The Decomposition of Remains and the Effect of Decomposition Rates on Volatile Organic Chemicals (VOC's) Released

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Background

Analyzing the states of decomposition and the organic compounds produced by decomposing tissues is an expanding field in the area of Forensic Science. By assigning specific criteria to these stages, researchers can better locate a buried corpse and determine the time interval since death (Rodriguez, 1985). However, in order to label the specific decomposition states extrinsic and intrinsic factors need to be considered while examining. Once the stages of decay have been determined the microscopic environment of decomposition can then be studied.

Corpse phenomena can be divided into two categories, abiotic and transformative. Abiotic phenomena can be further broken down into immediate and consequential sections. Immediate abiotic phenomena can be classified as those of the heart, lungs and brain which effect such functions as consciousness, sensitivity, motion, muscle tone, breathing and circulation. Once these functions cease, abiotic phenomena can be observed. Consequential abiotic phenomena include vital activities that occur some time after death. Body cooling, hypostasis, rigor mortis, dehydration and acidification are all examples of consequential phenomena. Transformative phenomena can be broken down into the separate classes of destructive and conservative. Destructive phenomena are the decay of organic matter through the processes of autolysis, autodigestion, and putrefaction. Autolysis and autodigestion involve the partial or complete breakdown of a cell or tissue by self-produced enzymes. They can also be referred to as self-digestion. Putrefaction can be defined as the decomposition of organic matter by bacteria and fungi. Intrinsic and extrinsic factors also affect the rate of decay of a corpse.

Intrinsic factors (nature of the corpse itself) include age, constitution, cause of death, and the integrity of the corpse. With age, fetuses and newborns have a slower rate of putrefaction. Obese corpses decompose more rapidly due to the excessive amount of fluid found in the tissue. Also, those persons who were suffering from illness at time of death, such as a septic infection, experience quickened decomposition as well as those persons who had abnormal openings in the skin. Extrinsic factors (external environment) include ambient temperature, ventilation and air humidity, clothing, and animal predators. Temperature is an important factor for bacteria growth. Optimal conditions for bacterial growth are temperatures between 25°C and 35°C. Dry and windy environments can cause the process of mummification by dehydrating the tissues of the corpse. Mummification impairs bacterial proliferation. When immersed in a water environment degradation slows down due to the tissue

soaking up the surrounding environments. Clothing inhibits postmortem body cooling which speeds up the process of putrefaction. Macrofauna and microfauna accelerate the consumption of organic matter. (Campobasso, 2001)

The stages of decay have been defined in the literature as having approximately four to six different phases. In an experiment conducted by Andrew Wilson *et al.,* the rate of decay is broken up into six different stages. They include fresh (beginning of death, rigor mortis, post-mortem cooling, skin intact and hair firmly attached), primary bloat (accumulation of gasses in the body, no disarticulation, loosening of skin, strong odor), secondary bloat (disarticulation of limbs, purging, strong odor), active decay (deflation, now advanced disarticulation of limbs and start of head, flesh still present, wetness, strong odor), advanced decay (collapse of abdomen, flesh liquefied, skin, bone, fat and cartilage may remain, wetness, adipocere formation) and skeletalization (flesh, skin, fat and cartilage disappear). In contrast, Breitmeier defines the stages of decomposition in four steps. They are Stage 1: early signs of decay; Stage 2: moderate decay; Stage 3: advanced decay with partial skeletization; Stage 4: complete or nearly complete skeletization. Although the stages differ from experiment to experiment they all contain a beginning stage, middle stages, and an end stage. Therefore the stages of decomposition can be defined as having a beginning autolysis stage, middle stages of putrefaction and a final stage of skeletalization.

Autolysis begins shortly after death. Enzymes occurring naturally in the body begin the degradation process. The process typically leads to increased permeability of the cell membrane which causes saturation of the tissues and leads to their liquefaction. (Fiedler, 2003)

The putrefaction process tends to be the most influential in the decay of organic matter. It can be both dry and wet decomposition (mummification or maceration) and is broken up into four stages: discoloration, bloating, liquefaction and advanced decay. The process begins when bacterial enzymes cause the breakdown of tissues by breaking down proteins, carbohydrates and lipids into their basic components. This causes gases to form, such as nitrogen, methane, hydrogen sulfide and ammonia. The production of gas causes the tissues to liquefy down to the skeleton (Rodriguez, 1985). No clear distinction of when the stages of putrefaction change from one another have been determined at this time. (Campobasso, 2001)

Skeletalization occurs when all the flesh and skin has been removed from the corpse and all that is left are the bones. The aerobic decay by bacteria and fungi leads to the entire skeletalization of a corpse. (Fiedler, 2003)

During the course of the decomposition stages various gases are released from a corpse. Thanatochemistry, or the chemistry of death, is a technique used to study these volatile organic chemicals (VOC's) given off from carcasses after death. The area of volatile organic chemicals has rarely been explored and therefore information on them is sparse. VOC's are important in training cadaver dogs, the development of cadaveric material detection devices and the determination of the postmortem interval. (Dekeirsschieter, 2009)

Research Goals

In the study being conducted, volatile organic compounds will be collected and analyzed from differing types of cadavers over various sampling periods. Gases will be acquired using a passive sampling technique involving activated charcoal. Once obtained, the sample containers will go through the process of thermal desorption and be injected for gas chromatography analysis. The results of the VOC's captured will help to better define the varying stages of decomposition with in a corpse. Also, collaborators at Sam Houston State University will be able to use the data, along with observations onsite, to predict the colonization of various insects.

Expected Outcome

At the conclusion of the work proposed, we hope to be able to publish the findings in reputable journals and/or present them to the scientific community at local, regional or national conferences.

References

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