Proceedings of the International Workshop on the Scientific approach to the Acheiropoietos Images, ENEA Frascati, Italy, 4-6 May 2010

List of Evidences of the Turin Shroud

Giulio Fanti[1], Jose A. Botella[2], Fabio Crosilla[3], Francesco Lattarulo[4], Niels Svensson[5], Raymond Schneider[6], Alan Whanger[7]

of ShroudScience Group

[1]University of Padua, Italy, giulio.fanti@unipd.it, www.dim.unipd.it/fanti
[2]Universität Regensburg Lehrstuhl für Entwicklungsbiologie, Germany, jose.botella-munoz@biologie.uni-regensburg.de
[3]University of Udine, Italy, fabio.crosilla@uniud.it
[4]Politecnico di Bari Italy, lattarulo@poliba.it
[5]Maribo, Denmark, nsvensson@dadlnet.dk
[6]Bridgewater College, VA, USA, rschneid@bridgewater.edu
[7]Council for Study of the Shroud of Turin, Durham, NC, USA, adw2@acpub.duke.edu

Abstract
This paper derives from a very wide discussion in the Shroud Science Group and from an in progress paper published in 2005. It has the aim to present all the evidences detected on the Turin Shroud that can be useful for a discussion about the problem of the body image formation. Many hypotheses about the image formation have been proposed, but, up to now, none, scientifically testable, simultaneously satisfies all the facts detected on the Shroud. For this reason this paper will be helpful for future researchers who will study and propose new hypotheses.
A list of facts directly related to the Turin Shroud is synthetically presented. They are subdivided in Type A that are, in the authors view, unquestionable facts and in Type B that are confirmed observations or conclusions based on a proof made in reference to Turin Shroud studies; in addition other facts or observations that were evidenced by some researchers but that are not accepted by others are also reported for completeness.

Keywords: Turin Shroud, Body Image, Characteristics.

1. INTRODUCTION

The Turin Shroud (TS) is believed by many to be the burial cloth of Jesus of Nazareth when he was put in a tomb in Palestine about 2000 years ago. It has generated considerable controversy but unlike other controversial subjects (e.g. ghosts), the TS exist as an archaeological material object: it can directly and objectively be observed [1, 2]. The results of studies can be analyzed by scientific methods [3].

The TS is a linen sheet about 4.4 m long and 1.1 m wide, in which the complete front and back body images of a man are impressed. The cloth is hand-made and each yarn (diameter about 0.25 mm) is composed of 70-200 linen fibers. It has been shown by many scientists that the linen sheet enveloped the corpse of a man who had been scourged, crowned with thorns, crucified with nails, and stabbed by a lance in the side. Also impressed are many other marks due to blood, fire, water and folding, which have greatly damaged the double body image.

The "Shroud of Christ" appeared in 1355 in Lirey, France. Before the sacking of Constantinople in 1204 there are some documents that refer to the presence of the TS: for example some characteristics of the Christ reproduced in some Byzantine coins (gold-solidus) of the 7th-13th century A.D. are very similar to those of the TS body image.

The TS has a front and a back image separated by a non-image zone of 0.18 m; the images show an adult male, nude, well proportioned and muscular, with beard, moustache, and long hair.

The TS has been radiocarbon-dated to 1260-1390 A.D. [4] but many scientists believe that the reliability of radiocarbon dating is not satisfactory because the linen underwent many vicissitudes (e.g., fires, restorations, water, etc.) [5, 6]. Recent robust statistical evaluation showed the presence of a non negligible bias in the data published [7]. It was also demonstrated that the 1988 sample is not representative of the whole TS [8].

Many hypotheses and experimental tests have been carried out on linen fabrics to explain the formation of the body image, both in favor of authenticity, and *vice versa* [1]. Despite macroscopic resemblance to the TS image which has often been achieved limited to the face, no individual or group has come close to reproducing all the characteristics found in the TS image. At first sight, the

image, is similar to that of the TS Man, until now no experimental test has been able to reproduce all the characteristics found in the image impressed on the TS.

After the publication of an in progress paper [9] originally developed by the first author, and amended and agreed to by various members of the Shroud Science Group (SSG), presenting various characteristics of the TS, this paper presents in a more concise and organized form a revised and updated list of TS facts and observations.

2. LIST OF FACTS AND OBSERVATIONS

The following list is subdivided into Type A which refer, in the authors' view, to unquestionable facts and observations made on the TS and Type B which refer to confirmed observations or conclusions based on a proof made in reference to the TS. They are numbered as "An" or "Bn" where n is the evidence number.

Seeing things and not seeing things, is perhaps the biggest problem in legitimate Shroud research. "*I think I see*" and "*I don't see*" seems to be the underpinning of many "scientific" analyses. The brain-eyes system may plays tricks on the researcher. Because of a priori assumptions, it may be that he perceives things that conform to something searched for and conversely, he may fail to perceive images because of not knowing what various objects look like. In addition goal-oriented studies and experiments done without following all the standards, which are not rare in this field, can lead to debatable results. Some data or observations are not numbered because the observations are controversial supported by some researchers and contested or rejected by others.

The list of facts is subdivided in five categories to which the statements are related: General; Body image; Optics; Chemistry & physics; Blood & body fluids.

In consideration of space limitations, the facts have been stated in very synthetic terms, but the rich bibliography enclosed will allow the reader to go far more in depth in reference to the argument of interest. It must be added that for space problems, among the many bibliographic references relative to each statement only the first in time has been reported.

2.1. GENERAL

A1) **Traditional dimensions** of the TS of 436 x 110 cm [10] are changed after 2002 "restoration": one side (the lower considering horizontal the body image, with the frontal side on the left) measured 437.7 cm in 2000 and 441.5 cm in 2002; the opposite side measured 434.5 cm in 2000 and 442.5 cm in 2002; its height of 112.5 cm and 113 cm respectively on the left and on the right in 2000 but 113.0 cm and 113.7 cm in 2002 [11]. A measurement made in 1610 reports the following dimensions: 410 cm x 137 cm [12].

A2) The TS samples examined have **herringbone 3:1** twill weave [13].

A3) The **thickness** of the cloth measured by J. P. Jackson [28] with a micrometer is variable from 318 to 391 micrometers; the first author confirms this measurement [6].

A4) The yarn used to weave the Shroud was spun with a "Z" **twist** [14].

A5) After weaving, the TS yarns were **washed** with a very mild, natural material because of the presence of **flax wax** on the fibers and the specular reflectance of the non-image fibers [15].

A6) **Earthy material** (limestone composed of aragonite with strontium and iron) was found on the **feet** of TS Man [16]. Earthy material was also found in correspondence with the **nose** and the **left knee** [17].

B1) The TS linen has a **lustrous** finish [15].

B2) The so-called **side strip** is a linen band 387 cm long; the **sewing** connecting this strip to the TS is very particular and typical of very old manufacture [18].

B3) Some **water stains** are older than the 1532 fire because they indicate a **different folding** of the TS [19].

B4) **Cotton** fibers were found in the Raes samples and they were identified as *Gossypium herbaceum*, a common Middle East variety [14]. The first author also found 1-3% of cotton fibers in threads adjacent to the sample used in 1988 for dating.

B5) There appears to be more variation in the **diameter** of warp yarns than weft [15].

B6) The TS weave is **very tight** [14].

B7) The **limestone** found on the feet contains calcium [20] in the form of **aragonite**. Similar characteristics were found on samples coming from first-century tombs in Jerusalem [16].

2.2. BODY IMAGE

From a microscopic point of view.

A7) The body **image color** resides only on the **topmost fibers** at the highest parts of the weave [17, 21, 40].

A8) Body image **color** resides only on the **thin layer** that is probably the primary cell wall (pcw) of outer surfaces of the fibers; the **color is uniform around all the fiber circumference;** relatively long fibers show variation in color from non-image to image area [6, 40].

A9) Photomicrographs and samples show that the image is a result of **concentrations of yellow to light brown fibers** [17, 40].

A10) There is a very thin coating (probably the pcw) on the outside of all superficial linen fibers on Shroud samples that was named "**Ghost**"; "Ghosts" are colored (carbohydrate) layers pulled from a linen fiber by the adhesive of the sampling tape and they were found on background, light-scorch and image sticky tapes [22, 40].

A11) According to M. Evans' photomicrographs [21], the color of the image-areas have a discontinuous distribution along the TS thread: **striations** are evident. The image has a distinct preference for running along the individual fibers making up a thread, coloring some but not others

[17, 40]. Fibers further from a flat surface, tangent to the fabric, are less colored, but a color concentration can be detected in correspondence to crevices where two or three yarns cross each other [6, 40].

From a macroscopic point of view.

A12) The body image is **very faint**: reflected optical densities are typically less than 0.1 in the visible range [3].

A13) The body image has a **resolution of 4,9±0,5 mm at the 5% MTF value** (for example the lips); the resolution of the bloodstains is at least ten times better (for example the scratches in the scourge wounds) [23].

A14) The body image shows **no evidence of image saturation** [24].

A15) The image-formation mechanism **did not char the blood** [15].

A16) The body image **does not have well defined contours** [23].

A17) The **finger image** shows an intensity decreasing from the center (contact point) to the edges letting the space among them uncolored [6, 40].

A18) There is a **darker spot** in correspondence of the back of the Man's hand near the knuckle of index finger [2].

A19) The **thumbs** are not visible in the hand image [34].

A20) In correspondence to the **middle of the nose** there is a **swelling** [6].

A21) Detailed photographs and microscopic studies of the cloth in the nose image area show **scratches and dirt** [25, 34].

A22) The **hair** on the frontal image shows **high luminance levels** relatively to the face: for example the anatomically left hair is darker than the cheeks [6].

A23) There is **no** evidence of **lateral body images** and of **image between** the tops of the front and dorsal **heads** [26].

A24) In the positive photograph of G. Durante (2000), the **luminance levels** of the front and back body images (face excluded) are **similar**; the front image is generally about 15% darker than the dorsal one [27].

A25) The image of the **dorsal side** of the body does **not penetrate the cloth** any more deeply than the image of the ventral side of the body [28].

A26) The **luminance level of the head** image in the positive photograph of Durante (2000) is about 50% **darker** than that of the whole body image [27].

A27) The **image-forming mechanism** operated regardless of different body structures such as skin, hair, beard [2].

A28) The **thermograms** did not show part of the mouth image [29, 46], even if it clearly appears in visible light [30].

A29) After a heavy image processing, filtering and contrast enhancement, a body image **color** is visible on the **back surface** of the cloth in the same position of some anatomic details as for the body image of the frontal surface of the TS. The **hair** appears more easily to the naked eye [11] but also other details of face and perhaps hands appear by image enhancement [31].

A30) **No image** color is visible on the **back surface** in correspondence of the **dorsal** image [11].

A31) The nose image on the back surface of the TS presents the same extension of both nostrils, unlike the **frontal**, in which the **right nostril** is less evident [31].

A32) Image details corresponding to face **grooves** are more faintly represented (e.g. eye sockets and skin around the nose), convex "**hills**" on the face (e.g. eyeballs and nose tip) however are more clearly represented [32].

A33) Although anatomical details are generally in close agreement with standard human-body measurements, some measurements made on the Shroud image, such as **hands, calves and torso**, **do not agree with anthropological standards** [33].

A34) The body image shows **no** evidences of **putrefaction** signs, in particular around the lips. There is no evidence for tissue breakdown (formation of liquid decomposition products of a body) [34].

A35) **No image formed under the blood stains** [35].

A36) The front image shows **hair** that **goes down to the shoulders** [36].

A37) The image of the TS Man, appears as if he was **scourged** [34].

A38) The image of the TS Man, appears as if he was **crucified:** it appears with nail holes and corresponding blood at the wrists and top of the feet [34].

A39) The image of the TS Man demonstrates no evidence of **maiming** or disfigurement [34].

B8) The enveloped body was a **corpse** [34].

B9) The **hair** on the front image is **soft** and not matted as would be expected if it were soaked with a liquid [6].

B10) When their lengths are measured, the **dorsal image is longer** than the ventral image in a manner similar to the imprint on a sheet of a man having the head tilted forwards, his knees slightly bent, and his feet extended [37].

B11) The **frontal body image** (195 cm long) is **compatible**, within an uncertainty of +/-2 cm, with the **dorsal** image (202 m long) if it is supposed that the TS enveloped a corpse having the head tilted forward, the knees partially bent and the feet stretched forwards and downwards [37].

B12) Based on traditional cloth measurements [10], the image corresponds to **a man 175+/-2 cm tall** [37].

B13) The body image has the **normal tones of light and dark reversed** with respect to a photograph, such that body parts nearer to the cloth are darker [38].

B14) The luminance distribution of both the frontal and dorsal images has been correlated to the clearances between a **three-dimensional** surface of the body and a covering cloth [39].

B15) The luminance distribution of the body image can be correlated with a **highly directional mapping function** [24].

B16) The body image shows **non-directional light sources** in the sense that there are no shadows, cast shadows, highlights, and reflected lights in or on the body image [41].

B17) The absence of saturation implies that the **image formation did not "go to completion",** i.e. it did not produce the maximum number of conjugated carbon-carbon double bonds [42].

B18) In correspondence of image sections of cylindrical elements such as legs, the **luminance levels variation** approximates a **sinusoidal law** [6].

B19) In reference to a cloth wrapping a body, there is **no** evidence of body **image** formation at the **sides** of the body on both the frontal and dorsal TS images [26].

B20) The **Fourier transform** of the body image shows a nearly continuous spectrum in correspondence to the spatial frequencies up to 100 [1/m] [43].

B21) The body image indicates the **absence of brush strokes** [44].

B22) The frontal image, at least in correspondence to the head, is **doubly superficial** [31].

B23) The **fingers** in the image appear to be **longer** than average for a man, but they are still within the normal range (Gaussian distribution) [35].

B24) **Image distortions** of hands, calves and torso on the TS of are very close to those obtained by a man enveloped on a sheet [23].

B25) The very **high rigidity of the body** is evident on the back image especially in correspondence of the buttocks: the anatomical contours of the back image demonstrate minimal surface flattening [34].

B26) The **most of the prominent parts** in the vertical direction (nose, beard, sole, calf) of the body image **are marked** [6].

B27) The image of the TS Man, shows the effects (wounds) of many **pointed objects** [34].

B28) The **tibio-femural anthropometric index** of the image of the TS Man is 83%-84% [43].

B29) **No broken bones** are evident on the body image [34].

B30) There is a **swelling** on the **face** over the right cheek [34].

B31) There is a slight **deviation of the nose** and at the tip of the nose is an area of discoloration [34].

B32) A **body image** is visible in areas of body-sheet **non -contact zones,** such as those between nose and cheek [6].

B33) Characteristics of the TS face and right foot are close to those found on some **Byzantine coins** (gold-solidus) of the 7^{th} -13^{th} century A.D. [45].

2.3. OPTICS

A40) Optical measurement showed that the color is an extremely thin layer, about 200 nm thick (pcw has just this thickness) [40].

A41) The colored fibers in non-image (background) areas show the **same type of superficial color** as body image fibers, their spectra are the same, and the cellulose in them is not colored [42].

A42) The body **image does not fluoresce** in the visible under ultraviolet illumination [42].

A43) The **non-image** area **fluoresces** with a maximum at about 435 nanometers [17].

A44) A **redder fluorescence** can be observed around the **burn holes** from the 1532 A.D. fire [17].

A45) The cloth does **not** show any **phosphorescence** [15].

A46) All the chemical and microscopic **properties** of **dorsal and ventral** image fibers are **identical** [38].

A47) An emission **image** was clearly **visible in the 8-14 micrometers infrared** range, but the image appears as positive while it appears as negative in visible light [46].

A48) **IR emission** of the image at a uniform **room temperature**, and in the **3-5-micrometer range** was **below** the instrument **sensitivity** [46].

A49) The cloth shows **bands** of slightly different colors of yarn that are best observed in ultraviolet photographs. For example between face and hair there are two non-colored bands that continue along the warp direction [47].

A50) There is a **correspondence** (even if not complete) between cloth **bands** of slightly different colors of yarn of the front and **back surface** [11].

A51) Reflectance spectra, chemical tests, laser-microprobe Raman spectra, pyrolysis mass spectrometry, and x-ray fluorescence all show results **not compatible** with those relative to **painted** images with any of the expected, historically-documented pigments [3].

A52) There are **no pigments** on the body image in a sufficient quantity to explain the presence of an image [17].

A53) The cellulose of the **medullas** of the 10-20-micrometer-diameter fibers in image areas is **colorless** because the colored layer on image fibers can be stripped off, leaving colorless linen fibers [35].

B34) The **chiaroscuro** effect is caused by a different **number of yellowed fibers** per unit of surface, so that this is an image with 'areal' density [41].

B35) **Crease** below the **chin** of the image: on the frontal surface of the TS, the inside part of **crease** has a lighter color similar to the background, but it has darker margins similar to the image-color. On the back of the cloth, the same crease is darker in correspondence of the lighter color of the frontal surface and the margins are confused with the background: the darker margins are of the same straw-yellow color of the body image [15].

B36) In the **ultraviolet** emission and absorption photographs the **background** cloth shows a light **greenish yellow** emission [26].

B37) Where one of the **image-thread crosses over another**, there is often **no color** on the lower one [48].

B38) The image of the **dorsal side** of the body shows fairly the **same color** density and distribution as the ventral [38].

B39) **IR photograph** of the face made by G. B Judica Cordiglia, see Figure 1, if compared with visible

photographs of the face indicates the **low absorption near the IR** of the products of image formation [49].

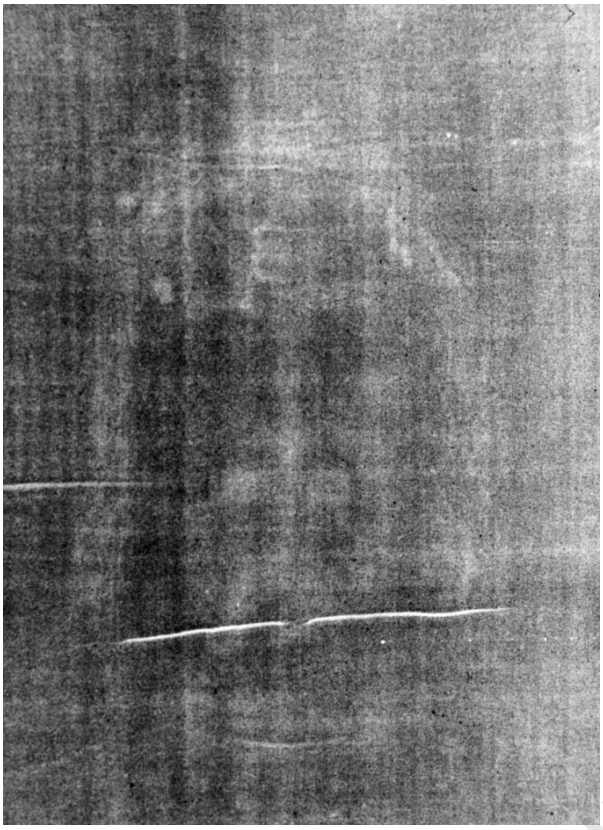

Figure 1. Unpublished IR photographic negative of the face of the TS Man, made by G. B. Judica Cordiglia [49] in 1969 using a Mamya camera and Nitraphot lamps. Due to the lack of time, an IR 24x36 film was used instead of a flat plate. If compared with a photo of face made in visible light, this IR photo evidences the lack of details and therefore the lower absorption near the IR due to the pronounced superficiality of the TS body image. (Courtesy of G. B. Judica Cordiglia).

2.4. CHEMISTRY & PHYSICS

A54) The colored coating cannot be dissolved, bleached, or changed by standard chemical agents, but it can be **decolorized** by reduction with **diimide** (hydrazine/hydrogen peroxide in boiling pyridine); the residue from reduction is colorless linen fibers [35].

A55) The pyrolysis/ms data showed the presence of **polysaccharides of lower stability** than cellulose on the surface of linen fibers (pcw) from the TS [15].

A56) The image was formed at a relatively **low temperature** (<200 °C) [15].

A57) The 1978 quantitative **x-ray-fluorescence-spectrometry analysis** detected significant uniform amounts of **calcium, strontium** (a normal impurity in calcium minerals) and **iron** concentrations in the Shroud [50].

A58) The **lignin** that can be seen at the wall thickenings and/or so called dislocations of the linen fibers of the TS does **not** give the standard **test for vanillin** [51].

A59) There is **no cementation** signs among the image fibers [17].

A60) **No painting pigments or media scorched** in image areas, or were rendered water soluble at the time of the AD 1532 fire [52].

A61) **No fluorescent pyrolysis products** were found in image areas [15].

A62) **Silver** traces were found around the burn holes in the scorch area of the TS [48].

A63) **Aldehyde and carboxylic acid functional groups were detected** in the TS fibers [35].

A64) There is **no** observed microscopic, chemical, or spectroscopic evidence for the presence of any **dry powder** responsible for the body image on the TS [8].

B40) The chemical **properties of the coatings (pcw layer)** are the **same** as the image color on image fibers. All of the color is on the surfaces of the fibers [35].

B41) The **crystal structure** of the cellulose of image fibers has **not visibly changed** with respect to that of the non-image fibers (scorches have) [15].

B42) Although yarns and design of Raes sample look like the main part of the cloth, linen fibers from the **Raes sample** that was cut in 1973 are chemically **different** (from reflected spectroscopy and chemical analysis) [53].

B43) Chemical tests showed that there is **no protein painting medium** or protein-containing coating in image areas [3].

B44) The image fibers do **not** show any sign of **capillary** flow of a colored or reactive liquid [21].

2.5. BLOOD & BODY FLUIDS

A65) Body fluids percolated into the TS by **capillary imbibitions** from the "warp side" to the "weft side" of the TS and they filled the mesh apertures [6].

A66) There is a class of particles on the TS ranging in color from red to orange that test as blood derived residues. They test positively for the presence of protein, hemin, **bilirubin**, and albumin; give positive hemochromogen and cyanmethemoglobin responses; after chemical generation display the characteristic fluorescence of **porphyrins** [8].

A67) The blood on the TS is **not burnt**. Therefore both the image-formation mechanism and the 1532 fire did not involve processes that would denature the blood [15].

A68) The **blood** from the large flow on the back **darkened** (scorched) at an adjoining **scorch** [15].

A69) The **red flecks** W. C. McCrone [54] claimed were hematite had an **organic matrix** [48].

A70) Microscopic observation of **blood flecks** of sample 3EB showed specular reflection: **the blood went onto the surface as a liquid** [15].

A71) **Blood** spots are much **more visible on the TS by transmitted light** than by reflected light; this implies that the blood saturated the cloth and it is not a superficial image as the body image is [15].

A72) Many **blood traces** visible on the frontal image are also visible **on the back** side in the **same position** [6].

A73) Blood traces on the back surface of the TS are less intense (or in some cases absent) when compared with the corresponding traces on the frontal side, showing that **blood was transposed** onto the cloth **touching the frontal** side of the TS [6].

A74) Some human **blood** stains appear on and **outside of the body image** (right elbow) [55].

A75) In proximity to the **knees** on the dorsal image, there are scourge marks in correspondence to **lower luminance levels** of the body image [6].

A76) The **blood** on the TS **does not fluoresce** under ultraviolet illumination (no porphyria and no fluorescent pigments) [15].

A77) The **blood** on the TS can be removed with a **proteolytic enzyme** [8].

A78) **No smears** and no broken crusts are evident in the blood traces [34].

A79) **No potassium** signals could be found in any of the blood area data [50].

A80) In UV fluorescence the **scourge** marks appear with **dumbbell shapes** [34].

A81) In UV fluorescence the **scourge** marks are resolved into **fine scratches**: three, and in some cases four, parallel scratches can be distinguished [34].

A82) The blood stain corresponding to the right side of the **chest** 6th ribs shows **separation of blood** from a clearer liquid material [34].

B45) There is a first **type of blood** stain that corresponds to the blood **exudated from clotted wounds** and transferred to the cloth by being in contact with a wounded human body such as scourging and crown of thorns wounds or wrists wounds [8].

B46) There is a second **type of blood** stain that came out after the death such as feet wounds or side wound with blood separation in a dense part and a serous part [56].

B47) The UV photographs of blood stains show a distinct **serum clot retraction ring** [8].

B48) The chemical and physical parameters of the **blood stains are different** than mineral compositions proposed by **artists** [8].

B49) The maintenance of the **red bright color** of the TS **blood** with time was observed, but the explanation of why the color is so red is not definitive [56].

B50) There are **blood traces not consistent** with scalp hair traces soaked with blood in correspondence to the image of the **hair** on the front side [57].

B51) The **wrist wound position** can be referred to as the hand nail used for the crucifixion [6].

B52) The **blood clots** were transposed to the linen fabric during **fibrinolysis** [58]. The process of fibrinolysis could cause clots to liquefy sufficiently for the blood to transfer to the cloth as a serous-laden liquid rather than a moist jelly-like substance [59].

B53) Some blood stains are comparable to transfers that would be expected if the arms were posed in **non horizontal position** [57].

B54) Some **bloodstains** such as those on the arms and the “reverse-3” on the forehead present a **discontinuity** in which a more attenuate region is evident [60].

B55) Some blood stains are comparable to transfers that would be expected if a person was posed in the **vertical position** [57].

2.6. OTHER

Among the many facts and observations made by some scholars, but not confirmed by others, listing them can be useful to suggest and motivate new studies.

The TS face shows no sign of pain, in spite of the horrible mistreatment of the body [61].

The **radiocarbon dating** of 1988 states that the TS linen dates back to 1260-1390 A.D. [4], but further statistical studies [5, 6, 7] demonstrated the presence of a linear bias which makes the sample not representative of the whole TS. Preliminary estimates of the kinetics constants for the loss of **vanillin** from lignin indicate a much older age for the cloth than the radiocarbon analyses [51].

Aloe and myrrh were recognized by microscopic analysis [62]. A **ponytail** (also interpreted as "banding" by others) is visible on the back image [2]. There is the image of an identified **coin** (dilepton lituus) on the right eye [63]. Perhaps there is also another an image **coin** (Pilate lepton simpulum) over the **left** eye [64]. There are various **writings** around the Face [65].

There are many identified **floral images** on the TS, which indicate that the Shroud originated in the vicinity of Jerusalem in the spring of the year, and which have the appearance expected from corona discharge. Some images are consistent with the **fruits** of pistacia plants, which were used as burial spices [66]. **Pollen grains** relative to the zones of Palestine, Edessa, Constantinople and Europe were found [67, 68].

Some **teeth**, the **skull**, some **bones,** a **sponge**, a large **nail,** a **shaft** and a **crown** of thorns have been recognized on the image [30]. Traces of **saliva** [32] and of **tears** can be seen on the image [69].

The human blood is of **AB group** [70]. **Human DNA** is present in Riggi’s blood samples taken from the TS; three gene segments were cloned and studied but it is highly **degraded** [71]**.**

3. CONCLUSION

The first goal proposed by R. Rogers in 2002 and accepted by many researchers of ShroudScience Group in order to better understand the TS, has been reached. A list of evidences of the TS upon which to base their further debate on the body image formation hypothesis has been defined according with the authors’ view, even if the TS characteristics are not definitive. Some open questions will be easier to solve if the Turin officials will be open to share their TS data, and especially those obtained from

2002, with e.g., the Shroud Science Group and to any credible researcher interested in the study about the most important Relic of Christianity.

Many hypotheses are still under investigation and new ones will be proposed. The facts reported in this paper will be useful for the proponent of a new hypothesis who should test it against the reported facts in order to be sure that his hypothesis will not be immediately eliminated by a simple scientific control.

ACKNOWLEDGMENTS

The authors wish to thank all the Members of ShroudScience Group who helped the compilation of the present paper; in particular R. Rogers who furnished many important first-hand data relative to the chemistry of the Shroud, M. Alonso who contributed to clarify some aspects relative to the percolation of body fluids into the Shroud, P. Di Lazzaro who pushed for the publication of the present paper, D. Fulbright who helped in the organization and B. Schwortz who helped on the compilation of the initial list and put the paper in the Web.

The authors wish also to thank G. B. Judica Cordiglia for the permission to publish for the first time the IR photo of face of the TS Man and the Referee for making suggestions that improved the quality of the paper.

REFERENCES

1. Fanti G. and Basso R., *The Turin Shroud: Optical Research in the Past, Present and Future*, Inc., New York, USA (2008).

2. Antonacci M., *The Resurrection of the Shroud*, M. Evans and C. Inc., New York, USA (2000).

3. Schwalbe L. A. and Rogers R. N., Analytica Chimica Acta **135**, 3-49 (1982).

4. Damon P.E., Donahue et al. (21 authors), Nature **337**, 611-615 (1989).

5. Van Haelst R., http://www.shroud.com/vanhels3.htm (1997).

6. Fanti G., *La Sindone, una sfida alla scienza moderna*, Aracne Ed., Roma, Italy (2009).

7. Fanti G., Crosilla F., Riani M., Atkinson A.C., *A robust statistical analysis of the 1988 Turin Shroud radiocarbon dating results*, IWSAI Frascati (4-6 May 2010), in this volume. See also www.sis-statistica.it/magazine/spip.php?article177

8. Adler, A.D., Updating Recent Studies on the Shroud of Turin, American Chemical Society, Symposium Series **625**, 17, 223-228 (1996); www.shroud.com/pdfs/adler.pdf (1999).

9. Fanti G., Schwortz B. et al. (24 authors), III Dallas Int. Conf. Shroud of Turin, Dallas, Texas, USA, Sept. 8-11, 2005, http://www.shroud.com/pdfs/doclist.pdf (2005).

10. Baima Bollone P.L. and Benedetto P.P., *Alla ricerca dell'Uomo della Sindone*, Ed Mondadori, Milano, Italy, 49 (1978).

11. Ghiberti G., *Sindone le immagini 2002 Shroud images*, ODPF, Torino, Italy (2002).

12. Balliani C., *Ragionamenti sopra la Sacra Sindone di N.S. Giesv Christo*, Per Luigi Pizzamiglio Stampator Ducale, Torino 1618.

13. Vial G., Actes du 1er Symposium Scientifique International, Paris, France, Sept. 7-8, 1989, OEIL, Paris, France, 75-97 (1990).

14. Raes G., Supplemento Rivista Diocesana Torinese, Jan., 79-83 (1976).

15. Rogers R. N., *A Chemist's Perspective on the Shroud of Turin*, editor B. Schwortz, www.Lulu.com (2008).

16. Kohlbeck J.A. and Nitowski E.L., Biblical Archaeology Review, **12**, 4, July-Aug., 23-24 (1986).

17. Pellicori S.F. and Evans M.S., Archaeology, Jan.-Feb., 34-43 (1981).

18. Flury-Lemberg M., Proceedings of the International Scientific Symposium, Torino, Italy, March 2-5, 2000, Effatà Editrice Ed., Cantalupa (TO), Italy, 21-43 (2000).

19. Flury-Lemberg M., in *Sindone, cento anni di ricerca*, Istituto Poligrafico e Zecca dello Stato, Libreria dello Stato, Roma, Italy, 255-267 (1998); Guerreschi A. and Salcito M., IV Symposium Scientifique International sur le Linceul de Turin, Paris, France, April 25-26 (2002), and Revue Internationale du Linceul de Turin 29, Juin, 30-45 (2007).

20. Levi-Setti R., Crow C. and Wang Y.L., Scanning Electron Microscopy **2**, 535-552 (1985).

21. Evans M. Collection of photomicrographs archived and copyrighted by B. Schwortz, especially ME-29 (1978).

22. Zugibe F.T. and Rogers R.N. collection of 86 photomicrographs, archived and copyrighted by B. Schwortz (1978, 1985).

23. Jackson J.P., Jumper E.J. and Ercoline W.R., IEEE 1982 Proceedings of the International Conference on Cybernetics and Society, October 1982, 559-575 (1982).

24. Jackson J.P. Jumper E.J., Mottern B., Stevenson E., Proceedings of the 1977 United States Conference of Research on the Shroud of Turin, Albuquerque, New Mexico, USA, March 23-24, 1977, Holy Shroud Guild, New York, USA, 74-94 (1977).

25. Bucklin R., Shroud Spectrum International, 1, 5, Dec., 3-10 (1982).

26. Adler A.D., *The orphaned manuscript*, a Shroud Spectrum International Special Issue, Effatà ed., Cantalupa (TO), Italy (2002).

27. Fanti G.: J. of Imaging Science and Technology, **54**, 020508-(11) (2010).

28. Jumper E.J., Adler A. et at., *A comprehensive examination of the various stains and images on the Shroud of Turin*, ACS Advances in Chemistry, Archaeological Chemistry III:205, 447-476 (1984).

29. Rogers R., SSG private communication (2003).

30. Whanger A. D. and Whanger M. V. *The Shroud of Turin, An Adventure of Discovery,* Providence House Publishers, Franklin, Tennessee, USA (1998).

31. Fanti G., Maggiolo R., Journal of Optics A: Pure and Applied Optics **6**, 491-503 (2004), www.sindone.info/FANTI.PDF

32. Scheuermann O., *Hypothesis: Electron emission or absorption as the mechanism that created the image on the Shroud of Turin – Proof by experiment*, Fondazione 3M, Segrate, Milano, Italy (2003).

33. Ercoline, W.R., Downs R.C. Jr. and Jackson J.P., IEEE 1982 Proceedings of the International Conference on Cybernetics and Society, October 1982, 576-579 (1982).

34. Bucklin R., Legal Medicine Annual, W.B. Saunders, Philadelphia, Pennsylvania, USA, July, 33-39 (1982).

35. Heller J.H. and Adler A.D., Canadian Society of Forensic Science Journal **14**, 81-103 (1981).

36. Fanti G., Faraon S., Atti del Congresso Mondiale Sindone 2000, Orvieto (TR), Italy, August 27-29, 2000, Gerni Ed., San Severo (FG), Italy, I, 25-31 and III, 11-18 (2002).

37. Basso R., Bianchini G. and Fanti G., Atti del Congresso Mondiale Sindone 2000, Orvieto (TR), Italy, August 27-29, 2000, Gerni Ed., San Severo (FG), Italy, I, 7-15 and III, 7-10 (2002), www.dim.unipd.it/misure/fanti/Manikin.pdf; accepted for publication in the J. of Imaging Science and Tecnology (2010).

38. Jackson J. P., Jumper E.J. and Ercoline W.R., Applied Optics, **23**, 2244-2270 (1984).

39. Quidor G., http://perso.wanadoo.fr/gira.cadouarn/english/faq_english/tridimensionality.htm (1913).

40. Fanti G, Botella J.A., Di Lazzaro P., Heimburger T., Schneider R., Svensson N.: J. of Imaging Science and Technology, **54**, 040201-(18) (2010).

.

41. Moran K., Fanti G., IV Symposium Scientifique International sur le Linceul de Turin, Paris, France, April 25-26 (2002), http://xoomer.virgilio.it/bachm/MORAN1.PDF

42. Gilbert R. Jr. and Gilbert M., Applied Optics **19**, 1930-1936 (1980).

43. Fanti G. and Marinelli E., *Cento prove sulla Sindone, un giudizio probabilistico sull'autenticità*, Ed. Messaggero Padova, Italy (2000).

44. Lorre J.J. and Lynn D.J., Proceedings of the 1977 United States Conference of Research on the Shroud of Turin, Albuquerque, New Mexico, USA, March 23-24, 1977, Holy Shroud Guild, New York, USA, 154-181 (1977).

45. Whanger M.V. and Whanger A.D., *The Impact of the Face Image of the Shroud on Art, Coins, and Religions in the Early Centuries, Part 3*, Insert for CSST NEWS, July (2007).

46. Accetta J.S. and Baumgart J.S., Applied Optics **19**, 1921-1929 (1980).

47. Miller V. D. and Pellicori S. F., Journal of Biological Photography **49**, 71-85 (1981)**.**

48. Heller J.H., *Report on the Shroud of Turin*, Houghton Mifflin C., Boston, Massachusetts, USA, 144 (1983).

49. Judica Cordiglia G.B., private communication (2001) and "Verbale di constatazione", Notaio P. Roz, Avigliana (Torino), Repertorio n. 2270/13323, 4 October 1973.

50. Morris R. A., Schwalbe L. A. and London J. R.: X-Ray Spectrometry **9**, 40-47 (1980).

51. Rogers R., Thermochimica Acta **425**, 189-194 (2005).

52. Rogers R. Proceedings of the 1977 United States Conference of Research on the Shroud of Turin, Albuquerque, New Mexico, USA, March 23-24, 1977, Holy Shroud Guild, New York, USA, 131-135 (1977).

53. Adler, A.D., Proceedings of the International Scientific Symposium, Torino, Italy, March 2-5, 2000, Effatà Editrice, Cantalupa (TO) Italy, 51-73 (2000).

54. McCrone W.C. and Skirius C., Microscope I, **28**, 105 (1980).

55. Heller J.H. and Adler A.D., Applied Optics, **19**, 2742-2744 (1980).

56. Brillante C., Fanti G. and Marinelli E., IV Symposium Scientifique International sur le Linceul de Turin, Paris, France, April 25-26 (2002), http://space.tin.it/scienza/bachm/BRILLAN2.PDF

57. Lavoie G.R., Lavoie B.B., Donovan V.J. and Ballas J.S., Shroud Spectrum International **7**, June, 15-20 (1983) and **8**, Sept., 2-10 (1983).

58. Brillante C., Atti del II Convegno Nazionale di Sindonologia, Bologna, Italy, November 27-29, 1981, CLUEB, Bologna, Italy, 239-241 (1983).

59. Craig E., private SSG communication (2004).

60. Jackson J.P., Shroud Spectrum International **24**, 2-11 (1987).

61. Barbet P., *A Doctor at Calvary: The Passion of Our Lord Jesus Christ As Described by a Surgeon*, Clonmore and Reynolds Ltd., Dublin, Ireland (1953).

62. Baima Bollone P.L., Atti del II Convegno Nazionale di Sindonologia, Bologna, Italy, November 27-29, 1981, CLUEB, Bologna, Italy, 169-174 (1983).

63. Filas F., *The Dating of the Shroud of Turin from coins of Pontius Pilate*, Cogan, Youngtown, Arizona, USA (1982).

64. Balossino N., *L'immagine della Sindone, ricerca fotografica e informatica*, Elle Di Ci, Leumann (To) (1997).

65. Marion A. and Courage A. L., *La Sacra Sindone*, Neri Pozza, Vicenza, Italy (1998).

66. Danin A., Whanger A.D., Baruch U., Whanger M., *Flora of the Shroud of Turin*, Missouri Botanical Garden Press, St. Louis, Missouri, USA (1999).

67. Frei M., Atti del II Congresso Internazionale di Sindonologia, Torino, Italy, October 7-8, 1978, Edizioni Paoline, Torino, 191-200 (1979).

68. Frei M., Atti del II Convegno Nazionale di Sindonologia, Bologna, Italy, November 27-29, 1981, CLUEB, Bologna, Italy, 277-284 (1983).

69. Guerreschi A., Atti del Congresso Mondiale Sindone 2000, Orvieto (TR), Italy, August 27-29, 2000, Gerni Ed., San Severo (FG), Italy, I, 41-45 and III, 23-26 (2002).

70. Baima Bollone P.L., Jorio M. and Massaro A.L., Sindon, **31**, December, 5-9 (1982).

71. Garza-Valdes L., *The DNA of God?*, Berkley Books, New York, USA (2001).