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An assessment of aging systems in zooarchaeology

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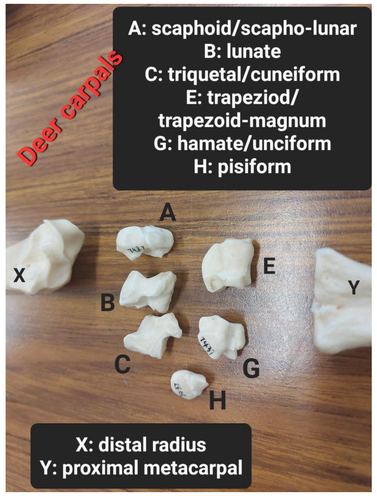
The importance of aging in zooarchaeology

Zooarchaeology is the study of animal remains at archaeological sites. There is a lot we can learn about people from the animals near them. Faunal remains can indicate hunting patterns, animal husbandry, and wealth distribution. The age-at-death of the animals is important, because it helps determine whether animals were domesticated; in a population of domestic animals kept for meat, there will usually be a lot of young animals that are killed, especially males. Also, aging can highlight seasonal feasts by revealing times of year where more animals were killed. Many aging methods in zooarchaeology are from the 1970s-80s, and have not been replaced by any newer science. The aim of this internship was to assess whether these methods are scientifically sound, or if they should be retired.

Identifying bones



A diagram of deer carpals that I made to help myself learn the different bones

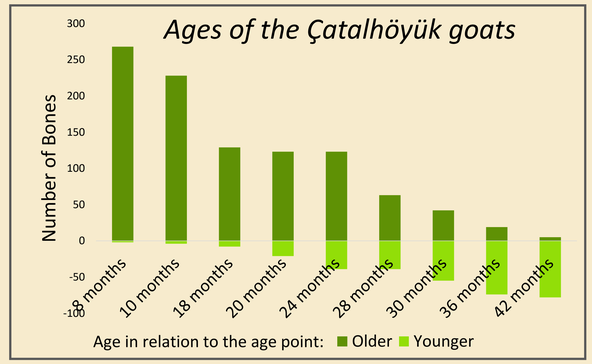
The beginning of my internship was spent learning all of the bones in the body, focusing on mammals. Despite looking very different, most mammals have the same bones. The area with the most variation is the feet, with animals having anywhere from one to five toes. Not all mammals have clavicles, and some species have lost their fibulas.

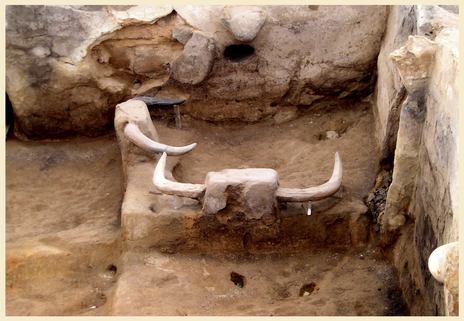
I used UVic's zooarchaeology teaching collection to get acquainted with the skeleton. As many bones found in archaeological assemblages are broken, I also practiced identifying broken bones. I compared the broken fragments to the set of complete deer bones and the articulated deer skeleton that UVic has. I completed this section by doing the practical exam from the Zooarchaeology course (ANTH 360), in which I had to identify 25 bones with only 30 seconds for each.

Replicating the aging of goats from Çatalhöyük

To exercise my new knowledge of aging methods and the general principles of zooarchaeology, I attempted to replicate the aging done on goats found at an archaeological site named Çatalhöyük in Turkey. I found that even though I used the same aging system (Silver, 1969) as the original authors of the dataset (Orton et al., 2013), the ages I produced were somewhat different. This is likely because I couldn't see the bones in person, and so couldn't adjust the ages based on the bones' size, shape or texture. This is evidence that although online datasets are much more accessible than collections of physical bones, sometimes studies are not replicable without the nuance that comes from seeing the bones themselves.

The Çatalhöyük section of my project also highlighted the importance of making terminology clear for people in the future. The problems I had with fusion zones and undefined age categories could have been eliminated if the original researchers clarified what they were talking about. The meaning of something might seem obvious to the author in the moment, but language changes quickly and if variables and terms are not explicitly defined, future researchers can find themselves unable to understand their most valuable resources.





The archaeological site of Çatalhöyük (Verity Cridland, 2008, *CatalHoyuk*)

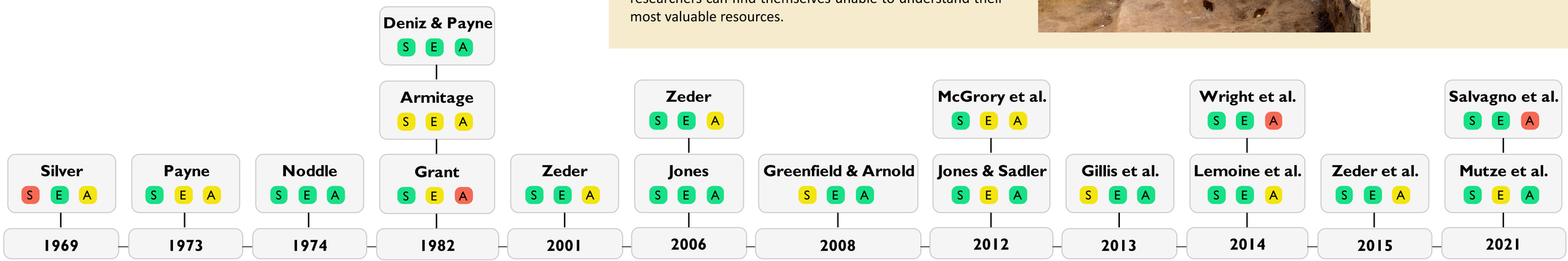
Legend

S Sample
How well is it defined? Is the system applicable to other populations?

E Ease of use
Is it simple? Does it use common body parts?

A Accuracy
How certain are the estimates for calendar ages?

Good
Fair
Poor



The qualities of various aging systems

(Thanks to Nat Weiland for this graphic)

Assessing zooarchaeological aging systems

The two main zooarchaeological aging methods are tooth eruption and wear, and epiphyseal fusion. The timing of animals' tooth eruption is largely genetically determined; how fast their teeth wear down depends on both genetics and diet. There are epiphyses, also called growth plates, at the end of animals' long bones. When the animal is young, these are separate bones held onto the main bones by cartilage. As the animal matures, the epiphyses fuse onto the main bones.

There are a number of factors which make it difficult to accurately age animals' remains. One is that there is always going to be some variation in how quickly animals mature, based on their breed, the climate they live in, what they eat, any diseases they have, and random genetics. Another problem is that the bones of young animals are smaller, more fragile, and less likely to survive taphonomic processes, which are things like being saturated with water or weathered by the wind. This means that kill-off profiles are often biased towards showing a larger number of mature animals. It is not usually possible to determine animals' ages to the exact month or year. However, in archaeology, knowing even relative ages such as "young", "mature", and "old" is useful in creating and interpreting kill-off patterns. Specificity to the year is often unnecessary.

Some aging methods are subjective, meaning that two people could produce different ages for the same specimen. For example, one method depends on which diagram someone thinks teeth look more like (Grant, 1982). Many studies try to draw conclusive results from a sample size which is small or is missing animals from certain age groups; these studies are not necessarily reliable for an entire species. One reason that aging methods from 40 or 50 years ago are still used is that it's easier for researchers to use a system well if they already understand it, rather than learning a new one and making a lot of mistakes in their work. It is also important for age profiles from different sites to be comparable. And for sites where the original bones or data are lost or inaccessible, people might have to use the same aging system on the second site in order to compare the age profiles.

With these things in mind, I evaluated the most influential aging methods for pigs, goats, sheep, and cows, which are some of the main domesticates from the Eastern Hemisphere. Summaries of the quality of each system are found in the timeline below.

Future research in zooarchaeological aging

More studies need to be done on animals of known age. For tooth data, ideally a population would be followed from birth to death, with the state of its teeth being recorded every few months, similar to the study done by Deniz and Payne (1982). For fusion data, there is a lack of samples which have older animals, because livestock are often slaughtered before they reach their full life expectancy. It would be beneficial to find a population of older animals, perhaps pets that lived until a natural death, to study their bone fusion. The barrier to these things being done is the time and money it requires to take care of live animals and to obtain animals' remains. Without sufficient funding, these studies cannot be carried out.

References

Armitage, P. (1982). A system for aging and sexing the horn cores of cattle from British post-medieval sites (with special reference to unimproved British longhorn cattle). In B. Wilson, C. Grigson, & S. Payne (Eds.), Ageing and sexing animal bones from archaeological sites (Vol. 109, Ser. British Series, pp. 37–54). essay, BAR.

Deniz, E., & Payne, S. (1982). Eruption and wear in the mandibular dentition as a guide to ageing Turkish Angora goats. In B. Wilson, C. Grigson, & S. Payne (Eds.), Ageing and sexing animal bones from archaeological sites (Vol. 109, Ser. British Series, pp. 155–206). essay, BAR.

Gillis, R., Arbogast, R. M., Pinsinge, J. F., Debue, K., & Vigne, J. D. (2013). Prediction models for age-at-death estimates for calves, using unfused epiphyses and diaphyses. International Journal of Osteoarchaeology, 25(6), 912–922. https://doi.org/10.1002/oa.2377

Grant, A., (1982). The use of tooth wear as a guide to the age of domestic ungulates. In B. Wilson, C. Grigson, & S. Payne (Eds.), Ageing and sexing animal bones from archaeological sites (Vol. 109, Ser. British Series, pp. 91–108). essay, BAR.

Greenfield, H. J., & Arnold, E. R. (2008). Absolute age and tooth eruption and wear sequences in sheep and goat: Determining age-at-death in zooarchaeology using a modern control sample. Journal of Archaeological Science, 35(4), 836–849. https://doi.org/10.1016/j.jas.2007.06.003

Jones, G. G., & Sadler, P. (2012). Age at death in cattle: Methods, older cattle and known-age reference material. Environmental Archaeology, 17(1), 11–28. https://doi.org/10.1179/1461410312z.0000000002

Jones, G. G. (2006). Tooth eruption and wear observed in live sheep from Butser Hill, the Cotswold Farm Park and five farms in the Pentland Hills, UK. In D. Ruscillo (Ed.), Recent Advances in Ageing and Sexing Animal Bones (pp. 155–178). essay, Oxbow Books.

Lemoine X., Zeder, M. A., Bishop, K. J., & Rufolo, S. J. (2014). A new system for computing dentition-based age profiles in Sus scrofa. Journal of Archaeological Science, 47, 179–193. https://doi.org/10.1016/j.jas.2014.04.002

McGrory, S., Svensson, E. M., Götherström, A., Mulville, J., Powell, A. J., Collins, M. J., & O'Connor, T. P. (2012). A novel method for integrated age and sex determination from archaeological cattle mandibles. Journal of Archaeological Science, 39(10), 3324–3330. https://doi.org/10.1016/j.jas.2012.05.021

Mutze, U. R., Mutze, U., Jones, G. G., & Peters, J. (2021). Wear of Teeth in Sheep (WoTiS) - A tool for determining the rate of mandibular tooth wear in sheep. Journal of Archaeological Science, 136. https://doi.org/10.1016/j.jas.2020.105300

Noddle, B. (1974). Ages of epiphyseal closure in feral and domestic goats and ages of dental eruption. Journal of Archaeological Science, (1), 195–204. https://doi.org/10.1016/0305-4403(74)90042-9

Orton D., Russell N., Twiss K., Martin L., Frame, S. (Eds.). "Çatalhöyük Zooarchaeology". (2013) Released: 2013-02-13. Open Context. <http://opencontext.org/projects/18426F7C-99EC-4322-4069-E8DBD927CCF1> ARK (Archive): https://n2t.net/ark:/28722/k2f47jz2k

Payne, S. (1973). Kill-off patterns in sheep and goats: The mandibles from Asvan Kale. Anatolian Studies, 23, 281–303. https://doi.org/10.2307/3642547

Salvagno, L., Fraser, T., Grau-Sologestoa, I., & Albarella, U. (2021). A method to assess wear rate in pig teeth from archaeological sites. Journal of Archaeological Science, 127. https://doi.org/10.1016/j.jas.2021.105331

Silver, I. A. (1969). The ageing of domestic animals. In D. R. Brothwell & E. Higgs (Eds.), Science in archaeology: A comprehensive survey of progress and research (pp. 283–302), Thames and Hudson, Britain.

Wright, E., Viner-Daniels, S., Parker Pearson, M., & Albarella, U. (2014). Age and season of pig slaughter at late Neolithic Durrington Walls (Wiltshire, UK) as detected through a new system for recording tooth wear. Journal of Archaeological Science, 52, 497–514. https://doi.org/10.1016/j.jas.2014.09.009

Zeder, M.A. (2001). A metrical analysis of a collection of modern goats (Capra hircus aegargus and C. h. hircus) from Iran and Iraq: Implications for the study of caprine domestication. Journal of Archaeological Science, 28(1), 61–79. https://doi.org/10.1006/jasc.1999.0555

Zeder, M. A. (2006). Reconciling rates of long bone fusion and tooth eruption and wear in sheep (Ovis) and goat (Capra). In D. Ruscillo (Ed.), Recent Advances in Ageing and Sexing Animal Bones (pp. 87–118). essay, Oxbow Books.

Zeder, M.A., Lemoine, X., & Payne, S. (2015). A new system for computing long-bone fusion age profiles in Sus scrofa. Journal of Archaeological Science, 55, 135–150. https://doi.org/10.1016/j.jas.2014.12.017