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The Relationship of Stomatal Conductance to Mechanical Strength in Leaves of Santa Monica Plants



Russell P. Mott, Steven R. Fleming, and John C. Macbeth

Pepperdine University

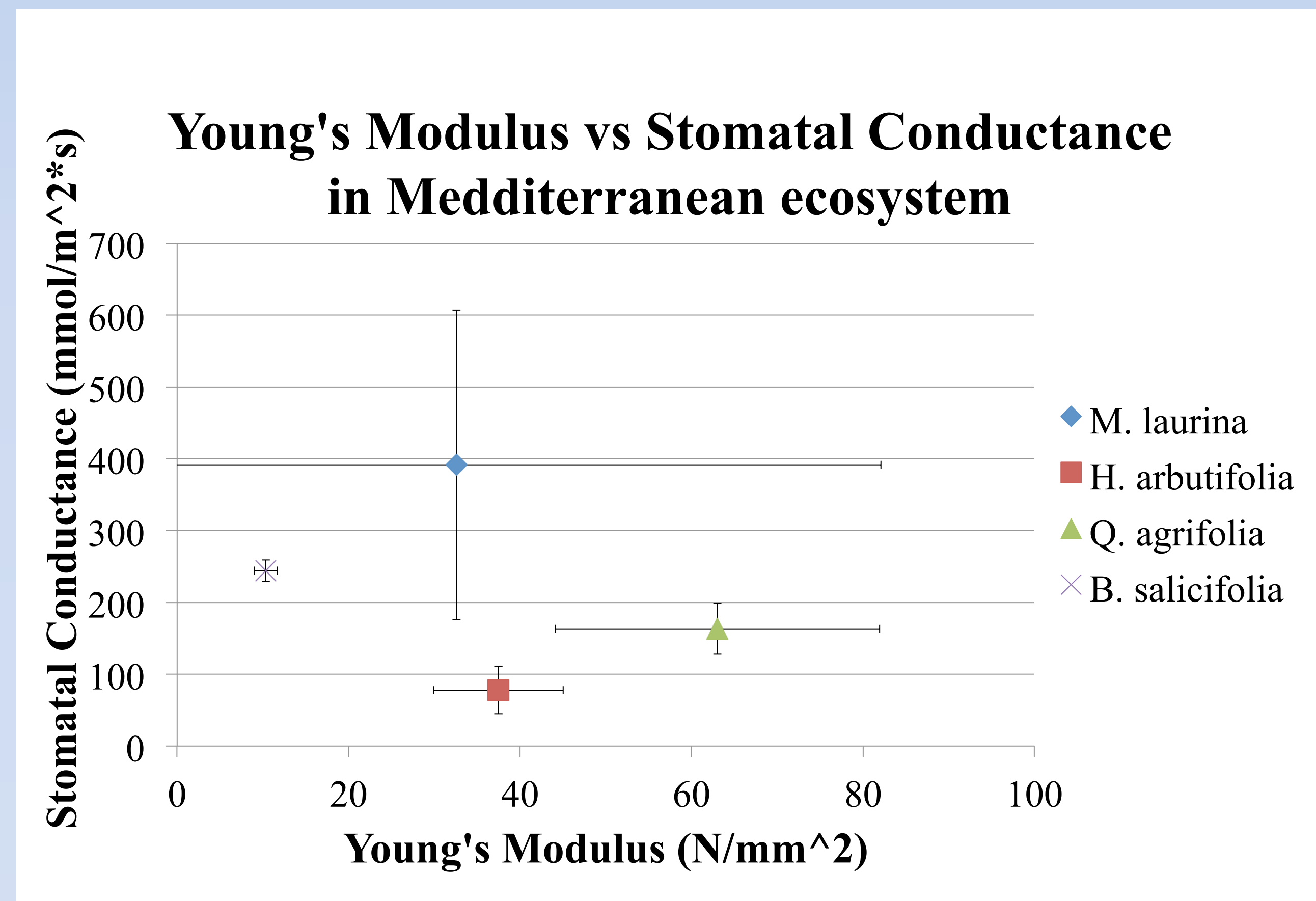
Abstract

The Santa Monica Mountains ecosystem has a high diversity of plants with different lifestyles that produce different physiological characteristics individual to all plants. Studies in Australia, another Mediterranean ecosystem, have shown that mechanical strength of leaves is related to soil stress. This experiment seeks to determine whether mechanical strengths of leaves correlate to stomatal conductance of leaves across different species in the Santa Monica Mountains. Four species of plants are tested for their stomatal conductance in the field, and the leaves are tested for tensile strength using Young's Modulus for comparison across leaves. These data show that there was no comparable linear relationship across species, but also found that there were statistical differences in tensile strength and stomatal conductance for all species.

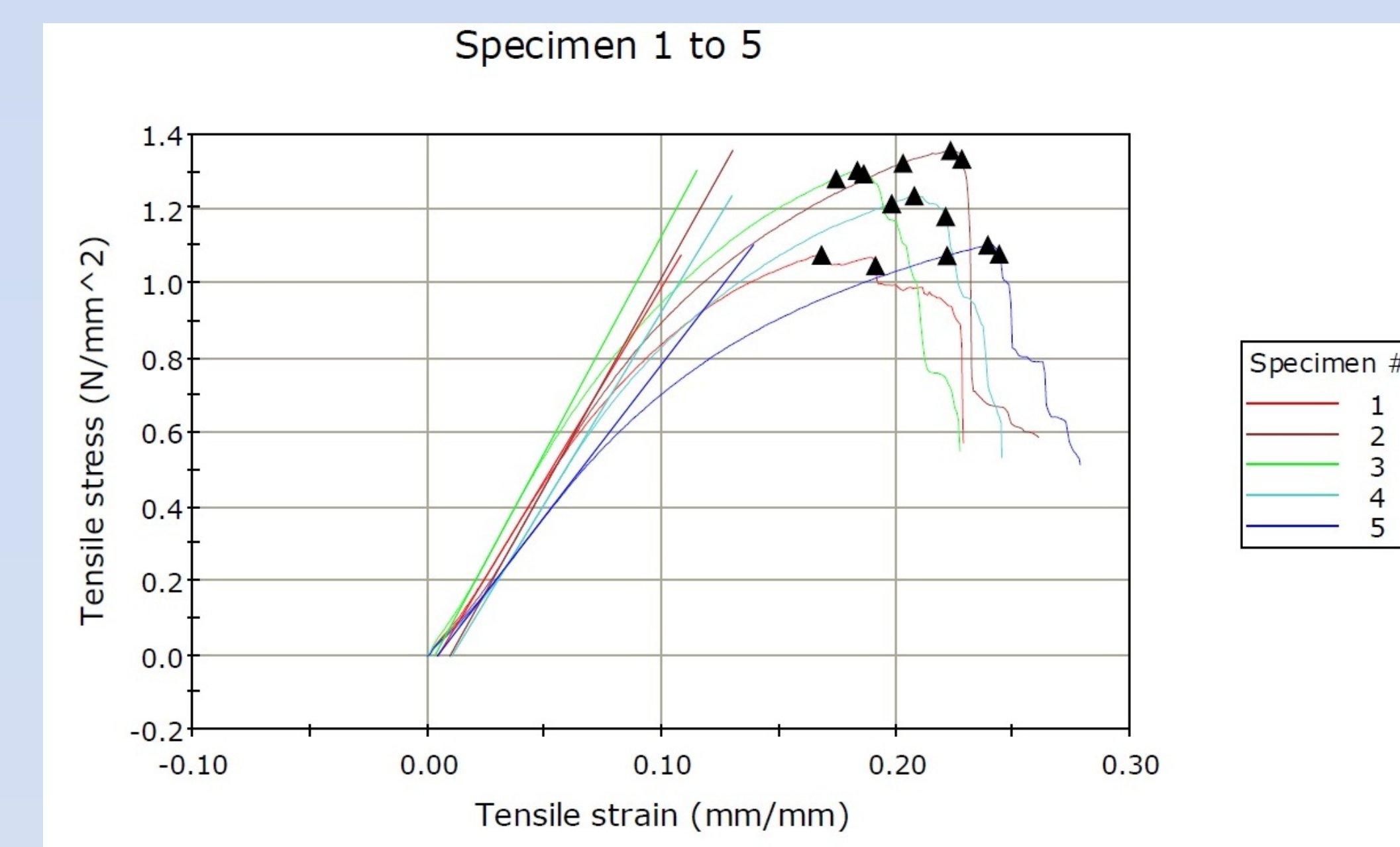


Baccharis salicifolia
http://wc.pima.edu/~bfiero/tucsonecology/plants/shrubs_sewi.htm

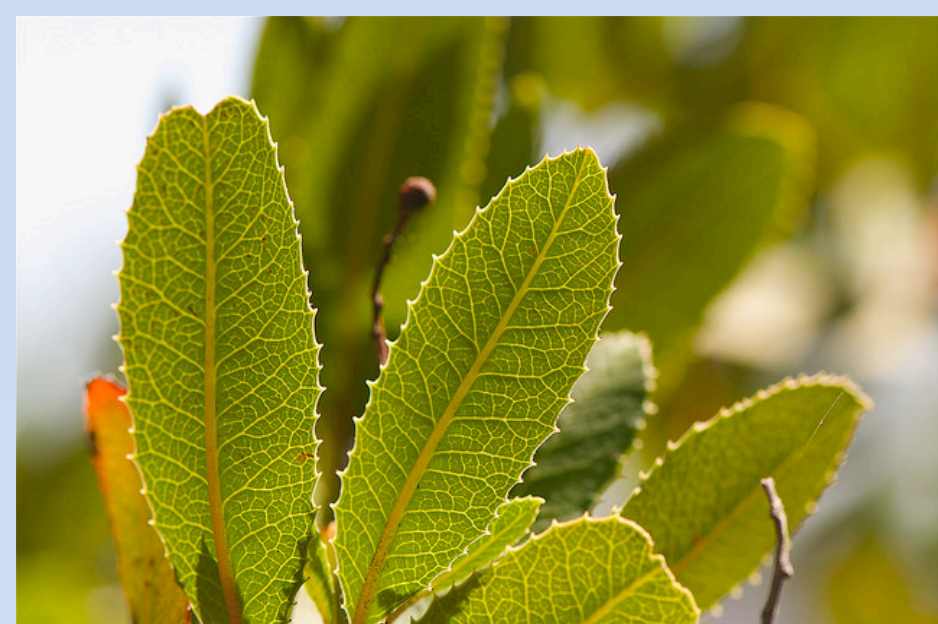
Results



- Anova tests show significant differences in stomatal conductance and tensile strength for all plant species tested
- No linear relationship was found



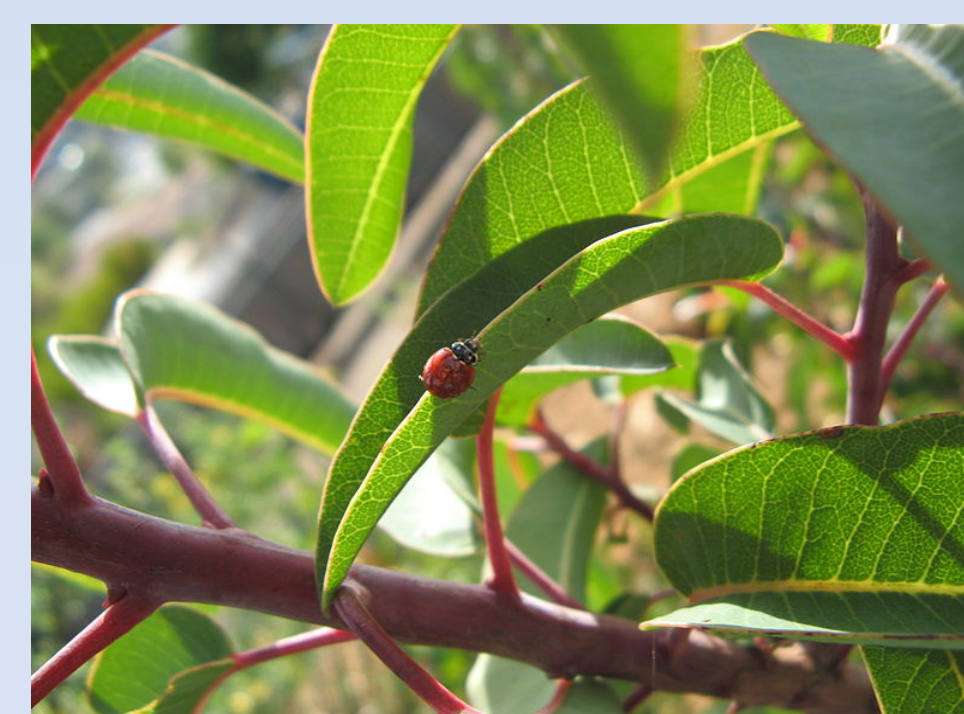
This chart shows the data collected for Young's Modulus tests for leaves of *B. salicifolia*.



Heteromeles arbutifolia
<http://www.searchdictionaries.com/?q=heteromeles>

Introduction

Mediterranean ecosystems are important for their unique biodiversity. Only covering about 5 percent of the world's landmass, Mediterranean ecosystems have about 20 percent of the world's plant species. This provides an amazing opportunity for plant study, as many unique species can be tested across different geographic areas to learn more about the tradeoffs of cost and function in plants (Cody and Mooney, 1978). A study in Australia determined that the soil conditions affect the physiology of different plants, and that leaves of high stress plants are mechanically stronger than low stress plants (Read, Sanson, and Lamont 2005). In the local Santa Monica Mountains, another Mediterranean ecosystem, there is a high diversity of habitats from riparian to chaparral. These habitats have different tradeoffs, and require different physiology in order to be successful. Sclerophylly, or mechanical strength of leaves, have been shown to correlate to the tolerance of water strain on plants (Balsamo *et al.*, 2003). Additionally, in Mediterranean environments, plants have been separated into two categories of stomatal regulation, plants that control stomatal conductance to maximize hydraulic conductance, and those that maximize stomatal conductance even at loss of hydraulic conductance (Vilagrosa *et al.*, 2003). It was observed by this group that riparian plants seem to have less water stress due to their proximity to water, while chaparral plants are constantly battling for water in order to survive in their drier habitat. Since water is a readily available resource to riparian plants, it was predicted that these plants would have high stomatal conductance due to lack of pressure due to water loss. At the same time, stomatal conductance would decrease in chaparral plants because of the high premium placed on water. Another observation was the lushness of riparian plants' leaves compared to that of chaparral plants. It was predicted that the riparian plants may have weaker leaves because they do not have to worry about the lost resources since they live in a high resource environment. These observations lead to this study, determining the relationship of conductance and tensile strength in leaves from different species in the Santa. Through the use of a CS-1 porometer and Instron mechanical testing device, stomatal conductance and Young's modulus for mechanical strength were measured for several different leaves for four species local to the Santa Monica Mountains. The four species studied were *Malosma laurina*, *Heteromeles Arbutifolia*, *Baccharis salicifolia*, and *Quercus agrifolia*.



Malosma laurina
http://en.wikipedia.org/wiki/File:Malosma_laurina_1.jpg

Hypothesis

Plants with a greater stomatal conductance will have a weaker mechanical strength. Therefore, riparian plants will have a weaker mechanical strength than chaparral plants, because they will have more stomata since they do not have to worry about water loss via transpiration as much as chaparral plants do.



Discussion

From our results, there is no correlation between the stomatal conductance and mechanical strength of leaves in California Chaparral plants. Of the four species tested, *Baccharis salicifolia* shows the most precise data, whereas *Malosma laurina* was very unpredictable in its results of responding to stress. We did not find a correlation in stomatal conductance relating to tensile strength as thought. While these data were inconclusive, this does not mean there is no correlation. More data with more ideal species is needed to properly compare these two factors. Since tensile strength testing for leaves is relatively new, there are few sources to compare our data. Our experiment is relevant to the scientific community because it could tease apart the relationship between metabolic cost and specific function for certain habitats. Thus, we will better understand which species will be more successful in certain conditions.

Materials and Methods

Conductance and Leaf Collection

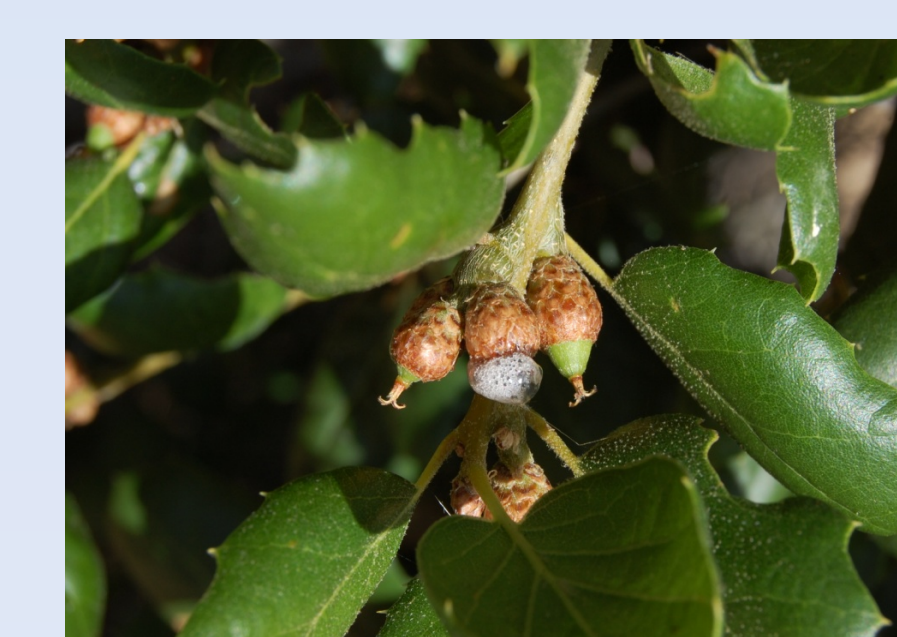
- Use SC1-porometer to measure stomatal conductance of plants in winter canyon from 9am-10am
- Pick 10-15 leaves from the middle to bottom of each plant species

H. arbutifolia
M. laurina
B. salicifolia
Q. agrifolia

- Leaves placed in a zip locked bag and stored on ice in a cooler to keep plants from transpiring.

Instron Mechanical Testing

- Used Instron to measure Young's modulus for leaf strength
 - Leaf length, width, and thickness at three places along the leaf were measured
 - A 25mm cross section of each leaf was cut out and tested.
 - The Instron clamps were set to 6mm apart
 - Leaf was placed between with midvein parallel to plates



Quercus agrifolia
http://commons.wikimedia.org/wiki/File:Quercus_agrifolia-13.jpg

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- Taylor Stucky



References

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