The Effect of Drought on Stomatal Conductance in the Biosphere 2 Rainforest

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INTRODUCTION

- Current climate models suggest a 2-5° C warming trend along with increased periods of drought in rainforests of the tropics by the end of the 21st century.
- It is poorly understood how individual plant species and entire forests will respond to these future conditions.
- Literature supports that during periods of drought plants preserve water through physiological adaptions such as closing of stomata; however there is marked variability between species and their individual response and resistance.

Figure 1. The rainforest biome in Biosphere 2 is enclosed in a glass framed structure that is 91 feet at its highest point

Figure 2. A static rope climbing ascension system was used to access leaves in the rainforest canopy

Figure 3.

Figure 4.

Figure 3. Each leaf was documented before the start of the drought(Hibiscus elatus) Figure 4. A handheld Decagon leaf porometer (SC-1) was used for conductance measurements

METHODS

- Biosphere 2 was chosen as a study site because of its unique ability to mimic the micrometeorology of tropical forests in a controlled mesocosm.
- *Clitoria racemosa, Hibiscus elatus,* and *Cissus sicyoides* were chosen as study samples because they make up the majority (~65%) of the B2 rainforest.
- A drought was imposed for ~4-weeks (07/04/15-08/01/15) after a previously consistent rainfall schedule.
- Study sites were set up at three elevations in the canopy to assess microclimate variables: 1-3m, 7-11m, and 14-17m.
- Groups of six leaves were chosen; criteria included size, age, and exposure to light for each leaf.
- Data was collected on each leaf, weekly, during the hours between 08:00 a.m. and 11:00 a.m.

RESULTS

- Transpiration rates of *H. elatus* and *C. racemosa* have strong to moderate negative correlations over the length of the drought.
- *C. racemosa* has no linear correlation with the length of drought.
- *C. racemosa* graph suggests that its conductance is affected by elevation change (higher VPD).
- In relation to canopy elevation the upper level has the strongest correlations among all three species.
- *H. elatus* had the most dramatic change in transpiration rates at each level during the drought (Δ = 242.95 mm²s).
- In addition *H. elatus* was the only plant to exhibit abscission of leaves (4 out of 18).
- *C. sicyoides* averaged to have the lowest transpiration rates.

Figure 5.

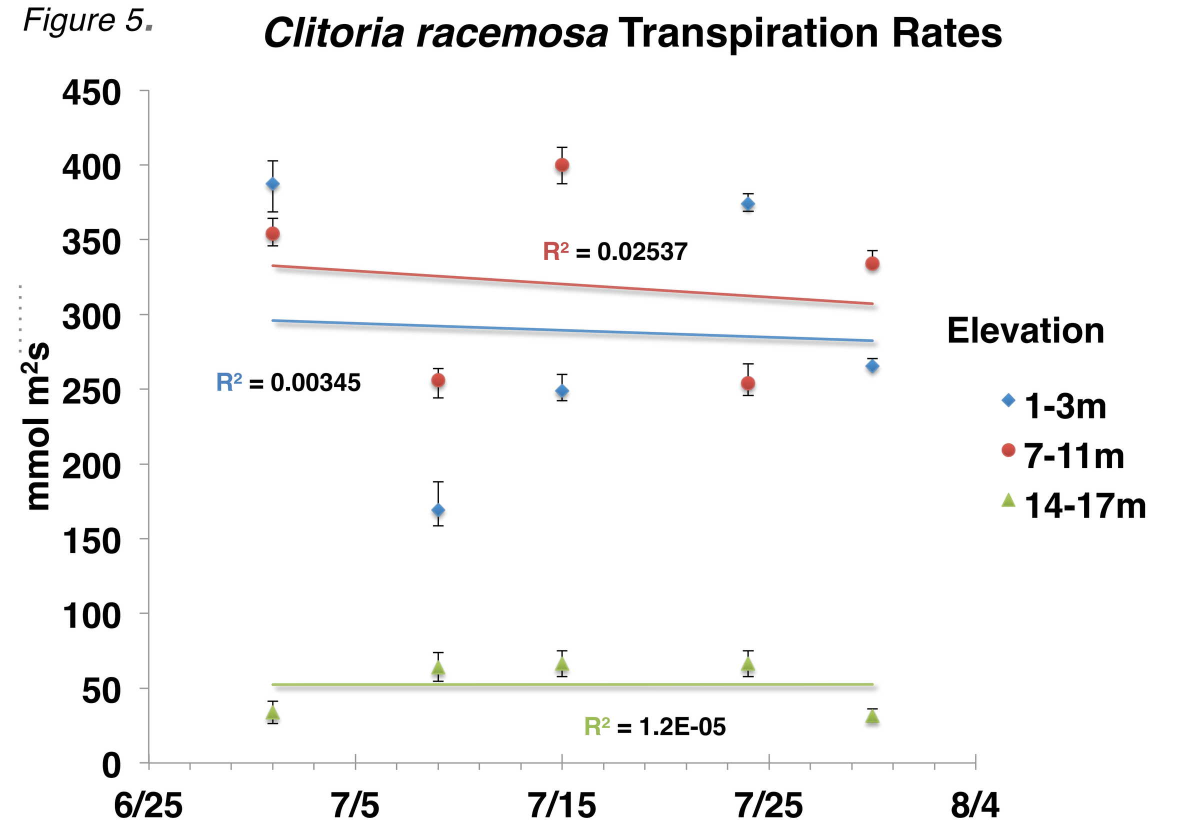

Figure 6.

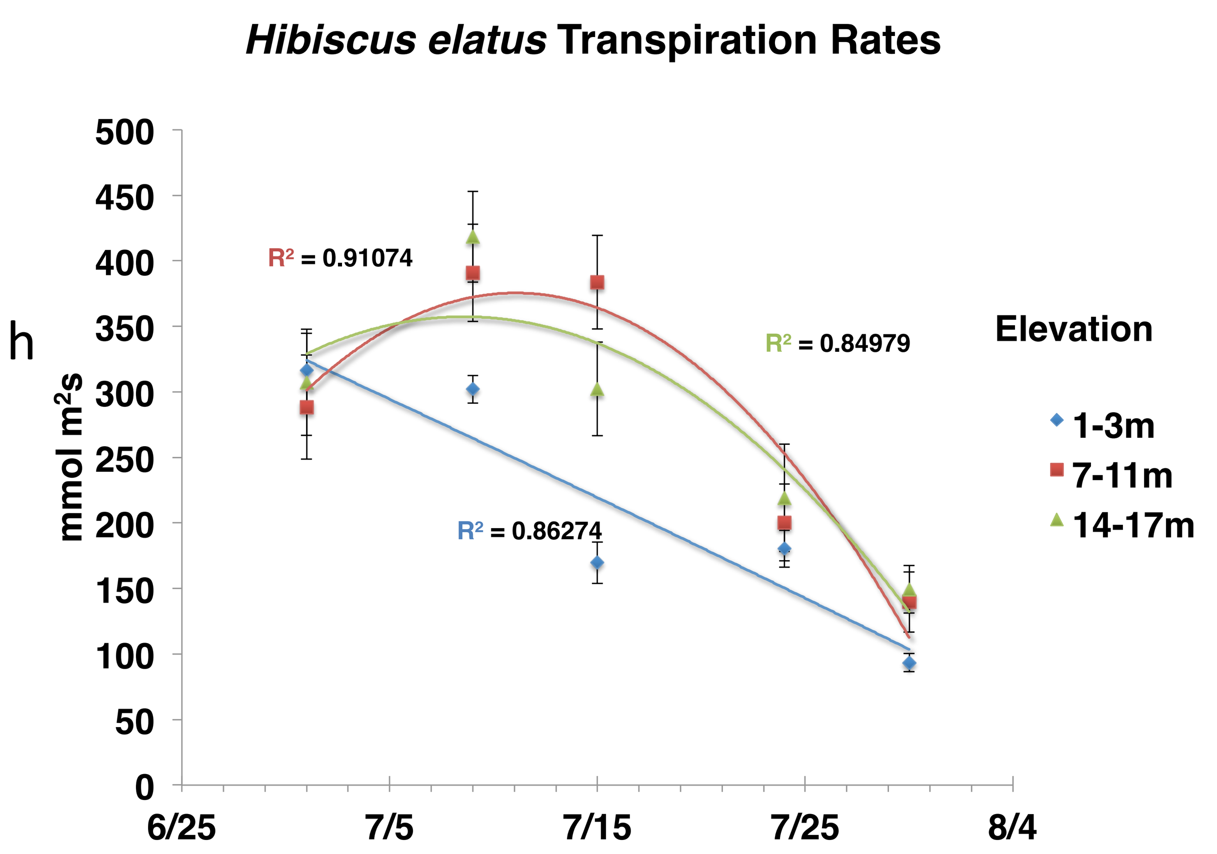

Figure 7.

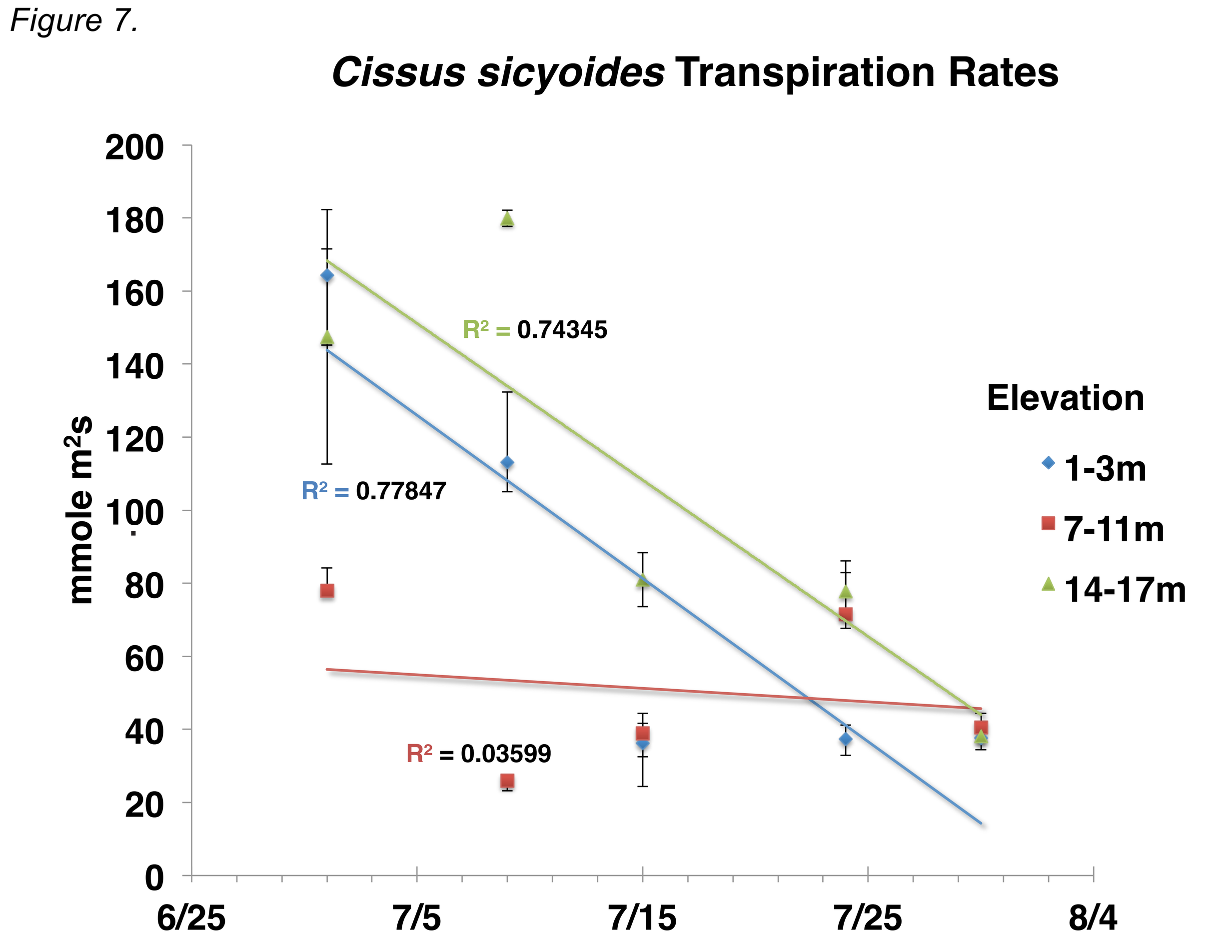

Figure 5, 6, and 7 show individual plant transpirations over time at each level in the canopy. It should be noted that the first data point was gathered pre-drought

CONCLUSIONS

- As anticipated, in response to drought, each species had its own unique functional response to the increased water stress.
- *C. racemosa* (Fabacee family) showed a resistance to short term water stress in comparison to the other species, as well as a sensitivity to changes in elevation; this suggests it has developed other long term adaptations. It may be adjusting stomatal density in correlation with Vapor Pressure Deficit (VPD).
- The overall low transpiration rates of *C. sicyoides*, a vine species, may have a connection to new research showing an increase in vine abundance in rainforests. Low transpiration rates could be a water conservation mechanism that are aiding their ability to outcompete other tropical forest plants.
- These results may be useful for future integrative modeling of how individual leaf responses extend to entire ecosystem scales. Additionally these rates will be useful in understanding the larger impact on the rainforest hydrological cycle. A major source of atmospheric water vapor in rainforests is from transpiration; rainforests heavily depend on this positive feedback loop as a source of continued precipitation.
- Although the length of drought was not indicative of a sustained period of water stress, the initial response that each species exhibited could help to establish a fundamental trend. Will rate of response impact overall resistance to drought?

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