Can size make a difference? Cross-predation occurrences between lizards and scorpions in the Brazilian seasonal dry tropical forest

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ABSTRACT. Cross-predation is an important event that may influence prey–predator dynamics, especially in arid and semiarid ecosystems. In this study, we report four predation events involving lizards and scorpions from different sites in the Brazilian seasonal dry tropical forest. In three of these events, the lizard acted as the predator, while in one event, the scorpion was the predator. Body size played a determining role when lizards were the predator of the scorpion, with larger vertebrates feeding on the arachnids. In contrast, when the sizes were similar, the scorpion acted as the predator of the lizard. Our findings suggest a complex relationship between lizards and scorpions in the Brazilian seasonal dry tropical forest.

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Может ли размер иметь значение? Случаи взаимного хищничества между ящерицами и скорпионами в бразильском сезонном сухом тропическом лесу

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РЕЗЮМЕ. Взаимное хищничество является важным явлением, которое может оказывать влияние на взаимоотношения добычи и хищника, особенно в аридных и полуаридных экосистемах. В этом исследовании мы сообщаем о четырех случаях хищничества, включающих ящериц и скорпионов из разных мест в бразильском сезонном сухом тропическом лесу. В трех из этих случаев ящерица выступала в роли хищника, тогда как в одном случае хищником был скорпион. Размер тела играл решающую роль, когда ящерица выступала в роли хищника скорпиона, крупные позвоночные питаются паукообразными. В отличие от этого, когда размеры были сходными, скорпион действовал в роли хищника ящерицы. Наши результаты указывают на сложные взаимоотношения между ящерицами и скорпионами в бразильском сезонном сухом тропическом лесу.
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КЛЮЧЕВЫЕ СЛОВА: Каатинга, конкуренция, хищничество внутри гильдии, онтогенетическая инверсия, полуаридный.

Introduction

Lizards play a crucial role in arid environments, with almost all species acting as arthropod predators (Pianka, 1973; Palmeira *et al*., 2021). Scorpions, which can reach densities of approximately 3,200 individuals per hectare, are particularly abundant in these regions (Polis, 1990). Additionally, both lizards and scorpions utilize similar shelters, such as fallen logs and rocks (Castilla *et al*., 2008, 2009, 2015).

Therefore, reports of interactions involving lizards and scorpions have been recorded in the literature (Pérez, Minoli, 2014; Castilla *et al*., 2015; Gabriel *et al*., 2021; Cubas-Rodriguez, Teruel, 2022). These taxa exhibit an intriguing relationship called cross-predation, where both may act as predator or prey depending on circumstances (McCormick, Polis, 1982). The role of predation is typically associated with body size, with larger individuals acting as predators (Polis *et al*., 1989). On one hand, it has been pointed out that larger lizards, such as *Podarcis atrata* (Boulenger, 1905), use the scorpion *Buthus occitanus* Amoreux, 1789 as prey in the Columbretes islands. On the other hand, in the same islands, *B. occitanus* may prey on *P. atrata* juveniles (Castilla, Herrel, 2009). This predation pressure on small individuals may affect the spatial distribution of individuals in a way that avoids predation (Marques *et al*., 2018). Thus, cross-predation has the potential to play a key role in the population structure of both lizards and scorpions in their habitats. Despite the importance of these antagonistic relationships, interactions between lizards and scorpions are poorly documented in the Brazilian seasonal dry tropical forest (SDTF). Although some cases of scorpion predation by lizards *Acratossaura mentalis* (Amaral, 1933) and *Diploglossus lessone* Peracca, 1890 have been reported in the field (Vitt, Zani, 1988), and pieces of these arachnids have been found in the stomach contents of other species, a precise identification of prey was not performed by the authors (Ferreira *et al*., 2017). This scarcity of reports is particularly surprising given that the Brazilian SDTF comprises a region of 912,529 km² (approximately 10% of the country's territory) (Silva *et al*., 2017), and both lizard and scorpion fauna have been addressed in recent studies (Mesquita *et al*., 2017; Lira *et al*., 2021; Palmeira *et al*., 2021). Thus, in order to provide information about the natural history of these taxa, the present work reports on predation events involving these two groups.

Material and Methods

Cross-predation reports were obtained through field studies carried out in the Brazilian SDTF between 2005 and 2022. In instances where lizards acted as predators, two events were registered in February 2005 in the municipality of Campina Grande 7°13′44.67″ S, 35°52′51.0024″ W), in the state of Paraíba. Lizards of the species *Ameiva ameiva* (Linnaeus, 1758) (Teiidae) and *Tropidurus hispidus* (Spix, 1825) (Tropiduridae) were found in the ground during morning hours (10:00–11:00 am) preying on the anterior portion of *Tityus stigmurus* (Thorell, 1876) (Buthidae) scorpions (see Fig. 1A–B). A third event was reported during the nocturnal period (9:00–10:00 pm) in January 2021, in the municipality of Ruy Barbosa (12°17′02″ S, 40°29′38″ W), in the state of Bahia. In this case, a *Phyllopezus policaris* (Spix, 1825) (Phyllodactylidae) lizard was found inside a human residence holding a *Tityus serrulatus* Lutz et Mello-Leitão, 1922 (Buthidae) scorpion in its mouth by the mesosoma (see Fig. 1C). Events where scorpions preyed on lizards were also recorded at night (10:00–11:00 pm) in May 2022, in the municipality of Caetés (8°46'22'' S, 36°37'22 W), in the state of Pernambuco. In this report, a *Tityus pusillus* Pocock, 1893 (Buthidae) individual was found on leaf litter holding a *Coleodactylus meridionalis* (Boulenger, 1888) (Sphaerodactylidae) lizard in its pedipalps (see Fig. 1D).

Results and Discussion

In this study, we observed four instances of cross-predation between scorpions and lizards in various locations within a Brazilian SDTF. In cases where lizards acted as predators, their larger body size was notable in comparison to their prey. Cross-predation is a common occurrence between these two taxa (Castilla *et al*., 2008, 2009a, b, 2015), and it occurs during a phenomenon known as "ontogenetic reversal". As an individual grows from a small, vulnerable predator to a larger, more specialized predator, cross-predation tends to decrease the risk of predation for themselves and their offspring (McCormick, Polis, 1982; Castilla *et al*., 2009a, b). In relation to lizard predation by scorpions, the events recorded here show that both prey and predator possess similar body sizes. Based on the larger body size of the predators, our work supports the hypothesis that body size is a determinant of the success of scorpion predation by lizards. When a scorpion selects its prey, its preference is noted to be dependent on size, the type of exoskeleton, and the possibility to ride (Polis, 1979), the first two of which reflect the capacity to be manipulated by the scorpion's pedipalps (Lourenço, 2018). Scorpions are venomous predators that immobilize their prey

Fig. 1. Cross-predation reports between lizards and scorpions from Brazilian Seasonal Dry Tropical Forest. A — *Ameiva ameiva* lizard preying on *Tityus stigmurus* scorpion, B — *Tropidurus hispidus* lizard preying on *Tityus stigmurus* scorpion, C — *Phyllopezus policaris* lizard preying on *Tityus serrulatus* scorpion, and D — *Tityus pusillus* scorpion preying on *Coleodactylus meridionalis* lizard.
Рис. 1. Сообщения о взаимном хищении между ящерицами и скорпионами из бразильского сезонного сухого тропического леса. A — ящерица *Ameiva ameiva* охотится на скорпиона *Tityus stigmurus*, B — ящерица *Tropidurus hispidus* охотится на скорпиона *Tityus stigmurus*, C — ящерица *Phyllopezus policaris* охотится на скорпиона *Tityus serrulatus*, D — скорпион *Tityus pusillus* охотится на ящерицу *Coleodactylus meridionalis*.

through the inoculation of toxins via a stinger (Polis, 1990; Lourenço, 2018; Simone, Van der Meijden, 2021). Therefore, due to their venom, scorpions may capture larger-bodied prey as recorded in our study. Furthermore, all species involved in this work are generalist predators of a broad spectrum of prey (Polis, 1990; Gardner *et al.*, 2007; Ribeiro, Freire, 2011; Recoder *et al*., 2012), thus potentially enhancing encounters between different predators and allowing for cross-predation mediated by body size. Finally, our reports of cross-predation involving lizards and scorpions were recorded in different and scattered sites of Brazilian SDTF, suggesting that this is a common interaction between these two taxa in this environment.

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Conflict of Interest

The authors declare no conflict of interest.

Ethical approval

No ethical issues were raised during this research.

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