Viscoelastic Properties of Byssal Threads of the *Californianus* Mussel

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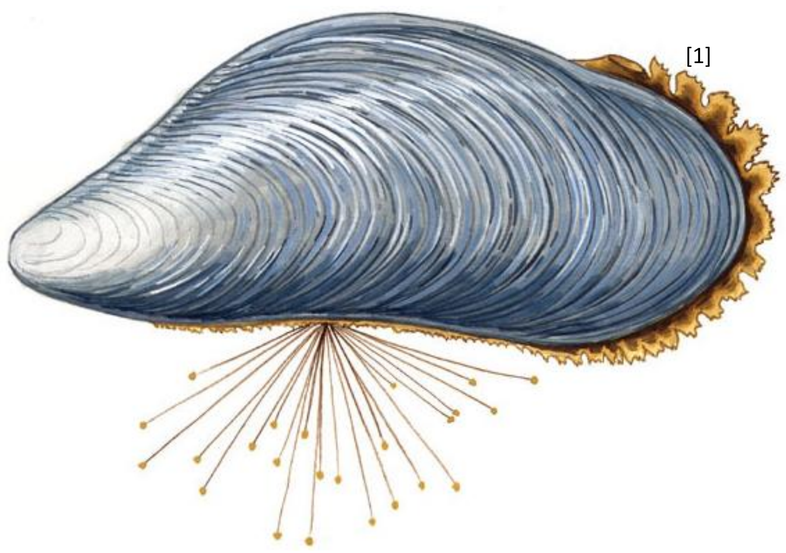
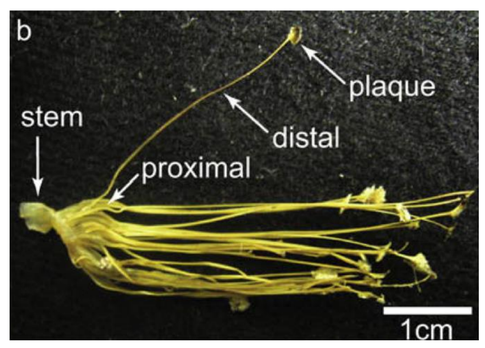
What are byssal threads?

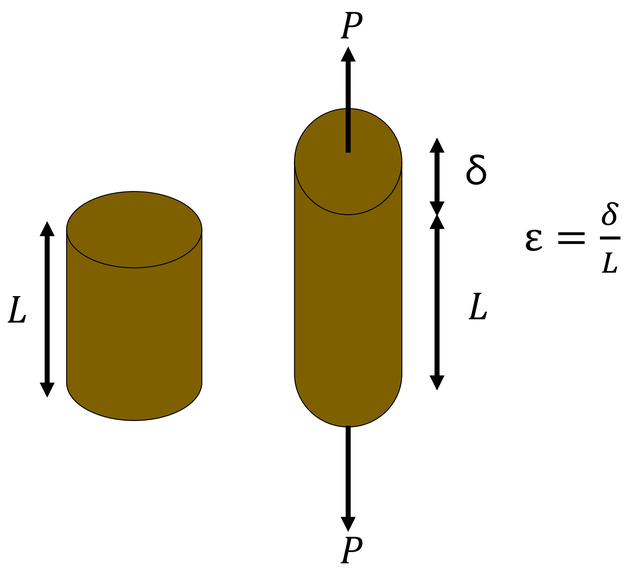
Mytilus *californianus* readily adhere to many types of materials such as rocks, metals, and wood despite hostile environmental conditions in the intertidal zone. The mussel can achieve this through the byssus, a collection of energy dissipative threads and adhesive plaques. In this work we focus in the byssal threads distal region where we seek to understand their viscoelastic properties. Understanding the relaxation properties will further our understanding on the byssal self-repair process, which may lead to better design principles for synthetic materials.





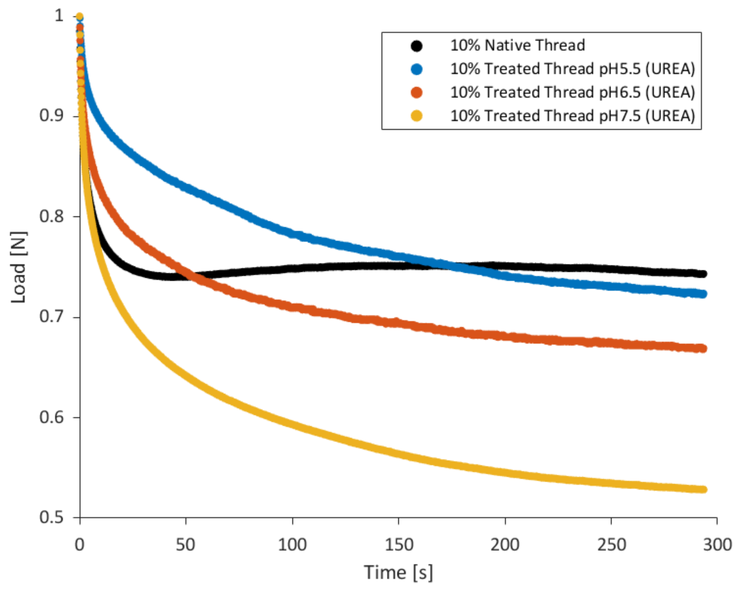
Byssal threads are deposited individually by a process called injection molding

Tensile testing



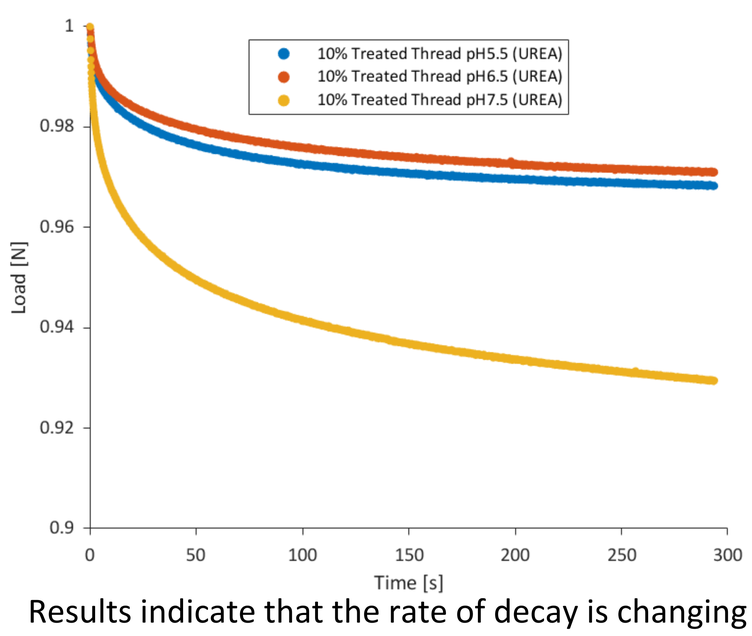
Performed in order to characterize mechanical properties such as elastic modulus and stress relaxation.

Stress relaxation in dry conditions



Results indicate that the rate of decay is changing with different treatments and a few treatments experience the same amount of relaxation.

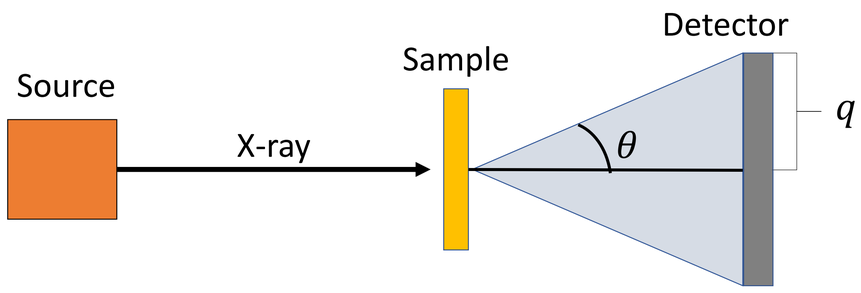
Stress relaxation in wet conditions



Results indicate that the rate of decay is changing with different treatments and relaxation is treatment dependent.

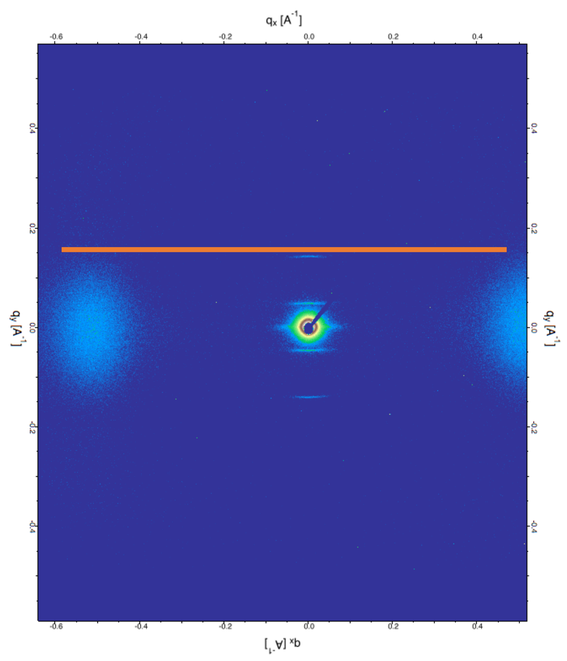
Small Angle X-ray Scattering (SAXS)

Defines molecular spacing

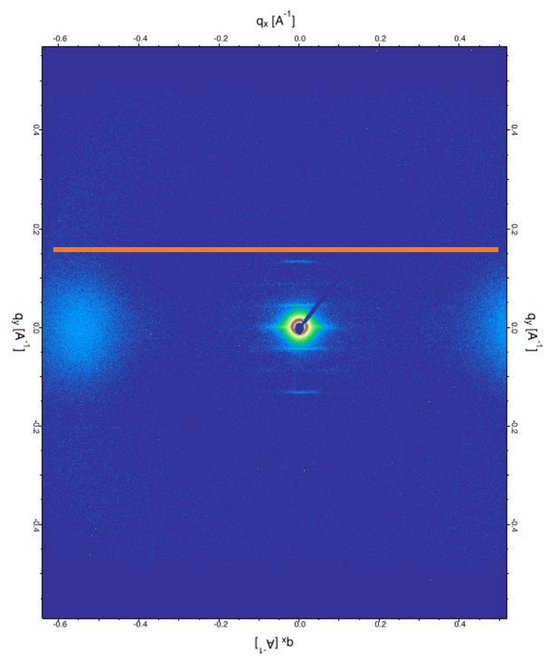


$$D - space = \frac{2\pi}{q}$$

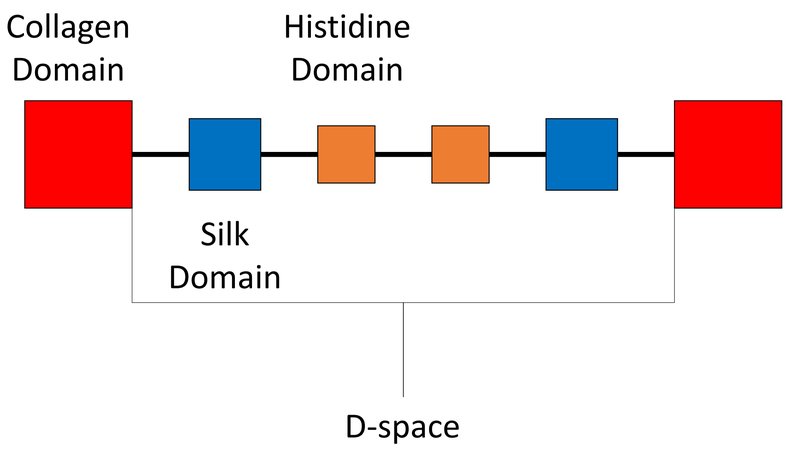
In order to connect bulk material properties, such relaxation %, to the molecular level.



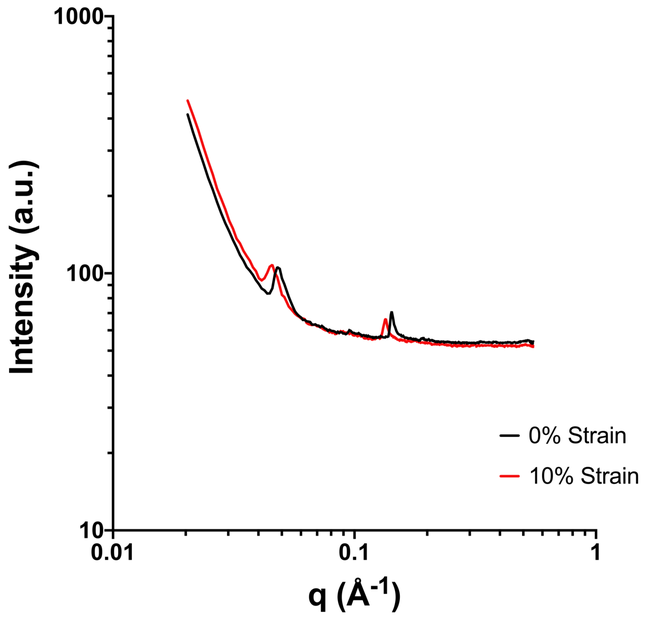
Diffraction pattern - no strain



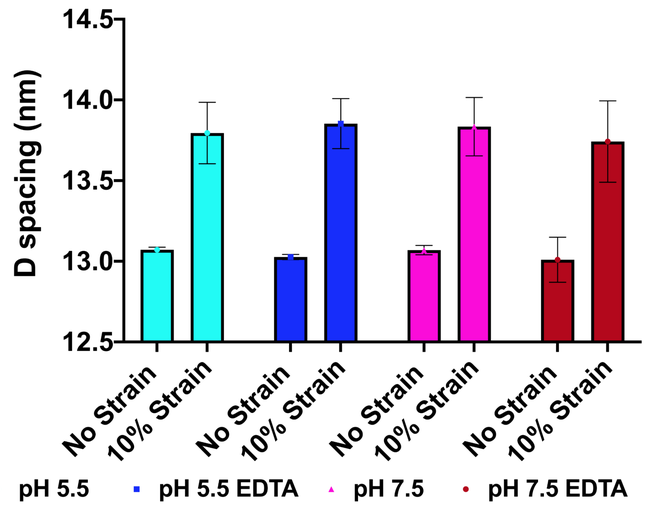
Diffraction pattern - 10% strain



PreCols with clearly defined modules



1D reduction of 2D diffraction patterns



D-space with various treatments

Conclusion

When byssal threads are strained to 10%, the increase in D - space is approximately equal to the bulk strain. We interpret this to mean that the domains flanking the collagen (silk + His-rich) extend at low strains and are responsible for a majority of the stress relaxation.

Acknowledgments

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References

[1] Adapted from *Zagata, C.; C. Young; J. Sountis and M. Kuehl 2008. "Mytilus edulis" (On-line), Animal Diversity Web. Accessed July 07, 2019 at* https://animaldiversity.org/accounts/Mytilus_edulis