B103 Recent Applications of Stable Isotope Forensics for Tracking Region-of-Origin and Residence Patterns of Unidentified Individuals

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The goal of this presentation is to highlight recent applications of stable isotope forensics for predicting region-of-origin and residence patterns in unidentified human remains. After attending this presentation, attendees will better understand the applications and limitations of stable isotope forensics as an investigative tool in human identification.

This presentation will impact the forensic science community by demonstrating how new approaches in stable isotope forensics can aid in the resolution of unidentified remains cases.

Over the past decade, the use of stable isotope analysis has become an increasingly important part of forensic casework. More recently, stable isotope analyses have been applied to unidentified human remains cases from local jurisdictions, United States service personnel from past wars and conflicts, undocumented border crossers, and victims of genocide. These applications of stable isotope forensics have been successful due to the recent development of baseline water and geological "isoscape" maps for various regions. In addition, recent collaborations between forensic anthropologists and analytical chemists have provided opportunities to develop and test new methods by evaluating samples of known origin.

Stable isotope ratios measured in human tissues, such as bones, teeth, and hair, provide a history of a person's diet and residence patterns. Bulk stable carbon and nitrogen isotope values of bone collagen or keratin (e.g., hair, nails) provide information on the types of foods consumed during life, which in turn may reflect regional or cultural dietary patterns. Stable oxygen isotopes of tap water and precipitation water vary between regions due to environmental factors (e.g., distance from the coast, elevation, aridity) and are incorporated into teeth and bone bioapatite at the time of tissue formation. Strontium isotopes are a product of the geological age of the underlying bedrock in a region and are incorporated into local plants and the animals that consume them, including humans. Thus, stable oxygen and strontium isotopes can be used together as an effective "geolocation" tool for predicting region-of-origin or residence patterns of unidentified individuals. This multi-isotope approach provides independent lines of evidence that narrow down residence patterns and/or region-of-origin of unidentified remains from tissues that form at different intervals (e.g., tooth enamel, bone, hair), which can generate new investigative leads. The approach is most effective in cases where the decedent was born outside of the area or was a recent traveler to the area in which he/she died.

A case study from the western United States demonstrates this potential for narrowing down region-of-origin through comparison of oxygen and strontium isotopes of tooth-versus-bone bioapatite, which represent childhood and adult residence patterns, respectively. Isotopic data indicate that the decedent was not local to the area based on oxygen and strontium isotope values of tooth enamel bioapatite; however, bone bioapatite oxygen isotope values were not inconsistent with the region-of-origin and include other possible regions such as western North America.

A second case study discusses the application of stable isotope forensics for predicting region-of-origin of human bone obtained by the Joint POW/MIA Accounting Command, Central Identification Laboratory. Previous research using stable carbon isotopes of bone collagen and bioapatite found that Southeast Asians could be discriminated from United States Americans with 96.3% accuracy (cross-validated) based on cultural differences in diet (mixed C_3/C_4 diet among United States Americans versus predominately C_3 diet among Southeast Asians).[1] These samples were recovered from various sites in Southeast Asia and were selected from known incidents and were of known origin. Analysis of stable oxygen isotopes of bone bioapatite from three samples allowed for more specific region-of-origin prediction, which could be further narrowed down based on contextual information on the incidents.

The use of stable isotope analysis has enormous potential in forensic science and recent approaches have been successful in predicting probable region-of-origin and residence patterns in undocumented border crosser cases and in victims of genocide.

Reference:

1. Bartelink EJ, Berg G, Beasley MM, Chesson LA. Application of Stable Isotope Forensics for Provenancing Human Remains Recovered from Southeast Asia and the Pacific. Proceedings of the American Academy of Forensic Sciences, 66th Annual Scientific Meeting, Seattle, WA. 2014.

Forensic Anthropology, Stable Isotope Analysis, Human Identification