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The Effect of Riparian and Arid Environments on Stomatal Conductance in Baccharis salicifolia and Heteromeles arbutifolia

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The Effect of Riparian and Arid Environments on Stomatal Conductance in *Baccharis salicifolia* and *Heteromeles arbutifolia*

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Abstract

A riparian environment is characterized by higher moisture levels than an arid environment; therefore they have different species of plants that can adapt to their natural habitats. It is critical that we explore the characteristics plants have in relation to their native environments. We propose to test the hypothesis that Baccharis salicifolia would have a higher stomatal conductance rate to water vapor loss compared to Heteromeles arbutifolia because *Baccharis salicifolia* thrives in a riparian environment in which water abundance would increase stomatal opening thereby contributing to the greater conductance. Using the LI-6400, we measured the conductance rate, photosynthetic rate, CO2 levels internally, CO2 levels of the air, fluorescence, phi PSII, electron transport rate, and qP of *Baccharis salicifolia* and *Heteromeles arbutifolia*. *Baccharis salicifolia* is a riparian species found on the Pepperdine campus, while *Heteromeles arbutifolia* is an arid species also found on the Pepperdine campus. By comparing the parameters we measured, we were able to observe that *Baccharis salicifolia* does have a higher photosynthetic rate, conductance, fluorescence yield, electron transport rate, quantum yield, and photosynthetic quenching than *Heteromeles arbutifolia* because of the riparian habitat that it is found in.

Introduction

The stomatal conductance of a plant is the process by which a plant releases water vapor concurrently with the intake of CO2. This plays a key role in transporting water throughout a plant. The influx of CO2 is crucial for plants to carry out photosynthesis and survive in its respected environment. The stomatal conductance of a plant is sensitive to a variety of factors. The environment in which a plant grows plays a crucial role in affecting its physiological properties. Two environments in particular, riparian and arid environments, differ vastly in that riparian plants are in a moist, wet area and arid plants are in a more dry environment. This study focuses on the effect of a riparian environment and an arid environment on the stomatal conductance in plants. Studies have shown that plants make adaptations to make possible to thrive in arid environments (Pugnaire and Haase, 1995). We have chosen to study a riparian plant (*Baccharus salicifoia*) and an arid plant (*Heteromeles arbutifolia*). We hypothesize that *Baccharus salicifolia* would have a higher stomatal conductance rate to water vapor loss compared to *Heteromeles arbutifolia* because *B. salicifolia* thrives in a riparian environment in which water abundance would increase stomatal opening, thereby contributing to the greater conductance. Previous studies have indicated that stomata of plants are sensitive to water abundance and pressure (Whitehead, 1997). Thus, with a greater water abundance in riparian environments, stomata opening is greater which in turn increases stomatal conductance as well. However, in arid environments, stomata opening is decreased to conserve water which decreases stomatal conductance, an adaptation that these plants must make to survive in a dry environment. Studies in the past have also shown that water stress decreases conductance in plants (Ackerson, 1979). Previous studies have also shown that stomata utilize negative feedback to respond to water stress, such that they close when water stress is detected (Saliendra et al., 1995). Our hypothesis suggests that a plant in a riparian environment would experience little water stress, thus, its stomatal opening would increase and the stomatal conductance would be greater. On the other hand, a plant in an arid environment is more likely to experience water stress, which would decrease its stomatal opening and in turn, decrease conductance as well. We will test this hypothesis by locating a riparian environment and an arid environment on Pepperdine University's campus. We will work with the plant *Baccharus salicifolia* (riparian) and *Heteromeles arbutifolia* (arid). We will use the LI-6400 gas exchange system to measure the stomatal conductance as well as other measurements such as photosynthetic rate, the Phi Psii 2 value, carbon internal, and fluorescence. We will then gather the collected data and analyze them to see whether *B. salicifolia* has greater stomatal conductance compared to *H. arbutifolia*.

Discussion

Using the LI-6400 gas exchange system, we were able to compare conductance of *Baccharis salicifolia* and *Heteromeles arbutifolia*. We measured the conductance rate, photosynthetic rate, CO2 levels internally, CO2 levels of the air, fluorescence, phi PSII, electron transport rate, and qP. We took a sample size of seven for both species of plants, expecting to see a difference in their characteristics since they thrive in two different environments. The arid environment was above the lacrosse field on our Pepperdine campus, and the riparian habitat was below the lacrosse field. The primary way that plants regulate their water flow is through the control of stomatal conductance (Sallendra, Sperry, and Consstock 1994). After analyzing our results, we found that stomatal conductance was higher in the *Baccharis salicifolia* than the *Heteromeles arbutifolia*, like we had predicted. Since *Baccharis salicifolia* is in a riparian environment it does not have the need to conserve water and more stomata can open, which increases stomatal conductance. On the other hand, *Heteromeles arbutifolia* had a lower conductance rate in each of the seven samples because it was located in the arid environment which would mean its stomata close to conserve water, and the water conductance rate decreases. Phi PSII was also higher for the *Baccharis salicifolia* in the riparian environment because there is more water available for water splitting, which is how photosystem two obtains electrons. The electron transport rate was also higher in the *Baccharis salicifolia* because there is a higher level of CO2 being taken up in the riparian environment because of the increase in stomatal opening. The photosynthetic rate was also higher for the riparian *Baccharis salicifolia* as expected from a species with a higher stomatal conductance. Plants subjected to water stress have decreased stomatal conductance (Radin and Ackerson 1981). *Heteromeles arbutifolia's* location in an arid environment has exposed it to water stress, which lowered photosynthesis, fluorescence, phi PSII, electron transport rate, and qP. After calculating a t-test we were able to conclude that the photosynthetic rate, conductance, fluorescence yield, electron transport rate, quantum yield, and photosynthetic quenching were significantly higher in *Baccharis silicifolia* than *Heteromeles arbutifolia* because of the riparian habitat that it is found in.

Materials and Methods

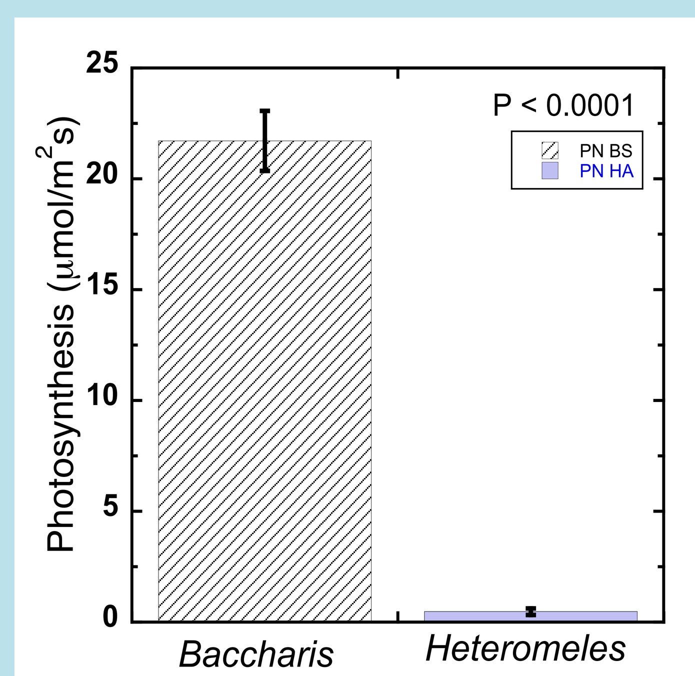
- Our sample size is seven leaves for each group of Mule Fat and Hollywood plant.
- The site for Hollywood plant is on Pepperdine campus and by the lacrosse field.
- The site for Mule Fat is the riparian area across the mail office on .
- LI-6400 Portable Gas Exchange System is used.
- Environmental parameter is set: CO2 at 400 µmol/mol, flow rate at 100 umol/s, block temperature at 22 °C, PQuantum at 2000 µmol/m2s.
- We document the values for CO2¬ of air and internal, photosynthesis, conductance.
- We increase light level to measure leaf performance in response, related values include Fv'/Fm, Phi PSII, ETR, and qP.

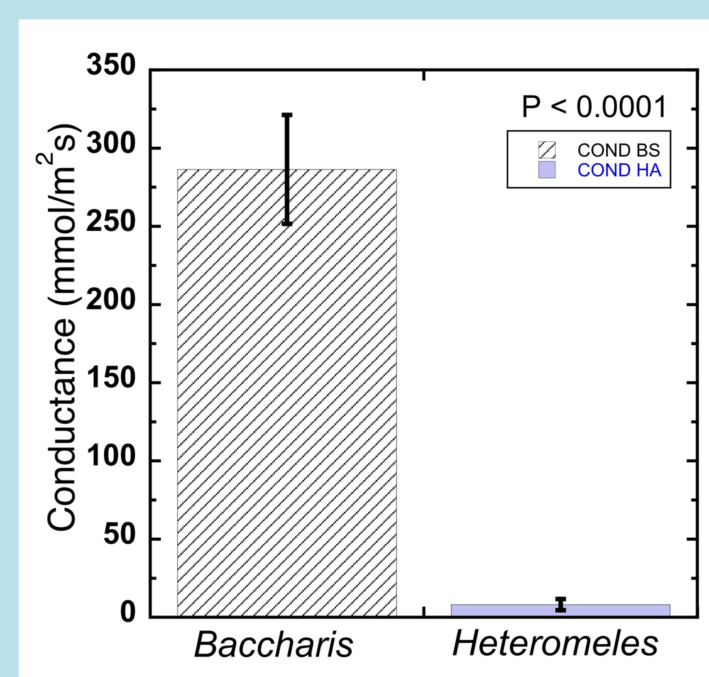
Heteromeles arbutifolia

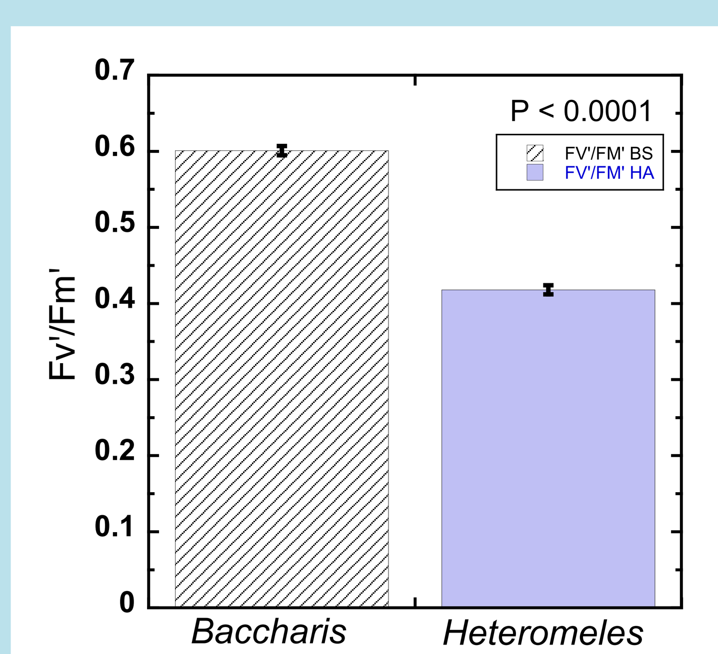
Baccharis salicifolia

Results

- Figure 1 shows the difference between photosynthetic rate, conductance, fluorescence yield, and electron transport rate of *Baccharis salicifolia* and *Heteromeles arbutifolia* after calculating a t-test with a p-value of less than 0.0001
- Figure 2 shows the difference between the quantity yield of *Baccharis salicifolia* and *Heteromeles arbutifolia* after calculating a t-test with a p-value of less than 0.001. The photosynthetic quenching of fluorescence t-test was calculated with a p-value of less than 0.02







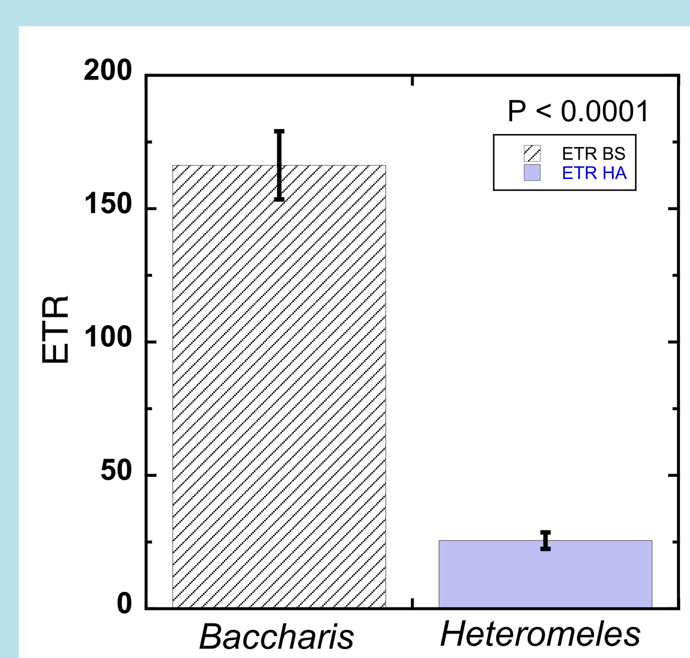
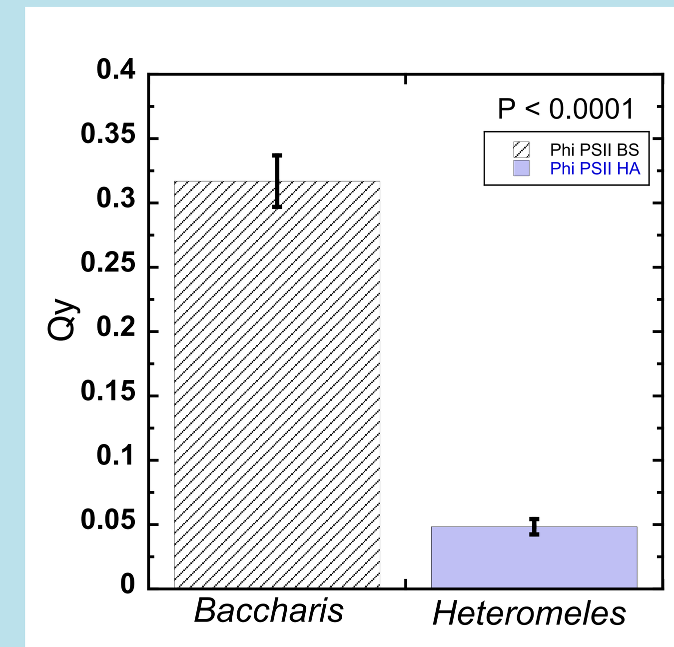


Figure 1. Comparison of Photosynthesis, stomatal conductance, fluorescence yield, and electron transport rate between *Baccharis salicifolia* and *Heteromeles arbutifolia* in a riparian versus arid habitat



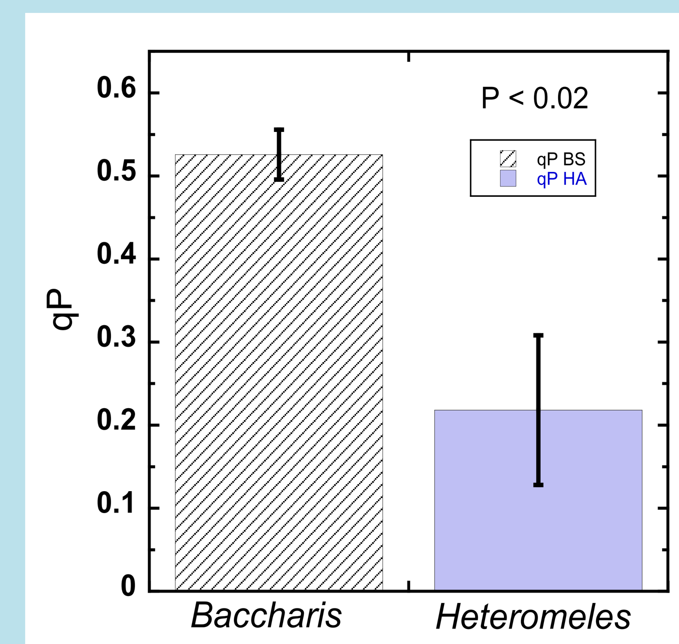


Figure 2. Comparison of quantum yield (Phi Psi2) and photosynthetic quenching of fluorescence between *Baccharis salicifolia* and *Heteromeles arbutifolia* in a riparian versus arid habitat

Conclusion

- The stomatal conductance in *B. salicifolia* (riparian) was on average higher than the stomatal conductance in *H. arbutifolia* (arid).
- *B. salicifolia* also had a higher photosynthesis compared to H. arbutifolia because there is a correlation between conductance and photosynthesis.
- *B. salicifolia* is more efficient in water splitting and electron acceptance, which in turn, allows it to have a greater electron transport rate (ETR) and a greater PSII value.
- Our observations show a significant difference between Baccharis salicifolia and Heteromeles arbutifolia due to their location in a riparian versus an arid habitat
- Important to study the relationship between environment and species characteristics to protect natural habitats

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