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A Comparison of the Tensile Strength of Leaves in Encelia californica in Canyon and Beach Species

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Figure 2. *Encelia californica*

Introduction

Encelia californica, commonly known as the California Sunflower, is prevalent in the canyons of Pepperdine University as well as beaches of Malibu (Figure 2). Although *E. californica* is adapted to exposures of high levels of afternoon sunlight, previous studies show that it is unable to maintain its leaves when grown in desert conditions (JR Ehleringer *et al*. 1989). The beach species is subject to higher humidity, sea spray, wind, and heat, and are subject to low nutrient content in the soil (Pickart 2008). We hypothesized that the beach species of E. californica would have greater leaf tensile strength than the canyon species as an adaptation resulting from the exposure to the aforementioned environmental stressors. We took measurements of factors including relative humidity, soil salinity, wind speed, and altitude and compared the tensile strength of leaves from the beach and canyon species using Young's Modulus.

Materials and Methods

A random survey of six healthy leaves each from species in the President's Canyon and Malibu Beach were collected into airtight plastic bags. The Vaisala Humicap was used to measure environmental factors including relative humidity, wind speed, altitude, and temperature. Soil samples were collected from under the plants. The salinity of the soil was measured using the Brix Refractometer. The tensile strength of the leaves were tested using the Instron within an hour of collecting the samples. The data was analyzed using the Student's T-Test.

Figure 3. (Left to right) Springs, Lee, and Chowaniec collecting samples and data

Abstract

Our research is concerned with the further exploration of leaf biomechanics, a relatively unexamined field. The purpose of this experiment was to find a correlation between environmental stress factors and tensile strength of leaves of *Encelia californica*. We hypothesized the beach species would have a higher tensile strength than canyon species. After evaluating data collected from both Pepperdine's Presidents Canyon and Malibu beach we found that while the canyon species could withstand a higher maximum load of force, there was no difference between the canyon and the beach species with leaf area taken into account. Using Young's Modulus, we see that there is no significant difference in the tensile strengths of *E. californica* in canyon and beach species.

		Maximum Load (N)	Tensile strain at Max. Load (mm/mm)	Young's Modulus (MPa)
Mean	Beach	3.81292	0.24579	1.89441
	Canyon	6.19799	0.24671	2.09860
Variance	Beach	1.671	0.065	1.31929
	Canyon	1.352	0.044	1.42697
T-Test	2 Tailed	p = 0.02162*	p = 0.9778	p = 0.4972
	1 Tailed	p = 0.01081*	----------	----------

Figure 1. *Results*. The mean of the maximum load was significantly higher in the canyon species than in the beach species. There was no significant difference between the mean of the tensile strain at maximum load (mm/mm) between the canyon and the beach species. There was not a significant difference between the mean of the Young's Modulus (MPa) in the canyon and the beach species.

Literature Cited

•Wilson, D.(1965), Nutritive value and the genetic relationships of cellulose content and leaf tensile strength in *Lolium.* The Journal of Agricultural Science. 65, 285-292.
•JR Ehleringer and CS Cook. 1989. Characteristics of Encelia species differing in leaf reflectance and transpiration rate under common garden conditions. Oecologia 82: 484-489.
•Pickart. 2008. Restoring the Grasslands of Northern California's Coastal Dunes. Grasslands 18: 4-8.

Discussion

It was observed that the leaves of the canyon species were generally larger than the leaves of the beach species. Plants with the highest cellulose content have the highest leaf tensile strength (Wilson 1965). This coincides with our observation that the canyon leaves can withstand a significantly higher maximum load than the beach species can (Figure 1). Young's Modulus is the measure of tensile strength, defined as the ratio of stress to strain. Taking leaf area into account, it was found that the tensile strength of the canyon species was comparable to that of the beach species.

Conclusions

•Morphological differences are present between beach and canyon species as an adaptation to exposure to different environmental stressors
• Leaves from the beach species are smaller than the canyon species
•According to Young's Modulus, there is no significant difference in tensile strength between the canyon and the beach species

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