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Differences in hydraulic conductance (Kh) as a function of leaf area (KS Leaf) and xylem size (KS Xylem) in Encelia californica and Venegasia carpesioides

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“Differences in hydraulic conductance (K_h) as a function of leaf area ($K_{S\ Leaf}$) and xylem size ($K_{S\ Xylem}$) in *Encelia californica* and *Venegasia carpesioides*”

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ABSTRACT

Southern California and the Santa Monica Mountains experience a climate similar to that of the Mediterranean basin. This means hot, dry summers, mild, wet winters, and large amounts of plant diversity. A major issue that can affect these regions is water availability and processing. To demonstrate this, hydraulic conductance (K_h) was measured as a function of leaf area ($K_{S\ Leaf}$) and xylem size ($K_{S\ Xylem}$). Two vascular plants were used for this study, *Encelia californica* and *Venegasia carpesioides*. This is because they are similar morphologically but are different genus and species. It was hypothesized that the larger plant (*V. carpesioides*) will have a larger hydraulic conductance (K_h), larger hydraulic conductance per leaf area ($K_{S\ Leaf}$), as well as a larger hydraulic conductance per xylem area ($K_{S\ Xylem}$) because of its larger need for water. K_h was found using a Sperry apparatus and the student t-test gave a P-value of 0.1517, which does not suggest a significant difference, $K_{S\ Xylem}$ (K_h/A_{xylem}) using venier caliper and gave a P-value of 0.2867, which does not suggest a significant difference, and K_{Leaf} (K_h/A_{leaf}) using Leaf Area Index which gave a P-value of 0.0385, suggesting a significant difference in Leaf-specific hydraulic conductance ($K_{S\ Leaf}$) between *Encelia californica* and *Venegasia carpesioides*. This shows that the hypothesis was only partially accepted.

INTRODUCTION

Southern California is one of the five Mediterranean climates in the world. These regions are characterized by hot, dry summers, mild, wet winters, and high biodiversity (Strahler). Specifically, the Santa Monica Mountains range 40 miles from the LA basin and Hollywood hills to Ventura County and the Channel Islands. Much of the diversity found in southern California is concentrated here.

But climate change is affecting the normal conditions for these regions and that diversity is shifting, both in type and physiology. A very important physiological feature is water potential and conductance (Chaves). In relation, this study will measure hydraulic conductance (K_h) as a function of leaf area ($K_{S\ Leaf}$) and xylem size ($K_{S\ Xylem}$). Changes in water availability is playing a major role is this environmental and physiological change.

The two plants chosen for this study are found largely in this area. The first is *Encelia californica* (Fig. 2), a member of the sunflower (Asteraceae) family and commonly called coast sunflower. The second plant observed was *Venegasia carpesioides* (Fig. 3), often called the canyon sunflower is also in the family Asteraceae. These plants were chooses to see the relationship in physiological structure and function between plants that are not exact phylogenetically relatives (different genus and species), but share similar morphological features.

It was hypothesized that the larger plant (*V. carpesioides*) will have a larger hydraulic conductance (K_h), larger hydraulic conductance per leaf area ($K_{S\ Leaf}$), as well as a larger hydraulic conductance per xylem area ($K_{S\ Xylem}$) because of its larger need for water.

STUDY SITE

Fig. 1. Pepperdine Malibu Campus

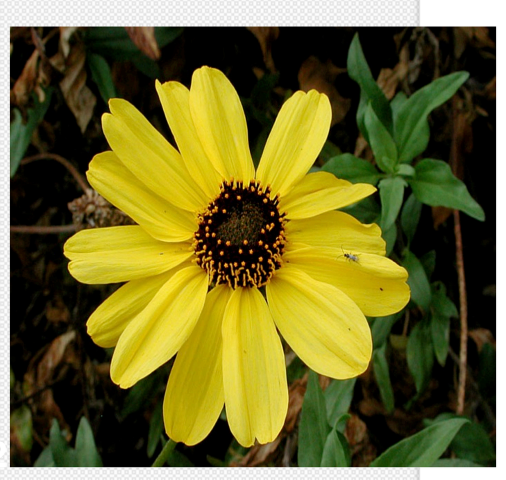

Fig.2. *Encelia californica*
This plant can reach up to 1.5 meters, bears yellow ray flowers, yellow and black disk flower, small green leaves, and a woody stem.

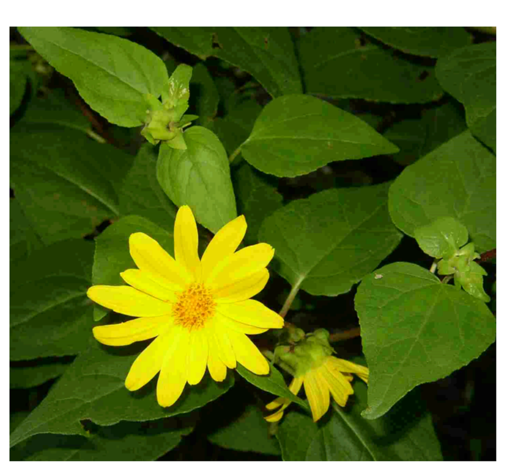

Fig.3. *Venegasia carpesioides*
This plant is morphologically similar to E. californica, except for larger height, leaf size, and purely yellow flowers.

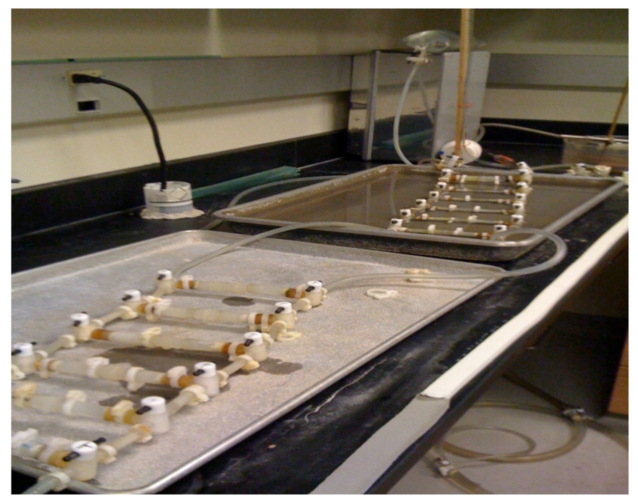

Fig.4. Sperry Apparatus

Fig.5. Leaf Area Index

MATERIALS AND METHODS

Collect samples (6 of each species) of stem and leafs from study site (Fig. 1). Using clippers, cut 14 cm segments of stem under water and attach to Sperry Apparatus (Fig. 4). Flush emboli with diluted HCl for 30 minutes. Measure initial, stem, and final flow for each segment, finding hydraulic conductance (K_h). Record data.

Using a razor, remove phloem from stem. Measure diameter of total stem and pith (using vernier caliper), subtract, and find area of xylem ($A = \pi \cdot r^2$) for each stem. Record data.

Using the Leaf Area Index (Fig. 5), find the total leaf area of all leaves above the cut segment. Calibrate the LAI to zero, and run all leaves through the machine. Record data.

Using the student t-test, measure difference of K_h between the 2 species. Use the student t-test to also measure difference of $K_{S\ Xylem}$ (K_h/A_{xylem}) and $K_{S\ Leaf}$ (K_h/A_{leaf}) between both species. Graph results and analyze.

RESULTS

Unpaired Means Comparison for t-test (Kh)
Grouping Variable: Category for t-test (Kh)
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value	95% Lower	95% Upper
EC-Kh, VC-Kh	-46.383	10	-1.552	.1517	-112.969	20.204

Group Info for t-test (Kh)
Grouping Variable: Category for t-test (Kh)

	Count	Mean	Variance	Std. Dev.	Std. Err
EC-Kh	6	11.908	32.021	5.659	2.310
VC-Kh	6	58.291	5326.453	72.983	29.795

Table.1. Student's t-test for K_h

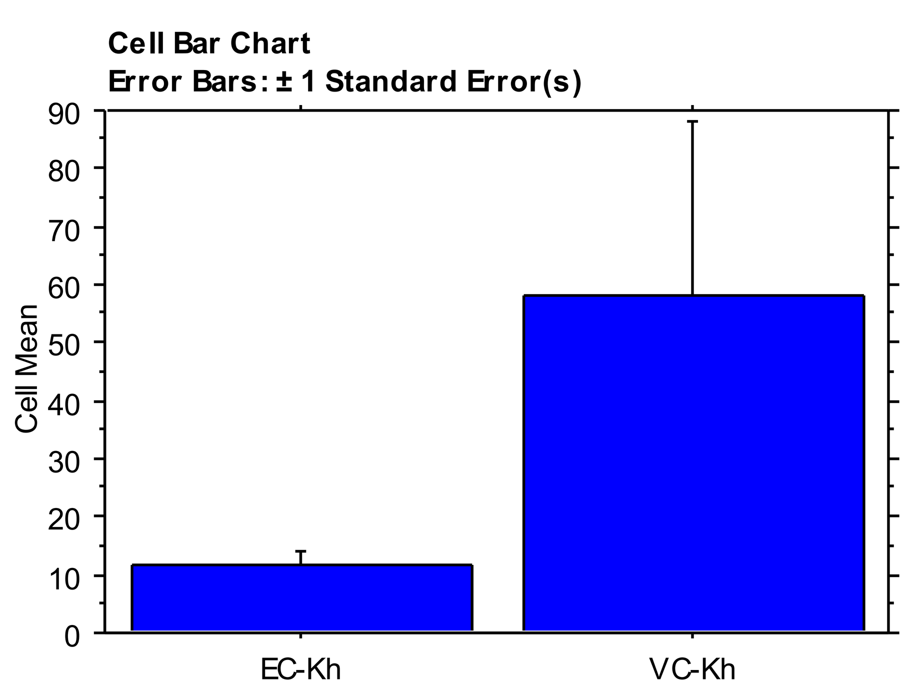

Fig.6. Bar Graph (K_h)

Though the mean Hydraulic conductance (K_h) of *Encelia californica* is lower than that of *Venegasia carpesioides*, the P-value, 0.1517, does not suggest a significant difference.

Unpaired Means Comparison for t-test (Ks xylem)
Grouping Variable: Category for t-test (Ks xylem)
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value	95% Lower	95% Upper
EC-Ks (xylem), VC-Ks (xylem)	-.761	10	-1.125	.2867	-2.267	.745

Group Info for t-test (Ks xylem)
Grouping Variable: Category for t-test (Ks xylem)

	Count	Mean	Variance	Std. Dev.	Std. Err
EC-Ks (xylem)	6	.631	.048	.219	.089
VC-Ks (xylem)	6	1.392	2.693	1.641	.670

Table.2. Student's t-test for $K_{S\ Xylem}$

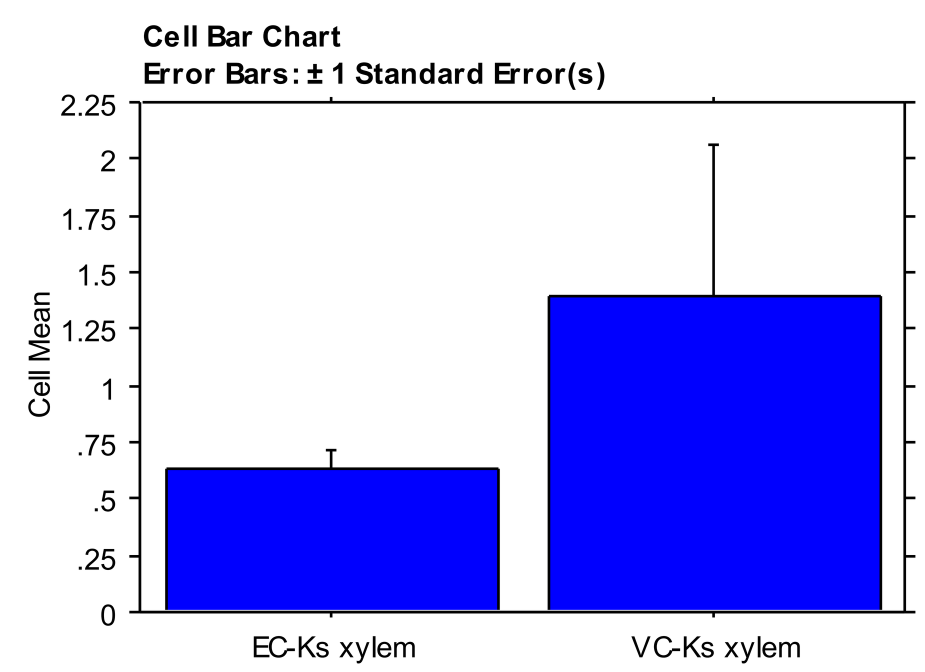

Fig.7. Bar Graph ($K_{S\ Xylem}$)

Though the mean Xylem-specific hydraulic conductance ($K_{S\ Xylem}$) of *Encelia californica* is lower than that of *Venegasia carpesioides*, the P-value, 0.2867, does not suggest a significant difference.

Unpaired Means Comparison for t-test (Ks leaf)
Grouping Variable: Category for t-test (Ks leaf)
Hypothesized Difference = 0

	Mean Diff.	DF	t-Value	P-Value	95% Lower	95% Upper
EC-Ks (leaf), VC-Ks (leaf)	4.263E-4	10	2.381	.0385	2.744E-5	.001

Group Info for t-test (Ks leaf)
Grouping Variable: Category for t-test (Ks leaf)

	Count	Mean	Variance	Std. Dev.	Std. Err
EC-Ks (leaf)	6	.001	1.276E-7	3.571E-4	1.458E-4
VC-Ks (leaf)	6	2.678E-4	6.475E-8	2.545E-4	1.039E-4

Table.3. Student's t-test for $K_{S\ Leaf}$

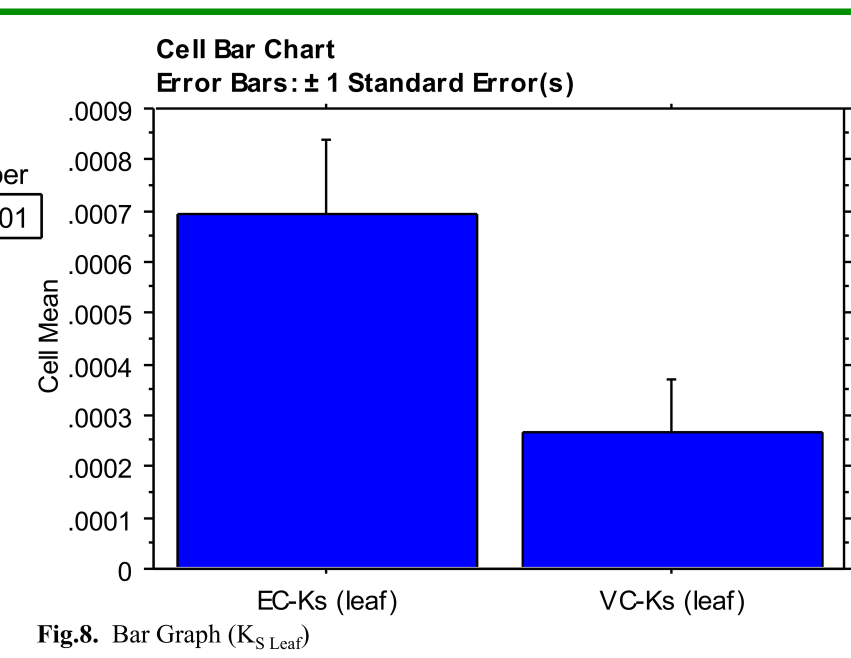

Fig.8. Bar Graph ($K_{S\ Leaf}$)

The P-value, 0.0385, suggests a significant difference in Leaf-specific hydraulic conductance ($K_{S\ Leaf}$) between *Encelia californica* and *Venegasia carpesioide*.

DISCUSSION

Hydraulic conductance (K_h) and Xylem-specific hydraulic conductance ($K_{s\ xylem}$) (K_h/A_{xylem}) between *Encelia californica* and *Venegasia carpesioides* were tested with the Student's t-test, finding P-values greater than 0.05, which allowed us to accept the null hypotheses. The average $K_{s\ xylem}$ of *V. carpesioides* as well the average flow of hydraulic conductance is seen to be larger than that of *E. californica*.

The Student's t-test conducted on Leaf-specific hydraulic conductance ($K_{s\ leaf}$) (K_h/A_{leaf}) between the two species resulted in a p-value of 0.0385, which less than 0.05. Hence, the null hypothesis is rejected, presenting a significant difference between the $K_{s\ leaf}$ of *E. californica* and *V. carpesioides*. Since the leaf size is much smaller in *E. californica*, the average $K_{s\ leaf}$ of *E. californica* was larger than that of *V. carpesioides*.

In measuring xylem-specific hydraulic conductance, hollow piths were observed within *V. carpesioides* and were modified by filling the piths with simple putty. This hollow pith could be due to several causes, including infection, rapid growth, senescence, or specialized function (Encyclopedia Britannica). The instance that the hollow piths were not completely sealed creates possible error in measurements of K_h, causing it to largely increase. A more specific way of accommodating for deficient construction of pith should be stressed in further research. This shows how differences in internal morphology, which can go undetected, can affect physiology greatly.

Additionally, a higher sample size can be accounted for in future research, as higher sample size will increase accuracy of the Student's t-test. Past research on these subjects were scarce, proving our efforts and knowledge gained even more significant.

CONCLUSIONS

- These 2 species, although morphologically-similar, exhibit differences in hydraulic conductance.
- Leaf size seems to vary more widely in regards to hydraulic conductance.
- Water relations and availability have a large effect on plant physiology and viability.
- Other pursuits in this subject could include transpiration rates for said leaves.

WORK CITED

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