Spider Bioadhesives: How the Unique Spreading Pattern of *Cyrtarachne* Spiders' Glue Allows Them to Capture Moths

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INTRODUCTION

Orb-weaving spiders produce upwards of 7 uniques types of silk; each built for its own purpose. The simple looking capture threads are actually composed of distinct types of silk, a silk thread covered in silk glue droplets. These glue droplets are composed of a glycoprotein core, which serves as the adhesive mechanism, and an aqueous solution of salts, which allows the glue to spread. Webs allow spiders to be generalist predators catching a plethora of flying insects, however, moths remain elusive due to the detachable scales on their wings.

Figure 1: Moth Specialist Study Species Cyrtarachne akirai (left) constructs a horizontal web (right) with large glue droplets

Here we study, *Cyrtarachne akirai* which have undergone evolutionary changes that allow them to capture moths in their webs. The glue of *C. akirai* is able to quickly penetrate the scales of moths and attach it to the underlying integument. It also appears to dehydrate during spreading, a unique feature even among spiders. The chemical composition of this glue, and most spider glues, is poorly understood. We hope to shed light on this phenomenon by analyzing the spread glue droplets of *C. akirai.*

OBJECTIVES AND HYPOTHESES

Our objective is to use Raman spectroscopy to analyze the concentration and distribution of salt and glycoproteins spread *Cyrtarachne* glue droplets combine special properties, self curing nature and its rapid spreading ability.

We hypothesize:

- self-curing is caused by the separation of salts and glycoproteins during spreading
- shown as gradients of salts/glycoproteins distribution
- Salts will spread further from the glue droplet center with higher concentrations at glue droplet edges, while glycoproteins do the opposite

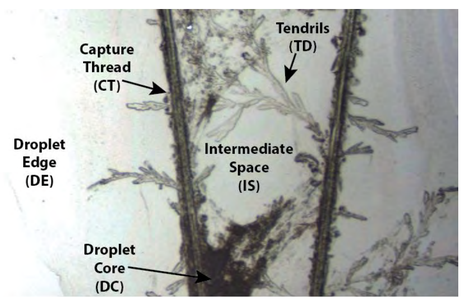

Figure 2: Spread Aggregate Glue droplets show distinct regions. Cyrtarachne akirai have unique features such as the crystal like tendrils.

ACKNOWLEDGEMENTS

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METHODS

Collect *C. akirai* capture threads on CaF_2 crystals (N = 3)

Use Raman Spectroscopy to analyze 5 locations along the glue droplet -- capture thread, core, tendrils, intermediate space, edge

Wash threads with deionized water to separate the soluble components from the insoluble components-- reanalyze both

Determine salt and protein specific peaks and use them to determine relative protein and salt levels in initial pristine samples

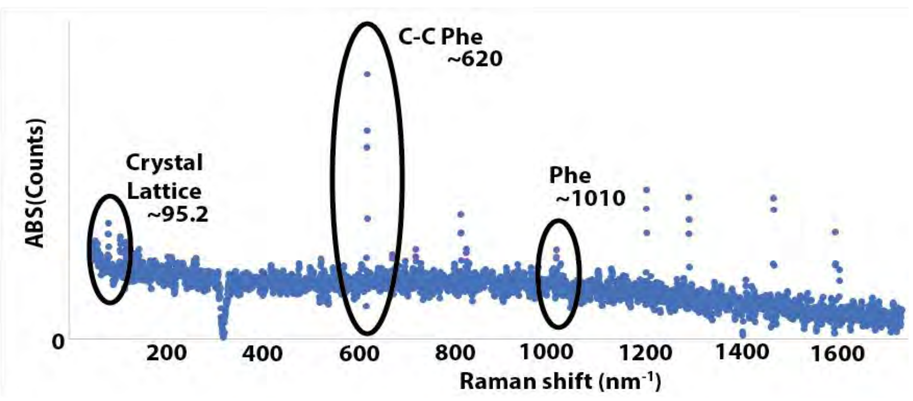


Figure 3: Raman Spectra showing peaks of salt (95.2), common peak (Phenylalanine carbon twist, 620) and protein peak (Phenylalanine, 1010)

RESULTS

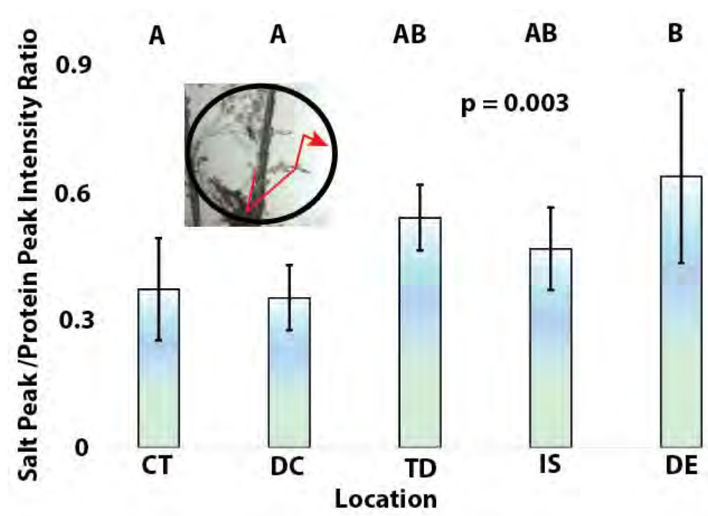
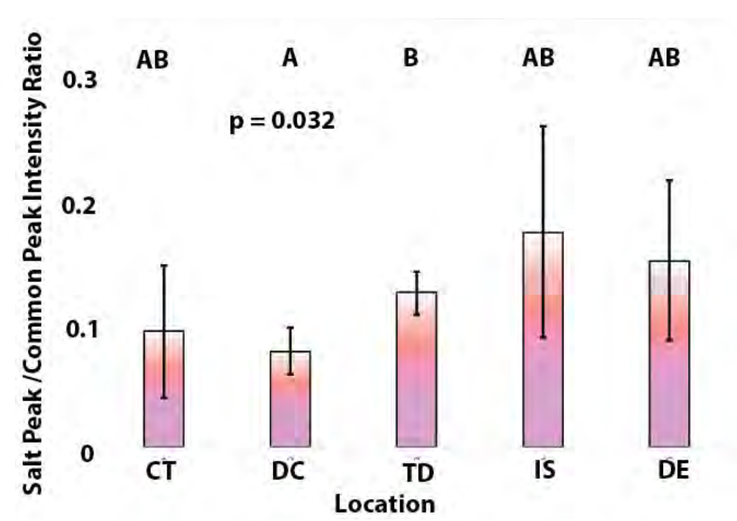


Figure 4: Salt/protein distribution varied across the droplet-- higher relative levels of salt/protein on the droplet edge, modern within the intermediate space, and the least in the center of the droplet. Distribution of protein was not found to be statistically significant.

Thus, the ratio changes due to salt distribution and proteins are heterogeneously distributed as found in a previous paper. Tendrils had the highest level of salt/crystallization. (Letters denote regions which are statistically the same, Tukey HSD)



CONCLUSION

- Glycoprotein components of the glue droplet were homogeneously distributed
- The salt components of the glue droplet were split into two distinct regions, the core/thread and the outside region

REFERENCES

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