Hypothesis that Explains the Shroud's Unique Blood Marks and Several Critical Events in the Gospels

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Abstract
This paper asserts that the Historically Consistent Hypothesis could also explain or provide insight into the Shroud's unique blood marks, Jesus' resurrection, the earthquake, and his sudden disappearances and reappearances reported in the Gospels.

PART I

1. BACKGROUND

Perhaps, the most important dichotomy in all of history is before us and the world. In 1988, the Shroud of Turin was radiocarbon dated to the Middle Ages. Yet, extensive scientific tests and experiments for the last four decades, along with a wealth of medical, archaeological and historical examinations throughout the 20th and 21st centuries have yielded a wide array of objective, independent and corroborating evidence that the Shroud of Turin wrapped a dead human male, who acquired intimate contact throughout both sides of this burial cloth. This man had been beaten about the head and face. He was scourged throughout his body with a Roman flagrum and crowned with a bundle of sharp pointed objects or thorns. He had broad excoriated areas across the back of his shoulders, endured falls and was crucified. After dying in the crucifixion position, he was pierced in the side by a Roman lancea causing blood and watery fluid to flow from the wound. Afterward his body was wrapped in a linen shroud and appears to have been buried according to detailed Jewish burial customs in the same rock shelf in which Jesus was reputed to have been buried. All of these events appear to have occurred in the first century in Jerusalem with some evidence pointing to the spring. However, within two to three days of having been wrapped in the Shroud, the body left the cloth in a mysterious manner.

An unprecedented event appears to have occurred to this body prior to or during its disappearance that caused the man's full-length frontal and dorsal body images and approximately 130 blood marks (along with several secondary features) to be encoded on this burial shroud. The full-length body images and blood marks are so unique they have never been duplicated in any age by any artist, scientist, physician or anyone utilizing any type of artistic, naturalistic or other method. While the most sophisticated science of today has been unable to duplicate the Shroud's

body images and blood marks, it has discovered and revealed scores of unique features throughout the cloth at both the microscopic and macroscopic levels that have never been seen before in history. (Antonacci 2000, 2010).

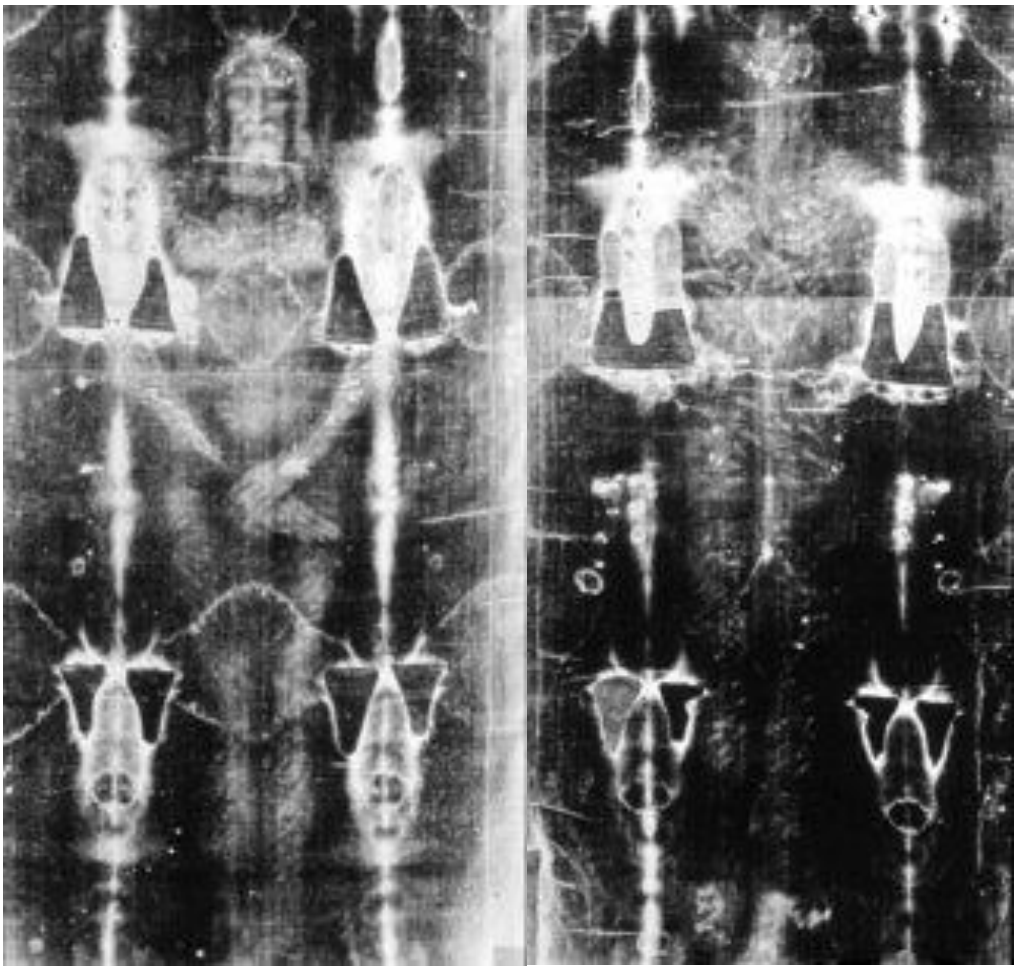


Figure 1. Positive mages (photographic negatives) of frontal and dorsal sides of the man in the Shroud.

2. INTRODUCTION

In a 2012 paper titled "Particle radiation from the body could explain the Shroud's images and its carbon dating" and in a 2000 book, compelling arguments were made that radiation caused the images on the Shroud, that the source of the radiation was the dead body wrapped within it and that the radiation included particles such as neutrons and protons.[1] (Antonacci, 2012, 2000) The above arguments assert that if the body suddenly disappeared or disintegrated while leaving behind a very small amount of some basic particles of matter, all of the Shroud's unique primary and secondary body image features would be encoded. The above paper and book observe how physical objects in the physical environment (such as cloth, chemicals, radiation, air and gravity) respond naturally during this event, along with the resulting consequences to the burial cloth itself.

The above publications and this paper highlight the Historically Consistent Hypothesis that was derived from the cloth's numerous full-length body image and blood mark features after all naturalistic and artistic methods to date have failed to duplicate the Shroud's body images and blood marks.

We also saw that if particle radiation irradiated the Shroud, the neutron flux within it would create new C-14 isotopes from the nitrogen indigenous to the linen. These C-14 isotopes would not be removed by the standard pretreatment cleanings administered to the Shroud in 1988, or by the heat incurred from the fire of 1532, nor by natural aging, nor by combinations thereof. (Lind et al., 2010) This event could easily account for the Shroud's aberrant medieval radiocarbon dating (Lind et al., 2010; Damon et al., 1988). As asserted in the earlier references, the Historically Consistent Hypothesis is the only method to explain the Shroud's body images, its medieval radiocarbon dating, the still-red color of its centuries-old blood, its outer side imaging, its possible coin or flower images, and its excellent condition. Other forms of radiation cannot account for all of these features.

This paper herein explains how the Historically Consistent Hypothesis could also explain or provide insight into the Shroud's unique blood marks, Jesus' resurrection, the earthquake on Easter and his sudden disappearances and reappearances reported toward the end of the Gospels, which no hypothesis has ever attempted to explain before.

3. DISCUSSION

The nearly unanimous conclusion of pathologists, physicians and anatomists who studied the Shroud since the beginning of the 20th century is that this cloth wrapped a dead human body. In summary, the arterial and venous blood flows that correspond to arteries and veins in the head; the different types of bruises and swelling identified on the face; the flow of watery fluid from the pleural cavity and of blood from the right auricle, which fills with blood on death; the photographically revealed abrasions on the knee, leg and across the shoulder blades; the abnormally expanded rib cage indicating asphyxia; the enlarged pectoral or chest muscles drawn in toward the collarbone and arms; the contraction of the thumbs from an injury to the median nerve; the unusual signs of traumatic shock; the numerous signs of rigor mortis; the post-mortem bleeding; the microscopically precise reactions around the more than 100 scourge marks throughout the body; the coagulated blood stains with serum surrounding borders and clot retraction rings that occur with actual wounds and blood flows, found throughout the front and back of the body, and revealed only by modern scientific technology; and the identification of human hemoglobin, human albumin, human whole blood serum, human immunoglobins, and human DNA from the man's blood marks — are just some of the signs that the Shroud wrapped the body of a dead human male (Antonacci, 2000, Ch. 2).

The Shroud not only appears to have wrapped a dead body, but even blood marks and parts of the body not originally in contact with the draped or underlying cloth were encoded onto it. The man's wounds and abrasions were inflicted at various times with various instruments resulting in

approximately 130 blood marks scattered throughout and perfectly aligned with his dead human body. This perfect alignment becomes far more apparent on the positive (photographic negative) images of the man. Although these blood marks vary in size, shape and intensity, they are congealed and pristine while showing no signs of having been broken or smeared at their edges. They are not just encoded but are embedded in the cloth with the same shape and configuration as when they formed and coagulated on the body. See for example the statement of Dr. Pierre Barbet, whose pioneering medical studies on the Shroud began in the early 1930's. As a battlefield surgeon in World War I, Barbet saw many bloodstains on cloth, but noted that the Shroud's distinctive blood was comprised of "stains with clearly marked edges, which with such outstanding truthfulness reproduce the shape of the clots *as they were formed naturally on the skin*." (emphasis added) (Barbet, 1953, p. 33). Millions of people have also been bloodied and/or buried under a variety of circumstances and covered with shrouds, blankets, sheets, shirts, jackets, soldiers' uniforms, bandages etc.; yet none have left any images approaching the full-length, frontal and dorsal images on the Shroud or their 130 corresponding blood marks.

Serum surrounding borders with clot retraction rings are revealed by photographic enlargers and ultraviolet lighting on blood marks throughout the entire body. The same technologies, along with chemical tests and microscopes, reveal upraised edges with indented centers and serum surrounding borders around each of the more than 100 scourge marks throughout the man's body (Heller and Adler, 1981; Miller and Pellicori, 1981; Scotti, In: Adler 1981; Adler, 1986; Heller, 1983; Adler, In: Case, 1996; Jumper, In: Adler, 1986; Gonella, 1987). Only *intimate* contact at some point in time between the blood and the Shroud throughout the length and width of both sides of the body could have yielded such intricate, detailed blood marks on both sides on the cloth.

Yet the body has obviously left the cloth. No decomposition stains have been detected anywhere on the cloth by modern technology. Since the body was also in rigor mortis (postponing staining due to decomposition) when both images were encoded, the body clearly appears to have left within two to three days of having been wrapped within and acquiring intimate contact with the cloth. If the cloth had been removed from the body by any human or mechanical means — some, most or all of these intimately encoded blood marks would have been broken or smeared at the edges. Although the body clearly left the cloth within two to three days, it did so in a mysterious manner.

In 1989, STURP scientist Dr. John Jackson announced the first body image forming hypothesis in which the body of the man in the Shroud disappeared within a fraction of a second as it gave off radiant energy (Jackson, 1990, 1991). The body's sudden disappearance is one of the most critical components of this ground breaking hypothesis. In the next decade, nuclear aspects of the body or its disappearance was proposed both by biophysicist, Dr. Jean-Baptiste Rinaudo (Rinaudo, 1998, 1996, 1994, 1992) and nuclear physicist, Dr. Kitty Little (Little, 1997, 1994), in which the basic building blocks of matter such as protons, neutrons, alpha particles, deuterium, electrons and/or possibly gamma rays were given off.[1]

The sudden disappearance of the body wrapped within the Shroud is not only a critical

component of the Historically Consistent Hypothesis, but is also consistent with Jesus' unexplained disappearance in the Gospel accounts of his resurrection. The evidence acquired from more than a century of scientific, medical, archaeological and historical examination of the Shroud is not only consistent with its authenticity as the burial garment of the historical Jesus Christ, but with his passion, crucifixion, death, burial and resurrection as described in the Gospels. This paper will point out even further consistencies with the Historically Consistent Hypothesis and the four Gospel descriptions of events that occurred during and after Jesus' resurrection.

The Historically Consistent Hypothesis proposes that the man in the Shroud was the historical Jesus Christ who immediately reappeared outside of the Shroud or the tomb shortly after he disappeared from inside the tomb. While the disappearance(s) or reappearance(s) of the man in the Shroud are critical assumptions for all features hypothetically accounted for under the Historically Consistent Hypothesis, the hypothesis is not required to explain what actually happened to the man between these events, or during the resurrection. However, as will be seen later, the events within the Historically Consistent Hypothesis that explain the Shroud's many unique features, the resurrection, or its related events do not necessarily violate the laws of science as they are currently known.

Although Little concludes that the small amount of particle radiation that was left behind and encoded the superficial body images on the Shroud would not have caused a large explosion, she thinks it could have had other localized effects consistent with the Gospels (Little, 1994). The remaining neutrons and possible gamma rays would have penetrated as much as a meter within the interior limestone structure of the tomb, according to physicists Arthur Lind and David Elmore and nuclear engineer Robert Rucker (personal communications). Rather than an explosion, this penetration might have resembled the limited earthquake on Easter morning described in Matthew 28:1-2, whose localized effect clearly does not damage Jesus' burial cloth or his tomb (Little, 1994).[2]

Nuclear analysis indicates that a release of only 3.0 x 10^18 neutrons by the body at thermal energy would be needed to shift the C-14 dating of the Shroud by more than 1200 years (Rucker, 2014). This is the approximate amount of neutrons (and protons) that Lind had calculated was released by the body in the Historically Consistent Hypothesis (Antonacci, 2012). This number of neutrons released from the body is only 0.000000015% of the total number of neutrons that were in the body. This and a somewhat larger amount of energy would be easily absorbed into the limestone walls of the tomb without inducing an earthquake (Rucker, personal communications, 2014).

The sudden disappearance and reappearance of the man wrapped in the Shroud would both be consistent with the Gospel accounts of the resurrection of Jesus Christ. Although numerous miracles and deeds were attributed to Jesus in the Gospels, his body was not reported to suddenly disappear or reappear until the accounts of his resurrection and afterward. In Luke 24:31, Jesus' entire body was said to literally vanish after he broke bread with two of the apostles on the road to Emmaus; however he soon reappeared at another location in person among the apostles, thereby

startling and frightening them (Luke 24:36-43). In two separate instances in John 20, Jesus also physically appeared in person after the apostles had gathered within closed rooms.

The Shroud's blood marks also disappear and reappear according to this hypothesis except they do so within the enveloped Shroud. Recall that the Shroud's unbroken and unsmeared blood marks are not just encoded, but are embedded in the cloth appearing in the same shape and configuration as when they formed and coagulated on the body. Microscopically precise, invisible to the naked eye reactions such as upraised edges and indented centers are also seen around each of the more than 100 scourge marks by using photographic enlargers and ultraviolet lighting. Modern technology also reveals coagulated blood stains with serum surrounding borders and clot retraction rings on the blood marks distributed throughout the Shroud's body images — even where the cloth would not have originally been in contact with the body and its blood marks. Direct contact alone cannot embed all the Shroud's various blood marks with their complete and intimate features. (See Experimental Research in Part II.)

Many of the Shroud's blood marks would not have been in contact with the body. For example, twenty different blood marks have been identified across the back of the head of the man in the Shroud. A round surface, such as the back of a head, will not make contact at all points on a hard limestone floor or a cloth spread upon it. Most of the contact on the dorsal side of a supine body will be at the shoulder blades, buttocks and upper legs. The top parts of the shoulders and much of the lower back will not make contact with the cloth or floor, especially if the man's arms have been folded over his groin and his legs are pointing down with the left one upraised. However blood, scourge marks and/or shoulder abrasions are quite noticeable on the tops of the shoulders and the lower back of the man in the Shroud. Much of his upraised left leg would not have been in natural contact with the dorsal side of the cloth, but scourge marks are also clearly evident at these locations on the man in the Shroud.[3]

The blood marks on the Shroud are so embedded, they can be seen on the opposite (or outer) sides of the burial linen that draped over and laid under the bloodied corpse. In 2002, the Shroud's patches and backing cloth from 1534 were removed. This revealed the full outer (or opposite) side of the cloth for the first time in five centuries. This allowed all 14 feet of the inner and outer sides of the Shroud to be photographed for the first time ever. Most of the man's blood marks are clearly visible on the opposite or outer side of this linen cloth in approximately the same shape and form as those on the inner side. The numerous blood flows from the front of the man's head, his side wound, his wrist, both of his arms and the front of both of his feet are clearly visible on the outer side of the cloth that draped over his body. The blood marks and/or blood flows from the back of the man's head, the small of his back and the back of both of his feet are also easily visible on the opposite or outer side of the burial cloth. Many of the scourge marks on the back of the man's calves and legs and on his back are also visible on the outer side of the cloth that laid under the man.

Many of these same blood marks would not even have been in contact with the inner side of the cloth, yet are visible on the outer side of this burial garment. Even where there was contact, the jelly-like, coagulated blood marks could not have been embedded *into* the cloth and onto its outer

side by pressing against all the blood marks on both sides of the linen. This would only have broken, smeared and altered the blood marks and their edges.

Figure 2. Blood marks from the inner and outer sides of the Shroud at the back of the head

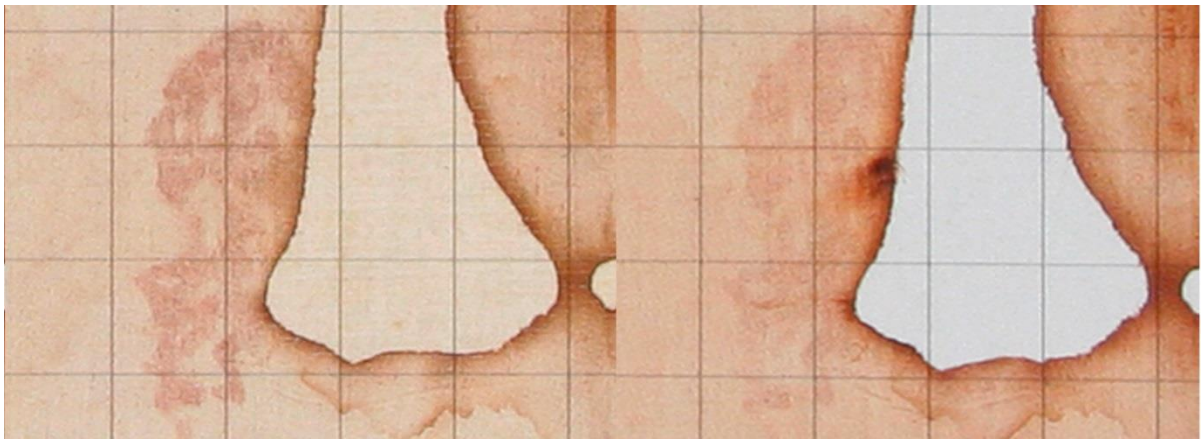


Figure 3. Blood marks from the inner and outer sides of the Shroud at the side wound

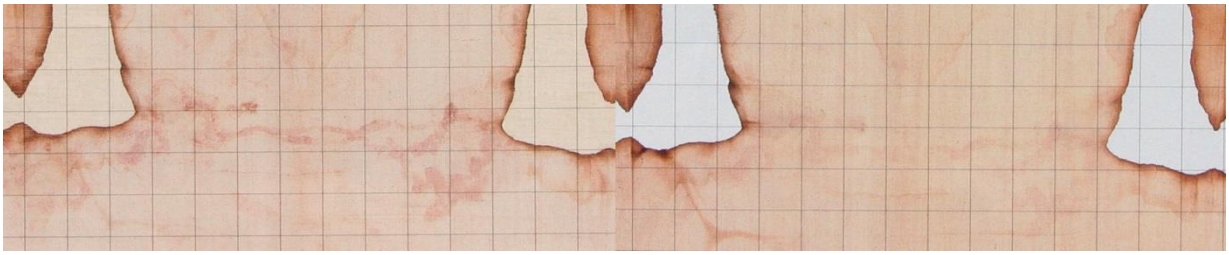


Figure 4. Blood flows are even visible on both the inner and outer sides of the Shroud at the small of the back.

Under the Historically Consistent Hypothesis, when the body disappears it allows the frontal side of the cloth to fall into the radiant region once occupied by the body, (while the dorsal side is drawn up into it by a brief vacuum). Because the blood marks consist of the same DNA, atoms, molecules, etc. as the body, they, too, disappeared. As we discussed earlier, the entire process occurs very quickly. When the blood marks reappear within a fraction of a second, they become trapped or embedded in the falling (or rising) cloth in the same shape and configuration as when they formed and coagulated on the body, without being smeared or broken at their edges. Because the cloth collapses on its frontal side and rises slightly on its dorsal side, even the blood marks not

originally in contact with the Shroud become embedded within it. If the shed, coagulated blood marks located on the outside of the man's body reappeared at their original locations within the burial cloth (while the body itself reappeared outside the cloth), it would account for the numerous pristine human blood marks that align perfectly with both body images and are found throughout both inner and outer sides of the linen Shroud.[4]

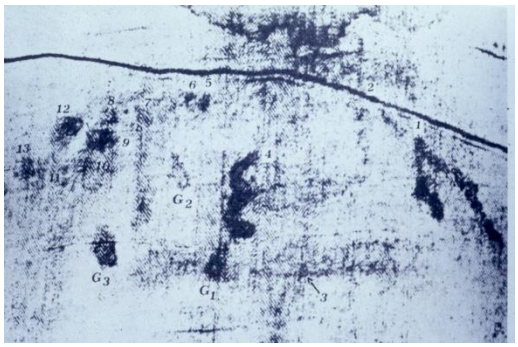
This process also explains the apparent misplacement of blood over the man's hair on both the frontal and dorsal images. About twenty blood marks can be seen encoded over or on the surface of the hair at the back of the man's head. If they were caused by sharp pointed objects such as thorns or anything else, they would have bled at the scalp. They would not have bled from the scalp out into and onto the outside surface of the hair. Our new hypothesis not only explains their misplacement on the hair, but how they also became encoded in the Shroud linen cloth. If these blood marks disappeared with the body, but reappeared immediately in their original location at the back of the scalp, they would appear to be encoded in the cloth, but on top of the *hair*. When the body disappeared and gave off particle radiation, the inner part of the dorsal cloth would have been drawn into and thus encoded by the radiant region at the hair. The cloth would then acquire the reappearing blood from the back of the scalp, but the cloth would have acquired the blood after the hair had already been encoded on it.

Figure 5. Approximately 20 human blood marks appear misplaced on or in the back of the man's hair.

The blood that is encoded on the man's hair above his forehead on the frontal image is also misrepresented, i.e. on the outer surface of the hair rather than on the scalp. This is especially apparent in the flow or spurt of arterial bleeding seen below on the man's hair above his right eye on the positive image (Fig. 6a) below (Rodante 1976, 1981). Blood, of course, would only spurt from an artery on the scalp. In addition, this blood would not have bled from the scalp out into and onto the outside surface of the hair. The negative image below (Fig. 6b) shows the original location of these wounds under the hair according to Dr. Sebastiano Rodante who studied the Shroud and its blood marks for five decades. Our new hypothesis also explains the transfer of all blood onto the man's hair above both sides of his forehead. If the blood disappeared along with the hair and head, the frontal side of the cloth would fall into this radiant region thereby encoding

the man's hair. If the blood then immediately reappeared at its original location formerly on the scalp, the cloth would then acquire the blood on or over the already encoded hair.


6a



6b

Figure 6. Positive image on left indicates spurt of arterial blood misplaced on or over the man's hair.*

The reappearance of the shed blood from the extensively wounded, crucified corpse within the Shroud, coupled with the body's physical appearance outside of the burial cloth or tomb, are both consistent with the man being Jesus and with his appearances on Easter morning. All four Gospels

* Like the body's skin and hair, when the blood marks disappear under this hypothesis, they give off protons and neutrons (along with alpha particles and deuterium that behave like protons). If these very attenuating protons were in contact or within a few millimeters of the cloth, they would have encoded superficial images of the blood marks consisting of oxidized, dehydrated cellulose comprised of conjugated carbonyl groups that would have formed over time. However, when the blood marks reappeared, they would have covered the areas of the cloth encoded by some of their protons. These covered areas would not oxidize and dehydrate, and thus would not leave straw yellow coloring of the blood marks on the cloth. However, if one of these blood marks fell completely off the cloth, allowing the underlying linen to be exposed to air, then straw-yellowed images of these blood marks could become visible at these particular locations on the cloth.

Some blood marks could become encoded in the cloth as degraded cellulose in another manner without the blood being physically present or embedded in the Shroud. If blood marks originally resided on the edge or side of a body part, say the inner part of the forearm, the cloth may have originally draped a few millimeters away from, and may not have been completely parallel over some of these blood marks. When these blood marks disintegrated, their protons would have reached the linen cloth, but when they reformed, they may not have become physically embedded into the falling, unparalleled cloth at this particular location.

Although the present data does not allow certainty, physicist John Jackson has identified three or more locations on the inner arms of the man in the Shroud toward the elbow joints where "it seems that blood clots generated images of themselves, such as the skin and hair did where cloth/clot contact was very doubtful." (Jackson, 1987, p. 3) One of these blood marks consisting of degraded cellulose on the man's inner forearms may also have had a very small amount of blood within it. According to Dr. Jackson, blood marks encoded as degraded cellulose could possibly be found at other locations on the Shroud. He calls for careful examination and confirmation of these blood mark images in the next scientific examination of the Shroud. Only the Historically Consistent Hypothesis, in which the blood marks disappear with the body and then immediately reappear in their original locations, can account for the Shroud's actual coagulated blood marks with all of their unique features and the Shroud's blood mark images that are comprised of degraded cellulose.

indicate that Jesus completely left his burial tomb at the time of his resurrection. It is also compelling to note that none of the various Gospel accounts of the first sightings of Jesus on Easter Sunday by several different people describe him as having any of the bloodstains on his person that he necessarily would have had from his scourging, being crowned with thorns, nailed in both of his wrists and feet, and stabbed in the side. The man in the Shroud, who suffered the same wounds as Jesus, is literally bloodied from head to feet on both sides of his body. Most, if not all, of the blood marks would have remained on the body in whole or in part.[5] The blood marks on the Shroud of Turin and the Gospels are consistent with most of Jesus' various coagulated blood marks being transferred onto his burial garment at the time of his disappearance, or resurrection. The Historically Consistent Hypothesis and the Gospels are also consistent with Jesus' reappearance outside of his burial tomb without his extensive blood marks.

Since the Historically Consistent Hypothesis was derived from many unique physical properties encoded on the Shroud of Turin and involves a miraculous event; the physical evidence on the Shroud is consistent with its authenticity as the burial garment of the historical Jesus Christ and with the Gospel accounts of his passion, crucifixion, death, burial and resurrection; the authors propose that this hypothesis, or one similar to it, could reflect aspects of the resurrection reported in the Gospels to have occurred to Jesus' body. The unprecedented information derived from the Shroud of Turin allows the Historically Consistent Hypothesis to attempt to provide some of the physical processes possibly involved in the Resurrection that were previously unknown to and absent from the Gospel accounts. Elements of the Historically Consistent Hypothesis or the Resurrection that play critical roles in explaining all aspects of the Shroud's body images, blood marks, and off-image features, are also utilized herein in an attempt to explain Gospel descriptions of the earthquake and Jesus' subsequent disappearances and reappearances.

Just because the resurrection is mentioned repeatedly in the Gospels and the New Testament, of course, does not mean that it actually occurred. However, manuscript, archaeological and many other historical studies and comparisons have independently established these sources as one of the most reliable and accurate sources in all of ancient history. In light of the numerous, astounding consistencies between this burial cloth and the many events that occurred to Jesus as described in the Gospels, along with the numerous features on this burial cloth that are uniquely accounted for by the above hypothesis, including its aberrant radiocarbon date — a hypothesis that the resurrection of the historical Jesus Christ caused the otherwise unexplainable body images and blood marks on the Shroud of Turin is reasonable and should be logically considered. This consideration is further warranted when it is observed that all naturalistic and artistic methods have failed and that no other images and blood marks exist that are remotely comparable to those on the Shroud of Turin.

As stated earlier, this hypothesis is not required to explain what actually happened to the man in the Shroud or Jesus during the resurrection or between his disappearances and reappearances. One possible explanation, however, was that it transitioned from our four dimensional reality to an alternate dimensionality (nuclear engineer, Robert Rucker, personal communications). Modern physics related to super symmetry and string theory generally postulates there are from 10 to 26

dimensions. In theory, a small amount of radiation could have been released from the body as it transitioned into the alternate dimensionality according to Rucker. The body continues to exist in the alternate dimensionality and can return to our dimensionality. Because the atoms in the body do not go through a nuclear disintegration when they disappear there is not a huge explosion, which is consistent with the Gospels. No such explosion was reported at the time of the resurrection nor was any reported in the several Gospel examples above where Jesus suddenly disappeared and then reappeared elsewhere.

Such as explanation could even account for Jesus' reported ascension to heaven. Only a power like that of God could ostensibly cause such events. The Gospels record in several places that, while alive, Jesus predicted God would resurrect him from just the type of suffering and death from which he and the man in the Shroud died. Like Jesus, the man in the Shroud was dead when an unprecedented event occurred to him. If this event involved the sudden disappearance of his corpse, the opening of a window or portal to an alternate dimensionality, the resurrection, or any other miraculous event to the dead body, then God would be the apparent, as well as the predicted cause of these events. If the man in the Shroud was Jesus Christ, the Son of God, with all the immortal powers ascribed to him in the Gospels and New Testament, he would be the apparent cause of his post-resurrection disappearances and reappearances.

The blood marks could have disappeared and reappeared within the burial cloth in this same manner. Alternatively, Rucker asserts the man's blood marks could have been thrust vertically onto the frontal and dorsal sides of the cloth by a burst of collimated radiation from the body. This same burst would re-liquefy the congealed blood marks by heating and particle interaction, so that when they reach the Shroud they can soak into the cloth. (Rucker, personal communication, 2014).

Traveling to or through an alternate dimension is not necessary to explain the Shroud's body images, its 1988 carbon dating, its excellent condition, its outer side imaging, its skeletal features or its possible coin and flower images. Nor is it necessary to describe the earthquake discussed earlier. Under the Historically Consistent Hypothesis, once the body instantaneously disappears and the particle radiation is released, all of the above consequences would occur. The overall hypothesis observes that the body and blood marks return or reappear, but the hypothesis is not required to explain how this occurs. Traveling to or from an alternate dimensionality, or something analogous to it, is only a possible explanation for the disappearance and reappearance of the body and blood marks of the man in the Shroud, or of Jesus at his resurrection, or for his subsequent reappearances following his sudden disappearances described in the Gospels. God or the Son of God could have possibly directed some type of analogous, limited, space-time travel that we have not realized or discovered from a physics point of view, which would also not cause an explosion.

Of course, the discussion of the resurrection cannot be limited to merely scientific confines as it clearly encompasses historical, religious, societal, philosophical, medical and many other areas. Since this event relates to everyone, all may consider it from a variety of perspectives. While this paper also relates to such other perspectives, it legitimately discusses possible scientific aspects of

the resurrection and the extraordinary events described in the Gospels. The reader should understand that while the unexplained events within this paper are not limited to science, they can nevertheless be studied by, and are not beyond the scope of science. We should not confuse our obvious inability to duplicate or recreate any event, such as the resurrection, with the study of its occurrence, or its consequences on the cloth, or to illuminate the details of the event. Likewise, subjects such as travel to and from an alternate dimension are not beyond discussion or the scope of science, and can be discussed in a hypothetical or conceptual manner. Their possible occurrence, examples, and consequences on the Shroud or in history can be considered without being able to recreate these events in as laboratory.

Actually, we can't precisely recreate any event that has already occurred in history whether it's Lincoln's assassination or the resurrection. We most assuredly cannot recreate the Universe or the Big Bang, yet that doesn't prevent us from scientifically studying whether or how the event took place. Of course, the creation of the universe was a much larger and arguably much more miraculous event than the resurrection. Not only was all matter and all energy created, but all time and space was also supposedly created by this event. Of course, we should and do study hypotheses like the Big Bang to explain the creation of the universe even though we can't begin to demonstrate such an event. Scientists can also consider hypotheses regarding a miraculous event or the resurrection when, in the case of the man in the Shroud, it is based on extensive data from observation and experimentation and can be further tested in a number of ways (Antonacci, 2000, 2010). Of course, all perspectives, including science, should study or consider hypotheses or events that are relevant to all individuals and are prominently mentioned in important historical sources.

4. CONCLUSION

The keynote address from the international conference at the ENEA Research Centre in Frascati, Italy, held in conjunction with the Shroud's Exhibition in 2010 recommended that a series of new scientific tests be performed on the Shroud of Turin and its samples (Antonacci, 2010). The authors recommend these tests be adapted and perfected on control linen, blood, charred linen material, and limestone and then applied to Shroud-related testing. Among other things, these experiments would test for the presence of C-14, Cl-36 and Ca-41 on various cloth, charred material, blood and limestone samples removed from the Shroud, and on limestone samples from Jesus' reputed burial tomb(s). Among other things these test results, along with much other acquired data from the Shroud, could indicate whether particle radiation irradiated the Shroud and its blood; whether the source was the length, width and depth of the dead body wrapped within it; whether the event happened in the first century; to a contemporary first century cloth; and whether it occurred in Jesus' burial tomb (Antonacci, 2010, 2012).

Only the Historically Consistent Method, in which particle radiation was released from the disappearing body within the Shroud, can physically explain or account for its unprecedented frontal and dorsal images, its many unique blood marks, its secondary image features, its non-

image features, its aberrant radiocarbon dating, the resurrection and several related events reported in history — which scientists have never attempted to explain before.

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ENDNOTES

1. Deuterons and alpha particles that contain one or two protons and neutrons, respectively, but behave like protons, would also be produced. Hereafter, where the effects of protons are mentioned, similar results would be expected for deuterons, alpha particles or other heavy charged particles. Electrons and gamma rays could also be released, but they would not discolor the cloth.
2. Matthew is the only Gospel that discusses earthquakes and it discusses two. The first one, described in 27:51-52, occurs after Jesus' death on the cross. It says that the earth shook, rocks were split and tombs were opened. While the second event is described in 28:2 as a great earthquake, which appears to have occurred on Easter morning (after the women went to see the tomb and just before an angel descended), it has a limited and localized effect that clearly does not damage Jesus' burial cloth or the tomb.
3. Even the hypothetical use of the side strip to loosely bind the Shroud around the man cannot account for the complete and intimate contact by all the blood marks on both sides of his body with the Shroud. Nor can such binding explain the blood marks being embedded in the Shroud in the same shape as when they formed and coagulated on the body.
4. While speaking of his resurrection in the days before he died, the Gospels also record Jesus referring to his body and his shed blood as two vitally similar, yet distinct things.
5. As one of the volunteers in Dr. Lind's experiments, I can verify that the dried, coagulated blood flows (that occurred within minutes on our arms) could only be removed by pouring water on them and rubbing vigorously.

   According to John 20, Mary Magdalene was the first person to see Jesus on Easter morning. She saw him so soon after his reappearance that Jesus would not allow her to hug him. Even though Mary Magdalene initially confused him with the gardener, she did not observe any of Jesus' numerous blood marks on his body, nor did anyone else on Easter Sunday.

PHOTO CREDITS

Figures 1, 5 and 6b. ©1978, Vernon Miller
Figures 2, 3, 4. ©2003, ODPF, in SINDONE 2002 by M. Flury-Lemberg
Figure 6a. Courtesy of Dr. Sebastiano Rodante and Dorothy Crispino

PART II: EXPERIMENTAL RESEARCH

1. INTRODUCTION

The hypothesis that is the subject of this paper concerns the blood stains that are found on the Shroud of Turin, the reputed burial cloth of Jesus Christ. The hypothesis is "The body suddenly reappeared outside of his burial cloth while the blood marks immediately reappeared at their original locations within the cloth." This hypothesis is predicated on the many, but insufficient, observations that have been reported about the blood stains on the Shroud. The hypothesis suggests that the blood was put on the Shroud during a miraculous event. This research consisted of both laboratory and field experiments combined with studying relevant literature. The purpose of this research was directed towards illustrating the properties of blood and how they relate to determining if the blood could be put on linen by natural methods, either by a bloody body contacting a burial cloth, or by an artist painting blood on linen. When possible, the results of our experiments were compared with what is actually on the Shroud. Unfortunately, complete detailed information about the blood stains on the Shroud does not now exist. More investigations of the Shroud need to be performed so that results of these and future experiments can be fairly compared to what is really on the Shroud. As it stands now the results of this research indicate that natural methods for putting the blood on the Shroud are not able to match all the characteristics that have been reported about the blood on the Shroud.

2. RELEVANT INFORMATION CONCERNING BLOOD ON THE SHROUD

In 1978 a well-organized team[1] under the leadership of John Jackson spent only 120 hours for a one-time scientific examination of the Shroud. Much valuable information was obtained from these examinations and for the last 36 years these results have been used by many for their studies. In 2002 during a preservation effort photographs were taken of the Shroud[2], but not in sufficient detail for many researchers. The best available detailed data for the purposes of this study came from a book first published in 1953, "A Doctor at Calvary" by Pierre Barbet, M.D[3]. Unfortunately Barbet's book does not contain detailed color photographs that this research requires. In particular, the information that is lacking for this research are detailed high resolution photographs and micrographs of corresponding blood marks on the forward and reverse sides of the Shroud. With this missing information in mind, the following describes research done in an attempt to show that the blood marks on the Shroud could only have been put there by a miraculous event as hypothesized.

Barbet indicated that one of the best blood stains on the Shroud is on the wrist. Below in Figure 1 both the forward and reverse sides of this blood stain are shown. These photographs were obtained in 2002 when the backing cloth was removed and it was possible to photograph the reverse side.[2]

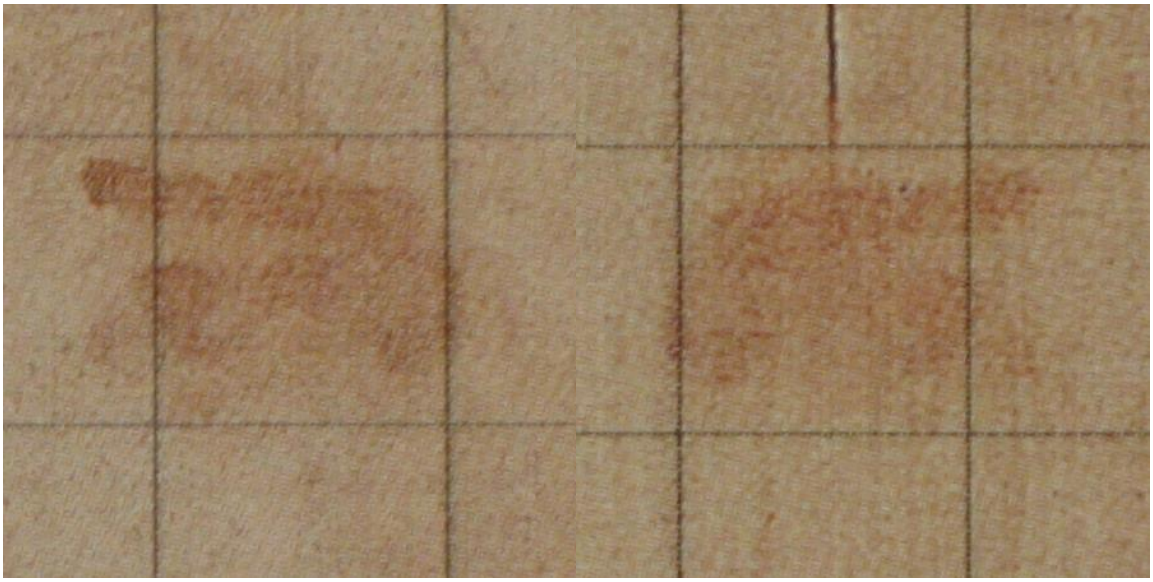


Figure 1. Blood stain on the wrist, views of both the forward and reverse sides of the Shroud[2]

Concerning the ability of a forger being able to create the blood stain on the wrist, Barbet made the following statement. "Never would he have succeeded in producing those stains with clearly marked edges, which with such outstanding truthfulness reproduce the shape of the clots as they formed naturally on the skin."[4] The details shown in Figure 1 are not adequate for the purposes of this research, but they do show that the forward stain is slightly more intense than reverse stain. The perimeter of the forward stain is perhaps slightly darker than the center of the stain; this is an observation made by other investigators and is discussed below as being a characteristic feature of the blood stains on the Shroud.

During the 1978 study of the Shroud, Mark Evans obtained professional photomicrographs of various areas of the Shroud and these formed a good reference for our research. Figure 2 is a photomicrograph that shows a clear area of the linen on the Shroud (Location C13). Figure 3 shows two photomicrographs of a dense blood area at the small of the back (Location D15) and blood at dorsal foot (Location D1). The description "dense blood" does not at first seem to be appropriate, as most of the fibers of the threads do not even contain traces of blood. Also, the sides of many of the threads contain no blood. The foot area has been described as heavy blood flow, but it too appears to contain little blood. This makes it seem unlikely that corresponding blood marks could appear on the reverse side of the shroud, but on the Shroud they do! Jumping ahead to the observations made in our experimental research, it must be said that blood stains like that shown in Figure 3 were generally not created in our attempts to duplicate the blood stains on the Shroud. Almost of the blood stains created in these experiments were generally much more densely covered with blood; perhaps wear and tear during the lifetime of the Shroud caused much of the blood to fall off.

Figure 2. Photomicrograph of a clear part of the Shroud (Location C13) taken by Mark Evans during the 1978 STURP investigation. © Mark Evans 1978

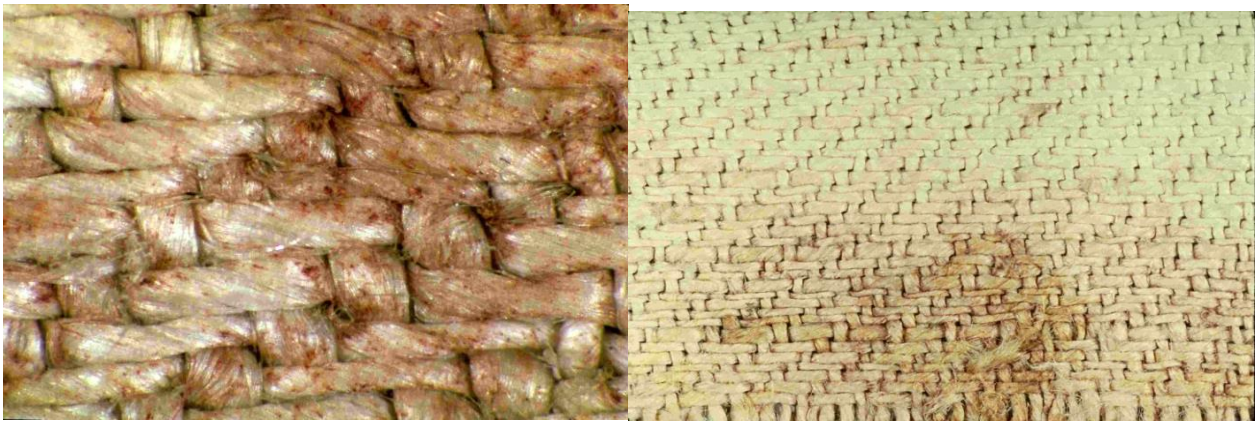


Figure 3. Photomicrographs: Dense blood at the small of back (Location D15) and dorsal foot blood (Location D1). © Mark Evans 1978

2. LINENS USED IN THIS RESEARCH

The linens used in this research are shown in Fig 4, where they are compared to the Shroud linen. All pictures are in the same scale and a 1 mm scale is included in the pictures of the modern linens that were used. The threads in all the modern linens are much more frayed than the threads of the Shroud. Perhaps the modern mechanical methods for extracting the fine linen fibers from the stem of flax plants are harsher than the manual methods of ancient times.

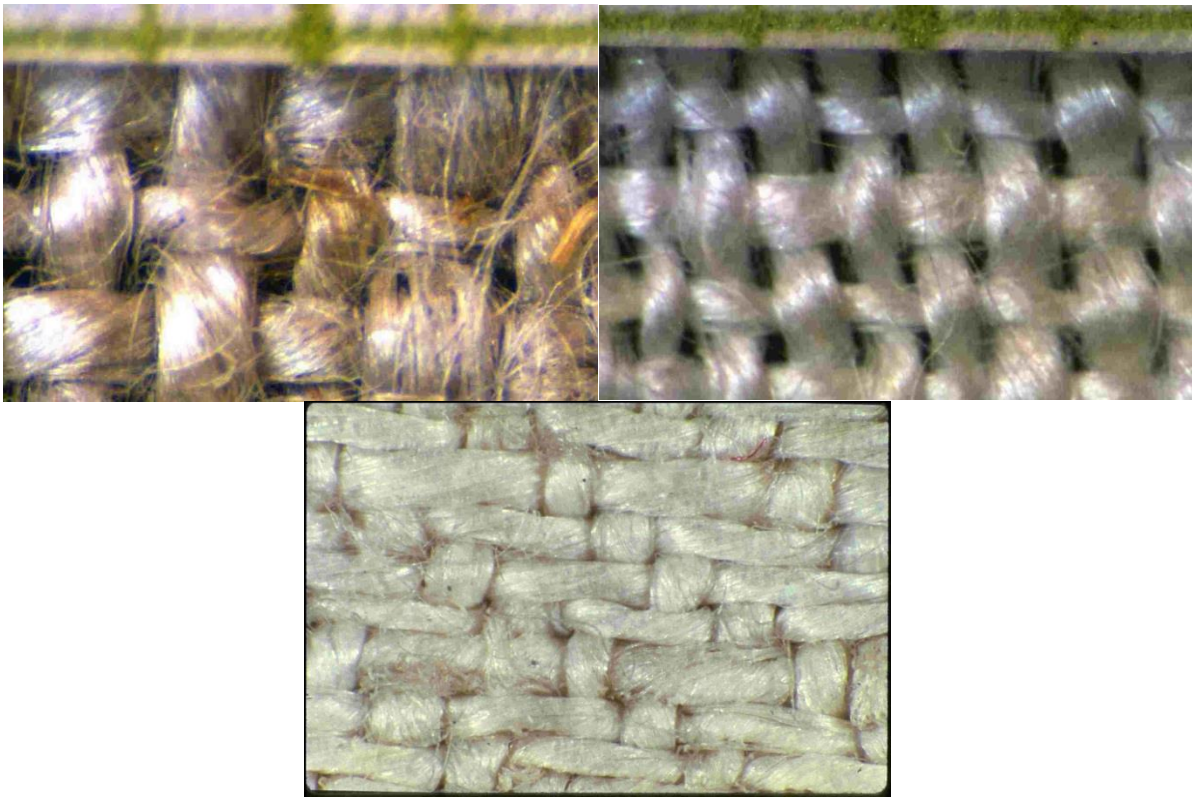


Figure 4. Comparison of the linens used in this research. Upper left is unbleached German. Upper right is French linen. Lower center is Shroud linen and photomicrograph was taken by Mark Evans © Mark Evans 1978. The pictures of the modern linens include a 1 mm scale at the top; all pictures are in the same scale.

Relevant Physical Characteristics of Linens used in this Research and Shroud Linen.

Name	Warp threads/cm	Weft threads/cm	Density, mg/cm^2	Comment
German	13	15	26	Unbleached
French	22	18	19	Bleached
Shroud	38.6	26	24	?

All modern linens used in this research were repeatedly washed and rinsed with distilled water to assure that no sizing material was on the threads.

4. COAGULATION OF BLOOD

Our experimental approach was not to duplicate a miracle, but to show that natural methods by an artist or by natural contact of a linen shroud with a bloody body cannot duplicate what has been reported about the blood on the Shroud of Turin. To accomplish this it is necessary to better acquaint the reader with the properties of blood by using photographs because much that has been written about blood on the Shroud lacks the information that can only be fully understood by actual visual observations. Barbet very succinctly described the coagulation

process as "Coagulation takes place in a very short time, never longer than a few minutes. Secondly, the clot grows smaller, exudes its liquid content, the serum. It then gradually dries."[5] This clotting process is described below using both words and photographs.

Blood is very complicated and it is known best by hematologists. Neither author of this paper is a hematologist, so what follows is confined to a very small part of what is called the coagulation cascade. When we accidentally puncture ourselves and blood leaves one or more blood vessels a complicated series of events takes place. The thing that triggers these events is the fact that blood leaves contact with its familiar interior tissue of the blood vessels and comes into contact with a different tissue. This trigger begins as soon as the blood senses a tissue change. This is called the "tissue factor". The first part of this event is to form clots to plug any holes in the blood vessels to prevent loss of blood. Another part of this event is for the blood to clot on the skin to close the wound and protect it; this is the part we can see when our skin is punctured and what we might be able to see on the Shroud.

5. HUMAN BLOOD CLOTTING ON PLASTIC

The clotting process outside of the blood vessel is illustrated in the pictures in Figure 5. It shows a drop of human blood from a pricked finger dropped on the surface of a clear Mylar plastic sheet. The length of the blood drop is about 4 mm. The C-shaped reflection is from a circular fluorescent lamp used to illuminate the blood. The first picture in the upper left hand corner was taken immediately after the blood dripped from the finger onto the plastic. Subsequent pictures were taken at 2 minute intervals. Very soon the blood begins to clot and shrink; in this case both the length and width of the drop shrunk by 15% as it clotted and dried to the touch after only 10 minutes. The pictures show that at the center of the blood a clot develops that is grainy and dark, but at the edge it is clear and transparent. This is because in the clotting process a tough fibrous cross-linked network (called fibrin) forms that collects, binds and pulls together the blood cells into a clot; this is the dark grainy center. This squeezes out a watery fluid that remains attached to this fibrous network by cohesive forces. This watery fluid is serum, which is blood plasma minus the clotting factors. Serum been detected on the blood stains on the Shroud, as first reported by Barbet[6]. This watery serum when dry is clear and brittle; the last two pictures show some of the brittle serum that broke off when the fibrous network shrunk the blood. For clarification, pure serum separated from blood in a laboratory is clear, but in a situation like this the serum contains some red blood cells, so it is red. Note also the development of the upraised edges of the blood along the perimeter of the blood drop and the depressed center. This occurs because the coagulation (shrinking) continues in the center and the serum that is squeezed out to the edges does not wet the plastic surface. Because microscope views of objects can be deceiving, the upraised edges in the photographs below were confirmed by altering the location of the light source and noting the changes in the reflection patterns. However, evidence for the upraised edges can be seen in the last two (perhaps three) pictures. Paying attention to the upper right hand part of the blood drop where the grainy clotted blood meets the clear serum, the white reflection of the illuminating light coming from the lower left can be seen on the inner edge of the upraised serum.

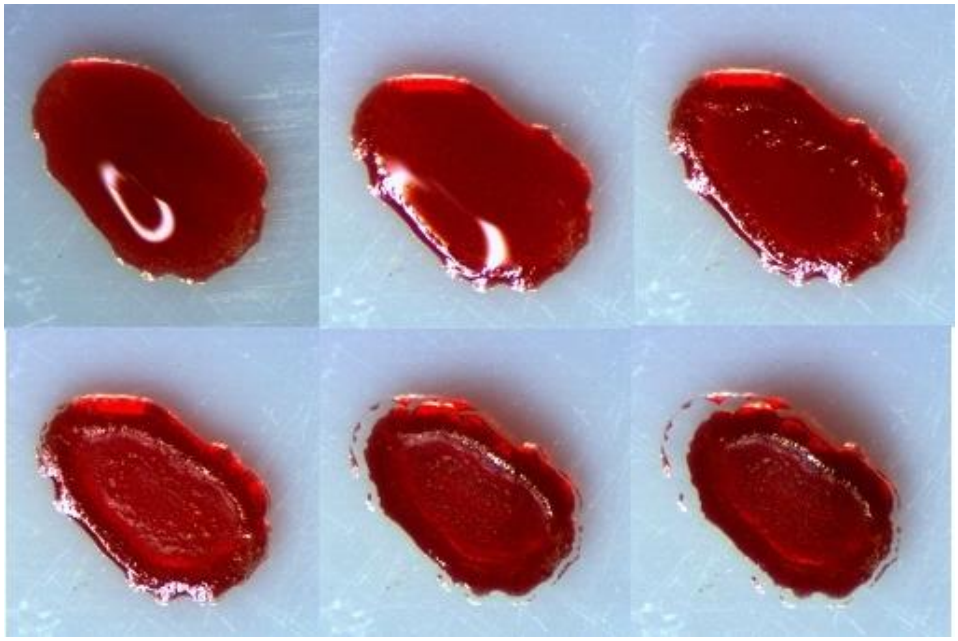


Figure 5. Pictures showing a drop of human blood clotting on a clear plastic sheet. The picture in the upper left was taken immediately after the blood was placed on the sheet. Pictures were taken every 2 minutes. The last picture in the lower right was taken 10 minutes after blood was put on plastic.

6. HUMAN BLOOD CLOTTING ON SKIN

The coagulation process on skin is slightly different from coagulation on plastic. This is because the blood does not wet the plastic well, so it is free to slide along the surface of the plastic as it coagulates. Skin is wetted by blood, so it attaches to the skin; another way of saying this is that the capillary forces between skin and blood are large. This is shown in Figure 6, which shows the blood on the tip of a finger soon after it was pricked with a needle. The length of the blood on the finger is about 4 mm. The first picture in the upper left was taken very soon after the finger was pricked and blood formed a sizeable drop. Pictures were taken every 1 minute. The last picture in the lower right was taken at 11 minutes, at which time the clotting was complete and the blood was dry to the touch. Because the blood attaches to the skin, as it shrinks, it pulls the skin together to close the wound. Because of this attachment to the skin, the shrinkage was restrained, so the 15% shrinkage in both length and width that occurred on plastic was much less on skin; here it was only 9% in width and 7% in length. Comparing the finger prints in the first and last picture shows that the skin was wrinkled as the coagulating blood pulled the skin together. It is also seen that the upraised edges of the serum that occurred with blood coagulating on plastic do not occur with blood coagulating on skin because serum wets the skin, so it makes a small contact angle with the skin. As an aside, this small contact angle makes it much less likely for the scab to be accidentally rubbed off from a wound on skin.

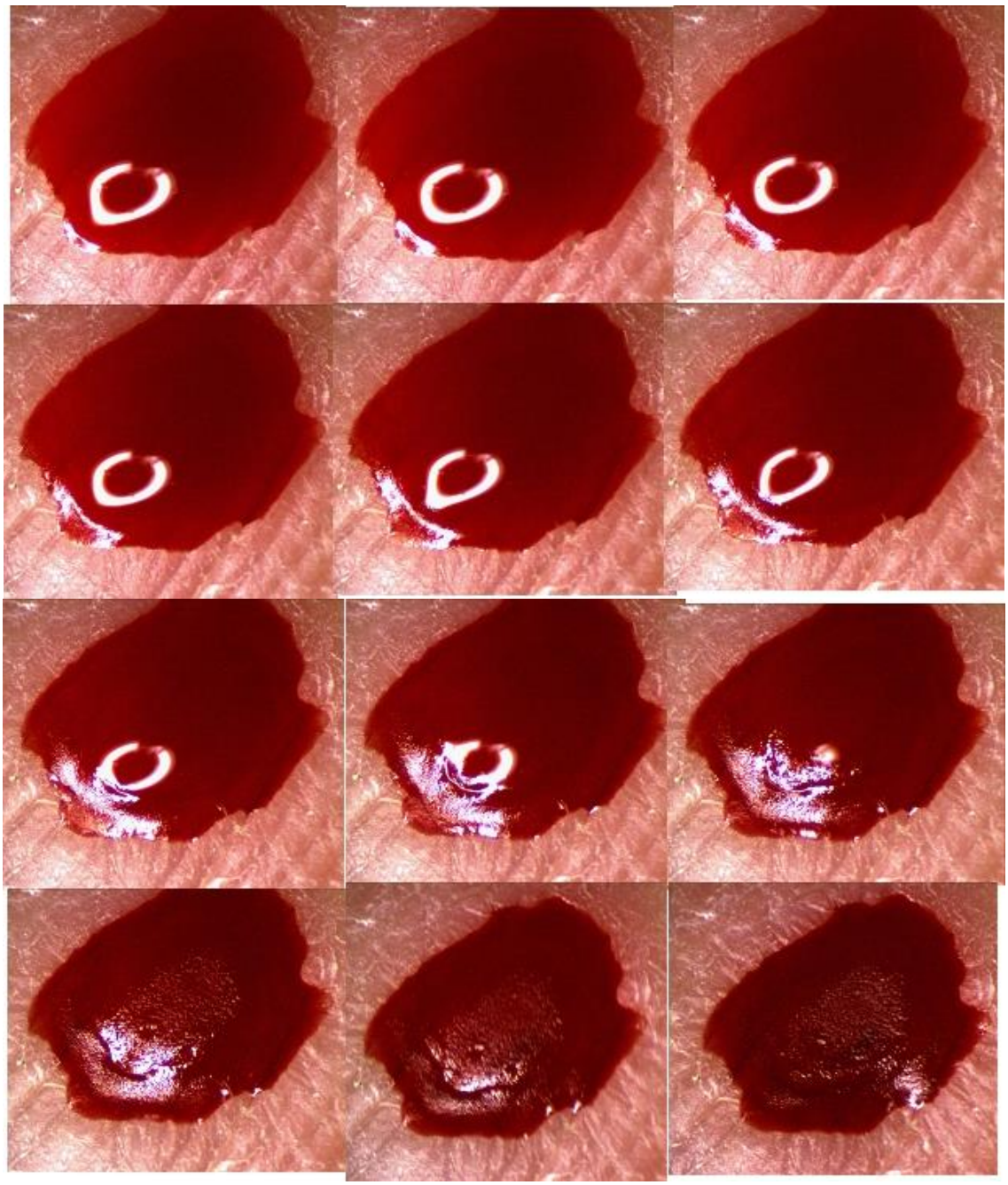
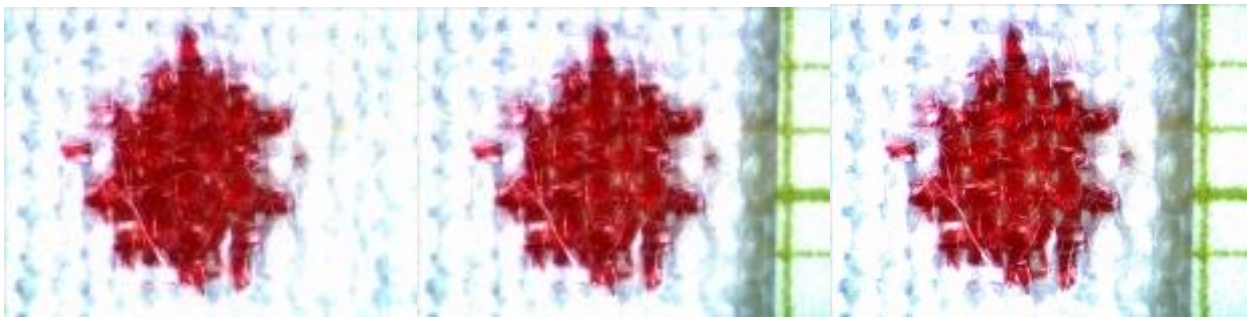


Figure 6. These are pictures of a drop of human blood on the tip of a finger as the blood clots and dries. The picture in the upper left was taken immediately after the blood flowed from a pin prick. Pictures were taken every 1 minute. The last picture in the lower right was taken 11 minutes after the blood flowed from the pin prick; the blood is dry.

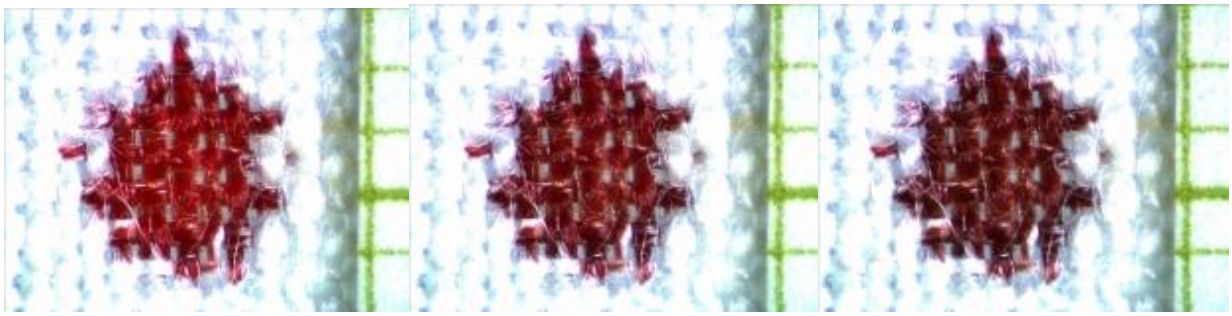
6. HUMAN BLOOD CLOTTING ON LINEN

In this experiment a drop of blood was placed on French linen. The blood is 4 mm long in the vertical direction, as can be seen using the 1 mm scale on the right side of the pictures. Figure 7 shows the sequence of what happens after human blood was dripped on the linen. The first

picture at 49 seconds was taken as soon as the linen could be quickly placed under the microscope, focused and the lighting adjusted.



49 sec. 148 sec. 300 sec.



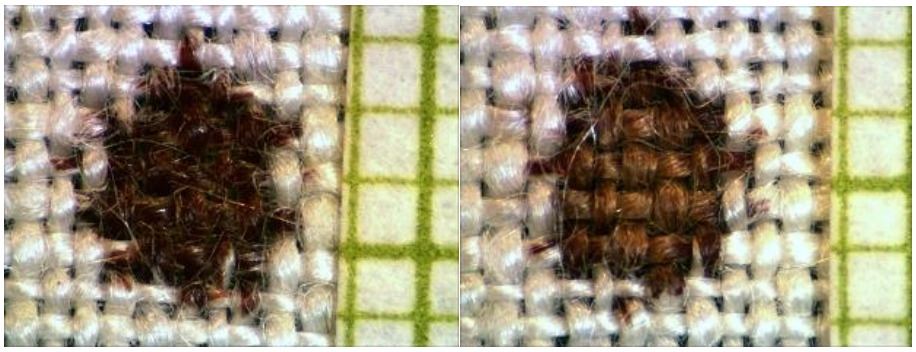
660 sec. 1804 sec. 4385 sec.

Figure. 7 Human blood on linen as it clots and dries; labels indicate the time after blood was dripped on the French linen.

The first picture at 49 seconds is blood red and it fills the gaps between the threads. The blood slowly turns brown. There are no signs of blood shrinking that causes adjacent threads to be pulled together. However, clot contraction is obvious by noting that the blood-filled gaps between the threads disappear as the blood contracts into the threads and reveals the gaps between the threads.

The lines of blood extending beyond the main body of the stain indicate capillary action along the threads has occurred. Reports of blood stains on the Shroud indicate that the edges of the stains are sharp, but the meaning of sharp was not quantified. Hence the results of the capillary action seen in Figure 7, which less than 1 mm in length might be considered "sharp."

Figure 8 was taken 63 days after the blood was dripped on the linen. Oxidation causes the blood to quickly darken. The pictures in Fig 8 show more detail and better lighting than those in Fig 7 because during blood clotting the microscope and lighting were quickly adjusted to capture the entire clotting process. The pictures show that during the 63 days the blood became much darker. The reverse side reveals that the center is of a lighter color than the perimeter, while the forward side is uniformly dark color. The dark color on the forward side does not agree with the reported red color seen on the Shroud.



Forward side where blood was applied Reverse side

Figure 8. Human blood on linen taken 63 days after blood was dripped on linen. Notice perimeter is darker that the center, especially on reverse side.

8. PAINTING FRESH BLOOD WITH A BRUSH AS AN ARTIST MIGHT HAVE DONE

Barbet's anatomical experiments took place in the years 1932 and 1935 after the exposition of the Shroud in 1931. On page 1 of his book Barbet make the following statement. "The bloodstained pictures were clearly not drawn by the hand of man; they could be nothing but the counter-drawing made by blood which had been previously congealed on a human body. No artist would have been able to imagine for himself the minute details of those pictures, each one of which portrayed the detail of which we now know about the coagulation of blood, but which in the 14th century was unknown. But the fact is that not one of us would be able to produce such pictures without falling into some blunder."[7]

The experiments in this research were conducted to determine that if an artist did have this knowledge, could the artist actually paint what is seen on the Shroud? Many approaches were tried to paint fresh pig blood on linen. Pig blood was used because it is very much like human blood and is actually being considered for transfusions to humans[8]; it was also readily available in large quantities[9]. In the following, all blood experiments were conducted using fresh pig blood. The pictures in Figure 9 show the results of two attempts to paint blood on German linen using a brush; both the forward side (painted) and the reverse side are shown.

Figure 9. Forward (painted) and Reverse sides of German linen that was painted with pig blood. Pictures were taken six months after blood was put on linen.

The large area of blood was an attempt to paint a narrow line with a brush dipped in pig blood 3 minutes after the blood was obtained from a slaughtered pig. When the brush first touched the linen the blood quickly diffused along the threads far beyond the intended boundary of the line. The reason this occurred was because the blood on the brush was watery. Thus, it was able to wet the threads and by capillary forces be pulled along the threads far away from the tip of the brush. The smaller line that is adjacent to the larger blood stain was drawn using a smaller brush containing a smaller amount of fresh blood that was obtained and used a few seconds after the blood first flowed from a slaughtered pig. In this case the blood did not spread out along the threads as much because it was not as watery. The increased amount of water in the older blood came from the watery serum that was squeezed out of the blood clot. In later attempts using older blood, the brush was deliberately inserted into the center of the clotting blood in an attempt to exclude the watery serum. However, when the brush was removed it passed through the surrounding watery serum causing much of the blood on the brush to be washed off and replaced by the watery serum. It was obvious that the rapid clotting was a serious problem and that it would have to be prevented for an artist to paint blood on linen as it appears on the Shroud.

Before going on to the discussion of methods for preventing the clotting of blood, some features of Figure 9 need to be discussed in view of what Barbet reported about the Shroud blood. Barbet says, "The colour of these counter drawings would vary in intensity according to the thickness of the clots. Vignon saw clearly that when a drop of congealed blood grows smaller, its thickness is greater in the circumference than in the centre. And that is why many of these counter drawings are highly colored at the circumference and have in their centre a zone of milder colour."[10] The pictures of painted blood on linen in Figure 9 and also in Figure 8 indicate the clotting process described by Vignon appears to be occurring in the linen as they were shown in Figure 5 to occur on plastic where the blood had upraised edges, but not as the blood clotted on skin because on skin the serum at the circumference was thinner than the blood at the center. In addition, if and when clotting occurs in the linen, it would be constrained by the threads of the linen and the typical shrinking of the central clot cannot occur, as shown in Figure 7. However, from Figures 8 and 9 it seems that the circumference of the blood is indeed more highly colored that the center. This could be an effect analogous to paper chromatography where different components of a liquid diffuse along a porous material different rates.[11] It seems that this is actually the case because the component in blood that is dark after drying in air is probably a heme group in blood,[12] which will oxidize to a dark brown. This observation by Vignon is something that would be good to carefully examine during future examinations of the Shroud; the perimeter of blood stains should be examined for higher oxidized iron content.

9. PAINTING BLOOD ON LINEN USING METHODS TO PREVENT COAGULATION OF BLOOD

It was not until the eighteenth century that chemical methods were discovered to prevent clotting of blood.[13] However, 13th century artists, who worked as quasi-scientists to evolve the range of pigments that they used[14] may have tried to stir the blood to obtain a homogeneous mixture suitable for painting. The artists may have mixed other things with the blood to curtail

clotting and one of these might have been lemon juice. The juice of the lemon is about 5% to 6% citric acid, which prevents the coagulation of blood. Therefore, in our experiments we investigated stirring blood and adding lemon juice to blood; both were found to be effective to prevent the clotting of fresh blood.

Not more than 30 seconds after blood flowed from a slaughtered pig, the blood was treated by either rapid stirring[15] or by adding lemon juice[16]. Both treatments produced blood that could be used for painting days after treatment if the blood was kept cool. Figure 10 shows the forward and reverse sides of linen on which stirred blood were delicately and crudely painted with a brush dipped in stirred blood.

Figure 10. Forward (top) side and reverse side of German linen painted with pig blood that was stirred to prevent coagulation. Notice reddish tint of blood and the dark perimeter.

The crudely drawn object consists of two circles connected by a line; the brush that was used was full of blood. A smaller brush with a small amount of blood was used to create the remaining figures. The images of the carefully drawn small figures do not have a noticeably darker perimeter. Only the large crudely drawn figure has its perimeter darker than the center. As mentioned above the effect is analogous to paper chromatography which separates compounds that percolate through a porous material at different rates. However, if the percolation distance is small, the separation is also small and that is why the small figures do not have a noticeable darker perimeter. Here again we have a conflict with the explanation of Vignon for the darker perimeter who interpreted this as being a result of the blood congealing [coagulating][10] and was observed with fresh blood in Figure 9. However, the blood shown in Figure 10 was treated to prevent coagulation! This raises questions about the presence of coagulated blood being seen everywhere on the Shroud.

When making the large blood mark on the linen, the blood was observed to spread out along the threads by capillary action, but even with these crude brush strokes, the perimeter is reasonably sharp and doesn't exhibit the "four prolongations following the threads of the warp and woof, which thus forms a little cross," as reported by Barbet[10]. In this research such prolongations were not observed with the linen materials used. However, when using cotton gauze bandage cloth to which Barbet made reference, Barbet's effect was observed.

One more observation was made concerning stirred blood and blood treated with the anticoagulant lemon juice. Clotting experiments were conducted on these samples as was done with human blood, as shown in Figure 5, where the blood was observed as it clotted and dried on a Mylar plastic sheet. The stirred blood never showed signs of clotting, but it did dry and shrink; stirring was very effective. The blood treated with lemon juice (1% by volume) exhibited some weak signs of clotting (granulated center and upraised edges); more lemon juice might have completely eliminated clotting. An interesting result of using anticoagulating methods was the condition of the drops after they had completely dried. Figure 11 shows these two blood drops two days after the drops of blood were placed on the plastic sheet. Because the clotting factors were absent or reduced, the dense fibrous network was also absent or reduced, so the blood was free to crack as it dried and shrunk, just as mud cracks when it dries. Christ's blood may also have lacked clotting factors as a result of excessive blood loss and have been brittle. This may account for the fact that blood stains on the Shroud contain only a small amount of blood, as shown in Figure 3; the blood that remained, being absent of the fibrous network could have been brittle, cracked and was free to fall off in the more than 600 years of its historically known age.

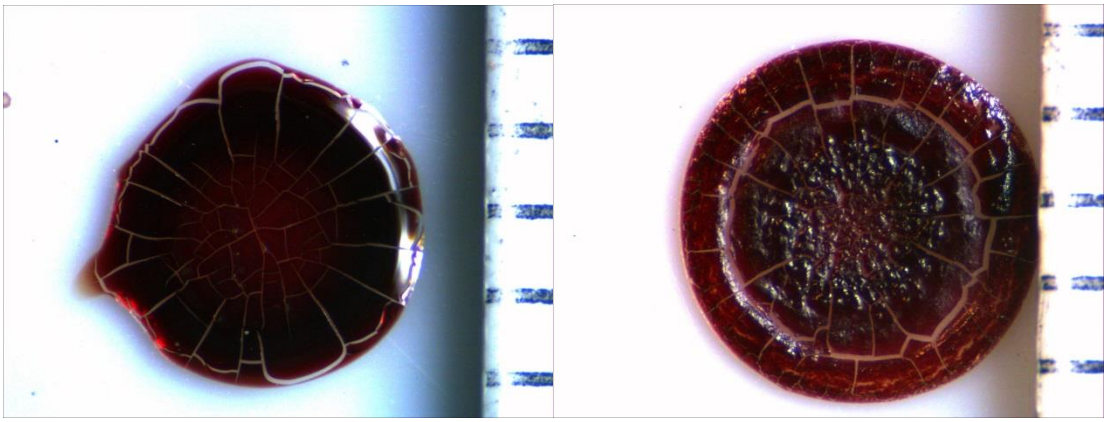


Figure 11. Completely dry drops of stirred blood and Lemon juice treated blood. 1 mm scale

10. EXPERIMENTS TO TRANSFER BLOOD FROM BLOODY SKIN TO LINEN

Barbet did not believe that the blood was put on the Shroud by painting with a brush for various reasons, one of which was the dark edges of the blood marks that he thought was serum resulting from the blood coagulating on the skin. He favored a direct contact method where an exact counter image (mirror image) of the clotted blood would be transferred to the cloth. When discussing the use of blood as a medium by an artist Barbet wrote[4], "Never would he have

succeeded in producing these stains with clearly marked edges, which with such outstanding truthfulness reproduce the shape of the clots as they were formed naturally on the skin."

Gilbert Lavoie[17] was the first to conduct and report results of blood transfer experiments and he has been a source of helpful information in the planning and understanding results of many of the blood experiments reported in this paper. In his excellent book he reported blood transfer experiments that he performed with human blood. He made several pools of blood on either plastic or skin. Each pool contained 9 drops of blood. He said it took ten minutes for the liquid blood to clot. Thirty minutes later he observed to clots to start clot retraction (shrink in size and squeeze out the serum). One half hour after forming the pools of blood, he placed a piece of linen on the first pool. At 0.5 hour intervals he added one more piece of linen on a pool, up to as long as 3.5 hours. He was able to obtain blood transfers to linen for as long as 3.5 hours after the blood was places on the surface of plastic, 1.5 hours from skin and 2 hours from skin moistened with saline solution. Lavoie suggested that the condition of Christ's skin after crucifixion might have kept the blood moist or it could have been remoistened while in His burial damp tomb.

Lavoie obtained his human blood as a doctor or nurse would do when obtaining a blood sample. He did not use an anticoagulant, but he did use a metal needle and a plastic Red Top blood collection tube. The use of these materials would not tend to trigger coagulation of the collected blood. This is suspected as the reason he was able to obtain good transfers of blood put on surfaces of either plastic or human skin to linen hours after putting the blood on a surface. In all of the experiments conducted and reported in this research the blood was obtained by cutting or puncturing the skin, which certainly had a different kind of tissue factor and caused the blood to clot much faster. In the case of Christ, it might be thought that the blood would have experienced a tissue factor that would cause more rapid clotting of the blood. It is also recognized that in cases of severe bleeding the clotting factors can be depleted, in which case the blood could remain moist for a longer time.

In our first set of experiments to duplicate Lavoie's results volunteers agreed to get up early in the morning, drive out of town out to the Williams Brother's pig slaughter house[9] and have blood dripped on their arms. Two volunteers were each subjected to the following treatment. Fresh blood from a pig collected in a plastic cup was immediately put in a plastic syringe and drizzled down the inner part of the arm of a volunteer from the elbow down to the wrist as the arm was hanging downward. This was repeated for the other arm. The blood flow for a crucifixion victim would be from the wrist down to the elbow, but for the sake of the volunteers comfort, they were not asked to hold their arms over their head for an extended period of time. This was repeated on the other arm with fresh blood. Typical appearance of an arm about 15 minutes after blood was applied is shown in Fig 12. The dull appearance of most of the blood is because the blood had clotted and dried. The air temperature was not measured, but it was probably about 24 C (75˚ F); no wind was blowing. In these experiments German linen was laid on the bloody arm without pressing down to make perfect contact 30 minutes after the blood was applied to the arm. No blood transfers occurred, except for about six tiny dots of blood.

Another trip to the slaughter house was made; in this case, as previously planned, the linen was pressed lightly on the skin 30 minutes after blood was put on the arm, but the blood was dry and again no transfer took place. This was surprising because the air temperature was

Figure 12. Arm of volunteer 15 minutes after pig blood was put on arm.

only 7.2 C (45˚ F) and there was only a slight breeze. The bloody arm was rubbed with a finger and all the blood was found to be dry and hard; see Figure 13. However, at this time it was noted that one tiny drop of blood had transferred and it was obviously still liquid and not clotted; it can be seen on the lower left hand corner of the linen that is visible in Figure 13. It was then noted that a few drops of liquid blood were still present on the tips of some of the arm hairs after more than 30 minutes. It was assumed that the tiny drop of blood that had transferred was from the tip of an arm hair. It is concluded that the clotting of blood in arm hair is slower than on skin, perhaps because hair has a tissue factor that does not promote rapid clotting of blood.

Figure 13. Arm is dry to touch after 30 minutes.

The question arises why clotted blood on the arm would dry faster than drops of un-clotted blood on the tips of the arm hairs. A guess would be that when blood clots, the clot contracts and

physically squeezes out the watery serum to the surface where it can quickly evaporate to the air, while in un-clotted blood the water must diffuse slowly to the surface in order for it to evaporate.

During these experiments it was noted that blood clotting on an arm causes the skin to wrinkle; this was shown above when blood clotted on a fingertip. On the arm the effect is much more obvious and severe, as shown in Figure 14. This wrinkling would prevent intimate contact with the linen, causing discontinuous blood stains on a transferred blood image to linen.

Figure 14. Large, deep wrinkles in skin caused by blood shrinking would prevent intimate contact between blood and linen, preventing continuous transfer of blood to linen.

11. EXPERIMENTS TO EXAMINE POSSIBLE WAYS FOR BLOOD TO REMAIN MOIST FOR EXTENDED TIME

The blood transfer experiments at the slaughter house indicated that the blood clotted and dried within 15 to 30 minutes after the blood flowed onto the skin. Thus, natural transfer of blood from the man in the Shroud to the linen is unlikely, with one possible exception and that is that during the time he was bleeding on the cross, he may have depleted the clotting factors in his blood. As seen in the preceding Section 10, blood on the tips of arm hair did not clot and dry rapidly and this was attributed to hair having a reduced clotting factor. Therefore, experiments were conducted using pig blood that was artificially treated to prevent clotting, as described in Section 9. Experiments were also conducted in a humid environment as suggested by Barbet who wrote, "On the other hand it seems to me quite possible that clots which had become more or less dry, would, without liquefying the fibrin, in a damp atmosphere become sufficiently moistened to form a fairly soft kind of paste. Thus transformed they would be able to impregnate the linen with which they came in contact and leave counter drawings on it with fairly definite outlines, which would reproduce the shape of the clots."[10]

Equal-sized drops of the lemon juice treated blood (1% by volume) were placed on the inner part of an arm in four locations. Figure 15 below shows an arm on which a piece of German linen was placed 11 minutes after four drops of blood were put on the arm. The uncovered blood drops show that the blood drops had dried a considerable distance inward from their edges. This

also shows that the edges of the blood are not upraised as claimed by Vignon and reported by Barbet.[10] The linen on the arm shows some blood that seeped through. Linen pieces were later put on the remaining three drops. The resulting blood stains on the linen are also shown in Figure 15. At the top are the reverse sides and at the bottom are the forward sides in contact with the blood (not mirror image, but as actually seen). The results indicate that uncoagulated blood does not dry as rapidly as fresh blood and that the results are similar to what is seen on the Shroud in that the reverse side is not as intense as the forward side. However, the blood on the forward side is much denser than seen in the Evans photomicrograph as seen if Figure 3, but because as seen above, un-clotted blood is brittle and could have fallen off during the life of the Shroud. Of greater importance is the fact that none of these transfers had the circumference a darker color than center, which in unlike the reported features of the blood stains on the Shroud. The very poor transfer at 16 minutes suggests that un-clotted blood alone would not have allowed transfers to have taken place to the Shroud without remoistening them in some manner. It must be mentioned that in repeated experiments of this same type, in one experiment it was observed that the blood did remain liquid enough to slightly transfer to linen after 32 minutes. High humidity environments would also delay drying and this is discussed below.

Figure 15 Transfer of blood treated with 1% lemon juice to prevent clotting. Top shows linen placed on first bloody area 11 minutes after blood drops were put on arm; remaining linens were put on at 14, 15 and 16 minutes after blood was put on arm. Notice edges of blood are thin and nearly parallel to the skin, rather than raised.
Middle: Reverse sides of linens after removing them, 22 minutes after blood put on arm.
Bottom: Forward sides of linens, in contact with blood.

To examine the effect of high humidity for extending drying time to allow blood transfers to occur, the following experiment was conducted. Fresh, moist chicken skin was used instead of a volunteer's skin because it was planned to be a 48 hour experiment in a humid environment. A drop of human blood was placed on fresh chicken skin. It was then placed on a pedestal in a glass container with water on the bottom. Because of the humid environment, drying took almost 2 hours versus the usual 11 minutes for blood in open air. Figure 16 (a) shows what the blood looked like after 2 hours; its appearance indicated it was probably not bone dry because of being in a humid environment. The blood was then very slightly dampened and a piece of French linen was placed on top of the blood. A circular washer was placed on the linen such that the location of the blood was well inside the center hole of the washer. This was done to assure intimate contact between the linen and blood. The container was then closed to assure 100% humidity, like one might expect in an underground tomb in Jerusalem following the rainy season in February and March.

Twenty four hours later the container was opened and the linen was peeled off the chicken skin. It took a modest force to peel it off. Figure 16 (b) shows a very small amount of blood remained on the skin after the linen was peeled off the chicken (unlike Jesus' reported appearances on Easter morning). This looks like a textured surface, but it is almost flat. The tiny linen fibers that are on the skin were pulled from the linen when it was removed. The large clean spot on the skin corresponds to the large piece of blood in Figure 16 (c), which shows it was completely transferred to the linen; the picture has been converted to a mirror image so that it can easily be compared with the other pictures. Note that a transfer was made only to topmost parts of the threads that were in contact with the blood. This indicates perfect contact is required to cause a transfer, which would be extremely unlikely for all the blood marks on the Shroud. No signs of wicking are seen outside the perimeter of blood. Figure 16 (d) shows that some blood had reached the reverse side and that the image is less intense than on the front side, as seen on the Shroud.

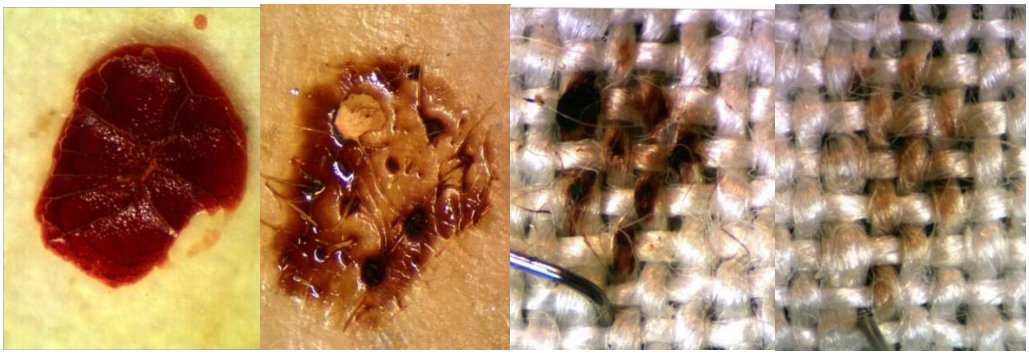


Figure 16. Transfer of blood on chicken skin to French linen in humid environment. (a) Blood after 2 hour time for the blood to clot and dry in humid environment. (b) Chicken skin after linen removed after 24 hours in humid air. (c) Mirror image of forward surface of linen. (d) Reverse side of linen. The shiny wire seen at the bottom of pictures (c) and (d) was inserted to aid in correlating features seen in (c) and (d).

In another experiment a large drop of fresh pig blood was dropped on leather and allowed to completely dry. This is shown in Figure 17. The blood's overall size was 19 cm. The dry blood was coated with pure aloe gel to moisten the dry blood as shown in Fig 17 (a); the presence of the aloe makes the picture look out of focus. Aloe was used because it was mentioned in John[18] as being brought to the burial tomb; the aloe provided moisture, which could also have been achieved in a damp burial tomb. A piece of German linen was placed on top and weighed down with a heavy flat weight to assure good contact. It was left for 48 hours. Figure 17 (b) shows what remained after pulling the linen off the leather. The tiny white dots are the imprint of the linen on the leather, which indicates good contact. However there is a darker area where the imprints are not seen. Figure 17 (c) is a mirror image of the forward surface of the linen that was in contact with the blood; a mirror image was used to allow all three pictures to be easily compared. The area where the linen blood transfer did not occur correlates with the area on the leather where the imprint of the linen is absent. It is also obvious that some blood remained in the area on the leather where the linen imprint is absent. Measurements of the surface of the leather showed that there was a slight dimple in the leather that was only 0.09 mm deep, about the thickness of a piece of paper. This is why the blood did not completely transfer to the linen. Therefore, a blood transfer occurs only with complete intimate contact between blood and linen. The surface of skin is not as smooth as leather and has body hair throughout it. Moreover, human skin lays over uneven surfaces, such as bones, muscles, edges and joints throughout our body. In addition, many parts of the front and back of the man in the Shroud would not even have been in contact with the draped Shroud. Pressure could not have been placed on the outer sides of the cloth, throughout all points on the front and back of a body that was in the configuration of the man in the Shroud. Figure 18 also shows both the forward and reverse sides of this transfer. It is seen that virtually no blood that transferred from the bloody leather to the linen also diffused to the back side of the linen. Perhaps different conditions would have caused more blood to diffuse the reverse side.

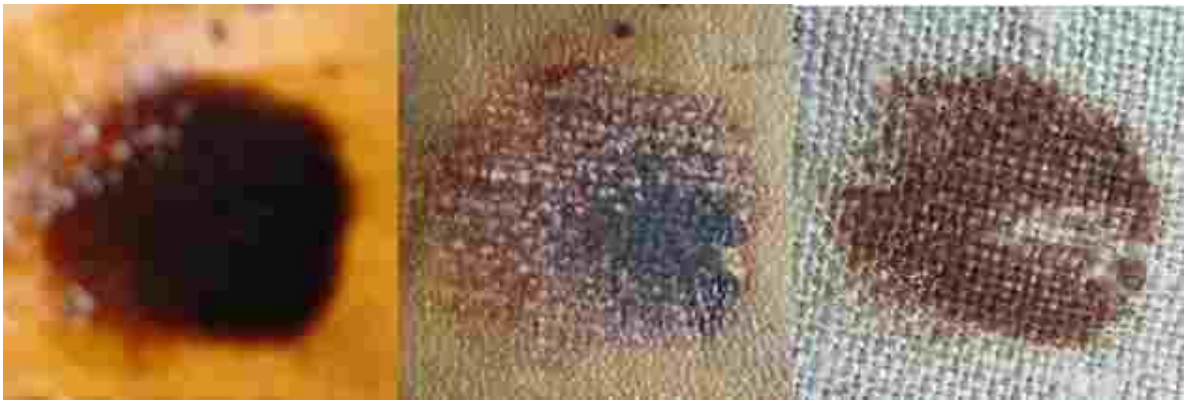


Figure 17. Transfer of blood on leather to German linen. (a) Leather with drop of clotted dried blood on surface and covered with aloe. (b) Leather surface after linen removed. (c) Mirror image of forward side of linen in contact with aloe coated leather. Note that perimeter of transferred blood is not darker than center, unlike blood on Shroud.

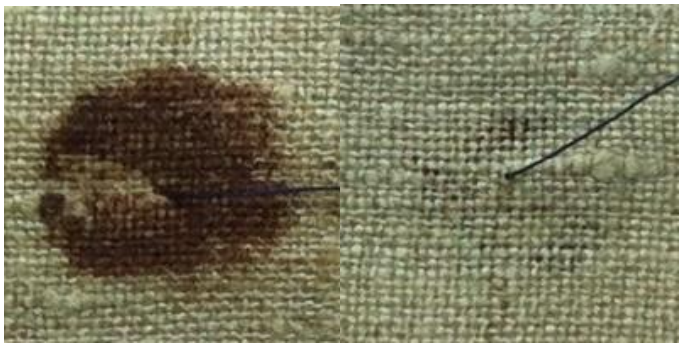


Figure 18. Blood transfer from aloe-covered leather whose surface contained clotted dry blood. Forward side and the mirror image of reverse side are shown. A blue thread was passed through the linen to help correlate forward and reverse sides. Only a tiny reverse image is present.

One might be convinced that, except for the requirement of intimate contact between the linen and the blood, that the contact method resulted in the blood images like those on the shroud. However, Figure 18 shows enlarged pictures of the forward side and reverse sides of the linen; only a tiny reverse image is present, which is not like the numerous blood marks seen on reverse side of the Shroud. Also the amount of blood seen in the enlarged forward image shown in Figure 19 on the left has much more blood than seen in a dense blood area on the Shroud in Figure 3. To estimate if the many years of wear might reduce the amount of blood on the Shroud, the surface of the linen just below and to slightly to the right of where the blue thread passes through the linen was vigorously rubbed until it seemed that the fibers of the threads might break. This was done to simulate the wear that the Shroud might have experienced during its long lifetime. The right hand side of Figure 19 shows the result of this simulated wear. Some reduction in blood was achieved, but comparing the density of the blood stain on the right hand side of Figure 19 with Evans' photomicrograph in Figure 3 shows that the dense blood stain on the Shroud has much less blood. Perhaps years of wear on the Shroud caused a greater reduction of blood.

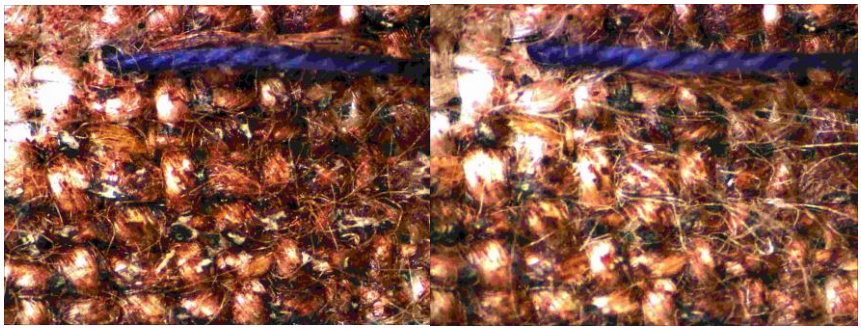


Figure 19. Enlarged views of area shown in Figure 18 (a); lighting is more intense in these pictures. The picture on the left is before the surface below the long blue thread was rubbed vigorously and the picture on the right was after rubbing this surface in an unsuccessful effort to remove excess blood to make it look like Mark Evans photomicrograph in Figure 3.

The reader may wonder what the numerous small black specks are in Figure 19. After microscopic examinations of many blood transfers and paintings on linen, it was determined that these are areas of high concentration of blood, whose color is black after aging. It was observed that thin coatings of blood on linen appear to be redder in color than thicker coatings of blood. Figure 20 is shown to provide some confirming evidence for the reader. It shows the forward and reverse surfaces of German linen on which fresh pig blood was transferred by contact. The air temperature was 9.4 C and there was no breeze. In this experiment fresh pig blood was put on a clear plastic sheet. The linen was put on the blood 17 minutes later, before the blood dried. Two hours later the temperature increased to 20 C after having been transported from the slaughter house to the laboratory. After waiting 24 hours the linen was removed from the plastic sheet. In Figure 20 the upper left shows that most of the blood remained on the plastic surface. Much of the remaining blood cracked into small pieces of blood and some had broken away. The upper right of Figure 20 shows the forward surface of the linen in contact with the blood (not a mirror image, but as actually seen). Not much thick blood had transferred to the surface. The thin transferred blood has a reddish tint. Some small pieces of blood that broke away are on the linen, but could easily fall off. The lower right of Figure 20 shows the reverse side of the linen, which has a lighter blood image.

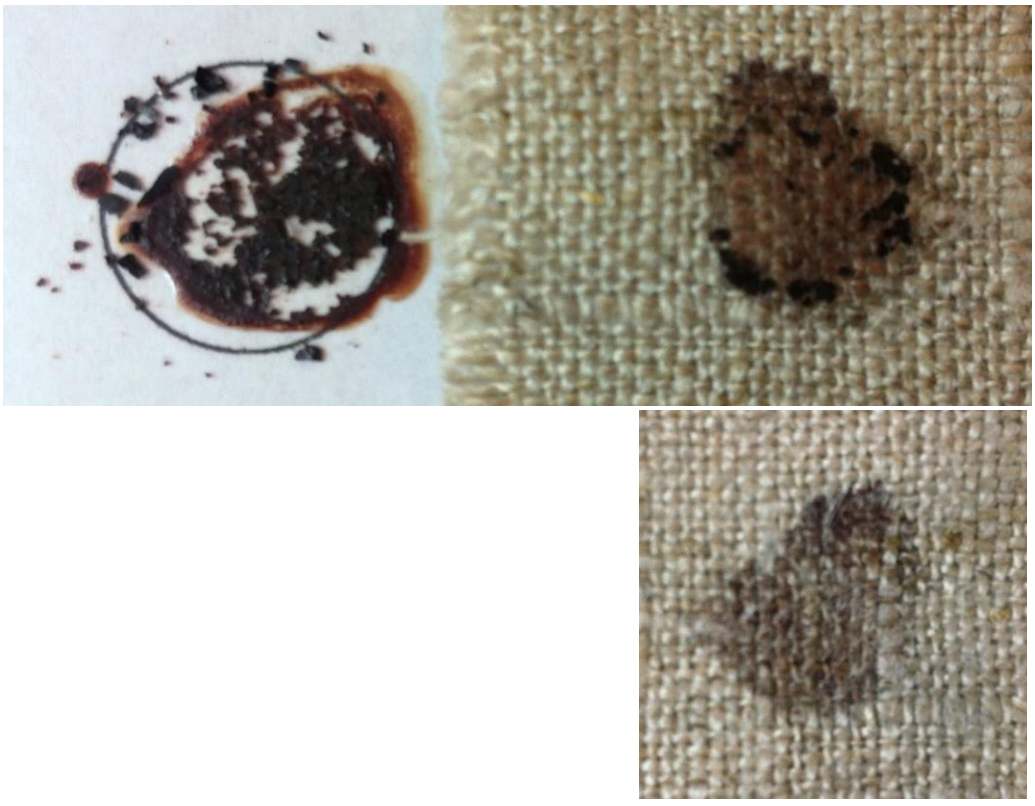


Figure 20. Results of fresh pig blood transfer from a Mylar plastic surface to German Linen. Upper left: remaining blood on plastic; the thin black circle is on paper below the plastic. Upper right: transferred blood to linen; note the red tint of the transferred blood. Lower Right: reverse blood image.

The small amount of blood that did transfer to the linen appears to have a reddish color, but the larger broken pieces of blood appear to be black. Because the small amount of blood on the linen appears to have a red tint, this may have some relevance to the red color of blood seen on the Shroud, which both authors have seen for themselves in 2000 and 2010.

Figure 21 is a photomicrograph of the forward side of the German linen that is shown in the upper right of Figure 20. Red and white slips of paper are included in Figure 21 to serve as color references because the light source, camera and display devices can alter true color of images. At the right along the border of the blood image are small pieces of dense, dry, brittle blood; they black. Most of this image is transferred blood and because it is a thin coating, it has a red tint and not black as might be expected with old blood. Black lines can be seen following some of the fibers of the threads. These are places where blood has collected between the linen fibers to form specks of dense blood; that is why they are black.

Figure 21. Enlarged view of upper left image in Figure 20. Notice the reddish color of the thin coating of blood on the linen fibers and the black color of the thicker pieces of same blood at the edge of the blood stain.

12. CONCLUSIONS

A variety of methods were used in an attempt to create blood stains on linen like those found on the Shroud of Turin. Some of the blood stains created in this research matched some of the reported features of blood stains on the Shroud. Other the blood stains created in this research matched different reported features. No one blood stain created in this research matched all the reported features. Reports frequently address the stains in a general manner without describing the exact location of the blood. Some blood stains on the Shroud were probably created from post mortem blood flow and others were not. Clearly any one blood stain created in this research

would not be able to match all the blood stains reported on the Shroud. Also, the reported features do not describe both the forward and reverse details of any one blood stain on the Shroud to allow it to be compared with the many stains created in this research. Only Reference 2 has pictures of both sides of the Shroud (Figure 1 above), but they are not detailed enough for this research.

Experiments conducted in this research revealed that accepted explanations previously reported for certain properties of blood on the Shroud are incorrect.

Painting blood on linen using a brush produced varied results depending on the method used. It also depended on if an anti-coagulant was used to prevent the coagulation of the blood. In almost all cases, whether or not an anti-coagulant was used, the blood mark on the linen was highly colored at the circumference and had a center of a milder color. Vignon reported this same thing and related it to the clotting process.[10] In this research it was concluded that the darker color of the circumference was caused not by the clotting process, but by an effect used in paper chromatography[11] and is used in crime scene investigations to separate blood from other compounds to allow the heme in the blood to be identified.[12] Using an anticoagulant made it much easier to paint the blood and some success was achieved in matching some of the features of blood stains on the Shroud. While methods for preventing coagulation of blood were not developed until the 18th century[13] it may be that creative artists might have stirred the blood or added lemon juice to the blood to successfully prevent coagulation. The blood stains for uncoagulated blood were shown to be much more brittle than coagulated blood and would cause the blood on the shroud to crack and fall off in places, as appears to be the case for the Shroud as seen in Figure 3. Future examinations of the Shroud could evaluate the brittleness of the blood. However, uncoagulated blood would not necessarily indicate the results of an artist's efforts; it could also be a result of the loss of clotting factors in the blood of the man in the Shroud as a result of his excessive bleeding.

The method that seemed obvious for depositing blood on the Shroud would be the transfer method in which blood on a surface was transferred to linen by direct contact. This would be the method that blood would have naturally transferred from the bloody body of the man in the Shroud to the burial cloth. However, this method did not work after the blood dried, which in our open air experiments always took place less than 30 minutes after blood was put on a surface. If the man's body were placed in the Shroud when the blood was still wet, the blood stains on the Shroud would have been smeared, but they are not. If the blood was dry when his body was wrapped in the Shroud, no smearing would have occurred, but dry blood would not have transferred to the linen. However, these experiments did demonstrate that if dry blood on a surface was placed in a moist environment and in intimate contact with linen, a good transfer of blood to the linen would occur. High humidity or moisture from the man's body could have moistened the dry blood.[6] High humidity might also be expected in an underground tomb in Jerusalem following the rainy season in February and March. These experiments showed that transfer of dry blood on a surface that was re-moistened occurred only with intimate contact (less than the thickness of paper) of the blood with the linen. It seems unlikely that the Shroud could

have been wrapped so tightly everywhere on the man's body that the blood stains would form on the Shroud to produce continuous blood stains that follow expected flow paths of blood.

In these experiments one important feature of the blood that was transferred by direct contact by providing additional moisture to soften the dried blood is that the circumference of the transferred blood was NOT "highly colored at the circumference and have in their centre a zone of milder colour," as observed by Vignon.[10] This seems to rule out transfer of blood by direct contact. In this study only painted blood exhibited this characteristic. Surprisingly, Evans' photomicrograph of dorsal foot blood (Figure 3), which is probably a blood flow and not a blood transfer does not display a dark circumference. Clearly, a more detailed study of the blood on the Shroud is needed.

These experiments showed that thick layers of old dry blood on linen fibers are black in color, as is generally known. However, when thin layers of blood were put on linen fibers by either painting or transferring by direct contact the resulting color has a distinct reddish tint (Figure 21), as has been reported for the Shroud and has been observed at a distance by the authors.

Thus, with the limitations of not having detailed photomicrographs of both the forward and reverse sides of many different blood stains on the Shroud, it is concluded that none of the stains created in this research using natural methods matched the all reported features of the blood stains found on the Shroud of Turin. Thus, until a detailed study of the Shroud blood is made and reported, the hypothesis is valid.

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2. Mechthild Flury-Lemberg, Sindone 2000 (EDITRICE, Torino IT, 2003)
3. Pierre Barbet, M.D., A Doctor at Calvary (New York: Doubleday and Co. Inc. 1963)
4. Barbet, 27 "Never would he have succeeded in producing those stains with clearly marked edges, which with such outstanding truthfulness reproduce the shape of the clots as they formed naturally on the skin."
5. Barbet, 23 "Coagulation takes place in a very short time, never longer than a few minutes. Secondly, the clot grows smaller, exudes its liquid content, the serum. It then gradually dries."
6. Barbet, 24 "These clots were clearly quite fresh, when the body was laid down on the shroud; they left their trace very easily, with an abundance of serum around the marks." "We must also remember that he corpse would continue to give out moisture for some time."
7. Barbet, 1 "The bloodstained pictures were clearly not drawn by the hand of man; they could be nothing but the counter-drawing made by blood which had been previously congealed on a human body. No artist would have been able to imagine for himself the minute details of those pictures, each one of which portrayed the detail of which we now know about the coagulation of blood, but which in the 14th century was unknown. But the fact is that not one of us would be able to produce such pictures without falling into some blunder."

8. http://www.crt-online.org/121800.html

9. Wiliams Brothers Meat Market, http://www.williamsbrothersmeats.com

10. Barbet, 26 "The colour of these counter drawings would vary in intensity according to the thickness of the clots. Vignon saw clearly that when a drop of congealed blood grows smaller, its thickness is greater in the circumference than in the centre. And that is why many of these counter drawings are highly colored at the circumference and have in their centre a zone of milder colour." Also on page 27, "….one can see four little prolongations following the threads of the warp and woof, which thus forms a little cross."

11. http://en.wikipedia.org/wiki/Paper_chromatography

12. This reference describes use of paper chromatography to detect blood at a crime scene http://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=3921&context=jclcT his reference describes the benzidiene test that is employed, which detects the heme group in blood. The heme group contains iron, which oxidizes and turns dark brown. http://onlinelibrary.wiley.com/doi/10.1016/0307-4412%2894%2990014-0/pdf

13. http://www.pbs.org/wnet/redgold/history/timeline3.html

14. http://online.wsj.com/articles/artists-long-struggle-to-get-just-the-right-color-1402691210)

15. Stirring was done with an electric blender for five minutes. Rapid stirring breaks up the fibrous clotting network and could have been done by hand.

16. Lemon juice contains citric acid, which is an anticoagulant. 1 part of lemon juice was added to 99 parts of blood.

17. G. Lavoie, "Unlocking the Secrets of the Shroud", (Thomas Moore Allen Texas 1998), pages 89-100

18. John 19:39, The Holy Bible

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