A60 Shining a Light on Forensic Anthropology: The Use of Alternative Light Sources (ALS) to Detect Skeletal Remains Underwater

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Learning Overview: The goal of this presentation, consisting of two pilot studies, is to demonstrate how ALS can be used to identify skeletal remains during terrestrial and underwater forensic investigations, explore the taphonomic impact of the aquatic environment on submerged bone, and discuss how maceration can be used as an effective preparation technique for bone undergoing laboratory ALS analysis.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting a novel use of ALS technology: to detect skeletal remains underwater, analyzed using an innovative research methodology combining custom-built fluorescence measuring software with Thermogravimetric Analysis (TGA) collagen quantification. This presentation will also introduce original complementary research into how bone collagen and consequent fluorescence levels are affected by the aquatic taphonomic environment and common maceration techniques, as well as discuss how ALS could also be used to distinguish bone from other material during excavations and crime scene investigations. This would be particularly helpful to crime scene practitioners, police divers, and search and rescue personnel.

Aquatic searches for human remains are time consuming and expensive, with current methods focusing on finding intact cadavers rather than skeletal material. ALS are a crime scene staple and are non-destructive and cost-effective, utilizing the natural autofluorescence properties of proteins to reveal latent evidence. Bone also produces fluorescence when exposed to ALS, due to a high organic content consisting primarily of collagen, providing a potential new approach to underwater searches. This research, consisting of two pilot studies, aims to demonstrate how ALS can be used to identify skeletal remains during terrestrial and underwater forensic investigations, explore the taphonomic impact of the aquatic environment on submerged bone, and discuss how maceration can be used as an effective preparation technique for bone undergoing laboratory ALS analysis.

The initial pilot study consisted of two phases, terrestrial and underwater, and used a combined methodology of digital photography to document fluorescence, bespoke C++ software to conduct fluorescence quantification, and TGA to quantify collagen. Phase 1 investigating terrestrial fluorescence identified a significant relationship between bone collagen per 1mg and observed fluorescence with an orange filter ($R=0.260$, $P=0.033$) when photographing porcine bone in air ($n=17$), with eight organic and inorganic controls showing possible differentiation between bone and non-bone material. Phase 2 examined the impact of three aquatic conditions—canal, sea and freshwater ($n=15$)—on porcine bone over 21 days, including monitoring of the water chemistry; pH, turbidity, conductivity and Total Dissolved Solids (TDS). Results identified water salinity as potentially contributing to collagen loss (interval and collagen loss in sea water [$R=0.962$, $P=0.019$], canal water [$R=0.925$, $P=0.038$]), highlighting the need for further research. However, residual tissue from manual defleshing hindered fluorescence results. Consequently, a second pilot study was completed, focusing on determining the most effective method to macerate porcine bone in order to optimize fluorescence output without compromising the collagen content. Using the same photographic and quantification methodology, three maceration techniques—hot water (80^{o}C), biological washing powder (55^{o}C), and enzymatic (55^{o}C)—were studied. It was found that hot water maceration proved the most successful, providing consistent fluorescence results with little impact on collagen, whereas biological washing powder was destructive to bone appearance and collagen levels. This research yielded promising results, highlighting avenues for future research, and demonstrating practical applications for missing persons cases, mass disaster investigation, and archaeological contexts. Overall, ALS examination has the potential to help simplify search methodologies, reduce costs, speed up recovery, and triage findings by aiding investigators unfamiliar with osteology to locate, differentiate, and identify possible skeletal remains.

Bone, Fluorescence, Underwater