RESEARCH ARTICLE

Detecting Blood Patterns in Soil with Luminol Two Years after Deposition

[1]Adair, T.W., [2]Shimamoto, S., [3]Tewes, R., and [4]Gabel, R.

Introduction

This is the second and final report on a two-year study conducted at the Highlands Ranch Law Enforcement Training Facility in Douglas County, Colorado (USA). The first report discussed the findings of the study through twelve months of observations (1). This report will discuss continued observations between the twelve and twenty-four month intervals. This study began in October of 2004 and was designed to last until October 2006. In the initial experiment six grid units were established on a hilltop at the research facility. Each grid unit measured twenty four inches square and the units were aligned north to south beginning with Unit #1. The grid units were exposed to full sun and other environmental conditions. No shade was available at the site. Five hundred milliliters (500 ml) of horse blood was poured in an "X" pattern in each grid unit during the first week of October 2004. Each arm of the "X" consisted of 250 ml of blood. There were no visible signs of the blood on the surface soil within one week of depositing the blood.

Elevation at the site is approximately 1830m (6000 ft) above sea level and is comprised mainly of gently rolling hills of Gambel oak (*Quercus gambelii)* with scattered stands of conifer. The site also consists of native grasses and low mesa topography. The site has been controlled by active law enforcement since 1985 and there is no history of blood letting or blood experimentation in the study location. Weather records for the two year study were obtained from the Colorado Climate Center at the Castle Rock station in the city of Castle Rock which was located approximately 10 miles to the south. A total of 33 inches of precipitation fell on the site during the two year study period. This is in line with the annual average of approximately 16.6 inches of precipitation recorded from 1948 to 2005 for the Castle Rock area as reported by the Colorado Climate Center.

Materials and Methods

Every two months the authors tested one half of the grid unit with the Luminol reagent beginning with grid Unit #4. Half of the unit was covered with plastic sheeting at the 14th, 18th, and 22nd month intervals to protect it from overspray. The reagent prepared for all testing sites consisted of both a commercially available kit and a mix of the following formula: .5g 5-amino-2,3-dihydro-1,4-phthalazinedione (Luminol), 25g sodium carbonate, 3.5g sodium perborate, per 500ml distilled water. The Luminol and sodium carbonate is combined in 250ml distilled water and the sodium perborate is mixed in the remaining 250ml of distilled water. Successful photographs of the reactions were obtained using digital cameras such as the Nikon D50, D100, D2H, Fuji Finepix® S7000, and the Fuji Finepix® S20pro. Acceptable exposures were from 10-30sec. at f3.5-f4.0.

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[1]Senior Criminalist, Westminster Police Department, Westminster, CO, [2]Criminalist, Lakewood Police Department, Lakewood, CO, [3]Laboratory Manager, Fort Collins Police Department, Fort Collins, CO, [4]Criminalist, Denver Police Department, Denver, CO

Results:

At the fourteenth month interval the authors found approximately three inches of freshly fallen snow on top of the grid unit to be tested. A small shovel was used to clear off the snow on half the soil surface. The Luminol reagent was applied directly to the soil with immediate and positive results (Figure 1.). At times, vegetation growing in the test grid was cut at the soil surface. This was done to reduce interference of the vegetation with the reagent application and subsequent photography. In the months to follow there was a noticeable, but expected, reduction in luminescence on the soil surface of the grid units. Up to the eighteenth month the surface luminescence became smaller in area. This was due in part to the movement and erosion of the surface soil as well as the leeching of the blood to lower soil levels through dilution by precipitation.

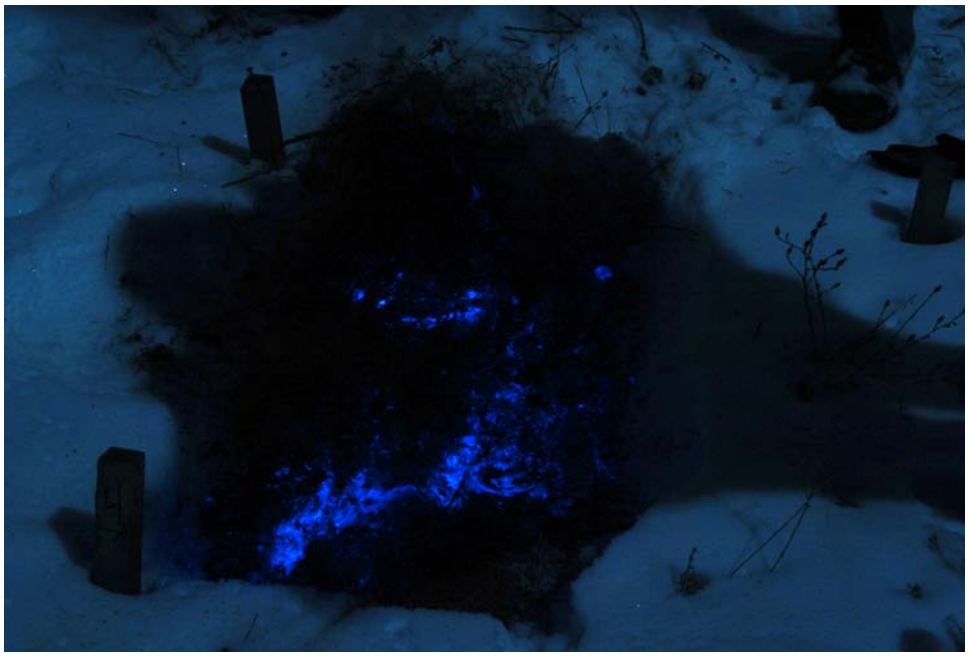

Figure 1. One half of "X" pattern in grid Unit #4 at 14 months.

By the twenty fourth month the surface luminescence was only a few square inches in sporadic areas. As discussed in the previous paper it was thought that by scraping off the surface soil a more complete reaction area could be detected. Beginning at the eighteenth month it became necessary to scrape the surface soil to a depth of about ¼". This minor surface scraping enhanced the reaction area considerably (Figures 2-4). While the scraping did increase the reaction area it simultaneously blurred and softened the edges of the "X" pattern. In addition, blood tainted soil was pulled through areas previously void of blood. While the intensity of the reaction was still stronger in the original arms of the "X", the areas between the arms created a reaction area over much of the grid unit. The "X" pattern was unrecognizable at the twenty-fourth month although the total reaction area was consistent with the original pouring. At the 24 month interval the authors re-applied the Luminol reagent to all six grid units of the study. These six grid units represent the entire study group for the two year study. The authors achieved

an immediate and strong Luminol reaction in each of the six grid units after minor surface scraping (Figure. 5).

Figure 2. Luminol reaction in grid Unit #4 at the sixteen month interval.

Figure 3. Luminol reaction in grid Unit #5 at the twenty month interval.

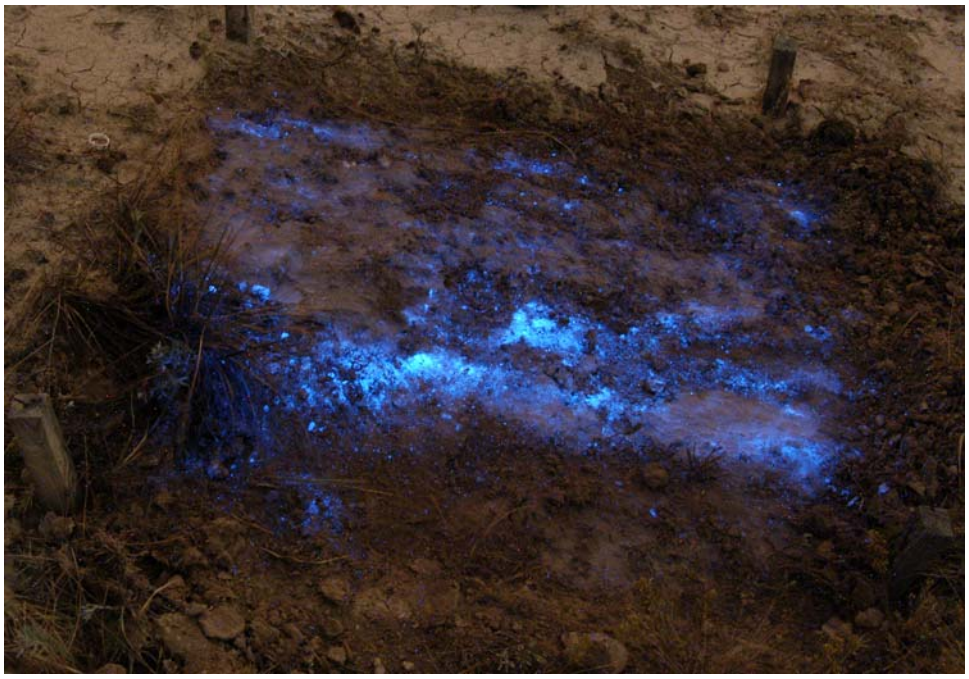

Figure 4. Luminol reaction in grid Unit #6 at the two year interval.

Figure 5. Luminol reaction in all six grid units.

On the final night of the study it was decided to dig deeper into the soil to test the depth of the reaction area. Reactions could be found approximately seven inches down into the soil. One interesting observation is that the reaction at this lower level appeared to follow the root structure of the surface plants (Figure 6). Reaction lines traveled both vertically and horizontally. It was unclear if the blood had flowed along the root structure as it penetrated the soil, or if it was actually absorbed by the roots themselves.

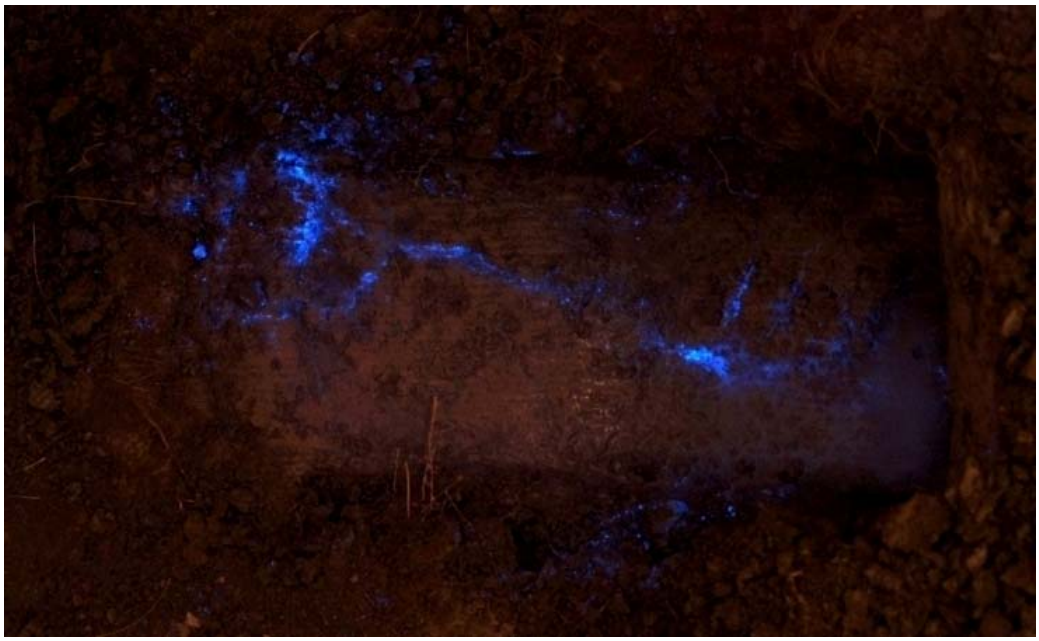

Figure 6. Luminol reaction along plant root lines.

Interestingly, this site is part of a larger study area researching clandestine grave sites under the supervision of NecroSearch International (NSI). Pigs have been buried at various locations across this eleven acre research area since 1986. Some of the burials are nearly twenty years old. Dog handlers for NSI have previously observed their bloodhounds indicating a "hit" on the leaves of Gamble oak above a grave instead of the grave sites below. This occurred several years after burial and it was surmised that the components of the "scent" detected by the dogs had been absorbed by the vegetation surrounding the grave and stored in the leaves. This theory was supported by a forensic botanist in the group. Our observations may give some additional indicators that biological material such as blood can be partially absorbed into plant material from the soil it occupies. Further research will undoubtedly be needed to fully understand and explain these observations.

Discussion

This project confirmed that bloodstains previously treated with Luminol could be detected in soil up to twenty four months following deposition with the Luminol reagent. While pattern detection may have limited value in an investigation (without confirmatory DNA results) it may serve to validate witness or co-conspirator statements of criminal activity. In some cases a negative result may indicate that such statements are inaccurate or misleading. Before reaching such a conclusion however, investigators must develop an understanding of the soil properties in the suspect area. Investigators should also be sure they are testing the correct area prior to concluding a negative result. Similar Luminol studies in these areas should be considered depending on the length of time involved.

The biggest challenge to the investigator will be locating the reaction area with the reagent. Because of the light sensitivity of the Luminol reaction searching will need to be conducted at night. In urban areas it may be difficult to find areas devoid of artificial light. In rural areas investigators may wish to search on a moonless and cloudless night if possible. The application of the reagent is another challenge. Approximately thirty-two fluid ounces of the Luminol reagent was used in each grid unit for both searching and photography. This was a known area with a small defined search area. Searching larger areas may prove to be impractical in both cost and time. The authors have successfully used a large gallon size pump sprayer to apply the reagent over larger areas. Obviously the more one can define the search area the better the likelihood one will find the reaction area.

Investigators may consider employing appropriately trained and bred cadaver dogs to locate areas of interest. These searches are best conducted during daylight with areas of interest marked for a subsequent search with Luminol reagent. The use of a hand held GPS unit may also be valuable in remote areas devoid of adequate landmarks. Once a reaction area is located we recommend obtaining photographs of the surface reactions followed by additional photographs as the soil is scraped away. We also recommend the testing of soil areas near but disconnected from the suspect area. This may help indicate any false positive properties present in the soil. It is hoped that similar studies will be conducted in other areas to better define the Luminol reaction in soil. A similar five year study is planned for the northern Colorado Front Range and results will be periodically reported.

Reference

1. Adair, T.W., Shimamoto, S., Tewes, R., and Gabel, R. The Use of Luminol to Detect Blood in Soil One Year After Deposition. *IABPA News* 22(3):4-7. September 2006.