# Zooarcheology: animals talk, just to complete the story

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**Abstract:** Zooarcheology is a Frankenstein hybrid, born from the ribs of a myriad of disciplines. Its research focuses on animal remains from archeological contexts under an anthropological perspective with the primary and ultimate object of gaining information about human behavior. It has been, and often still is, considered a subdiscipline of archeology. And yet, it has the potential to greatly contribute to the advancement of knowledge in archeology. By using a variety of analytical methods, it provides independent lines of complementary scientific evidence from archeofaunal, geological, and sedimentary archives. It can yield detailed information on the environments in which past peoples lived, as well as on the intensity of human impacts on landscapes, on past human diets and on their evolution through time. It can also provide insights into the nature of the social organization of the people. All this reveals zooarcheology in a role that has not often been recognized.

## 1. Introduction

Since 1950, when they were virtually inexistent, zooarcheologists have been growing worldwide paralleling researchers who were specializing in the fields of lithic and ceramic analysis (Zeder 1997). From earlier times, when archeologists merely provided lists of the species unearthed from the sites they were excavating, often with little more than "rare," "common," or some other quantitative estimates noted, zooarcheology has become a discipline taught in a number of university departments of anthropology or archeology.

Zooarcheology (Olsen 1971) designs the use of faunal remains with the aim of addressing archeological questions. It requires reading faunal remains not only from a zoologist's and paleontologist's perspective, but also, and primarily, for evidence of past human behavior.

The zooarcheological literature has been growing exponentially over time. Research in this field particularly benefited from application of new technologies to faunal research, including scanning electron microscopy of signatures left by human and non-human bone modifiers, and stable isotope analyses aimed at reconstructing diets or at exploring many different aspects, ranging from climate, seasonality, paleoecology and biogeography, to herd management and hominin foraging strategies.

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## 2. The help of modern equivalents

Current research strategy aims at improving our understanding about the past making use of modern analogues, in compliance with the principle known as "actualism" (Binford 1981; Gifford 1981; Herm 1972; Hooykaas 1970; Lawrence 1971). Actualism means studying modern-day processes and their products to explain evidence from the past. The validity of this principle hinges on the capacity to find modern equivalents of past organic remains or to experimentally replicate distinctive specimen states that are commonly observed in archeofaunal assemblages. Only under such perspective do animal remains become reliable indicators of past processes and contexts. Inferring the age-at-death of an archeological mammal from its state of tooth eruption or wear, or from its unfused epiphyses means assuming that those features were produced the same way and by the same growth processes in the past as in the present. A tooth mark left on a bone by a carnivore will be expected to have the same features either if it were created in the past or today.

Analogy is used pervasively working with archeofaunal specimens. Examples can range from identifying anatomically and/or taxonomically an osteological remain, to inferring past environmental contexts or ecological interactions. Naming an archeofaunal bone means making an analogy with modern equivalents, based on relevant criteria of similarity. Through a whole set of analogies and similarities to equivalents documented in the modern world researchers can infer the physical features and perhaps even the putative behaviors of past animals.

When there are aspects of archeofaunal remains for which we cannot find modern analogues ready at hand, we need to create them through experimental studies. This is especially necessary when humans are the agents modifying faunal remains and generating bone modifications. Resemblance of an experimental outcome to the archeofaunal evidence enhances our confidence that a similar process produced that same feature in the past. The whole range of investigational approaches involving analogical reasoning and actualism forms the basis of experimental zooarcheology. These studies contributed significantly to our understanding of bone surface modifications and, more in general, of animal carcass processing.

Analogy needs to be used with caution. Ambiguous evidence should be avoided in determining the agent(s) responsible for specific modification patterns; causal inference should rather be based on multiple, independent lines of evidence than on one type of data. If more lines of evidence suggest the same causal process and agent, the probabilities that these were responsible for the outcomes being analyzed are increased. In other words, if most independent lines of evidence point to a specific agent, process or context, we feel more strongly warranted in indicating it as the most likely possibility. This approach, which applies Binford's (1987; 2001) independent "frames of reference", was called "forensic" by Lyman (1987) and is often known as "contextual analysis". What is important is that independent lines of evidence may not be produced by the same process. For example, pits and scores, which are morphologically distinct marks made by carnivore teeth on a bone, are both produced virtually simultaneously by gnawing and are thus not independent evidence for the action of carnivores. Nonetheless, many gnawed bones not associated with human artifacts in a small cave are convincing evidence of the activities of a carnivore. In this case, two independent lines of evidence, the gnaw marks and the context, both point to the same agency or context production.

Zooarcheologists use actualistic research to define distinctive traces made by specific agents. Unfortunately, actualistic experimental investigations have shown that very similar final effects can be produced by different causes. Exemplary of this are the so-called pseudo-cut marks, or trampling marks. Bones trampled by hoofed animals against a substrate with angular particles can be marked by pseudo-cuts. In this case, pseudo-cut marks and stone tool cut marks are produced by the same causal processes and effectors, i.e., sharp, angular edges of stones dragged over relatively fresh bone surfaces. However, the agents differ. Hence, traces yield ambiguous inferences about effectors and agents. Lyman (1987) described these as "equifinality" issues, where the same final result is obtained from different processes.

The discrimination between cut marks and pseudo-cut marks addresses the issue of equifinality. Rogers (2000) asks whether this concerns primary data (physical qualities of the materials) or secondary data (the statistical and interpretative characterizations of the materials). Dealing with pseudo-cut marks, several independent lines of evidence need to be examined to better identify the most likely agent. These include, among others, the nature of the bone-bearing matrix and the possible presence of angular lithic elements that could have produced pseudo-cuts when the bones were trampled. Another crucial aspect is the topographic location of the marks on the bone: is their placement in anatomical zones expected for butchery, or are they more or less randomly distributed on convex surfaces, which are more exposed to the contact with angular stones if trampled? Multiple studies are focusing on the immanent properties of the materials to reduce ambiguities in any single line of evidence.

## 3. Taphonomic caveats

Paleontological and archeological faunal assemblages are the end products of complex pathways, and often palimpsests of multiple assemblages. Some of the many processes they were exposed to leave traces of their operation, some do not, and some may obfuscate or obliterate previous modifications. For example, a bone lying out in open air weathers progressively through time, in a way that shallow cut marks present on its original cortical layer are gradually erased. This phenomenon is known as "taphonomic overprint" (Lawrence 1968), which includes a variety of postmortem processes acting on organic remains (Lawrence 1968; Meadow 1980; Clark and Kietzke 1967). This causes progressive, postmortem divergence of animal remains from their equivalent constituents in living organisms. The challenge for taphonomists and zooarcheologists is that to attempt detecting the overprints and biases and to remove them to bring an archeofauna back to its original context in a living system.

According to Lyman (1994), Gifford (1981) and Gifford-Gonzalez (1991) these attempts to strip away overprint from biological remains is unworthy and unrealistic; researchers should rather consider taphonomic evidence as post-mortem additions to specimens. In fact, these altered faunal remains are all we can deal with and thus we need to learn how to read all we can from their preserved evidence.

## 4. Essentials of zooarcheology

Zooarcheological analysis always starts with recording data from individual specimens. There are attributes functionally related to ontogenetic development and there are others produced by the processes that acted upon the remains after death.

The dominant processes that created a bone assemblage are normally the final outcome of a series of steps involving the detailed scrutiny of individual specimens. They are aggregate patterns resulting from repeated detection of specific types of human-derived bone damage and of bone modification actions of other processes.

Zooarcheologists are historical scientists that aim at understanding what created those dominant patterns, nonetheless aware that some of the processes the archeofaunal remains were exposed to left few or no recognizable traces.

Zooarcheologists thus primarily aim at deriving useful aggregate patterns from careful bone-by-bone analysis. They use two basic categories of data to build nearly all other inferences: primary and secondary data. These categories were introduced by Clason (1972) and Reitz and Wing (2008), to indicate more objective and more subjective data, respectively. Primary data include observational information and therefore are, or should be, more easily replicated by other researchers. By contrast, secondary data are the result of elaborative processing, and are thus more amenable to subjective interpretation, although other researchers should be able, in theory, to replicate them if the manipulatory methods are described clearly enough.

Anatomical and taxonomical identification of specimens, age, sex identification and bone modifications all form primary data. Secondary data include relative frequencies of specimens, of bone elements, of individuals, age structure, sex ratios, body size estimates, estimates of dietary contributions, incidence of bone modification, butchery patterns, and niche breadth. These are all non-readily available properties of an archeofaunal assemblage, which can only be derived through mathematical manipulation.

Bone modifications and frequencies are among the most important and informative aspects of archeofaunal assemblages. The former include a whole variety of alterations. There are cortical modifications, which range from abiotic abrasion/polishing, weathering, or corrosion, to biotic root etching, tooth and claw marking, gastric corrosion, human-produced cut-marking, chopping, combustion. However, the intervention of more impacting actions, of either mechanical, or biological origin, can cause more severe bone damage, such as crushing, fracturing/breakage, plastic deformation, and so forth.

Bone frequencies are the relative amounts of specimens of skeletal elements represented in a faunal sample. By establishing the proportional abundances of the different species and skeletal parts, these counts permit inferences about seasonality, hunting, herd management, or domestication targets. Frequencies of different skeletal segments can reveal whether the humans responsible for the formation of the archeofaunal assemblages were still hunter-gatherers, and how far did they had to transport the carcasses or carcass parts, or if they had already changed into market-economy butchers. Inferences can be strengthened by also considering age-at-death profiles of animals in a sample, constructed based on the relative frequencies of age-diagnostic bones and teeth. In sum, the frequency of the different skeletal parts is important for taphonomic analysis, for elucidating patterns of human processing, transport, food preparation, consumption and disposal, for nutritional analysis, for establishing site function and possibly also social organization.

More typical and specific zooarcheological targets are reached through studies of body size variation of species over time. These often relate to climatic fluctuations, or to selection or impact by humans, although human impact does not depend only on the exploitation pressure, but also on the vulnerability of the species that are exploited.

## 5. Concluding remarks

This brief outline was meant to illustrate how crucially important zooarcheological feedback is to the advancement of archeological knowledge and understanding. Until recently, archeology and zooarcheology have been proceeding on two parallel tracks. However, these two fields of research have been converging ever more often: by realizing the reciprocal benefits to be gained by each party to this relationship, a basis for sustained, fruitful collaboration can be established. Archeology helps in creating a cultural heritage by combining tangible objects (sites, landscapes, structures, and artifacts) with intangible values (the ideas, customs and knowledge that gave rise to them). Zooarcheology has the goal of understanding prehistoric and historic human life through the systematic study of animal remains recovered from archeological sites. By covering many topics – such as environmental reconstruction, assessment of subsistence strategies, foodways, animal domestication, and the ritual use of animals in the past – too often overlooked by classical archeological research zooarcheology reveals that there still are open issues that need to be addressed, and data and knowledge gaps that need to be filled. It thus sets the ground for a more holistic and integrated approach to be taken for more comprehensive and analytical structured archeological research work.

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