Longitudinal assessment of DNA recovery from teeth recovered from a semi-natural marine environment

L. MALAN[a], V.E. GIBBON[b], C. FINAUGHTY[c], L.J. HEATHFIELD[a]

a Division of Forensic Medicine and Toxicology, Department of Pathology, Faculty of Health Science, University of Cape Town, South Africa
b Division of Clinical Anatomy and Biological Anthropology, Department of Human Biology, University of Cape Town, South Africa.
c Department of Analytical, Environmental and Forensic Sciences, King's College London, United Kingdom

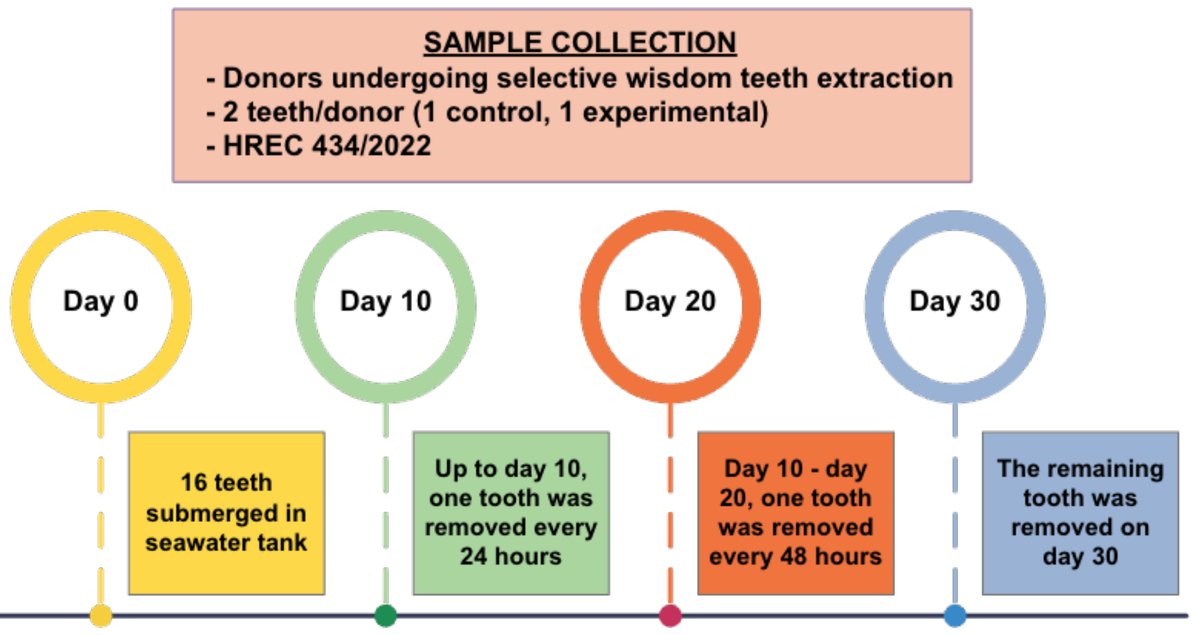
INTRODUCTION

- Many unidentified bodies are recovered from the ocean each year[1].
- Post-mortem identification is complicated by the effects of the marine environment on bodies[2].
- Hard tissues, such as teeth, are often the only samples available for DNA profiling[3].
- Limited research on the effects of the marine environment on DNA recovery[3].

AIM – Conduct a longitudinal assessment of DNA recovery from human teeth exposed to a semi-natural marine environment, simulating the western coast of Cape Town, South Africa

MATERIALS AND METHODS

SAMPLE COLLECTION
- Donors undergoing selective wisdom teeth extraction
- 2 teeth/donor (1 control, 1 experimental)
- HREC 434/2022



ENVIRONMENTAL CONDITIONS
- Experimental teeth submerged in flow-through tanks (water collected from Table Bay) kept between 10.2-14.2°C.
- Control teeth kept at room temperature for same duration as corraleting experimental tooth.

DOWNSTREAM ANALYSIS
- **DNA extraction** (QIAamp® DNA Investigator Kit (QIAGEN, Germany))
- **qPCR** (Quantifier® Trio DNA Quantification Kit(Applied Biosystems, USA))
- **Forensic STR profiling** (Investigator® IDplex Plus Kit (QIAGEN, Germany))

STATISTICAL ANALYSIS
- Spearman rank order correlation
- Willcoxon signed rank test

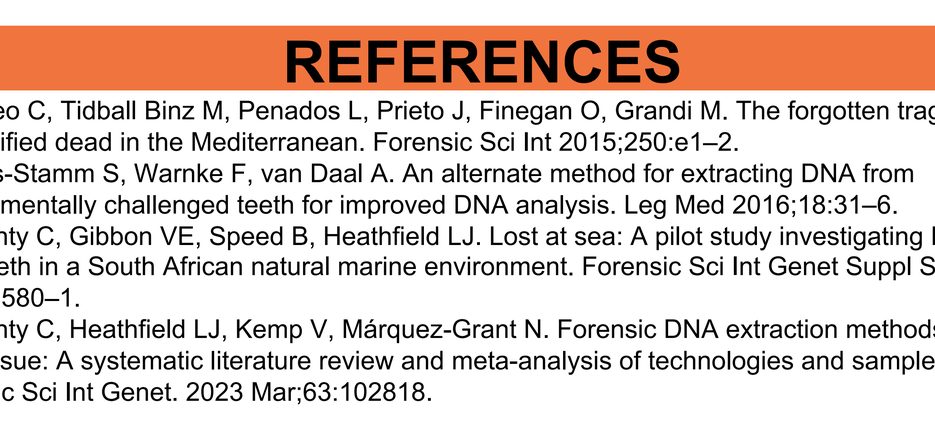


Figure 1: Flow-through tanks
Flow-through tanks from in the University of Cape Town Marine Biology department were used to simulate the marine environment surrounding Cape Town. Water from Table Bay is constantly circulated through the tanks in the laboratory.

RESULTS

DNA Quantity

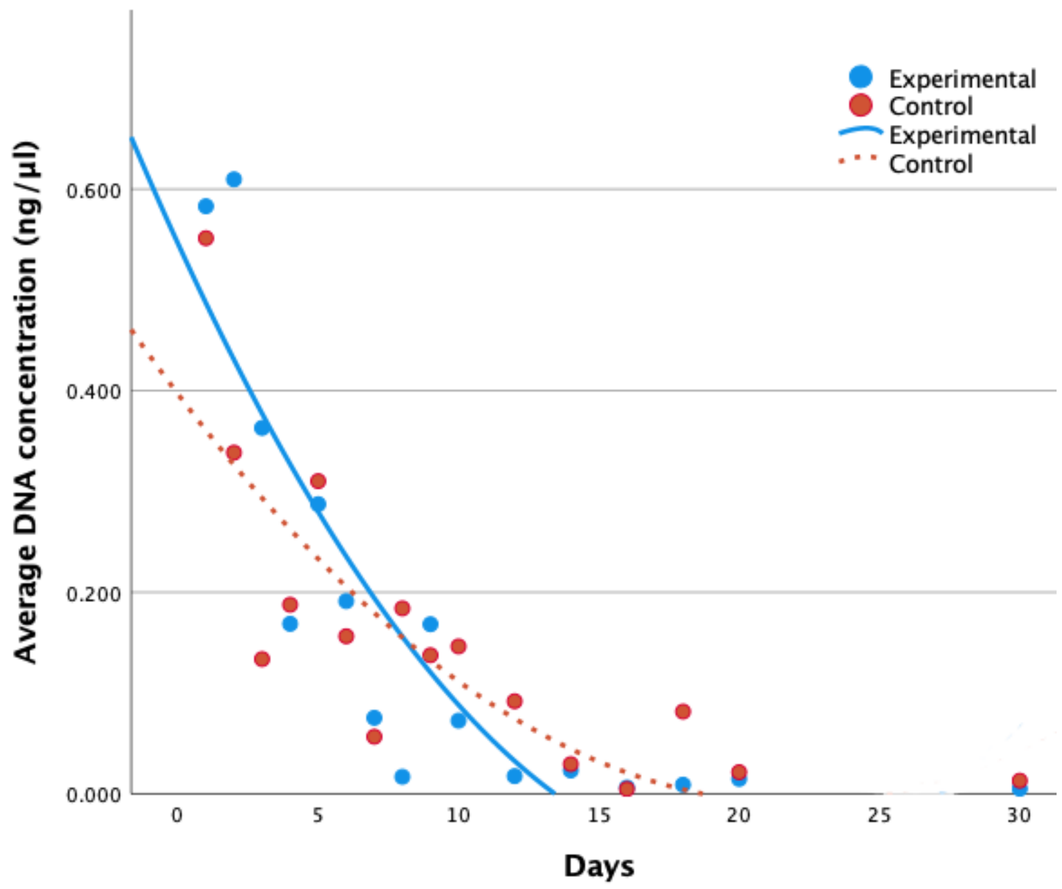


Figure 2: Average DNA concentration over time
A clear decrease in average DNA concentration over time was observed for both experimental (*p<0.001*) and control (*p<0.001*) samples. No significant difference was observed between the control and experimental samples (*p=0.836*).

DNA Quality

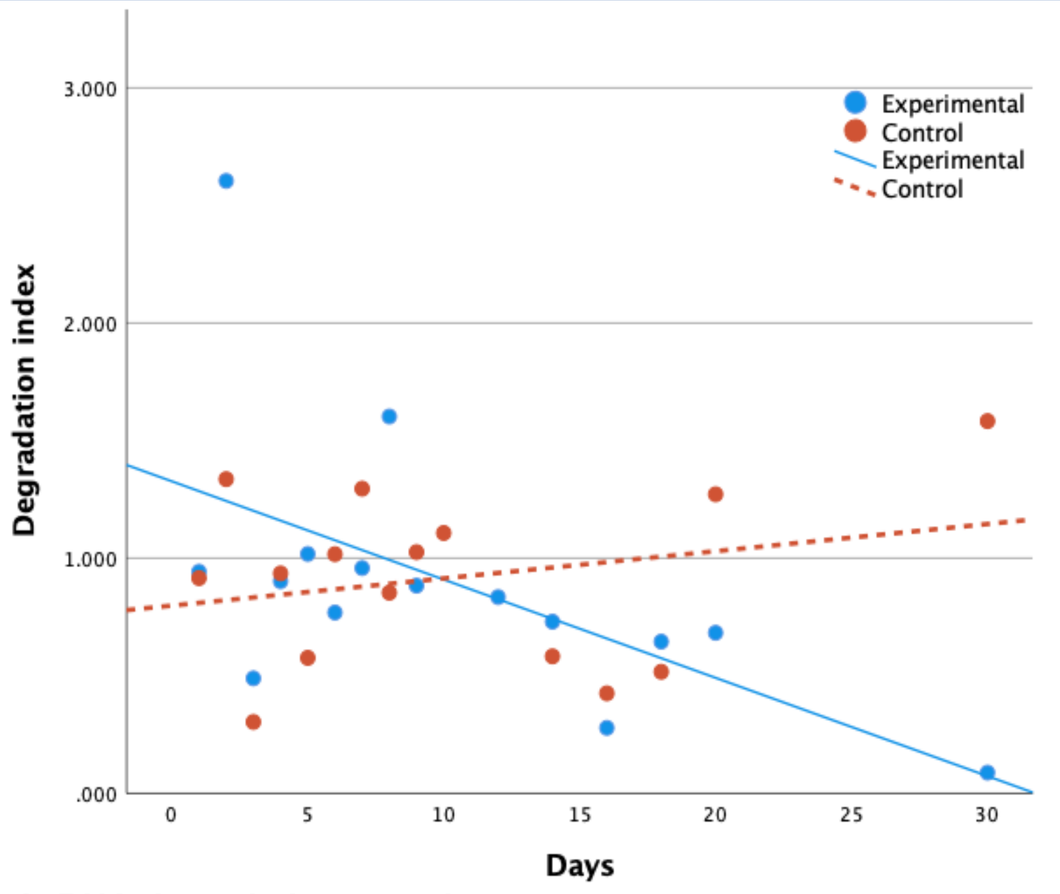


Figure 3: DNA degradation over time
A significant decrease in DNA degradation over time was observed for experimental samples (*p=0.014*), while no significant change was observed for control samples (*p=0.665*). DNA degradation for both groups is, however, considered minimal (< 3.0).

CONCLUSIONS

This study is the first longitudinal study of its kind, contributing to a novel understanding of DNA recovery in marine environments. While it established a baseline measure for DNA concentration and degradation, these are not always indicative of profiling success[4]. Although preliminary STR profiling results indicates a decrease in profiling success after 10 days of submersion, further investigation in needed and could indicate when the application of more sensitive methods, such as massive parallel sequencing, must be considered in forensic case work, given the post-mortem submersion interval. These findings represent a crucial initial stride towards enhancing our comprehension of DNA recovery for the purpose of human identification in marine environments.

REFERENCES

1. Cattaneo C, Tidball Binz M, Penados L, Prieto J, Finegan O, Grandi M. The forgotten tragedy of unidentified dead in the Mediterranean. Forensic Sci Int 2015;250:e1–2.
2. Hughes-Stamm S, Warnke F, van Daal A. An alternate method for extracting DNA from environmentally challenged teeth for improved DNA analysis. Leg Med 2016;18:31–6.
3. Finaughty C, Gibbon VE, Speed B, Heathfield LJ. Lost at sea: A pilot study investigating DNA recovery from teeth in a South African natural marine environment. Forensic Sci Int Genet Suppl Ser 2019;7:580–1.
4. Finaughty C, Heathfield LJ, Kemp V, Márquez-Grant N. Forensic DNA extraction methods for human hard tissue: A systematic literature review and meta-analysis of technologies and sample type. Forensic Sci Int Genet. 2023 Mar;63:102818.

Faculty of Health Sciences
University of Cape Town

MOLECULAR FORENSICS RESEARCH GROUP

University of Cape Town • iYunivesithi yaseKapa • Universiteit van Kaapstad