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Review

Open issues regarding the Turin Shroud

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The Turin Shroud is a linen cloth which shows the front and back images of a man who had been scourged, crowned with thorns and crucified, who died on a cross and who was stabbed in the side with a lance after his death. The Catholic Christian tradition identifies him as Jesus Christ who was resurrected from the dead, but not all researchers are unanimous in believing this tradition, partly because science has not been able to give definitive answers to the questions of the identity of the Man and how the images were produced. There are many indications in favor of authenticity, but there are also still many open issues which do not allow us to reach a conclusion. This paper discusses these open issues, after presenting the very peculiar features of these "impossible" images, in the hope that future scientific research in this direction will cast light on the most important Relic of Christianity. The bibliography relative to the Turin Shroud is copious, but it is not easy to find a summary of scientific issues still open regarding it. The present discussion frames the arguments debated in the papers of this Special Issue and will be also a useful tool to persuade more scientists to address research in these fields.

Key words: Turin Shroud, Catholic Christian tradition, open issues, body image formation, dating.

INTRODUCTION

The Turin Shroud (TS) (Schwalbe and Rogers, 1982; Jumper et al., 1984) is a piece of linen cloth, 4.4 m long and 1.1 m wide, on which the complete front and back images of a human body are indelibly impressed (Figure 1). The word "shroud" corresponds to the Italian "*Sindone"* deriving from the Ancient Greek "σινδών = sindòn", meaning the burial cloth in which a corpse is wrapped.

According to the Catholic Christian tradition, the TS is the burial cloth in which Jesus Christ was wrapped before being placed in a tomb in Palestine about 2000 years ago; for this reason, it is the most important Relic of Catholic Christianity. Science has not demonstrated the contrary, but the Catholic Christian Church does not impose on its adherents any veneration of the TS. Of all religious relics, it has generated the greatest controversy because no definitive results regarding its authenticity have been obtained.

The "Shroud of Christ" first appeared in Europe in 1353 at Lirey (Wilson and Miller, 1986) in France, during a dispute for its ownership between the owner Geoffry de Charny and the canons of Lirey with the bishop of Troyes, Pierre d'Arcis; also involved were the king of France, Charles VI, and the anti-pope, Clemens VII. In 1203, a crusader noted that a church in Constantinople was accustomed to exhibiting every Friday a cloth in which it was stated Christ had been buried, with the figure of his body impressed on it. It is probable that this cloth and the TS are one and the same, also because the face of Christ on Byzantine coins after the VII century AD is very similar to that on the TS: more than 100 congruence points were detected between the two images (Whanger, 1998). There are some indications that the TS was in Palestine in the first century AD: for example, "De Viris illustribus" (a manuscript by Jerome of the II century AD) contains a passage of the Hebrews' Gospel in which it is reported that the Shroud was given to the servant of a priest.

In 1532, a fire damaged the TS while it was conserved at Chambéry in France. The Chambéry nuns later restored it by sewing some patches of cloth on the front. The TS was the property of Savoy from 1453 to 1983, the year in which it was donated to the Pope by Umberto II of Savoy. Until the XIX century, scientific interest in the TS was limited, because of the scarcity of direct analyses and the lack of photographs. Interest greatly developed after 1898, when S. Pia photographed it and sent copies to the scientific world for independent studies.

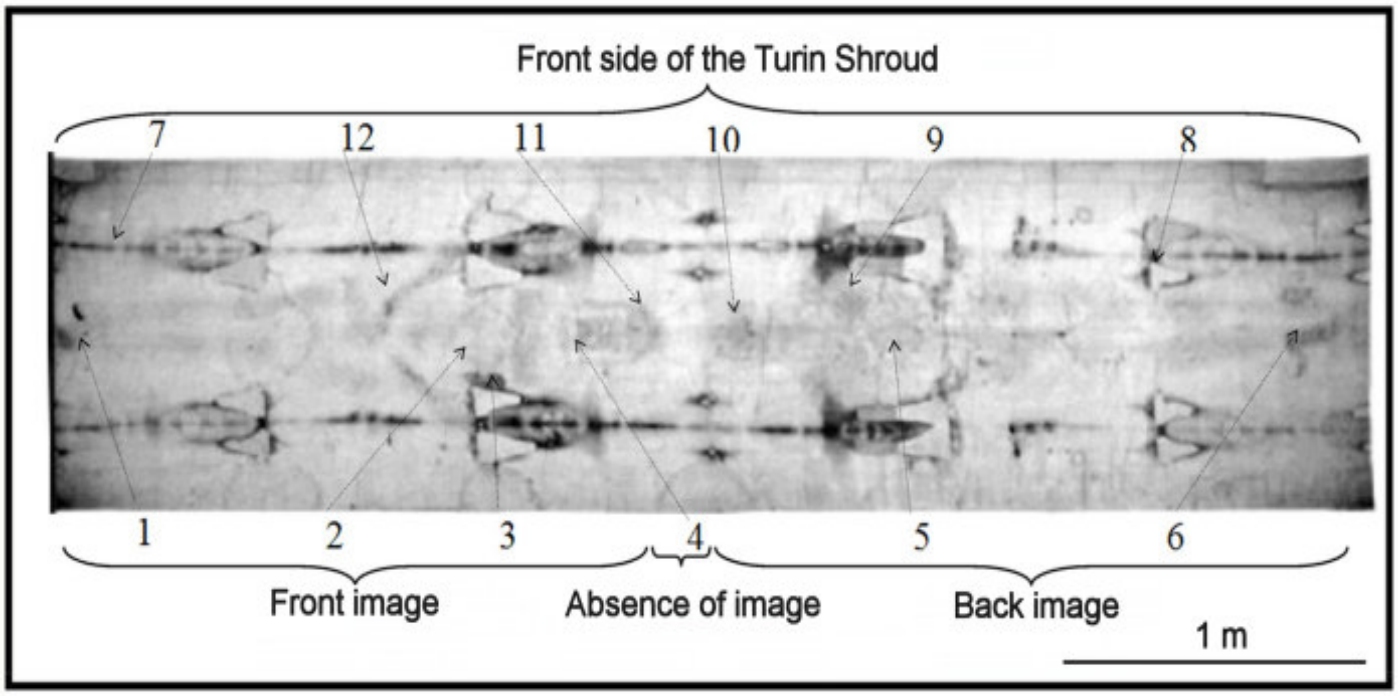

Figure 1. Body image and marks visible on TS: 1. Wound in right foot. 2. Marks of water. 3. Wound in side. 4. Folds in cloth. 5. Marks of scourging. 6. Heel and sole of right foot. 7. Carbonized lines in cloth, due to fire of 1532. 8. Mending carried out by Chambéry nuns after fire of 1532. 9. Bruises due to scratching cross. 10. Wounds on head, due to crown of thorns. 11. Wound on forehead. 12. Wound in left wrist (Fanti and Maggiolo, 2004).

Notwithstanding contrary opinions (Meacham, 1987), in 1988, the TS was radiocarbon-dated to 1260-1390 AD (Damon et al., 1989), but the results are questionable (Walsh, 1999; Riani et al., 2012). In particular, as the process which formed the body image is still unknown, the method cannot be rigorously applied because one of the postulates of its inventor, W.F. Libby, states that the object under analysis must be known. The imaging mechanism may have interacted with a percentage of carbon isotopes of the TS, thus producing a non-negligible systematic effect.

Some researchers have shown that the 1988 sample is not representative of the TS, because its chemical characteristics differ from the main part of the TS itself (Rogers, 2005). In any case, as science cannot reproduce all the characteristics of the body image, the validity of a measurement method such as radiocarbon dating, which depends to a great extent on environmental conditions, must be doubted when it refers to an incompletely known object.

During the 2002 intervention (Ghiberti, 2002), all the patches which had been sewn on by the Chambéry nuns were unstitched, thus revealing the holes in the fabric left by the fire. On that occasion, the length of the cloth was increased by a few centimeters. Lastly, a reinforcing cloth, which no longer allows direct observation of the back of the TS, was sewn onto the back.

GENERAL CHARACTERISTICS

The front and back images of the TS show an adult male, nude, well-proportioned and muscular, with beard, moustache and long hair, and are compatible with a man 175 ± 2 cm tall enveloped in a sheet (Fanti et al., 2010a). Due to rigor mortis, which began after his crucifixion, the TS Man was not completely supine; his head is tilted forwards, his knees are slightly bent and his feet extended, as a result of being nailed to a cross.

Some researchers (Garlaschelli, 2010) have attempted to reproduce the TS, but without considering many particular features (Fanti and Heimburger, 2011), especially at microscopic level. The body image has many peculiar physical and chemical features which, even now, cannot be reproduced (Fanti et al., 2010b).

The body image is very faint: reflected optical densities are typically less than 0.1 in the visible range, and the image shows no evidence of saturation. It is therefore not easy for the naked eye to discriminate all its details, and digital enhancement of photographs is frequently required.

The TS cloth is hand-woven in 3:1 twill, and each thread (non-constant diameter of about 0.25 mm) is composed of 80 to 200 linen fibers (Fanti et al. 2010b). It has been shown (Fanti et al., 2010a; Jumper et al., 1984; Adler, 1996) that the linen sheet enveloped the corpse of

a man who died on a cross. The double images visible on it are compatible with a man who had been scourged, crowned with thorns and crucified, who died on a cross, and who was stabbed in the side with a lance after his death.

Also impressed on the cloth are many other marks due to blood, fire, water and folding, which have greatly damaged the double body image. Of greatest interest to forensic pathologists are the wounds, which are not easy to reproduce (Brillante et al., 2002).

The most important and reliable scientific analysis on the TS was performed in 1978 by the Shroud of Turin Research Project (STURP) (Schwalbe and Rogers, 1982; Jumper et al., 1984; Adler, 1996; Jackson, 1998), a group of 52 American scientists who worked non-stop on the cloth for 120 h. They concluded that the body image on the TS cannot be explained scientifically, and their only attempt at explanation consists of stating that the image formed as if it were caused by exposure to a short-lived but intense source of energy coming from the body wrapped in the TS itself. Now we can also state that the image on the TS cannot be explained from a scientific point of view because all its details cannot be reproduced all together (Fanti and Basso, 2008; Fanti et al., 2010b). For example, the details reported here below have not yet been reproduced all together in a TS-like image.

In white light, the color of the body image is yellow/brown but, when viewed under UV it is neutral gray or black (Jumper et al., 1984); in the 3-5 μm IR range the image disappears, but in the 8-14 μm IR range a white image is evident (Accetta and Baumgart, 1980).

The cause of the yellowing of the body image in visible light is due to chemical alteration of the polysaccharides in the linen fibers, consisting of chemical structures formed by dehydration, oxidation and conjugation products in the linen itself. This chemistry is similar to the characteristics of aging linen (Jumper et al., 1984).

The front and back images are superficial (Schwalbe and Rogers, 1982; Fanti et al. 2010b); only the most external fibers of the linen threads are involved in the TS. This superficiality is also found at fiber level, because the inner cellulose is not colored: only the external layer (primary cell wall about 0.2 μm thick) was involved in the chemical reaction. In addition, there are uncolored fibers side by side with colored ones. Referring to the statement regarding the present impossibility of reproducing the image, we should for example think of painting each fiber of the colored thread, one by one, using an acid (not pigments) but avoiding coloring the adjacent fibers; the hypothetical paintbrush should have one only bristle about 10 μm in size, but capable of "painting" the linen fiber uniformly all around its circumference. The acid or the reagent substance should be immediately removed in order to avoid reactions with the inner cellulose of the fiber. Lastly, we should remember that a hypothetical artist should perform this operation, not using a micro-scope to be able to see the single fibers, but from a distance of 1 to 2 m from the TS, because the body image disappears to the eye-brain system of a person who is any closer to it.

In 2004, the presence of an image on the back of the TS was detected (Fanti and Maggiolo, 2004), verifying one researcher's postulate: Jackson (1998) hypothesized a mechanism of formation of an image as the result of a burst of energy from inside the enveloped body. Walsh (1999) observed: "The Shroud of Turin is either the most awesome and instructive relic of Jesus Christ in existence ... or it is one of the most ingenious, most unbelievably clever, products of the human mind and hand on record. It is one or the other; there is no middle ground." Analyzing up to 100 statements formulated for and against the authenticity of the TS by means of various probabilistic models (De Gail, 1972, Fanti and Marinelli, 2000), it has been shown that the TS is the burial sheet of Jesus Christ with a probability of 100% and negligible uncertainty, but these results are not valid from a strictly scientific point of view, because the model starts from subjective evaluations.

Although the beginning of the third millennium is a period in which the owners of the TS are not willing to allow new research to be undertaken, various studies are still in progress. For example, in 2002 a group of researchers interested in the scientific aspects of the TS formed a no-profit Internet Group named Shroud Science which discusses and proposes new scientific studies and publishes their results on "Yahoo!" and at symposia organized for this purpose; the University of Padua, Italy has financed a Research Project (Ban 2009 prot. CPDA099244) entitled: "Multidisciplinary analysis applied to the Turin Shroud: study of the body image, of possible ambient pollution and of micro-particles capable to characterize the linen fabric."

From a scientific point of view, it would be very interesting to understand how a corpse, that does not emit energy if we neglect the body heat, could have generated such a peculiar image. From a religious point of view, it is important to understand what the TS is, because, if it is authentic, it witnessed the event of the burial and Resurrection of Jesus Christ.

MAJOR OPEN ISSUES

Until now, no sure proof of the authenticity or otherwise of the TS had been available from the scientific point of view, and therefore further studies are needed to clarify whether it is authentic or not. In 1998, Pope John Paul II stated: "The Church entrusts to scientists the task of continuing to investigate" and, in agreement with his words, scientists should try to solve, at least partly, some of the open issues connected with the TS.

Among the many unanswered questions three are of major importance: the formation of the image, its conservation, and its dating. These and other minor issues still unresolved as well as others resulting from the STURP project (1984) will be discussed in the course of

this study. In order to update readers about some recent discoveries, there will be brief summaries of some findings discussed in scientific papers published in the last few decades.

Before any discussion, it seems necessary to define first of all exactly what we intend by the “authenticity” of the TS, because this point is frequently discussed in the literature although its details are not specified. There are four different levels, explained below.

The first level of “authenticity” states that the TS is an ancient linen cloth, hand-woven in Palestine about 2000 years ago. The second level states that the TS enveloped a scourged man, crowned with thorns, and crucified; he had also been stabbed in the side with a lance. The third level of authenticity states that the TS enveloped the historical Jesus, as described in the Gospels. The fourth level states that the TS shows signs of the Resurrection of Jesus Christ. As the Resurrection is not a reproducible phenomenon, it goes beyond the realm of science and therefore the fourth level of authenticity cannot be tested. Nor is the third level easy to check definitively from a scientific point of view, because it is not easy to find certain scientific proof regarding the name of the person represented in the TS body images, front and back.

We can therefore assume that the goal of Science should be that of providing an answer to the first two levels of authenticity. In particular, the following question, regarding the first and second levels of authenticity, should be answered by Science: “Is the TS authentic, in the sense that it is an ancient linen cloth hand-woven in Palestine about 2000 years ago, which enveloped a scourged man who was crowned with thorns, who died on a cross, and who had been stabbed in the side with a lance?” Answering some of the following open issues may help us to ascertain whether the TS is “authentic”. The three major problems are the following.

Image formation

We know little about the process which generated the body image on the TS. Ever since 1898, when S. Pia published the first photographs of the shroud, many scholars have noted some peculiar characteristics of the body image and attempted to explain how it could be reproduced in a linen fabric. Although they have proposed several hypotheses to account for the formation of the image (Fanti and Basso, 2008), they have not reached any common agreement, because the results appear inadequate. The most important hypotheses are the following.

Gas diffusion

R. Rogers (2008) improved on P. Vignon’s “vaporigraphic hypothesis” (1902) by referring to the Maillard reaction to form the body image and presuming the interaction of amines generated by the body during decomposition with a polysaccharide layer, produced all round the external fibers of a linen cloth.

Contact hypothesis

J. Volkringer (1991), studying imprints caused in old herbaria by the pressure of leaves, hypothesized that the TS image was produced by direct body/sheet contact, as a consequence of a similar natural chemical reaction. Various researchers proposed some improvements using sculptures or real human heads.

Mixed mechanisms

Some researchers, such as M. Alonso (2005), realizing that the hypothesis of gas diffusion can reproduce some of the characteristics of the TS image but not others, and that the hypothesis of contact can reproduce other characteristics, proposed a mixed mechanism, that is, both contact and diffusion.

Artistic copies

Many copies of the TS have been made by artists since the Middle Ages, and many of them were painted in contact with the original TS, in order to make the copies second-order relics. At the end of the 20th century, some researchers, such as Craig and Bresee (1994), Delfino Pesce (2000), Nickell (1998) and Garlaschelli (2010), believed that some artists, perhaps in the Middle Ages, had indeed been able to reconstruct the TS in spite of its extraordinary characteristics. Instead, Allen (1998) proposed that form of medieval proto-photography existed.

Hypothesis of radiation

Many scientists have formulated various hypotheses of radiation to explain the TS image, because there are some areas, like those between the cheeks and nose, where a body/cloth contact cannot be explained and because other hypotheses cannot explain many of the features of the TS like the circumferential coloration of the TS image fibers that are posed adjacently to non image fibers.

Among those researchers, the following must be remembered: Rinaudo (1998), who hypothesized proton radiation, which produced the body image, coupled with neutron radiation, which caused rejuvenation of the carbon-14 age of the fabric; Jackson (1998), who assumed that a burst of energy, prevalently of soft UV type, formed the TS image; and a group of scientists led by Baldacchini (2008), who used excimer lasers to test part of Jackson (1998) hypothesis.

In the present author's view, the most probable

hypothesis, also supported by experimental results, is based on Corona Discharge (Fanti, 2010). Nevertheless, no complete results can be obtained because of the difficult and in some cases dangerous environmental conditions (for the presence of radon) required for experiments. For the time being, Corona Discharge may be caused by various more or less scientifically identified sources such as (ball) lightning, earthquakes and radioactive environments (radon), but perhaps the truth is beyond science. Imaging of the TS by a Corona Discharge may even be a by-product of the Resurrection (Fanti, 2010) and this may be why the image cannot be reproduced scientifically.

TS conservation

The TS is now conserved, laid flat, in the Cathedral of Turin in a dark container at uniform temperature. It is rarely exposed to the public, because light may accelerate the aging process of the background, reducing the already low contrast with the image. Many studies involving direct analyses will be necessary to solve the issue mentioned in "Image formation" but, from a conservation point of view, it is necessary to perform a small number of tests, mainly avoiding those which require high-power light sources, in order to minimize the aging process.

In the last few decades, much has been done to improve the conservation status of the TS, especially when it was decided to keep it in a controlled environment, no longer rolled up on itself. But can it be stated that all the conservation problems have been solved? We should not forget some problems (Schwalbe and Rogers, 1982; Adler and Schwalbe, 1993) related to prolonged deterioration, because our care in conserving the TS will make us responsible for ensuring that future generations can see the body image as we admire it today.

In Ghiberti (2002), an intervention was carried out on the TS, but was questioned (Schwortz, 2002) by many scientists because it was invasive and changed something from the historical point of view. Before deciding on any further action on the TS, it is important that a large committee of international experts should evaluate in advance, very accurately, any possible negative aspect regarding any proposed intervention on the TS, including experimental tests.

The problem of radiocarbon

The 1988 radiocarbon result (Damon et al., 1989) is the only scientific result against the authenticity of the TS, and must therefore be clearly verified. This result has been questioned by many scientists; some detected systematic errors in the samples and statistical errors in the results (Walsh, 1999; Riani et al., 2012); others found that the sample of the TS used for the 1988 test was not representative of the original TS (Adler, 1996; Rogers, 2005).

We must remember that the body image has not yet been explained at all, and therefore the environment in which the TS was exposed in the past is not known. Matching W. F. Libby's postulate about the dating of an ancient object, which states that the environment in which the object was exposed must be known, this fact is sufficient to arouse serious doubts about the radiocarbon result. For example, some scientists (Phillips, 1989; Rinaudo, 1998) hypothesized a neutron flux during the formation of the body image, which may have greatly affected the radiocarbon result. Other environmental factors connected with the body image formation are under study by the author and, from preliminary analysis, do not seem negligible. It is therefore necessary, at least partially, to solve the issue mentioned in "Image formation" before thinking about carrying out other radiocarbon tests on the TS to verify the 1988 result.

In addition to the three major problems presented above, there are many others of lesser importance. Some of them are described below.

MINOR OPEN ISSUES

DNA analysis of blood

The only official DNA analysis of the blood on the TS is that published in Canale (1995); it turned out to be a very old sample, with damaged and fragmented DNA strands, which had undergone contamination with both male and female DNA.

More recently, Tipler (2007), analyzing the electropherograms made in 1995, interpreted them not as contamination of blood, but as the result of a male with the XX chromosome containing the SRY gene; Tipler (2007) therefore assumed that this indicated a virgin birth. Obviously, this is only an interpretation of data referring to one sample but, in the future, it will be important to verify this extraordinary result.

The pollen found on the TS

Frei (1979, 1983) studied pollen taken from the TS using adhesive tape pressed in a particular way on the linen fabric, but did not have time to describe definitive results, due to his premature death. Some of the tape samples were later studied by palynologists in Israel (Danin et al., 1999), but the interesting results obtained have been debated by others (Ciccone, 2011; Mariotti Lippi, 2011) even if the author has recently found clues in favor of Frei's results. It is therefore important to perform a careful classification of pollen grains from the TS, as well as identification of the pollen at both genus and species level, to confirm the results available today. One technique yielding reliable results may be DNA analysis.

Aloe and Myrrh on the TS?

Referring to the Gospel of St John, some scholars believe that, if the TS is the Shroud which enveloped Jesus, it must contain some residue of the aromatic oils used for burial. However, from a scientific point of view, the presence or absence of aloe and myrrh does not seem a point of fundamental importance, but an investigation could help to confirm the authenticity of the TS.

Some researchers (Kohlbeck and Nitowski, 1986; Baima Bollone, 1983; Scannerini, 1997) have found traces of aloe and myrrh in the threads of the TS, but their results were mainly based on surveys carried out by light microscopy, and are therefore not complete. However, the STURP scientists found no traces of aloe or myrrh. Were these traces perhaps released over time, leaving only some tiny particles visible under light microscopy, but not detectable by other instruments? This is possible, but further analyses seem necessary.

Coins on the TS?

Since 1954, after several years of studies carried out on the photographs taken by Enrie (1931), F. Filas (1980) discovered traces of a small Roman coin on the TS, in the area of the right eye: a Dilepton Lituus, minted by Pontius Pilate in 29 AD. Other researchers (Haralick, 1983) later confirmed the discovery and suggested the presence of a second coin on the left eyebrow, a Lituus Simpulum (Balossino, 1997).

A disc-shaped protuberance similar to that coin appears on the photographic enlargement of the area in Enrie's photos, but more recent photos, starting with those of G. B. Judica Cordiglia made in 1969, do not seem to show this detail. The finding is therefore now doubtful. In the future, an answer as to why Enrie's photo showed this detail should be given: was it perhaps a pareidolia effect?

Are there any inscriptions on the TS?

Marastoni (1983) hypothesized the presence of writing on the TS and, Marion (1998) found additional letters using computer enhancement. For example, Marastoni identified, among others, the inscription "NAZARE"(which would stand for "Nazarenus") and "IN NECE" (at death) on the side of the face. However, as just discussed, these inscriptions are evident in Enrie's photo but not in more recent ones; again, further investigations need to be performed.

What was the cause of death of the Man of the TS?

As reported in - "Did the TS envelop a dead man?", it results that the Man of the TS was enveloped in the TS as a corpse, but up to now it is not yet clear which was the real cause of his death. Many researchers (Barbet, 1993; Bucklin, 1970; Zugibe, 2005) proposed different causes of death like hemothorax, hemopericardium, induced coagulopathy and asphyxia basing their conclusion on almost subjective deductions but up to now no common agreement has been found. A detailed study of all the characteristics of the corpse shown on the TS will probably evidence the real cause of death in the next future.

STILL OPEN ISSUES RESULTING FROM THE STURP PROJECT

After the important scientific research carried out in 1978, the STURP team, which issued its final report in 1981, proposed a second testing campaign (Project, 1984), during which it intended to answer 85 questions, related to problems of conservation, authenticity, and determination of the formation mechanism of the body image. Unfortunately, the Turin authorities did not permit the analysis, because they preferred to address study only to the radiocarbon dating, so that many questions remained open. Although some studies have been performed in recent years, several questions still need answers. These are reported below, in that they represent a basis for future scientific research on the TS.

What is the tensile strength of the threads of the TS?

In particular, it would be interesting to compare the tensile strength of the image fibers with that of non-image fibers. This may indicate to what extent the chemical process of imaging affected the linen fibers. From preliminary qualitative analysis made by the author of the present paper, the difference is clear-cut.

In addition a comparison of the tensile strength of non-image TS fibers with the tensile strength characteristic of ancient linen fibers having a known age, could be an alternative dating method of the TS.

Which kind of dust is present in the TS?

This has been previously discussed under the sub heading: "The pollen found on the TS", which reveals that pollen grains were present in the TS. However, to confirm the results available today, identification of the pollen should be made at both genus and species level.

How old is the TS?

A carbon-14 dating was made in 1988 but, as shown in "The problem of radiocarbon", its results are not definitive.

What is the structure of the edges of the TS?

A very preliminary study has been done by the present author in correspondence of the shorter edge near the feet of the front image because same author had the possibility to analyze a small piece of TS cut during 1988 sampling. The TS is folded at about 2 mm from the edge and it is folded again after about 3 mm. The double folding is sewed using a linen thread brighter than the TS.

What is the nature of the features present near the eye, attributed to a Lepton coin?

As discussed in the sub heading “Coins on the TS?”, Filas (1980) discovered traces of a small Roman coin on the TS, in the area of the right eye; a Dilepton Lituus, minted by Pontius Pilate in 29 A.D. A discovery later confirmed by other researchers (Haralick, 1983) suggested the presence of a second coin on the left eyebrow, a Lituus Simpulum (Balossino, 1997).

Does the assumption that the image is that of Jesus Christ match that observed on the TS?

From the introductory part of this study, it seem evident a congruence that has to be better verified in the future. This is because, in 1203, a crusader noted that a church in Constantinople was accustomed to exhibiting every Friday a cloth in which it was stated Christ had been buried, with the figure of his body impressed on it. It is probable that this cloth and the TS are one and the same, also because the face of Christ on Byzantine coins after the VII century AD is very similar to that on the TS: more than 100 congruence points were detected between the two images (Whanger, 1998).

In what type of climate (e.g. Europe or the Middle East) did the TS flax grow?

At the moment no clear answer exist even if the elevated number of dislocations (Nyholm et al., 2001) detected by the author, relative to the linen fibers of the TS may lead us to think of a relative hot and dry environment.

Was the TS body image always visible, or did it develop over time?

Further knowledge of the chemical dynamics of the image could help in understanding the imaging process. From the experience of the author (Fanti, 2010), who made tests using corona discharge to produce TS-like images, it is easy to think that the image developed after years.

What is the depth of penetration of the body image into the fabric?

It would also be interesting to ascertain whether the depth is related with the color intensity.

What is the elemental composition of the areas corresponding to scourge marks in comparison with areas of bloodstains, body image and the background?

This will be evidenced in the future.

Do the areas of the shoulders and calves contain dirt or dust, like the heel area?

This will be detected in the future.

ALREADY ANSWERED QUESTIONS

As studies on the TS are highly multidisciplinary and since it is not easy to follow all the publications on the subject, it is possible that some authors still have doubts about a subject which has already been discussed, solved and published. For this reason, some old questions are here listed, with answers.

Did the TS envelop a man?

The discussion as to whether the TS really enveloped a man lasted for many years, but a solution was found, starting from different points of views. To explain the particular bloodstains present on the TS, it turned out that a real human body should have produced them (Brillante et al., 2002). In addition, some distortions of the TS body image may be explained if it enveloped a dead body in a particular way (Ercoline et al., 1982; Jackson et al., 1984; Jackson, 1990; Fanti and Marinelli, 2001). The TS did envelop a man, partially wrapping some parts of the body like the thorax and legs, but no other large distortions are evident, for example, near the face, because several objects were placed on the sides of the body, such as rolls of bandages impregnated with anti-putrifying substances.

Did the TS envelop a dead man?

A discussion about whether the TS enveloped a wounded but still living man started with K. Berna, otherwise known as Hans Naber, in 1962, but nowadays, after much evidence testifying to the death of the TS Man, such as rigor mortis and the blood separated from serum from the wound in the chest, there seems to be almost complete agreement that the TS Man was dead when he was

wrapped in the TS (Faccini et al., 2008).

Is the TS body image a perfect negative?

There are some who still think that the TS body image corresponds to a perfect negative and try to interpret the features of the enveloped body. For example, the negative image of the face shows a man with white hair, moustache and beard, incorrectly resembling an old man. It must be remembered that the image is monotone and therefore the color of the hair is not coded there. The intensity of the image can be only related to the intensity of the energy which produced it.

Has the TS body image a perfect 3D characteristic?

It is well-known that the TS body image has some 3D characteristics (Wilson and Miller, 1986) but it is perhaps not evident that these characteristics are not perfectly 3D, because they follow different laws. A mathematical relationship has been found between the hypothetical body/sheet distance and the luminance of the image. This relationship is roughly linear (Jackson, 1984); it was later better approximated with an exponential curve, but there are some areas which do not fit this law (Fanti, 2010). Matching the electrical laws of the hypothetical radiation which generated the image, there are some protuberances, such as the eyeballs, which show more intense luminance of the image, invalidating the perfect 3D characteristic of the image.

CONCLUSIONS

This paper presents the actual state-of-the-art of our scientific knowledge of the Turin Shroud. After a presentation of the peculiar features of the double body image, series of open issues were then considered and some already answered questions were reported at the end. First of all, the problem of the formation of the body image is examined: although some researchers state that they have solved it, considering it superficially, until now no experimental techniques have been proposed which can reproduce all the particular characteristics of the two body images. The problem of conservation is also considered, together with that of the radiocarbon dating of 1988, which provided a debatable result. Other minor problems like that of DNA and pollen analysis are discussed as due to the possible presence of aloe and myrrh. Questions recently raised about the possible presence of coins and writing on the TS, which do not seem to be confirmed by the latest photographs, are also mentioned. Then some open issues defined by STURP, after the important scientific research carried out in 1978, are also reported, because until now they have not supplied complete answers. The author hopes that discussion on these problems will be a useful tool to persuade more scientists to address research to these fields. Lastly some recently answered questions are reported as those relative the enveloping of a man, the enveloping of a really dead man, the negativity and the 3D features of the body image.

Discussion about the unresolved issues of the most important Relic of Christianity has shown how much we know about it, from a scientific point of view. It may seem that modern science knows almost everything about the physical world, but we see here how much it knows about a simple piece of cloth.

If we knew 5% of what we should know about it, perhaps we would know a lot.

Concluding this paper, the author is in agreement with R. Schneider a Shroud Science member (Associate Professor Emeritus, Bridgewater College, VA, USA, Shroud Science message of Oct 3rd 2008): “I have taken the position that the enduring character is the mystery, since whether authentic or inauthentic the mystery remains.

If it is actually Jesus and Jesus is God, then a miraculous account cannot be ruled out. If it is representative of Jesus, but made in some way, then the mystery in not removed, in fact I think it is deepened because then a miraculous account whether of the first or second kind is ruled out, and then we have an unheralded genius who created the most convincing image of Jesus ever created with a technique unknown but compelling hidden in the folds of history unheralded and unrecognized. I think that is a deeper mystery and harder to explain than authenticity.”

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