Case Report

Using Ninhydrin to Reconstruct a Disturbed Outdoor Death Scene

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Abstract: Ninhydrin reacts with various nitrogen-containing compounds, including some that are released from a body during decomposition. Previous research has shown that ninhydrin can be used to identify gravesoils, however, its potential value in death scene reconstruction has not been previously demonstrated. To explore this possibility, the concentration of ninhydrin-reactive nitrogen (NRN) was measured in soil associated with a scavenged death scene where the remains had been scattered. Levels of NRN in the decomposition area were 7 to 13 times higher than in other areas of the scene (under lower body, upper limb, manure and fecal matter, scalp) after more than a four-month postmortem interval. The ability to reconstruct the scene was enhanced, as this measure identified the most probable location of death and decomposition prior to disturbance.

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Introduction

Ninhydrin is a chemical that reacts with amino acids and has long been used to recover fingerprints from paper [1]. Recently, Carter et al. [2] observed that, upon decomposition, a body releases a significant amount of nitrogen into associated soil in the form of compounds that will react with ninhydrin. As a consequence, ninhydrin has been used to detect the presence of soils associated with decomposing bodies (gravesoils). In areas of low population density where a body can go undiscovered for an extended period of time, ninhydrin might be used to locate clandestine bodies. In addition, as discussed in the current case, ninhydrin might also be used to reconstruct death scenes that have been subject to a natural disturbance event such as scavenging.

Case Summary

On November 23, 2007, partially decomposed human remains were discovered by a farmer within a semiwooded draw in rural Lancaster County, Nebraska. The remains were generally localized, although separated into four distinct spots (Figure 1). A search of the area yielded a shotgun, shotgun case, and cellular telephone. No vehicle was found and a records query for vehicles towed from the vicinity was unsuccessful. The serial number of the shotgun was not unique and could not be traced. A search warrant was served on the cellular telephone service provider, and the subscriber of the telephone had reported his 27-year-old son missing since July 11, 2007. Dental x-rays were compared to known dental records of the missing male, which resulted in an identification. The police investigation, autopsy, and entomological evidence were used to estimate the postmortem interval and to establish the cause and manner of death. The 27-year-old male died on or about July 11, 2007 from a single shotgun wound to the head; the manner of death was determined to be suicide.

Because the remains had been scattered, probably through the activity of scavengers, this case provided an opportunity to investigate the use of ninhydrin in the reconstruction of an outdoor death scene following disturbance, with the specific aim of determining the location of death and where most of the decomposition occurred. Consequently, the concentration of ninhydrin-reactive nitrogen (NRN) was measured in soils collected from the scene.

Materials and Methods

Soils were collected from a depth of 0 to 3 cm with a Kleen Hole Spade (Clear Lake, Iowa) stainless steel probe (1-inch diameter). Soils were collected from seven areas. Specific sampling sites were chosen based on recovery of remains, indicators of greatest decomposition (vegetation loss and association of insects), potential confounding material (cow manure), and control sites. Specifically, these six sampling sites were (1) the presumptive primary decomposition area that included the head and torso (area A), (2) the lower body (area B), (3) arm and hand (area C), (4) scalp (area D), (5) manure, and (6) two control samples (soils not associated with the body or manure) (Figure 1) that were collected approximately two meters northwest and northeast of the decomposition area. The measurement of NRN in these soils, conducted in triplicate, followed the method described by Carter et al. [2] Data were tested for normality and homogeneity of variance using the Kolmogorov-Smirnov test and Levene's test, respectively. Parametric statistics were generated with a univariate analysis of variance using Statistical Package for Social Sciences (SPSS), version 16.

Results

Soils recovered from this scene were identified as Judson silt loam, which represents 5.1% (27,437 acres) of all soils in Lancaster County, Nebraska. The soil in the presumptive decomposition area contained a concentration of NRN that was significantly ($P < 0.001$) (approximately 7 to 13 times) greater than soil associated with no remains, the scalp, the arm and hand, the lower body, and manure (Figure 2). The scalp, arm and hand, lower body, and manure did not have a significant effect on the levels of NRN in the soils on which they were located.

Discussion

Based upon previous observations that a decomposing body will release a significant amount of NRN into associated soil [2], the decomposition area was concluded to represent the location of the majority of decomposition and, most likely, death. Thus, the components of the body were likely moved after most of the body had decomposed or were consumed by scavengers before

they were able to release NRN into the soil. Although a visual inspection of the decomposition area supported the hypothesis that it was the location of death and decomposition (because of the death of vegetation), the analysis of NRN provided a quantitative means to test our hypothesis.

Arguably, the most important finding in this case was the effect of fecal matter on NRN levels in soil. The release of NRN into the soil is not unique to humans or other mammals. Ninhydrin-reactive nitrogen can be released from others sources such as manure, urine, and plant materials. Thus, an elevated level of NRN in soils does not necessarily indicate the presence of a human body. However, the somewhat unique opportunity to measure the concentration of NRN associated with manure, plant material, and components of the body increases the level of scientific certainty that the decomposition area represented the location of death and initial decomposition.

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References

1. Odén, S.; von Hofsten, B. Detection of Fingerprints by the Ninhydrin Reaction. *Nature* **1954**, *173*, 449-450.
2. Carter, D. O.; Yellowlees, D.; Tibbett, M. Using Ninhydrin to Detect Gravesoil. *J. For. Sci*. **2008**, *53* (2), 397-400.

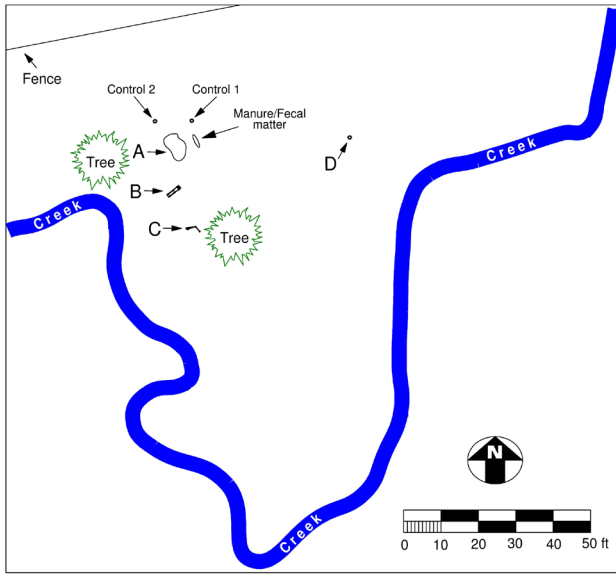
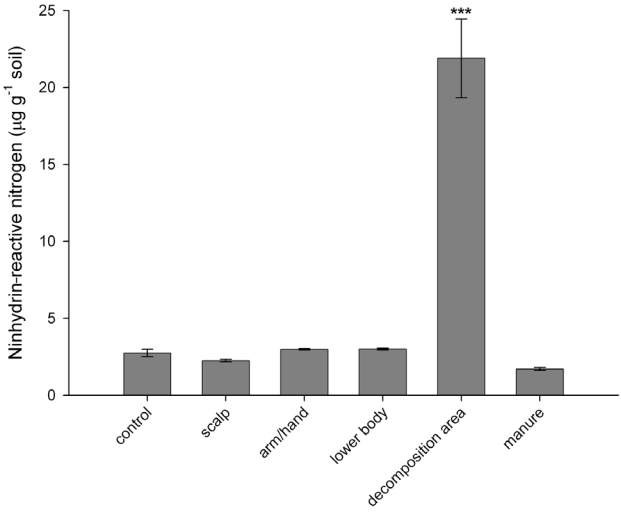


Figure 1

Finished sketch of death scene located in rural Lancaster County, Nebraska. (A=decomposition area, B=lower body, C=arm/hand, D=scalp)



Bars represent standard errors where n = 3.
*** represents a significant (P < 0.001) difference between the decomposition area and other sampling locations.

Figure 2

Concentration (micrograms per gram of soil [µg g^{-1} soil]) of ninhydrin-reactive nitrogen in soil associated with no remains (control), the scalp, arm and hand, lower body, decomposition area, and manure on 25 November 2007.