A110 Using Stable Nitrogen Isotope Ratios From Fly Larvae for Postmortem Interval (PMI) Estimation

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Learning Overview: After attending this presentation, attendees will understand how changes in stable nitrogen isotope ratios ($\delta^{15}N$) of some species of flies collected from decomposing human bodies may aid in the estimation of the PMI.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a novel application of stable isotope analysis of $\delta^{15}N$ values of fly larvae residing on decomposing human bodies to use as an alternative to traditional PMI estimation techniques. Furthermore, this study builds on previous research on the application of $\delta^{15}N$ ratios of decomposing muscle tissue for PMI estimation. By combining muscle and fly larvae data, seasonal differences in PMI can be estimated from the point of death through the entire skeletonization process as long as larvae are recovered.

One of the most difficult periods to estimate PMI is during initial skeletonization. Imagine recovering a surface scatter of a skeleton in late summer or early fall: Did the skeletonization process happen quickly during a hot humid summer or had a long slow winter decomposition occurred over many months? To test if PMI estimation can be improved during initial skeletonization, the putrefaction process of $\delta^{15}N$ ratios in maggots may help. What is happening to nitrogen during decomposition and subsequent consumption by fly larvae? Nitrogen has two stable isotopes with different masses, a heavy (^{15}N) and a light (^{14}N) isotope. In a chemical reaction, the isotopes with different masses will react at different rates, resulting in a preferential selection of one isotope (^{14}N) compared to the other (^{15}N). During decomposition (e.g., putrefaction), the breakdown of amino acids produces a variety of volatile compounds, which preferentially incorporate the light isotope (^{14}N) because it will react faster in a chemical reaction, resulting in an enrichment of the heavy isotope (^{15}N) in the remaining decomposition fluid, which is nutrient rich for fly larvae. The impact to $\delta^{15}N$ values as putrefaction progresses would be higher values through time recorded by fly larvae feeding on the nutrient-rich source.

This research was conducted at the Anthropology Research Facility in Knoxville, TN, an outdoor laboratory for the study of human decomposition. A total of 20 donors were enrolled in the study, placed on the surface in two trials with 10 donors each in January (winter) and July (summer) to test differential seasonality effects to the method as a PMI estimator. Blow fly larvae, an early decomposition insect, were present from February through August. Soldier fly larvae, a late stage decomposition insect, were present from June through December. Regardless of whether raw $\delta^{15}N$ ratios or $\Delta^{15}N$ ($\Delta^{15}N = \delta^{15}N_{Day\ X\ larvae} - \delta^{15}N_{Day\ 1\ muscle}$, with Day 1 as the initial fresh tissue sample to normalize the baseline of different donors), the blow fly larvae did not predict seasonal differences for PMI estimation (p=0.61), while soldier fly larvae could be used to predict winter vs. summer placement (p=0.00).

The winter trial (n=43) had soldier fly larvae arrive after five months of decomposition with a mean $\delta^{15}N$ of 27.4‰ (1SD=6.4) and range of 18.0 to 43.2‰. The summer trial (n=66) had soldier fly larvae arrive after three weeks of decomposition with a mean $\delta^{15}N$ of 18.0‰ (1SD=4.0) and range of 10.7 to 30.0‰; however, there are only four samples above 23.3‰. With a sectioning point of 21.7‰ calculated from the mean $\delta^{15}N$ of the soldier fly larvae, the overall accuracy rate for the sample was 79.8%. For conservative PMI estimates, it is recommended that $\delta^{15}N$ values from soldier fly larvae be used as general indicators of winter versus summer placement when values are above 24‰ vs. below 19‰, respectively.

This East Tennessee pilot study indicates that the significant influence to $\delta^{15}N$ values of soldier fly larvae is time of decomposition prior to arrival of this late stage decomposition insect. The impact to $\delta^{15}N$ ratios as putrefaction progresses would be higher values later in decomposition recorded by soldier fly larvae. This initial study indicates there is value in the method as a PMI estimate for recently deceased individuals when soldier fly larvae are present. This relationship does not hold for early stage insect activity, as seen in $\delta^{15}N$ values of blow fly larvae.

Stable Nitrogen Isotope Ratios, Postmortem Interval Estimation, Fly Larvae

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