The Potential for Bioarchaeological Assessment of Human Skeletal Remains in Maritime Contexts

This paper explores the importance of specialization pertaining to underwater sites, particularly the importance of bioarchaeology in interpreting human remains found at sites. Human skeletal remains that are found at shipwreck sites could potentially offer a unique insight of life at sea. Bioarchaeologists are skilled at discerning skeletal pathologies, trauma, musculoskeletal stress markers indicative of activity patterns, and detecting taphonomic modifications of bone. The frequency of recovering remains in maritime contexts will be explored through various case studies to evaluate the necessity of bioarchaeological specialization in a maritime context. The purpose of this paper is to utilize research in the field of bioarchaeology and case examples in an effort to either demonstrate the importance of the inclusion of bioarchaeology in the field of nautical archaeology or to illustrate the importance of expanding nautical archaeology into other fields in an effort to gain a multifaceted understanding of this field.

Keywords: bioarchaeology, maritime archaeology, underwater bone preservation

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Introduction

For terrestrial archaeological sites, bioarchaeologists are the primary individuals tasked with understanding and interpreting human remains. The study of bioarchaeology stems from two sub-disciplines of anthropology: biological anthropology and archaeology. Bioarchaeology is the ‘study of human skeletal remains from archaeological settings to aid in reconstructing the biological and cultural pasts of populations’. There is a debate on correct terminology in nautical archaeology, with the terms ‘underwater archaeology’, ‘shipwreck

archaeology’, ‘maritime archaeology’, and ‘nautical archaeology’ all having separate meanings. However, for the purposes of this paper, these terms will be utilized interchangeably as the study of archaeological sites in an underwater setting or a setting relating to maritime culture. Both bioarchaeology and maritime archaeology are fairly recent sub-disciplines. This may explain the lack of specialization in underwater contexts. For example, only three schools in the United States have specific maritime archaeology programs, the University of West Florida being one of them.

**Human Remains in Marine Contexts**

There are no specified requirements on who should be the primary individual tasked with recovering skeletal material at an archaeological site, but in the academic community, it is generally accepted that an individual with an advanced knowledge of osteology should be the one appointed with such a task. If human remains are known to be at a particular underwater site, the osteologist should be involved during the planning stages so that they can take a position of advising in order to directly supervise during the process of uncovering human remains to make sure it is done properly.\(^2\) Most cases where individuals are recorded underwater are in ‘temperate shallow coastal locations’.\(^3\) Typically, the context of these remains will be in a shipwreck environment, as a result of a catastrophic event, and most of these shipwrecks are of warships. This means the biological profile will be fairly consistent, with males of similar occupation.\(^4\)

**Potential Bioarchaeological Assessment of Life at Sea**

Poor diet on board, which has been reported in historical accounts, could result in a variety of vitamin deficiencies which make themselves evident on bone. Iron deficiency is caused by a scarce amount of meat consumption or consuming a substantial amount of iron inhibiting foods, as well as parasitic infections.\(^5\) This pathology is evident through the porosity

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\(^3\) Mays, 2008. p. 124.


of bone in two primary places: the orbits of the eye, called cribra orbitalia, and of the cranium, called porotic hyperostosis. I hypothesize that dental hygiene at sea was not paramount, and therefore evidence of poor dental care may be evident on human remains. This can be seen through an analysis of dental caries, dental calculus, and abscesses. The analysis of dental caries will lend itself to understanding the kind of diet of those on board, or even distinguish the diet between individuals of low class and an individual of high class who may have been on board at the time of the wreck. When analyzing a population in an archaeological setting, the rate of carious lesions on teeth is one of the most effective means of diet and health reconstruction, according to Weiss. Historical accounts and archaeological findings verify that a proportion of sailors suffered from syphilis. Both endemic and venereal syphilis leave evidence on bones. In the case of shipwrecks, sailors may have had venereal syphilis, which is evident in the os coxae, patella, cranium, and bones of the elbow.

One of the most notorious pathologies that may be evident on bone caused by life at sea would be scurvy, which is caused by a dietary deficiency of vitamin C. The dietary deficiency stems from an insufficient supply of a variety of foods that those on board may not have had access to during a long voyage, such as milk, meat, vegetables, and fruits. Using radiographic technology, analysis of scurvy is non-specific when looking at the skeletal features of the pathology and can be present as osteopenia on the vertebrae, the os coxae, the ribs, as well as on the long bones with a particular characteristic of unevenness around the knee and ankle regions. When relating to the vertebrae, compression fractures may have occurred as a result of the osteopenia, which could also be recognized in the diagnosis. One precaution that must be understood before definite pathology diagnosis caused by life at sea, are that the pathologies evident in the skeletal record usually have been occurring for a length of time and may have pre-dated that individual’s life at sea. One way to combat this precaution is

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determining whether the skeletal lesion indicative of a particular pathology is an active lesion. If it was active at the time of death, this confirms that the individual suffered from this pathology while on the ship.  

Cross-sectional geometry studies of long bones can be conducted on the human remains found at a shipwreck site because this type of analysis would be beneficial if a substantial amount of human remains were found at a shipwreck site for purposes of determining the division of labor in that sample population. Cross-sectional asymmetry could also be used in determining dominance between right and left bones, commonly that of the humerus to differentiate between handedness. Musculoskeletal stress markers (MSMs) could also be used to determine activity patterns of those on board. Musculoskeletal stress markers are classified as marks on the skeleton in areas of muscle or ligament insertion where repeated stress occurs at an insertion site, osteoblastic activity occurs at this site, and there is a subsequent increase of the MSM specified. In addition to musculoskeletal stress markers, analyses of osteoarthritis on a specific joint would also lend itself to interpretation of activity patterns at sea.

Post-Depositional Processes

In order to accurately utilize the aforementioned analyses, there must be an understanding of the taphonomic processes that happen to a body after death in marine contexts. Much like terrestrial scavengers, marine scavengers leave certain modifications on bone. During the process of decomposition, terrestrial scavengers usually produce gnaw marks (rodent) or pitting caused by carnivore activity (fox). Marine scavengers are known to consume carrion of marine mammals and fish and will utilize carrion of human remains just the same. According to Casper’s Ratio, human remains decompose twice as slow if in a body of water as

13 Sorg et al., 1997. p. 569.
compared to an open air site.\textsuperscript{14} Therefore, this is two times the amount of potential animal scavenging activity on the decomposing remains as opposed to a terrestrial open air site. The marine scavengers that could potentially create impressions on the bones are various ‘fishes, gastropod mollusks, crustaceans, and echinoderms’.\textsuperscript{15} Certain marine animals prefer specific regions of the body, such as crabs preferring the eyes and flesh of the face, which would leave marks in the eye orbits and the splanchnocranium. There is also the concept of erosion or postmortem eburation of various bones that must be understood due to taphonomic processes. Sediments that are driven by currents can result in abrasions with the bone and breaking of bones could result from a hard impact with rocks on the sea floor.\textsuperscript{16} Remains that are underwater will become commingled based on a variety of factors, such as water currents. Understanding the sedimentation process at a particular shipwreck site will also explain why some bones are in better shape than others.

**Technique and Technology**

Interpreting the need for bioarchaeologists within maritime archaeology necessitates the question of how frequently bones are recovered in underwater contexts. According to Hershey, important findings of human remains have been discovered in over twelve well-known shipwrecks: the *HMS Monitor*, the *HL Hunley*, and the *La Belle* shipwreck to name a few.\textsuperscript{17} However, there have been few sufficient collections that have been studied for purposes of osteology or bioarchaeology.\textsuperscript{18} One example where substantial human remains were found and studied was on the *Mary Rose* shipwreck, where there was a minimum number of individuals (MNI) of 179 individuals.\textsuperscript{19}

\textsuperscript{14} Mann, 1902. p. 54.

\textsuperscript{15} Sorg et al., 1997. p. 569.

\textsuperscript{16} Mays, 2008. p. 125.

\textsuperscript{17} Hershey, 2012. p. 365.

\textsuperscript{18} Mays, 2008. p. 128.

\textsuperscript{19} Bell and Elkerton, 2008. p. 526.
The presence of skeletal remains during underwater archaeological excavations has been found in shipwrecks dating to the late Roman Empire. On this basis alone, it is vital that an individual with advanced knowledge of osteology should be on the recovery mission, or that bioarchaeologists should be trained in underwater excavation methods and become certified in diving. This should be done as a precautionary measure to ensure that they can react much the same as a terrestrial site where bones have been uncovered if they are ever called to an excavation site that is underwater.

Another concern is how well bone preserves in a marine environment, because if preservation is poor and bone is altered severely, this would inhibit bioarchaeological research. Arnaud et al. conducted research on how bones preserve in seawater and utilized seven long bones that came from wreck sites off the coast of Cape Dramont and near Sainte-Marguerite Island in France.20 These researchers found that the only major change was that there was an overall increase in weight caused by the increase of the inorganic portion of bone and that microorganisms do in fact bore into the bone, but the overall deterioration is very limited.21 Based on this study, there are no present issues surrounding the preservation of bone underwater that would in any way inhibit a bioarchaeological/osteological analysis of submerged human remains.

Case Example

The Mary Rose was a ship that was a part of King Henry VIII's fleet, which sunk in the 16th century. Ann Stirland analyzed the remains found on the vessel and she revealed many features on the skeletal remains that give us clues about the physical activities of the ship's crew.22 Stirland looked at the robusticity index using the humerus and femur and then compared this population to a population from a similar time period who came from Norwich.23 She found that there were no major differences between the left and right femur when

20 Arnaud et al., 1980. p. 53.


compared to the skeletal population from Norwich but when analyzing the humerus, there was more robusticity associated with the right humerus in the Norwich population. This pattern was not evident in the skeletal population from the Mary Rose. This means that the crew did not exhibit a dominant arm and instead used arms equally in activities. This analysis is associated with the first assumption that additional bone reflects additional muscle using the foundation of long bone asymmetry. There were not very many traumatic injuries associated with this population and also a minor amount of fractures. However, there was a high prevalence of avulsion fractures on the bones of the feet that Stirland attributes to landing onto unstable surfaces, which could be a believable activity for life at sea. It was unusual to note that there was little osteoarthritis found on the skeletal remains, which can be an indicator of bodily stress and physical activity. Stirland found that there were instances of vertebral body pitting in the demographically young males and also ossified spinal ligaments which could be attributed to heavy manual labor, such as hauling heavy materials.

Interestingly, Stirland makes a connection between longbow usage and the high prevalence of os acromiale on the left scapula. When looking at the areas on bone associated with muscle attachments in the arms and shoulders, there were changes associated with persistent use, an example of a musculoskeletal stress marker. This analysis could also be attributed to long bow use because the changes are relevant to the raising and lowering of the arms. The left shoulder dimensions were longer on these individuals. The left arm was also known to be the dominant arm that held the bow. Based on context, there were individuals believed to have been part of the gun crew. One of these individuals had a spine that resembled that of an elderly person with new bone growth at the muscle attachment sites and the spinal joints. Because of the known context and a basic understanding of the laborious nature of life at sea, some behaviors of the crew were able to be identified using musculoskeletal markers, biomechanical analysis, trauma, and prevalence of osteoarthritis.

Overall the crew exhibited bone robusticity which in turn meant higher muscle content. The specified skeletal markings of stress consistently indicated repeated activity patterns, in the case of the archer remains and those of the gun crew.

Aside from Stirland’s 2012 analysis of the human remains found on the *Mary Rose* shipwreck, there was another study conducted by Bell and Elkerton, where marine taphonomy was studied, particularly related to microstructural alterations caused by marine microorganisms. It is important to understand the depositional environment that the remains existed in, and in this case, upon the lifting of the watercraft and excavation, it was discovered that the ship rested on the starboard side which created an artificial bottom during the sedimentation process. Analyses of sediment deposits were also important for this study and they found there were four periods of sedimentation. The human remains were within the first two sedimentation layers, therefore, the third and fourth layers will not be discussed in this case example. The first, the Tudor layer, occurred within several months of the wreck and some of the remains were buried under this layer. According to Bell and Elkerton, during the second sedimentation layer formation process, the hull malformed and the context of the shipwreck was consequently more exposed to the outside marine environment.

In this same study, a microanalysis of teeth was conducted in an effort to find microscopic configurations caused by tunneling of microorganisms. It was found that the human remains from the first Tudor layer did not have any microstructural changes. Bell and Elkerton attributed this to the fact that this sedimentation period occurred during winter, where the cold waters would not have been a safe habitat for the microorganisms responsible for tunneling. The human remains in the second Tudor layer had evidence of tunneling upon microscopic investigative technique analysis. Bell and Elkerton consider this as a result of a better environment for the microorganism to thrive in. In this depositional layer, there was evidence of seaweed, which means there was light availability. Bell and Elkerton speculated the

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microorganism responsible is either a Polychaete, Thraustochytrid, or cyanobacterium. This case example notes the importance of understanding the depositional environment, including processes of sedimentation and micro-taphonomy, in uncovering skeletal remains.

Conclusion

There is great potential for utilizing bioarchaeological methods in an underwater context with minor drawbacks. One potential drawback would be the commingling of bones due to the unique underwater taphonomy that would potentially inhibit proper identification of a human skeleton. Another drawback related to post-depositional processes would be the possibility of postmortem breakage and alterations caused by water currents. There is also the concern of osteological paradoxes, where paleopathological analysis of disease is only in those who exhibit the pathology on bone. If an individual were to succumb quickly to a disease or dietary deficiency, the evidence would not lend itself to interpretation on the skeletal remains. Many pathologies that are attributed to long voyages at sea and are also generally non-specific and the same identifying characteristics on bone could be related to a variety of pathologies. Without context, it could also be unclear when that individual started to succumb to the disease. In some instances, there is a potential for its manifestation prior to living at sea. This particular setback can be resolved if the bioarchaeologist contributes most attention to active lesions on the bone rather than healed lesions.

Regardless of these drawbacks, there is still much to be learned about human remains found at shipwreck sites. Through bioarchaeological analysis, it is possible to discern life at sea, activity patterns, class differentiations, and the origins of the crew to name a few. The case example of the Mary Rose exemplified this concept on a multifaceted analysis on submerged human remains. The importance of underwater environments not having any adverse or harmful effects on human bone is promising for the study of bioarchaeology as is the frequency of human remains found at underwater sites. Overall, the strengths outweigh the weaknesses in regards to the inclusion of bioarchaeology within the subfield of nautical archaeology.


31 Mays, 2008. p. 130.
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References


