Revista Ibérica de Aracnología, nº **24** (30/06/2014): 107–108.
Grupo Ibérico de Aracnología (S.E.A.). ISSN: 1576 - 9518.

Microhabitat use by scorpion species (Arachnida: Scorpiones) in the montane Atlantic Rain Forest, Brazil

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Abstract: The increasing devastation of tropical forests makes it critical to understand the structure of their animal communities. Based on this assumption, we conducted a field study to investigate the microhabitat use of the scorpion community in a montane marsh ('Brejo' formation). During three months, samples were actively collected during the night with the help of a UV flashlight. The distinct spatial distributions within a habitat indicated distinct niche partitioning among coexisting species of scorpions. Based on these results, we conclude that individual differences in the use of the environment can facilitate coexistence among species. Competition for shelters at different spatial scales and predation pressure can highly affect the dynamics and distribution of scorpion species in a tropical forest.
Key words: Scorpiones, Buthidae, community ecology, spatial distribution, *Tityus brazilae*, *Tityus neglectus*, *Tityus pusillus*, Brazil.

Uso de microhábitats por las especies de escorpiones (Arachnida: Scorpiones) en la pluviselva atlántica montana, Brasil
Resumen: La creciente devastación de los bosques tropicales hace esencial el entendimiento de la estructura de sus comunidades animales. Basándose en este principio, se realizó un estudio de campo para investigar el uso de microhábitats de la comunidad de escorpiones en un pantano (formación "Brejo"). Durante tres meses se recogieron muestras de forma activa durante la noche con ayuda de una linterna UV. Las distribuciones espaciales diferentes en el hábitat indicaron distinto reparto de nichos entre las especies de escorpiones coexistentes. Sobre la base de estos resultados, se concluye que las diferencias individuales en el uso del medio ambiente pueden facilitar la coexistencia entre las especies. La competencia por los refugios en diferente escalas espaciales y la presión de depredación pueden afectar en gran medida a la dinámica y la distribución de las especies de escorpiones en un entorno de bosque tropical.
Palabras clave: Scorpiones, Buthidae, ecología de comunidades, distribución espacial, *Tityus brazilae*, *Tityus neglectus*, *Tityus pusillus*, Brasil.

Introduction

Scorpions are a group of Arthropods comprising about 1,900 species (Stockman & Ythier, 2010) widely distributed over all continents except Antarctica (Sissom, 1990). Approximately 50% of these species occur in tropical regions (Lourenço, 2002a), including Brazil, where roughly 130 species are recorded (Porto *et al*., 2010). These arachnids are primarily solitary and sedentary arthropods and live preferentially in microhabitats that are colonised by other arthropods on which they prey (Brownell & Polis, 2001). Intra- and inter-specific coexistence has been recorded in several species of scorpions (Kaltsas *et al*., 2009; Lira *et al*., 2013; Shehab *et al*., 2011), producing different levels of aggregation and sociability (Polis & Lourenço, 1986; Polis, 1990). Species may either co-occur in the same habitat or co-occur in the same shelter (Warburg, 2000).

The coexistence of Brazilian scorpions was assessed by Lira *et al*. (2013) with specimens of *Tityus pusillus* Pocock, 1893 and *Ananteris mauryi* Lourenço, 1982 in the Atlantic Forest. They found that both *T. pusillus* and *A. mauryi* colonized the leaf litter, sharing the same shelter more frequently between juveniles of *T. pusillus* and adults of *A. mauryi*. However, this is the only study that has addressed the microhabitat uses of scorpions in Brazilian tropical forest. Ecological studies with these organisms as models in Neotropical regions are rare, especially in the Brazilian Atlantic Forest (Dias *et al*., 2006; Lira *et al*., 2013; Yamaguti & Pinto da Rocha, 2006). This lack of previous studies is not that surprising, since no experts are available in Brazil, despite the high biodiversity of such environments and evidence that environmental change is transforming the ecology of the tropics (Brazil & Porto, 2010; Lewis *et al*., 2009).

The focus of this study was to characterize the microhabitat uses of scorpion species in Brazilian Montane Atlantic Forest. The presence of conspecifics and heterospecifics in the same environment most certainly results in substantial competition for the resources of food and shelter and may decisively influence habitat selection. We tested the prediction that co-occurring species of scorpion would exploit different microhabitats to avoid intra-guild predation. The findings of the present study on the ecology of a scorpion species assemblance can contribute to a better understanding of the arthropod community structure in tropical forests of Brazil.

Material and Methods

Study area

Fieldwork was conducted in the Parque Natural Municipal João Vasconcelos Sobrinho, an area composed of 359 ha of Seasonal Evergreen Forest (08º22'09"S, 36º05'00"W) (Andrade-Lima, 1961), in the state of Pernambuco, in the northeast of Brazil. The area is characterised by a mean annual temperature of 24°C and an annual rainfall of 650–900 mm (CPRH, 1994). The Montane Atlantic Forest of north-eastern Brazil consists of remnants product of cyclic expansions and contractions of rainforest cover beginning in the Pleistocene, and are represented by rain forest patches covering various isolated plateaus and mountain ranges from 600–1200 m of altitude within the Caatinga region (Tabarelli & Santos, 2004).

Scorpion sampling

Three expeditions were conducted between September and November 2011, each expedition lasted two days/month. The data were obtained actively searching with the assistance of UV lamps between 1900 and 0100. The time spent in each collection was 6 h/night, totalling 36 h of observations. Microhabitat use was evaluated based on the characteristics of the environment which could be used as a microhabitat, including stones, leaf litter, fallen logs, and bromeliads. The data collected were on active individuals that were either outside of their refuges or just emerging from the refuges, as suggested by McReynolds (2008). Voucher specimens were deposited in the Arachnological Collection of the Universidade Federal da Paraíba, João Pessoa, Paraíba, Brazil.

Table I. Microhabitats (in %) colonized by the scorpions *Tityus brazilae* Lourenço & Eickstedt, 1984, *Tityus neglectus* Mello-Leitão, 1932, and *Tityus pusillus* Pocock, 1893 in the Montane Atlantic Forest in the northeast of Brazil.

	Microhabitat			
Species	**Stone**	**Fallen log**	**Bromeliad**	**Leaf litter**
Tityus brazilae	66	34	0	0
Tityus pusillus	0	0	0	100
Tityus neglectus	0	0	100	0

Results and Discussion

A total of 23 scorpions, nine *Tityus brazilae* Lourenço and Eickstedt, 1984, four *Tityus neglectus* Mello-Leitão, 1932, and ten *T. pusillus*, were captured in this study. Only *Tityus brazilae* was observed in two types of microhabitats, stones and logs (Table I). While, *Tityus neglectus* was found on soil bromeliads and *T. pusillus* on leaf litter (Table I).

The spatial distribution in each microhabitat found in this study was highly dependent on the scorpion species. Information on microhabitat distribution is crucial for understanding the processes of species coexistence (Brown, 1984; Lankau, 2011). Although the co-occurrence of different species of scorpions is widely recognised (Polis, 1990; Polis & McCormick, 1987; Shehab *et al*., 2011), little attention have been given to microhabitat use between species, particularly in tropical forests (Lira *et al*., 2013). In the present study, *T. brazilae*, *T. neglectus*, and *T. pusillus*, were found together in the same habitat. *Tityus neglectus* is a large scorpion species (54-78 mm) (Lourenço, 2002b) commonly associated with soil bromeliads, which provides a microhabitat favourable for the establishment of the species (Lourenço & Eickstedt, 1988). Corroborating these authors, all specimens collected in this study were found inside soil bromeliads. *Tityus pusillus*, the most abundant species in this study, is a small (24-35 mm) (Lourenço, 2002b), sedentary animal inhabiting the upper layers of leaf litter (Lira *et al*., 2013), widely distributed in the Atlantic Forest of northeastern Brazil (Dias *et al*., 2006; Lourenço, 2002b; Porto *et al*., 2010). Our findings corroborated the microhabitat use observed by Lira *et al*. (2013): all *T. pusillus* individuals where collected on leaf litter. While all the specimens of the larger (50-70 mm) scorpion *Tityus brazilae* (Lourenço, 2002b) showed behaviour classified by Lira *et al*. (2013) as a hunting position, being found under the bark of dead logs and in cracks in stones suggest that this species could be classified as a 'bark scorpion'.

The use of different substrates could reduce the possibility of contact and subsequent conflict between scorpion species, as proposed by Lira *et al*. (2013) for *T. pusillus* and *A. mauryi* and by Warburg (2000) for *Nebo hierichonticus* (Simon, 1872) and *Scorpio maurus fuscus* (Linnaeus, 1758) in tropical and Mediterranean regions, respectively. Smaller species and immature individuals of larger species would avoid microhabitats with larger scorpion species, since they are active at the same time (Polis & McCormick, 1986; Ramos, 2007). According to Polis & McCormick (1987), the principal predators of scorpions are other large-sized scorpions. However, predators can easily see, and therefore, capture large scorpions, which would explain the higher frequence of larger species such as *T. brazilae* and *T. neglectus* for microhabitats where they can hide.

In conclusion, the present study describes the microhabitats used by three buthid scorpions (*T. brazilae*, *T. pusillus*, and *T. neglectus*) in the Montane Atlantic Forest, with differences in microhabitat colonization by each species. It is possible that these tendencies were due to predation pressure and possibly to spatial resource partitioning. The colonisation of different microhabitats allows different species of generalist predators like scorpions to coexist in the same habitat.

Acknowledgements

The authors are very grateful to Prefeitura do município de Caruaru for collection permission and financial support. We are also very grateful to CAPES for a scholarship to the first author

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