Exploring Early Colonial Foodways and Animal Husbandry Practices Through Zooarchaeology by Mass Spectrometry (ZooMS): Preliminary Results

Keri Burge
University of Tennessee, Knoxville

Introduction

Coan Hall

The site of Coan Hall (44NB11) in Northumberland County, Virginia, identified by Stephen Potter in the 1960s and excavated by the University of Tennessee, Knoxville since 2011, offers insight into both indigenous and early colonial life in Virginia.

The land on which Coan Hall sat once belonged to the Sekakawon but later became the plantation and manor home of John Mottrom, a county justice and member of the House of Burgesses in 1643. After his death in 1655, it remained under Mottrom care for three more generations until disappearing from the landscape in the early 18th century.[1]

Overall, archaeological assemblages can vary greatly in their state of faunal preservation and fragmentation. While some bones are well-preserved and easily identifiable, others are not. As seen by the specimens, below many fragments from the earliest layer of the site (pre-1680) are morphologically unidentifiable beyond "indeterminate mammal."

Zooarchaeology by Mass Spectrometry (ZooMS):

ZooMS uses collagen peptide fingerprinting in order to analyze ambiguous archaeofaunal remains. Since collagen is relatively resistant to diagenetic alteration, ZooMS can provide analyses for materials that are thousands of years old. By specifically digesting collagen with trypsin, constituent peptides can be measured with mass spectrometry and then compared to reference data in order to determine taxonomic identification.[2,3]

Goal: To use ZooMS to more precisely identify nine specimens from the earliest levels of the Coan Hall site (pre-1680) that are morphologically unidentifiable beyond "indeterminate mammal."

1. Heath, Barbara J., Pogue D.J., and Eric G. Schweickart, E.G. (2017). The Architecture of John Mottrom's Coan Hall." The Bulletin of the Northumberland County Historical Society, vol. LIV, p. 5–18.
2. Harvey, V., LeFebvre, M., deFrance, S., Toftgaard, C., Drosou, K., Kitchener, A., & Buckley, M. (2019). Preserved collagen reveals species identity in archaeological marine turtle bones from Caribbean and Florida sites. Royal Society Open Science, 6(10), 191137–191137. https://doi.org/10.1098/rsos.191137
3. Korzow Richter, K., McGrath, K., Masson-MacLean, E., Hickinbotham, S., Tedder, A., Britton, K., Bottomley, Z., Dobney, K., Hulme-Beaman, A., Zona, M., Fischer, R., Collins, M., & Speller, C. (2020). What's the catch? Archaeological application of rapid collagen-based species identification for Pacific Salmon. Journal of Archaeological Science, 116, 105116–. https://doi.org/10.1016/j.jas.2020.105116
4. Buckley, M., Collins, M., Thomas-Oates, J., & Wilson, J. C. (2009). Species identification by analysis of bone collagen using matrix-assisted laser desorption/ionisation time-of-flight mass spectrometry. Rapid Communications in Mass Spectrometry: RCM, 23(23), 3843–3854. https://doi.org/10.1002/rcm.4316

Methods

1. Weigh out 15-20 mg of bone powder into a microcentrifuge tube
2. Acid demineralization with 0.6 M HCl
3. Gelatinization
4. Digest with trypsin overnight; stop digestion with TFA
5. Use C18-ZipTipping to purify peptides with a conditioning and wash solution
6. Analyze collagen digests with matrix-assisted laser desorption/ionization mass spectrometry (MALDI-MS).
7. Use reference data to indicate particular peptide markers on the spectra in order to determine taxonomic identification.

Followed protocol as described by Buckley et al. 2009.[4]

Figures

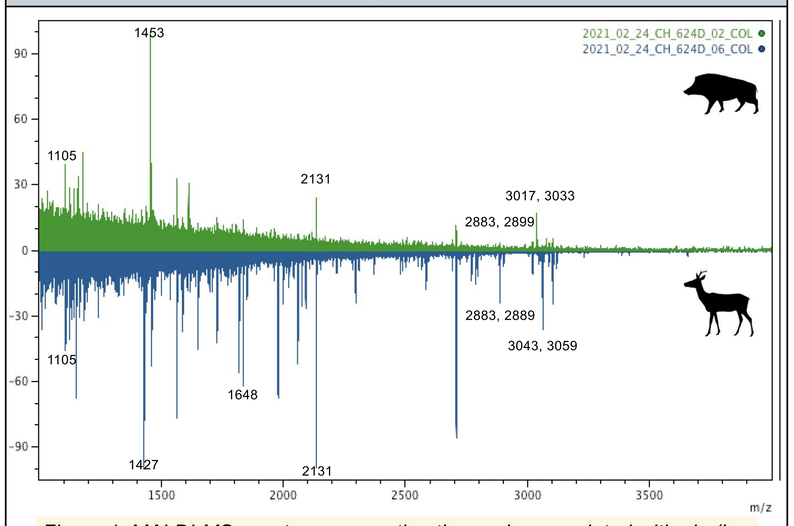

Figure 1: MALDI-MS spectra representing the peaks associated with pig (in green) and deer (in blue); mass to charge ratio is measured on the x-axis and relative abundance on the y-axis.

Results

After ZooMS, six specimens were concluded to be deer and one pig (Table 1). Specimen 1 did not produce a viable spectra and could not be further identified. While specimen 5 did produce a clear spectra, peaks did not match with current reference data. This specimen could possibly be a bird or fish, but there is not enough reference data to make a comparison yet.

Spec.	Morph ID	ZooMS ID
1	Mammal	*Fail*
2	Mammal	Pig
3	Mammal	Deer
4	Mammal	Deer
5	Mammal	Animal indet.
6	Mammal	Deer
7	Mammal	Deer
8	Mammal	Deer
9	Mammal	Deer

Table 1: Morphological and ZooMS IDs of each specimen

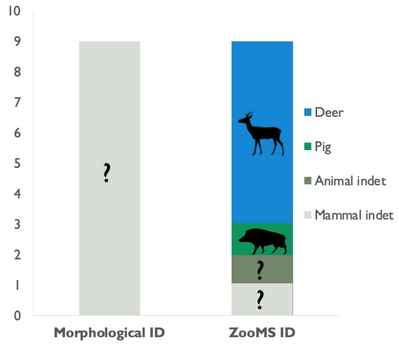

Figure 2: Graphical comparison of Morphological and ZooMS IDs

Conclusion

Overall, these results demonstrate that ZooMS is a beneficial technique that can gather valuable information from archaeological specimens that are often never analyzed due to their ambiguous nature.

Site specifically, these identifications also highlight the importance of hunting wild animals (deer) in the earliest occupations of the site. When Mottrom and his companions first arrived, they had yet to establish solid foundations in agriculture, causing them to rely on wild food sources, such as deer. However, it is important to note that the nine specimens analyzed may not be representative of all fragments from this early context. There is a possibility that all six deer fragments are from the same individual. Nevertheless, the use of ZooMS has allowed for a more detailed understanding of this early context at Coan Hall.

Next Steps: Stable Isotope Analysis

Both carbon and nitrogen stable isotope analysis will be performed on the nine specimens analyzed as well as other faunal remains and charred seeds pre-dating 1680 and post-dating 1720 from Coan Hall in order to address the following questions:

1. How did residents and workers at Coan Hall manage both agriculture and their domestic animals?
2. How did agricultural and animal management practices change over time (e.g. in response to soil exhaustion over the duration of occupation)?

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