

Full Length Research Paper

The Shroud of Turin and its ancient copies

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There are copies of the Shroud of Turin, which could be described as "Shroud" actually made by man's hand. We can share our experience in the analysis of some of them. By using the results from these examples and comparing them with the results of the analysis of the Shroud of Turin itself, we could assess the actual possibility that the true Shroud was made by an artist. The negativity, the absence of contour, the absence of the figure at the hidden side and the transparency of the Shroud image differ considerably from their copies. Moreover, the laboratory analyses confirmed the presence of pigments based on heavy elements. In our opinion, the original Shroud of Turin can not be the work of a painter.

Key words: Turin Shroud copies, transparency, negativity, capillarity, pigments.

INTRODUCTION

There is an opinion that the image on the Shroud of Turin is the work of an artist of the period that has been dated to by the Carbon 14 method (1290-1390 AD). However, attempts by artists to reproduce this cloth just a century and a half after that time (from about 1509) exist today and are available for study. These are copies of the Shroud of Turin, and could be described as "Shrouds" in fact created by man's hand.

As such, they were never meant to be passed off as the true burial shroud of Christ, but rather, only as copies of the one kept by the House of Savoy. Usually, the copies were put in contact with the original, considered as a holy relic, thereby "gaining" the holiness by "direct transfer" from the relic (Marinelli and Marinelli, 2010). Rather than being mere speculations about which techniques our ancestors might have used to make a "Shroud", these copies are true examples of what they really did achieve when they tried in those days.

There are roughly one hundred of examples, many of which even exhibit printed text certifying that it is a copy of the original owned by the House of Savoy at that time. We can share our experience in the analysis of some of them kept in Spain and Portugal. All the most ancient copies we know of, which are those made at Chambery,

remain in these countries. Only the Lier copy in Belgium was made during this period but it has not the life size. Furthermore, in terms of evaluating the actual possibilities of making a shroud by hand in the past, it may be stated that the older the copy, the more interesting the information given about how our ancestors conceived the way that a shroud could be created. Among the oldest copies studied here are the three created before the fire of 1532. For our line of reasoning, our preference was to ask the owners of the oldest for permission to examine them. We present here those for which permission was granted. In none of them did the artist attempt to do anything other than paint the figure he was seeing. Comparing the results obtained from these copies with those from analysing the Shroud of Turin itself allows us to assess the likelihood that the true Shroud was done by an artist.

COPIES ARE PAINTINGS

Among those who believe that the Shroud is the work of an artist, the most widespread hypothesis is that it is a painting. This idea has some grounds, because, in fact, documents from the time of its appearance in Lirey (France c. 1356) are clear on this point. Furthermore, they claimed to have discovered the painter who had painted it (Chevalier, 1903). The text of the controversial Memorandum of Pierre de Arcis says: *questus, quemdam*

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pannum artificiose depictum in sua ecclesia procuravit habere, in quo subtili modo depicta erat duplex effigies unius hominis. Which translates as: 'He got for his church a cloth artistically painted. In it was painted, in a subtle way, the double portrait of a man'. That means the people that suspected a fraud at the time of its appearance in Lirey only imagined it could have been painted. The hypothesis of paint was alleged also to be supported by scientific observations and experiments, such as in the case of Mc Crone (1990).

Nevertheless, there are a number of old "painted shrouds" which can be used to assess the potential capability of man to create a shroud such as the Shroud of Turin when he tries to make it. Since the sixteenth century, when the Shroud already belonged to the house of Savoy, it has been copied by various artists with varying degrees of skill. Currently, copies of the Shroud are kept around the world (Marinelli and Marinelli, 2010; Duque, 2004a). The oldest copy containing a printed date of execution (1516) is in Lier and its size is a third the size of the original. The oldest copy of full size may be the one at Xabregas (Lisbon), but its completion date of 1509 is only an estimate as there is no printed text. Several copies of the Shroud of Turin have been studied in person for this paper, all of which make up a significant example of the characteristics of the copies made from 1500 to 1650 AD. Photographic evidence was compiled in a variety of configurations and samples have been analyzed in the laboratory. The copies show us what the technology and culture available in those days were able to come up when people took up the challenge of creating a Shroud.

They only made paintings. In some of the copies, an inscription along the edges expressly avows that it is a painting. None of the artists considered scorching or rubbing a cloth over a bas-relief (Garlaschelli, 2010). Other researchers (Heimburger and Fanti, 2010; Fanti and Heimburger, 2011) have refuted these modern attempts. The Garlaschelli copy would not be the first handmade whole copy as has been claimed (Heimburger and Fanti, 2010). As we report in this article, there are dozens of handmade whole copies much older than the Garlaschelli copy. It would appear that it never occurred to ancient artists to do anything other than paint with different substances. Other alternatives, such as some kind of proto-photography (Allen, 1998), are mere speculations without any historical or documentary basis. The copies themselves show that other hypotheses, other than paint, are merely anachronistic speculations.

Moreover, in these cases the authors were exempt from "inventing" the negativity; they rather had to imitate it. Even so, the vast majority seemed betrayed by their subconscious and they misrepresented some features as positive in order to better interpret what they were doing. In most cases the result was rather naive and clearly showed their hand-made nature (Duque, 2004a). The Xábregas copy, which is the oldest one analysed and

may be the oldest one of all, can immediately be recognised as the work of a human artist (Figures 1 and 2). The borders, especially on the head, are well-defined, the eyes are two dark dots that evoke a gaze and the hair on the dorsal image is well-combed into eight locks. It was not really necessary to make a thorough analysis of their nature to determine that they were paintings done by an artist. In many copies the human work is obvious, and in all of them a simple observation with unsophisticated media work (magnifier, microphotography, transparency...) is enough to dispel any doubt (Figure 1).

THE COPIES FROM CHAMBERY AND THE COPIES FROM TURIN

On most copies of the Shroud there is an inscription with a date and, in many cases, where the original stood when it was done. This information allows us to contrast the characteristics of the copies that were made in Chambery against those which were made in Turin. For example, the inscription of the Navarrete copy reads: *A LA RIQVESTA DIL SIGNOR DIEGO GONZALES QVESTA PICTVRA ESTATA FACTA AL PIV PRESSO DEL PRECIOSO RELIQUIARIO QVE RIPOSA NELLA SACTA CAPPELLA NEL CASTELLO DI CHIÁBERI ET ESTATA DISTESA DISOPRA DI IVNIO 1568.* Which translates as: 'By request of M. Diego Gonzales this painting was made close to the beautiful reliquary that stands in the Saint Chapel of the Chambery castle and was lying above in June 1568'. The text layout comprises the two long sides of the canvas and the date is in the short sides. This layout of the text is typical of the copies made in Chambery (Figure 3) whereas none of the copies from Turin has the text placed in this arrangement but rather, along the bottom, according to the usual way of presentation, and in a limited space between the two heads of the man figure. For example, the Logroño copy says *SACADO DEL ORIGINAL EN TVRIN EN 4 DE MAYO DEL 1623* (Figure 4). This translates as: Got from the original in Turin the 4th May 1623. Another feature of the copies from Chambery that distinguishes them from those of Turin is the presence of the 4 points arranged in an "L" that are holes existing before the fire that burned part of the Shroud in 1532 (Figure 5). This shows how these signs were a hallmark of the Shroud, and they caught the attention of the copiers. It is therefore likely that the artist of the illustration of the Pray codex (Lejeune, 1993) included these holes in his depiction of the funeral cloth of Jesus Christ if and only if he was representing the Holy Shroud that is today in Turin. Both the pre-fire copies as well as the subsequent copies from Chambery show these 4 points. It is nevertheless amazing because, after the fire, the 4 holes went unnoticed in comparison with the large burn marks from the 1532 fire. The Shroud was moved to Turin in 1578 but copies made between the fire and the transfer, do not

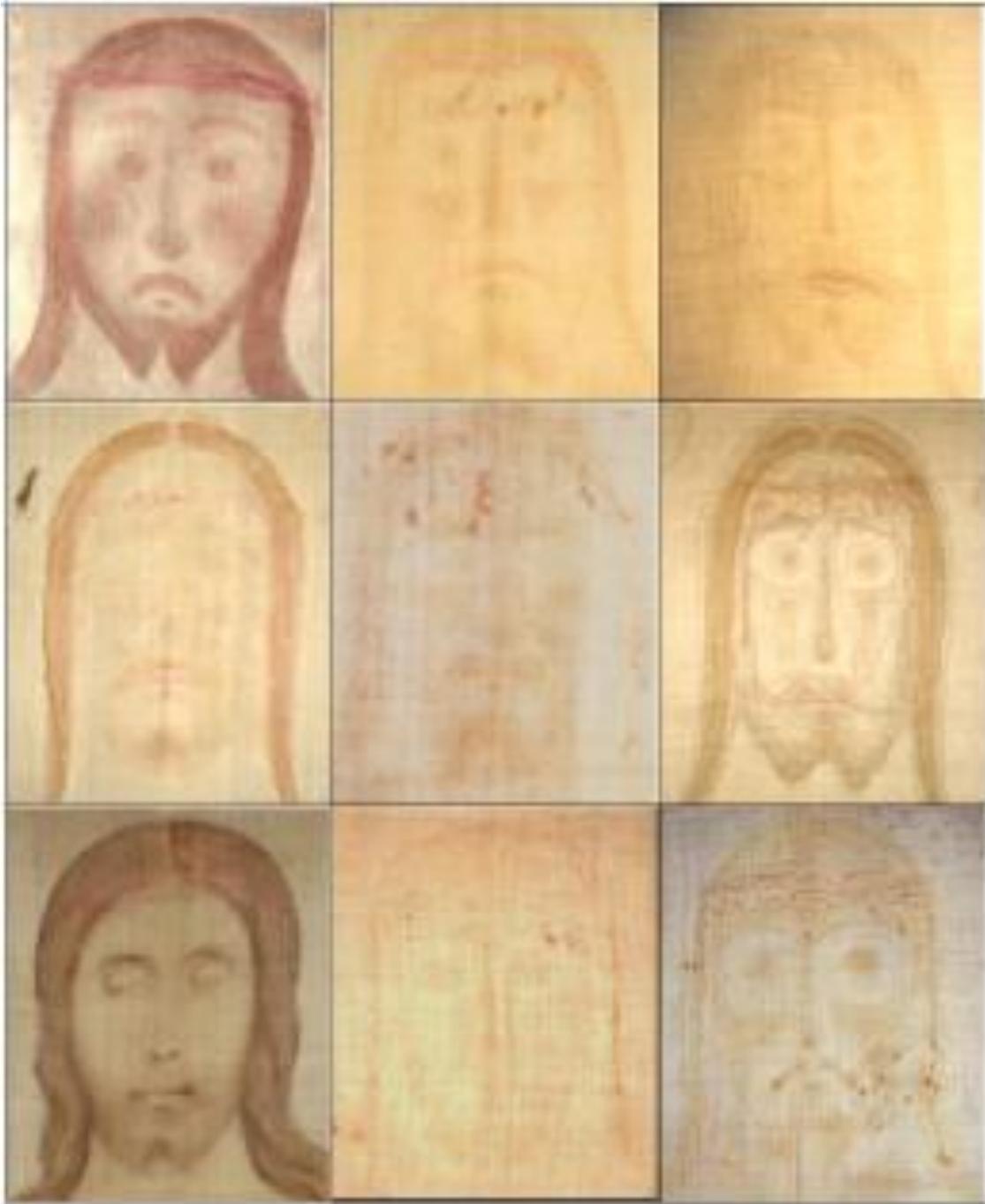


Figure 1. The face in the Shroud of Turin and in the copies. From left to right and from top to bottom. Xabregas, Noalejo, El Escorial, Navarrete, Turin (© B.Schwartz), Pamplona, Sanlúcar, Logroño and Castillo de Garcimuñoz.

show the burns of 1532 and instead show the 4 points from previous fire. Perhaps the authors of the copies in Chambery were sketching from a master copy made before the fire. Few copies made in Turin have the 4 holes, but do represent the Chambery fire burn marks (Figure 6). The copy of Torres de la Alameda is one of the few copies that shows the 4 holes together with the

large burns (Figure 7). The most common pattern for the copies of Chambery is therefore a text which covers all over the edges and the representation of the 4 holes in an "L". A fairly common pattern of the copies made in Turin is a short length text on the bottom between the two heads and the representation of the large burns from the 1532 fire.



Figure 2. Edges marks to enclose the strands of hair on the copy of Xabregas.

The copies made in Chambery before 1532 are the most interesting copies for the purposes of our study because they are the oldest and were done prior to the fire. We studied three preceding the fire: the Xabregas copy (~1509) and the two copies from Noalejo (1527). Among the copies following the Chambery fire, we studied the El Escorial copy (1567), the Navarrete copy (1568), the Pamplona copy (1571) and the Sanlucar copy. Among those copies made in Turin we have studied the Torres de la Alameda copy (1620), the de Logroño copy (1623), the Castillo de Garcimuñoz copy (1640) and the Campillo de Aragón copy (1650). In total, the study encompassed eleven copies whose execution period spans almost a century and a half, from 1500 to 1650 AD.

The copies were not always preserved in the best conditions. Some copies were kept in a convent or monastery and others placed in parishes or cathedrals and have suffered damage in times of war. In the case of the El Escorial' copy, it is suspected that someone daubed the mouth in mockery during the invasion of Napoleon's troops (Duque, 2001a). Moreover, it is usual to find some frayed area of the copy cloth being one of those parties that have suffered more stress. The fabric of some of them has been patched, as is the case of the Castillo de Garcimuñoz copy, which has the patches from

the 1532 fire drawn on it but curiously also has other true patches from damages suffered in its own history. Regarding the image that they show, it is not always easy to distinguish. Particularly in the cases of the Navarrete (Figure 8), Campillo (Figure 10) and Logroño (Figure 4) copies, the image is too dim now and we assume it was more intense originally.

EXPERIMENTAL PROCEDURE

The following observations were made systematically if the copy owner allowed them:

- i) Full display supported by a frame of ~4.4 m x 2.2.
- ii) Measurement of the overall dimensions of the cloth.
- iii) General and detailed pictures with visible light.
- iv) General and detailed pictures with flash lighting.
- v) Photographs of details with ultraviolet light.
- vi) Photographs with transmitted light.
- vii) Photographs of the cloth reverse.
- viii) Microphotographs.
- ix) Description of the fabric, threads per cm in weft and warp, twist, etc.
- x) Description of the figure.
- xi) Description of the text if any.

The instrumentation has varied from one observation to another because the observations have been carried out over several years. In addition to a metallic meter and magnifiers, we used digital and film cameras with additional lens for microphotography approach. For ultraviolet lighting we used a Wood's lamp (320 to 400 nm). Thread counters were used for the fabric description. When the owner gave us permission, we collected some fragments of textile in areas with different pigments and saved them between two glass plates. Later, they were analyzed using optical microscopy and scanning electron microscope (SEM) (Figure 11). Microanalysis was used on three occasions to determine the nature of the pigments. The Noalejo samples analysis was carried out by M. Furió under the direction of Dr. A.V. Carrascosa with the environmental scanning electron microscope (ESEM) using a Quanta 200 FEI microscope with energy dispersive X-ray spectroscopy (EDX) (7509 Oxford) at the MNCN-CSIC service. The analysis of samples of the copy of Torres de la Alameda was carried out by Felipe Montero, researcher of the Centro Español de Sindonología in April 2000. And the analysis of El Escorial was performed by himself in February – March 2001. Table 1 summarizes the analyses carried out on each copy.

The Noalejo samples were a tiny fragment of cloth taken from the image area and from the text area (Figures 3 and 12). For the El Escorial samples, a common adhesive tape was used (Figure 13). A sample from the copy of Torres de la Alameda was taken from a corner without any image (Figure 11). A description of the history and characteristics of some of these copies can be found in the bibliography (Duque, 2001a, b, 2004b, 2006; Barta et al., 2009).

CHARACTERISTICS OF THE SHROUD OF TURIN AND OF ITS COPIES

More than 100 characteristics of the Shroud have been identified (Fanti et al., 2005). Some of them can be observed only with laboratory equipment. Here we select some of the easier to perceive for comparing the characteristics of the Shroud of Turin and of its copies.

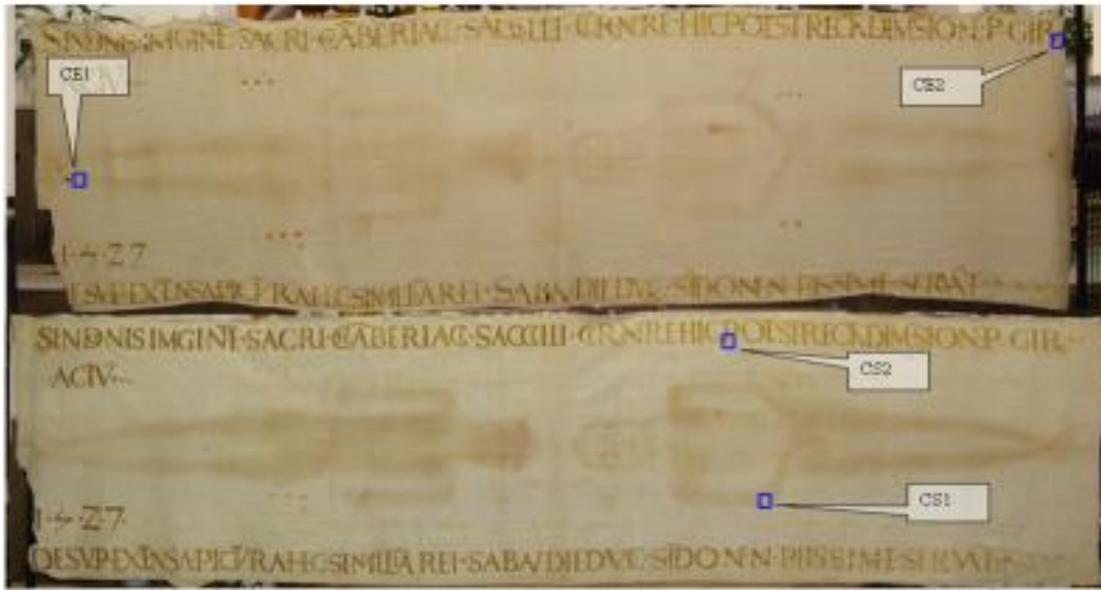


Figure 3. Noalejo copies and the place of sampling.

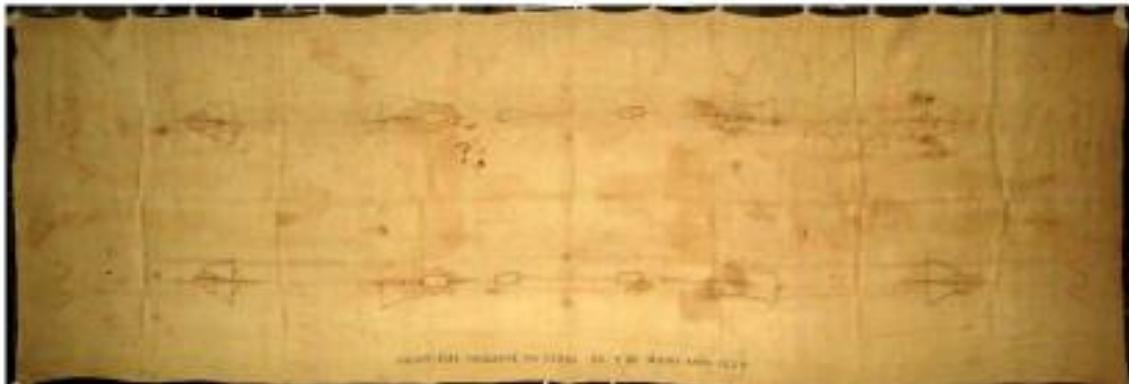


Figure 4. Copy of Logroño.

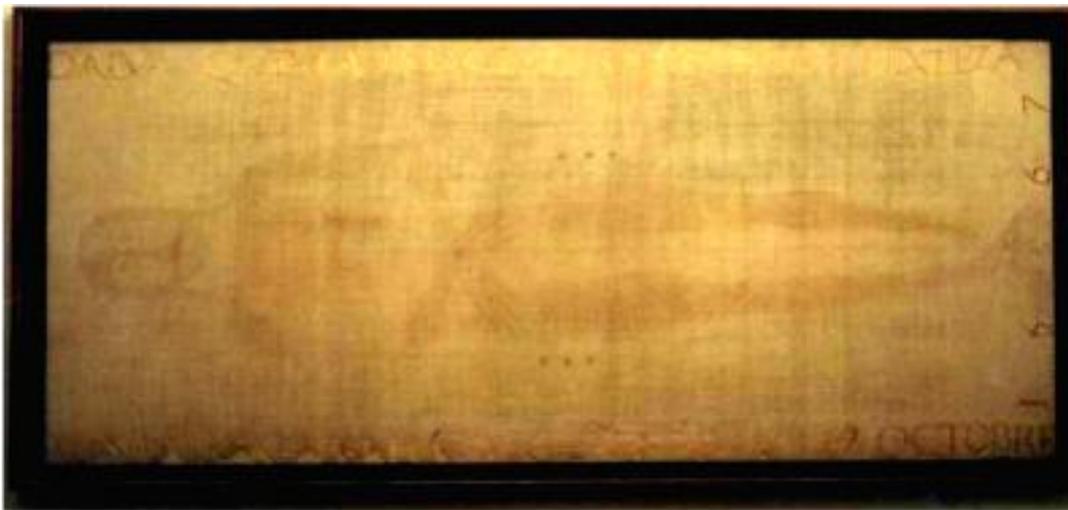


Figure 5. Copy of El Escorial. It is kept folded by the middle with a wood plate in between and surrounded by a frame. The artist represented the poker holes close to the upper side of the legs.



Figure 6. Drawing of 1532 burns in the copy of Castillo de Garcimuñoz.

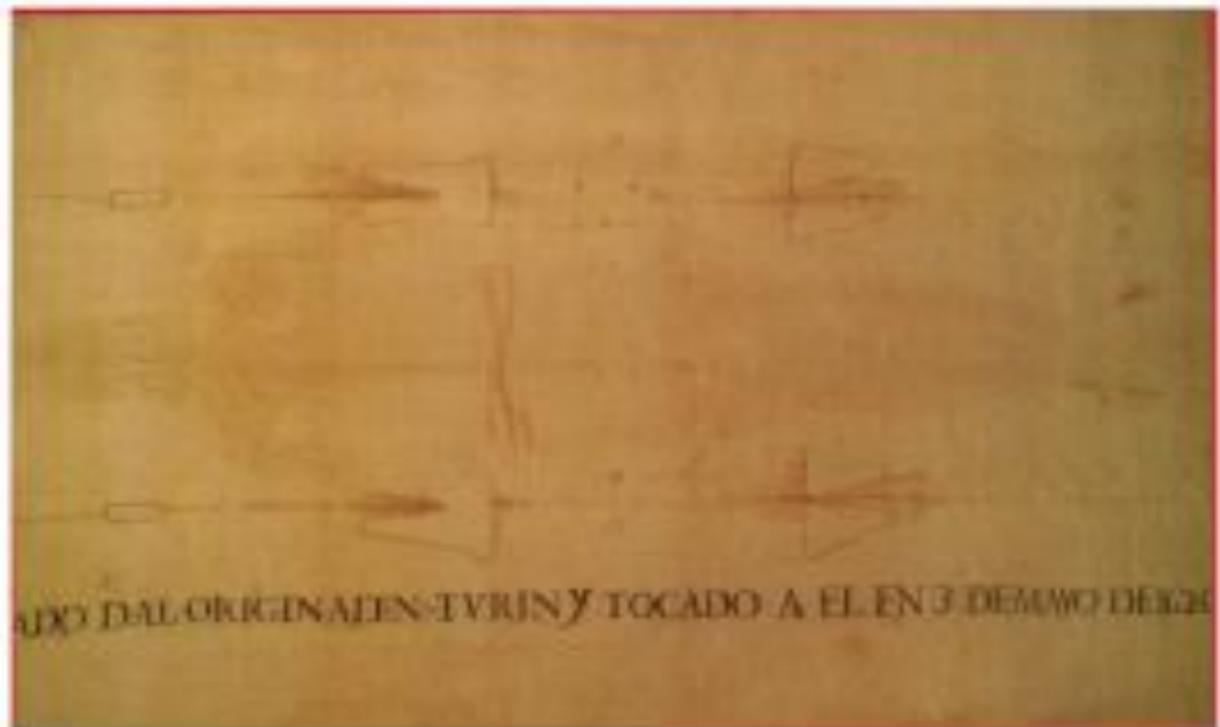


Figure 7. Copy of Torres de la Alameda. It shows the 4 “poker holes” and the Chambery burns.



Figure 8. Front of the copy of Navarrete.



Figure 9. Reverse of the copy of Navarrete.



Figure 10. Copy of Campillo de Aragón inside a shrine integrated in the altar.

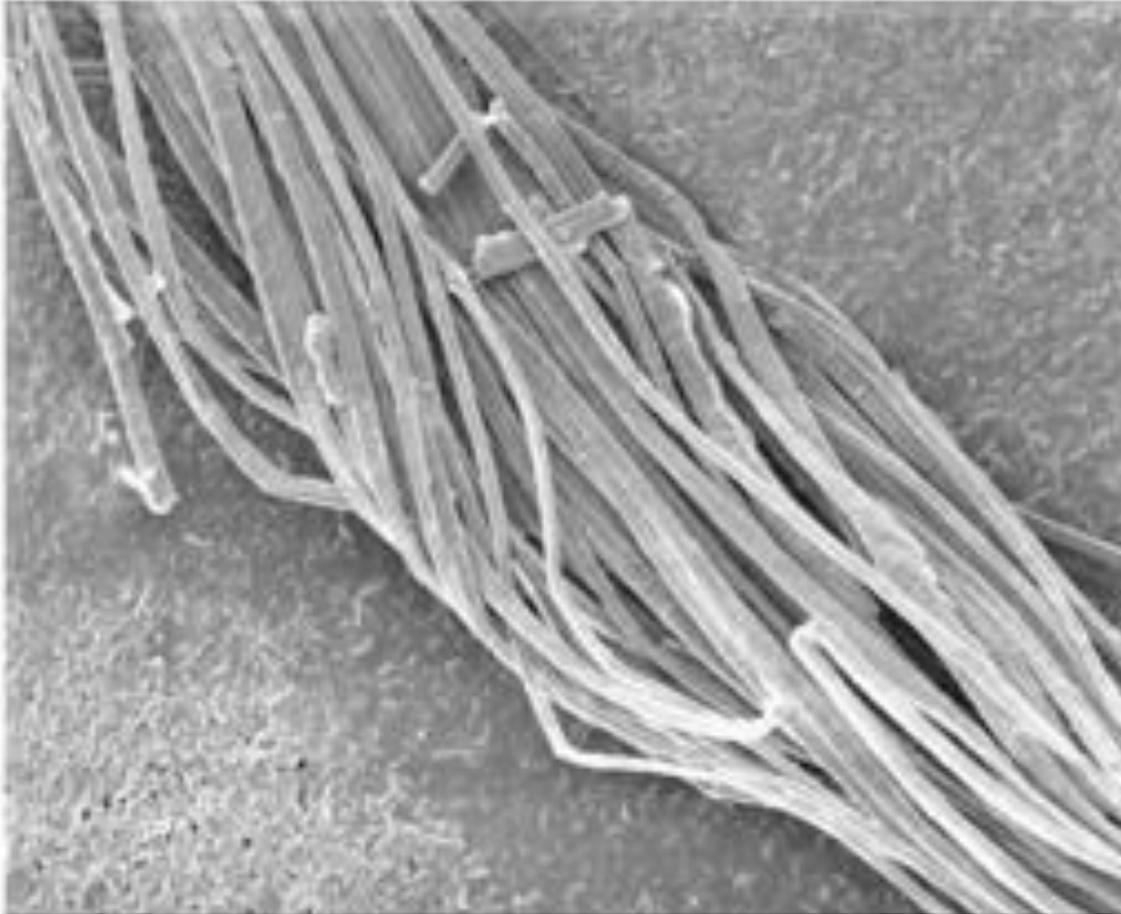


Figure 11. Image of a thread from the Torres de la Alameda copy taken with a Scanning Electron Microscope (SEM). It is linen twisted Z.

Table 1. Analyses and other data of the copies.

Copy	Photograph	Reverse	Transparency	UV	Samples	Microanalysis	Observation date	Figure
Xábregas	X		X	X			13/05/2007	1, 2, , 17, 20
Noalejo	X	X	X	X	X	X	04/10/2008	1, 3, 12, 22, 23, 24, 25, 26
Escorial	X			X	X	X	29/08/2000	1, 5,13, 18, 19
Navarrete	X	X	X	X			13/11/2010	1, 8, 9
Pamplona	X						22/10/2006	1
Sanlúcar	X	X		X			10/07/2009	1,15
Torres	X				X	X	13/01/2001	7, 11
Logroño	X	X	X	X			13/11/2010	1, 4
Castillo	X		X	X			19/08/2004	1, 6, 14, 16, 21
Campillo	X						27/06/1992	10

Negativity

The first feature used in the comparison between copies and the original is the difficulty for artists to imitate the negativity (Figure 14). Although they only had to reproduce it, the vast majority were not faithful to the original

but rather, they transformed some anatomical features to positive that were negative in the original. This is particularly interesting in the copy from Sanlúcar de Barrameda. Due to its characteristics, it is most likely a copy made in Chambéry before 1578 as the associated documentation suggests. Moreover, it does not present



Figure 12. Samples CE1 and CE2 from Noalejo.

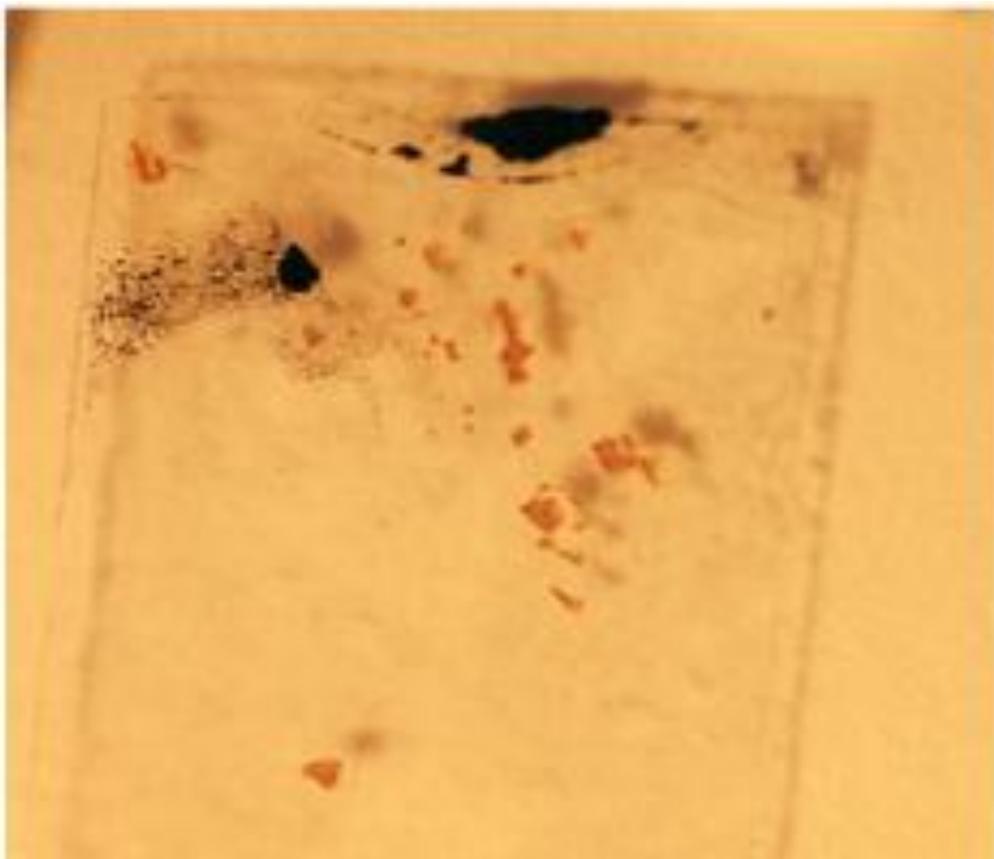


Figure 13. Adhesive tape samples from the gold leaf letters of the El Escorial copy.

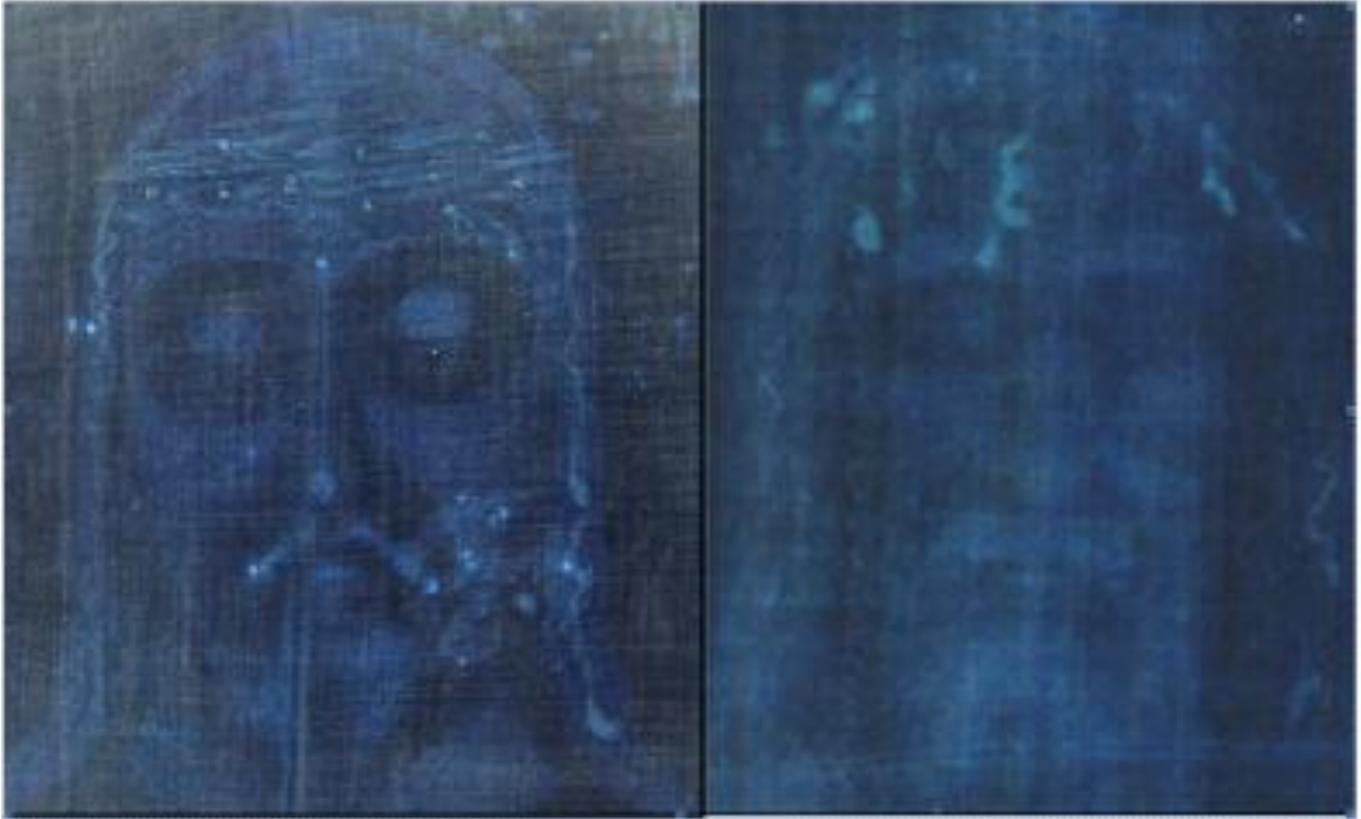


Figure 14. On the left, negative of the face of the Castillo de Garcimuñoz copy. On the right, negative of the face of the Shroud of Turin (© B.Schwartz).

the burns of 1532 but does show the four points of burns in an “L” prior to 1516. But the uniqueness of this copy is that it has completely ignored the negative character of the original, and the author has made a figure entirely positive. However, from a scientific standpoint and in relation to the original story of Turin, the copy from Sanlúcar presents an interesting effect. It is recorded that this copy, which bears the full double figure, has been exposed for hundreds of years folded in such a way that you could only see the rectangle around the face in the altarpiece of San Pablo on one side of the *Nuestra Señora de la Caridad* church where the copy is now hosted (Cruz, 1997). It was still visible in this layout in the twentieth century, although today it is kept in a reliquary. A very similar configuration has been proposed as hypothesis for the image of Edessa. That is, the Shroud being complete, only the part of the face was actually displayed (Wilson, 1998). However, the experience with the copy of Sanlúcar can rule out the most common interpretation of this hypothesis. The Sanlúcar copy has a rectangle of fabric clearly darkened around the face because of exposure for perhaps 350 years (Figure 15). If the Shroud of Turin had been exposed, as it was assumed, for a similar period in Edessa, from the 7th to the 10th century, it would probably feature a noticeably darker mark on the exposed area.

In only a few cases, among them the Noalejo copies, which stand out as the most remarkable (Figure 3), the painter made enough effort to be faithful to the original against his artistic sense. In most cases, however, the effect of negativity is lost or limited when the photography of the copy is inverted.

Lack of edges

Another feature that differentiates the Shroud of Turin from its copies is the absence of edges. The original image has no defined edges, that is, the image fades gradually as it passes from the image area to the -imageless area. But on the copies it is even usual to see a line that borders the figure to facilitate its implementation. It is a common practice for the artist to mark an area with a smooth line around it to help shape the painting and then fill the area with colour. We have the example of Castillo de Garcimuñoz, where the line is thin (Figure 16). How the artists drew these contours does not differ substantially from the way they drew the patches of the 1532 fire. And we have the Xabregas example in which the line is rather thick (Figure 2). In the latter, it is also noteworthy that its canvas was prepared with a plaster in the area under the image to facilitate the setting

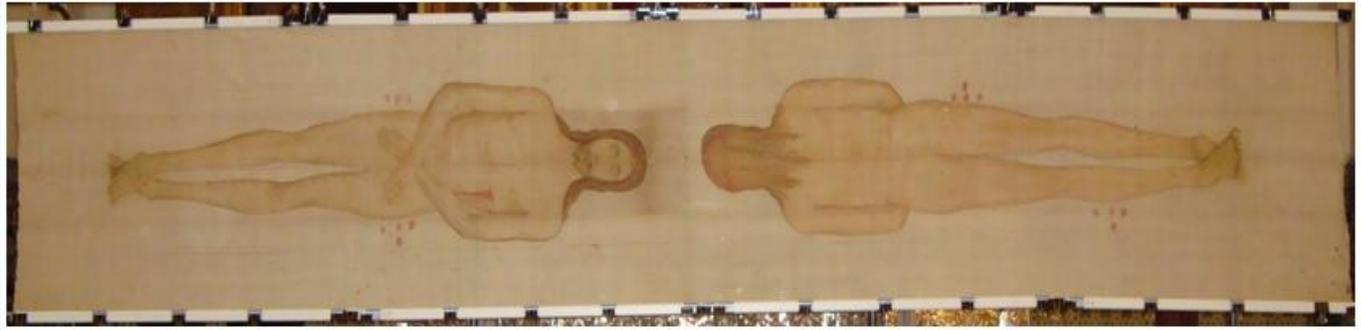


Figure 15. Copy of Sanlúcar de Barrameda.



Figure 16. Edges marks of the figure of the copy of Castillo de Garcimuñoz.



Figure 17. Ultraviolet observation of preparatory plaster in the copy of Xabregas.

of the painting. The pre-coating was observed by shining the cloth with ultraviolet light (Figure 17). That UV light also made it easier to see the parallel lines along preferred directions made by the artist's hand when he was painting in the drawing area. This was seen, for example, in the legs and cheekbones of the copy of El Escorial (Figures 18 and 19). In the case of the Shroud of Turin, the only preferred directions highlighted by the Fourier analysis are those of the fabric. The image of the Shroud of Turin has no preferred direction (Fanti and Marinelli, 1999; Maggiolo, 2002). According to Daniel Duque (Duque, 2001b, 2004b), the authors of some copies have tried to mimic the original using a technique

called "sfumato", involving a damp cloth or cotton ball soaked in an aqueous medium, as the watercolour type, to wet the cloth in the area of the figure. The brush was reserved for the contours, patches, burns and other ornaments.

No image on the hidden side

Another feature easy to verify that makes the copies different from the original is that the image on the copies passes through the fabric and it can be seen on the reverse side. In fact, any liquid-based paint is absorbed

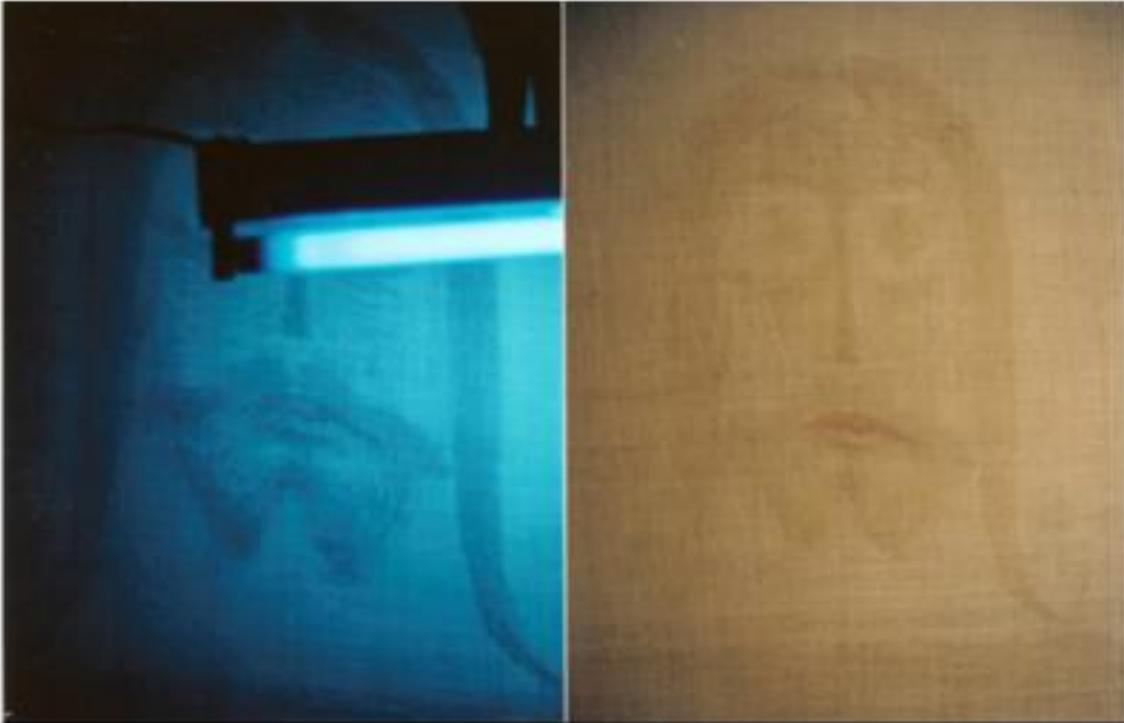


Figure 18. Face of the copy of El Escorial. Ultraviolet light and natural light.



Figure 19. Ultraviolet light illumination on the back of the legs in the copy of El Escorial. The preferred direction of the hand to apply the paint strokes can be observed.



Figure 20. Photography by transmitted light of the Shroud (© B.Schwartz) and of the copy of Xabregas.

by capillary action of the threads and soaks through to the reverse of the fabric. We verified this feature as well in the copies in our study. The copies that best simulate the original image have either been performed on the fabric without the typical preparatory plaster or this has been very subtle to better mimic the original. The paint used by the artist soaked considerably and the image is seen on both sides with almost the same clarity (Figures 8 and 9). This characteristic of the image of the Shroud also differs from the paintings that attempt to reproduce it. For centuries, the reverse of the Shroud had been hidden by the fabric reinforcement or Holland cloth placed by the poor nuns of Saint Clare after the 1532 fire. But during the restoration of 2002, the reinforcement fabric was temporarily withdrawn and the hidden side of the cloth was extensively photographed (Flury-Lemberg, 2003). The findings were that there is no actual image on the reverse side or hidden side and that only the blood that permeates the Shroud has transferred across. In fact, the Shroud image only penetrates the topmost part of the fibres (Fanti et al., 2010). More precisely, the Shroud of Turin, does not show any image for the whole human figure and maybe there is only a faint image in the area of the face and perhaps on the hands (Fanti and Maggiolo, 2004). However, in the case of copies, we have consistently examined the reverse side when it was possible to do so. On the Xabregas copy, it was not possible to observe the reverse side because both halves are sewn against one another. In the case of Campillo de

Aragon, the copy is enclosed in a large reliquary integrated into an altar at a side of the church. The El Escorial is also folded and sewn around a wood plate that gives it consistency. In the rest we saw with the naked eye the image of both the figure and any existing letters. This feature is due to the use of fluid media for the application of pigment and the lack of plaster for cloth preparation that was the most common procedure in the making of the copies. Fluids are transferred by capillary action through the threads and carry the pigment diluted in them. So the image is viewed with the same sharpness on both sides.

Transparency

But the most definite and simple feature that makes the original different from the painted copies is the photograph against the light, that is, by transparency. In 1978, during the days of observation, the STURP made pictures of the Holy Shroud by transparency (Figure 20). The silhouette of the blood stains could clearly be seen as the substance added to the cloth blocks the passage of light and makes a dark shadow. However, there was no silhouette for the image because it is not formed by any substance added to the cloth. The image disappears with lighting by transparency on the Shroud. In contrast, the picture painted in the copies makes a shadow, as expected, and its silhouette is easily seen (Figure 21).



Figure 21. Photography by transmitted light of the copy of Castillo de Garcimuñoz.

In the case of Xabregas in Lisbon, the copy is folded in half with the fold between the two heads so that the image back and front are opposed in both sides of the assembly and we need to turn it to see each one. Thus, on the photograph for transparency we can see both shapes simultaneously highlighting this feature we describe and discovering a shift between the two figures (Figure 20). The absence of silhouette when the cloth is lighted by transparency is one of the most definitive characteristics. It is what easily distinguishes any copy from the original Shroud of Turin and it is easy for anyone to verify as it does not require any sophisticated instrumentation. The image transparency on the Shroud itself implies that the image is not "additive", that is, the image on the Shroud of Turin was not formed by the addition of fluid substances that soak through the cloth due to capillarity, or with any other substance added to the cloth. This in turn implies that it is neither paint, print, rubbing, nor a proto-photography. Nor is the Shroud of Turin a photographic negative in the technological sense because in the classical photography technique the negative is specifically used from transmitted light illumination. If the Shroud of Turin were used for this purpose it would not get the positive image. That is, if the Shroud is placed between the light source and a photosensitive reagent layer, the light would not print a

positive image on the impregnated surface after passing through the fabric of the Shroud. This feature also invalidates the hypothesis that the copies were done by placing a clean copy cloth on the Shroud and tracing the image while the assembly is illuminated by transparency.

If the image is not additive, the image must be "reactive", that is, something has reacted with the fabric to make it change. We have seen that the characteristics of negativity, absence of edges, penetration to the reverse side and transparency of the Shroud image all differ considerably from its copies. But among the copies directly studied by us, the ones from Noalejo stand out from the rest (Figure 3).

PIGMENTS AND THE NOALEJO COPIES

The copies studied by the Centro Español de Sindonología in Noalejo, a small village in the province of Jaén in the south of Spain, revealed the work of a master craftsman. Here are two of the best Shroud copies, the most delicate and best preserved we know of.

Both copies have an inscription in golden letters around the edge, dated 1527, that is, 5 years before the fire in Chambery. The inscription is the same on both copies. It is written in faulty Latin and says:

Upper part

**SINDONIS IMAGINEM SACRI CHAMBARIACI
SACCELLI CERNERE HIC POTEST RECTA
DIMENSIONE PER GIR. ACTUM**

Lower part

**DESUPER EXTENSA PICTURA HEC SIMILLIA REI
"SABAUDI EDUC" SINDONEN PISSIME SERVATUR**

A preliminary translation (by Mark Guscini, Master in Medieval Latin and Alberto Alonso, Centro Español de Sindonología) would be:

Upper part

Here you can see the image of the Holy Shroud which is kept in the chapel at Chambery, in its true dimensions, by "Gir" in 1527.

Lower part:

This depiction spread out from above is similar to the Shroud kept by the Duke of Savoy with great reverence.

They have the four sets of L-shaped holes present on copies coming from Chambery. It is curious that all the copies that show these holes have them painted red. A possible explanation for this is that the red silk the Shroud was wrapped in at the time (Wilson, 1998) could be seen through them, if this red backing was kept in place behind the cloth when it was exhibited.

We see that the Noalejo copies are more faithful to the original than the others. These two copies, especially the fainter of the two, do not seem so different from the original on a first viewing. The artist tried to reproduce a faithful reflection of what he saw, even though he might not have understood it. The borders are not as clearly defined as they are on other copies. The artist, P. Gir, has tried to imitate the blurred edges of the original. Nor is the hair so well-defined on the dorsal image. The beard is forked, the thumbs are not visible on the hands, and one foot is on top of the other. The artist also wished to highlight the blood flowing from the left heel, visible on the dorsal image of the Shroud.

Closer inspection is needed to appreciate the differences in comparison to the original. It is true that the wounds have not been as well copied as they appear on the Shroud. For example, the inverted 3 (or epsilon) on the forehead has been copied as a more or less straight line (Figure 1), and the forked bloodstain on the wrist is reduced to a simple circle (Figure 22). But the characteristics that make one realize they are a mere painting are that the image can be observed on the reverse, as it has soaked through and we can see the silhouette of the figure when lights are shone through the

cloth (transmitted light).

By observing some threads from copies with the optical and scanning microscopes, we readily distinguish the pigments (Figures 23 and 24). The components of the pigments used for these copies appear without difficulty when analyzed in the laboratory. The images on the Noalejo copies were painted with some kind of soil pigment. A preliminary analysis of the samples identified the presence of tin (Sn), lead (Pb), calcium (Ca), aluminium (Al), iron (Fe), and other heavy elements. Figure 25 shows an example of a spot analysis. For more representative results, microanalysis on eight particles found in the image sample CE1 were performed and the sum of the atomic percentages of the elements determined by EDX (Energy-Dispersive X-ray Spectroscopy) is shown in Figure 26. Nickel (Ni) may be another component in the pigment. There was no previous preparation for the cloth and no oil was used. The binding substance must be diluted gum (Opinion of Juan Manuel Miñarro. University of Seville. Sculpture department. Personal communication). The text is printed in gold leaf.

Some samples of the copy of El Escorial were also analyzed with energy dispersive microanalysis (EDS). We took a sample of the image area on the back. The elements detected were mainly aluminium (Al), calcium (Ca), Silicon (Si), Sulphur (S) and iron (Fe). The 4 holes in the L pigment were, however, composed of aluminium oxide. Despite their reddish colour, no iron was detected. The letters have also been made with gold leaf on a support using organic varnish.

The EDX analysis performed on threads from Torres de la Alameda copy by Felipe Montero show that the image was painted with iron oxide and possibly with linseed oil. The letters of the inscription, in this case would have been made with carbon black.

Conclusion

It is relatively easy to demonstrate the artificial execution of the ancient copies of the Shroud. Even though there are many peculiar characteristics of the Shroud image, conclusive evidence can be found by using only a few of them. The negativity, the lack of edges, the absence of image on the hidden side and the transparency of the Shroud image differ considerably from their copies. Among the ancient copies studied and possibly among the vast majority of existing copies, the copies of Noalejo are the most similar to the original and the execution time (1527 AD) does not differ too much from the appearance in France of the Shroud (1356 AD). They can serve, then, to show the best ability to make a Shroud by our ancestors. But even with the copies of Noalejo, all doubt is dispelled after a precursory glance with the naked eye. Moreover, the laboratory analysis confirmed the presence of pigments based on heavy elements. Our experience, described in this article, allows us to say that the original Shroud of Turin can not be the work of a painter because



Figure 22. On the left, wound in the hands in the Noalejo copy. On the right, wound in the hands in of the Shroud of Turin (© B.Schwartz).

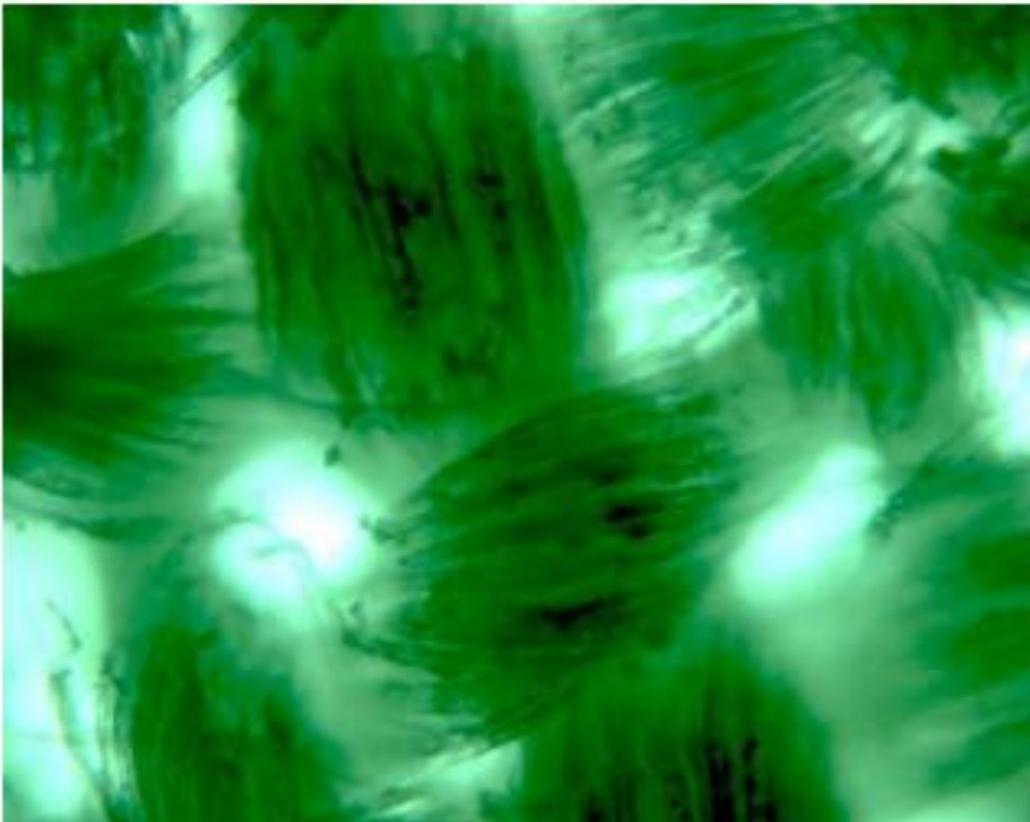


Figure 23. Photograph with optical microscope of the pigments of one copy of Noalejo.

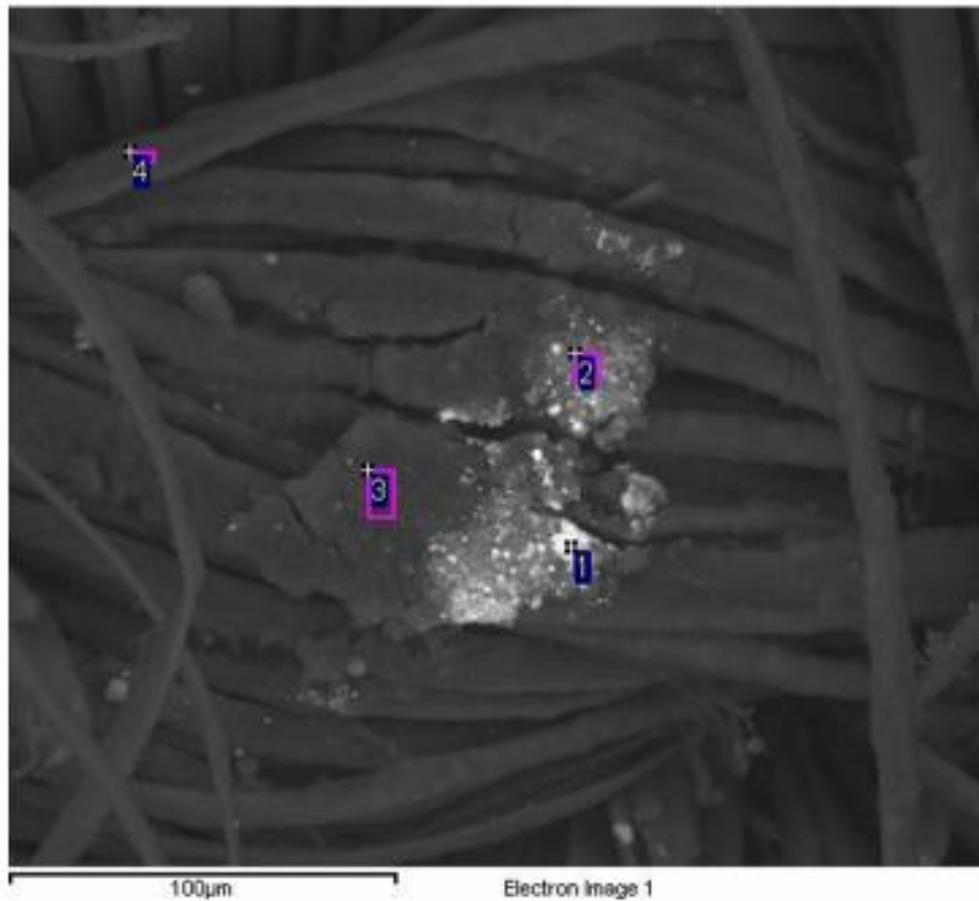


Figure 24. Photograph with scanning electron microscope of the pigments of one copy of Noalejo.

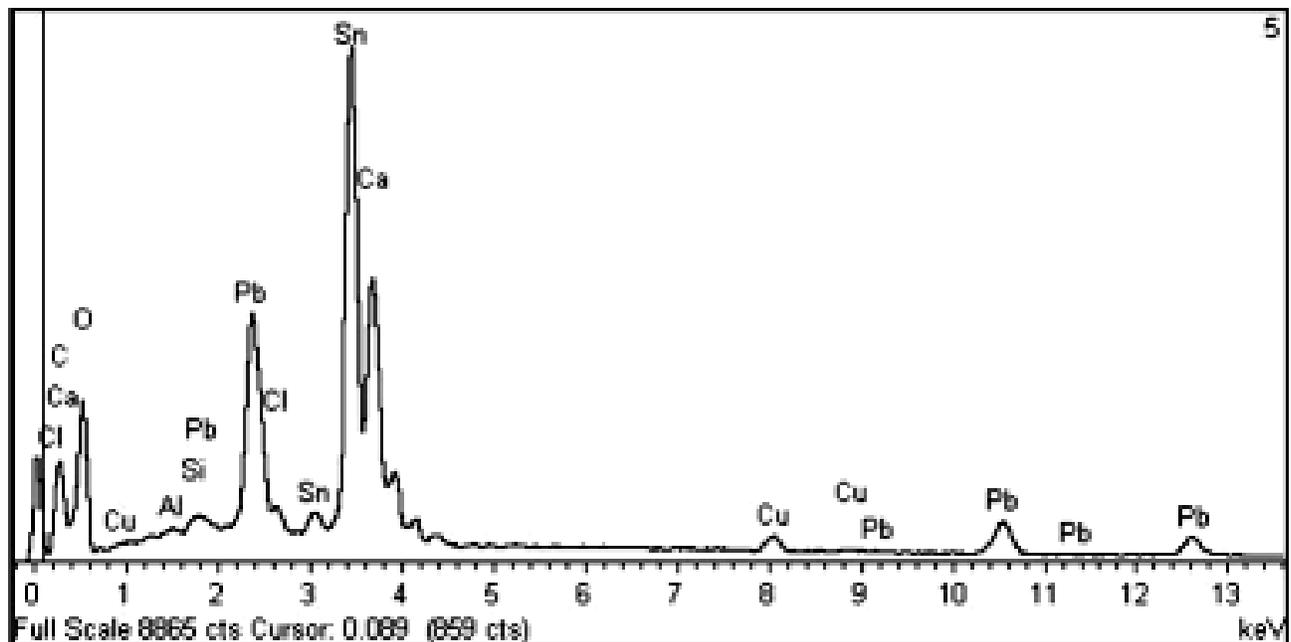


Figure 25. Spectrum of dispersive energy analysis made on the pigments of one copy of Noalejo. Presence of Tin (Sn) and Lead (Pb).

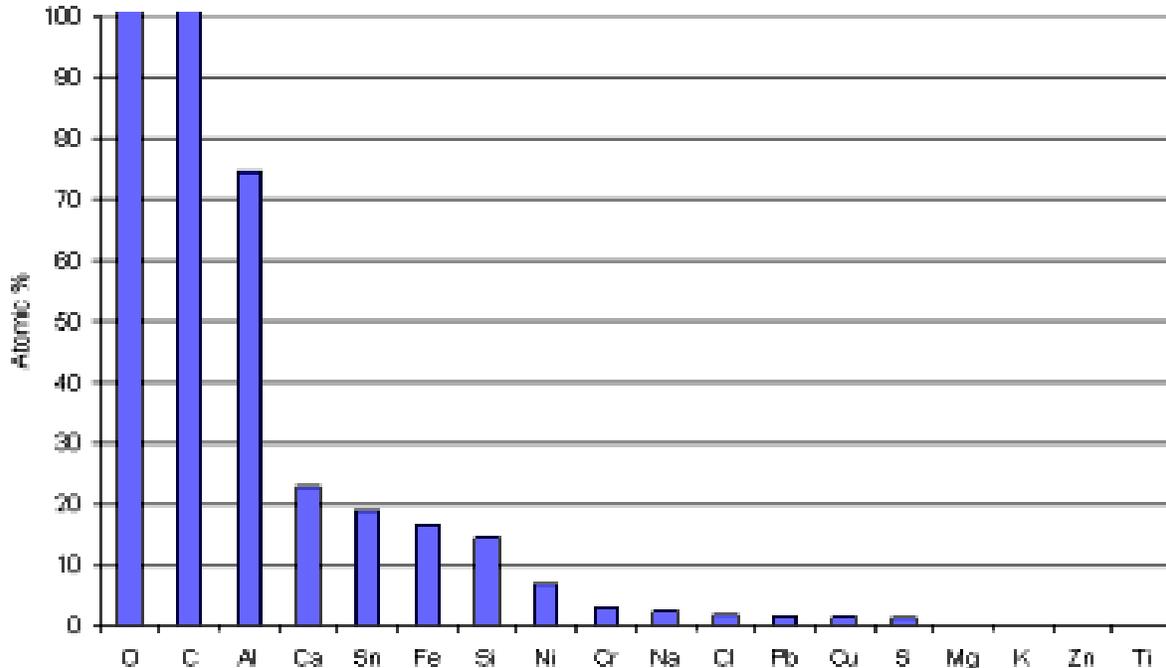


Figure 26. Sum of atomic percentages for each element determined by EDX for eight particles found in the image sample CE1. Aluminium (Al), tin (Sn), iron (Fe) and nickel (Ni) may be the main components of the pigments.

it would have been clear after a few minutes of direct inspection by the experts who have analyzed it with the specific instrumentation used on several occasions. An artist in past centuries did not have the facilities and the capabilities to create a work with features comparable to those of the Shroud. In our opinion, if the Shroud of Turin were a painting, no doubt would have remained after the 1978 research.

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