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The Affect of Temperature on the Fluorescence of Heteromeles arbutifolia (Hollywood) in the Santa Monica Mountains

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Abstract

Presented here is a comparison of the predawn fluorescence of adult *Heteromeles arbutifolia* growing on the Pepperdine Seaver campus next to the lacrosse field, and adult *Heteromeles* growing in Tapia canyon. The analysis of the leaf temperature measured by an IR thermometer showed an average of 9.32˚C drop when measuring plants in Tapia canyon compared to those growing on the warmer Pepperdine campus. The air temperature measured by the Kestrel and IR thermometer showed Tapia canyon being an average of 7.27˚C colder than predawn measurements on Pepperdine campus. Finally, the fluorescence of the plants in both locations was measured using a Pulse-modulated fluorometer, and based on these results it is evident that there is no difference between the fluorescence of *Heteromeles arbutifolia* grown in a cold climate versus a warm climate.

Introduction

The problem chosen was whether a cold climate would have any effect on the fluorescence of *Heteromeles arbutifolia*. The goals for completing this experiment were to try to understand more about *Heteromeles arbutifolia* and the larger Mediterranean climate, which is very unique and to discover a connection between fluorescence and temperature that will lead to a better understanding of how *Heteromeles arbutifolia* has grown and adapted to living in areas with largely varying temperatures.

This problem was solved by measuring the predawn fluorescence, leaf temperature, and air temperature during predawn in different sample plants in each area each morning so that the plants would be at their coldest temperature and there would be more variation in the data. Once these measurements were taken the difference was calculated using a Mann-Whitney U test to see whether the data supported or rejected the hypothesis.

A experiment similar to this was conducted in the past on Pinus sylvestris L. seedlings except in this experiment in Sweden, some plants specimens had to be protected from frost at night instead of having the natural control of the warmer coastal temperatures similar to this experiment (Strand and Lundmark 1987). There was also a similar experiment performed on *Heteromeles arbutifolia* testing how the plants fluorescence levels would react when the plant was shaded (Valladares and Pearcy 1997). For a practical and worldwide importance an experiment was carried out on how fluorescence can improve crop production, which bears important similarities to this project (Baker and Rosenqyist 2004). Finally, an experiment was conducted showing how great of an effect temperature can have on the photosynthetic efficiency and metabolic efficiency of St. Johns Wart, which bears many similarities to testing how temperature affects the fluorescence of *Heteromeles arbutifolia* (Zobayed and Kozai 2005).

Materials and Methods

Measurements of leaf fluorescence and leaf temperature of *Heteromeles arbutifolia* specimens were taken before sunrise at the Pepperdine University lacrosse field and Tapia Park (Figures 3 and 5). The fluorescence (Fm and Fv/Fm), air temperature, and leaf temperature were measured on two leaves of each individual plant. Leaves that appeared healthy and intact were selected from different regions of each plant to insure accurate measurements for the entire plant. The temperature of the top surface of each leaf was measured with the Everest Interscience model 210 Infrared Radiometer and Dr. Stephen Davis' custom built infrared theromometer (Figure 4). Fluorescence of the top surface of each leaf was measured using the Opti-Science OS1-FL Pulse modulated Fluorometer. The air temperature around each plant was measured with the Kestral model 3500.

Figure 3

Fluorescence measurements taken in Tapia Park

On March 24th 2010, pre-measurements were taken at 8:00 am and it was found that measurements needed to be taken at predawn. Predawn measurements were taken from March 27th 2010 to April 4th 2010 on every Wednesday, Saturday, and Sunday morning. In total, 14 measurements of this type were taken at Tapia Park, and 18 measurements were taken at the Pepperdine lacrosse field (1 measurement per 1 leaf). The data was analyzed with the Mann-Whitney U test (α=0.05).

Data

Table 4

Location	Air Temperature Average ˚C	Leaf Temperature Average ˚C
Lacrosse	16.41	13.86
Tapia	9.14	4.54

The average air temperature and the average leaf temperature at both the Lacrosse field and Tapia park are shown.

Table 1

Lacrosse Field Fv/Fm Averages	Tapia Park Fv/Fm Averages
0.839	0.806
0.833	0.828
0.832	0.817
0.807	0.834
0.826	0.805
0.828	0.834
0.823	0.785
0.805	
0.816	

The average fluorescence of two leaves from each individual plant is shown.

Table 2

Descriptive Statistics

	Lacrosse
Mean	.823
Std. Dev.	.012
Std. Error	.004
Count	9
Minimum	.805
Maximum	.839
# Missing	7
Variance	1.374E-4
Coef. Var.	.014
Range	.034
Sum	7.409
Sum Squares	6.100
Geom. Mean	.823
Harm. Mean	.823
Skewness	-.414
Kurtosis	-1.066
Median	.826
IQR	.018
Mode	•
10% Tr. Mean	.823
MAD	.007

Statistical analysis of data from the Lacrosse field.

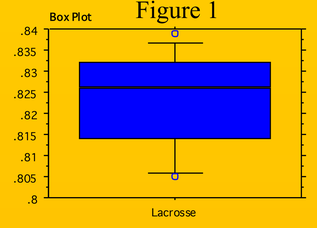
Table 3

Descriptive Statistics

	Tapia
Mean	.816
Std. Dev.	.018
Std. Error	.007
Count	7
Minimum	.785
Maximum	.834
# Missing	9
Variance	3.290E-4
Coef. Var.	.022
Range	.049
Sum	5.709
Sum Squares	4.658
Geom. Mean	.815
Harm. Mean	.815
Skewness	-.489
Kurtosis	-.935
Median	.817
IQR	.027
Mode	.834
10% Tr. Mean	.816
MAD	.012

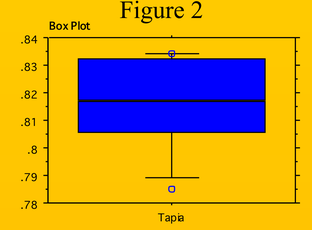
Statistical analysis of data from Tapia park.

Figure 1



Box plot summarizing the data collected from the Lacrosse field.

Figure 2



Box plot summarizing the data collected from the Tapia park.

Figure 4

The IR Thermometer was used in the experiment.

Figure 5

Fluorescence of the leaves was measured using the fluorometer at the Lacrosse field.

Table 5

Mann-Whitney U for Fv/Fm
Grouping Variable: Location

U	26.000
U Prime	37.000
Z-Value	-.582
P-Value	.5604
Tied Z-Value	-.583
Tied P-Value	.5596
# Ties	3

The results of the Mann-Whitney U test, showing a P-Value of 0.5604.

Results

The fluorescence of two leaves of each individual *Heteromeles arbutifloia* was measured and then averaged (Table 1). This was done to account for the fluorescence variation in each plant. From this data, statistical data could be calculated for each location surveyed (Tables 2 and 3). The air and leaf temperature (Table 4) of the Lacrosse field (16.41˚C and 13.86˚C) was greater than that of Tapia Park (9.14˚C and 4.54˚C). The data is then represented by a box plot for each location (Figures 1 and 2). The P-value was 0.5604 and therefore the difference between the two locations' fluorescence was not significant (Table 5). The Lacrosse field Fv/Fm mean (0.823) was greater than the mean of Tapia Park (0.816). It was also observed that the standard deviation and variance of the Lacrosse field (0.012 and 1.374E-4) was smaller than that of Tapia Park (0.018 and 3.390E-4). In fact the range and IQR of the data for the Lacrosse field for the box plot (0.034 and 0.018) was smaller than the data for Tapia Park (0.049 and 0.027).

Discussion

Based off the P-value (0.5604) obtained from the Mann-Whitney U test, the null hypothesis is not rejected. There is more than a 50% chance that a difference between the two sets of data was merely because of random selection. The data did not display what was expected (Maxwell and Johnson 1999). This is insufficient evidence to prove that the fluorescence of the *Heteromeles arbutifolia* from Tapia Park is negatively affected by the colder temperatures in that location despite the fact that the average fluorescence was smaller than the average fluorescence of the Lacrosse field.

There may have been some reasons for this outcome. The range and variance of data was greater in Tapia Park than the Lacrosse field. If more data was collected from both areas a difference may have been detected. Unfortunately because of the time constraints and instrumental malfunctions, there was not a sufficient amount of data to analyze. The areas may have been better represented if around forty individuals were measured instead of sixteen. It was also measured that the average air and leaf temperature differences between the two locations were noticeable. Although this is true, there might not have been a cold enough temperature in Tapia Park to significantly affect the fluorescence of the leaves. Unlike the results found in Scots Pine (Strand and Lundmark 1987), the fluorescence of *Heteromeles arbutifolia* appeared to be freeze tolerant at temperatures as low as 0˚C. Measurements may need to be taken at even lower temperatures to detect a difference in fluorescence. (Quinn and Keeley 2006).

Conclusion

- There was no significant difference between the fluorescence levels of *Heteromeles arbutifolia* individuals located at the Pepperdine lacrosse field and *Heteromeles arbutifolia* individuals located in Tapia Park.
- Therefore, the original hypothesis was rejected and the null hypothesis was not.
- Although our sample size was not very large, we can conclude that *Heteromeles arbutifolia* is a freeze tolerant plant that is able to grow sucsesfully in a colder environment such as Tapia park.
- If the experiment was to be continued, a larger sample size would be used and tests would be performed in even colder study sites that reached -10°C.

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