Analysis of DNA Preservation in Human Remains Embedded in Solid Building Materials

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INTRODUCTION

The disposal of human remains is a critical aspect of concealing homicides, with offenders using methods like burial, burning, and dismemberment to hinder forensic investigations [1]. While these techniques are well-documented, the encasement of remains in concrete is less studied, despite its growing use in organized crime. For example, in Jalisco, Mexico, authorities uncovered mass graves containing dozens of bodies linked to criminal organizations [2]. Such cases emphasize the need for research into this disposal method.

Concrete significantly slows soft tissue decomposition, complicating the estimation of post-mortem intervals (PMI) and DNA recovery [3]. Bones, especially long and compact ones, are crucial for DNA analysis due to their protective matrix of hydroxyapatite and collagen. However, environmental factors can degrade DNA quality, further hindering forensic efforts [4].

This study will focus on the effects of standard concrete and other building materials on decomposition and DNA degradation. It will assess DNA quantity and percent of alleles recovered to better understand decomposition trends and DNA preservation. By enhancing forensic techniques for identifying human remains encased in concrete or similar materials, this research aims to address a critical gap in forensic science and support justice in complex cases.

MATERIALS & METHODS

Sample Treatment:

- Forearms were collected from three donors at the Southeast Texas Applied Forensic Science (STAFS) Facility with the left acting at control and right experimental
- Right forearms were sectioned into 6 sections and embedded in concrete (Figure 1)
- Samples (tissue, bone, building material) were collected on months 0, 1, 2, and 3

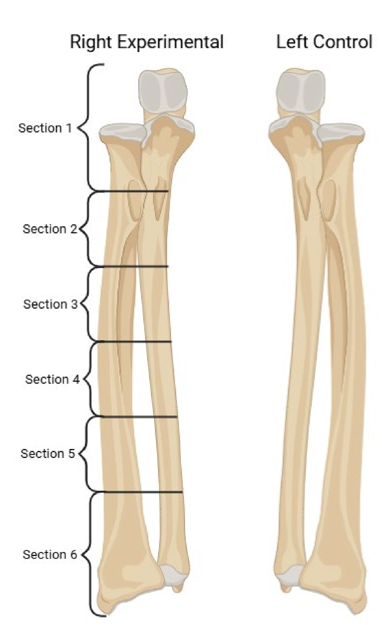

Figure 1: Experimental set up for forearms.

DNA Extraction:

- Bone – EZ2 DNA Investigator® Extra Large Bone Protocol (QIAGEN)
- Tissue, Nails, Building material – EZ2 DNA Investigator® Trace Protocol (QIAGEN)

Quantification: Quantifiler™ Trio (Thermo Fisher Scientific)

STR Analysis: VeriFiler™ Plus, 3500 Genetic Analyzer (Thermo Fisher Scientific)

RESULTS & DISCUSSION

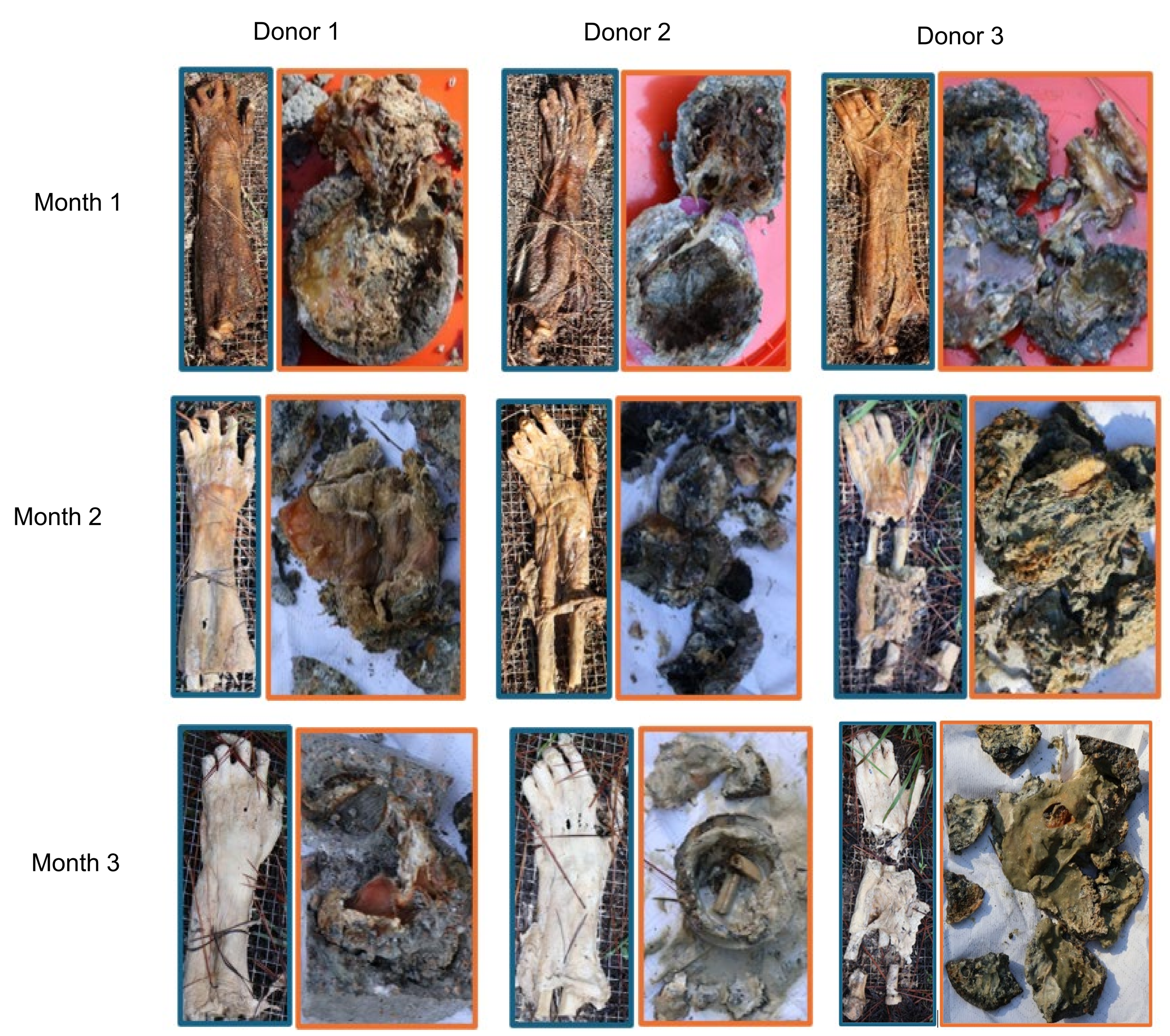

Figure 2: Donor 1, 2 and 3 control and concrete forearms for month 1, 2 and 3.

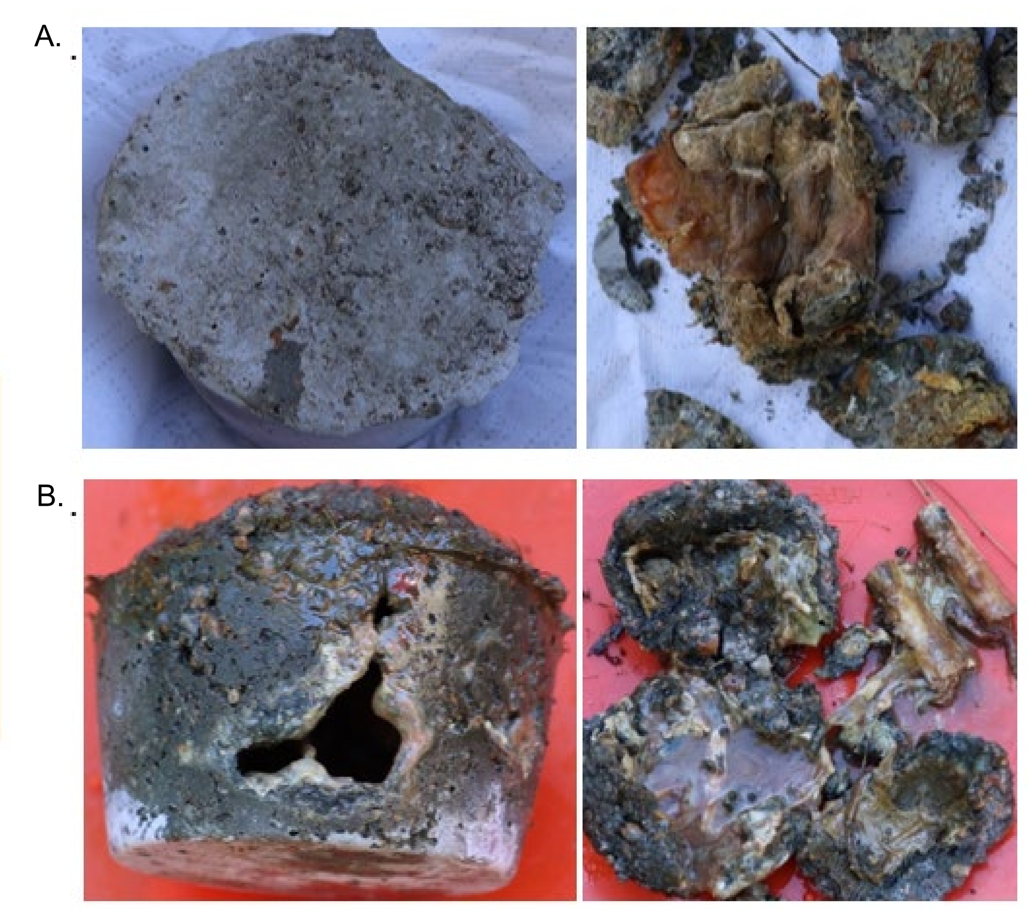

Figure 3: A.) Donor 1 month 2 demonstrating intact concrete structure on left and preserved tissue on right. B.) Donor 3 month 1 demonstrating compromised concrete structure on left and decomposed tissue on right

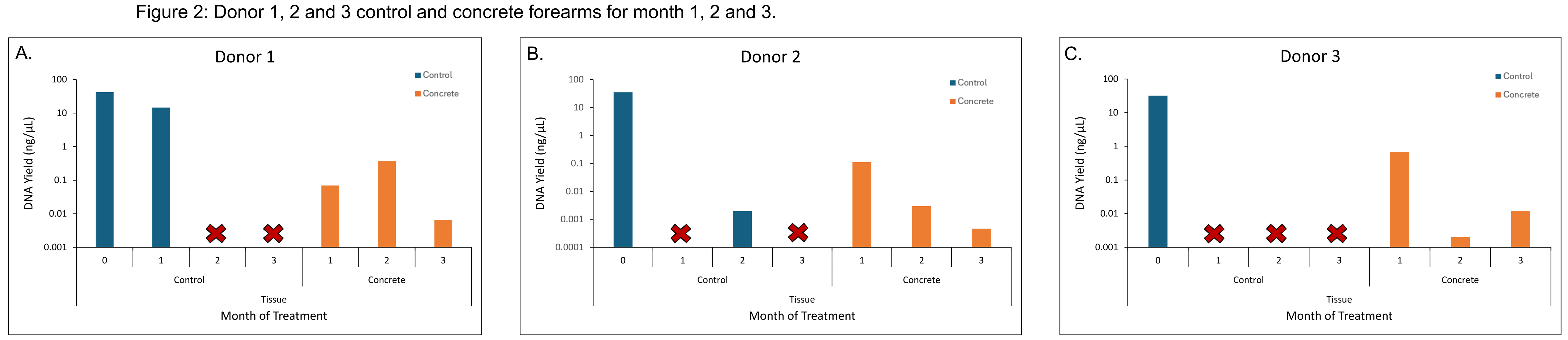

Figure 4: Logarithmic scale of DNA yield of collected tissue samples. A.) Donor 1 B.) Donor 2 C.) Donor 3. Red "X" representing a DNA yield of 0 ng/µL

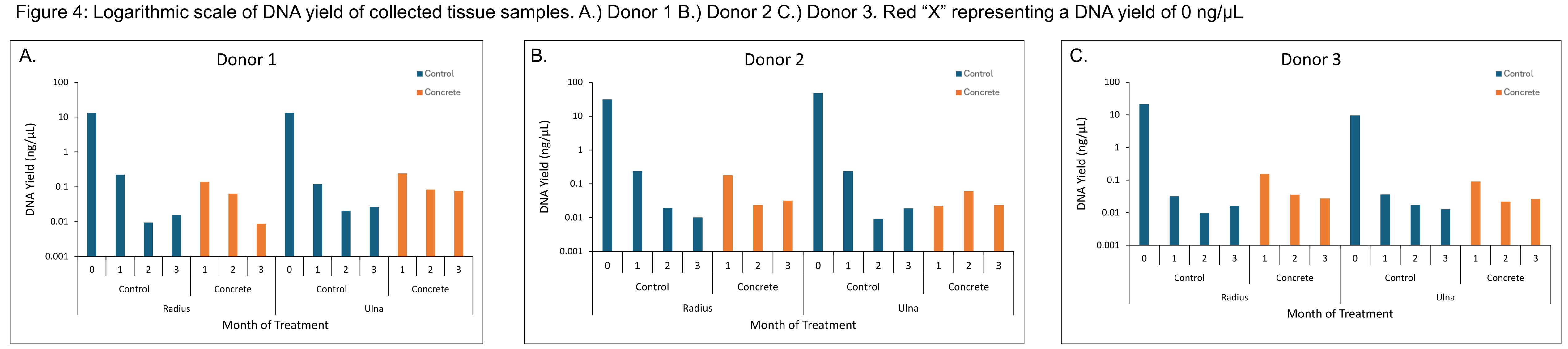

Figure 5: Logarithmic scale of DNA yield of collected bone samples. A.) Donor 1 B.) Donor 2 C.) Donor 3

- Results indicate concrete slows the decomposition process of tissue by limiting environmental factors (Figure 2)
- When concrete remained intact there were minimal alterations in sample appearance (Figure 3)
- DNA preservation is improved in tissue embedded in concrete (Figure 4)
- The quantity of DNA in bones from samples embedded in concrete is comparable to naturally decomposed remains (Figure 5)
- Skeletal remains embedded in concrete exhibit more than 90% allele recovery rates (data not represented)
- Embedded tissue yielded greater allele recovery than tissue subjected to natural decomposition (data not represented)

CONCLUSIONS

- Human identification of remains embedded in concrete is achievable
- Concrete acts as a preservation medium delaying the degradation compared to exposure to open environments
- Concrete does not impact DNA degradation in bone samples
- Skeletal elements (radius and ulna) embedded in concrete provide high allele recovery rates, with tissue samples embedded showing superior rates compared to those from naturally decomposed
- Concrete may serve as a stabilizing matrix for genetic material, potentially improving forensic DNA analysis

CONTINUING RESEARCH

- Rights fingers embedded in various solid building materials (Figure 7)
  - Thumb in standard concrete; Index in crack-resistance concrete; Middle in mortar; Ring in Type S masonry; Pinky in asphalt
- Left fingers served as controls, exposed to natural environmental conditions
- Samples collected at month 4 (tissue, nails, bone and solid building materials) (Figure 8)
- DNA testing is currently being conducted

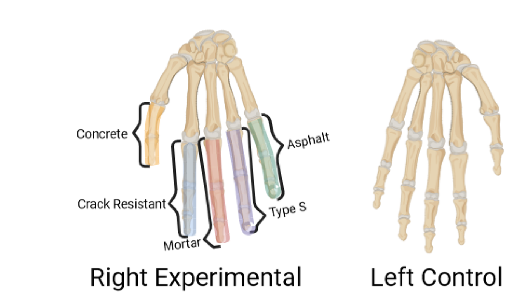

Figure 7: Experimental set up for fingers.

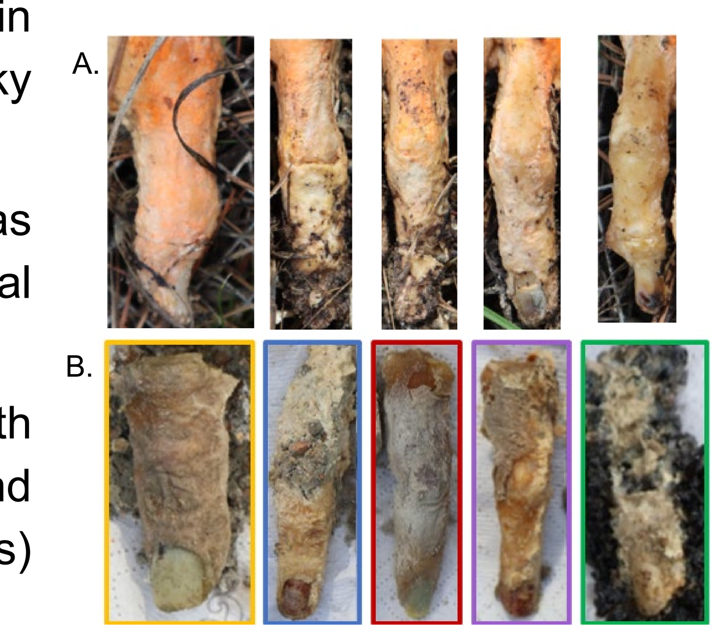

Figure 8: A.) Donor 3 control fingers B.) Donor 3 experimental fingers. From left to right: thumb, index, middle, ring, pinky.

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