Jacquinia pungens abundance and height in deciduous and evergreen forests: does dry season leafing maximize exposure to sunlight?

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Abstract: Unlike most deciduous trees, *Jacquinia pungens* maintains leaves in the dry season and sheds them in the wet season. We hypothesized that the increased access to sunlight provided by this strategy would result in greater abundance and height of *J. pungens* in predominantly deciduous forests than in predominantly evergreen forests in the dry forest of Palo Verde National Park. We sampled *J. pungens* in both deciduous and evergreen forest across three sites. There was no significant difference between deciduous and evergreen forest types in *J. pungens* abundance. However, *J. pungens* height was significantly taller in deciduous forests. We suggest that, although germination success may not differ between deciduous and evergreen forests, survival and continued growth of *J. pungens* may be better in the higher light environment under deciduous canopies.

Key Words: dry forest

Introduction

As light is often a limiting factor for plant growth, many plants have developed strategies for maximizing light exposure. *Jacquinia pungens* is a shrub or small tree found in tropical dry forest. Unlike most deciduous trees, *J. pungens* maintains leaves in the dry season and sheds them in the wet season (Janzen 1983). Consequently, it can take advantage of the additional light available when deciduous trees lose their leaves in the dry season. In evergreen forests, however, there is no seasonal variation in canopy cover to be exploited by *J. pungens*. We recognize that different soil conditions (i.e. depth, moisture, and nutrients) may cause differential rates of survival and growth of *J. pungens* in deciduous versus evergreen forests, regardless of light availability. Despite this possible effect, we hypothesized that light effects would dominate these rates. Consequently, we predicted that *J. pungens* will be more abundant and taller under deciduous canopies than under evergreen canopies.

Methods

We sampled at 2 subsites in each of 3 sites in Palo Verde National Park, Costa Rica: northwest of the Park Ranger Station (Site 1), below the limestone cliffs and in the high saddle north of the OTS research station (Site 2), and along the El Mapache trail (Site 3). We chose one predominantly evergreen and one predominantly deciduous subsite in each site. We sampled four 4 m x 30 m belt transects in each subsite, each of which passed under a minimum of two evergreen canopy trees in evergreen subsites and under no evergreens in deciduous subsites. We recorded the number of *J. pungens* individuals above and below 1m height in each belt, as well as the number of evergreens having canopies over part of the belt. We classified as evergreen only the tree species we could identify, i.e. the most common evergreens in the area: *Brosimum alicastrum, Manilkara chicle, Sideroxylon capiri, Samanea saman,* and *Astronium graveolens* (N. Turner, pers. comm.).

We tested for differences between forest type (evergreen or deciduous), site, and for an interaction of the two using a 2-way ANOVA for both *J. pungens* abundance and for the percentage of *J. pungens* above 1 m (using an arcsin square root transformation in the latter).

Results

J. pungens abundance was not significantly different between forest types and there was no significant interaction between the two variables of site and forest type (2-way ANOVA, forest type: $F = 0.16$, $df = 1$, $P = 0.69$, site*forest type: $F = 1.32$, $df = 2$, $P = 0.29$, Fig. 1). Though statistically insignificant, there was a suggestion of a trend in abundance between sites ($F = 2.82$, $df = 2$, $P = 0.09$). Evergreen subsites had a significantly greater percentage of *J. pungens* above 1 m than did deciduous subsites (2-way ANOVA, $F = 5.53$, $df = 1$, $P = 0.03$, Fig. 2). *J. pungens* height did not differ significantly by site ($F = 0.84$, $df = 2$, $P = 0.45$), but there was a suggestion of an interaction between site and forest type in our data ($F = 2.51$, $df = 2$, $P = 0.11$).

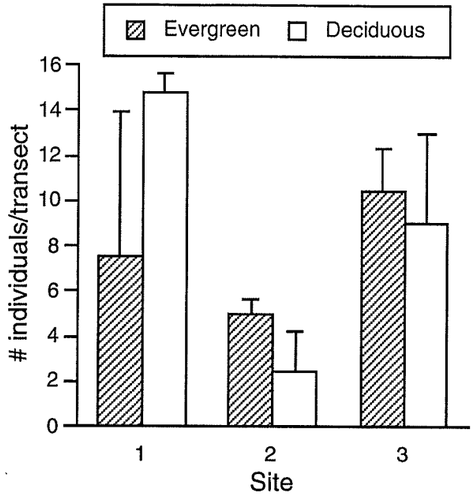

Fig. 1. Mean *Jacquinia pungens* abundance (±1 SE) in deciduous and evergreen forest across three sites in Palo Verde National Park, Costa Rica. Belt transects were 120 m^2 in area (n = 4 in each site, for both deciduous and evergreen forest types).

Discussion

Contrary to our first prediction, *J. pungens* abundance did not differ between evergreen and deciduous forest types. Consistent with our second prediction, however, *J. pungens* was significantly taller in deciduous habitats. We suggest the following scenario to explain this pattern. Seedlings may be able to establish in moist soils such as those found in evergreen forests as well (or better than) in the drier, rockier soils of deciduous forests. As individuals in the evergreen forest grow larger, however, their energy needs increase as the ratio of photosynthetic tissue (leaves) to support tissue (stem) decreases. Thus, though they have survived germination, these larger plants may be unable to obtain sufficient radiant energy to survive and grow in this more shaded environment. In contrast, they could survive as taller individuals in the deciduous environment, where they can take advantage of the abundant sunlight passing through the bare canopy in the dry season. In this way, overall abundance may not differ between the two forest types, yet plants could be taller in the deciduous forest. Further study comparing seedling recruitment and mortality in evergreen and deciduous habitats could provide insight into the dynamics and causal mechanisms behind these observed patterns.

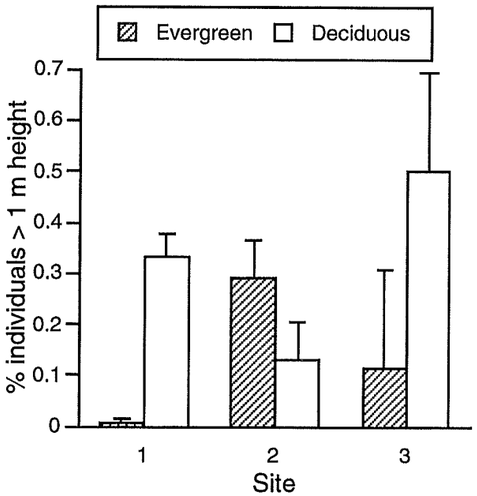

Fig. 2. Mean percentage of *Jacquinia pungens* individuals (±1 SE) above 1m height in deciduous and evergreen forest across three sites in Palo Verde National Park, Costa Rica. See Fig. 1 for sample sizes.

Though the relationship was statistically insignificant, our data suggest that site may have had an effect on *J. pungens* abundance and height across the two forest types. These patterns may be related to variation in topography, soil, and moisture between the three study sites. In particular, the high saddle evergreen subsite has deep, moist soils, while the paired deciduous subsite, below the limestone cliffs, was rocky and dry. This may explain why the patterns at this site (Site 1) differ from those in the other two sites (Figs. 1 and 2).

Literature Cited

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