TECHNICAL NOTE

John I. Thornton,[1] *D.Crim.; Kevin Guarino,*[1] *M.P.H.; Ferdinand G. Rios,*[1] *M.P.H.; and Paul J. Cashman,*[2] *D.Crim.*

Enhancement of the Luminol Test by Means of Light Amplification

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ABSTRACT: The type of device commonly referred to as a "starlight scope" will amplify available light by a factor of approximately 17 000. The use of this device will permit an image to be formed by exceedingly small amounts of blood when reacted with luminol reagent. Modification of the apparatus is necessary to permit focusing at short distances.

KEYWORDS: forensic science, luminol, luminescence

The sensitivity of the luminol test is variously reported at 1:100 000 to 1:5 000 000, depending upon the prior treatment of the suspected bloodstain and the composition of the reagent [*1-3*]. In the authors' laboratories, the sensitivity tends decidedly toward the lower figure, or even worse. Whatever the sensitivity is with a particular system, however, it may be enhanced greatly through the use of a so-called "starlight scope" (Fig. 1). These devices are used by police agencies for purposes of nighttime surveillance and by the military (under the rubric of "Night Vision Sight, Miniaturized, Personal") for rifle sights. Unlike the older infrared devices requiring a source of infrared radiation, starlight scopes are passive, amplifying available light by means of a photomultiplier and creating an image on a green phosphor screen. These devices will amplify light by a factor in excess of four orders of magnitude (generally about 17 000 times) and will magnify the image by four times.

When dealing with exceedingly dilute bloodstains, the luminol reaction may provide an insufficient luminous flux to stimulate the rods of the retina to result in a visual image. The desired reaction may indeed be taking place, but the observer would be oblivious to it. If, however, the area tested with the luminol reagent is viewed with a starlight scope, very small amounts of blood may be visualized. This would be useful in those situations where an overt

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[1]Professor, graduate student, and graduate student, respectively, Forensic Science Group, Department of Biomedical and Environmental Health Science, University of California, Berkeley, CA.

[2]Associate professor, Department of Criminal Justice, California State University, Sacramento, CA.

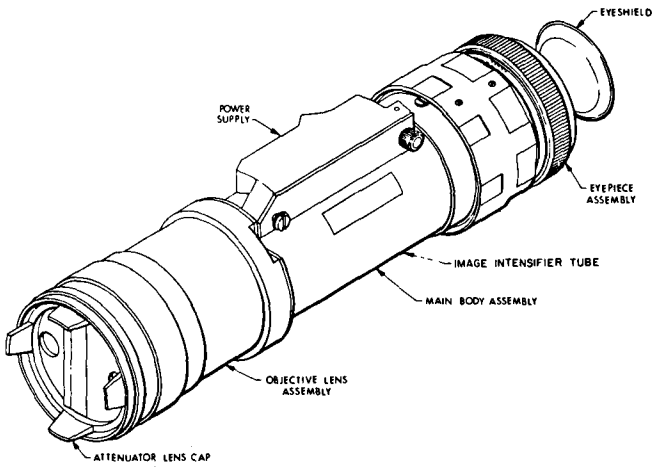

FIG. 1—*Night Vision Sight, Miniaturized, Personal, AN/PVS-3, or "starlight scope."*

attempt has been made to clean up a bloodstain. Since this is perhaps the most conspicious application of the luminol test anyway (given its relative lack of specificity), the use of the starlight scope in situations such as these would appear to be of some benefit (Fig. 2).

Methods and Materials

An Army AN/PVS-3 Night Vision Sight was used for the present study. Devices such as this are available as surplus equipment (although costly), or may be borrowed from local Department of Defense establishments. The device used in this study weighed approximately 1.5 kg (3 lbs) and is quite portable. Since the device will normally only focus down to 4 m, a modification was necessary to provide the focus needed to search for dilute bloodstains in restricted areas. This modification involved the attachment of a 50-mm diameter biconvex lens with a focal length of 500 mm to the front of the starlight scope. A lens of this description may be obtained from a common low-power hand magnifier, a la Sherlock Holmes, and attached to the front of the scope with vinyl electrician's tape.

Removing the rubber eyeguard from the starlight scope exposes a slip ring with a diameter just in excess of 49 mm, enabling a press fit of a 49-mm diameter macro lens of a 35-mm camera. The macro lens was set at infinity, and focusing was accomplished by means of the starlight scope focusing ring. This arrangement permitted focusing down to approximately 15 cm.

Serial dilution of blood in water were made in the range of 1:1 000 to 1:1 000 000. These dilutions were brushed or sprayed onto white filter paper. When dry, the paper was sprayed with luminol reagent made up according to the method of Weber [*4*]. The stock solutions were: (a) 0.354 g of luminol (3-aminophthalhydrazide) in 62.5 mL of 0.4*N* sodium hydroxide to a final volume of 500 mL with water; (b) 8 g of sodium hydroxide in 500 mL of water; and (c) 10 mL of 30% hydrogen peroxide in 490 mL of water. The working solution is made up of 10 mL of each of the three stock solutions with water to a final volume of 100 mL. Using Kodak Tri-X film with an ASA of 400, an exposure time of between 1 and 5 s was sufficient to obtain a suitably exposed negative through the starlight scope. Longer exposures resulted in a diffuse luminosity resulting from autochemiluminescence, rather than a discrete image of the bloodstain. The film was developed normally in Kodak D-76 developer.

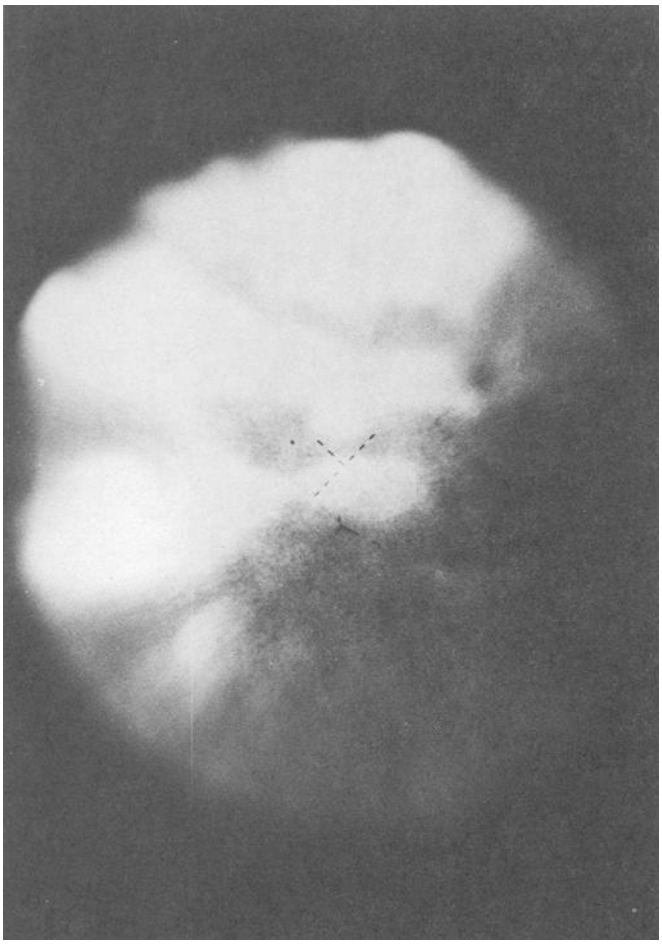

FIG. 2—*Starlight scope image of the reaction of luminol with blood diluted 1:100 000. The field of view is approximately 10 cm in diameter. The dotted lines in the center of the field represent the sight reticule. The total amount of blood represented by the light areas in the photograph does not exceed 0.1 pg.*

Results and Discussion

In the present study, the writers were unable to visualize by the unaided eye a reaction between luminol and blood diluted 1:10 000, but were able to see clearly the reaction and photograph the reaction through the starlight scope when the blood was diluted to 1:100 000. With the technique employed in the present study, blood diluted to 1:1 000 000 was not detectable (above the eventual background light level resulting from autochemiluminescence) even with the starlight scope. It should be stressed, however, that the purpose of the present study was not to push the luminol test to its ultimate sensitivity, whatever that sensitivity may be, but rather to enhance the sensitivity of the technique regardless of what technique or formulation of the reagent is used. Other workers have reported success with bloodstains in excess of 1:100 000 *without* the use of a starlight scope. The present writers do not wish to engage in agonizing over which formulation of luminol is the most efficacious, but rather to point out that the starlight scope will permit at least two orders of

magnitude enhancement of the reaction in those instances where the luminous flux would otherwise be insufficient to produce an image capable of being visualized directly or photographed.

References

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Address requests for reprints or additional information to
Professor John I. Thornton
Forensic Science Group
Department of Biomedical and Environmental Health Science
University of California
Berkeley, CA 94720