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Relating Leaf Temperature on Malosma Laurina to Leaf Proximity From Soil

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Abstract.

The Santa Monica Mountains are home to countless vegetation and plant species, many of which have been forced to adapt to southern California's stressful environment. With recent droughts and a steady change in climate, an increase in leaf temperature within some species in the Santa Monica Mountains has been observed. One prominent plant found within the mountain range is the malosma laurina, or laurel sumac, the only species of the malosma genus. Malosma laurina is a perfect example of a specie adapting to its stressful environment. Constant brush and shrub fires within the chaparral area where it commonly grows have enabled it to grow new leaves year round, even during the summer dry season. Initially, we planned on measuring the malosma laurina leaf temperatures and comparing them to temperatures in past years, believing we could find correlation between global climate change and an increase in leaf temperatures over the years. While measuring leaf temperatures, however, we noticed something curious. Different leaves of different canopies within the m. laurina plants reported different temperatures; it seemed the temperature of a leaf could be determined based on its distance from the soil. Interested in this discovery, we decided to experiment on whether the leaves on the malosma laurina varied in temperature based on which canopy they grew in, and perhaps why the temperatures were the way they were. Using a radiometer to test light levels and an infrared thermometer to measure individual leaf temperatures, we discovered that higher canopy leaves had consistently higher temperatures than lower canopy leaves, which contested our initial prediction that lower canopy leaves would have cooler temperatures.

Introduction

Little research has actually been done regarding whether leaves of different canopies on a plant vary in temperature. According to a 1966 study conducted by 3 botanists at the University of Georgia at Athens, upper surface or canopy leaves were generally slightly warmer than lower canopy leaves when soil water was adequate. However, there was otherwise little to no difference in leaf temperature when soil water was inadequate, with lower canopy leaves actually reporting higher temperatures. Obviously, one study not even focused primarily on the temperature differences of leaves in separate canopies does not draw enough evidence to support the claim that higher canopy leaves tend to have lower temperatures then their lower counterparts. Despite this, the fact that we were able to find a study that backed up our very obscure and almost unheard of experiment results meant that we were possibly on track to discovering something. Global climate change is a very real thing that has been observed over the last 100 years. The center for environmental science and policy at Stanford University reports a global temperature increase of 0.6 degrees Celsius over the last 100 years. Since global climate change has been a heavily studied topic in recent years, we aimed for our experiment to bring something new to the table. We initially expected for lower canopy leaves to have lower temperatures than upper canopy leaves for the reason that they are closer to the roots of the plant where soil water is absorbed. Our findings found differently however, as upper canopy leaves consistently had lower temperatures than any of the lower canopy leaves. There could be several reasons for this, the most plausible being that upper canopy leaves are more exposed to surrounding air, which is generally cooler than the plants it surrounds.

Methods

- Found two malosma laurina plants within close proximity towards each other and determined the light levels of their respective areas with the radiometer
- Light levels were determined to be the same between the two plants in order to provide for the most accurate results possible
- Measured the temperature of three different leaves on the lower canopy of the first malosma laurina plant with an infrared thermometer
- Three leaves were also measured for the middle canopy and the upper canopy
- The process was repeated on the second plant for a total of nine leaves measured for each malosma laurina specimen

Results

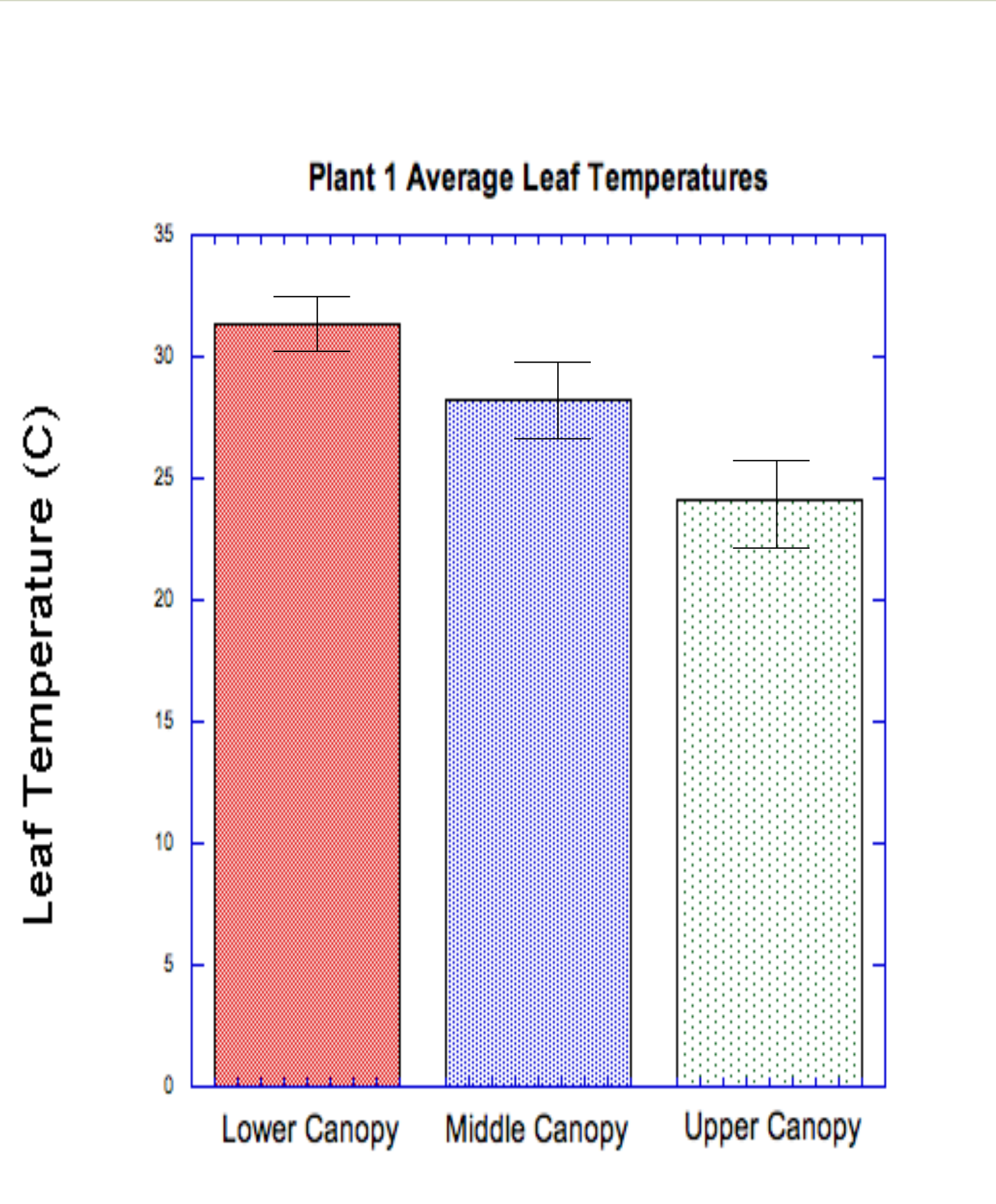

Figure 1. Average temperatures of 3 leaves from 3 canopies of the malosma laurina plants. The higher from the soil a leaf was, the cooler its temperature.

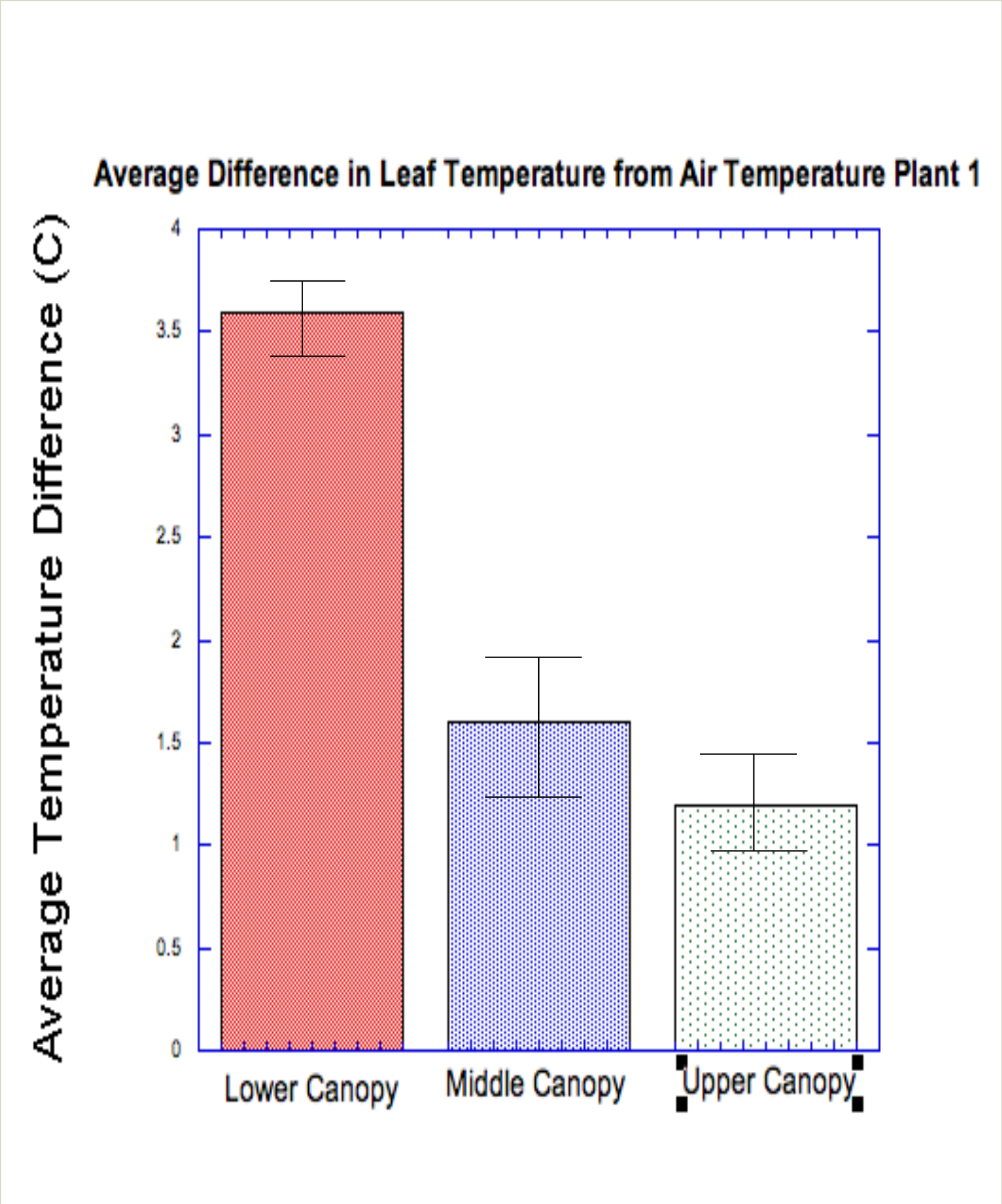

Figure 2 Average difference in air temperature in respect to the average temperatures of leaves from each canopy. The upper canopy leaves' temperatures most closely related the air temperature.

Fiigure 5, left. Measuring individual leaf temperatures with an infrared thermometer.

Figure 6, right. Determining light levels with a radiometer

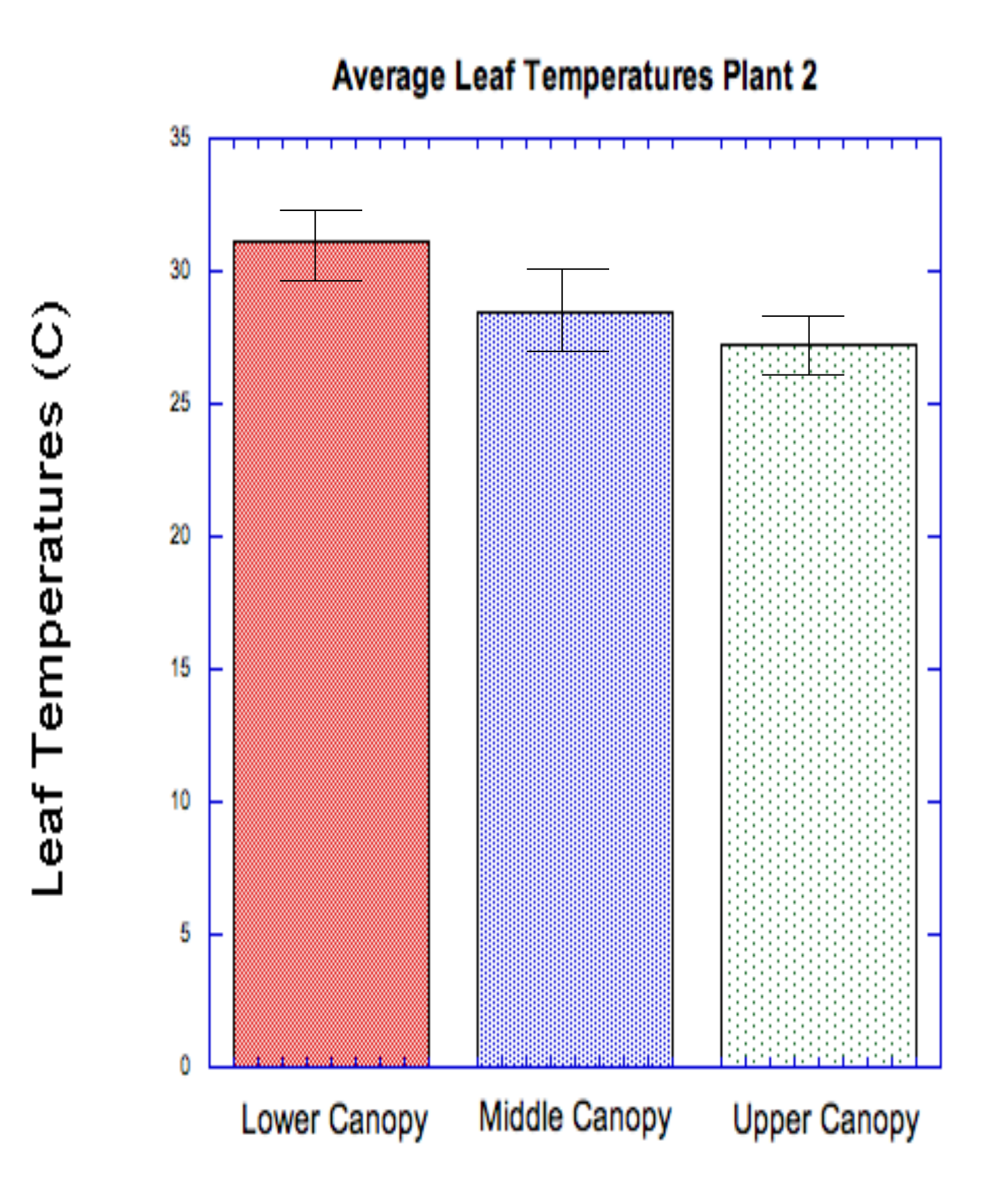

Figure 3 Similar comparison as figure 1, this graph displays the average leaf temperatures for malosma laurina specimen number 2

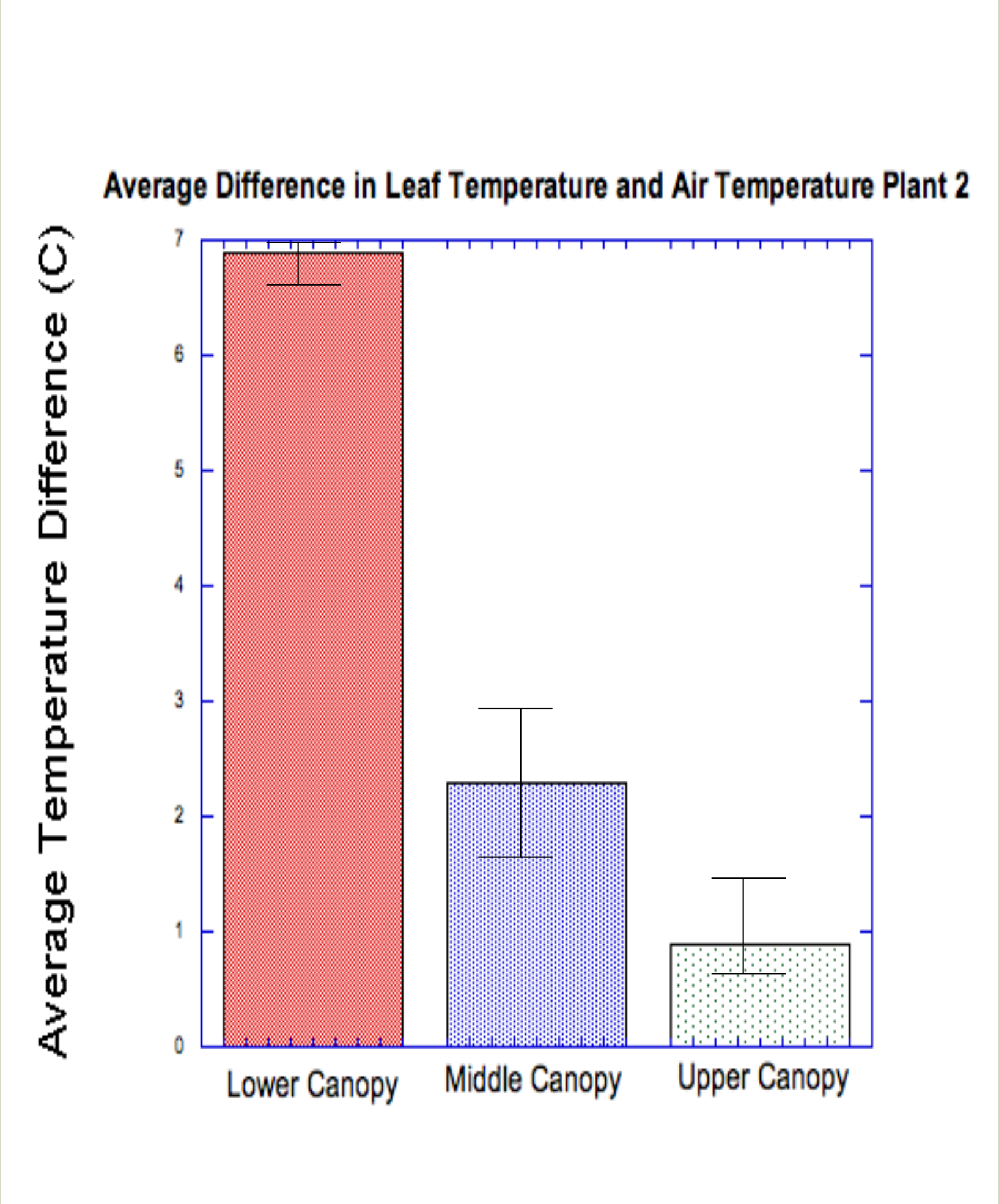

Figure 4 Similar to graph 2, this graph displays the average difference in air temperature to leaf temperatures measured on the second malosma laurina specimen

Figure 7 (Left). Malosma Laurina

Figure 8 (Right) The Santa Monica Mountain range

Discussion

The results showed that upper canopy leaves were undisputedly cooler than both mid-level and lower level canopy leaves. Previous findings reported that this is consistently true especially when soil water uptake is inadequate. Considering the malosma laurina we studied were in the Santa Monica Mountains, where they have been subjected to harsh living conditions, including one of the worst droughts in California's history according to the California University of Agriculture and natural resources. For the best precision, three leaves were taken from each of the two tested plants for each canopy for a total of 9 leaves per plant. To ensure the most diverse results, the leaves tested within each canopy were distant from each other, as opposed to testing three leaves on the same branch. An obvious question to add to the experiment would be if such an occurrence as this is unique to malosma laurina or plants native to stressful environments such as California, or just all plants with taco shaped shells in general.

One important thing to mention as shown in the data is that the upper level canopy leaves also showed smaller differences between their temperature and the air temperature than the other canopies. Since the upper canopy leaves are naturally more exposed to the air based on where they grow on the malosma laurina, it makes sense that their temperatures would be closely related to air temperatures. The lower canopy leaves though better shaded are less exposed to the air, and without adequate soil water uptake are higher in temperature than upper canopy leaves. Because plants thrive under the best light quality, quantity, and duration (photosynthesis actually increases with temperature up to a certain point), leaves better exposed to light could be expected to be more efficient in producing energy than those less exposed to light. Although an increase in the rate of photosynthesis is directly related to the increase in temperature, there is a temperature threshold that when reached will cause respiration to exceed the rate of photosynthesis, which as a result means the products of photosynthesis are being used more rapidly than they are being produced. Because the data we have was collected in late autumn when temperatures are not too great, we believe that our results were not distorted by temperatures that could have negatively affected the leaves' rate of photosynthesis.

Conclusion

Although our hypothesis that lower canopy leaves would yield lower overall temperatures than leaves of either of the upper canopies was contradicted by our experiment results, there was sufficient evidence to show that within the malosma laurina plants we tested, higher canopy leaves enjoyed lower temperatures than both the middle and lower canopy leaves. What this means for the leaves however isn't entirely conclusive. Photosynthesis thrives as temperature and light levels increase, but only to a certain temperature. Since the temperature needed to negatively affect photosynthesis in the malosma laurina was most likely never reached during the day we conducted our tests, we cannot be certain that the leaves with lower temperatures benefited in any way. Because plants reflect green light and absorb very little, the more exposed to green light they are the greener in color they will appear, which explains why the upper canopy leaves, being more exposed to light then the lower canopy leaves were of bright green pigmentation, as opposed to the browner colors found on lower canopy leaves. Therefore, only a quick observation of the color of the leaves could have quickly determined the amount of light they were receiving, and with that, their photosynthetic efficiency. This study has reaffirmed the important role adequate light and temperatures play in photosynthesis, and perhaps how upper canopy leaves have a slight advantage over lower canopy leaves.

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