



Identifying the Relationship Between Nest Architecture and Strength

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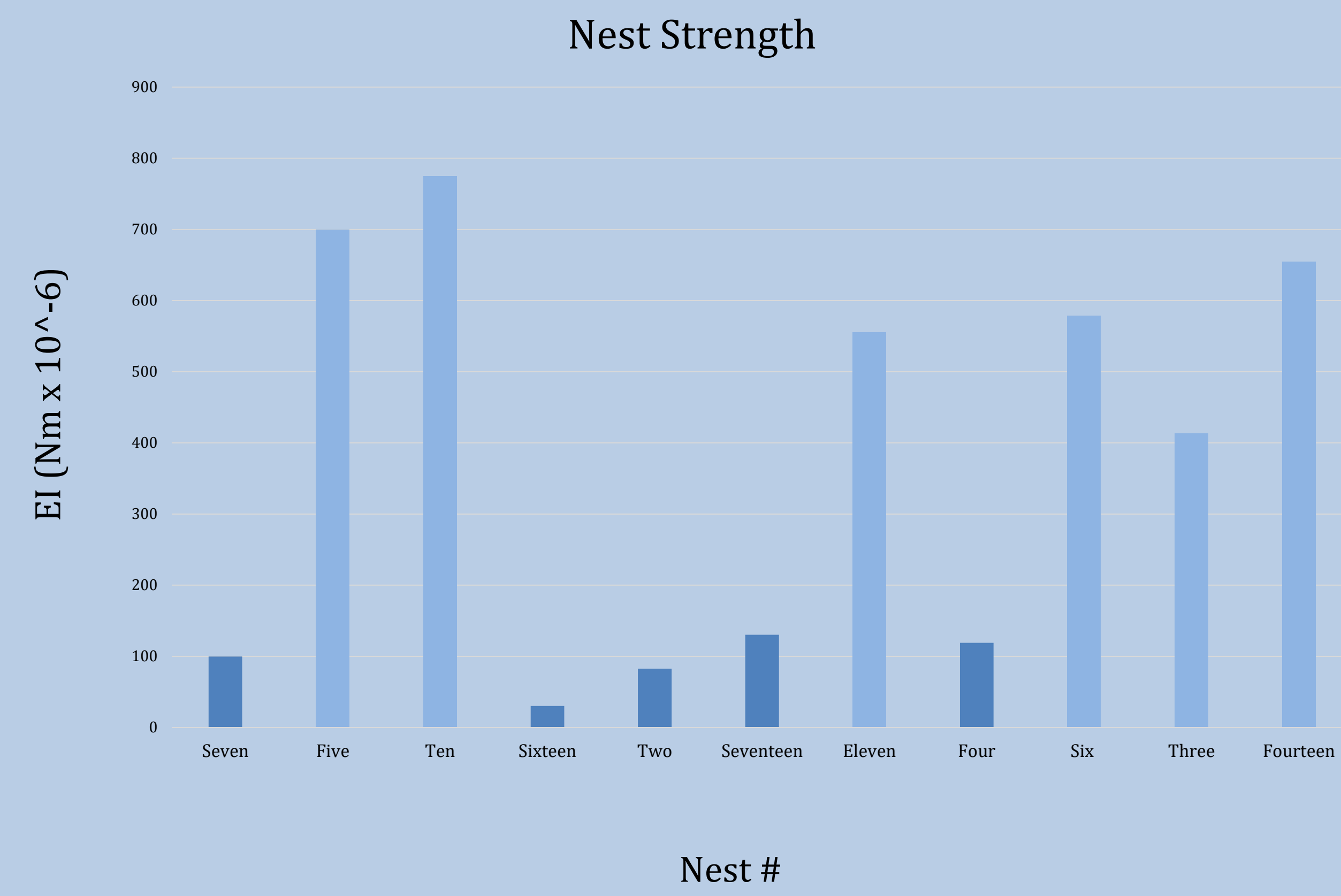
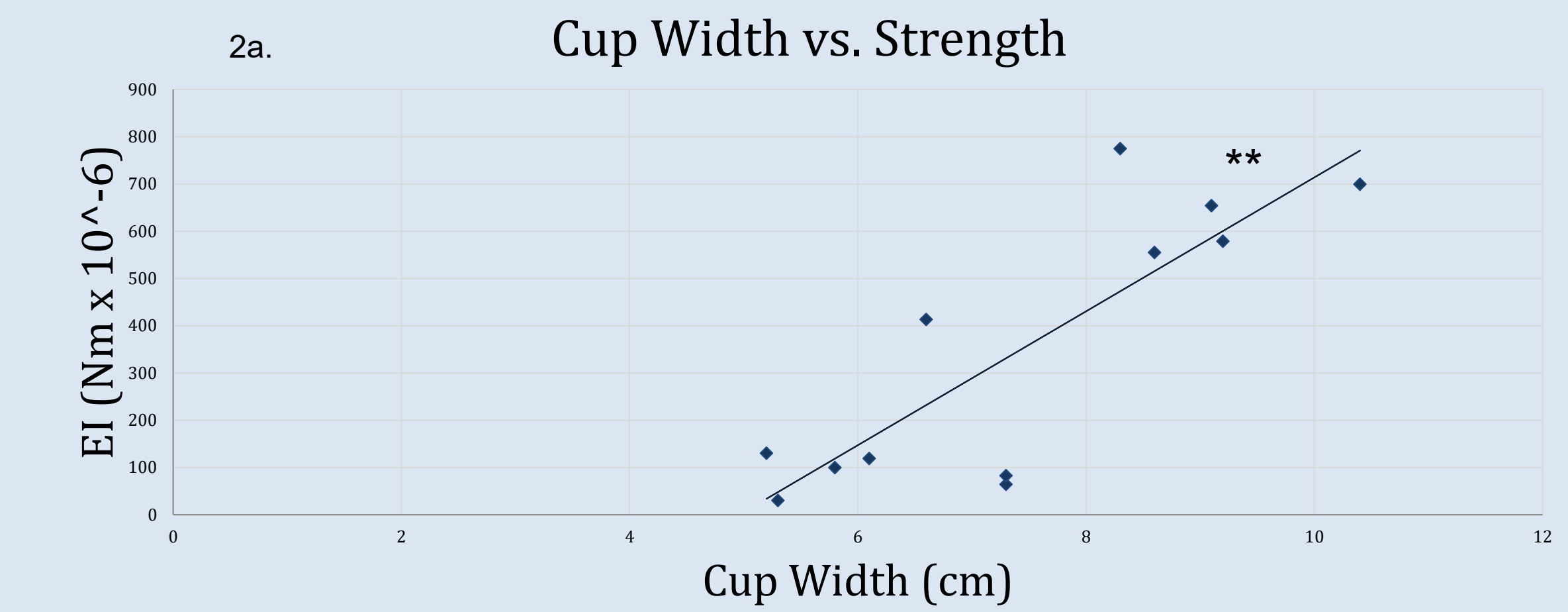
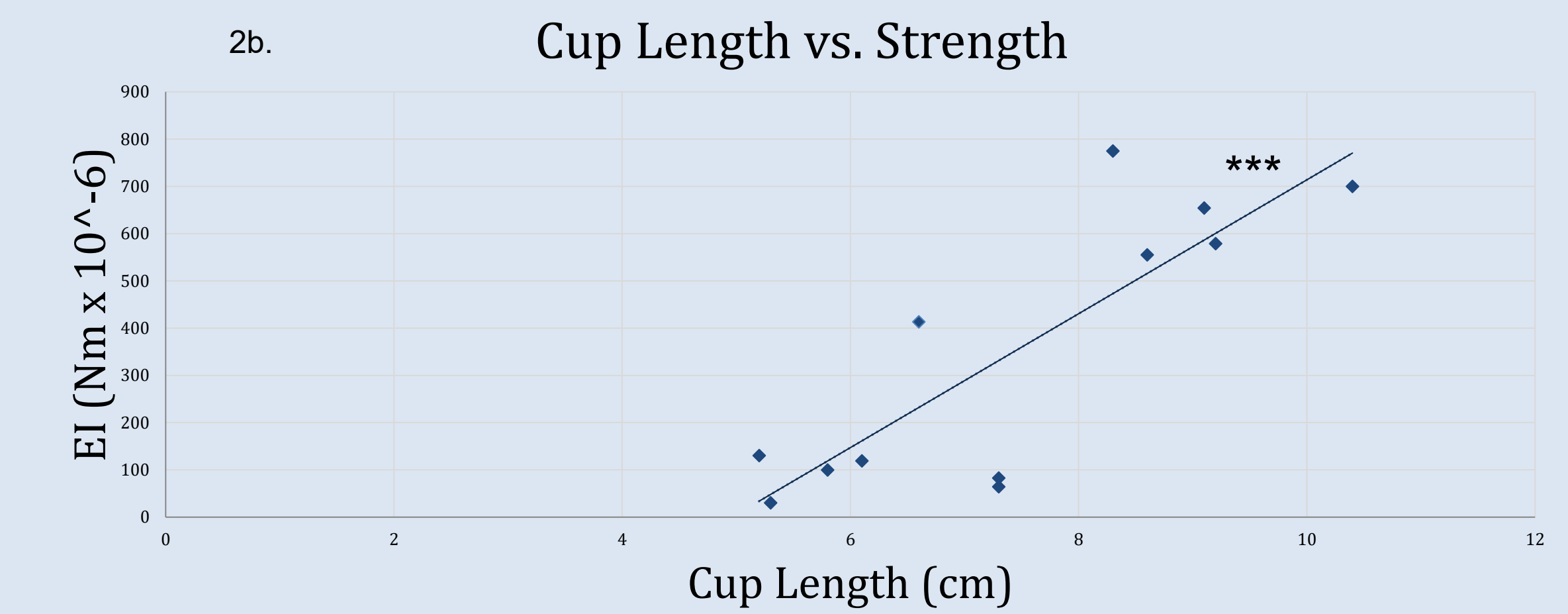


Figure 1: Graph of the bending rigidity in Nm x 10⁻⁶ of the nests studied. This graph demonstrates that the nests with mud cups (light blue) are significantly stronger than nests without mud cups (dark blue). (p=.0003)



Graph 2a: Graph of the Cup Width of the nest (cm) versus the bending rigidity of the nest (Nm x 10⁻⁶). Pearson Correlation=.770, **=p-value=.003.



Graph 2b: Graph of the Cup Length of the nest (cm) versus the bending rigidity of the nest (Nm x 10⁻⁶). Pearson Correlation=.832, ***=p-value<.001.

Introduction

- Past research suggests that material placement in bird nests is **deliberate** and is determined **based on structural properties**, such as diameter (Biddle et al. 2018). However, these studies have failed to look at how these material choices influence the structure of the nest as a whole.
- The structure of bird nests has the potential to **enhance man-made structures**, suggesting that the architecture of the nest lends to its strength (Sindhu Nachiar et al., 2023).

Mud Cups are Stronger



Image 1: Image of nest 10, which has a mud cup

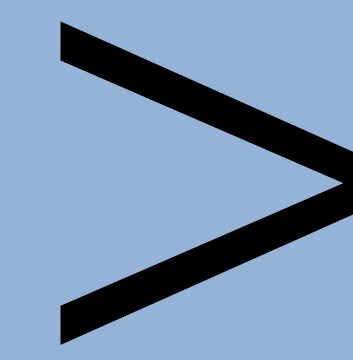
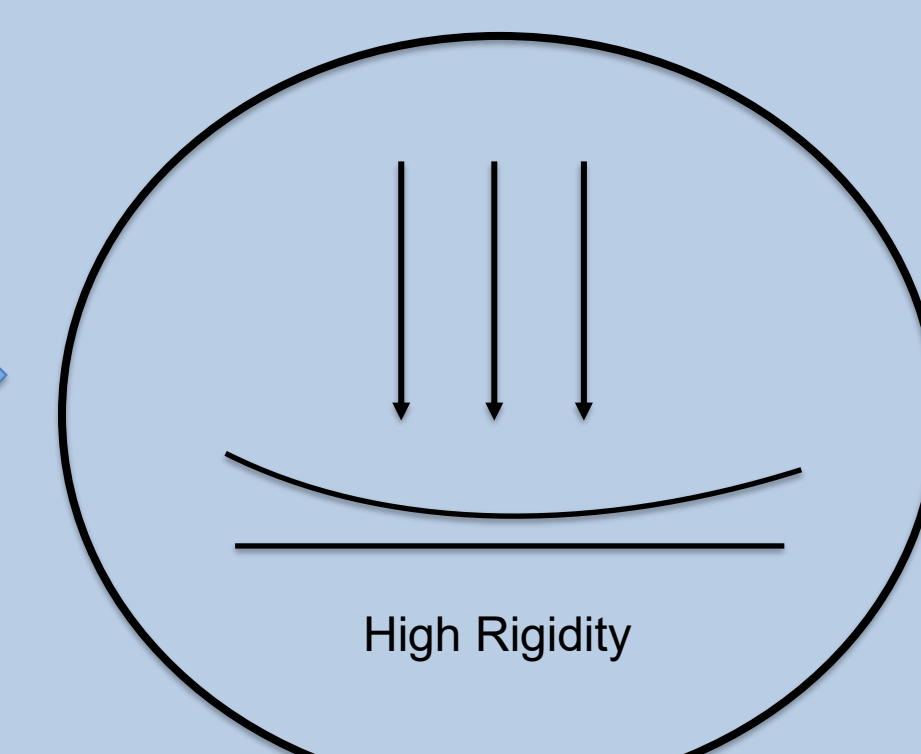
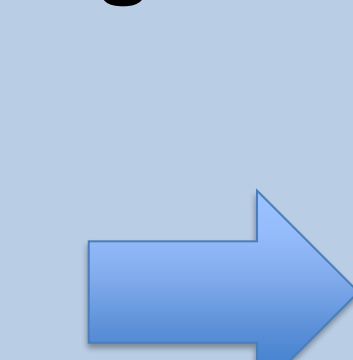


Image 2: Image of nest 1, which does not have a mud cup

Cup length and width have the greatest relation to nest strength



Research Question

How does the diameter, orientation, and location of the materials within the bird nest, as well as nest size and cup type, influence the overall load strength of the nest?

Hypothesis

There will be a significant relationship between nest architecture and nest strength.

Conclusion

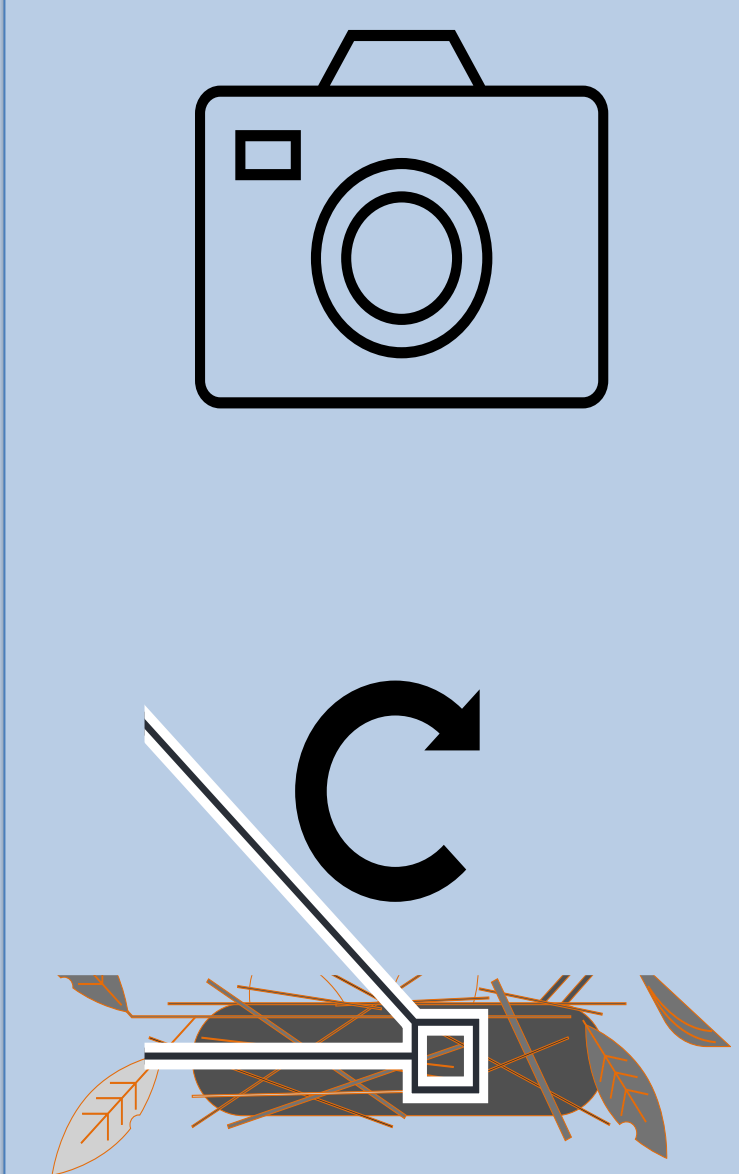
- If solely looking at statistical significance, strength may not be the reason for the deliberate placement of materials.
- Birds may choose a mud cup when in need of a stronger nest.

Implications

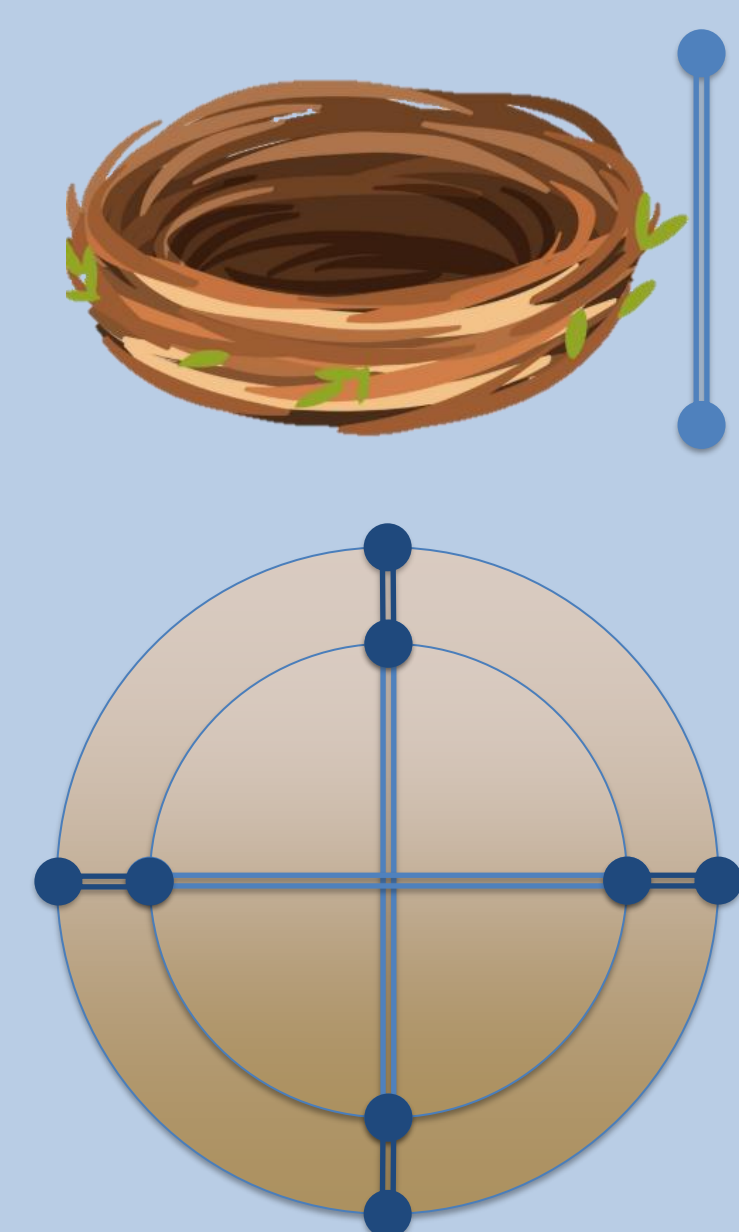
- Man-made structures should be made out of concrete as opposed to sticks/rods.
- Easier analysis of adaptation to surroundings regarding birds and nest strength.

Methodology

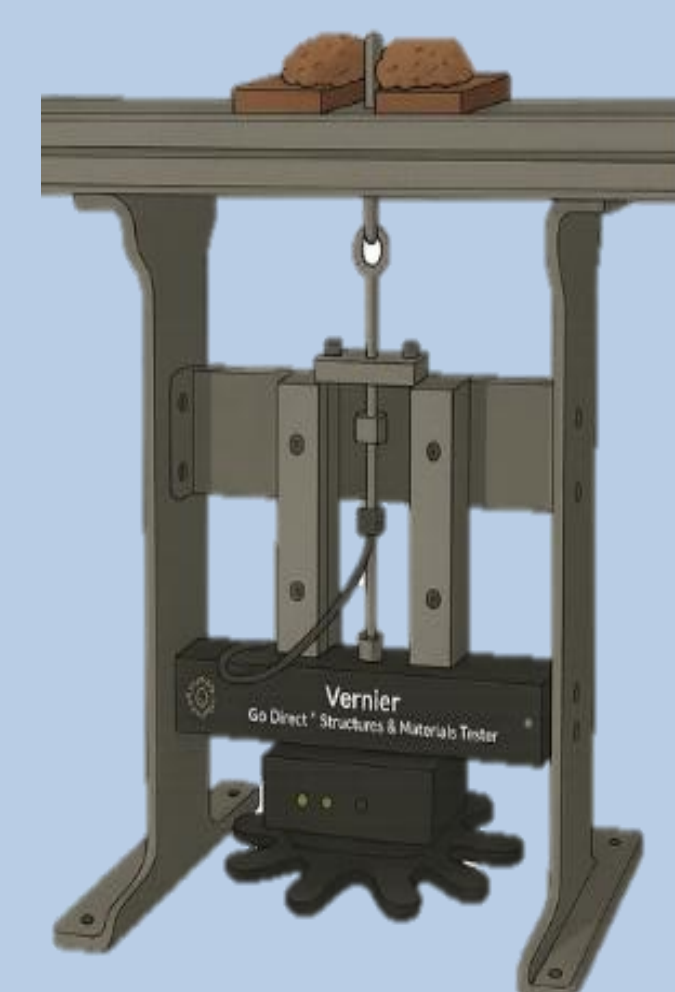
Step 1: Measure Material Orientation



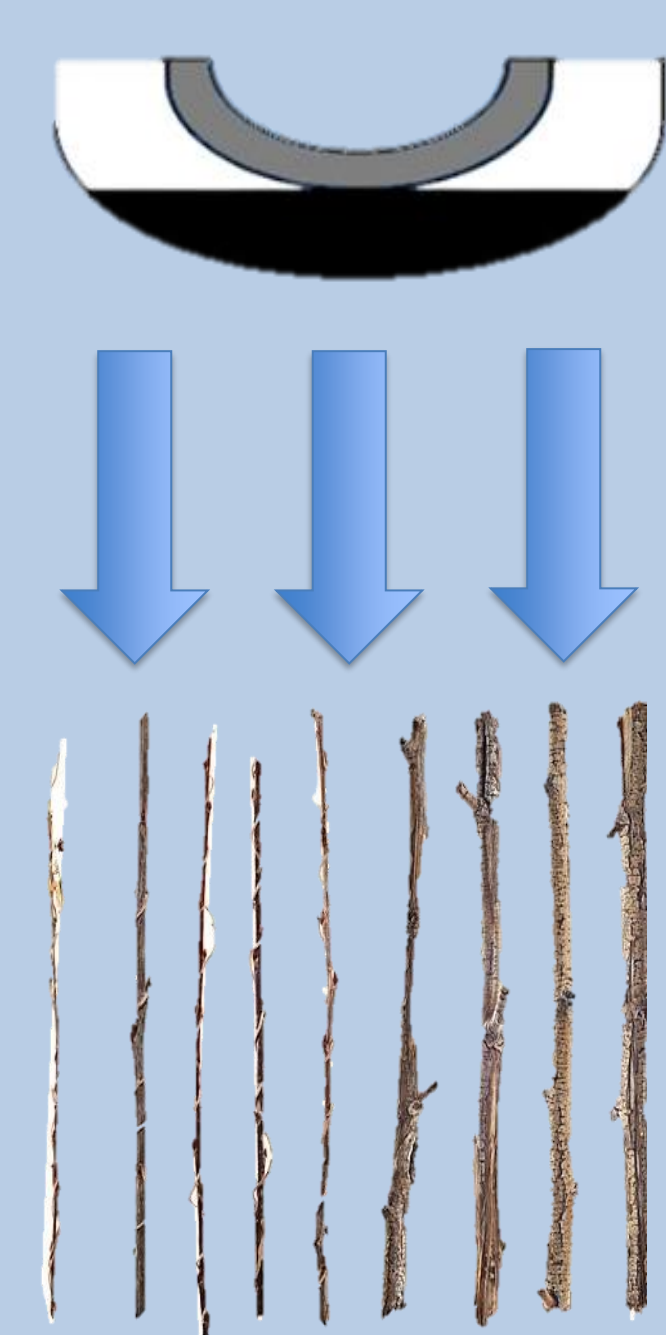
Step 2: Measure Nest Size



Step 2: Measure Nest Strength



Step 3: Identify Material Location and Diameter



Methodology Pictures



Image 3: Image of nest 2. This image was used for measuring the angle of inclination of the materials for nest 2.



Image 4: Image of the apparatus used to replace the u-bolt for nests that were unable to have the u-bolt wrapped around it. This apparatus consists of a string looped over multiple times and the top part of a U-bolt.



Image 4: Image of the Vernier Structure and Materials tester. The nest was on the top, and the U-bolt was wrapped around the nest.

Future Work

- Creating a 3D model to simulate the different characteristics of the bird nest in relation to strength.
- Collecting and analyzing more nests.

References

- Biddle, L. E., Deeming, D. C., & Goodman, A. M. (2018). Birds use structural properties when selecting materials for different parts of their nests. *Journal of Ornithology*, 159(4), 999–1008. <https://doi.org/10.1007/s10336-018-1571-y>
- Sindhu Nachiar, S., Anandh, S., Yegasainathan, N., & Kowsalya, M. (2023). Shape optimization of hanging structure using the concept of biomimics. *Materials Today: Proceedings*, 93, 6–53. <https://doi.org/10.1016/j.matpr.2023.09.164>