EduceLab | A DIGITAL RESTORATION INITIATIVE

CHARACTERIZATION OF PLEUROBEMA RUBRUM SHELLS

Angela Wang, Michael J. Detisch, Jillian J. Cramer,
W. Brent Seales, T. John Balk, Katharine G. Napora

University of Kentucky College of Engineering, Florida Atlantic University Department of Anthropology

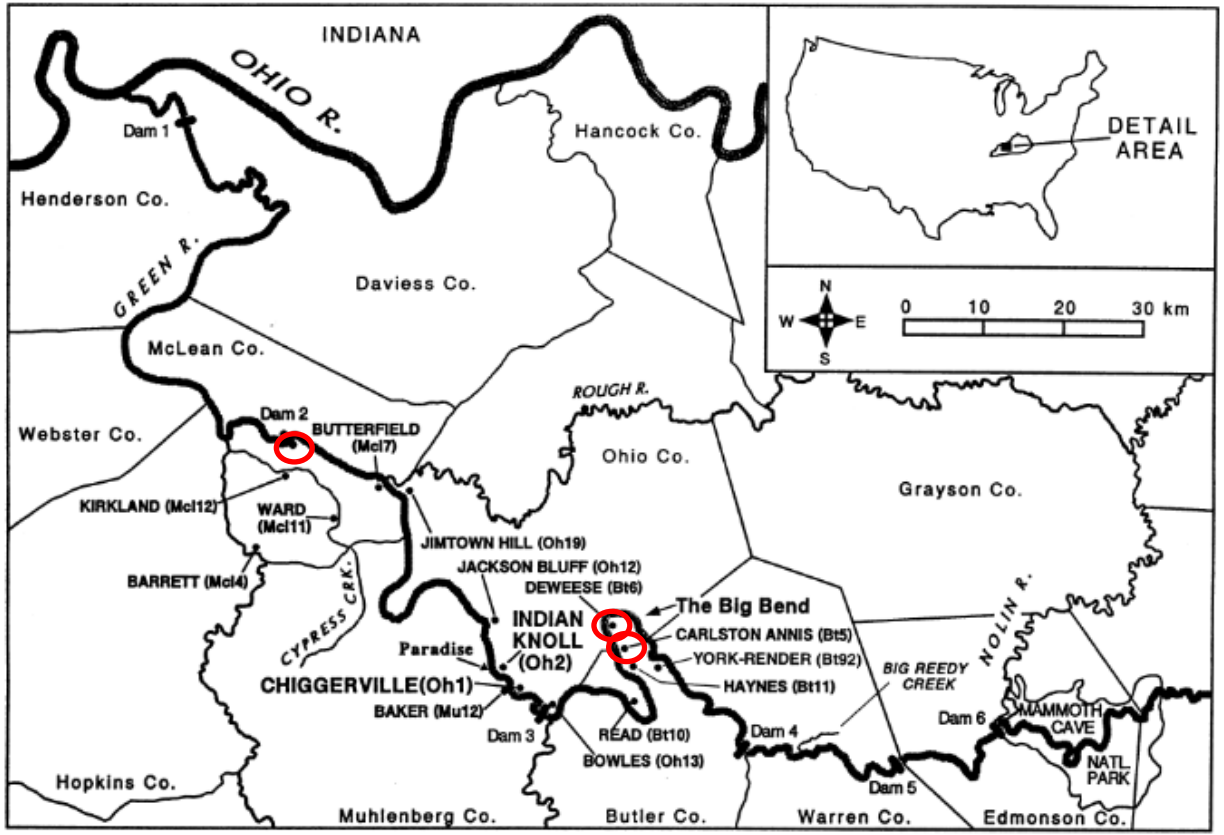
Background

- Mussels produce a band of $CaCO_3$ each year during growth
- The width of bands can be measured to gain insight into climate and weather conditions.
- During production of the $CaCO_3$ crystal structure, other ions in the water may be incorporated into the lattice. This includes heavy metals and transition metals which serve as indicators of rivers conditions.
- To study these effects, several historic and pre-historic specimens of *Pleurobema rubrum* sp. were selected from sites along the Green River in Kentucky.

(Marin, LeRoy, et al. 2012)

Background

- DeWeese Shell Mound
  - Late Archaic (~3000-1000 BC)
- Annis Mound
  - Mississippian (~1100-1450 AD)
- Baber Hotel
  - Historic (1830-1840)



Map of Green River with major archaeological sites, locations of shells circled in red. Retrieved from Morey, Crothers, et al. (Geoarchaeology, 2002).

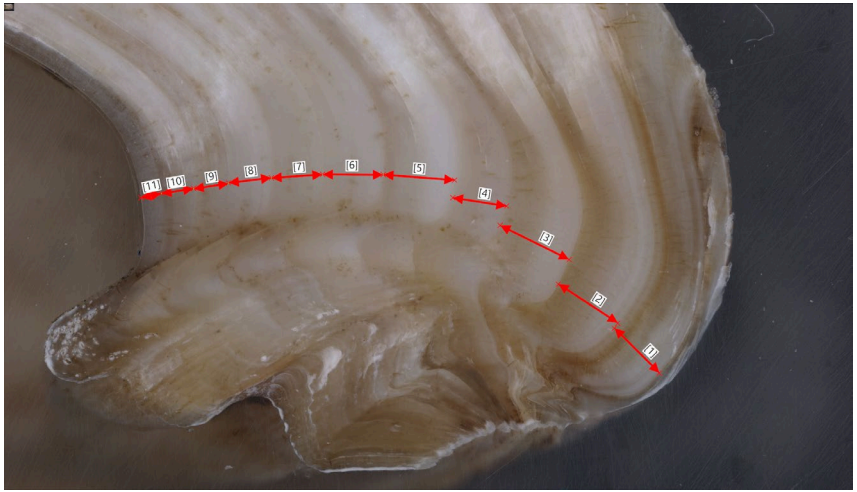
Background

- Annual growth bands
  - Light + dark
- Two layers
  - Nacreous
  - Prismatic

Left: DeWeese shell 1 prismatic layer
Above: Annis shell umbo

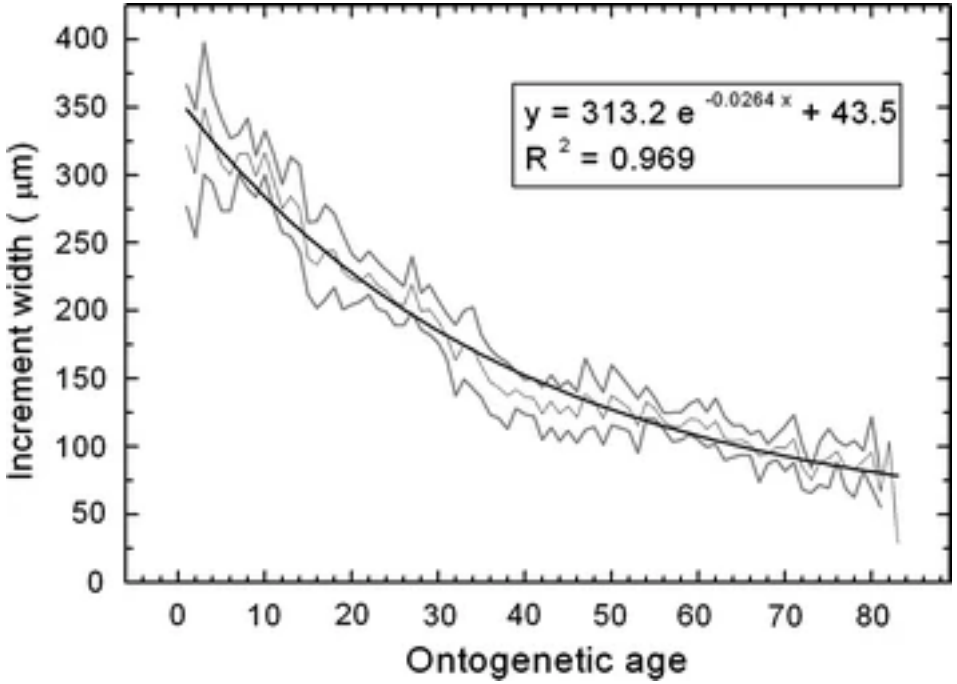
Results

Microscope image of DeWeese shell 2



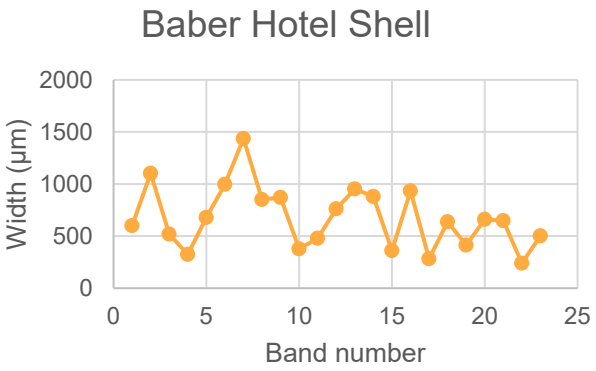
DeWeese shell 2 umbo with measurements

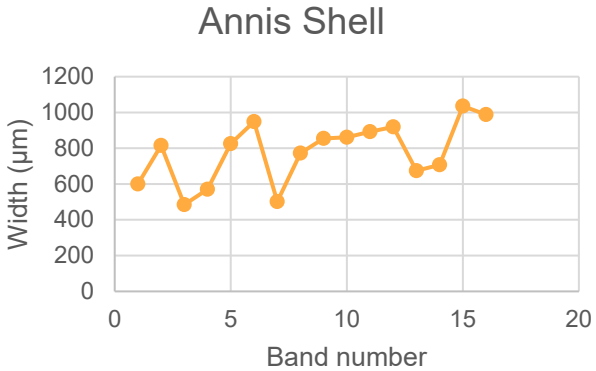
Results

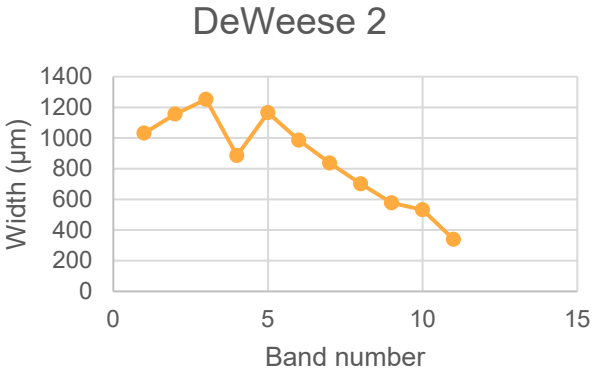


Annual shell growth of *Margaritifera margaritifera* , freshwater pearl mussels. Retrieved from Helama and Nielsen (Journal of Paleolimnology, 2008).

Results



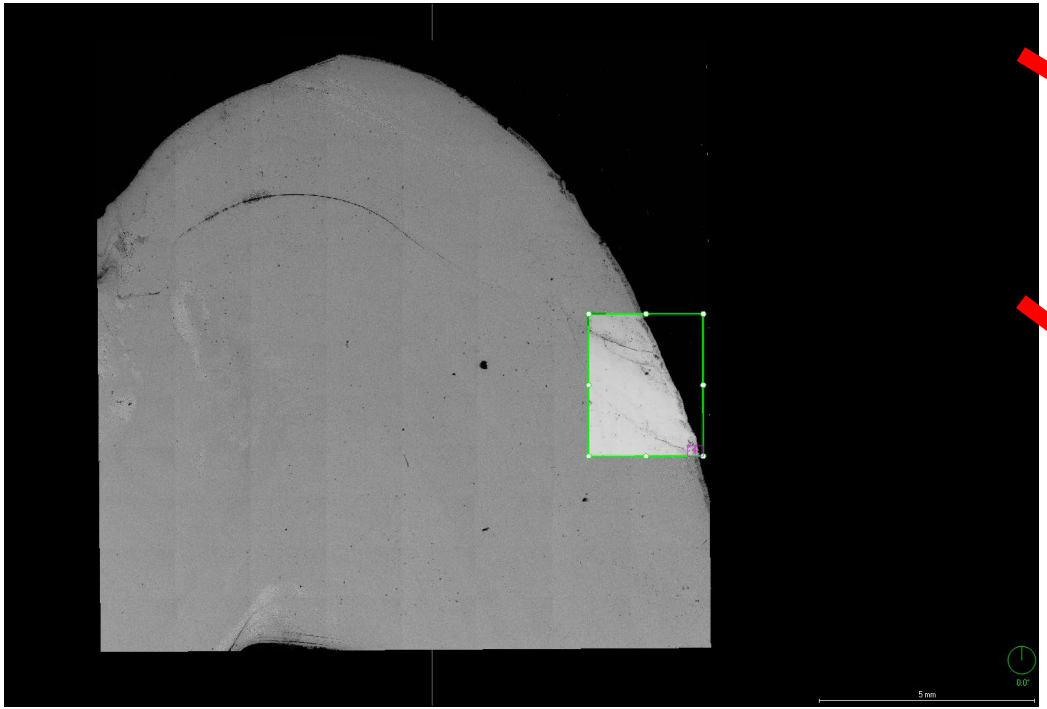


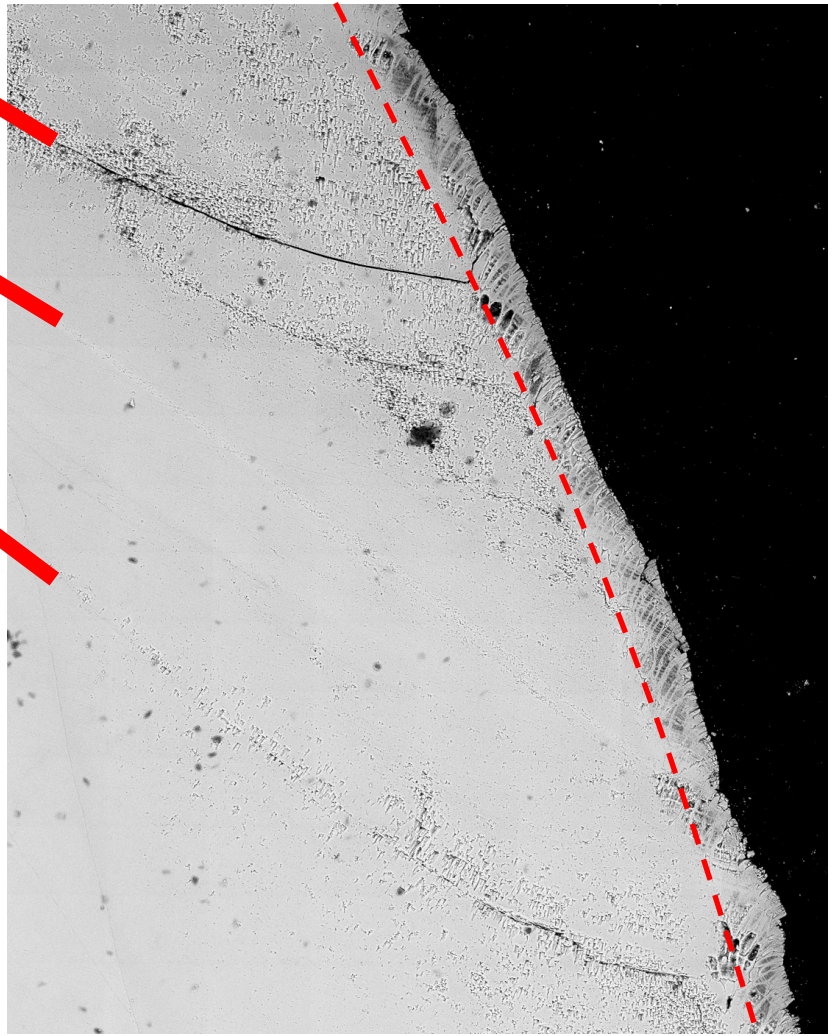


The growth trend of shells should be decreasing however, DeWeese shell 2 is the only one that seems to fit the trend.

All sample shells had shorter lifespans compared to previous graph.

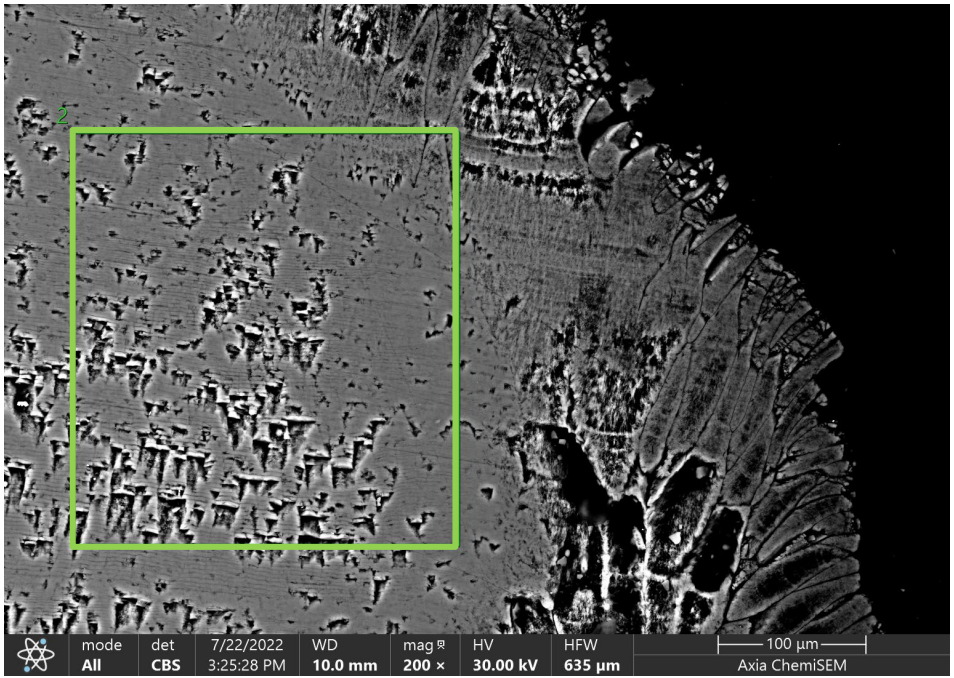
Results



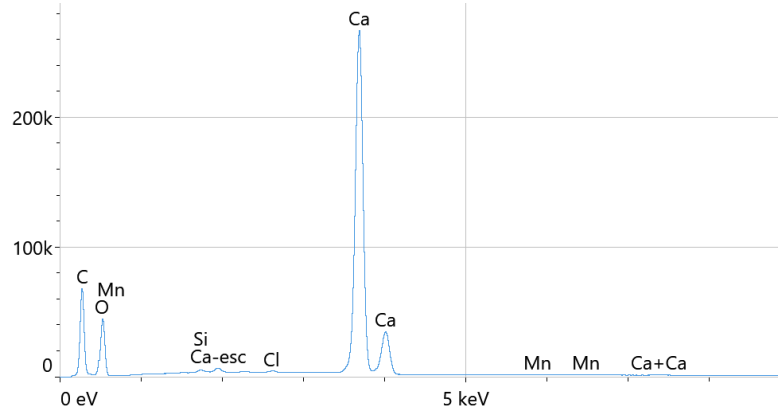


SEM backscatter electron images of Annis shell

Results

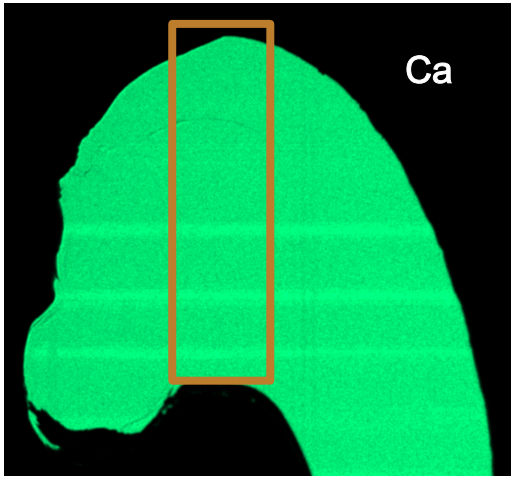


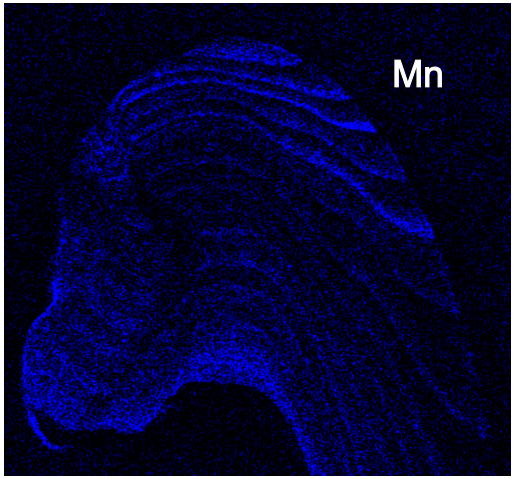
Element	Atomic %	Atomic % Error
C	30.5	0.1
O	52.7	0.3
Si	0.1	0.0
Cl	0.1	0.0
Ca	16.6	0.1
Mn	0.0	0.0

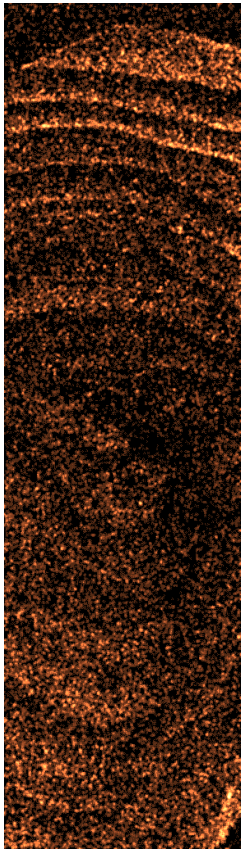


SEM backscatter electron image of Annis shell

Results







Above: Optical image of Annis shell
Right: XRF images of Annis shell

Conclusion

- Historic and prehistoric shells were identified and prepared for cross-sectional analysis using optical and electron microscopy for annual growth band width measurements.
- Expected downward trend in band width was overshadowed by yearly growth variations, likely due to the shorter life-span of these mussels.

Conclusion

- Elemental analysis was performed via EDS and scanning micro - XRF.
- The majority of shell was $CaCO_3$. Trace levels of Mn were also found which varied between growth bands and within a single band.
- Mn concentration in the $CaCO_3$ structure has been shown to correlate with an increase in biological or organic material in the water habitat as well as decreased shell growth rates in winter.

(Siegele, Orlic et al. 2001)
(Langlet, Alleman et al. 2007)

References

Claasen, C. P. (2005). Analytical study of shellfish from the DeWeese Mound, Kentucky. *Archaeology of the Middle Green River Region*.

Dunca , E., Schöne, B. R., & Mutvei , H. (2005). Freshwater bivalves tell of past climates: But how clearly do shells from polluted rivers speak? *Palaeogeography , Palaeoclimatology, Palaeoecology , 228*(1), 43-57. doi:https ://doi.org/10.1016/j.palaeo.2005.03.050

Helama , S., & Nielsen, J. K. (2008). Construction of statistically reliable sclerochronology using subfossil shells of river pearl mussel. *Journal of Paleolimnology, 40* (1), 247-261. doi:10.1007/s10933 -007-9155-5

Langlet, D., et al. (2007). "Manganese content records seasonal upwelling in Lake Tanganyika mussels." Biogeosciences 4(2): 195-203.

Marin, F., Le Roy, N., & Marie, B. (2012). The formation and mineralization of mollusk shell. *Frontiers in bioscience (Scholar edition*), 4(3), 1099–1125. https://doi.org/10.2741/s321

References

Morey, D. F., Crothers, G. M., Stein, J. K., Fenton, J. P., & Herrmann, N. P. (2002). The fluvial and geomorphic context of Indian Knoll, an Archaic shell midden in West-Central Kentucky. *Geoarchaeology, 17* (6), 521-553. doi:https ://doi.org/10.1002/gea.10027

Sandefur , T. A., et al. (2008). *From Tavern to Hotel: Archaeology of the Baber Hotel (15McL137), a 19th Century Hotel on the Green River in McLean County, Kentucky.*

Siegele, R., Orlic, I., Cohen, D. D., Markich , S. J., & Jeffree, R. A. (2001). Manganese profiles in freshwater mussel shells. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 181* (1), 593-597. doi:https ://doi.org/10.1016/S0168 -583X(01)00528-6

QUESTIONS?

EduceLab is a 2021 National Science Foundation Mid -Scale Research Infrastructure Project: Award Number 2131940