2020; Teruel *et al.*, 2020; *Podarcis erhardii* and *Scolopendra cingulata*, Patharkar *et al.*, 2022). However, for European li-

Table 1: Summarized predation records for lacertids on scorpions with the taxonomic identity (to the lowest level reported) of prey items based on the literature.

Tabla 1: Resumen de registros de depredación de lacertidos sobre escorpiones con la identidad taxonómica (hasta el nivel más bajo registrado) de las presas según la bibliografía.

Lizard taxon	Scorpion taxon	Type of observation	Location	Reference
<i>Acanthodactylus boskianus</i>	<i>Buthacus tadmorensis</i>	Direct observation	Syria	Shehab <i>et al.</i> , 2011
<i>Darevskia praticola</i>	Not stated <i>Euscorpis solegladi</i>	Faeces	Bulgaria	Vacheva & Naumov, 2022 Vacheva, 2023
<i>Dalmatolacerta oxycephala</i>	<i>Euscorpis</i> sp.	Stomach contents	Croatia	This study, Anthony Herrel, personal observation, 2001
<i>Iberolacerta horvathi</i>	Not stated <i>Euscorpis gamma</i>	Stomach contents Direct observation	Italy Slovenia	Richard & Lapini, 1993 Žagar <i>et al.</i> , 2011
<i>Latastia longicaudata</i>	<i>Parabuthus liosoma</i>	Direct observation	Kenya	Kirchhof <i>et al.</i> , 2018
<i>Nucras bolubi</i> , <i>N. lalondii</i> , <i>N. ornata</i>	Not stated	Stomach contents	Africa	van der Meer <i>et al.</i> , 2010 Edwards <i>et al.</i> , 2013
<i>Nucras intertexta</i>	Not stated Not stated	Stomach contents Stomach contents	Botswana (Kalahari)Africa	Pianka <i>et al.</i> , 1979 van der Meer <i>et al.</i> , 2010
<i>Nucras tessellata</i>	Not stated	Stomach contents	South Africa (Kalahari)	Pianka <i>et al.</i> , 1979
<i>Podarcis hispanica atrata</i> (or <i>P. atrata</i> therein)	<i>Buthus occitanus</i>	Direct observation Stomach contents Experimental studies Experimental studies Direct observations and experimental studies	Spain (Columbretes archipelago)	Castilla <i>et al.</i> , 1987 Castilla, 1995 Castilla <i>et al.</i> , 2008 Castilla & Herrel, 2009 Castilla <i>et al.</i> , 2009
<i>Podarcis muralis</i>	<i>Euscorpis solegladi</i> Not stated	Faeces Faeces	Bulgaria	Vacheva, 2023 Vacheva & Naumov, 2024
<i>Podarcis siculus</i>	<i>Euscorpis balearicus</i>	Direct observation	Spain (Minorca Island)	This study
<i>Lacerta</i> spp.	Not stated	Not stated	Not stated	Millot & Vachon, 1949

zards, scorpions are only rarely documented in their diet, as these reptiles often rely on small insects and spiders (Capula & Luiselli, 1994; Carretero, 2004; Vacheva & Naumov, 2020; 2022; 2025). Interestingly, most documented cases of predation by European lizards on scorpions are related to lizards of the genus *Podarcis* (Castilla & Herrel, 2009; Vacheva, 2023. Table 1).

Below, we present a novel observation – the predation of an introduced population of the Italian Wall Lizard *Podarcis siculus* (Rafinesque-Schmaltz, 1810) on the Balearic Small Wood-Scorpion *Euscorpis balearicus* Caporiacco, 1950. Additionally, a summary of documented cases of predation by Lacertidae on scorpions is presented (Table 1).

On 15 September 2022, at 14:40 h in Freginal Park on the eastern side of Menorca, Spain (39°53'10"N, 4°15'49"E; elevation 45 m), an adult female *P. siculus* approximately 18–22 cm in total length was observed foraging on rocky substrate. The weather conditions at the time were overcast, and there was no wind (approx. 26° C). Shortly after being observed, the lizard rapidly grabbed something, which at first appeared to be a bush cricket. We photographed and recorded most of the interaction between these two animals. After closely examining the photos and video, the prey was identified as an endemic scorpion species, *E. balearicus*, recognizable by the characteristic light spots on the side of the abdomen (Figure 1a).

The lizard deliberately tried to bite the scorpion in the head region and control its tail, during which the scorpion tried to attack the lizard. The scorpion was shaken so vigorously that its tail could not make contact with the lizard's body (Figure 1b). After about a minute of struggling, the scorpion appeared to be dead, hanging motionless from

the lizard's mouth (Zdunek Herp, 2025). For about 20 seconds after immobilizing the prey, the lizard remained motionless with deep, rhythmic breathing, which may have indicated the high energetic cost of the hunt. Soon after that, the lizard moved away to the vicinity of a crevice where it swallowed the scorpion whole and then hid.

The Italian wall lizard is a European species that has been introduced into different regions



Figure 1: a) An adult female *Podarcis siculus* holds an adult *Euscorpis balearicus* in its mouth. b) Violently shaking the prey prevents it from escaping, thereby avoiding contact with the potentially dangerous tail-tip.

Figura 1: a) Una hembra adulta de *Podarcis siculus* sostiene en la boca a un adulto de *Euscorpis balearicus*. b) Al sacudir violentamente a su presa, evita que esta escape y, por lo tanto, evita el contacto con la punta de la cola, que puede ser peligrosa.

of the world. Introduced populations have been recorded in the Iberian Peninsula, Turkey, the United Kingdom, the United States of America, France, and some Greek Islands (Mollov, 2009; Rivera *et al.*, 2011; Silva-Rocha *et al.*, 2012; Berroneau *et al.*, 2021; Pantagaki *et al.*, 2025). This species has a very high rate of successful establishment wherever it is introduced (Silva-Rocha *et al.*, 2014; Ortega *et al.*, 2016). In Menorca, introduction of this species appears to date back to medieval times (Carretero & Silva-Rocha, 2015). *Podarcis siculus* is considered an active forager and generalist predator that preys on a wide range of invertebrates and sometimes small vertebrates (e.g. Sorci, 1990; Capula *et al.*, 1993; Rugiero, 1994; Sicilia *et al.*, 2001; Capula & Aloise, 2011). Its feeding behaviour appears to be opportunistic, as indicated by the consumption of different prey items in various habitats and/or geographical areas. For example, in Menorca, the dominant prey are spiders and beetles (Pérez-Mellado & Corti, 1993). Although this lizard species has been introduced and established for a long time in many locations, these features suggest it could pose a potential threat to the endemic scorpion, *E. balearicus*. *Podarcis siculus* can also be a possible threat to a second, rarer species found on Menorca and the Balearic Islands: *Euscorpius flavicaudis* (Pons, 2001). These scorpions mostly lead nocturnal lifestyles, unlike the diurnal lifestyle of the aforementioned lizards. Nonetheless, interactions between these species can occur as presented above (Figure 1). Different activity hours during the day cannot exclude interactions if the species utilize similar niches – for example, hiding places. In fact, many lizard species use burrows and/or crevices which are also occupied by scorpions (e.g. Castilla *et al.*, 2008). Some species of scorpions have even adapted a strategy of creating burrows, which lure prey that seeks shelter (Williams, 1966). Lizards, on the other hand, use different hiding places depen-

ding on their age – juveniles may choose safer places (such as dense vegetation), whereas adults use a wider range of microhabitats (Whiting *et al.*, 2003). Interactions can be induced in urbanized landscapes (e.g. Rodríguez-Cabrera *et al.*, 2021), due to a wide range of unique human-made microhabitats. Combined with the limited area of habitats suitable for the species mentioned above, this creates greater opportunities for their interactions. Unexpectedly, scorpions have not been previously documented in the diet of *P. siculus*.

Consumption of potentially dangerous prey, such as stinging insects, scorpions, centipedes, or even praying mantises, is not typical in lacertids. In some cases, lizards may fall prey to scorpions (Banta, 1957; McCormick & Polis, 1982; Bauer, 1990), centipedes (Guimarães Moura *et al.*, 2015; Koleska *et al.*, 2023), or mantises (Jehle *et al.*, 1996; Nardi & Spada, 2023). Indeed, scorpions represent only a minor part of the diet of European lacertids (Table 1). In most reported cases, adult males are more likely to use such food sources, possibly due to the larger size of the male's head and greater bite force compared to females (Verwajen *et al.*, 2002).

Due to their defensive behaviour when attacked (i.e., rapid movement of the stinger towards the attacker, sometimes assisted by locating easier-to-penetrate locations on a predator's body, allowing to inject it with venom finally), scorpions are among the most challenging prey to subdue. Consequently, small lizards show specific hunting techniques to address this issue. Lizards, when faced with a scorpion as potential prey, carry out executed prolonged and violent attack sequences, such as head-shaking with the prey clutched in the jaws and the throwing of the prey (Whitford *et al.*, 2022). Moreover, the size of the scorpion further affects the sequence of attacks made by adult lizards, with more

attacks and more violent attacks directed toward large scorpions when compared to small ones (O'Connell & Formanowicz, 1998). Although such behaviour has been documented in other lizard species dealing with potentially dangerous prey (Whitford *et al.*, 2022; Roudil *et al.*, 2024), our observation is the first for *P. siculus*.

Behavioural experiments comparing the reactions of two closely related *Podarcis* species (from mainland and island) to contact scorpions showed a tendency for mainland lizards to flee or ignore this potential prey (Castilla *et al.*, 2008). However, the island lizards considered scorpions to be suitable prey (Castilla *et al.*, 2008; 2009). In our case, an introduced continental lizard was observed preying on scorpions on an island. As the prey consumption by lacertids depends on different factors such as prey availability, season, size of the lizard, sex, predation risk, and species, a larger study based on representative populations should be conducted to understand better this aspect of their diet (Díaz & Carrascal, 1993; Capula & Luise-lli, 1994; Verwajen *et al.*, 2002; Carretero, 2004; Žagar *et al.*, 2011). Vacheva (2023) documented that for *P. muralis*, scorpions do not appear to be a rare food item. *Podarcis erhardii* includes the potentially dangerous *Scolopendra cingulata* in its diet (Patharkar *et al.*, 2022). Both of these lizard species are regarded as dietary generalists, which, combined with their prey subduction strategies, may lead to an increased reliance on hazardous food items (Herrel *et al.*,

2004). Although not documented in *Podarcis*, resistance to scorpion venom, as observed in some other lizard species, could be an essential trait that allows the use of scorpions as a food resource (e.g. Zlotkin *et al.*, 2003). Protection from the venom does not have to occur on the physiological or metabolic level – it can be achieved through mechanical barriers or behavioral responses (Edstrom, 1992). Recently, it has been demonstrated that the high consumption of *Scolopendra centipedes* by juvenile Chinese Crocodile Lizards, *Shinisaurus crocodilurus* Ahl, 1930, promotes growth and maintains their gut microbiome homeostasis (Xie *et al.*, 2024). Moreover, cross-predation on potentially dangerous prey leads to decreased future predation and interactions between a potential predator and their offspring (Bücherl, 1971). Thus, predation on scorpions could also be potentially beneficial for lizards, although further studies are required. Observations such as these, even as single events, can broaden the scope of information about the natural history and ecology of lacertids and their interactions with scorpions. By summarizing records from literature with the inclusion of our new observations (Table 1), we hope to facilitate future research on this subject.

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