Quantifying Intraspecific Variation of Red Mangrove Leaf Traits in the Southeast Saline Everglades

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Introduction

• Intraspecific variability is known to capture niche and trait overlap in species assemblages (Viole, et al., 2012) and is especially useful along gradients (Albert, 2011), as it facilitates prediction of species fate in response to environmental changes (Albert, 2011; Viole, et al. 2014).

• In the Southeast Saline Everglades (SESE) increased rates of sea level rise have resulted in significant landward encroachment of marine water, retreat of freshwater marsh communities (Wanless et al., 1994) and encroachment of mangroves (Ross et al. 2000).

• R. mangle remains ubiquitous along this gradient of nutrients and salinity. The study of intraspecific variation in leaf traits of R. mangle populations along these gradients may contribute to a broader understanding of how phenotypic plasticity allows plants to navigate multiple stressors, and improve prediction of the ecological repercussions of changing environments.

• Prior works have been found to focus on only one environmental variable, or to experiment mainly with seedlings or young mangroves. Others works do compare adult fringe and scrub mangroves, but not tree island mangroves, which are also taller growth forms, but not subject to tidal action as fringing mangroves are.

Study Sites

Research Questions

• Does salinity concentration have a relation to intraspecific variation in leaf traits?
• Does phosphorus limitation have a relation to intraspecific variation in leaf traits?
• Does growth form have a relation to intraspecific variation in leaf traits?

Methods

Site Selection

• Nine sites consisting of a tree island and adjacent mangrove scrub plot were selected among prior study sites to capture a spatial and environmental gradient range (Fig. 1a, b).
• Phosphorus limited
• Range: Distance from coast: 1.7-8.12 kilometers
• Dry Season Salinity: 1 to 23 parts per thousand

Field Sampling

• Three trees were sampled within each tree island and scrub plot
• Three leaves were analyzed for fresh and dry weight
• Dry season pore water salinity (Table 1).

Lab Methods

• Leaf Stomate Imprint by nail varnish method (Hodgson et al., 1993)
• Visualization and image capture: Leitz Dialux 20 Fluorescence Light Microscope
• Nikon Coolpix camera and MDC lens adaptor.
• ImageJ Image Analysis and Analysis in Java
• Stomata counted within 0.48 mm²

Leaf Measurements

• n=3 for each site
• LI-COR Portable Area Meter Model LI-3000A
• Weight, petiole removed
• Fresh Weight
• Dry weight, oven dried at 70°C until constant weight

Stomatal Density (abaxial)

• Average of stomatal count in four fields of view per leaf.

General Terms and Traits

• Specific Leaf Area (SLA): ratio of leaf area to dry mass
• Low SLA values are associated with denser leaf - resource-poor environments, and slow-growing species
• Carbon isotopic ratio (δ13C). Ratio of δ13C to δ13C in atmospheric CO2
• δ13C values 13C enriched in plants grown in rich environments
• Higher δ13C = more 13C uptake, or less plant discrimination
• “More stress”
• Higher long term water use efficiency
• Nutrient limitation
• N: P molar ratios (Aerts & Chapin, 2000)
• N-P ratios in leaf tissues at 117: 2
• Nitrogen limitation at N : P < 14

Results

Table 1. Table of intraspecific variation for each study site. Community Type (a) shows a scatter plot of leaf island and scrub mangrove growth forms respectively. Leaf area and specific leaf area across all sites. With increased phosphorus limitation (increased N/P ratio, and N/P) there is a decrease in SLA.

Discussion and Conclusions

Variation in Leaf Traits with Salinity and Phosphorus Limitation:

With increased pore water salinity there was decreased SLA (Fig. 4b), increased stomatal density (Fig. 4c), and increased 6C ratio (Fig. 4d). With increased phosphorus limitation there was decreased SLA, and increased 6C ratio. Both of these parameters had a higher R2 in the regression for P limitation than in the model for salinity.

Intraspecific variation in R. mangle stomatal density appears to be salinity driven (Fig 4c) rather than phosphorus driven (p>0.05) within our dataset. The model for leaf area and pore water salinity, although significant, had a low R2 (Fig. 4a)

Variation in Leaf Traits of Tree Island and Scrub Mangrove Growth Forms:

Overall, mean leaf area was higher in the scrub growth form of R. mangle than in the tree island growth form (Fig. 7a). Mean values for the scrub leaves are well within Lind & Sternberg’s (1995a) 23.4–4.1 cm² mean area in scrub. This would mean leaf area is not solely attributed to growth form, as tall fringe mangroves in the aforementioned study had a higher area than the scrub counterpart, contrary to this case with tall, tree island red mangrove.

There was lower plant stress in tree islands. The 6C ratio was lower (Fig. 7d) and the SLA higher in tree island R. mangle (Fig. 7b) than in scrub mangrove, which is typical of resource rich environments. This is unlikely to be the result of growth form alone, and further analysis taking into consideration the simultaneous effect of variation in site salinity, available nutrients, and community competition is an important next step. Stomatal density was lower (Fig. 7c) in tree island R. mangle, which coupled with smaller leaf area also resulted in significantly less total stomata per leaf in tree island R. mangle. While stomatal density does not appear to be nutrient driven, the effect of nutrient limitation on leaf area, may have some implications on plant dynamics in relation to stomatal activity as well.

Future work will address stomatal dimensions, as this is an important component in implications for gas exchange, and water use efficiency along with stomatal density.

References


