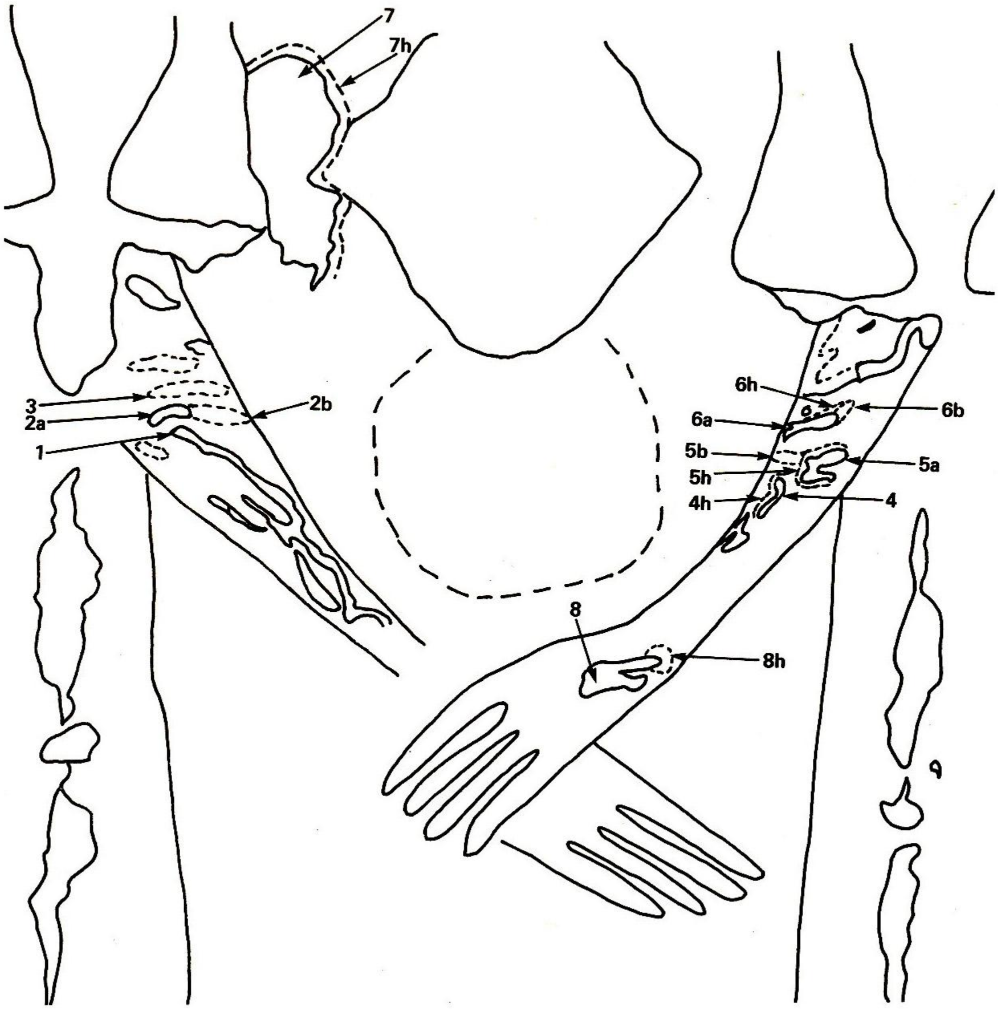

Fig. 1. Diagram showing Features of the present study (negative image):
Subscript *a* denotes features with bloodlike characteristics.
b denotes features with bodylike characteristics.
h denotes halo features as seen in the ultraviolet fluorescent photograph of Figure 3.

BLOOD AND POSSIBLE IMAGES OF BLOOD ON THE SHROUD

JOHN P. JACKSON

In this paper, I would like to report and discuss what could be a significant observation regarding the Shroud image. I will show examples where it seems that blood clots generated images of themselves, much as the skin and hair did where cloth/clot contact was very doubtful. Careful examination and confirmation of this characteristic should be part of the protocol for the next scientific examination of the Shroud.

Observations

Figures 2 through 5 show the frontal image at the level of both forearms, just below the elbows. These photographs were taken by Vern Miller and Barrie Schwortz, using different recordation techniques, during the 1978 STURP expedition. Figure 2 (p. 5) is a black and white image, Figure 3 (inside front cover) an ultraviolet fluorescent picture, Figure 4 (p. 7) a transmitted light photograph where the illumination source was positioned behind the cloth, and Figure 5 (on front cover) is a color image. Supplementing these photographs is a diagram, Figure 1, showing the features of the present study.

Consider the apparent blood images on both forearms, in particular the features labeled 1 through 6 in Figure 1. As can be seen in the black and white photograph of Figure 2, Features 1 and 4 appear to be continuous patterns of intensity considerably brighter than that of the body image. Such heightened intensity is characteristic of the bloodstains; compare, for example, the brighter wounds of the side (Feature 7) and wrist (Feature 8) with the less intense body image at the fingers. This is due to the physical differences between the bloodstains and body images, the former being composed of a dried reddish substance added to the cloth, while the latter is a subtle molecular discoloration of the cloth itself. Heller and Adler have shown that the blood images are indeed composed of blood material, more precisely a reddish blood exudate, while the body image is due to cellulosic dehydration.[1]

Features 2 and 5 in Figure 2, however, are not continuous in their intensity distributions. Rather, their intensity patterns abruptly change from those (labeled 2a and 5a) characteristic of other bloodstains to those (labeled 2b and 5b) characteristic of the body image. Feature 3 is a continuous pattern, but of an intensity similar to that of the body image.

Good color photographs show that the intensity change is also correlated with a color change. The intense features labeled 1, 2a, and 5a are of the same reddish color as other blood images, for example the wrist and side wounds. In contrast, the less intense features labeled 2b, 3, and 5b appear to be of a light brown color similar to the body image.* This conclusion is based on examination of an original 3 x 5 inch color transparency taken of the frontal Shroud image by Barrie Schwortz in 1978 and confirmed independently by a colleague, Dr. Ron Sega, of the University of Colorado. The color difference may not be evident in the Figure 5 color reproduction.

In Figure 3, which reproduces an ultraviolet fluorescent photograph, the aforementioned intensity discontinuities are also apparent. However, the color differences are not as obvious as in the reflected light photographs owing to the general similarity of color structure for the body and blood regions in the ultraviolet fluorescent imagery; compare, for example, the brownish color of the wrist wound with nearly the same hue of the neighboring forearm region. However, the ultraviolet fluorescent photographs reveal image structures that are not readily apparent in other photographic recordations. In particular, where bloodstains are superimposed upon or intersect the body image, clear narrow halos can sometimes be observed. Halo patterns labeled 7h and 8h in Figure 1 are good examples. These halos have been explained as being due to a serum exudation from the blood clots into the surrounding cloth.[2] Of particular interest is the appearance of a halo surrounding the bloodstain labeled 5a on the forearm, the possible significance of which is discussed below.

In the transmitted light photograph of Figure 4, another manifestation of the discontinuities of the forearm features noted above can be observed. All of the red features labeled 1, 2a, 4, and 5a can be easily recognized as dense patterns, similar to other bloodstains, for example Features 7 and 8. However, the brown features labeled 2b, 3, and 5b are invisible, as is the body image in general. For known blood and body images, this marked difference must be due to the relative optical transmission factors for the different image structures; the blood regions are characteristically opaque (due to significant amounts of blood encrustations) while the body image is optically thin (due to dehydration of only the surface fibers of the clothe). The point is that in transmitted light some or parts of the forearm features appear dense like other bloodstains while the others appear tenuous like the general body image.

Before attempting an interpretation of these observations, let us discuss Feature 6. In the photographs of Figure 2 (black and white) and Figure 5 (color, on front cover) this feature displays intensity

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*Feature 5b may contain a very thin line of reddish coloring along its short length, an observation difficult to confirm with available photographic data.

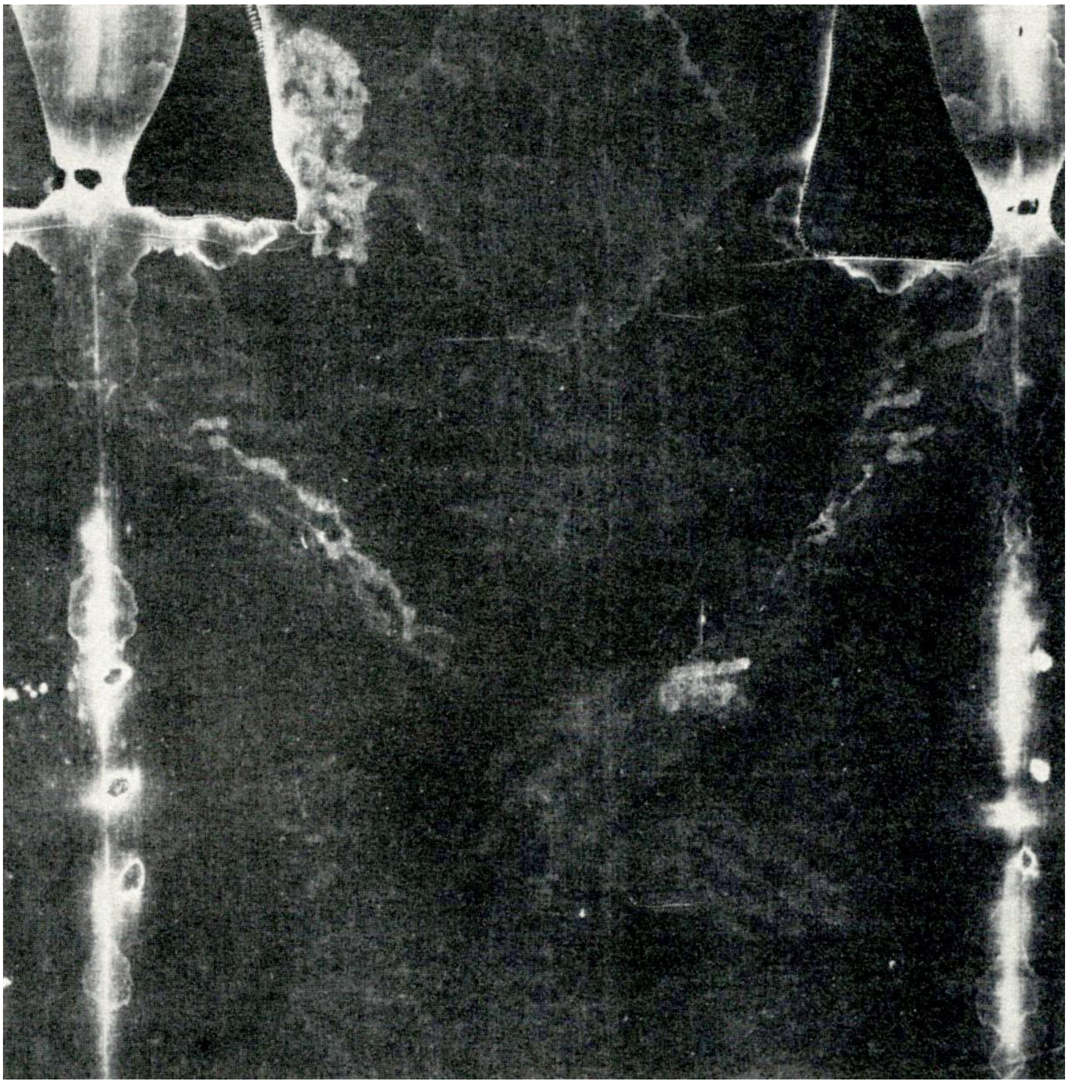

Fig. 2. Black and white photograph (negative image). Copyright Vern Miller, 1978.

and color discontinuities like Features 2 and 5. However, in the transmission imagery of Figure 4, Feature 6b can be discerned as an optically thick pattern, while Features 2b, 3, and 5b are invisible. This is particularly significant in that the neutral density of Feature 6b in Figure 2 is nearly the same as for Features 2b, 3, and 5b. Thus although Feature 6 displays intensity and color discontinuities similar to Features 2, 3, and 5, its lighter portion does not appear to have the same optical density characteristics.

Interpretation

Let us now discuss the possible explanations of these observations. It is generally recognized that there are two distinct types of image patterns on the Shroud: those associated with the body image and those with the blood. Morphologically, optically, and chemically the body and blood images are quite dissimilar, the former due to a molecular change of the existing cellulose of the

Shroud while the latter to the addition of extraneous material (in the form of blood) atop and between the cloth threads. Historically, all patterns of the Shroud image have been categorized into one or the other of these two groups. However, the features labeled 2 and 5 appear to have characteristics of both groups, and indeed appear to change abruptly from one to the other along their lengths.

This observation needs an explanation. While it is to be emphasized that direct microscopic and microchemical examinations are the only rigorous way to determine the true nature of the apparent blood clot transition phenomenon discussed above, let us nevertheless attempt a preliminary evaluation.

Under the hypothesis that the Shroud enveloped a body, it is reasonable to assume that all blood images were transferred by direct, intimate contact of the cloth with a blood clot residing on the body surface, for example as discussed by Lavoie.[3] This would account for the features labeled 1, 2a, 5a, 6a, 7, and 8. To account for the features labeled 2b, 3, and 5b, there are several possibilities:

1. A pre-existing bloodstain broke loose and separated from the cloth leaving, by some catalytic mechanism, an underlying brownish imprint of itself as a cellulose decomposition region.

2. The light brown discolorations represent initially clear serous transfers to the cloth from an underlying clot followed by a discoloration or browning of the serum with time.

3. The less intense regions are locations where blood, or colored blood exudate, was transferred by contact with an underlying clot but in smaller amounts, perhaps due to reduced cloth contact pressure or insufficient moisture available in the clot as a result of serous migration within the clot.

4. The transition represents a place where the cloth ceased to touch the clot and the image formation mechanism which generated the body image discolorations, apparently at a distance,[4] formed an image of the underlying clot as a pattern of decomposed cellulose.

Let us now consider each of these hypotheses in detail against available data. Published photomicrographs of the bloodstains appear to show regions where dried blood encrustations have broken loose leaving clean, white fibrils underneath.[5] Further, protease digestion of serum-coated fibrils showed that the underlying fibril surface was like the off-image areas rather than the body image when viewed by phase contrast microscopy.[1,5] Although these important observations should be reconfirmed by further examination, they are contrary to Hypothesis One which proposes that there are brownish fibrils composed of degraded cellulose directly beneath the blood.

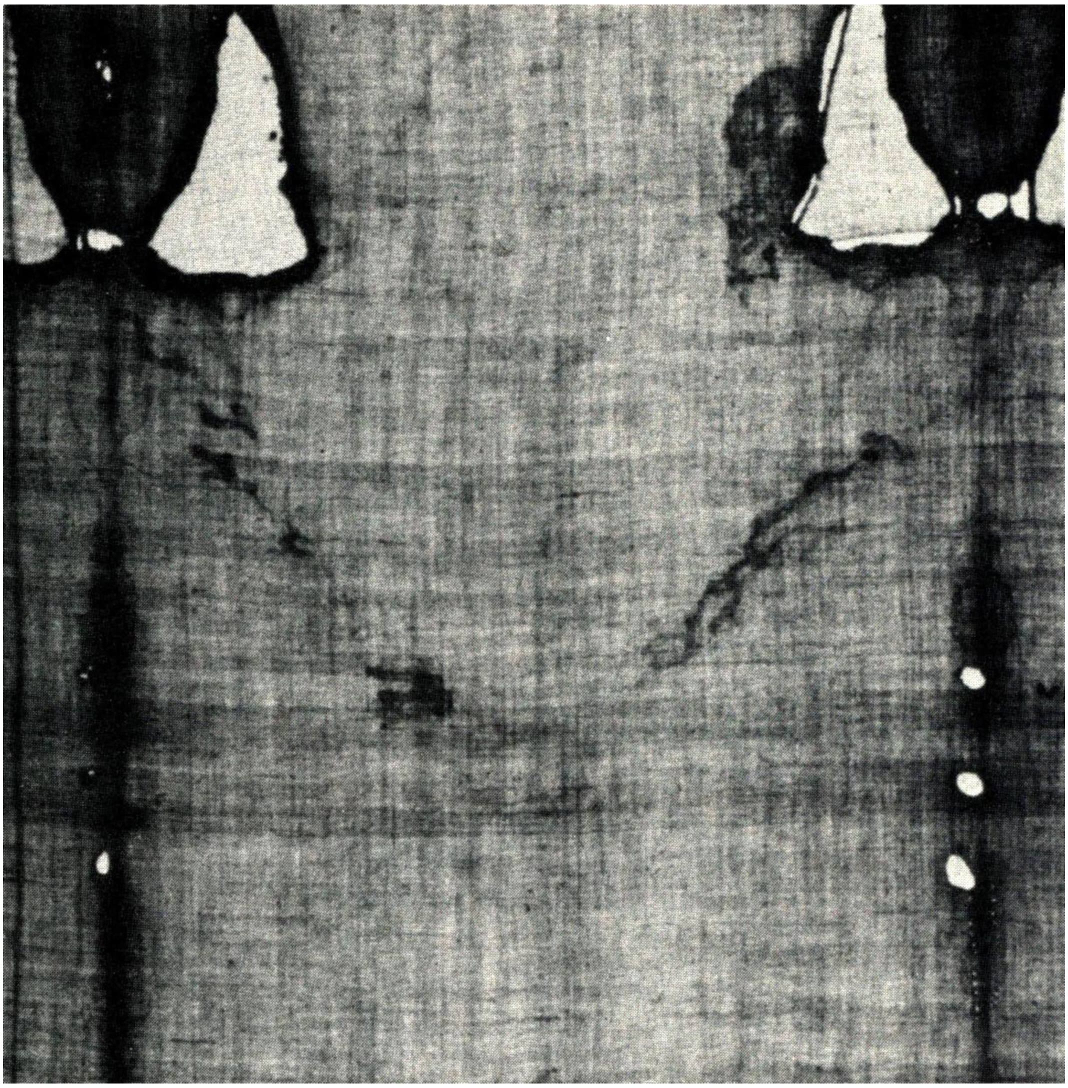

Fig. 4. Transmitted light photograph (positive image). Copyright Barrie Schwortz, 1978.

The second hypothesis poses that only serum was transferred in the lighter regions of the forearm blood patterns and subsequently browned with time. This possibly can be addressed via the ultraviolet fluorescent photographs. In these photographs, clear halos can be seen surrounding many bloodstains, for example those indicated by the features labeled 7h and 8h. It has been suggested that these halos represent regions where the clear, serous component of blood migrated a small distance into the adjacent cloth during normal clot retraction and as such show how serous regions appear today on the Shroud. Thus, if the 2b, 3, and 5b patterns were due to aged serum-only transfer, as Hypothesis Two asserts, we should expect those regions to also appear as blank or clear areas in the ultraviolet fluorescent imagery. In fact, they appear as just the opposite, a brownish discoloration similar in character to the general body image.

But perhaps the most significant observation is the existence of a halo surrounding much of clot 5a. In particular, we may note that there is a halo in the transition region between the 5a and 5b features, labeled 5h. This argues strongly against the light brown features, particularly 5b, being due to discolored serum because the colorless halo which intersects the light brown 5b region, is apparently itself a serous pattern. Accordingly, the second hypothesis is inconsistent with the halo observations and must be rejected.

Hypothesis Three proposes that the discoloration of locations 2b, 3, and 5b are due to a reduced but nonzero transfer of colored blood material. However, the optical transmission photograph in Figure 4 shows no evidence of any light-absorbing material in these regions while the tenuous waterstains and low density scourge marks show up well.[4] This observation (i.e., lack of optical opacity) argues against any significant blood material as being the primary composition of the light brown portions of the forearm clot features 2a, 3, 5a, whose nature we are trying to explain.

In addition, there are further objections which can be raised against Hypothesis Three. If the fainter portions of the forearm clots are due to reduced transfer of colored blood material, then we might ask what caused the reduced transfer. One possibility is a reduction of moisture in part of the clot due to serous migration within the clot due to gravity. Such a phenomenon is observed on the Shroud, for example, at the halo labeled 8h located at the tip of the Blood Clot 8 emanating from the wrist wound. This blood pattern is consistent with what would be produced by blood flowing under the influence of gravity (note direction of clot) where serous separation occurred at the tip of the blood clot in the presumed downward direction.* In contrast, the existence of Halo 5h surrounding the clot 5a with virtually a constant thickness would argue against serous flow having occurred within that clot (i.e. from 5b to 5a) because, as the wrist wound suggests, such serous movement should be accompanied by a serous exudation in some preferred direction which is not observed.

Finally, if there is significant blood material comprising the brownish Feature 5b, then the even and apparently unperturbed serum penetration depicted by Halo 5h into the transition region between 5a and 5b would have to be explained. More specifically, microscopic photographs show blood encrustations into and around cloth fibers in blood regions and this could be expected to impede serum migration into the cloth or possibly cause the migration to deflect around the perimeter of Feature 5b, and this did not occur.

Thus, Hyphothesis Three appears to be inconsistent with several important observations for Features 2b, 3, and 5b. However, this does not seem to be the case for Feature 6b. As noted above, this

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* It is noteworthy that if the hand and forearm images are positioned so that the direction of wrist blood flow and serous separation are in a vertically downward direction, the arm would be in an attitude consistent with crucifixion.

feature appears to be light brown, but optically opaque. In addition, the ultraviolet fluorescent photograph of Figure 3 shows a halo, labeled 6h, along the outer boundary of Feature 6 as opposed to a penetration into the transition region such as occurred in Feature 5. Thus, it would seem that Feature 6b could be an example of where Hypothesis Three applies. As such, it provides a point of calibration by which to compare Features 2b, 3, 5b. The latter seem to display characteristics more like those of the body image.

This leaves Hypothesis Four which proposes that the brownish forearm regions are images of blood clots, following the same image intensity correlation that has been demonstrated for the general body image.[4] In this regard, we note that in all images of Figures 2 through 5 the light portions of the forearm patterns labeled 2b, 3, and 5b have characteristics similar to the body image, while the darker regions resemble the bloodstains. It is important to note that, unlike for Hypothesis Three, Hypothesis Four is consistent with the evenness of the halo thickness surrounding clot 5a, in that serum can exude evenly into the cloth from the boundaries where the cloth contacts the clot, even if the clot is physically larger than the area of contact.

One possible reservation against Hypothesis Four, however, involves the apparent lack of blood clot images (as degraded cellulose) anywhere else on the frontal body image. According to Lavoie,[6] it is likely that the Man of the Shroud was covered with blood to a much greater extent than what the bloodstains would indicate because these stains represent special locations where the cloth happened to come in direct contact with blood. Hence, it might seem reasonable that images of other noncontact bloodflows should be visible as images composed of degraded cellulose, as is suggested by the forearm clot examples. However, it is possible that the image formation mechanism was incapable of producing visually discernible blood clot patterns at cloth-body distances greater than near contact (millimeters), as possibly for the forearm examples discussed in this paper. If this was the case, then the number of discernible bloodclot patterns composed of degraded cellulose could be quite limited.

Nevertheless, elsewhere on the image there might be other examples of bloodclot images in the sense of Hypothesis Four. For example, some scourge-like marks on the hips and pectorals of the frontal image can be seen. It is not clear from available photographs if all of these are constituted by blood material or might be merely a cellulose degradation of enhanced intensity. If these marks are of the latter type, then these features might be additional examples of bloodclot images composed of degraded cellulose. A search for such examples could and should be made by direct examination of the Shroud.[7] With these caveats, in the available photographic data there appears to be no obvious inconsistency with Hypothesis Four.

Conclusion

The purpose of this paper is to present an observation which could be significant in helping to determine the image formation mechanism on the Shroud. As such, a future examination of the Shroud should not miss a complete examination of the forearm regions and thereby critique the thoughts presented in this paper.

In conclusion, let us consider the possible significance of the blood features on the upper forearm, assuming that Hypothesis Four is the correct explanation for the dual color intensity structure of the forearm bloodstains. First, one could conclude that the image formation mechanism, which discolored the Shroud fibrils through some cellulosic dehydration process, must have acted through space. For if we posit that the cloth had to touch the clots in order to create the light brown discolorations, we must then explain why in those regions there was no transfer of blood material to the cloth. This would be difficult to argue because we apparently have examples (e.g. features labeled 2 and 5) where blood transfer simultaneously occurred and failed to occur for the same clot. Thus, we might have an independent confirmation of the so-called "three-dimensionality" of the image where intensity is correlated with cloth-body distance; that is, images of degraded cellulose might have been generated from blood clots which arguably could not have been in contact with the cloth because otherwise they would have left a colored, opaque blood residue. Second, we could conclude that there are two types of blood images on the Shroud:

(1) those that are actual bloodstains impregnated into the cloth and

(2) those that are images of blood clots, composed only of dehydrated cellulose, for which cloth contact did not occur. And third, we could further confirm that the image formation process was independent of body surface qualities. For not only are there images of skin, hair, and possibly fingernail regions, composed of dehydrated cellulose, but also similar images of blood clots as well. Such statements concerning the image formation mechanism, if correct, pose considerable restrictions upon hypothetical mechanisms which might be proposed.

I do not presume to have demonstrated conclusively that Hypothesis Four is the correct explanation for the forearm features; I only suggest that, based on available photographic data, it appears to be the most reasonable. I do have some reservations regarding the possible thin color line in Feature 5b which might indicate some blood contamination in a region that otherwise has the color and transmission characteristics of the body image. But owing to the potential significance of the apparent clot images of the forearm region, I urge that such regions be studied in detail directly on the Shroud in light of the discussion presented in this paper. It should be a rather simple and straightforward matter to determine definitively the microchemical nature of the features in question and thereby confirm or refute the interpretation discussed herein.

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