LITTLE LIZARDS WITHIN THE LEAF LITTER: SUBSTRATE SELECTION ENSURES SURVIVAL OF ENDEMIC DWARF GECKOS AT THE SALT FLATS REFUGE IN CABO ROJO, PUERTO RICO

Rhianna F. Smith-Dorr, MS[1]

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Abstract - Substrate selection is of the utmost importance to the survival of two endemic geckos, *Sphaerodactylus nicholsi and Sphaerodactylus roosevelti,* at the Salt Flats Refuge in Cabo Rojo, Puerto Rico. Both species use leaf litter and fallen termite mounds to the same degree with the purpose of regulating their temperature and metabolism thereby avoiding desiccation. In addition, their substrate selection serves as protection from predators and as an efficient means to locate food by reducing predation chances. We can help the survival success of these geckos by preventing the deforestation of trees and mangroves associated to their habitats.

Keywords: Sphaerodactylus, salt flats refuge, leaf litter, termite mound

Resumen - La selección de sustrato es de gran importancia para la sobrevivencia de dos gecos endémicos, *Sphaerodactylus nicholsi y Sphaerodactylus roosevelti,* que se encuentran en el Refugio Las Salinas en Cabo Rojo, Puerto Rico. Ambas especies utilizan al mismo grado la hojarasca y nidos de termitas caídos en el suelo con el fin de regular su temperatura y metabolismo, evitando la desecación. Además, su selección de sustrato sirve de protección contra depredadores al igual que de una fuente de alimento. Podemos asegurar la sobrevivencia de estos gecos al prevenir la deforestación de árboles y mangles asociados a su hábitat.

Palabras clave: Sphaerodactylus, Refugio Las Salinas, sustrato, hojarasca, nidos de termitas

Introduction

All species on Earth possess specialized strategies that allow them to survive and flourish in a given habitat. This habitat can be as large as a continent or as miniscule as the patches of leaf litter under our feet as we walk through a refuge. The Salt Flats Refuge in Cabo Rojo is a harsh and arid habitat with summer temperatures that surpass 105 degrees Fahrenheit. Despite this hostile environment, this refuge is home to various species of endemic lizards. Among them, reside two species of endemic *Sphaerodactylus,* some of the smallest and extreme species found on our island.

[1]Natural Sciences Faculty, Biology Department, University of Puerto Rico, Arecibo Campus; email: rhianna.smith@upr.edu

The *Sphaerodactylus* genus currently encompasses a Neotropical distribution, including most of the Caribbean, Central and South America, as well as small areas of the North American continent (Vitt & Caldwell, 2014; Powell & Henderson, 1999).

Sphaerodactylus geckos differ from other geckos in many ways. For starters, they are diurnal or crepuscular being mostly active during daylight hours, particularly dawn and dusk (Gamble, Greenbaum, Jackman & Bauer, 2015). In addition, they are mostly terrestrial and lack the ability to vocalize. Instead, Regalado (2003) suggested that members of *Sphaerodactylus* rely on visual cues as well as chemical signals for communication. Currently, Puerto Rico is home to nine species of *Sphaerodactylus* including one species from Mona, Monito and Desecheo (Schwartz & Henderson, 1991; Rivero, 2006). Other species are yet to be described, like a new species found in Rincón (Díaz-Lameiro, Oleyksyk, Bird-Picó & Martínez-Cruzado, 2013) and another from Culebra Island (Rios-Franceshi, García-Cancel, Bird-Picó, & Carrasquillo, 2006). Furthermore, the species *S. macrolepis* has nine subspecies (Rivero, 1998).

Sphaerodactylus nicholsi (Figure 1) and *Sphaerodactylus roosevelti* (Figure 2) are two species of endemic dwarf geckos that live in sympatry at the Salt Flats Refuge. Interestingly, these two species vary significantly in their sizes. *Sphaerodactylus nicholsi* is the smallest member of the genus found in Puerto Rico as well as the smallest amniote (Rivero, 1998). This species has an average Snout-Vent-Length (SVL) of 20mm for adults (Rivero, 1998) By contrast, *S. roosevelti* can reach a maximum Snout-Vent-Length (SVL) of 39mm for adults making it the largest species of Sphaerodactilid found in Puerto Rico (Rivero, 1998). Although most species of Sphaerodactilids on the island have very similar physical attributes, we can identify *S. nicholsi* by the presence of a "crescent moon shape" pattern on the head as well as a chevron on the base of the tail (Figure 1). For *S. roosevelti*, we note the presence of sexual dimorphism between adult males and females. Females of the species possess white coloring with black longitudinal lines that start at the head forming a sort of mask like pattern that

Figure 1. Sphaerodactylus nicholsi adult.

Figure 2. Sphaerodactylus roosevelti adult male.

extends along the length of the body (Figure 3). By contrast, males lack the presence of this mask and black longitudinal lines (Figure 2). In most mature males, we see grey, almost light blue longitudinal lines along the body (Figure 2). Another factor that may help with the identification of Sphaerodactilid on the island is the geographic location of individual, since most species are only found at certain elevations or microclimates. In addition, the size or length (SVL) of the adult individual may also serve as an identification parameter.

Figure 3. Sphaerodactylus roosevelti adult female within termite mound.

Due to the diminutive size of Sphaerodactilids, they have high surface area to volume ratios, which in turn cause high risks of desiccation (Bentley, 1976; Nava, 2006; Turk, Wyszynski, Powell, & Henderson, 2010; Johnson, Parmerlee, Eifler, & Powell, 2013; Allen & Powell, 2014). Similarly, Bentley (1976) and Turk et al. (2010) noted that smaller animals lost water faster than larger individuals did and this was due to the relationship of body size to biomass. Thus, larger lizards have relatively less surface area from which water is lost than smaller ones. As a means to buffer the effects of water loss, Sphaerodactilids are usually found inhabiting shady canopy areas as well as leaf litter patches. This use of microhabitat selection allows them to avoid direct sunlight while taking advantage of lower temperature gradients and increased humidity within a hostile environment. For example, while studying *S. gaigae, S. macrolepis* and *S. townsendi* in Puerto Rico, Nava (2004) stated that humidity was the most vital parameter used for habitat selection. Similarly, there was a trend in microhabitat preference of shady, moist and deep leaf litter areas when studying *Sphaerodactylus vincenti* on the island of St. Vincent in West Indies (Steinberg, Powell, Powell, Parmerlee, & Henderson, 2007).

Substrate selection

Substrate selection is essential to ensure survival of tiny geckos in harsh environments such as the Salt Flats Refuge. By being *thigmothermic, S. nicholsi* and *S. roosevelti* perform thermoregulation with the use of substrates and objects found in their habitat. These species do not bask in sunlight in order to be able to regulate their metabolism and other physiological processes because of the risk of desiccation (Snyder, 1979; Steinberg et al., 2007; Allen & Powell, 2014). Although there are significant differences between the sizes of *S. nicholsi* and *S. roosevelti,* no statistical differences exist in their selection of leaf litter depth (cm) within the Salt Flats Refuge (Figure 4). These species use an average depth

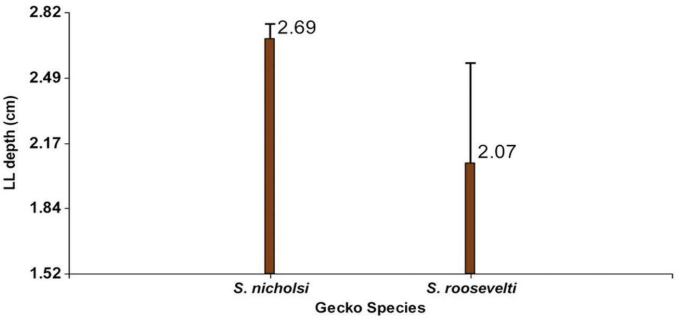

Figure 4. Comparison of leaf litter depth (cm) selection between *Sphaerodactylus nicholsi and S. roosevelti*

Note. Study sample size included 667# *Sphaerodactylus nicholsi* and 124# *Sphaerodactylus roosevelti.* No significant differences exist in leaf litter depth selection between species. Both species use leaf litter as substrate within the Salt Flats Refuge. (Wilcoxon Test-Mann- Whitney U, *p*-value 0.1677).

of leaf litter of 2.38cm. At the Salt Flats Refuge, the canopy cover and leaf litter was predominantly comprised of the following vegetation: *Prosopis* sp. (Mesquite), *Pithecellobium ungis cati* (Cat's Claw), as well as three species of mangroves: *Avicennia germinans* (Black), *Conocarpus erectus* (Button) and *Laguncularia racemose* (White). Because of the importance of shade and leaf litter for these species, the conservation of trees and mangroves in the refuge is paramount. Without trees, there can be no leaf litter patches and thus no geckos to inhabit these habitats. Similarly, by opening up canopy habitats, there may be an increase in predation by larger, more active lizards that feed on smaller vertebrates (Lewis, 1989; Vitt, Sartorius, Aviles-Pires, Zani, & Esposito, 2005). Furthermore, this genus is vulnerable to anthropogenic disturbances due to their specialized habitats and limited dispersal abilities (Nava, 2004).

In addition to leaf litter use, *S. nicholsi* and *S. roosevelti* at the Salt Flats Refuge also use other substrate types, such as rocks, debris, fallen tree trunks and termite mounds. Within these substrate types, the use of fallen termite mounds is the most prevalent (Figure 5).

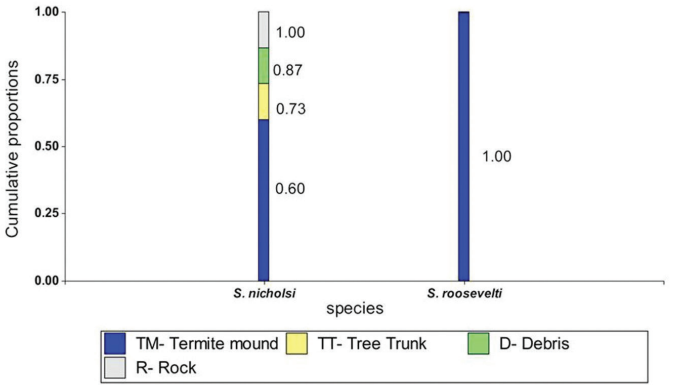

Figure 5. Comparison between *Sphaerodactylus nicholsi* and *S. roosevelti* of "Other" type of substrate selected.

Note. Study sample size included 667# *Sphaerodactylus nicholsi* and 124# *Sphaerodactylus roosevelti.* No significant differences exist between species within the "Other" substrate type selected (Chi-Square, *p*-value 0.2280). Both species were predominantly found in termite mounds.

Further importance of substrate selection

Aside from the importance of substrate as a means to buffer the effects of desiccation, substrate selection may serve as protection from predators. Leaf litter allows these diminutive lizards to be shrouded from known predators such as lizards within the *Pholidoscelis* (previously *Ameiva*) and *Anolis* genera (Lewis, 1989 ; López-Ortiz & Lewis, 2002 & 2004). Leaf litter may be exceptionally useful for S. *nicholsi* whose dark mottled color pattern allows perfect camouflage within this substrate. Similarly, fallen termite mounds may serve this same purpose, allowing diminutive Sphaerodactilids the ability to hide inside the crevices of the mound much too small for other lizards to enter (Figure 3).

Substrate selection may also aid these geckos in the acquisition of food. For example, leaf litter and termite mounds at The Salt Flats Refuge are associated with a variety of micro invertebrates that may serve as a food source for Sphaerodactilids. Prey items have never been documented for *S. nicholsi* and *S. roosevelti.* However, studies focusing on stomach contents of *S. vincenti* on the island of St. Vincent report various orders of insects, isopods (crustaceans), arachnids and snails (Steinberg et al., 2007). The fact that these tiny geckos can be able to locate food without having to roam outside of substrate is especially vital since it may reduce the possibility of being hunted by predators.

Concluding remarks

These two species are found living together only on the southwestern coast of Puerto Rico. Because of this limited distribution, it is imperative to educate the public about these geckos and help conserve their habitat in order to ensure their survival. These lizards are endemic to Puerto Rico and they belong on this island as much as we do.

Sphaerodactilids thrive in the extreme habitat of The Salt Flats Refuge because they have learned to exploit their resources by means of microhabitat selection. They have become experts in locating and using areas within their habitat that possess more advantageous characteristics for survival. These characteristics mainly include substrate selection focused on lower temperatures, higher humidity, food availability, and shade among other parameters.

Let us work together to conserve the vegetation that is essential to their survival. All species benefit from the conservation of our natural resources. Ultimately, we are all a part of the delicate cycles governed by planet Earth. It is time we started acting like it.

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