TECHNICAL NOTE

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Deciphering Bloody Imprints Through Chemical Enhancement

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ABSTRACT: Obliterated bloody impressions are occasionally submitted to the crime laboratory, and potentially to the document examiner, for decipherment. Nondestructive methods often lead to inconclusive results in these circumstances. With this point in mind, the researchers explored a series of chemical reagents with the intent to enhance bloody imprints to a legible degree. The reagents selected for this comparison include rhodamine dye, luminol, and Coomassie Blue stain.

KEYWORDS: criminalistics, impressions, blood, reagents

On occasion, obliterated written or mechanical impressions are submitted to the laboratory for interpretation. The possibility that such impressions are of value, if deciphered, poses itself as an unusual sort of questioned document problem.

The medium incorporated to transfer impressions onto receptive surfaces ranges from the common, such as ink, to the deviant, such as blood. The transfer of blood, intentional or not, often leaves an imprint indecipherable to the human eye, even using photographic enhancement, computerized image enhancement, or other nondestructive enhancements such as various lighting conditions including panchromatic (visible or white), ultraviolet, infrared, or laser.

With this point in mind, we evaluated a series of chemical reagents to enhance bloody impressions to a legible degree, either solely with chemicals or in combination with a range of lighting conditions or photographic enhancement or both [*1*].

The reagents selected for this comparison include rhodamine dye, luminol, and Coomassie Blue stain.[2]

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[2]The chemicals used in this experiment may be potentially harmful or carcinogenic in high concentrations. It is recommended that precautions be taken (that is, gloves, goggles, and masks be used) for personal safety when handling these chemicals, even in low concentrations.

Methods

Test blood impressions were prepared by immersing a rubber stamp in liquid human blood and making contact to white cotton cloth, Cascade Xerographic White Bond paper, and Dixon Paper Company Blue Basket Weave La Monte Safety paper.[3] Varying degrees of pressure were applied to prepare these impressions (Figs. 1 and 2).

The "blood stamps" on cotton cloth were stored in manila envelopes for seven weeks before chemical testing ensued, and the paper specimens, in similar envelopes, were stored for one week.

The reagents, rhodamine dye (Kodak $C_{28}H_{31}ClN_2O_3$) [*2*], Coomassie Blue stain (Sigma

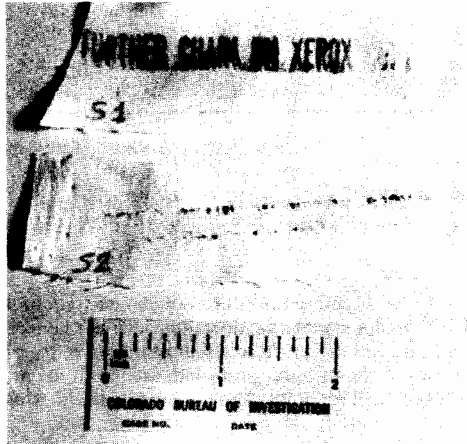

FIG. 1—*Test impressions prepared in blood on white cotton cloth.*

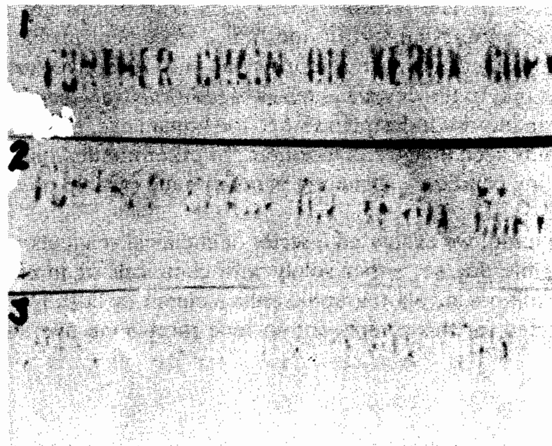

FIG. 2—*Test impressions prepared in blood on white bond paper and blue safety paper.*

[3]Safety measures should be used when handling unknown serological evidence. These would include polyvinyl gloves, masks, and goggles.

Brilliant Blue R) [3], and luminol [4], selected for the chemical enhancements were prepared as shown in Tables 1 through 4.

Three series of examinations were conducted using the "blood stamps." Untreated reference bloodstains were maintained along with the chemically treated test stains throughout the experiment. Initially, the blood impressions were photographed for preservation.

Next, the stamps were examined unprocessed under visible, ultraviolet, infrared, and laser light conditions.

The observations under panchromatic, or visible, lighting conditions were performed with overhead fluorescent light fixtures incorporating four 40-W bulbs per fixture.

The short- and long-wave ultraviolet light examinations were completed with a Model UVGL 54 Mineral light operating at 254 and 366 nm.

Infrared reflectance examinations were performed with a Pulnix Silicone Chip Video camera with a Tiffin 7-87 glass filter equipped with a RCA black-and-white video monitor [5].

The laser used in these examinations was a Cooper Lasersonics copper vapor laser. This direct-beam laser operates at 510 nm with a frequency of approximately 6 Hz. It emits a very intense bright green with an average power of 12 kW [6,7].

TABLE 1—*Preparation of rhodamine dye.*

Stock solution:
50 mg/100 mL of methanol
Working solution:
1 mL of stock solution, dilute to 100 mL with methanol

TABLE 2—*Preparation of luminol.*

0.5-g luminol
500-mL H_2O (distilled)
3.5-g sodium perborate
25-g sodium carbonate

TABLE 3—*Preparation of Coomassie Blue stain (Brilliant Blue R).*

400-mL methanol
80-mL glacial acetic acid
400-mL H_2O (distilled)
(10:2:10 ratio)
add 8.8-g Coomassie Blue to the above solution (0.1 g/100 mL), place on stirrer, and add dry Coomassie Blue slowly.

TABLE 4—*Preparation of Coomassie Blue destain.*

400-mL methanol
80-mL glacial acetic acid
400-mL H_2O (distilled)
(10:2:10 ratio)

A VGC POS Total Camera II with negative black-and-white film was used for the photographic enhancement of the samples.

Finally, the "blood stamps" were chemically processed with various combinations of rhodamine dye, Coomassie Blue stain, and luminol, as well as up to three repetitions of solely Coomassie Blue stain (Tables 5 and 6). Upon completion of the chemical testing, the stains were reexamined under various lighting conditions and rephotographed.

The chemical processing is destructive and damages serological evidence. Any serological stains should be preserved before attempting to decipher obliterated impressions in actuality.

Results

"Blood Stamps" on Cotton Cloth

Observations of the unprocessed "blood stamps" under alternate lighting conditions provided inconclusive results, as did special photography; therefore, chemical enhance-

TABLE 5—*Format for chemical processing of "blood stamps" on cotton cloth.*

Stain	Application of Reagent[a]
1	standard
2	A
3	B
4	C
5	A,B,C
6	A,C
7	B,C
8	A,C
9	B,B,B

[a]A = Spray with rhodamine dye (under a fume hood), wait 30 s, rinse with methanol. B = Soak in Coomassie stain for 20 min (max), rinse thoroughly with destain solution. C = Spray with luminol (under a fume hood).

TABLE 6—*Format for chemical processing of "blood stamps" on white bond paper and blue safety paper.*

Stain	Application of Reagent[a]
1	standard
2	A
3	B
4	A,B
5	B,A
6	A,B,A
7	B,B,B

[a]A = Spray with rhodamine dye (under a fume hood), wait 30 s, rinse with methanol. B = Soak in Coomassie Stain for 20 min (max), rinse thoroughly with destain solution.

ment was necessary. The application of Coomassie Blue stain, rhodamine dye, and luminol, and combinations thereof, to the stains produced interesting and potentially useful results.

The Coomassie Blue stain chemically darkened the bloodstain (while observed under visible light) by reacting with the proteins present in the blood (Fig. 3). In combination with the other lighting conditions, it did not produce useful results. The Coomassie stain was applied to the blood stamps up to three times and found to enhance the blood slightly after each additional application. Note that a point of no return was reached when the blood's protein supply was depleted.

Rhodamine dye contrasted the stains slightly by acting as a background reducer when used in combination with the laser light.

Luminol was the most disappointing; although it indicated the presence of blood, it smeared and obliterated the stain even more (Fig. 4).

The combination of rhodamine dye, Coomassie Blue stain, and the laser provided the most striking results. The reduction of the background with the rhodamine dye under

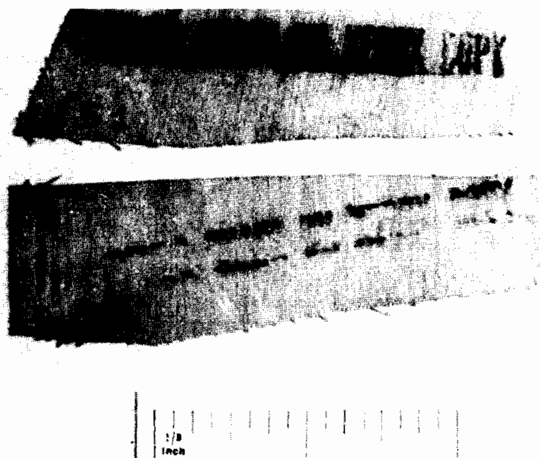

FIG. 3—*Blood imprint chemically treated with Coomassie Blue stain and visualized under panchromatic light.*

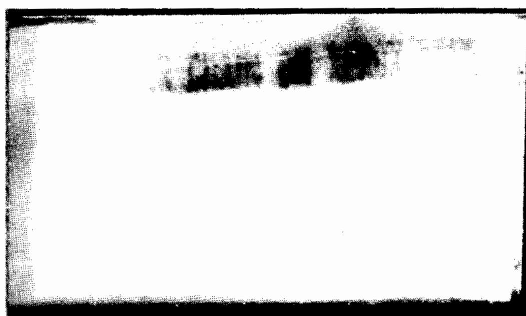

FIG. 4—*"Blood stamps" on white cotton cloth chemically treated with luminol.*

laser light and enhancement of the bloodstain with the Coomassie resulted in the highest contrast, and an otherwise illegible impression was deciphered (Fig. 5).

A compilation of these results is depicted in Table 7.

"Blood Stamps" on White Bond and Blue Safety Paper[4]

As with the bloodstains on cotton cloth, the observation of these "blood stamps" under various lighting conditions proved inconclusive, as did special photography.

The next step, chemical enhancement, was then conducted. When applied to the "blood stamp" on paper, a large amount of Coomassie Blue stain was absorbed by the paper fibers. A majority of this could be removed from the background by washing with the

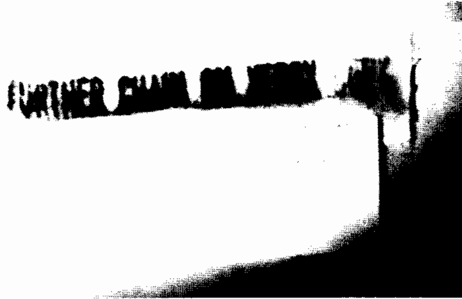

FIG. 5—*"Blood stamp" on white cotton cloth chemically treated with Coomassie Blue stain, rhodamine dye, and observed under laser lighting conditions.*

TABLE 7—*Results from the chemical processing of "blood stamps" on cotton cloth.*

Stain	Panchromatic	Ultraviôlet	Infrared	Laser	Photography
1	no change	no change	no change	no change	no change
2	no change	no change	no change	background lightened	no change
3	stain darkened	no change	no change	no change	no change
4	stain ran	no change	no change	no change	no change
5	luminol ran stain	no change	no change	no change	no change
6	luminol ran stain	no change	no change	no change	no change
7	luminol ran stain	no change	no change	no change	no change
8	stain darkened	no change	no change	stain darkened background lightened[a]	no change
9	stain very dark	no change	no change	no change	no change

[a]Optimal results obtained with the combination of Coomassie Blue, rhodamine rye, and laser.

[4]Luminol testing was not conducted on paper surfaces since inconclusive results were obtained on the cotton cloth.

destain solution numerous times (Fig. 6). After a maximum of two applications, the paper fibers were saturated with the Coomassie Blue stain. The Coomassie stain could then no longer be sufficiently removed by destaining.

The addition of Rhodamine dye under laser light served little purpose, since no significant background reduction occurred. The paper merely appeared pinkish, indicating the absorption of the rhodamine dye.

Photographic enhancement of the "blood stamps" treated with Coomassie Blue stain did prove beneficial by creating a higher degree of contrast between the impression and the background (Fig. 7).

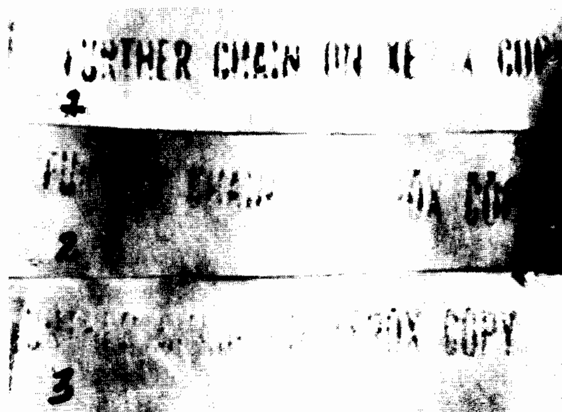

FIG. 6—*"Blood stamps" on white bond paper chemically treated with Coomassie Blue stain one time and washed with destain numerous times.*

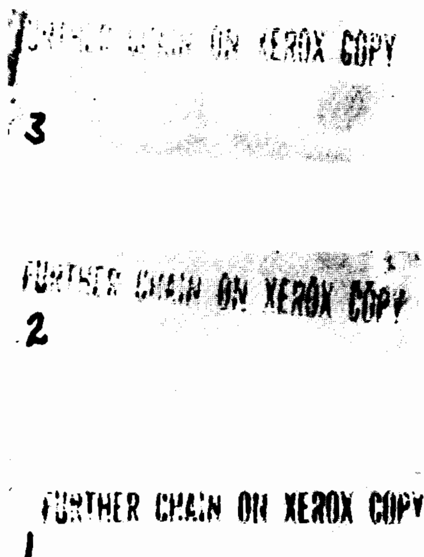

FIG. 7—*Photographic enhancement of "blood stamps" on white bond paper chemically treated with Coomassie Blue stain.*

TABLE 8—*Results from the chemical processing of blood imprints on paper.*

Stain	Panchromatic	Ultraviolet	Infrared	Laser	Photography
1	no change	no change	no change	no change	no change
2	paper pink color	no change	no change	no change	no change
3	stain darkened	no change	no change	no change	stain darkened background reduced[a]
4	stain darkened	no change	no change	no change	no change
5	stain darkened	no change	no change	no change	no change
6	stain darkened	no change	no change	no change	no change
7	stain and paper darkened	no change	no change	no change	no change

[a]Optimal results obtained with the combination of Coomassie Blue stain and photographic enhancement.

These observations indicated that chemical enhancement with the Coomassie Blue stain does provide useful results by providing a means to decipher imprints on paper surfaces. A compilation of these results is provided in Table 8.

Conclusion

Successful results were obtained through the chemical enhancement of experimental "blood stamps" on cloth and paper surfaces. The Coomassie Blue stain reacted with the blood's proteins, rhodamine dye eliminated possible background interferences on cloth surfaces, and photography eliminated any background interferences on paper; thus, otherwise illegible impressions proved decipherable. As long as a sufficient amount of the blood's protein is present, though not to the naked eye, the potential for deciphering bloody imprints remains.

Acknowledgment

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