H35 Non-Destructive Microscopic Differentiation of Human From Non-Human Fragmentary Burned Bone

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After attending this presentation, attendees will learn the Nondestructive methods for differentiating human from non-human bone in cases of fragmentation and burning encountered in mass disasters and forensic cases.

This presentation will impact the forensic community and/or humanity by improving field analysis of fragmentary and burned bone for differentiating human from non-human bone.

Fragmentary burned bone presents challenges to field investigators questioning the fundamental probability of skeletal remains being of human or animal origin. This affects the development or termination of criminal investigations, recovery techniques, and methods of identification. These issues are important when human remains are suspected in addition to animal remains or encountered among debris of mass disasters (aircraft and mass transit accidents, wild fires, or explosions) involving fragmentation and burning. Normally this problem is resolved by identifying morphological variations in anatomical landmarks present on suspect fragments. However, fragmentation of brittle burned bone reduces diagnostic features producing small pieces of compact cortical and trabecular bone as primary specimens for analysis. In these cases, examining microscopic structures of bone is necessary for differentiating human from non-human fragments.

Routine forensic cases encounter this issue when unknown skeletonized remains are discovered by the public and relinquished to law enforcement for identification. To the untrained observer, this question is resolved by consulting a biological anthropologist, zooarchaeologist, or medical professional trained in osteology. Morphological variants of size and shape in skeletal anatomy distinguish extreme cases of small (cat, opossum, or chicken) and extremely large (horse or cow) animals as obviously differing in size from humans. However, postcranial skeletal remains of medium-sized animals such as pig, deer, sheep, or large canine may resemble human bone in relative dimensions of cortical thickness for extremely fragmented remains and require definitive identification. Burning increases the difficulty of this task and the degree of fragmentation of bone, especially if larger diagnostic remains are purposely crushed or removed to a secondary location for disposal to conceal criminal acts and destroy evidence of identity.

Compounding the identification problem is the variable degradation of bone's structure through stages of unburned, initial burning, charring, and calcination. Pyrolosis of organic constituents through progressive stages of cremation gradually leaves bone structurally deficient as a dry and brittle material. In calcined bone this reduction produces shrinkage, deformation, embrittlement, and heat fractures from prolonged burning. Partial fragmentation of skeletal material is expected from the dynamic fire environment from heat, movement, or impact. Changes in microstructure of human burned bone have been previously documented by Bratmiller and Buikstra (1981) and Nelson (1992). The presenter's intention is not to redefine their research but instead expand it into the general identification of animals similar in human size or cortical thickness called into question as potential forensic specimens.

A sample of southeastern American domestic and wild animal species were selected as household food refuse and common animal types suspected as human remains; *Sus scrofa* (pig), *Odecolius virginanis* (white tailed deer), *Canis familiaris* (medium-large dog), *Bos tarus* (cow), *Ovis aries* (domestic sheep), and *Terrapene carolina* (box turtle carapace). Specimens were burned and sampled for cranial and postcranial exemplars of unburned, charred, and calcined bone for each species. Identical burn stages of human cranial and postcranial bones were obtained for comparative analysis.

Due to the fragmentary nature of burned bone, traditional destructive and expensive techniques were not necessary since fracture margins were exposed and amenable to microscopic analysis. Specimen margin surfaces were visually examined under a basic stereoscopic laboratory scope with low power magnification (10-40X) and angled lighting. Specimens were placed on a variable height platform, often secured with clay under the lens, analyzed, photographed, and morphologically documented first for progressive degradation from burning within each species and then later comparatively to identify differences among species.

Characteristics of human microstructure were first established in dry bone for cranial and postcranial fragments, noting differential size, shape, and distribution of osteons ranging from endosteal to periosteal lamellar bone and texture of external cortical surfaces. The identical protocol was applied to each non-human species. Fragmentary surfaces of non-human bone yielded unique patterns of osteon size, distribution, shape, banding, and external cortical surface morphology different from human.

Microscopic analysis of fleshed bone fracture surfaces presented difficulties under low power magnification as grease and organic materials were still present in Haversian canals and skeletal matrix. Charred bone with its uniform blackened structures was also challenging to visually differentiate unique microstructural patterns for each species. Calcined and dry bone surfaces yielded the best conditions from loss of their organic constituents for accurately analyzing microscopic characteristics. Descriptions of techniques and a comparative visual atlas of microstructural differences among human and non-human specimens will be presented for use in problematic cases

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involving fragmentary and burned bone.

Burned Bone, Fragmentary Bone, Mass Disasters

