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Borrini, M and Garlaschelli, L (2018) A BPA Approach to the Shroud of Turin. Journal of Forensic Sciences. ISSN 0022-1198

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Authors' Response

Sir,

We are grateful for the opportunity to reply to the Scientific Group of Padua's University and Hospitals for Studies on the Turin Shroud (henceforth SGPUHSTS).

This group seems to be very interested in the topic of the blood on the Turin Shroud, particularly after their article has been retracted by PLoS ONE Editors "concerned about the validity of the conclusions and the reproducibility of the results." (1). We also understand that our conclusions on the artificial origin of the Shroud can be seen as "provoking" by the SGPUHSTS and upset Professor Fanti, who is a firm believer in the authenticity of the relic since he received supernatural personal signs and communications from Jesus Christ while standing in front of the Shroud and from the Virgin Mary when in Medjugorje, as he stated in his publication (2).

However, we are pleased to answer the points raised by the SGPUHSTS as a result, and think there is misunderstanding of the BPA analysis due to their lack of forensic scientific expertise. In relation to this, it is not irrelevant to stress that a paper published by these same authors in *Forensic Science Today* (3) can, in our opinion, hardly be considered as evidence of expertise, since the journal itself (now discontinued) was well known as one of several "predatory publishers" (4–6).

First of all, it seems necessary to reiterate how our experiments were the first performed according to generally accepted modern forensic techniques; Bloodstain Pattern Analysis (BPA) is indeed a very important field of modern forensic investigations and has its own active AAFS Standards Board Consensus Bodies like several other disciplines (7).

The primary aim of our investigation was restricted to verifying the pattern and directions of bloodstains in a crucified man when fixed to the cross. Due to the motivating results obtained with the first set of experiments—also presented at the 2014 AAFS meeting in Seattle (8)—we decided to compare what was obtained with the two main positions (fixed to the cross and lying supine in the grave) traditionally hypothesized for the Man of the Shroud.

It is also important to stress how, in a real-life scenario, a scourged, crucified, and wounded individual would be completely covered with blood; consequently his impression on a fabric would in no way look as neat and "perfect" as that in the Turin Shroud. This seems to be neglected by the SGPUHSTS authors. If therefore, as pointed out by Zugibe (9), the body had been washed beforehand, all bloodstains should have originated from *postmortem* bleeding. Even assuming that a cadaver still could copiously bleed, the arms should still be upward in the position reconstructed by our experiment to obtain blood rivulets with the same direction.

For a more comprehensive response to the letter of the SGPUHSTS, we now summarize their 26 remarks and our replies:

- The SGPUHSTS claims that the C-14 test, which had determined the Shroud age to be 1290-1360 C.E., was widely questioned for statistical issues and should not be compatible with other dating methods.

The radiocarbon dating of the Shroud of Turin that we quoted in our paper is the only one available and was officially accepted (10) by the owner of the cloth (the Roman Catholic Church) as also underlined by cardinal Ballestrero: "I do not think we should question these results. And there is no point in nitpicking

scientists if their response does not fit with the reasons of the heart" (11). In addition, it was recommended by the scientists of the Shroud of Turin Research Project (STURP) who examined the Shroud in detail in 1987, that the evidence would conclusively solve the controversy. The dating was performed in 1988 by three different laboratories with 12 separate measurements, all falling within 200 years ca. 1300 V.E. In addition, the reliability of radiocarbon dating of ancient fabric is supported by current publications on the topic (12–17). The statistical issue (ref. 8 in the SGPUHSTS comments) consists only in a mathematical review of the results performed by Fanti et al. in a statistical journal without a specific focus on radiocarbon analysis.

Regarding the age of the Turin Shroud, the SGPUHSTS authors question our citation of historical records. We do not see how their references 20–24 are relevant here. In the article, we were referring to well-known historical Medieval documents (18). One of the earliest is a report to Pope Clement VII written by the Bishop of Troyes, Pierre d'Arcis. (19) This report, dated approximately to 1389 C.E., states that the bishop's predecessor, Henri de Poitiers, believed the cloth had been created as part of a faith-healing scheme. Very relevant is the mention of the painter that actually made the alleged relic: "the truth being attested by the artist who had painted it." In the text, it is possible to read how the exhibition of the "cunningly painted" cloth started again after Henri de Poitiers' death; this gave rise to a lengthy controversy between Pierre d'Arcis and the new canons in Lirey, culminating in the 1389 memorandum to the Pope. Later, Pope Clement VII permitted exhibitions on the condition that it was declared clearly every time that the Shroud was only a painted "representation."

Regarding alternative dating methods:

- Reference 9 in the SGPUHSTS comments has been questioned in the same journal (20). Therefore, we believe the readers should be informed of the existence of (20) if this paper is mentioned.
- Reference 10 in the SGPUHSTS comments is not a scientific paper but a book by Fanti et al., in which he reports on a new technique, developed by himself, for old fibers based on reduced tensile strength. The fibers used by Fanti were recovered from the old filters of a vacuum cleaner used in 1978 to aspirate dust and other debris between the Shroud and the backing cloth (removed in 2002). Besides being mixed with much spurious material, and therefore difficult to identify, these fibers were evidently the weakest of the cloth and not representative of the entire sample. Furthermore, it is worth remembering that the Catholic Church always firmly denied any scientific value to tests performed on Shroud samples not officially delivered (21,22).
- Additionally, the SGPUHSTS states that a former paper by one of the present authors (L.G.) (23) was unnecessarily quoted and that L.G. did not comment on critics by Fanti & Heimburger, published as a "Letter to the Editor" in *J. Imag.Sci. and Technol.*, the Journal where the paper was published.

Since the very same Fanti & Heimburger stated in a different document (24) that L.G.'s full-size reproduction of the Shroud "is undoubtedly one of the best ever obtained until now," and since LG's paper also gives the reader a summary of the analyses and properties of the Shroud, it was deemed useful to quote it. L.G. did not reply to Fanti and Heimburger's comments because they

simply repeated statements already made by L. G. himself within his paper (that the reproduction is still not perfect, in particular, it lacks some of the half-tones visible in the Shroud.). It should be stressed that the reproduction of *any* object—especially one that is 700 years old—would be impossible at the microscopic level that Fanti and Heimbürger would suggest.

L.G., furthermore, naively thought that it was better to not get into the controversies (such as the present one), which appear to be unavoidable whenever the Shroud is at stake. However, we now thank the SGPUHSTS for making us aware that a letter to the Editor is a useful way to spread one's own opinions without the bother of dealing with copyright issues of a full paper.

The SGPUHSTS authors criticize the fact that, when referring to the controversy about the nature of the stains (blood or tempera painting?) we do not mention a more recent paper “that solves such controversy. The discoloring blood-stains present on the TS were in fact reinforced by an artist, probably in XVII century, who used reddish pigments like red ochre (iron oxide) and cinnabar (mercury sulfide).”

In our article, we stated that we were not dealing with the controversy about the real nature of the blood stains; thus, we just gave a few examples of the different papers published in the literature. We were glad to see that the SGPUHSTS' Ref. 15 acknowledges (self-citing) that which is quite obvious, namely that a possible artist/forgery might have used blood, pigments, or both.

The above would also explain why a test performed on very small samples (as performed by Fanti and colleagues on samples of dubious origin) can give contrasting results. Single threads or fibers from the cloth are likely not representative of the entire object. Incidentally, this controversy seems *not* to be at an end, since in these very days, a new paper has been published (25) that attempts to explain the unnaturally red color of old bloodstains (blood quickly darkens with time) by supposing that bilirubin-rich blood gets temporarily redder when subjected to UV radiations.

The SGPUHSTS authors find an inconsistency between the description in our Materials and Methods Section (body laid flat) and that in Results Section (flexed position).

What we wrote was: “. . . the Shroud represents the print of a body on a cloth which was laid flat on it. . .” and “. . .this *flexed position* [of the body] was chosen according to. . .” etc.). The *cloth* was laid *flat* on a body. The *body* was in a flexed position. Perhaps the SGPUHSTS authors misinterpreted the English text.

The SGPUHSTS authors criticize our description of the blood marks on the front side of the forearm as “ill-defined.” They explain that the marks are just not easy to explain.

We are grateful to them for suggesting better definitions, such as “various and discontinuous,” to describe these blood marks. However, this does not change the location (on the front side of the forearm) and the direction (along the forearm) of the rivulets.

The SGPUHSTS authors also state that it is questionable the presumed correspondence of stains on the sheet and actual blood patterns on a human body when considering a partial and discontinuous contact between body and sheet.

This is a remarkable consideration since three authors from the SGPUHSTS claim (3) that from the image of the T.S., they were able to reconstruct position and features of the “Man of the Shroud” with a 1-cm precision.

The SGPUHSTS authors state that one of our cited references (17 in the Borrini & Garlaschelli paper) does not seem appropriate because only “scourge bloodstains” are reported and discussed there, and Ref. 18 appears more appropriate.

They are correct. This was indeed a typo due to the renumbering of references during the editing process.

The SGPUHSTS authors challenge our description of “The Blood belt” (a thin, transverse blood print at the waist, visible on the dorsal image of the Shroud, traditionally considered the result of a postmortem bleeding from the chest wound) by saying that “in the literature the origin of the ‘blood belt’ is not clear yet: it could come from the blood flow of the chest, but more likely it derives from the blood flow of the arms or from the wounds in the kidney area”.

It is true that the “blood belt” has been interpreted in various ways (even the print of a chain or of a loincloth. . .) by authors that support the authenticity of the Shroud; what our experiments demonstrate is that it *cannot* originate from the chest wound. Also, our experiments showed that blood dripping from the back of the hands in a horizontal body does not flow on the front of the forearm and does not pool transversally at the lumbar region. Other possibilities, for now, are only speculations.

The SGPUHSTS authors challenge our experiment devised to test the smearing of blood on the back of the hand, by saying that it is an “oversimplification made by the Authors who only considered two positions of the TS Man: when he was crucified and when he was laid horizontally in the sepulcher.”

In our paper, we stated that: “a preliminary test was set up to simulate bleeding in contact with a wood surface. A circular stain of 0.3 mL of synthetic blood was applied onto the back of the hand of a living volunteer to simulate a puncture-type injury; pieces of wood with different textures (from bark to smooth finish) were pressed on the hand for 10 sec and the resulting pattern observed (Figs. 2a and 2b). The results were not conclusive, as the wound is not clearly decipherable.” In other words, our test shows that blood on the back of the hand smears when the hand is pressed against a surface, as it is supposed to happen if the body is nailed to the cross. Consequently, the exit wound of the supposed nail is therefore unclear; the whole analysis has nothing to do with the position of the body. Again, it seems that the English text was not clearly read.

After these comments, the SGPUHSTS authors criticize nearly every sentence of our article by repeating (11 times) that they are “too hasty conclusion due to the oversimplification made by the Authors. All the blood-stains visible on the TS appear coherent with specific positions and postures assumed by the TS Man, from the crucifixion to the deposition into the sepulcher.”

What they oppose to our experimental results are simply their speculations, which at times are not consistent with other speculations that they made, for example, when they claim that “blood on the forearms originated not on the cross, but when the nails were pulled out. . .”—but also that there is a “blood flow of the arms” when the body is supine in the sepulcher to justify the position of the “blood belt.” Or when they claim that the body was in an evident state of *rigor mortis*, but in a previous publication (3), they state that the *rigor mortis* had been broken by forcing the muscles at the neck, at the arms and at the legs to uncross the feet. Or, when they criticize one of our statements regarding the absence of ligature to tie the upper limbs to the crossbeam by saying that “No clear evidence on the TS appears about a possible ligature to tie the arm,” while in their Ref. 3, they wrote that “the hand would have torn and would not have supported the body, if cords posed along the arms on the patibulum did not bind it.”

More specifically regarding BPA, the SGPUHSTS authors point out that we did not consider the “important role” of blood viscosity “in the resulting pattern of the blood-stains produced.” Unfortunately, due to their lack of knowledge in forensic sciences and BPA, they neglected to consider how viscosity can indeed influence the speed of bleeding, but not its direction,

which follows the law of gravity. In addition, they refer to the “hypothetical status” and the defibrination of blood flowing from the chest wound assuming that it was a fact, without considering all different factors concerned in this phenomenon of nature.

The influence of the arm “probably very close to the chest” for the creation of “blood stagnation on the chest” seems to be insignificant. The SGPUHSTS authors, in fact, apparently forget that there is no evidence of blood staining related to this “stagnation” on the frontal image of the Shroud. However, this form of incoherence seems common in the observations of the SGPUHSTS, as pointed out particularly regarding the lack of blood following the alleged scourging.

It is not surprising that the misinterpretation of the BPA experiments lead the SGPUHSTS authors to wrong goal-oriented assumptions regarding the realistic appearance of bloodstains and the coherence of the “belt of blood” “with the blood flow from either the arms or the wounds in the kidney area.” As a matter of fact, there is no evidence of any bleeding wound on the lumbar region of the man of the Shroud; as well, the experiments proved that the blood did not flow from the arms to the posterior area.

In conclusion, whenever the SGPUHSTS authors say that if we “had considered other configurations of the TS Man, like those assumed by the TS Man during the deposition on the sepulcher, during the un-nailing, the deposition from the cross, the transportation to the sepulcher or the burial operations, [we] should certainly have found a position of the TS Man coherent with the bloodstains in question.,” we can only reply that we would be happy to compare, in the future, our experimental results with other BPA practical tests performed with an appropriate forensic background, and not based upon sheer speculations.

We are confident in our conclusion (26) that demonstrates how “to obtain the same pattern present on the ‘Man of the Shroud’, the individual would have to be in a standing position with his upper limbs raised at an angle between 80° and 100° and approximately 45° to have the pattern of the small rivulets on the wrist. “Other positions, with lower (e.g., the classical artistic representation of a crucifix) or higher (crucifixion to a single vertical pole) arms, and also postmortem bleeding in a reclining subject cannot account for the blood pattern on the forearms.”

This inconsistency between the stains on the wrist and the forearm, as well as between the bleeding of the chest wound and “belt of blood” cannot be oversimplified by assuming movements and various positions of the body on the cross and during transportation to the burial site. This would only be mere speculation; in fact, if movements occurred, particularly *postmortem*, they should influence the stains from all wounds. If blood drained from the chest wound during cadaver transportation, we should find evidence of the same *postmortem* bleeding on the upper limbs. However, no evidence of this has been found.

Considering the actual state of the research on this topic, we stand firm in our conclusions and are proud to have been able to demonstrate how forensic sciences can not only be used for the sake of justice, but to shed a light on historical artifacts.

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