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Tensile Strength of Malosma Laurina Leaves in Wet and Dry Conditions

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Abstract:

Pepperdine University is one located in one of the most diverse places of the world. It is located in the Mediterranean which occupies less than 5% of the earths landmass and is only found in five areas which includes California. On the campus there are several canyons. One of the canyons is called Winter Canyon. The canyon contained a plant called *Malosma laurina* which is located in a riparian environment and a chaparral environment. The plant grows in both areas however, our hypothesis was that the dry plants' leaves would demonstrate more plasticity. The soil humidity was also measured to compare the difference between the two and there was a significant difference. The average humidity for the wet soil was 43.5% and the dry was 22.5%. Our hypothesis was proven to be true after analyzing the results of the instron machine. The tensile strength was higher among dry leaves.

Introduction:

"The chaparral plant community of southern California must be resistant to multiple stress factors, including protracted summer drought, periodic wildfires, and, in some regions, freezing air temperatures" (Langan, 1997, 433). "Xylem must withstand both the mechanical stresses associated with negative pressure as well as the risk of air entering the hydraulic pathway" (Jacobsen, 2005, 546). Thus, tradeoffs between biological costs and benefits exist and vary amongst chaparral species.

In order to overcome greater negative pressures and resist collapse of conduits, plants exhibit a higher degree of cavitation resistance in the form of thicker vessel walls relative to lumen diameter, and denser xylem (Jacobsen, 2005, 549). A greater thickness to diameter ratio, or young's modulus, indicates increased strength of cells against implosion under negative pressure (Jacobsen, 2005, 547). Furthermore, studies performed on leaf tensile properties in Cape Town have demonstrated that there is a positive correlation between %lignin/unit cross-sectional area and tensile strength of hydrated leaves (Hedderson, 2008). Thus, in order to overcome possibly arduous periods of drought chaparral species tend to invest in xylem density and lignification in order to increase cavitation resistance, but must be cautious as doing so also decreases hydraulic conductance.

Malosma Laurina (previously known as Rhus Laurina) has deep roots, the largest vessel diameters reported for chaparral plants, and maintains a high seasonal water potential (Langan, 1997, 426). M. Laurina's deep root system contributes to it's highly negative water potentials. Researchers have shown that M. Laurina has weak stems (Low Modulus of Rupture (MOR)) comparatively, low transverse fiber wall area, and vessels that are predominantly surrounded by fibers (Jacobsen, 2005, 554). Hence, M. Laurina must spend a fair amount of its cellular energy on overcoming such comparatively negative water potentials due to its basal burl, and possible ensuing drought induced cavitation.

Leaves were collected from M. Laurina growing near a stream in Winter Canyon in Malibu, California on the campus of Pepperdine University. To measure the tensile strength of leaves the instron in the Natural Science Division of Pepperdine University was utilized. Each obtained young's modulus from leaves in the riparian group and leaves in the non-riparian subset were tested for a statistical difference with a t-test.

Material & Methods:

We went to Winters Canyon to collect samples in the riparian and chaparral environments of the plant, *Malosoma laurina*. Our leaves were placed in a plastic bag to prevent dehydration. The instron machine was used to test the tensile strength. The leaf measurements were made by using a digital vernier caliber then clamped in the instron so the leaf would lie laterally to be centered. Continuous and increasing force was applied to transverse leaf area until leaf ripped. The instron software was used to calculate to transverse area that underwent the force of the system and Young's modulus. The moisture of the soil was also measured in both environments and compared. The device was a called a soil moisture probe.

Dry Leaves

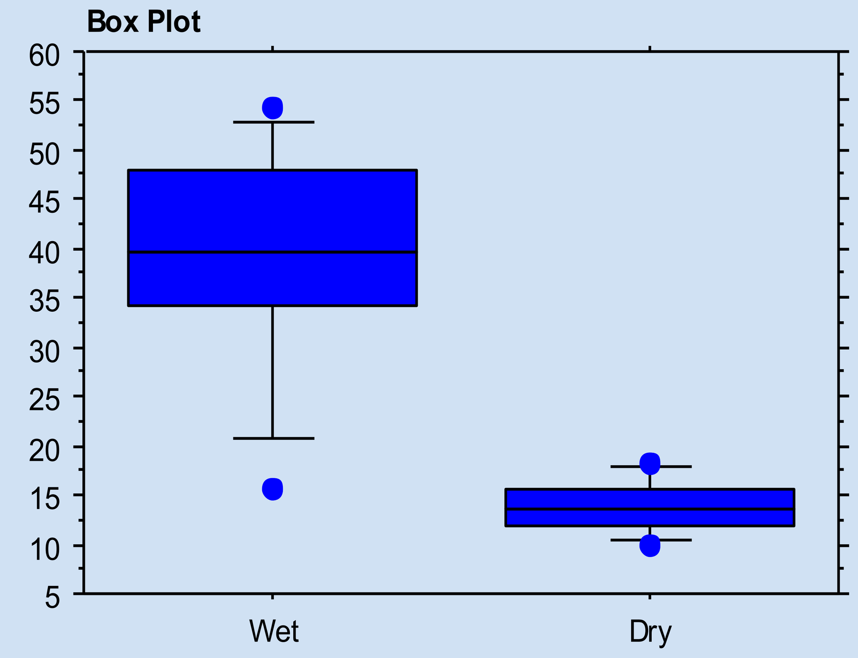
	Maximum Load (N)
1	12.12149
2	17.05282
3	18.31295
4	6.41919
5	12.79910
6	14.38367
7	11.30113
9	14.17522
10	11.89157
11	15.16461
Maximum	18.31295
Mean	13.36217
Minimum	6.41919
Standard Deviation	3.326

Wet Leaves

	Maximum Load (N)
1	37.38889
2	42.31786
3	54.36862
4	33.93885
5	35.34615
6	46.55944
7	49.54084
9	15.58039
Maximum	54.36862
Mean	39.38013
Minimum	15.58039
Standard Deviation	11.978

Paired Means Comparison
Hypothesized Difference = 1

	Mean Diff.	DF	t-Value	P-Value	95% Lower	95% Upper
Wet, Dry	25.450	7	6.237	.0004	16.181	34.718



Discussion:

Upon measuring strength of the leaves from the wet and dry samples of *Malosma laurina*, the leaves of the wet sample were shown to exhibit greater resistance to breakage. On average, the wet leaves broke at a force approximately 3 times greater than those of the dry samples. It was determined using the instron machine that this was due to the extension of the wet leaves as they were pulled apart. The leaves stretched and this enabled it to resist greater force before breaking. The dry leaves were shown to beak at a greater tensile strain on average compared to the wet leaves, and this demonstrated that these leaves resisted stretching more, yet still broke at a weaker force. We had to reject our hypothesis because the wet leaves, not the dry, in fact demonstrated greater strength by resisting breakage till a much greater force.

The soil moisture data demonstrated that the water levels near the stream were, on average, more saturated with water than that on the ridges. However, the wet soil showed much more variability which can be explained because of the high sand content of the soil near the stream which doesn't hold water well.

Conclusion:

Still, the dry plants were definitely less hydrated than the wet plants.

One possible explanation was that the fiber-strengthening of xylem was simply genetically-governed over centuries of selective adaptation which wouldn't change in a single generation due to an environmental factor. The extra water hydration within leaves of the wet plant enabled xylem vessels to become more plastic and flexible than those of the dry plant. Because of this extra flexibility, it was able to resist greater pulling force.

For future experiments, we would need to collect many more samples of leaves, and stems, and test for strength. In addition, the soil moisture probe would have to be repaired because the broken probe demonstrated measuring problems which had to be addressed in-situ. Furthermore, the test area would need to be expanded to include a wider collection of smaller systems and samples.

Literature Cited

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