Investigation into how archaeological gar scales are affected by water and sea level rise

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Introduction

- Rising sea levels are putting Florida coastal archaeological sites in danger from climate change (Lecher & Watson, 2021).
- Fish scales and spines seem to hold up better when exposed to moisture over time compared to artifacts made from mammal bones or vertebrae (Lecher et al., 2023)
- Testing if degraded gar scales absorb more water when submerged in comparison to pristine scales.
- Measuring the amount of water absorbed in pristine vs. degraded scales that were previously exposed to solutions of various acidity levels.

Methods

- Picked out gar scales 32 of each pristine and degraded
- Premeasured the length and weight of each scale
- Then placed each gar scale into its individual petri dish filled with water. The gar scales soaked for 4 days. After soaking they were weighed again.
- Then created 3 pH solutions of 6, 7, 8
- Filled the periti dishes again with the 3 different pH solutions
- Let the scales soak for over 2 weeks in the pH solutions
- After soaking they dried out for 4 days
- The scales were again measured in weight and length
- Then the petri dishes were filled with water once again for 4 days
- Scales were weighed and the final results were recorded

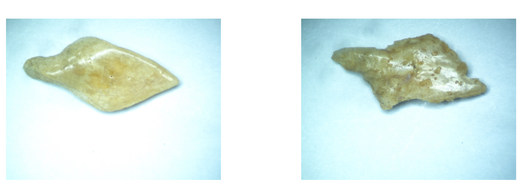

Figure 1: Pristine gar scales (left) show intact ganoid covering with no chipping. Degraded gar scales (right) show chipping and/or dimpling in the ganoid.

Results

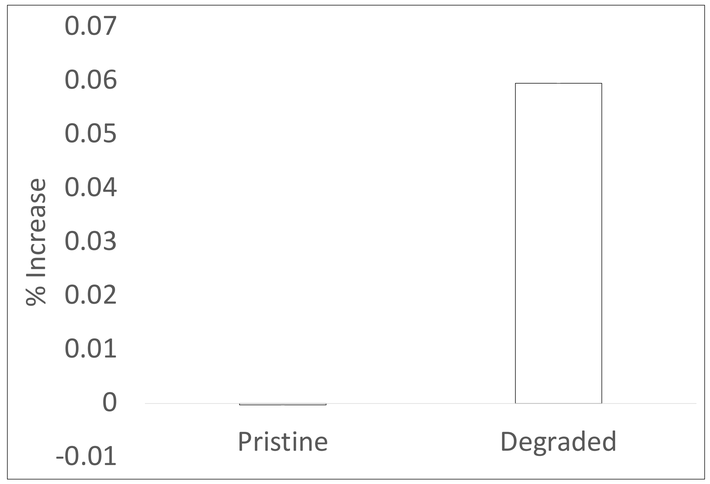

Figure 2: Initial water soak test results. Degraded scales absorbed significantly ($p < 0.05$) more water than pristine scales, indicating degraded scales are more prone to diagenetic effects of water.

- Increased ability to absorb water initially (Figure 2) indicates degraded scales with damage to the outer ganoid layer are more at risk to chemical change caused by water.
- Exposure of degraded scales to buffer of pH 6 caused no meaningful increase in weight or change in ability to absorb water.
- Exposure of degraded scales to buffer of pH 8 caused an increase in the weight of the degraded scales along with an increased ability to retain water, indicating remineralization of the scales that creates more structure with an ability to hold water.
- Exposure of degraded scales to buffer of pH 7 cause the largest increase in weight indicating the largest amount of remineralization. This corresponds with a decrease in amount of water absorbed, indicating the remineralization is so great that pore spaces within the scale have begun to fill in.
- Across the different measurements pristine scales were largely unaffected.
- The project will continue with a buffer of pH 5 group to see if a more acidic pH will cause a reduction in weight as predicted by these results.

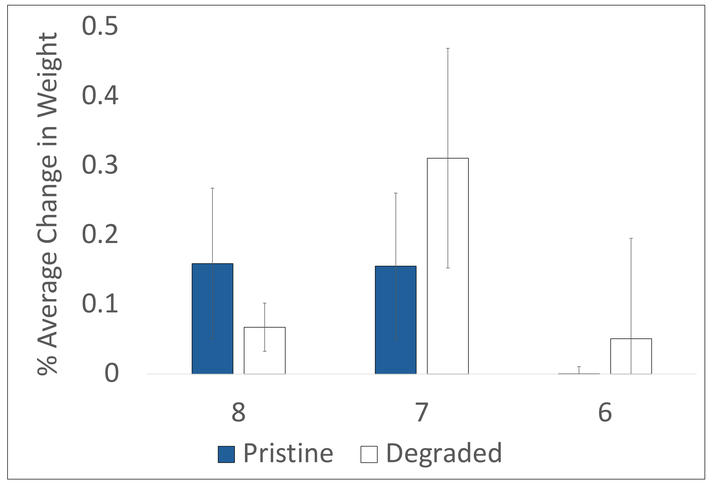

Figure 3: Change in dry weight of scales by pH buffer exposure. Scales exposed to pH 8 and 7 increased in weight on average, indicating remineralization (possibly fossilization) of the scales. Scales exposed to pH 6 experiences no meaningful change in weight.

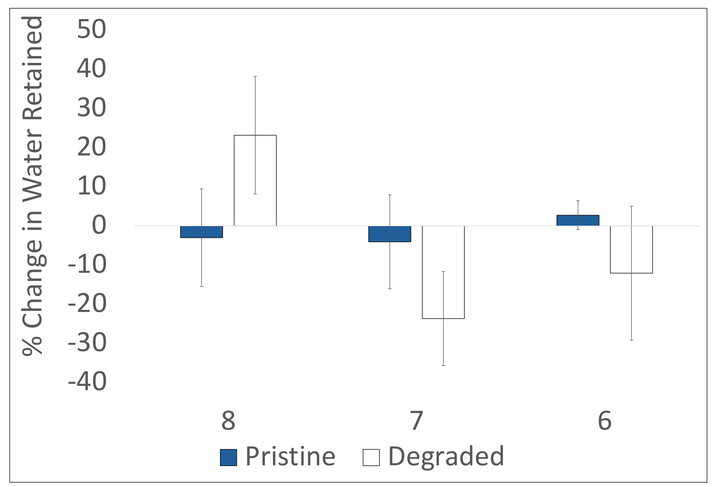

Figure 4: Percent change in ability to absorb water after exposure to different pH buffers. Pristine scales experienced no meaningful change in ability to absorb water, indicating their intact ganoid coating prevents water intrusion and is less susceptible to modification by water. Degraded scales exposed to pH buffer 8 increased in the amount of water retained whereas degraded scales exposed to pH buffer 7 decreased in amount of water retained.

References

Lecher, A. L., & Watson, A. (2021). Danger from beneath: groundwater–sea-level interactions and implications for coastal archaeological sites in the southeast US. Southeastern Archaeology, 40(1), 20–32. https://doi.org/10.1080/0734578x.2021.1874769
Lecher, A. L., Gabriel Acevedo Montalvo, & Watson, A. (2023). Documenting the effects of diagenesis on bone artifacts in coastal Florida through wetting experiments. Southeastern Archaeology, 42(3), 223–232. https://doi.org/10.1080/0734578x.2023.2215103