H131 Extending the Biological Profile: Using Stable Isotope Analysis as an Exclusionary Tool in Region-of-Origin Investigations of Unidentified Remains

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After attending this presentation, attendees will understand the application of hydrogen and oxygen stable isotope analysis in forensic anthropology, highlighting how stable isotope analysis can contribute to the biological profile of unidentified remains by tracking the movement of a victim prior to death.

This presentation will impact the forensic science community by demonstrating how an extended biological profile that includes stable isotope data has enormous potential for aiding in the positive identification of unknown individuals.

Although anthropologists have used stable isotope analysis extensively since the 1970s to examine diet, weaning, and migration in prehistory, the technique has had limited application in forensic anthropology, demonstrated by the paucity of stable isotope presentations and publications. Stable isotope analysis offers another tool to the medicolegal community to reconstruct the movement prior to death of unidentified decedents and to exclude possible matches and narrow search areas.

Stable isotope analysis is most beneficial to forensic anthropologists in cases where standard methods of identification are unsuccessful. Although the biological profile typically consists of sex, age, ancestry, stature, and antemortem characteristics, stable isotope analysis of biological tissues can provide additional information regarding migration history, including birthplace, the last decade of life, or the weeks and months before death, depending on the tissue sampled. Previous research has demonstrated the utility of using multiple stable isotopes to identify region of origin and/or dietary patterns in border-crossers' deaths from Mexico, U.S. soldier war-dead from the Vietnam conflict, unidentified individuals from California, and the identification of a U.S. airman's remains recovered in Laos.

The application of stable hydrogen and oxygen isotope analysis of biological tissues to investigate origin is possible because stable isotope ratios of water vary systematically and predictably across landscapes due to environmental factors. These isotope distributions can be visualized using GIS maps highlighting distinct isotopic regions, or isotope landscapes (isoscapes). In turn, the isotopes of biological tissues record the isotopic composition of locally available water. For example, human hair records the isotopic composition of drinking water consumed by an individual throughout the duration of hair growth. Ehleringer et al. demonstrated that predictive models relating human hair stable isotope ratios to drinking water—and thus, geography—achieved an overall 86% success rate between observed and predicted region of origin within the continental U.S.[1]

However, the success of origin predictions based on the analysis of stable isotopes in tissues is dependent upon the quality of water isotope data used in building the foundational predictive isoscapes. Here, the impact of a fine-scale tap water collection scheme within two U.S. states on the performance of a continental U.S. tap water isoscape model originally developed by Bowen et al. was investigated. The collected sample set consisted of 186 tap water samples from several cities throughout California and Oregon. These samples were then used to develop a tap water isoscape specifically for the two coastal states.[2] The new model was then used to predict the isotopic composition of 20 validation samples randomly selected from the dataset that were not used in model generation. The agreement between measured isotope ratios and those predicted using the new isoscape was compared to agreement between measured isotope ratios and those predicted using the previous Bowen *et al.* isoscape in order to judge the accuracy of tap water predictions in the new model generated from samples collected at a finer spatial resolution.[2]

This project highlights the utility of stable isotope analysis in forensic anthropology investigations by demonstrating the application of the technique to tissues that record geographic information and by presenting methods for increasing the reliability of region of origin interpretations based on measured stable isotope data.

References:

1. Ehleringer JR, Bowen GJ, Chesson LA, West DW, Podlesak DW, Cerling TE. Hydrogen and oxygen isotope ratios in human hair are related to geography. PNAS 2008;105(8):2788-93.
2. Bowen G, Ehleringer J, Chesson L, Stange E, Cerling T. Stable isotope ratios of tap water in the contiguous United States. Water Resour Res. 2007;43(W03419):1–12.

Stable Isotopes, Isoscapes, Biological Profile

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