Decoding Degradation: The Rate of DNA Decay in Varied Burial Depth Environments

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INTRODUCTION & SIGNIFICANCE

The method of DNA analysis can be used in a forensic context to determine the identify of deceased individuals if their physical characteristics are no longer visually identifiable, such as in cases of mass disasters and terrorist attacks.

If adequately preserved, DNA can help refute or confirm the identification of deceased persons. This can aid police in prioritizing their time and resources in an investigation.

This study examined how different burial depths of surface level, 2ft, and 3.5ft affect the rate of DNA degradation. The variables that were considered alongside burial depths included: exposure to fluctuations in temperature, water damage, animal activity, and soil acidity.

It was deduced that due to the 3.5ft specimens' isolation from most of the variables, its genomic material preservation would be superior to the surface specimens. This was assumed due to the surfaces' predicted increase of exposure to rainfall, animal activity, and temperature changes.

MATERIALS & METHODS

- Bone dust
- Table salt
- Dawn dish soap
- 91% isopropanol
- Distilled water
- Centrifuge
- Electrophoresis unit
- SYBR Safe
- Agarose
- SBE buffer
- Xylene cyanol
- Bromophenol blue
- Light box
- Methylene blue
- Microscope
- pH paper

pH paper being used to test the acidity of the 2ft environment

- Buried specimens at surface level, 2ft, and 3.5ft for 6 weeks
- After 6 weeks, ground bone into dust for DNA extraction
- Mixed together bone dust, table salt, dish soap, distilled water, and isopropanol
- Placed DNA into centrifuge for further separation
- Mixed DNA with loading dye
- Injected electrophoresis wells with mixture and ran it
- Placed gel matrix into lightbox and observed visible DNA smears
- Took photos of stained DNA samples under microscope
- Tested pH of soil samples

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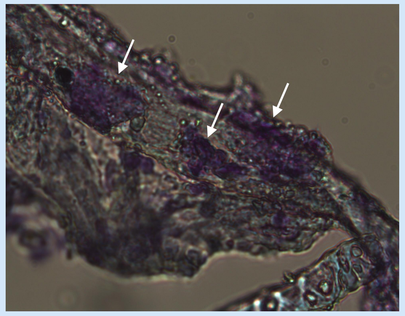
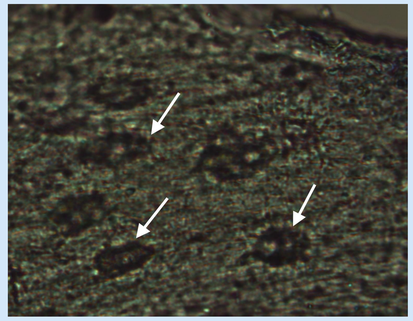
Nuclei of Fresh Sample (Control)



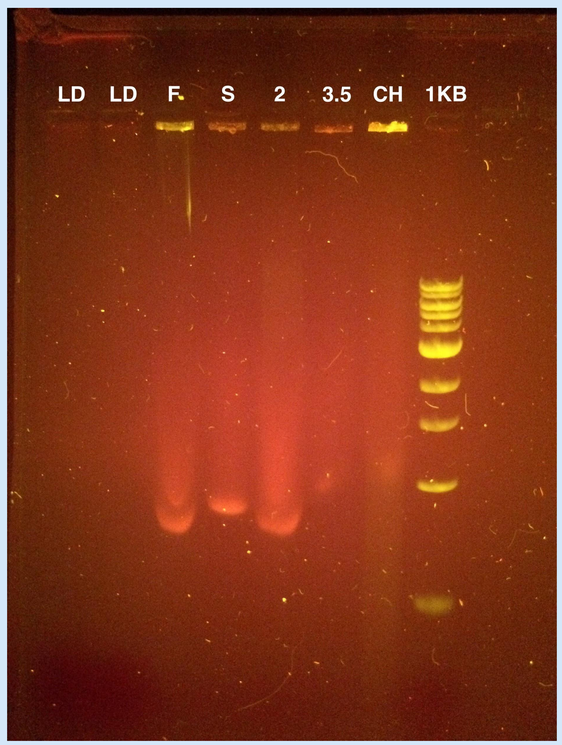
The nuclei have a crisp border (nuclear membrane) and intact shape. The methylene blue has also bound to the copious amounts of genomic material.

Nuclei of Surface Sample



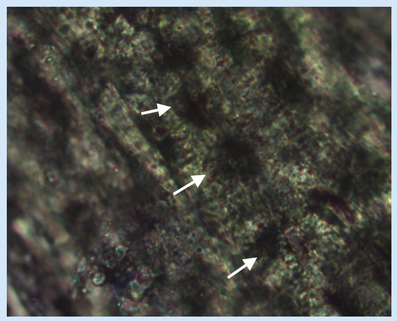
The nuclei have maintained a circular form, however the nuclear membrane is losing distinction. Mild nuclear damage has occurred.

Electrophoresis Smear



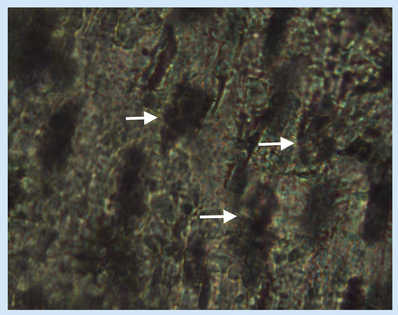
From left to right, the first two wells of the electrophoresis unit were loaded with a combination of xylene cyanol and bromophenol blue, followed by a fresh rib sample, surface rib sample, 2ft rib sample, 3.5ft rib sample, a cheek cell sample, and 1KB.

Nuclei of 2ft Sample



The circular shape of the nuclei has begun to lose integrity. The nuclear membrane is quite indistinct. Intermediate damage has occurred.

Nuclei of 3.5ft Sample



The nuclei have elongated, and lost their membrane integrity. The nuclei from this sample are the most degraded, showing signs of heavy damage.

CONCLUSIONS

While analyzing the results from both the electrophoresis unit and the microscope images, it was concluded that the 3.5ft specimens had undergone the most DNA degradation, followed by the 2ft specimens, with the surface specimens having undergone the least amount of damage. It is important to take two factors into consideration while observing the electrophoresis results: the length of the smear and the light intensity. The length of the smear represents the size of DNA fragments present in the sample. The longer the smear, the smaller the fragments were in the sample. Light intensity indicated the concentration of genomic material - the brighter the region of the smear, the more DNA fragments present. There was high light intensity within the wells of the fresh sample, and as the burial depths of the samples increased, the light intensity decreased. This would indicate that the burials closest to the surface had a high concentration of near-complete DNA strands remaining. It was observed that the 3.5ft specimens had the least DNA concentration and the longest smear, which was a result of it being the most degraded. As for the microscope results, the more elongated the cell shape was and the more indistinct the nuclear membrane, the more degradation the cell had undergone. This was seen in the specimens buried at 3.5ft, and was therefore consistent with the results interpreted from the electrophoresis unit.

After accounting for variables such as water exposure, soil acidity, insect and faunal disturbances, and temperature fluctuation, it was determined that soil acidity had the strongest impact on DNA degradation. Soil samples taken from each burial indicated that the specimens on the surface were placed on soil with a pH of 8, while the 2ft specimens were buried in soil with a pH of 6.5, and the 3.5ft specimens in that of a pH of 5.5. Given that not all of the specimens came into contact with insects, water, and linear temperature fluctuations, it was deemed that these three factors weren't as strong of contributors to DNA degradation as originally assumed.

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