Stomata size-density tradeoff is scale-dependent in southern oaks

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Introduction

- Given projected climate warming, there is an urgent need to better understand patterns of plant adaptation to drought and temperature.
- Because stomata control the rate of water loss at the whole plant scale and the ability of the plant to evaporatively cool, stomatal anatomy (Fig 1) is among the characteristics most directly linked to function with respect to drought and heat tolerance.
- We used southern oaks as a model system to test the relationship between anatomy and species climatic niche, across the phylogeny (Fig 2).

Objectives / Hypotheses

- There will be a trade-off between stomatal size and density, within and across species of southern oak.
- Oak phylogenetic sections will diverge into separate stomatal syndromes.

Methods

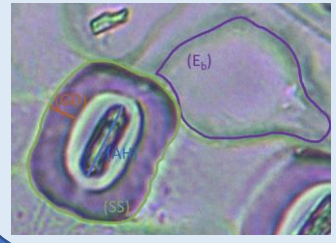
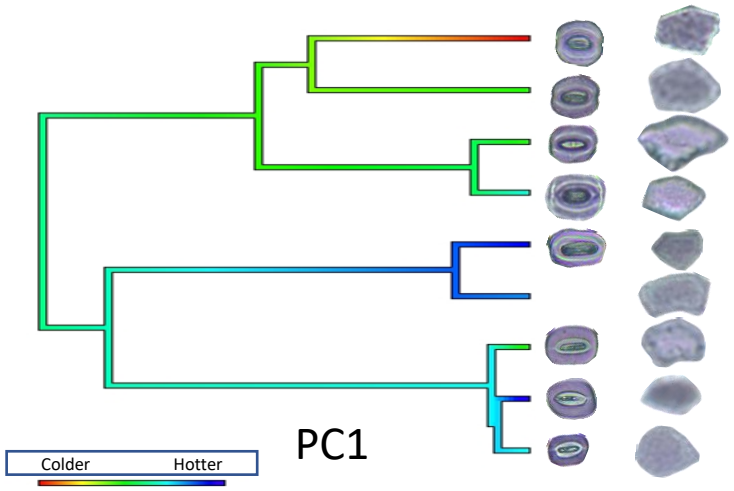


Fig 1. Light micrograph of a stomate. Stomatal size (SS), stomatal density (SD), stomatal aperture height (AH), single guard cell diameter (GD), and and epidermal pavement cells size on the ab- and adaxial surface (E_b, E_d)



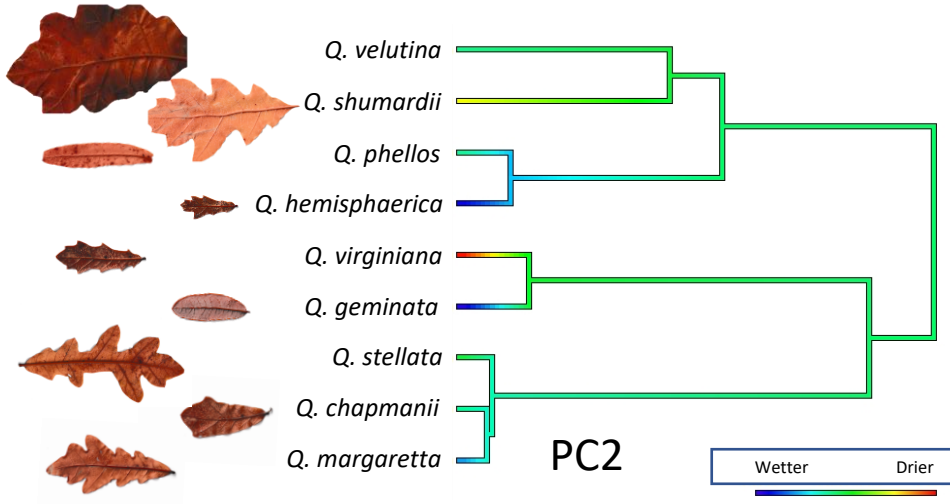


Fig 2. Phylogenetic trees for the 9 species of oaks used in this study. Representative stomatal epidermal micrographs and whole leaf scans. Colors in the phylogeny denote evolutionary patterns in climate parameters based on climate geographic occurrence, mapped by maximum likelihood. PC1 represents temperature related climate variables, while PC2 represents precipitation related parameters.

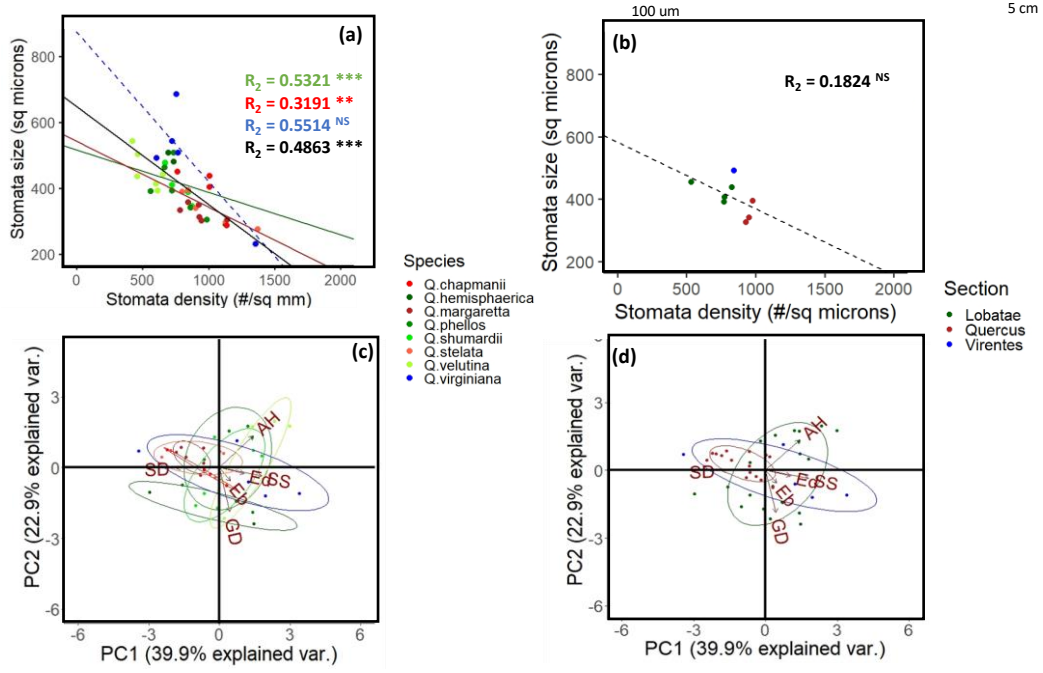


Fig 3. Linear regression demonstrating stomatal size ~ density tradeoff where each point represent a single leaf (a) or a species mean (b) of each of 8 oak species. Principle component analyses show divergence in trait space by species (c) and phylogenetic section (d). Dashed lines indicate non-significant trends (p-value = 0.05-0.1). *P*<0.05=*, *P*<0.01=**, P<0.001=***.

Conclusion / Discussion

- Movement along the SS-SD axis is phylogenetically independent. The tradeoff occurred only on the species level (Fig 3a,b).
- Although further research is needed, this study indicates that divergence in stomatal anatomy occurs at the species level (Fig 3c,d).
- This is likely due to community-scale niche partitioning or environmental conditions at smaller geographic scales (Fig 2).

About the author

Nicholas Smith is a Sophomore at the University of Florida on the pre-med track, majoring in Biology at the College of Agriculture and Life Sciences.