B198 Forensic Source Attribution Using Stable Isotopes: Hairs to Humans and Insects to Carrion

Glen P. Jackson, PhD, West Virginia University, Dept of Forensic and Investigative Science, 208 Oglebay Hall, Morgantown, WV 26506-6121; Kateryna Konstantynova, 1056 Van Voorhis Road, K416, Morgantown, WV 26505; Mayara P.V. De Matos, MS, West Virginia University, 208 Oglebay Hall, Morgantown, WV 26506-6121; and Rachel M. Mohr, PhD, Dept of Forensic & Investigative Sci, 1600 University Avenue, Morgantown, WV 26506*

After attending this presentation, attendees will understand how stable isotope ratio measurements can be used to: (1) provide physical and characteristic traits about donors from their hair, such as body mass index and age; and, (2) link different life stages of blow flies to their larval food source.

This presentation will impact the forensic science community by providing examples of objective chemical measurements and statistical classification methods for comparing human hairs with the traits of the donors. In addition, this presentation will provide an example of an instrumental method of analysis for predicting the food (carrion) source of blow fly larvae, pupae, and adult flies.

Although Isotope Ratio Mass Spectrometry (IRMS) has historically been considered a specialized technique requiring significant training and expertise, modern instruments provide such automation and ease-of-use that it is becoming more user friendly and a more common tool for answering a variety of forensic, ecological, geological, anthropological, and environmental questions. In the forensic community, IRMS is already in use in many government forensic laboratories and has passed *Daubert* standards for admissibility in court on many occasions. This presentation provides two studies involving source attribution using IRMS.

In the first part of the presentation, two different methods will be presented to classify and attribute human hair to subject groups such as body mass index, age, and sex. One method uses the absolute abundance of the amino acids in human hair, as determined by derivatization Gas Chromatography/Mass Spectrometry (GC/MS). Using this method, the classification model Fuzzy Rule Expert System (FuRES) can predict age or body mass index with better than 90% and 80% success rates, respectively. The second approach uses bulk and amino acid-specific isotope analysis as input variables for classification. Both methods of amino acid analysis required the analysis of 14 amino acids that were released from the hair following acid hydrolysis. Unlike GC/MS, the liquid chromatography/IRMS measurements did not require derivatization prior to analysis. Statistical techniques such as Canonical Discriminant Analysis (CDA) are used to overlook the covariance of amino acid values between individuals caused by dietary factors and instead highlight the selective differences caused by grouping factor(s) such as age, body mass index, and sex. For example, using leave-one-out cross-validation, CDA is able to predict the body mass index of a donor's hair sample with an approximately 80% success rate. Age group can be predicted with an approximately 87% success rate using leave-one-out cross-validation.

The second part of the presentation uses isotope ratios to link blow fly larvae, pupae, and adult flies to different food (carrion) sources. Ecologists often use isotope ratio analysis to determine the trophic level of organisms and their primary food sources; however, such analyses are rarely interested in linking adult insects to a specific meat source in a forensic context. This study presents a proof-of-concept study to test the hypothesis that adult blow flies can be linked to specific food sources via their stable isotope ratios. The results indicate that whereas carbon does not undergo systematic fractionation between carrion source, larvae, pupae, and adult flies, nitrogen undergoes significant fractionation (toward ^{12}C enrichment) at each lifecycle providing a total enrichment of approximately six per mil relative to the source carrion.

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