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Research Letters

Germination niche breadth differs in two co-occurring palms of the Atlantic Rainforest



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ABSTRACT

Niche germination breadth may determine species occurrence under distinct environmental conditions. We choose *Euterpe edulis* and *Lytocaryum weddellianum* to evaluate germination niche breadth under light or dark at water potential of 0 MPa, and in either decreasing water potentials (−0.4 and −0.8 MPa) or flooded. In contrast to *L. weddellianum*, *E. edulis* showed high seed germination at both light conditions and expressive seed germination at low water potentials and flooding. *E. edulis* had wide seed germination niche breadth and seed addition of the same geographic region might be used for the reintroduction of populations of this threatened palm in different types of habitats of the Atlantic Rainforest. *L. weddellianum*, however, is unlikely to be able to germinate under altered conditions due to narrower germination niches and might be more vulnerable to extinction if the restricted germination cues no longer occur. Thus, *ex situ* initiatives might be used for the species conservation.

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Introduction

After seed dispersal, germination is one of the earliest ecological processes that determine the occurrence of a species in a plant community. To recruit a new individual into a population, a set of specific environmental conditions is required for seed germination in the place where seeds are dispersed (Donohue et al., 2010). However, species have different environmental requirements to effect germination (Baskin and

Baskin, 2001) and consequently, have distinct germination niche breadths. Species with a broader germination niche breadth germinate seeds in a wider range of environmental conditions than species with a small niche breadth (Luna and Moreno, 2010).

Among distinct environmental factors, light and water are key in determining the location and time of seed germination (Baskin and Baskin, 2001). In moist tropical forests, the light requirement for seed germination is usually more important for pioneer species and small-seeded species (Vazquez-Yañes

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and Orozco-Segovia, 1993). However, a deficit or excess of water in the soil also affects seed germination (Baskin and Baskin, 2001) and a spatial heterogeneity of water availability occurs within and between tropical forests (Svenning, 2001). Soil water potential has a great heterogeneity within and among tropical forests. In a Bornean lowland rain forest, ψ_{soil} were higher than -0.05 MPa during the wet season; while in the driest periods, the ψ_{soil} decreased to -0.53 MPa (Gibbons and Newbery, 2002). In contrast, the ψ_{soil} of a dry tropical forest in Mexico ranging from -0.42 MPa to -7.31 MPa, 60 days after the last rain. However, the evergreen species were restricted to habitats with ψ_{soil} higher than -1.2 MPa during the dry period (Méndez-Alonzo et al., 2013). In general, seed germination of several tropical species is precluded or strongly decreased under low water potentials (Baskin and Baskin, 2001); however, many tolerant species occurring in dry or semi-arid ecosystems germinate seeds under low water potentials ($\psi \leq -1.0$ MPa) (Schütz et al., 2002; Tobe et al., 2006). The ability of seeds to germinate under a low water potential might allow a species to occupy habitats that species with drought-sensitive seeds cannot inhabit (Schütz et al., 2002). In contrast, species that can germinate seeds in flooded conditions might be able to colonize swamp habitats in the forest (Gomes et al., 2006).

Palms (Arecaceae) are abundant plants in tropical moist forests (Henderson, 1995) and their distribution is strongly correlated with light availability and water-related variables (Svenning, 2001; Eiserhardt et al., 2011). Although ecological niche characteristics have a crucial role in determining the pattern of species abundance (Kristiansen et al., 2012), few studies have addressed the interspecific variation in palm germination niche breadth (Orozco-Segovia et al., 2003). Specifically, we are unaware of any studies that have evaluated the seed germination characteristics of palms under low water potentials.

Our aim is to investigate, in palm species, the existence of differences in niche germination breadth in relation to distinct levels of light and water availability under controlled laboratory experiments. We hypothesized that palms with distinct ecological and geographic range have different germination niche breadth. Hence, we choose two species of the Arecaceae (*Euterpe edulis* Mart. and *Lytocaryum weddellianum* (H. Wendel.) Tol.) with contrasting ecological characteristics and geographic range, but occurring sympatrically in some areas of the Atlantic Rainforest (Henderson, 2009). Additionally, *E. edulis* is a vulnerable species due to over-exploitation for the use of the palm heart, named "palmito" (Martinelli and Moraes, 2013).

Materials and methods

The study was conducted in the ombrophilous Atlantic forest of Guapiaçú Ecological Reserve (REGUA) and Três Picos State Park (PETP) (22°25'02" S, 42°44'18" W; Cachoeiras de Macacu, Rio de Janeiro, Brazil). The private reserve of REGUA comprises 7,200 ha and overlaps with PETP at 500 m of elevation, corresponding to 58,790 ha contiguous forest occurring at Serra do Mar. *E. edulis* is a shade-tolerant species which occur in different vegetation types (e.g. ombrophilous; deciduous;

swamp and restinga forests) up to 1000 m of elevation along the Atlantic Rainforest biome (Henderson, 2009). *L. weddellianum* is an understory palm that grows on steep slopes at elevation ranges from 50 to 800 m a.s.l., but is restricted to a very small geographical part of the ombrophilous forest of the Atlantic Rainforest biome (Henderson, 2009).

For *E. edulis*, we collected regurgitated de-pulped fruits from the ground and also ripe fruits from different individuals at the beginning of September 2011 at REGUA. Pizo and Simão (2001) found a similar germination percentage for seeds of *E. edulis* from de-pulped or ripe fruits. In addition, Leite et al. (2012) demonstrated that seeds regurgitated by small frugivores had a similar rate of seed germination to that of manually defleshed seeds. For *L. weddellianum*, ripe fruits were collected from at least 15 individuals at the end of October 2011 at Três Picos State Park. In the laboratory, the flesh fruit of both species was removed and seeds were exposed to two light treatments, light and dark at $\psi = 0$ MPa, and also to four treatments with different water availability: $\psi = 0$ MPa, $\psi = -0.4$ MPa, $\psi = -0.8$ MPa and flood. We choose these four water treatments because seeds of palms could be frequently subjected to these water potentials in the soils of the distinct ecosystems of the Atlantic Rain Forest Biome. The water potential of -0.4 MPa would be probably found during the driest periods in the ombrophilous Atlantic forest; while, $\psi = -0.8$ MPa might be more predominantly in the deciduous and restinga forests. In addition, it is very common the occurrence of seasonal swamp forests during the wet season in the forests of the Atlantic Rain Forest Biome. Ten replicates each of ten seeds were analyzed per treatment per species. Seeds of *E. edulis* were sown on filter paper moistened with 5 mL deionized water in a 9 cm-Petri-dish, whereas the larger seeds of *L. weddellianum* were sown on filter paper moistened with 10 mL deionised water at $\psi = 0$ MPa (light and dark) in a 11 cm Gerbox. For the water deficit treatment, seeds were moistened with PEG 6000 solution as in Michael and Kaufmann (1973). For the dark experiments, the Petri-dishes and Gerbox were wrapped in a double layer of aluminum foil. For the flood treatment, seeds were submerged in 40 mL deionised water in a Becker for 40 days for *E. edulis* and 110 d for *L. weddellianum*. The submersion period in water of *L. weddellianum* seeds was longer than for *E. edulis*, since *L. weddellianum* seeds took longer to onset seed germination in the flood treatment.

Seeds were incubated in a germination chamber at a day/night temperature of 25°C/20°C with a 12 h photoperiod. The seeds were inspected every day, except weekends, to count and remove the germinated seeds and to replace the water lost by evaporation. During the dark treatment, we monitored seeds under dim green light ($v/v_e = 0.05 \mu\text{mol}$ of photons $\text{m}^{-2} \text{s}^{-1}$). Seeds were scored as germinated when the germinative bottom protruded at least 1 mm through the seed coat. When no seeds germinated for 15 consecutive days in a treatment, the experiment was ended. Following the end of the experiment, ungerminated seeds subjected to $\psi = -0.4$ MPa, $\psi = -0.8$ MPa and the flood treatment were transferred to deionised water at $\psi = 0$ MPa (light) to test the proportion of seeds that can maintain germinability.

Final germination percentages were calculated and were arcsine square root transformed before analyses. Germination time was calculated as the number of days taken to reach 50%

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