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Surface soil type preference for burrowing of the endangered and endemic trapdoor spider *Calathotarsus simoni* (Araneae: Migidae)

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Abstract

Calathotarsus simoni Schiapelli & Gerschman, 1975 is an endemic and rare trapdoor spider that lives exclusively in the mountainous systems of southern Buenos Aires province, central Argentina. In previous studies, authors suggested the preference of this species to a particular soil surface type. Thus, we hypothesized that this species differs in its responses to the soil surface type for burrow construction. To test this, we placed 26 adult females in chambers providing two choices (soil with moss and without moss) and compared the proportions of observations in each to evaluate species preference. *Calathotarsus simoni* significantly preferred the soil with moss. We observed a remarkable behaviour before the construction of the burrow when spiders were at the soil with moss. Finally, we discuss the possible ecological significances of this preference.

Keywords: Argentina • burrow construction • Mygalomorphae

Introduction

Organisms are able to select a particular habitat based on a variety of cues used as stimuli (Krebs 1985). In particular, soil type may affect many characteristics of the microhabitat, such as litter amount and its associated fauna (Luizão, Luizão & Proctor 2007). A recent study demonstrated that spiders can rely on soil type as a cue to select habitat (Portela, Willemart & Gasnier 2013). A relationship between the distribution of spiders and the soil type has often been found in studies with burrowing spiders (Halloran, Carrel & Carrel 2000; M'Rabet *et al.* 2007; Rezác *et al.* 2007). Moreover, soil properties are certainly a key factor determining the presence of some burrowing species in a particular habitat (M'Rabet *et al.* 2007).

Trapdoor spiders, as the name suggests, are characterized by the construction of a door at the entrance of their small tubes like burrows, which serves the dual purpose of protection or cover, and also as a trap to capture prey. The door is made of a thick layer of silk and is held tightly hinged to one end of the burrow entrance (Coyle, Goloboff & Samson 1990; Ferretti *et al.* 2014). Usually, dry leaves, moss, lichens and soil particles adhere to the outer wall of the door, simulating the surrounding environment.

Calathotarsus simoni Schiapelli & Gerschman, 1975 is an endemic and rare trapdoor spider that lives exclusively in the mountainous systems of southern Buenos Aires province, central Argentina (Schiapelli & Gerschman 1973; Goloboff 1991; Ferretti *et al.* 2014) and comprises a threatened species (Ferretti, Pompozzi & Cardoso 2017). Recently, Ferretti *et al.* (2014) and Ferretti, Pompozzi & Cardoso (2017) presented some data on its natural history and trapdoor characteristics. These spiders were only found on steeply sloping hillsides where they construct their burrows in highly humid soil covered with mosses of the species *Anacolia laevisphaera* (Taylor) Flow. and *Tortula atroviren* (Turner Ex SM.) (Ferretti *et al.* 2014). Although all burrows from that study were found where mosses were present (Ferretti *et al.* 2014), the authors could not be sure of the surface preferences for this species when selecting microhabitat characteristics for burrow construction.

Based on this previous study, and the presence of burrows of this species on a particular soil surface type, we hypothesized that, in captivity, *C. simoni* would avoid soil without moss as a primary selected soil surface type, thus spending more time on the surface with moss and begin burrow construction.

Material and methods

Adult females of *C. simoni* (n = 26), and samples of soil with and without moss, were collected in March 2016 at the "Funke" ranch, inside the mountainous system of Ventania (38°4′20.40″S 62°3′8.12″W). Spiders were collected from a hillside of about 2300 m^2. We kept the spiders individually in plastic vials (4 cm diameter × 10 cm height) and subjected them to a constant 12:12 light/dark cycle at about 27°C in the laboratory. We provided water *ad libitum* and fed the spiders with one cockroach (*Blatella germanica*) once every two days. We carefully removed the soil with and without moss using a small shovel and then transported it in moist black plastic bags to avoid dehydration. We stored the soil samples in plastic cages with regular moisture for a week after collection until the days of experiment. We checked the soil samples before the trials to ensure no individuals were found between them.

We placed samples of soil without moss and with moss in a glass container, 15 cm length × 15 cm wide × 15 cm height, which had a styrofoam base and also to prevent contact between the two arenas with different surface soil types (Fig. 1). We placed each spider in a centre circle (of paper) of the container located between the two arenas and left it there to acclimate for 2 minutes. After this period, we recorded every 15 minutes between 08:00 a.m. and 16:00 p.m. on which arena type each spider was found and also recording if burrow digging behaviour was initiated. We obtained a number of 32 observations per spider totalizing 832 observations, testing each spider once. For each spider, we recorded the proportion of observations on soil with moss from the total observations son soil with and without moss. When a spider was observed with at least four legs touching one of the soil types and none touching the other soil type we considered them as valid observations. The results were analysed using PAST statistical package v.3.14 (Hammer, Harper & Ryan 2001). We compared the pairs of frequencies of observations of spiders for soil with and without moss using the Chi-squared test.

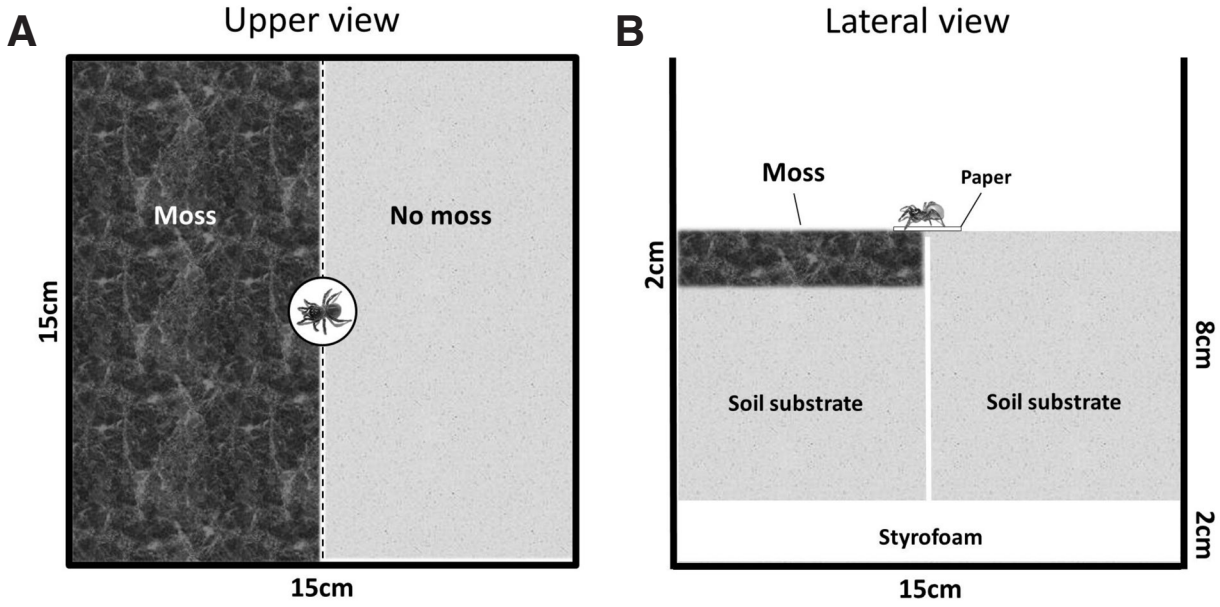

Fig. 1: Testing container as viewed from above (**A**) and laterally (**B**). A small partition of styrofoam was built on the base to prevent contact between the two surface soil types (moss and no moss).

Results and discussion

We obtained 561 observations on soil with moss (mean value of 21.5 ± 13.25 SD) and 271 observations on soil without moss (mean value of 10.4 ± 13.25 SD) (Fig. 2A). The frequencies of observations of spiders differed among the soil types ($\chi^2 = 202.16$, $P < 0.0001$, df = 1). The proportion of observations for soil with moss was significantly higher than the expected value in the absence of preference for soil type, indicating a preference for soil with moss on surface by the species. The percentages of observations on the different soil types from each spider are shown in Fig. 2B. This result corroborates the hypothesis that *C. simoni* is able to select areas with soil surface covered by moss over areas without a moss cover, which seems to be a proximal cause for their greater abundance on this type of soil (Ferretti *et al.* 2014). From the 26 spiders observed, only ten spiders (38%) constructed and established a burrow. On the remaining cases the digging behaviour was not performed when observations finished thus maybe more time is needed for spiders to engage on that behaviour. However, one individual constructed a small burrow under the moss with no evidences of door construction and seven individuals constructed a thin door with moss on upper surface and a short burrow. Two individuals were observed to construct a burrow on the soil with no moss. Although we did not examine the preference of different soil types for burrow construction, we believe that the choice made by C. simoni is not related to a direct advantage of the soil type, such as a better material for the construction of burrows, since we observed a perfect burrow and door construction on soil with no moss under laboratory captivity. However, a relationship between the distribution of spiders and the soil type has often been found (M'Rabet *et al.* 2007; Řezáč, Řezáčová & Pekár 2007; Portela, Willemart & Gasnier 2013). Regarding the observations of the spiders that selected the soil with moss, we observed a remarkable behaviour; spiders quickly began to make perforations under the moss in a circular shape and covered under a thin layer of moss and soil. Then, spiders began the construction of the burrow always covered by the moss layer. This feature could allow a quick camouflage under the moss and then proceed to the burrow construction. Otherwise, on the soil without moss we observed that spiders immediately began the burrow construction, presumably without such coverage of moss. Although we did not examine the preference of this species to soil type, future studies should include this feature since trapdoor spiders usually show preferences for soils that buffer temperature and humidity contrasts more efficiently corresponding to ecological adaptations (Řezáč, Řezáčová & Pekár 2007).

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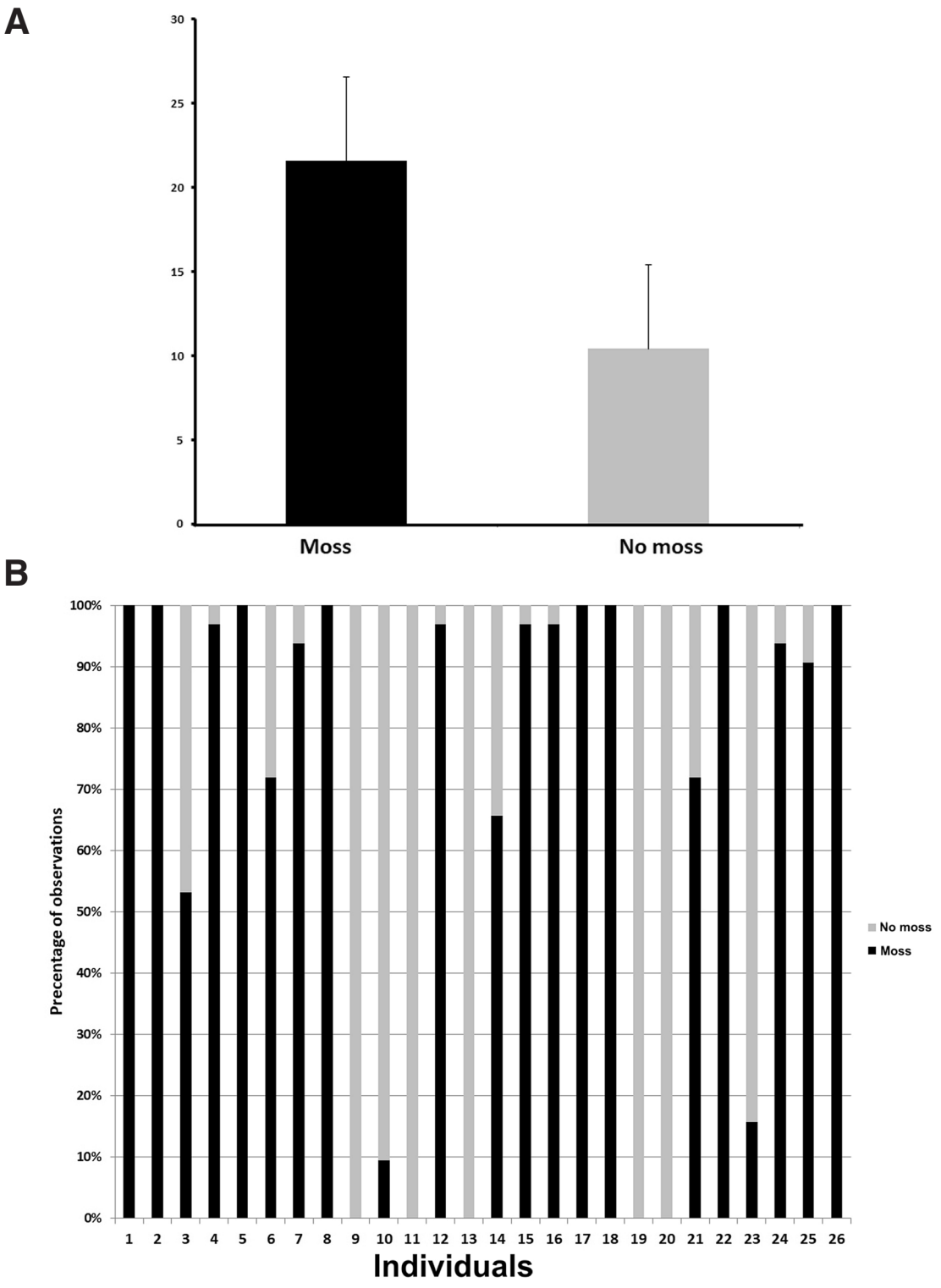

Fig. 2: Observations of *C. simoni* on different surface soil types. **A** mean number of observations on soil with and without moss; **B** percentage of observations of each individual in the testing arena.

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