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## The setting for the radiocarbon dating of the Shroud

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### *Abstract*

*La datación por el carbono 14, que tuvo lugar en 1988, colocó el origen de la Síndone entre 1260 y 1390 d. de C. ; pero la reconstrucción de los acontecimientos que llevaron a este análisis, y las polémicas que siguieron su realización, echan fuertes sombras sobre la validez del resultado. Los procedimientos seguidos para la realización del examen con el carbono 14 no fueron todos regulares. La historia de los acontecimientos y de los traumas sufridos por la reliquia la convierten en un sujeto difícil, cuya datación radiocarbónica no puede darnos datos seguros. La muestra analizada, por sus características particulares, no representaba toda la sábana. En consecuencia, según la datación por radiocarbono, no se puede decir en absoluto que la fabricación de la Síndone se remonta a la mitad del siglo XIV.*

The method of radiocarbon dating, performed in 1988, placed the origin of the Shroud between 1260 and 1390 A.D.; but the reconstruction of the events that led to that analysis, and the controversy following its course, throw heavy shadows on the validity of the result. Not all the procedures followed for the completion of the radiocarbon test were regular. The history of the events and of the traumas suffered by the relic make it a difficult object, whose radiocarbon dating cannot provide reliable data. The analyzed sample, because of its peculiar characteristics, was not representative of the whole sheet. Consequently, according to the radiocarbon dating it cannot be definitely stated that the manufacture of the Shroud should be placed in the middle of the fourteenth century.

**Keywords:** Shroud, radiocarbon, dating.

### *Introduction*

The Shroud is an extraordinary relic because, in addition to its being stained with blood<sup>1</sup>, bears the imprinted image of the corpse that was wrapped in it<sup>2</sup>. A long tradition<sup>3</sup> believes it is the burial Shroud of Jesus, but the reliable documented history can only go back to its presence in France between 1353 and 1356<sup>4</sup>. The dating with the method of radiocarbon,

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<sup>1</sup> P.L. BAIMA BOLLONE, *Indagini identificative su fili della Sindone*, in *Giornale della Accademia di Medicina di Torino* 1-12 (1982), pp. 228-239; J.H. HELLER - A.D. ADLER, *Blood on the Shroud of Turin*, in *Applied Optics* 19, 16 (1980), pp. 2742-2744.

<sup>2</sup> P.L. BAIMA BOLLONE, *Rilievi e considerazioni medico-legali sulla formazione delle immagini sulla Sindone*, in *La Sindone e la Scienza, Atti del II Congresso Internazionale di Sindonologia*, Turin, October 7-8, 1978, Ed. Paoline, Turin 1979, pp. 109-114; R. BUCKLIN, *A pathologist looks at the Shroud of Turin*, in *La Sindone e la Scienza*, op. cit., pp. 115-125.

<sup>3</sup> L. FOSSATI, *La Sacra Sindone. Storia documentata di una secolare venerazione*, Ed. Elledici, Leumann (TO) 2000.

<sup>4</sup> G.M. ZACCONE, *Storia e "preistoria" della Sindone*, in G. GHIBERTI - U. CASALE, *Dossier sulla Sindone*, Queriniana, Brescia 1998, pp. 33-53, on pp. 33-34.

performed in 1988, placed the origin of the cloth between 1260 and 1390 A.D.<sup>5</sup>. Can we therefore conclude that the manufacture of the Shroud must be placed in the middle of the fourteenth century?

To answer this question, however, we must first ask ourselves other questions. Have all the procedures followed for the development of radiocarbon tests been regular? May the Shroud have undergone changes that affected the radiocarbon dating? Was the analyzed sample representative of the whole cloth? The existing data allow an investigation of these issues and the conclusions will therefore gain a better ground.

### ***Have all the procedures followed for the development of radiocarbon tests been regular?***

#### ***Phase one: the long path toward the sampling***

The method of radiocarbon dating (<sup>14</sup>C) was created in 1947 by chemist Willard F. Libby, who just for this reason received the Nobel Prize for Chemistry in 1960. Since the early 50s Libby himself considered the idea of dating the Shroud cloth with the <sup>14</sup>C, but he pointed out that to do that it would have been necessary, at that time, destroying half a square meter of the Shroud, which was obviously impractical<sup>6</sup>.

In the late 70s the sample required for dating had been reduced to a thread 20 cm long. At that time there were two different techniques: the conventional counting method and the new method of the Tandem accelerator developed by physicist Harry Gove and associates at the University of Rochester (NY, USA)<sup>7</sup>. The accuracy provided by the new method was about ±150 years<sup>8</sup>. But competition started among laboratories that used the new method, still not much tested on cloths, and those who continued to date with the conventional method<sup>9</sup>.

In the communication presented at the congress held in Turin in 1978, Gove explained: “It would be preferable to obtain threads from several places throughout the material”. He requested at least three weft yarns, each 20 cm long, and two or three warp yarns, each 63 cm long<sup>10</sup>. During the same conference, chemist Walter C. McCrone, director of the McCrone Research Institute in Chicago (IL, USA), instead, suggested to use the sample taken from the Shroud in 1973 and examined by Gilbert Raes, director of the Institute of Textile Technology in Ghent (Belgium)<sup>11</sup>.

In 1979, Garman Harbottle, a chemist who developed the method of proportional counter at Brookhaven National Laboratory in Upton (NY, USA), along with Gove, sent to Cardinal Anastasio Ballestrero, Archbishop of Turin and Custodian of the Shroud, a proposal to

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<sup>5</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, in *Nature* 337, 6208 (1989), pp. 611-615; R.E.M. HEDGES - R.A. HOUSLEY - C.R. BRONK - G.J. VAN KLINKEN, *Radiocarbon dates from the Oxford AMS system: Archaeometry datelist 11 - Historical and religious artefacts - Shroud of Turin*, in *Archaeometry* 32, 2 (1990), p. 233; W. WÖLFLI, *Die datierung des Turiner Grabtuches*, in *Jahresbericht 1988 der ETH Zürich*, 1989, pp. 48-53.

<sup>6</sup> R. GALLINO, *Willard F. Libby e il <sup>14</sup>C*, in *Sindon* 29 (1980), pp. 44-47, on p. 45.

<sup>7</sup> *Ibid.*, p. 46.

<sup>8</sup> H.E. GOVE, *Letters*, in *Science News* 115, 3 (1979), p. 35.

<sup>9</sup> I. WILSON, *The carbon dating results: is this now the end?*, in *British Society for the Turin Shroud Newsletter* 20 (1988), pp. 2-16, on p. 5.

<sup>10</sup> D. ELMORE - H.E. GOVE - R.P. BEUKENS - A.E. LITHERLAND - K.H. PURSER - M. RUBIN, *A method for dating the Shroud of Turin*, in *La Sindone e la Scienza*, op. cit., pp. 428-436, on pp. 429-430.

<sup>11</sup> W.C. MCCRONE, *A current look at carbon dating*, in *La Sindone e la Scienza*, op. cit., pp. 437-445.

perform the dating on the Raes sample with both methods. It was not possible to carry out this request, though, because the chain of evidence of this small sample was irreparably broken at a formal level and its use would have given ground for well-justified criticism<sup>12</sup>. However, the Cardinal never received it<sup>13</sup>.

In 1982 another proposal came informally from the laboratories of Tucson (AZ, USA), Oxford (UK) and Harwell (UK); the response, only verbal, was interlocutory, but it was specified that it was desirable perform the dating in a multidisciplinary-research context that could give valuable contributions to the conservation issue as well<sup>14</sup>. In that year physician and biophysicist John Heller of the New England Institute for Medical Research in Ridgefield (CT, USA) sent to the University of California a thread of the Shroud extracted from the area of the Raes sample. The thread was divided into two parts and dated: one half turned out to date back to 200 A.D. and the other half to 1000 A.D. It should be pointed out that one of the two halves was starched<sup>15</sup>.

In 1983, in order to verify the actual chance of dating the Shroud, the British Museum coordinated a comparison among six laboratories that had expressed an interest in dating the relic. Some of them used the accelerator method (Oxford, Rochester, Tucson and Zurich), the others used the proportional-counter method (Brookhaven and Harwell). All six laboratories agreed not to entrust the dating of the Shroud to only one of them or to carry out the procedure with a single technique. They received two samples to be dated, weighing about 100 milligrams each. Their source was communicated, but not their age. One sample was Egyptian, made of linen and dating back to 3000 B.C., and the other was Peruvian, made of cotton and dating back to 1200 A.D. The British Museum was chosen as supervisor for its impartiality, experience in dating with <sup>14</sup>C and easy access to available materials<sup>16</sup>.

One of the laboratories, the one in Zurich<sup>17</sup>, used a new method of pretreatment that introduced contamination to such extent as to move the dating of about a thousand years. And there was also another problem: the Peruvian cloth turned out to be for everybody more recent (1400-1668 A.D.) than it actually was, so it was replaced with another sample without explanation. In its place, another Peruvian finding going back to 1000-1400 A.D. was dated<sup>18</sup>. The problems with the new method of pretreatment and the first Peruvian fabric confirmed that the radiocarbon analysis could not be considered an infallible verdict<sup>19</sup>.

Besides, radiocarbon scientists themselves admit it: "The existence of significant undetermined errors cannot be excluded from any age determination. No method is immune

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<sup>12</sup> G. RIGGI DI NUMANA, *Rapporto Sindone 1978-87*, Ed. 3M, Milan 1988, pp. 148-149.

<sup>13</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, in *Sindone, il mistero continua*, Fondazione 3M Ed., Milan 2005, pp. 28-87, on p. 29.

<sup>14</sup> *Ibid.*

<sup>15</sup> T.W. CASE, *The Shroud of Turin and the C-14 dating fiasco*, White Horse Press, Cincinnati (OH), USA 1996, pp. 75-77; W. MEACHAM, *The Rape of the Turin Shroud*, Lulu.com, 2005, pp. 102-103.

<sup>16</sup> R. BURLEIGH - M. LEESE - M. TITE, *An intercomparison of some AMS and small gas counter laboratories*, in *Radiocarbon* 28, 2A (1986), pp. 571-577.

<sup>17</sup> I. ANDERSON, *Teams agree on medieval origins of the Shroud*, in *New Scientist*, October 22, 1988, p. 25.

<sup>18</sup> R. BURLEIGH - M. LEESE - M. TITE, *An intercomparison of some AMS and small gas counter laboratories*, op. cit., pp. 571-577.

<sup>19</sup> R. VAN HAELST, *L'esattezza della datazione radiocarbonica medievale*, in *Collegamento pro Sindone*, July-August 1997, pp. 20-22; R. VAN HAELST, *Influenze ambientali su datazioni radiocarboniche di tessuti*, in *Collegamento pro Sindone*, November-December 1998, pp. 42-44; R. VAN HAELST, *Natural deviations of the radiocarbon equilibrium in the atmosphere. Finally, a scientific explanation for the mediaeval dating of the Shroud?*, in *Collegamento pro Sindone Internet*, December 2001, <http://www.shroud.it/VHAELST5.PDF>

to processing grossly incorrect dates when unknown problems may exist with the sample at the collection site. Our results illustrate that this situation can occur frequently. A combination of at least two independent dating techniques is indispensable for the highest level of confidence<sup>20</sup>.

One of the cases of problematic radiocarbon dating is that of the mummy 1770 of the Manchester Museum (UK). The Egyptologist Rosalie David wrote in 1988: “The carbon dating provided different dates for the bones and the bandages of the mummy (the bones were approx. 800-1000 years «older» than the bandages), which led us to speculate that the mummy had been rewrapped 800-1000 years after death. An alternative, of course, is that the resins and unguents used in mummification may affect the bandages and bones in ways which affect the carbon dates. (...) From our experience, carbon dating of mummified remains and their associates bandages has produced some unexpected and controversial results<sup>21</sup>. In a subsequent dating the difference between bones and bandages was reduced to 340 years<sup>22</sup>.

Two other cases made people discuss: those concerning the Lindow Man and the Lindow Woman, human remains found in Lindow Moss (UK). In 1983, the Lindow Man was dated by Harwell back to the fifth century A.D., by Oxford to the first century A.D. and by the British Museum to the third century B.C., while the Lindow Woman, believed by the Police and by an expert in facial reconstruction to be a victim of a murder by her husband in the 60s, was dated by the Oxford laboratory back to 400 A.D.<sup>23</sup>

On the validity of the radiocarbon method, Cardinal Ballestrero asked the Pontifical Academy of Sciences, getting a positive response from the President, the Brazilian biologist Carlos Chagas. On the advisability of dating the Shroud, the Cardinal asked the Congregation for Divine Worship and the Congregation for the Doctrine of the Faith, obtaining the *nihil obstat* from both. Cardinal Joseph Ratzinger, at that time Prefect of the Congregation for the Doctrine of the Faith, stated that there were no objections to date the Shroud, provided that the operation was well planned and carried out among other tests that would complete those of 1978<sup>24</sup>.

After the multidisciplinary research carried out in 1978<sup>25</sup>, in 1979 the STURP (Shroud of Turin Research Project) had formed a Committee on the radiocarbon<sup>26</sup> and in 1984 developed

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<sup>20</sup> R.A. JOHNSON - J.J. STIPP - M. A. TAMERS - G. BONANI - M. SUTER - W. WÖFLI, *Archaeologic sherd dating: comparison of thermoluminescence dates with radiocarbon dates by beta counting and accelerator techniques*, in *Radiocarbon* 28, 2A (1986), pp. 719-725.

<sup>21</sup> *But is the Shroud mediaeval?*, in *British Society for the Turin Shroud Newsletter* 21 (1989), pp. 3-5.

<sup>22</sup> R. BURLEIGH - J. AMBERS - K. MATTHEWS, *British Museum natural radiocarbon measurements XV*, in *Radiocarbon* 24, 3 (1982), pp. 262-290, on p. 275.

<sup>23</sup> *Ancient skull or modern-day murder victim? Another gaffe for radiocarbon dating?* In *British Society for the Turin Shroud Newsletter* 47 (1998), pp. 22-24.

<sup>24</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 30.

<sup>25</sup> J.H. HELLER - A.D. ADLER, *A chemical investigation of the Shroud of Turin*, in *Canadian Society of Forensic Sciences Journal*, 14 3 (1981), pp. 81-103; E.J. JUMPER - A.D. ADLER - J.P. JACKSON - S.F. PELLICORI - J.H. HELLER - J.R. DRUZIK, *A comprehensive examination of the various stains and images on the Shroud of Turin*, in *Archaeological Chemistry III, ACS Advances in Chemistry* 205, J.B. Lambert Editor, American Chemical Society, Washington D.C., USA (1984), Chapter 22, pp. 447-476; L.A. SCHWALBE - R.N. ROGERS, *Physics and chemistry of the Shroud of Turin. A summary of the 1978 investigation*, in *Analytica Chimica Acta*, 135 (1982), pp. 3-49.

<sup>26</sup> R.H. DINEGAR - L.A. SCHWALBE, *Isotope measurements and provenance studies of the Turin Shroud*, in *Archaeological Chemistry IV, ACS Advances in Chemistry* 220, R.O. Allen Editor, American Chemical Society, Washington D.C., USA (1989), Chapter 23, pp. 409-417, on p. 412.

another multidisciplinary program<sup>27</sup>, which aimed to answer 85 questions. The research covered three topics: the conservation of the cloth, the authenticity and the image formation. One of the questions was: “How old is the Shroud”? To answer this question, the STURP would have taken six samples and have them delivered to the laboratories of Brookhaven, Harwell, Oxford, Rochester, Tucson and Zurich<sup>28</sup>.

The new STURP program, with the proposal of 26 tests to be performed on the Shroud, was sent to the Vatican, who forwarded it to the Pontifical Academy of Sciences and to the Congregation for the Doctrine of the Faith. In the covering letter, Cardinal Ballestrero suggested a meeting among the scientists the Academy would have entrusted with monitoring the dating, the representatives of the proposing scientific groups and engineer Luigi Gonella, professor of Physics Instrumentation at the Polytechnic of Turin and scientific consultant of the Cardinal. What happened next was thus described by Gonella: “For reasons that Cardinal Ballestrero and I were never able to understand, a deployment formed aiming at excluding any research that was not the radiocarbon dating”<sup>29</sup>.

The arrangements for the meeting were very painful. After many disputes and difficulties, it was settled from 29 September to 1 October 1986. Gonella commented bitterly: “It was two years since Cardinal Ballestrero proposed a meeting to discuss a proposal for a multidisciplinary research and now we find ourselves discussing only the radiocarbon dating and in a very tense climate, with unclear alternative proposals”<sup>30</sup>.

The meeting was held at Turin seminary. It was attended by the physicist Michael Tite, director of the research laboratory of the British Museum in London, the representatives of the six laboratories interested in the dating and of the laboratory of Gif-sur-Yvette (France) as well. Representatives of the Pontifical Academy of Sciences and STURP, Gonella and other scientists were also present<sup>31</sup>.

The discussion grew hot on the size and number of the samples, their certification and the use of control samples. Everybody agreed that the Swiss textile expert Mechthild Flury-Lemberg would be entrusted with the sampling.

Gove insisted that no other tests on the Shroud could be performed until the date of origin was known, in opposition to Gonella who wanted the sampling to be appropriately put in the context of the other tests<sup>32</sup>. Archaeologist William Meacham, of the University of Hong Kong, reminding the use of dating different samples of a site, proposed to take samples from various parts of the cloth, but Flury-Lemberg objected strongly, thinking that the borders could not be more contaminated than the rest of the fabric<sup>33</sup>. STURP suggested to take samples at least in three different areas of the sheet<sup>34</sup>.

Meacham, like every other archaeologist and geologist, considered contamination a very serious issue<sup>35</sup> and proposed to take a thread from the middle of the cloth, between the dorsal and ventral image, a small piece from the edge next to the site of the 1973 sampling, a piece of

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<sup>27</sup> T. D’MUHALA - J. JACKSON - W. ERCOLINE - A. ADLER - R. DICHTL - R. DINEGAR - E. JUMPER, *A scientific proposal for studying the Shroud of Turin*, in *Shroud Spectrum International* 13 (1984), pp. 9-22.

<sup>28</sup> G. RIGGI DI NUMANA, *Rapporto Sindone 1978-87*, op. cit., p. 149.

<sup>29</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 31.

<sup>30</sup> *Ibid.*, p. 45.

<sup>31</sup> *Ibid.*, pp. 46-47.

<sup>32</sup> *Ibid.*, pp. 48-53.

<sup>33</sup> *Ibid.*, pp. 54-55.

<sup>34</sup> J. MARINO, *The Shroud of Turin and the carbon 14 controversy*, in *Fidelity* 8 (1989), pp. 36-45, on p. 37.

<sup>35</sup> W. MEACHAM, *On carbon dating the Turin Shroud*, in *Shroud Spectrum International* 19 (1986), pp. 15-25.

the charred cloth, a piece of the side strip and a piece of the backing cloth sewn on in 1534. All samples would be carefully examined (microchemical tests, mass spectrometry, micro-Raman) and appropriately pretreated for impurities and intrusive substances<sup>36</sup>.

Chagas sent to the Secretary of State a report on the meeting in Turin, but that report had not been read and signed by the participants<sup>37</sup>. Gove published it<sup>38</sup> stating that it was an agreement signed during the meeting, without even informing Turin authorities<sup>39</sup>. Also other participants to the meeting independently released a list of decisions taken on that occasion<sup>40</sup>. The amount of the sampling had not been defined, the opposite of what Gove wrote, but the multidisciplinary approach of the operation was actually maintained, and Gove was not satisfied. Chagas sided with Gove and wrote to the Secretary of State that STURP intended to perform tests considered dangerous by the radiocarbon experts<sup>41</sup>.

This taking up a position was followed by another hot period, marked by maneuvers by Chagas and Gove to prevent at all costs any other test, keeping only the dating. They reached their goal, but in May 1987 from the Secretary of State the decision came to grant the removal of only three samples<sup>42</sup>. Thus, the laboratories had also to be reduced to three. The choice was made in Turin<sup>43</sup>.

Gove's laboratory was excluded and furious protests broke out<sup>44</sup>. Some laboratories claimed that accelerator technology was not ready yet, primarily because of the high number of spurious readings from small samples<sup>45</sup>. According to Harbottle, there was one chance out of five for each measurement that the answer would be incorrect<sup>46</sup>. Moreover, a controversy broke out between the director of the Oxford laboratory, physicist Edward Hall<sup>47</sup>, and Gove<sup>48</sup>. The bulletin of the Secretary of State did not mention the other tests, which were postponed<sup>49</sup> and never carried out.

Meanwhile, *Nature* published a letter full of suspicion<sup>50</sup>. Art historian Denis Dutton of the University of Canterbury (New Zealand) complains that there is still confusion about the protocols related to the tests. He states that the Turin's protocol leaves serious unanswered questions about the possibility of tampering with the samples. He worries that fibres of

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<sup>36</sup> W. MEACHAM, *Radiocarbon measurement and the age of the Turin Shroud: possibilities and uncertainties*, in *Turin Shroud – Image of Christ?, Proceedings of a Symposium held in Hong Kong*, Hong Kong, March 3-9, 1986, Cosmos Printing Press Ltd., Hong Kong 1987, pp. 41-56, on pp. 52-53.

<sup>37</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 55.

<sup>38</sup> H.E. GOVE, *Turin workshop on radiocarbon dating the Turin Shroud*, in *Nuclear Instruments And Methods In Physics Research B29* (1987), pp. 193-195.

<sup>39</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 65.

<sup>40</sup> G. HARBOTTLE - W. HEINO, *Carbon dating the Shroud of Turin - A test of recent improvements in the technique*, in *Archaeological Chemistry IV, ACS Advances in Chemistry* 220, R.O. Allen Editor, American Chemical Society, Washington D.C., USA (1989), Chapter 16, pp. 313-320, on pp. 318-319; R.H. DINEGAR - L.A. SCHWALBE, *Isotope measurements and provenance studies of the Turin Shroud*, op. cit., p. 413.

<sup>41</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., pp. 55-56.

<sup>42</sup> *Ibid.*, p. 62.

<sup>43</sup> *Ibid.*, p. 64.

<sup>44</sup> *Ibid.*, pp. 65-68.

<sup>45</sup> M. WARNER, *The Shroud of Turin*, in *Analytical Chemistry*, 61, 2 (1989), pp. 101-103, on p. 102.

<sup>46</sup> J. RALOFF, *Controversy builds as Shroud tests near - attempt to date Shroud of Turin*, in *Science News* 133, 16 (1988), p. 245.

<sup>47</sup> E.T. HALL, *The Turin Shroud: an editorial postscript*, in *Archaeometry* 31, 1 (1989), pp. 92-95.

<sup>48</sup> H.E. GOVE, *Letter to the editor: the Turin Shroud*, in *Archaeometry* 31, 2 (1989), pp. 235-237.

<sup>49</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., pp. 68-69.

<sup>50</sup> D. DUTTON, *Still shrouded in mystery*, in *Nature* 327, 6117 (1987), p. 10.

mummy linen rather than actual Shroud samples may be supplied to the laboratories and wonders: “Are we simply to take the Vatican’s word for it?” The insinuation is offensive also for the experts who met in Turin<sup>51</sup>.

Tite answers Dutton: all the institutions involved are fully aware of the crucial need to ensure that the “chain of evidence” remains unbroken. The British Museum accepted the invitation to act as “guarantor” and independent observer for this very reason. The procedures will be monitored at every stage by the three certifying institutions, the British Museum, the Pontifical Academy of Sciences and the Archbishopric of Turin, to preclude any possibility of tampering with the samples<sup>52</sup>.

Also Gove reassures Dutton, confirming that the agreements made in Turin exclude any possibility of “tampering”<sup>53</sup>. But Dutton insists, saying that a veritable industry has been built up around the Shroud and that the Vatican can rightly be seen as having a vested interest in keeping alive at least the possibility that it is the actual burial cloth of Jesus<sup>54</sup>. He also adds his disappointment for the reduction of the laboratories to three and repeats that the procedures do not make it impossible to replace the Shroud sample with that of a mummy<sup>55</sup>.

In this poisonous atmosphere they arrive at the meeting, held in London on January 22, 1988 in the headquarters of the British Museum. The representatives of the three chosen laboratories, Oxford, Tucson and Zurich, all equipped with the new accelerator method, attend with Gonella. The request put forward by the laboratories is 40 mg each, which corresponds to about 2 cm<sup>2</sup> of cloth. They admit that the blind test is impossible and claim that the sampling must be from a single site to better ensure the homogeneity of results. Gonella agrees, to minimize the defacement of the cloth. The sampling site will be indicated by a qualified textile expert, chosen by the Custodian of the Shroud, who will entrust a person with carrying out the sampling itself. Control samples, dating from first and fourteenth century, would be provided by Tite.

The representatives of the laboratories ask to attend to the sampling. They intend to come to Turin to take samples to ensure the chain of evidence. Gonella replies that their presence should not be linked to the certification of the samples but they could be admitted as guests. They committed themselves to completing the measures within three months, to maintain the strictest confidentiality and to send data to Tite and the “G. Colonnetti” Institute of Turin for statistical analysis. Then there would be a joint meeting in Turin for the preparation of a scientific communication and to inform the Custodian about the results. The representatives of the laboratories ask that the Custodian himself has to make the results public. Cardinal Ballestrero approved the proposals of the London meeting, leaving the point of the results public release unsettled<sup>56</sup>.

Tite published a summary of the London agreements. The radiocarbon dating of the Shroud will be performed by the three laboratories of the University of Arizona (Tucson), of the University of Oxford and of the Federal Institute of Technology in Zurich. Each laboratory will be provided with a 40 mg sample from the Shroud, as whole piece, not unravelled or shredded, and two known-age control samples. A blind test procedure will be adopted. Even if shredded, the Shroud sample would be distinguishable, so the blind test depends ultimately on

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<sup>51</sup> P.R. SMITH, *Dating the Shroud*, in *Nature* 328, 6127 (1987), p. 196.

<sup>52</sup> M. TITE, *Turin Shroud*, in *Nature* 327, 6122 (1987), p. 456.

<sup>53</sup> H. GOVE, *Turin Shroud*, in *Nature* 327, 6124 (1987), p. 652.

<sup>54</sup> D. DUTTON, *Protocols for Turin Shroud*, in *Nature* 331, 6152 (1988), p. 108.

<sup>55</sup> D. DUTTON, *The Shroud of Turin*, in *Nature* 332, 6162 (1988), p. 300.

<sup>56</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., pp. 70-71.

the good faith of the laboratories. The Shroud sample will be taken from a single site, away from any patches or charred areas. The removal will be undertaken under the supervision of a qualified textile expert. All the samples will be weighed, wrapped in aluminium foil and sealed in numbered stainless-steel cases.

All the operations will be certified by Cardinal Ballestrero and Tite. Immediately after the packaging of the samples, they will be all handed over to representatives of the three laboratories who will be in Turin for this purpose. All stages of the operation will be fully documented by video recording and photography. On the completion of the measurements, the laboratories will send their data to Tite and to the Institute of Metrology "G. Colonnetti" in Turin for preliminary statistical analysis. The laboratories agreed not to discuss their results with each other until after they have deposited them for statistical analysis. A final discussion of the measurement data will be made at a meeting in Turin among representatives of the British Museum, of the "Colonnetti" and of the three laboratories, to whom identification of the three samples will be revealed in this occasion. The results as finalized at this meeting will be a basis for both a scientific paper and a communication to the public<sup>57</sup>.

This protocol elicited the reaction of Gove, who emphasized seven points of difference from the original protocol of 1986: 1. The laboratories are reduced from seven to three. This eliminates the possibility of detecting a mistake made in the measurement by one or more of the three laboratories. Such mistakes are not unusual. 2. The use of the two dating methods has been reduced to one. 3. The amount of cloth that each laboratory will receive has been doubled. With this further material other laboratories could be included. 4. Representatives of the laboratories will not be allowed to observe the sampling. 5. The samples will not be unravelled, and thus that of the Shroud will be more easily identifiable. 6. The Pontifical Academy of Sciences was unaccountably excluded. 7. The acknowledged textile expert selected to remove the sample was replaced by an unnamed person.

Gove, who had just misread the section 4, concludes: "All these unnecessary and unexplained changes unilaterally dictated by the Archbishop of Turin will produce an age for the Turin Shroud which will be vastly less credible than that which could have been obtained if the original Turin Workshop protocol had been followed. Perhaps that is just what the Turin authorities intend"<sup>58</sup>.

### ***Phase two: the painful wait for the results and the subsequent controversy***

The sampling took place on April 21, 1988. The execution was entrusted to technician Giovanni Riggi in the presence of two textile experts, Franco Testore, professor of Textile Technology at the Polytechnic of Turin, and Gabriel Vial, general technical secretary of the International Center for Study of Ancient Textiles in Lyon (France)<sup>59</sup>. Cardinal Ballestrero, Gonella, Tite, the responsables of the laboratories entrusted with the dating, the priests in charge of the case opening and the representatives of the Ministry for Cultural Heritage were there too<sup>60</sup>.

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<sup>57</sup> M. TITE, *Turin Shroud*, in *Nature* 332, 6164 (1988), p. 482.

<sup>58</sup> H. GOVE, *Radiocarbon-dating the Shroud*, in *Nature* 333, 6169 (1988), p. 110.

<sup>59</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., pp. 72-73.

<sup>60</sup> P. SAVARINO, *La radiodating della Sindone*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, Atti del III Congresso Internazionale di Studi sulla Sindone, Turin, June 5-7, 1998, pp. 1-6, on p. 1.

There is no report or document summarizing the actual sampling conditions and Riggi himself will comment: “Who fantasized and was not soft in criticism and accusations, perhaps was not entirely wrong; because without documents to rely on, every fantasy was possible, every doubt was permissible and every conclusion, incorrect or unjust, when not authoritatively contradicted, could be reasonable”<sup>61</sup>.

When the four floodlights were switched on, pointing toward the ceiling, the sudden increase of light caused an immediate reaction from the Superintendent of Cultural Heritage of Turin, who asked to reduce lighting power to avoid damage to the Shroud. Riggi reluctantly resigned to the request because “the poor visibility of the details of the cloth could make uncertain the observation and critical any technical precision intervention on the cloth”<sup>62</sup>. The variation of brilliancy put in serious trouble Testore, Vial, Tite and Riggi, who had to operate “in a generalized semi-darkness”<sup>63</sup>.

The textile experts agreed that the sampling ought to come from the left corner of the frontal image, where the Raes sample was already been taken. A sample larger than necessary was cut to keep a part of it in store. According to Gonella, the numbers of 7 cm x 1 cm “has often been erroneously reported as covering the entire cut”<sup>64</sup>; but this is the measure that appears in the official report of the dating published in *Nature*<sup>65</sup>.

In their reports, presented at the congress held in Paris in 1989, Riggi<sup>66</sup> and Testore<sup>67</sup> unanimously reported the measure 8.1 cm x 1.6 cm and the same pattern, which states that the weight of the taken sample was 0.497 g; however, in the text Riggi writes that the weight was 0.540 g and then<sup>68</sup> writes that the weight was 0.4775 g. Anyway, being the unit weight<sup>69</sup> of the Shroud cloth 0.023 g/cm<sup>2</sup>, the weight of the removed fragment (8.1 cm x 1.6 cm) should have been approximately 0.300 g, weight which instead is attributed to the sample reduced in size to 7 cm x 1 cm<sup>70</sup>.

The trimming was necessary “for the pollution of the cloth itself with threads of a different nature which even in small amounts could have lead to variations in dating, being a later addition”<sup>71</sup>. The *Nature* report<sup>72</sup> says that three samples were prepared from the taken fragment, each of about 50 mg.

In fact, the sample was divided into two parts, weighing 0.1549 g and 0.1448 g respectively. At this point, Testore’s report presents two versions, which have been published both<sup>73</sup>. The first states that the largest portion (0.1549 g) was divided into three fragments almost identical: 0.0520 g, 0.0528 g and 0.0537 g.

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<sup>61</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, in *Sindone, il mistero continua*, op. cit., pp. 88-171, on p. 96.

<sup>62</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., pp. 125-126.

<sup>63</sup> *Ibid.*, p. 126.

<sup>64</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 74.

<sup>65</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 612.

<sup>66</sup> G. RIGGI DI NUMANA, *Prélèvement d’un morceau de tissu du Saint Suaire de Turin*, in *1 - Le prélèvement du 21-4-1988 - Études du Tissu, Actes du Symposium Scientifique International*, Paris, September 7-8, 1989, OEIL, Paris 1990, pp. 27-44.

<sup>67</sup> F. TESTORE, *Le Saint Suaire. Examen et prélèvement effectués le 21 avril 1988*, in *1 - Le prélèvement du 21-4-1988 - Études du Tissu*, op. cit., pp. 45-69.

<sup>68</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., p. 133.

<sup>69</sup> F. TESTORE, *Le Saint Suaire. Examen et prélèvement effectués le 21 avril 1988*, op. cit., p. 52.

<sup>70</sup> G. RIGGI DI NUMANA, *Prélèvement d’un morceau de tissu du Saint Suaire de Turin*, op. cit., p. 39.

<sup>71</sup> G. RIGGI DI NUMANA, *Rapporto Sindone 1978-87*, op. cit., p. 166.

<sup>72</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 612.

<sup>73</sup> F. TESTORE, *Le Saint Suaire. Examen et prélèvement effectués le 21 avril 1988*, op. cit., p. 54.

Riggi said: “By chance it happens that each of these three parts is identical to the others because the weight of the three fragments on an electronic balance varied by about a thousandth of a gram per piece and was almost equivalent to 0.053 g on average for each sample”<sup>74</sup>. In the second version, however, Testore states that the portion chosen for the subdivision into three parts was not the largest but the smallest (0.1448 g). The three pieces respectively weighed 0.0520 g, 0.0528 g and 0.0396 g. Not to discriminate the one laboratory, which would have received slightly less material, another piece of 0.0141 g was taken from the other half of the sample, the one kept in store. This second version will be confirmed later by Riggi himself<sup>75</sup>.

The inconsistency about weights and measurements of the Shroud samples<sup>76</sup> gave way to suspicions of substitution of the cloth fragments<sup>77</sup>. The rejection of this hypothesis by chemist Eberhard Lindner<sup>78</sup> raised the reactions by theologian Holger Kersten and psychologist Elmar Gruber<sup>79</sup>, who said there must have been a swindle. Chemist Piero Savarino, professor of Industrial Organic Chemistry at Turin University, said: “Unfortunately, a set of facts, or rather of deficiencies and carelessness, leaves the suspicion survive”<sup>80</sup>.

Three fragments were also cut from the two control samples brought by Tite, which had orthogonal weaving<sup>81</sup>. Because the distinctive herringbone twill weave of the Shroud could not have match in the controls samples, it was possible for any of the laboratories to identify the Shroud sample<sup>82</sup>. Tite found it difficult to obtain a medieval control sample, so Vial brought a few threads of the cope of St. Louis of Anjou<sup>83</sup>, who died in 1297.

The samples of the Shroud and those brought by Tite, one dating back to the first century and the other to the eleventh century, were introduced in small metal cylinders. The operation took place in the adjacent capitular room at the sole presence of Tite, Gonella and

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<sup>74</sup> G. RIGGI DI NUMANA, *Prélèvement d'un morceau de tissu du Saint Suaire de Turin*, op. cit., p. 39.

<sup>75</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., pp. 136-138.

<sup>76</sup> E. BRUNATI, *Lettera aperta al Prof. Franco Testore*, in *Collegamento pro Sindone*, November-December 1989, pp. 41-45; E. BRUNATI, *Testimoni, non accusati*, in *Collegamento pro Sindone*, January-February 1990, pp. 45-51; G. VIAL, *Lettera al Sig. Testore*, in *Collegamento pro Sindone*, March-April 1990, pp. 42-44; E. LINDNER, *Risposta al contributo di R. Van Haelst*, in *Collegamento pro Sindone*, November-December 1994, pp. 38-40; R. VAN HAELST, *Quando gli esperti del radiocarbonio diventano esperti tessili*, in *Collegamento pro Sindone*, January-February 1992, pp. 39-41; R. VAN HAELST, *Osservazioni sulle “Ipotesi su tutte le tracce della Sindone”*, in *Collegamento pro Sindone*, May-June 1994, pp. 39-44; R. VAN HAELST, *The validity of the 1988 Shroud sampling*, in *Collegamento pro Sindone Internet*, April 2001, <http://www.shroud.it/VHAELST1.PDF>; R. VAN HAELST, *A tantalizing photograph of the Oxford samples*, in *Collegamento pro Sindone Internet*, June 2001, <http://www.shroud.it/VHAELST3.PDF>

<sup>77</sup> E. BRUNATI, *Considerazioni sui vari rapporti pubblicati in merito alle operazioni di datazione della Sindone*, in *La datazione della Sindone, Atti del V Congresso Nazionale di Sindonologia*, Cagliari, April 29-30, 1990, Edicar, Cagliari 1990, pp. 112-120, on p. 117; G. DE NANTES, *Une double substitution*, in *La Contre-Réforme Catholique au XX<sup>e</sup> Siècle*, 271 (1991), pp. 54-60; G. DE NANTES, *Les trois substitutions du docteur Tite*, in *La Contre-Réforme Catholique au XX<sup>e</sup> Siècle*, op. cit., pp. 65-71; H. KERSTEN - E.R. GRUBER, *Das Jesus Komplott*, Langen Müller, München, Deutschland 1992.

<sup>78</sup> E. LINDNER, *The ambiguity of the radiocarbon results of the Turin Shroud*, in *La datazione della Sindone*, op. cit., pp. 149-166; *Recent publications*, in *British Society for the Turin Shroud Newsletter* 35 (1993), pp. 17-20.

<sup>79</sup> H. KERSTEN - E.R. GRUBER, *Letters*, in *British Society for the Turin Shroud Newsletter* 36 (1993-1994), pp. 18-20.

<sup>80</sup> P. SAVARINO, *La radiodazione della Sindone*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., p. 2.

<sup>81</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., p. 138.

<sup>82</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 612.

<sup>83</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 73.

Ballestrero<sup>84</sup>. This delicate moment was not filmed<sup>85</sup>, unlike what was settled in the London protocol<sup>86</sup>. A reader<sup>87</sup> of *Nature* will ask Tite explanations: he replies that it happened to follow the blind procedure, even if this aspect was “quite illogical, because in that moment we knew that because of the unusual weaving of the Shroud, the blind test was not feasible without unravelling the samples”<sup>88</sup>. Yet Tite emphasizes that the movie would have only been a memorandum, not intended to be an identification proof for the samples, of which he and the Cardinal were guarantors<sup>89</sup>. In any case, he believes that moving to a separate room was “quite unnecessary”<sup>90</sup>.

The cope threads were left in small envelopes. The cases were sealed and delivered to the representatives of the laboratories, who signed a receipt bearing the dates of the two control samples<sup>91</sup>. On the following day the Vatican Press Office issued a bulletin, published by the *Osservatore Romano*<sup>92</sup>, where, among other things, it is written: “The samples, of the total mass of about 150 mg, were obtained by cutting a strip of about 1 cm x 7 cm”. It is also specified that the control samples “come from a cloth dating from the first century A.D. and a cloth from the eleventh century A.D.; a fourth sample, dating from about 1300 A.D., was provided as an additional control. There is also a specification on the sampling area: “The sampling site was chosen so as to ensure that the sample belonged to the main body of the Holy Shroud and that its removal could cause the least possible damage to the fabric”. But was it really necessary to provide laboratories with the age of the control samples? This is just one of the burning questions that doctor Olivier Pourrat of the University of Poitiers (France) put<sup>93</sup>.

A long wait began, lasting six months. In this period, in May, there were two blatant violations of the confidentiality obligation. In Zurich, the filming of all operations by a crew from BBC *Timewatch* program was allowed. It is reported by Anglican Reverend David Sox, who was also there<sup>94</sup>. Two twill weave cloths and one tabby weave cloth were extracted from the cylinders, while only the Shroud should have presented herringbone weave. Anyway, the Shroud sample was recognized, even if it was minutely smaller than it was in Turin<sup>95</sup>. In the final report in *Nature*, instead, it will be argued that the control samples did not have the same weave of the Shroud. The blind procedure was abandoned<sup>96</sup>. Tite will declare that the decision was taken in Turin as the samples were drawn<sup>97</sup>.

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<sup>84</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., pp. 139-141.

<sup>85</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 612.

<sup>86</sup> M. TITE, *Turin Shroud*, in *Nature* 332, op. cit., p. 482.

<sup>87</sup> R. HALISEY, *More on the Shroud*, in *Nature* 346, 6280 (1990), p. 100.

<sup>88</sup> M. TITE, *More on the Shroud. Tite replies*, in *Nature* 346, 6280 (1990), p. 100.

<sup>89</sup> *Ibid.*

<sup>90</sup> *Radio Courtoisie*, in *Shroud Spectrum International* 32/33 (1989), pp. 36-37.

<sup>91</sup> G. RIGGI DI NUMANA, *Il giorno più lungo della S. Sindone di Torino*, op. cit., pp. 141-149.

<sup>92</sup> *L'Osservatore Romano*, April 23, 1988, p. 2.

<sup>93</sup> O. POURRAT, *Shroud dating still questioned*, in *Nature* 349, 6310 (1991), p. 558.

<sup>94</sup> D. SOX, *The Shroud unmasked - Uncovering the greatest forgery of all time*, The Lamp Press, Basingstoke (UK) 1988, pp. 135-142.

<sup>95</sup> *Ibid.*, p. 137; P. BUSSON, *Sampling error?* in *Nature* 352, 6332 (1991), p. 187.

<sup>96</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 612.

<sup>97</sup> *Intervista al Prof. Tite del British Museum effettuata a Parigi da Orazio Petrosillo del Messaggero e da Emanuela Marinelli l'8 settembre 1989*, in *Collegamento pro Sindone*, January-February 1990, pp. 38-44, on p. 39.

Gove and his administrative assistant Shirley Brignall, with whom Gove had wagered a pair of cowboy boots, were admitted in Tucson. Gove won them<sup>98</sup>. Knowing the result of the dating, Gove later softened the tone of his grievances<sup>99</sup>, and declared that had the three laboratories obtained the same date, it would have been credible<sup>100</sup>. In the meantime he continued to decry STURP members, which he termed “self-appointed religious zealots”<sup>101</sup>.

For his part, Gonella complained: “The experts of the British Museum did not trust the Cardinal and wanted to be present when the samples were taken from the Shroud, but then they did not allow a representative of the Church to watch the analysis as an observer”<sup>102</sup>. Savarino remarked: “This behavior is truly incomprehensible. It is to be considered that in legal ambit any analysis performed in the absence of the other party is rejected by the courts”<sup>103</sup>.

From the description given on *Nature* it is clear that in all three laboratories the samples were fully used for dating<sup>104</sup>. Thereafter, on the contrary, it will be known that in Tucson part of a sample of the Shroud had been kept by chemist Timothy Jull, new director of the Tucson laboratory<sup>105</sup>. Many years ago, chemist Paul Damon, director of the Tucson laboratory, had already said it: “We have preserved a piece of the sample, if there was a dispute, to show it to the Church authorities”<sup>106</sup>. The director of the Zurich laboratory, physicist Willy Wölfli, also admits that he has preserved a portion of the sample<sup>107</sup>.

In July, leaks in English papers start, making a stir and reaching the climax on August 26 with the announcement on the *Evening Standard* front page: “The Shroud is a fake”<sup>108</sup>. Historian Richard Lockett of Magdalene College in Cambridge (UK) comments ironically the leak: “Laboratories are rather leaky institutions”<sup>109</sup>. Gonella reacts indignantly when he learns that the ones responsible for the leaking of the news are actually Robert Dinegar, chemist of the Los Alamos National Laboratory in Los Alamos (NM, USA) and member of STURP, and physicist Robert Hedges of Oxford laboratory: “They still have not announced anything to us. It is an ill-mannered behavior. They gave their word. Now they betrayed it”<sup>110</sup>.

Also Riggi is angry: “The laboratories committed themselves on their honor to provide that nothing would have leaked. Instead, they have exploited the research, they use the rumors to promote themselves. For sure they don’t come out clean”<sup>111</sup>. But Hall says candidly: “Frankly, I think it was a hopeless prospect to keep the result secret. You couldn’t. With the best will in the world”<sup>112</sup>. In the same interview, Hall said he believes the Shroud is a fake; he concedes

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<sup>98</sup> D. SOX, *The Shroud unmasked - Uncovering the greatest forgery of all time*, op. cit., pp. 143-147.

<sup>99</sup> H.E. GOVE, *Progress in radiocarbon dating the Shroud of Turin*, in *Radiocarbon* 31, 3 (1989), pp. 965-969.

<sup>100</sup> *Ibid.*, p. 966.

<sup>101</sup> *Ibid.*, p. 968.

<sup>102</sup> G. RUGGIERO, “Uno show degli scienziati”. È polemica sulla Sindone, in *Avvenire*, September 28, 1988, p. 1.

<sup>103</sup> P. SAVARINO, *La radiodattazione della Sindone*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., p. 2.

<sup>104</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 613.

<sup>105</sup> R. A. FREER-WATERS - A. J. T. JULL, *Investigating a dated piece of the Shroud of Turin*, in *Radiocarbon* 52, 4 (2010), pp. 1521-1527, on p. 1526.

<sup>106</sup> G. DE NANTES, *La datation au carbone 14 - La traque des faussaires*, in *La Contre-Réforme Catholique au XX<sup>e</sup> Siècle*, op. cit., pp. 35-42, on p. 37.

<sup>107</sup> *Ibid.*, on p. 39.

<sup>108</sup> C. LANGLEY, *Turin Shroud is a fake*, in *Evening Standard*, August 26, 1988, p. 1.

<sup>109</sup> R. LUCKETT, *No longer shrouded in mystery*, in *Evening Standard*, August 26, 1988, p. 12.

<sup>110</sup> E. FERRERO, *Da New York e Londra: la Sindone è un falso*, in *La Stampa*, September 23, 1988, p.7.

<sup>111</sup> B. ANGELICO, *Sindone, il sudario strappato*, in *Epoca* 1981 (1988), pp. 147-154, on p. 153.

<sup>112</sup> J. CORNWELL, *Science and the Shroud*, in *The Tablet*, January 14, 1989, pp. 36-38, on p. 37.

that there is blood on the sheet, but adds: “But whether it’s human or pig’s blood – who knows?”<sup>113</sup>.

Hall wants to ensure the survival of his chair after his retirement and hopes a Sunday newspaper will pay a large sum for the rights to the story of the Shroud dating<sup>114</sup>. He receives one hundred thousand pounds from ITV, the independent television, BBC's rival<sup>115</sup>, and a million pounds from 45 businessmen and “rich friends”. The chair is to be filled by Tite<sup>116</sup>. Gonella emphasizes: “Since the beginning, this story of dating the Shroud has been vitiated by publicistic aspects, to which <sup>14</sup>C laboratories showed to be even too much sensitive”<sup>117</sup>.

The Cardinal’s consultant, exasperated, expresses a heavy judgment: “The custodians of the cathedral of Turin behaved more seriously, kept silent about the sampling of seven centimeters of the sheet, than a group of scientists, who took the liberty of violating the secret and of announcing to scandal-seeking tabloids that the Shroud is a medieval fake. In my opinion there is an anti-Catholic conspiracy of specific milieus”<sup>118</sup>. Which milieus? In a later interview, Cardinal Ballestrero will be asked this question: “In this whole affair could the Freemasonry have had a hand? And external pressures?” Cardinal Ballestrero answered: “I think it's indisputable!”<sup>119</sup>

The agreements taken in London in January are completely disregarded. Not only the laboratories did not complete the measures within three months and did not maintain confidentiality, but they did not even send the data to the “Colonnetti” Institute in Turin for the statistical analysis<sup>120</sup>. At this point the “Colonnetti” asks not to be involved anymore and at the Institute only engineer Anthos Bray agrees to be still committed, as a personal favor to Cardinal Ballestrero<sup>121</sup>. The representatives of the laboratories do not meet in Turin as expected to prepare a scientific communication and to give notice of the results to the Custodian, who will be informed by Tite with a letter delivered by hand on September 28<sup>122</sup>. Rumors are that during the summer there was a secret meeting in Switzerland, instead<sup>123</sup>.

The announcement was made in Turin by Cardinal Ballestrero on October 13, in the morning. On that same afternoon Tite and the representatives of the Oxford laboratory held a press conference in London<sup>124</sup>. Behind them a blackboard stood with the date followed by an exclamation mark. Tite does not remember who put it there<sup>125</sup>. Hall said that nobody scientifically trustworthy could now deny the Shroud is a fake. According to him, anyone who thinks differently might as well join the Flat Earthers<sup>126</sup>.

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<sup>113</sup> *Ibid.*, p. 38.

<sup>114</sup> N. SCHOON, *Analysing the strands of time*, in *The Independent*, April 25, 1988, p. 17.

<sup>115</sup> G. SERVADIO, *La Sindone ammalia gli inglesi*, in *La Stampa*, August 8, 1988, p. 15.

<sup>116</sup> A. BERRY, *Turin Shroud professor raises £1m for Oxford post*, in *The Daily Telegraph*, March 25, 1989, p. 7.

<sup>117</sup> L. GONELLA, *E ora il mistero si infittisce*, in *Avvenire*, October 14, 1988, p. 6.

<sup>118</sup> R. PATRUNO, “*Un complotto anticattolico contro la sacra Sindone*”, in *La Repubblica*, September 29, 1988, p. 18.

<sup>119</sup> P. G. CAVIGLIA, *La Santa Sindone. Un enigma appassionante*, in *Il Messaggero del S. Bambino Gesù di Praga* 7 (1997), pp. 18-23, on p. 20.

<sup>120</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 78.

<sup>121</sup> *Ibid.*, p. 79.

<sup>122</sup> *Ibid.*, p. 81.

<sup>123</sup> U. FOLENA, “*La Sindone rimane un'icona*”, in *Avvenire*, October 14 1988, p. 5.

<sup>124</sup> L. GONELLA, *Storia degli avvenimenti connessi alla datazione della S. Sindone*, op. cit., p. 82.

<sup>125</sup> *Radio Courtoisie*, op. cit., pp. 36-37.

<sup>126</sup> I. WILSON, *The carbon dating results: is this now the end?*, op. cit., on p. 3.

On the following day the Cardinal's statement appeared in the *Osservatore Romano*. In the text the evaluation of the test results is remitted to the Science<sup>127</sup>. This will not be the last official pronouncement from the Vatican. In fact, in the Bulletin of the Vatican Press Office of August 18, 1990 it is written: "The result of the medieval dating became an odd point, even in contrast, compared with previous results, which were not inconsistent with a 2000-year old dating. These are experimental data, among others, with the validity and also the limits of sectoral tests which are to be integrated in a multidisciplinary framework"<sup>128</sup>.

The final report of the laboratories will appear in the magazine *Nature* on February 16, 1989, four months after the official announcement of the results. Here goes this lapidary statement: "These results therefore provide conclusive evidence that the linen of the Shroud of Turin is mediaeval"<sup>129</sup>. But many perplexities on the event led Savarino to an opposite consideration: the results "cannot be considered axiomatically conclusive"<sup>130</sup>.

The comments will not be spared<sup>131</sup>. Riggi expresses a heavy reserve on the test: "We believe that a single test, unconnected with other 25 proposed, cannot give a reliable answer"<sup>132</sup>. Gonella is furious: "The gentlemen in Oxford and London misbehaved; in their attitude there is an attack to other scientists without even reading their articles. I had great respect for the University of Oxford that I no longer have. The scientists came out of this test very discredited"<sup>133</sup>.

The advisor of the Cardinal believes that the procedure adopted by the three scientific laboratories is not flawless: "The vast majority of my colleagues are not satisfied, either by the adopted procedures, or by the conclusions. These gentlemen, moreover, shout from the rooftops that now the last word was pronounced on the question. Theirs, of course"<sup>134</sup>. Furthermore, he emphasizes that a preliminary chemical-physical examination lacked and the operations of pretreatment of the three samples, i.e. the techniques of removal of impurities, are questionable<sup>135</sup>.

Tite will write to Gonella on September 14, 1989: "I am writing to put on record the fact that I myself do not consider that the result of the radiocarbon dating of the Turin Shroud shows the Shroud to be a forgery. As you have correctly pointed out, to describe the Shroud as a forgery implies a deliberate intention to defraud and the radiocarbon dating clearly provides no evidence in support of such a hypothesis. I myself have always carefully tried to avoid using the word forgery in discussing the radiocarbon dating of the Shroud but I fear that the description of the Shroud as a forgery has still cropt into a number of newspaper articles based

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<sup>127</sup> *L'Osservatore Romano*, October 14, 1988, p. 2.

<sup>128</sup> *Bollettino della Sala Stampa della Santa Sede*, 310, August 18, 1990, in *Sindone - Nuova Serie* 2 (1990), pp. 17-18, on p. 18.

<sup>129</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 614.

<sup>130</sup> P. SAVARINO, *Recenti studi chimico-fisici sulla Sindone e la datazione con il metodo <sup>14</sup>C*, in *Sindone, cento anni di ricerca*, Istituto Poligrafico e Zecca dello Stato, Libreria dello Stato, Rome 1998, pp. 185-208, on p. 205.

<sup>131</sup> A.M. DUBARLE, *Y a-t-il eu fraude et complot dans la datation du Linceul de Turin par le carbone 14?*, in *Montre-Nous Ton Visage* 4 (1990), pp. 18-26; J. EVIN, *Questions de MNTV - Réponses et commentaires de Jacques Evin au sujet de la datation radiocarbone du Linceul de Turin*, in *Montre-Nous Ton Visage* 5 (1991), pp. 9-14.

<sup>132</sup> R. ALLEGRI, "Abbasso la scienza, la Sindone è sacra", in *Gente* 46 (1988), pp. 15-17, on p. 17.

<sup>133</sup> R. CASCIOLI, *Sindone, chi ha barato*, in *Avvenire*, May 12, 1989, p. 5.

<sup>134</sup> M. TRAVAGLIO, "Non basta il carbonio 14". *Altre polemiche sulla Sindone*, in *Il Giornale*, May 12, 1989, p.

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<sup>135</sup> *Ibid.*

on interviews that I have given. I can therefore only apologise once again for any problems that such reports have caused you and others in Turin”<sup>136</sup>.

The British Museum, however, will include a full-size replica of the Shroud among the forgeries in the exhibition *Fake? The Art of Deception*, held from March 9 to September 2, 1990<sup>137</sup>. In the presentation of the exhibition catalog it is written: “What is a fake and why are fakes made? Did the forgers of the Turin Shroud and Piltdown Man<sup>138</sup> have the same motives?”<sup>139</sup> The mathematician Arnaud-Aaron Upinsky, vice president of CIELT (*Centre International d'Etudes sur le Linceul de Turin*) of Paris, sent a vibrating protest letter to the director of the British Museum.

In the answer of the public relations manager, Geoffrey House, it is written: “The photograph of the Shroud was included as an illustration of a recent and very widely known use of radiocarbon dating. It was not meant to suggest that the Shroud was created as a forgery and to clarify this point we have put an extra explanatory label. The publishers text on the back of the catalogue to which you refer was unauthorised and was included as an oversight. All reference to the Shroud has been removed from the cover in the reprint currently on order”<sup>140</sup>.

Gonella accuses the laboratories of “intoxication by success” and adds: “Misconducts there were tons. The colleagues of the <sup>14</sup>C behaved in a disgusting manner. Those scientists have hatched a true plot to discredit the Shroud. At first, when they did ask us to examine a sample of the Shroud, assured us of the utmost seriousness and completeness of the analyses, along with the collaboration with the Custodian of the Shroud, that is the Bishop of Turin, and his scientific advisor, i.e. the undersigned. Driven by celebrity fever, those scientists began to turn their backs on their own commitments: no more interdisciplinary examinations, only <sup>14</sup>C. They flooded even Rome with pressures so that Turin had to accept their conditions. They used the then president of the Pontifical Academy of Sciences, professor Chagas, to get the undersigned out of the way and go their own way”.

It is natural to ask Gonella: then why did the Holy See and Cardinal Ballestrero accept it? “Because Chagas - the professor of the Polytechnic says - acted alone, bypassing other academics. The Vatican was continually threatened by the laboratories themselves, who went on repeating: if you don't leave it to us, only to us, the results will not be acceptable. So, in the end, Ballestrero had to surrender, though suffering badly. And I to submit. Also because these gentlemen did everything to support the argument that the Church was throwing a spanner in the works of science”<sup>141</sup>.

Gonella explains: “It was blackmail. They put us up against the wall just with a blackmail. Either we accepted the test of <sup>14</sup>C on the terms imposed by the laboratories, or it would break out a campaign of accusations saying the Church fears the truth and is an enemy of Science”<sup>142</sup>.

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<sup>136</sup> Letter, in *British Society for the Turin Shroud Newsletter* 24 (1990), p. 7.

<sup>137</sup> J. LEVEQUE – R. PUGEAUT, *Le Saint-Suaire revisité*, Sarment, Éditions du Jubilé, Paris 2003, p. 120.

<sup>138</sup> [http://www.time.com/time/specials/packages/article/0,28804,1931133\\_1931132\\_1931125,00.html](http://www.time.com/time/specials/packages/article/0,28804,1931133_1931132_1931125,00.html)

<sup>139</sup> M. JONES (editor), *Fake? The Art of Deception*, British Museum Publications, London 1990.

<sup>140</sup> A.-A. UPINSKY, *Le procès en contrefaçon du Linceul*, OEIL-F.-X. de Guibert, Paris 1993, pp. 55-62.

<sup>141</sup> M. TRAVAGLIO, “Non basta il carbonio 14”. *Altre polemiche sulla Sindone*, op. cit., p. 7.

<sup>142</sup> M. BERCHI, *Un test molto indiscreto*, in *Il Sabato*, November 19-25, 1988, pp. 29-30, on p. 29.

Cardinal Tarcisio Bertone will declare: “The analysis of carbon-14 seems to have been a mistake, particularly because of prejudices, of which it is useless to speak, because the verdict was decided even before performing the analyses”<sup>143</sup>.

In the statement of the scientific committee of the International Symposium, held in Paris in 1989, it is written that there are strong reserves on the statistical analysis of the results, especially on the value of chi-squared ( $\chi^2$ ) 6.4 for samples of Shroud, which have provided not homogeneous radiocarbon dates. Therefore, the Scientific Committee requested the release of all raw data obtained by the three laboratories and of the commentary written by professor Bray of the “Colonnetti”<sup>144</sup>. During the International Symposium, held in Rome in 1993, statistician Philippe Bourcier de Carbon listed fifteen points of failure in the radiocarbon history of the Shroud<sup>145</sup>:

1. absence of a formal report of the sampling;
2. absence of a video archive on the final steps of the samples packaging;
3. in the official reports, contradictions about the cutting and the weight of the samples by people in charge of sampling;
4. breaches of the protocols initially planned for the operation of dating;
5. rejection of the usual procedure of double-blind test;
6. refusal of the interdisciplinary documentation, which is usual in the procedures for radiocarbon dating;
7. exclusion of acknowledged specialists in the Shroud, particularly American scientists who participated in previous works of STURP;
8. communication to the laboratories, most unusual, of the dates of the control samples prior to testing;
9. intercommunication of results among the three laboratories during the job;
10. disclosure to the media of the first results before the delivering of the findings;
11. refusal to publish raw results of the measurements (requested also with insistence in its official statement by the Scientific Committee which prepared the Symposium in Paris in 1989);
12. non-explanation of the unique isolation of the confidence interval of the measures performed by the Oxford laboratory compared to those made by other laboratories;
13. unacceptable value of 6.4 published in the journal *Nature* for the chi-squared statistical test on the results of the radiocarbon dosage on the Shroud;
14. rejection of any cross-debate on the statistical measures performed;
15. rejection, absolutely uncommon, of the publication of the statistical expertise of this operation, officially entrusted to professor Bray of “G. Colonnetti” Institute of Turin (requested also with insistence in its official statement by the Scientific Committee which prepared the Symposium in Paris in 1989).

Bourcier de Carbon concludes: “Such a remark of deficiencies remains completely unusual in the context of a truly scientific debate, and one can only deplore this exception to the usual ethics”<sup>146</sup>.

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<sup>143</sup> B. PERRIER, *Qui a peur du Saint Suaire ?* Ed. Florent Massot, Paris 2011, p. 162.

<sup>144</sup> *Declaration of the Scientific Committee of the Paris International Scientific Symposium*, in *Shroud Spectrum International* 32/33 (1989), pp. 33-35, on p. 33.

<sup>145</sup> P. BOURCIER DE CARBON, *Bilan du Symposium Scientifique International de 1989*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth, Actes du Symposium Scientifique International*, Rome, June 10-12, 1993, OEIL-F.-X. de Guibert, Paris 1995, pp. 17-19, on p. 18.

<sup>146</sup> P. BOURCIER DE CARBON, *Bilan du Symposium Scientifique International de 1989*, op. cit., p. 19.

Nevertheless, Robert Otlet of Radiocarbon Dating Laboratory in Wantage (UK) and Jacques Evin of Radiocarbon Laboratory of the University of Lyon (France) will assert that the result of the dating of the Shroud cannot be scientifically challenged<sup>147</sup>; chemist Joseph Virlet<sup>148</sup> claims the same opinion, while other scientists express their perplexities<sup>149</sup>.

### ***May the Shroud have undergone changes that affect the radiocarbon dating?***

The perplexities on the appropriateness of trying the dating of a sheet that underwent many events in the course of its history added up to the doubts raised by the anomalous behavior of radiocarbon scientists. The most famous incident is the Chambéry fire back in 1532. Biochemists Andrey Ivanov and Dmitri Kouznetsov thought an enrichment of the amount of radiocarbon in the Shroud possible due to various factors, including the biofractionment, but especially to an isotope exchange between the cloth and the gas containing CO and CO<sub>2</sub> developed during the fire<sup>150</sup>.

Physical-chemist Marie-Claire Van Oosterwyck-Gastuche emphasized the importance of the presence of water vapor among the conditions to be considered in a simulation experiment of the fire<sup>151</sup> and also reminded other problems, including the difficulty of completely removing pollution present in the sample<sup>152</sup>. Tite got instantly skeptical about Ivanov's and Kouznetsov's hypothesis<sup>153</sup> and had an immediate reply<sup>154</sup> to which the arguments of Van Oosterwyck-Gastuche were added<sup>155</sup>.

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<sup>147</sup> J. EVIN, *In anticipation of carbon 14 dating of the Shroud of Turin*, in *Shroud Spectrum International* 27 (1988), pp. 2-12; J. EVIN, *Bientôt la datation carbone 14 du Linceul de Turin*, in *Montre-Nous Ton Visage* 1 (1988), pp. 11-23; J. EVIN, *La datation radiocarbone du Suaire de Turin - Commentaire sur la datation*, in *Montre-Nous Ton Visage* 2 (1989), pp. 21-28; R. L. OTLET - J. EVIN, *The present state of radiocarbon dating*, in *The Turin Shroud, past, present and future, International Scientific Symposium*, Turin, March 2-5, 2000, Effatà Ed., Cantalupa (TO) 2000, pp. 455-477; J. EVIN - R. L. OTLET, *Dating the Shroud of Turin – Two radiocarbon specialists' point of view and proposal*, in *Sindon - Nuova Serie* 16 (2001), pp. 79-87.

<sup>148</sup> J. VIRLET, *The Shroud literature and the <sup>14</sup>C datation: solid state NMR, a useful tool*, in *The Turin Shroud, past, present and future*, op. cit., pp. 177-188.

<sup>149</sup> G. BENE - Y. SAILLARD, *Quelques réflexions sur les réactions à la datation du Linceul au carbone 14 (1988)*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 237-238; O. POURRAT, *La datation par le radiocarbone du suaire de Turin: les questions méthodologiques toujours sans réponse*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 239-241; R. SOUVERAIN, *La datation du Linceul de Turin: situation en 2001*, in *Revue Internationale du Linceul de Turin* 22 (2002), pp. 14-31.

<sup>150</sup> A.A. IVANOV - D.A. KOUZNETSOV, *Biophysical correction to the old textile radiocarbon dating results*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 229-233; D.A. KOUZNETSOV, *Un effetto termico sul contenuto degli isotopi di carbonio pesanti nella cellulosa*, in *Collegamento pro Sindone*, March-April 1997, pp. 46-47.

<sup>151</sup> M.-C. VAN OOSTERWYCK-GASTUCHE, *Dates radiocarbone sur tissus d'âge archéologique bien connu*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 219-228.

<sup>152</sup> M.-C. VAN OOSTERWYCK-GASTUCHE, *Problems related to the unreliability of the radiocarbon dating method application to the <sup>14</sup>C dating of the Turin Shroud*, in *Sindone 2000, Proceedings of the Worldwide Congress*, Orvieto, August 27-29, 2000, Gerni Ed., San Severo (FG), Vol. I, pp. 199-221.

<sup>153</sup> *A check of the Russian arguments*, in *British Society for the Turin Shroud Newsletter* 35 (1993), pp. 8-9.

<sup>154</sup> D. KOUZNETSOV, *An answer to the criticism of Prof. Tite*, in *British Society for the Turin Shroud Newsletter* 36 (1993-1994), pp. 3-6.

<sup>155</sup> M.-C. VAN OOSTERWYCK-GASTUCHE, *Another contribution to the radiocarbon dating debate...*, in *British Society for the Turin Shroud Newsletter* 36 (1993-1994), pp. 6-12.

A following article by Kouznetsov *et al.* presented experiments of enrichment in radiocarbon induced by the simulation of the fire that caused a carboxylation of cellulose in the presence of water and silver cations<sup>156</sup>. This work was immediately challenged by scientists in Tucson who complained the lack of full information to replicate these experiments and denied any validity to the theory<sup>157</sup>. Chemist Remi Van Haelst thinks there had been a misunderstanding<sup>158</sup>. Kouznetsov's answer, with his counterobjections addressed to Tucson<sup>159</sup>, was followed by a clarification from Jackson<sup>160</sup>.

The possibility of isotopic fractionation caused by fire has been excluded by physicist Yves Saillard<sup>161</sup>. Also engineer Georges Salet strongly criticized Kouznetsov's work<sup>162</sup>. Similar assessments were later expressed still by Tucson<sup>163</sup> and Oxford<sup>164</sup>, criticized in turn by the engineer Marcel Alonso<sup>165</sup>.

Van Haelst<sup>166</sup> judged insufficient, as the sole cause of the rejuvenation, the possibility of absorption of carbon materials, which originated in the dry distillation of the reliquary's wood<sup>167</sup>, but he found promising the work of Kouznetsov<sup>168</sup>, whose researches have led other scientists to investigate the problem of transformations induced by heating in linen<sup>169</sup>.

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<sup>156</sup> D.A. KOUZNETSOV - A.A. IVANOV - P.R. VELETSKY, *Effects of fires and biofractionation of carbon isotopes on results of radiocarbon dating of old textiles: the Shroud of Turin*, in *Journal of Archaeological Science* 23 (1996), pp. 109-121.

<sup>157</sup> A.J.T. JULL - D.J. DONAHUE - P.E. DAMON, *Factors affecting the apparent radiocarbon age of textiles: a comment on "Effects of fires and biofractionation of carbon isotopes on results of radiocarbon dating of old textiles: the Shroud of Turin", by D.A. Kouznetsov et al.*, in *Journal of Archaeological Science* 23 (1996), pp. 157-160; *Dr. Kouznetsov's claims attacked in leading U.S. scientific journal*, in *British Society for the Turin Shroud Newsletter* 41 (1995), pp. 10-11.

<sup>158</sup> R. VAN HAELST, *Kouznetsov-Ivanov contro Damon-Donahue*, in *Collegamento pro Sindone*, March-April 1996, pp. 46-48.

<sup>159</sup> D.A. KOUZNETSOV, *Letters to the editor*, in *British Society for the Turin Shroud Newsletter* 42 (1996), pp. 32-36.

<sup>160</sup> J.P. JACKSON, *The non-communicative Dr. Kouznetsov - A stop press*, in *British Society for the Turin Shroud Newsletter* 43 (1996), pp. 39-40.

<sup>161</sup> Y. SAILLARD, *Isotopic fractionation required for explanation of Turin Shroud's age by contamination during 1532 fire*, in *The Turin Shroud, past, present and future*, op. cit., pp. 523-529.

<sup>162</sup> G. SALET, *Pour en finir avec les thèses de MM. Ivanov et Kouznetsov*, in *Revue Internationale du Linceul de Turin* 3 (1996-1997), pp. 8-18; G. SALET, *Les thèses de messieurs Ivanov et Kouznetsov rebondissent*, in *Revue Internationale du Linceul de Turin* 10 (1998), pp. 2-20.

<sup>163</sup> A. LONG, *Attempt to affect the apparent <sup>14</sup>C age of cotton by scorching in a CO<sub>2</sub> environment*, in *Radiocarbon* 40, 1 (1998) pp. 57-58.

<sup>164</sup> R.E.M. HEDGES - C. BRONK RAMSEY - G.J. VAN KLINKEN, *An experiment to refute the likelihood of cellulose carboxylation*, in *Radiocarbon* 40, 1 (1998) pp. 59-60.

<sup>165</sup> M. ALONSO, *Les effets de la carboxylation sur la datation*, in *Revue Internationale du Linceul de Turin* 15-16 (1999-2000), pp. 50-52.

<sup>166</sup> R. VAN HAELST, *Osservazioni su "Ipotesi sul <sup>14</sup>C della S. Sindone" di G. Tessiore*, in *Collegamento pro Sindone*, July-August 1990, pp. 36-38.

<sup>167</sup> G. TESSIORE, *Ipotesi sul <sup>14</sup>C della S. Sindone*, in *Collegamento pro Sindone*, March-April 1990, pp. 9-10.

<sup>168</sup> R. VAN HAELST, *Kouznetsov: l'ultima soluzione?* in *Collegamento pro Sindone*, January-February 1994, pp. 40-47; R. VAN HAELST, *R.I.E. (Reazioni di scambi di ioni) e datazione radiocarbonica della Sindone*, in *Collegamento pro Sindone*, January-February 1995, pp. 41-43; R. VAN HAELST, *Sono veramente costanti le proporzioni tra gli isotopi <sup>13</sup>C e <sup>12</sup>C???*, in *Collegamento pro Sindone*, July-August 1995, pp. 28-31; R. VAN HAELST, *Una nuova ipotesi sulla datazione radiocarbonica della Sindone*, in *Collegamento pro Sindone*, May-June 1997, pp. 29-33.

<sup>169</sup> F. FERRERO - F. TESTORE - G. MALUCELLI - C. TONIN, *Thermal degradation of linen textiles: the effects of ageing and cleaning*, in *The Journal of the Textile Institute* 89, 3 (1998), pp. 562-569; E. BRUNATI, *La datazione, Kouznetsov e l'Istituto "O. Rivetti" di Biella*, in *Collegamento pro Sindone*, March-April 1999, pp. 24-28.

Physicist John Jackson, noting that it must also be considered the possible influence of the mechanism of image formation<sup>170</sup>, suggested that during the fire the radiocarbon at first increases and then decreases and this would explain the different results obtained in the experiments<sup>171</sup>. Jackson also exchanged views with Saillard and Salet<sup>172</sup>. Then Ivanov revived the theory of enrichment in radiocarbon caused by fire, but did not provide additional data, and developed the hypothesis of the influence of particular biofractionment and environmental factors<sup>173</sup>.

Jackson has also assumed a rejuvenation due to contamination by carbon monoxide (CO) as a percentage of 2% and submitted samples of his experiments to the Oxford laboratory, but without significant results<sup>174</sup>. Engineer Pierre de Riedmatten, skeptical about some other hypotheses, gave a chance to Jackson's theory<sup>175</sup>.

Chemist Michele Petrucci, of the iron works ILVA of Taranto, points out that in the Chambéry fire the Shroud was in a closed casket. In these conditions of lack of air, carbon monoxide is formed, causing the deposition of very refined graphite also within the fibers. This deposit could not be attacked by the cleaning systems used by the three laboratories<sup>176</sup>. Van Haelst, however, stresses that the fire cannot be the sole cause of contamination of the Shroud<sup>177</sup>.

Also textile expert John Tyrer of AMTAC Laboratories in Altrincham (UK) expressed his perplexity about the validity of the dating of the Shroud because of contaminants, especially those introduced by the Chambéry fire<sup>178</sup>. Hall answered him that the cleaning systems performed certainly removed all contamination<sup>179</sup>. Murdoch Baxter, director of the Scottish

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<sup>170</sup> J.P. JACKSON, *The radiocarbon date and how the image was formed on the Shroud*, in *Shroud Spectrum International* 28/29 (1988), pp. 2-12.

<sup>171</sup> J.P. JACKSON, *Carbon-14 in perspective*, in *Sindon - Nuova Serie* 9-10 (1996), pp. 91-100; J.P. JACKSON - K. PROPP, *On the evidence that the radiocarbon date of the Turin Shroud was significantly affected by the 1532 fire*, in *Acheiropoietos - "Non fait de main d'homme"*, *Actes du III Symposium Scientifique International du CIELT*, Nice, May 12-13, 1997, Éditions du CIELT, Paris 1998, pp. 61-82; J.P. JACKSON - K. PROPP - D.R. FORNOF, *A scientific evaluation of the radiocarbon date*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., pp. 1-6; J.P. JACKSON - K. PROPP - D.R. FORNOF, *On the scientific validity of the Shroud's radiocarbon date*, in *Proceedings of the 1999 Shroud of Turin International Research Conference*, Richmond, Virginia, June 18-20, 1999, Magisterium Press, Glen Allen (VA), USA 2000, pp. 283-301; J.P. JACKSON, *Datation scientifique du linceul de Turin*, in *Revue Internationale du Linceul de Turin* 28 (2006), pp. 29-39.

<sup>172</sup> J. JACKSON - Y. SAILLARD - G. SALET, *L'incendie de 1532 et le carbone 14*, in *Revue Internationale du Linceul de Turin* 13 (1999), pp. 20-23.

<sup>173</sup> A.A. IVANOV, *Carbon dating of the Turin Shroud: reasons for scepticism, alternative approaches, prospects and further research*, in *The Turin Shroud, past, present and future*, op. cit., pp. 479-494.

<sup>174</sup> O. POURRAT, *Le Linceul de Turin: vers un reprise du dialogue*, in *Revue Internationale du Linceul de Turin* 31 (2008), pp. 34-37, on p. 37.

<sup>175</sup> P. DE RIEDMATTEN, *Du nouveau sur le Linceul*, in *Cahiers sur le Linceul de Turin* 38 (2008), pp. 10-15; P. DE RIEDMATTEN, *20 ans après le test au carbone 14*, in *Cahiers sur le Linceul de Turin* 40 (2009), pp. 14-40.

<sup>176</sup> M. PETRUCCI, *Considerazioni sulla datazione della Sindone con il metodo del carbonio radioattivo*, in *Collegamento pro Sindone*, January-February 1993, pp. 47-50.

<sup>177</sup> R. VAN HAELST, *Osservazioni sull'articolo "Considerazioni sulla datazione della Sindone con il metodo del carbonio radioattivo" di Michele Petrucci*, in *Collegamento pro Sindone*, September-October 1993, pp. 45-48.

<sup>178</sup> J. TYRER, *Textile questions that remain following the carbon dating test*, in *Shroud Spectrum International* 28/29 (1988), pp. 13-15; J. TYRER, *Pulizia dei campioni di materiali tessili dai contaminanti prima dell'effettuazione di esami di datazione col radiocarbonio*, in *Collegamento pro Sindone*, January-February 1989, pp. 37-38; J. TYRER, *Is it really a fake?*, in *Textile Horizons* 9, 3 (1989), pp. 51-52.

<sup>179</sup> E.T. HALL, *Turin Shroud update - Contamination theory criticised*, in *Textile Horizons* 10, 1 (1990), p. 14.

Universities Research and Reactor Centre in East Kilbride (UK), nevertheless pointed out that there are also unaccounted sources of error<sup>180</sup>.

New director of the Oxford laboratory, Christopher Ramsey, said: “There are also other possible types of contaminant, and it could be that one, or some combination of these, might mean that the Shroud is somewhat older than the radiocarbon date suggests. It is important to realize, however, that only if some enriched contaminant can be identified does it become credible that the date is wrong by 1000 years. As yet there is no direct evidence for this, or indeed any *direct* evidence to suggest the original radiocarbon dates are not accurate. There is a lot of other evidence that suggests to many that the Shroud is older than the radiocarbon dates allow and so further research is certainly needed. It is important that we continue to test the accuracy of the original radiocarbon tests as we are already doing. It is equally important that experts assess and reinterpret some of the other evidence. Only by doing this will people be able to arrive at a coherent history of the Shroud which takes into account and explains all of the available scientific and historical information”<sup>181</sup>.

An attempt at radiocarbon enrichment of cloths, simulating the Chambéry fire, was performed by expert Mario Moroni in collaboration with engineer Francesco Barbésino and chemist Maurizio Bettinelli. They obtained a “rejuvenation” of about 300 years in the presence of water, while they obtained no changes without water. It is also interesting their experiment with a cloth that has been irradiated by a neutron flux, resulting in a rejuvenation of 360 years; the subsequent heat treatment of the sample has led to a further rejuvenation of 760 years, that is 1120 years in total<sup>182</sup>.

Moroni, who was already interested in dating the Oviedo Sudarium<sup>183</sup>, with Barbésino and Bettinelli found in this experiment also an explanation for the dating of the Sudarium, that the analysis conducted by the radiocarbon laboratory of Tucson and by the Isotracer Radiocarbon Laboratory in Toronto (Canada) attributed to about 650 d. C.: the Sudarium may have suffered only the irradiation, since it was never involved in a fire<sup>184</sup>.

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<sup>180</sup> A. COGHLAN, *Unexpected errors affect dating techniques*, in *New Scientist* 1684 (1989), p. 26.

<sup>181</sup> C. RAMSEY, *The Shroud of Turin*, Oxford Radiocarbon Accelerator Unit, March 2008, <http://c14.arch.ox.ac.uk/embed.php?File=shroud.html>

<sup>182</sup> M. MORONI, *L'incendio di Chambéry e le radiazioni di tipo nucleare possono aver mutato l'età della Sindone? Verifiche sperimentali*, in *Sindone - Nuova Serie* 5-6 (1993), pp. 49-61; M. MORONI - F. BARBESINO - M. BETTINELLI, *Verifica di una ipotesi di ringiovanimento radiocarbonico*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., pp. 1-25; M. MORONI - F. BARBESINO - M. BETTINELLI, *Possible rejuvenation modalities of the radiocarbon age of the Turin Shroud*, in *Proceedings of the 1999 Shroud of Turin International Research Conference, Richmond, Virginia*, op. cit., pp. 302-320; M. MORONI - F. BARBESINO - M. BETTINELLI, *Una suggestiva ipotesi riguardante i risultati della radiodattazione del Sudario di Oviedo e della Sindone di Torino*, in *Sindone 2000*, op. cit., Vol. I pp. 75-84 e Vol. III pp. 37-38; M. MORONI, *The age of the Shroud of Turin*, in *The Turin Shroud, past, present and future*, op. cit., pp. 515-522; M. MORONI, *“Ringiovanimento radiocarbonico” di vari tipi di tessuto dopo trattamento termico*, in *Sindone - Nuova Serie* 14 (2000), pp. 73-123; F. BARBESINO - M. MORONI, *Effects of neutron irradiation on linen fibres and consequences for a radiocarbon dating*, in *The Shroud of Turin - Perspectives on a multifaceted enigma, Proceedings of the 2008 Columbus International Conference, Columbus, August 14-17, 2008*, Ed. Libreria Progetto, Padua 2009, pp. 341-346, <http://ohioshroudconference.com/papers/p03.pdf>

<sup>183</sup> P.L. BAIMA BOLLONE - N. BALOSSINO - M. MORONI - S. ZACÀ, *Risultati della valutazione dei rilievi e degli esami su alcuni prelievi effettuati sul Sudario di Oviedo il 24 maggio 1985 ed il 7-8 maggio 1994*, in *El Sudario del Señor, Actas del I Congreso Internacional sobre El Sudario de Oviedo*, Oviedo, October 29-31, 1994, Servicio de Publicaciones, Universidad de Oviedo, Spain 1996, pp. 387-412; M. MORONI, *La radiodattazione del Sudario di Oviedo*, in *Collegamento pro Sindone*, March-April 1999, pp. 29-36.

<sup>184</sup> M. MORONI - F. BARBESINO - M. BETTINELLI, *Una suggestiva ipotesi riguardante i risultati della radiodattazione del Sudario di Oviedo e della Sindone di Torino*, op. cit., Vol. I pp. 75-84 e Vol. III pp. 37-38.

Lindner thought of a radiocarbon enrichment caused by neutron irradiation that would be emitted from the body of Christ during resurrection<sup>185</sup>. The hypothesis had already been put forward by physicist Thomas Phillips<sup>186</sup> of Harvard University in Cambridge (MA, USA) and rejected by Hedges<sup>187</sup>. A letter of reply by Phillips to the objections of Hedges was rejected by *Nature*<sup>188</sup>. Also biophysicist Jean-Baptiste Rinaudo of the University of Montpellier (France) suggests an enrichment in radiocarbon caused by neutron irradiation<sup>189</sup>. This hypothesis is taken into consideration by de Riedmatten<sup>190</sup> and physicist Peter Carr<sup>191</sup>. The Jesuit J. Loring reported the unanimous opinion of many Spanish scientists, among whom D.J. Amado Moya, M. Ordeig, F. Bosch Asís de Ariño, D.R. Salcedo, J. Munarriz, M. Arvesú<sup>192</sup>. The radiocarbon produced by neutron irradiation is not removed by high temperatures or chemical cleaning treatments used in the examinations of 1988<sup>193</sup>. The hypothesis of the effect of a supernova explosion is felt to be highly unlikely<sup>194</sup>. It was also discussed a possible influence of the metal reliquary, in which the Shroud was kept for centuries<sup>195</sup>.

<sup>185</sup> E. LINDNER, *La Sindone: una falsificazione?* In *Collegamento pro Sindone*, November-December 1988, pp. 52-54; E. LINDNER, *The ambiguity of the radiocarbon results of the Turin Shroud*, op. cit., pp. 149-166; E. LINDNER, *Ipotesi su tutte le tracce della Sindone - Parte prima*, in *Collegamento pro Sindone*, September-October 1993, pp. 25-44; E. LINDNER, *Ipotesi su tutte le tracce della Sindone - Parte seconda*, in *Collegamento pro Sindone*, November-December 1993, pp. 30-44; E. LINDNER, *Hypothèse expliquant la formation de toutes les traces dans le Linceul de Turin*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 285-291; E. LINDNER, *The Shroud of Jesus Christ: the "scientific Gospel" to renew the faith in Resurrection*, in *Sindone 2000*, op. cit., Vol. I pp. 165-173 e Vol. III pp. 55-58.

<sup>186</sup> T.J. PHILLIPS, *Shroud irradiated with neutrons?*, in *Nature*, 337, 6208 (1989), p. 594.

<sup>187</sup> R.E.M. HEDGES, *Shroud irradiated with neutrons? Hedges replies*, in *Nature*, 337, 6208 (1989), p. 594.

<sup>188</sup> *The letter that 'Nature' did not print*, in *British Society for the Turin Shroud Newsletter* 22 (1989), pp. 8-11.

<sup>189</sup> J.-B. RINAUDO, *Nouvelle hypothèse sur la formation de l'image du Linceul de Turin invalidant son âge radiocarbone*, in *Montre-Nous Ton Visage* 3 (1990), pp. 9-12; J. EVIN - J. GREY - J.-C. POIZAT - J. REMILLIEUX, *Commentaires sur l'article de Monsieur Rinaudo et sur son protocole expérimental*, in *Montre-Nous Ton Visage* 3 (1990), pp. 13-17; J.-B. RINAUDO, *Reponse de Mr Rinaudo aux commentaires de Mm. Jacques Evin, Jean Grey, Jean Claude Poigot et Joseph Remilleux*, in *Montre-Nous Ton Visage* 4 (1990), pp. 13-17; J.-B. RINAUDO, *Hypothèse protonique sur la formation de l'image du Linceul de Turin - Le verdict expérimental*, in *Montre-Nous Ton Visage* 6 (1991), pp. 7-14; *Table ronde sur les recherches du P. Rinaudo*, in *Montre-Nous Ton Visage* 7 (1992), pp. 6-23; J.-B. RINAUDO, *Réponse à trois objections et à deux considérations complémentaires*, in *Montre-Nous Ton Visage* 12 (1994), pp. 16-21; J.-B. RINAUDO, *Nouveau mécanisme de formation de l'image sur le Linceul de Turin, ayant pu entraîner une fausse radiodatation médiévale*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 293-299; J.-B. RINAUDO, *Quelques nouveaux tests*, in *Cahiers sur le Linceul de Turin* 36 (2007), pp. 9-11.

<sup>190</sup> P. DE RIEDMATTEN, *Synthèse de l'affaire C14, vingt ans après le test de 1988*, in *Cahiers sur le Linceul de Turin* 42 (2010), pp. 12-19.

<sup>191</sup> *British scientist Peter Carr on the dating of the Shroud and the formation of its image*, in *Shroud Newsletter* 49 (1999), pp. 23-29.

<sup>192</sup> J. LORING, *¿Qué pasa con la Sabana Santa y el carbono-14?*, in *La datazione della Sindone*, op. cit., pp. 182-189.

<sup>193</sup> A.C. LIND - M. ANTONACCI - G. FANTI - D.ELMORE - J.M GUTHRIE, *Production of radiocarbon by neutron radiation on linen*, in *Proceedings - International Workshop on the Scientific approach to the Acheiropoietos Images*, Frascati May 4-6, 2010, ENEA, Frascati (Rome) 2010, pp. 255-262, <http://www.acheiropoietos.info/proceedings/LindWeb.pdf>

<sup>194</sup> J. EVIN, *Une supernova: une hypothèse parmi tant d'autres sur la teneur en carbone 14 du Linceul de Turin*, in *Montre-Nous Ton Visage* 12 (1994), pp. 22-35.

<sup>195</sup> B. MAKIEJ - J. CHODASIEWICZ - W. FENRYCH - S. WALISZEWSKI, *L'influenza del reliquiario sulla datazione della Sindone col <sup>14</sup>C*, in *Collegamento pro Sindone*, March-April 1989, pp. 34-35; T. FLEMING, *Could carbon dating be erroneous if the Shroud was kept in a metallic container for a significant period between A.D. 30-2000?*, in *Shroud Newsletter* 51 (2000), pp. 29-37.

### ***Was the analysed sample representative of the whole cloth?***

Physicist Bernard Power believes that contamination, considering how many times the Shroud has been touched in that corner, may have affected the radiocarbon result<sup>196</sup>. Savarino emphasized: “Cases of sure divergence between the true age of objects and their age determined by radiocarbon dating are well known. The more frequent differences can be detected for highly contaminated samples in the course of centuries by contact with the environment. In contrast, the more accurate radiocarbon datings can be found on samples stored in almost watertight sealed containers.

Among the finds at risk are the textile fibers. In fact, the surface-per-unit weight exposed to the interaction with the outside is much higher than other systems (wood, leather) because of the small diameter of the fibers (of the order of tens of microns). If during the preparation of the samples the whole foreign material is not removed, we can easily incur in significant errors in dating”<sup>197</sup>.

A spectroscopic investigation carried out by chemist Alan Adler of the Western Connecticut State University in Danbury (CT, USA) is particularly interesting. From the Shroud samples taken by STURP with sticky tapes in 1978, nineteen fibers were extracted, representative of the different zones of the Shroud: non-image, waterstain, scorches, image, backing cloth, and serum. These were compared with other fifteen fibers taken from three threads of the radiocarbon sample. The patterns obtained show differences in chemical composition, further confirmed by peak frequency analysis.

In particular the radiocarbon samples are not representative of the non-image areas that comprise the bulk of the cloth. This difference was also supported by the scanning electron microprobe analysis that showed gross enrichment of the inorganic mineral elements in the radiocarbon samples, even compared to the waterstain fibers taken from the bulk of the cloth. In fact, the radiocarbon sample’s fibers appear to be an exaggerated composite of the waterstain and scorch fibers, thus demonstrating that it is not typical of the non-image sections of the main cloth<sup>198</sup>.

Before the publication of the results of radiocarbon test, Gove said: “The fact that all three laboratories received a sample from essentially the same place on the Shroud, and all will use essentially the same cloth cleaning procedures, means that any contamination that is not removed by such cleaning methods will equally affect all three measurements making them in agreement but wrong”<sup>199</sup>. Subsequently, however, Gove believes that the different cleaning methods used did remove all contamination, which, in order to move the date from the first to fourteenth century, would represent 64% of the sample<sup>200</sup>.

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<sup>196</sup> B.A. POWER, *Datazione con il <sup>14</sup>C ed energia d'immagine per la Sindone di Torino*, in *Collegamento pro Sindone*, September-October 1992, pp. 20-34.

<sup>197</sup> P. SAVARINO, *La radiodattazione della Sindone*, in B. BARBERIS - P. SAVARINO, *Sindone, radiodattazione e calcolo delle probabilità*, Elle Di Ci, Leumann (TO) 1997, pp. 3-26, on p. 11.

<sup>198</sup> A.D. ADLER, *Updating recent studies on the Shroud of Turin*, in *American Chemical Society, Symposium Series 625*, 17 (1996), pp. 223-228; A.D. ADLER - R. SELZER - F. DEBLASE, *Further spectroscopic investigations of samples of the Shroud of Turin*, in *The Shroud of Turin - Unraveling the Mystery, Proceedings of the 1998 Dallas Symposium*, Alexander Books, Alexander (NC), USA 2002, pp. 166-181.

<sup>199</sup> H.E. GOVE, *Progress in radiocarbon dating the Shroud of Turin*, op. cit., p. 967.

<sup>200</sup> H.E. GOVE, *Dating the Turin Shroud - An assessment*, in *Radiocarbon* 32, 1 (1990), pp. 87-92, on p. 87.

Hedges reminded that the amount of contamination required to shift a date by 1300 years would require the addition of about 50% more material of “modern” carbon<sup>201</sup>. According to Hall, it is 40%<sup>202</sup>. Physicist Roberto Gallino, of the University of Turin, calculated that to rejuvenate of 1300 years a sample of two thousand years of age, an extra amount of <sup>14</sup>C by about 17% should be necessary<sup>203</sup>. But he complains about the inappropriate choice of the sampling site, the statistical analysis with the test of chi-squared which is not good only for the Shroud sample, the age of the control samples previously stated, the presence of unauthorized persons during the measurements, the uncertainty about the weight of the samples<sup>204</sup>.

Van Haelst shows a notice received by the laboratory of Oxford together with the results of some request dating: “One should bear in mind that these measurements have been made on organic material and that this cannot be regarded as a guarantee of the article date of manufacture. It should be noted that the undetected presence of any contaminant may affect any radiocarbon result”<sup>205</sup>.

Misleading dates are not rare at all. Meacham reminded his experience as an archeologist in dating more than one hundred samples: 78 dates were considered credible, 26 were rejected as unreliable, and 11 were deemed problematic<sup>206</sup>. Archaeologist Stewart Fleming, director of MASCA (Museum Applied Science Center for Archaeology) of the University of Pennsylvania in Philadelphia (PA, USA), stressed the frequency of rogue samples, which he thought might be one in ten<sup>207</sup>.

Ettore Morano, head physician of the hospital *Sant'Andrea* in Vercelli, examining a piece of thread coming from the Shroud with a scanning electron microscope, saw that “the surface of individual fibers shows a ‘filthy’ appearance with abundant deposits of pollutant material extraneous to but intimately connected with individual fibers of the cloth”<sup>208</sup>. That material was composed by spores and fungal hyphae in significant amounts: more than 10% of the mass of the thread. This pollution can heavily influence the results of radiocarbon dating<sup>209</sup>.

Chemist Alberto Brandone of the University of Pavia stressed the influence of fungi, bacteria and spores on the linen fibers of the Shroud, with the development and deposit of

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<sup>201</sup> R.E.M. HEDGES, *A note concerning the application of radiocarbon dating to the Turin Shroud*, in *Approfondimento Sindone* 1 (1997), pp. 1-8, on p. 6.

<sup>202</sup> J. CORNWELL, *Science and the Shroud*, op. cit., p. 36.

<sup>203</sup> R. GALLINO, *Sul problema del “ringiovanimento” del tessuto sindonico con la datazione al radiocarbonio*, in *Sindon - Nuova Serie* 1 (1989), pp. 71-75, on p. 73.

<sup>204</sup> R. GALLINO, *La Sindone e il radiocarbonio*, in *La datazione della Sindone*, op. cit., pp. 59-64.

<sup>205</sup> R. VAN HAELST, *A critical review of the radiocarbon dating of the Shroud of Turin. ANOVA - a useful method to evaluate sets of high precision AMS radiocarbon measurements*, in *Proceedings - International Workshop on the Scientific approach to the Acheiropoietos Images*, op. cit., pp. 267-273, on p. 267, <http://www.acheiropoietos.info/proceedings/VanHaelstWeb.pdf>

<sup>206</sup> W. MEACHAM, *Thoughts on the Shroud <sup>14</sup>C debate*, in *The Turin Shroud, past, present and future*, op. cit., pp. 442-454, on p. 444.

<sup>207</sup> *Letter from archaeologist Paul Maloney to Father Peter Rinaldi*, in J.G. MARINO, *Wrapped up in the Shroud*, Cradle Press, St. Louis (MO), USA 2011, pp. 251-255.

<sup>208</sup> E. MORANO, *Aspetti ultrastrutturali al microscopio elettronico a scansione di fibre della Sindone di Torino*, in *La Sindone e la Scienza*, op. cit., pp. 201-204, on p. 202.

<sup>209</sup> P.L. BAIMA BOLLONE - P. COERO BORGIA - E. MORANO, *Prime osservazioni sulla fine struttura della Sindone al microscopio elettronico a scansione*, in *Sindon* 26 (1977), pp. 15-22.

products of metabolism and degradation<sup>210</sup>. On the contrary, Wölfli said that he found no contaminating material on the sample<sup>211</sup>.

Chemist Valery Golikov of the Research Institute for Cultural and Natural Heritage in Moscow (Russia) reminded the possible influence of carbonaceous contamination<sup>212</sup>. A group of physicists at the University of Cagliari stressed that locally abnormal environmental situations can occur, that are reflected in a wrong radiocarbon dating<sup>213</sup>.

Leoncio Garza-Valdes and Stephen Mattingly, two microbiologists at the University of Texas Health Science Center in San Antonio (TX, USA), noticed that some Shroud fibers are coated with a layer of bacteria and fungi that cannot be removed with conventional cleaning methods. This coating can affect the dating also by 500-600 years<sup>214</sup>.

The research by Garza-Valdes and Mattingly was strongly criticized by McCrone<sup>215</sup> and Adler<sup>216</sup>, but, instead, drew the attention of David<sup>217</sup> and Gove<sup>218</sup>. The latter believed that the layer could not move the dating of more than one hundred years<sup>219</sup>. However, he observed that the bandage of the mummy of an ibis, whose bands showed the same bioplastic coating of the Shroud, appeared by 400-700 years younger than the bones<sup>220</sup>. Gove, who does not believe the Shroud an authentic relic, however prefers not to call it a hoax, but an icon<sup>221</sup>.

Sindonologist Maria Grazia Siliato, considering the abnormal weight of the Shroud sample used for the radiocarbon dating, suggested the presence of a mending instead<sup>222</sup>. Sindonologists Joseph Marino and M. Sue Benford provided some evidence of the existence of an “invisible” mending dating to the sixteenth century in the area where the sample for radiocarbon analysis was taken, including differences in thread color and size and weave

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<sup>210</sup> A. BRANDONE, *Datazione di reperti archeologici: problematiche connesse*, in *Sindon - Nuova Serie* 1 (1989), pp. 31-33, on p. 33.

<sup>211</sup> R. VAN HAELEST, *La Santa Sindone e la datazione col <sup>14</sup>C*, in *Collegamento pro Sindone*, May-June 1989, pp. 30-33.

<sup>212</sup> V. GOLIKOV, *The analysis of natural factors capable of modifying the radiocarbon age of the Turin Shroud*, in *Sindone 2000*, op. cit., Vol. I pp. 151-164.

<sup>213</sup> F. ARAMU - C. MUNTONI - G. ERRIU - S. ONNIS - N. ZUCCA, *Possibili alterazioni dell'equilibrio generale del <sup>14</sup>C*, in *La datazione della Sindone*, op. cit., pp. 127-132.

<sup>214</sup> L.A. GARZA-VALDÈS - F. CERVANTES-IBARROLA, *Biogenic varnish and the Shroud of Turin*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 279-282; J. TRAVIS, *Microbes muddle Shroud of Turin's age*, in *Science News* 147, 22 (1995), p. 346; J. BARRET, *Science and the Shroud - Microbiology meets archaeology in a renewed quest for answers*, in *The Mission*, The University of Texas Health Science Center at San Antonio, 23, 1 (1996), pp. 6-11.

<sup>215</sup> WALTER MCCRONE, *Letters to the editor*, in *British Society for the Turin Shroud Newsletter* 40 (1995), pp. 22-24.

<sup>216</sup> A.D. ADLER, *The nature of the body images on the Shroud of Turin*, in *Proceedings of the 1999 Shroud of Turin International Research Conference, Richmond, Virginia, June 18-20, 1999*, op. cit., pp. 19-29, on p. 25.

<sup>217</sup> *Interest in Garza-Valdès's bioplastic hypothesis from Manchester Museum Egyptologist Dr. Rosalie David*, in *British Society for the Turin Shroud Newsletter* 43 (1996), pp. 9-10.

<sup>218</sup> H.E. GOVE, *Relic, icon or hoax? Carbon dating the Turin Shroud*, Institute of Physics Publishing, Bristol (UK) and Philadelphia (PA), USA 1996, p. 308.

<sup>219</sup> H.E. GOVE, *Letters to the editor*, in *British Society for the Turin Shroud Newsletter* 40 (1995), pp. 20-22.

<sup>220</sup> H.E. GOVE - S.J. MATTINGLY - A.R. DAVID - L.A. GARZA-VALDÈS, *A problematic source of organic contamination of linen*, in *Nuclear Instruments and Methods in Physics Research*, B 123 (1997), pp. 504-507.

<sup>221</sup> H.E. GOVE, *Relic, icon or hoax? Carbon dating the Turin Shroud*, op. cit., p. 309.

<sup>222</sup> M.G. SILIATO, *La Sindone di Torino e la sua radiodatazione*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 243-246.

pattern<sup>223</sup>. Flury-Lemberg denies the existence of such a darn<sup>224</sup>, but according to Savarino “the sampling site does not exclude this hypothesis”<sup>225</sup>.

Chemist Raymond Rogers of Los Alamos National Laboratory in Los Alamos (NM, USA) stressed that in the Raes sample some cotton fibers were identified. He observed that the fibers of the Raes sample and those of the sample used for the radiocarbon dating appear coated and impregnated by a yellow-brown amorphous substance which is not present, however, in the fibers of other areas of the Shroud. The coating of these fibers is a vegetable gum (Gum Arabic) containing a dye, alizarin, in two forms: one part is dissolved in the gum and a part is bound to hydrous aluminum oxide [AlO(OH)]. Alum has been used as a common mordant for millennia.

Furthermore, UV fluorescence photograph shows that the area of the radiocarbon sampling has a chemical composition different from the rest of the sheet. It can also be noted a different aspect in radiography<sup>226</sup>. The dye, relatively viscous, did not penetrate through the intersection of the threads. Physicist John Brown said: “This would appear to be obvious evidence of a medieval artisan’s attempt to dye a newly added repair region of fabric to match the aged appearance of the remainder of the Shroud”<sup>227</sup>.

Adler also considers a restoration as likely: “That’s an area which has obviously been repaired”<sup>228</sup>. Archaeologist Paul Maloney holds the same opinion and stresses the importance of the discovery of the coating of encrustations found on some cotton fibers of the Raes sample<sup>229</sup>.

The threads of the Raes sample, such as those of the Holland cloth, and those of modern linen, have much less lignin in growth nodes compared to the fibers of the rest of the Shroud. A segment of yarn of the Raes sample also shows a particular junction of two ends: a darker and more encrusted thread is inserted in a larger and clearer thread. Rogers concludes that the sample used for radiocarbon dating was not representative of the original Shroud cloth due to

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<sup>223</sup> J. MARINO - M.S. BENFORD, *Evidence for the skewing of the C-14 dating of the Shroud of Turin due to repairs*, in *Sindone 2000*, op. cit., Vol. I pp. 57-64 e Vol. III pp. 27-30; J. MARINO - M.S. BENFORD, *Could the Shroud’s radiocarbon date have been skewed due to 16<sup>th</sup> century repairs?*, in *Shroud Newsletter* 54 (2001), pp. 18-27; R.N. ROGERS, *Supportive comments on the Benford-Marino “16<sup>th</sup> century repairs” hypothesis*, in *Shroud Newsletter* 54 (2001), pp. 28-33; M.S. BENFORD - J.G. MARINO, *Discrepancies in the radiocarbon dating area of the Turin Shroud*, in *Chemistry Today* 26, 4 (2008), pp. 4-12; J. MARINO - M.S. BENFORD, *Invisible mending and the Turin Shroud: historical and scientific evidence*, in *The Shroud of Turin - Perspectives on a multifaceted enigma*, op. cit., pp. 291-298, <http://ohioshroudconference.com/papers/p11.pdf>; M.S. BENFORD - J.G. MARINO, *Discrepancies in the radiocarbon dating area of the Turin Shroud*, in *The Shroud of Turin - Perspectives on a multifaceted enigma*, op. cit., pp. 299-318, <http://ohioshroudconference.com/papers/p09.pdf>

<sup>224</sup> M. FLURY-LEMBERG, *The invisible mending of the Shroud in theory and reality*, in *Shroud Newsletter* 65 (2007), pp. 10-27.

<sup>225</sup> P. SAVARINO, *La radiodattazione della Sindone*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., p. 3.

<sup>226</sup> R.N. ROGERS, *Studies on the radiocarbon sample from the Shroud of Turin*, in *Thermochimica Acta* 425 (2005), pp. 189-194; R.N. ROGERS, *A chemist’s perspective on the Shroud of Turin*, B.M. Schwartz, lulu.com, 2008.

<sup>227</sup> J.L. BROWN, *Microscopical investigation of selected Raes threads from the Shroud of Turin*, in *Shroud Newsletter* 61 (2005), pp. 24-28.

<sup>228</sup> T.W. CASE, *The Shroud of Turin and the C-14 dating fiasco*, op. cit., p. 73.

<sup>229</sup> P. C. MALONEY, *What went wrong with the Shroud’s radiocarbon date? Setting it all in context*, in *The Shroud of Turin - Perspectives on a multifaceted enigma*, op. cit., pp. 286-290, <http://ohioshroudconference.com/a14.htm>

the existence of a mending<sup>230</sup>. This statement does not convince de Riedmatten<sup>231</sup>, while chemist Robert Villarreal of Los Alamos National Laboratory in Los Alamos (NM, USA) confirmed and continued Rogers' research<sup>232</sup>.

The presence of cotton in the sample used for radiocarbon dating was also detected by the Oxford laboratory<sup>233</sup>, who found also crystals of sodium chloride<sup>234</sup>. Hall reported that they were colored cotton fibers<sup>235</sup>. "The cotton - said Peter South, director of the laboratory of textile analysis in Ambergate (UK) who examined the Shroud fibers found in the sample - is a fine, dark yellow strand, possibly of Egyptian origin and quite old. Unfortunately, it is impossible to say how it ended up in the Shroud, which is basically made from linen. It may have been used for repairs at some time in the past, or simply became bound in when the linen fabric was woven"<sup>236</sup>. In Zurich it was noted "an odd assortment of debris, from fungi to bits of nylon"<sup>237</sup>.

In Tucson a thread of red silk and blue fibers were found on the sample<sup>238</sup>. Freer-Waters and Jull confirm that in the sample of the Shroud in their possession, there are traces of cotton, but they deny the presence of any coating or dyeing on the fibers<sup>239</sup>. Physicist Gian Marco Rinaldi, however, notes that in their article the counting of the number of warp threads and weft threads per centimeter is wrong; also for the thickness of the fabric it is supplied a value lower than that of the Shroud. From the photograph of the preserved fragment, Rinaldi argues that it was cut from the larger sample of the two received in Tucson; the remaining part of the larger sample was not sufficient to be divided into four for dating, so it must have been used also the smaller fragment<sup>240</sup>.

Engineer Giulio Fanti, professor of Mechanical and Thermic Measurements at Padua University, however, told him that he heard from Jull that the dated sample was only the larger one<sup>241</sup>. At this point the account is at odds with what was communicated from Tucson about the weights of the fragments into which the material received was divided<sup>242</sup> and this is underlined by Saillard<sup>243</sup>. Even de Riedmatten expresses his doubts on the textile study of Freer-Waters and Jull<sup>244</sup>.

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<sup>230</sup> R.N. ROGERS, *Studies on the radiocarbon sample from the Shroud of Turin*, op. cit., pp. 189-194; N. ROGERS, *A chemist's perspective on the Shroud of Turin*, op. cit., 2008.

<sup>231</sup> P. DE RIEDMATTEN, *L'échantillon C14 était-il représentatif?*, in *Cahiers sur le Linceul de Turin* 44 (2011), pp. 14-31.

<sup>232</sup> R. VILLAREAL - B. SCHWORTZ - M.S. BENFORD, *Analytical results on threads taken from the Raes sampling area (corner) of the Shroud*, in *The Shroud of Turin - Perspectives on a multifaceted enigma*, op. cit., pp. 319-336, <http://ohioshroudconference.com/a17.htm>

<sup>233</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 614.

<sup>234</sup> I. WILSON, *From a forgotten memorandum: a visit to the Oxford Research laboratory, 7 July 1988*, in *British Society for the Turin Shroud Newsletter* 41 (1995), pp. 15-18, on p. 18.

<sup>235</sup> J. CORNWELL, *Science and the Shroud*, op. cit., p. 36.

<sup>236</sup> WORLD NEWS NETWORK, *Rogue fibres found in the Shroud*, in *Textile Horizons* 8, 12 (1988), p. 13.

<sup>237</sup> D. SOX, *The Shroud unmasked - Uncovering the greatest forgery of all time*, op. cit., p. 141.

<sup>238</sup> D. SOX, *How an age of mystery ended*, in *The Times*, October 15, 1988, p. 36.

<sup>239</sup> A. FREER-WATERS - A. J. T. JULL, *Investigating a dated piece of the Shroud of Turin*, op. cit., pp. 1521-1527.

<sup>240</sup> G.M. RINALDI, *Autogol a Tucson*, January 2011, <http://sindone.weebly.com/autogoltucson.html>

<sup>241</sup> G.M. RINALDI, *Autogol a Tucson - Poscritto*, January 12, 2011, <http://sindone.weebly.com/autogoltucson.html>

<sup>242</sup> G. DE NANTES, *La datation au carbone 14 - La traque des faussaires*, in *La Contre-Réforme Catholique au XX<sup>e</sup> Siècle*, op. cit., pp. 35-42

<sup>243</sup> Y. SAILLARD, *L'échantillon de la datation de 1988 conservé par le laboratoire d'Arizona est-il authentique?*, in *Revue Internationale du Linceul de Turin* 35 (2011), pp. 58-63.

<sup>244</sup> P. DE RIEDMATTEN, *L'échantillon C14 était-il représentatif?*, op. cit. 14-31.

Strong criticisms were leveled even against the statistical analysis of results. Engineer Ernesto Brunati emphasized that when comparing a set of values, you must be sure they are uniform and also the average requires uniformity of terms. The verification of this is done using the chi-squared test that allows to determine the level of significance. The chi-squared must be less than 5.991 and the resulting level of significance should be above 5%<sup>245</sup>.

In *Nature* is written: "The agreement among the three laboratories for the samples 2, 3 and 4 is exceptionally good. The spread of the measurements for sample 1 (Shroud) is somewhat greater than would be expected from the errors quoted"<sup>246</sup>. For the Shroud it is indicated an average of 646±31 for the sample of Tucson (Arizona), 750±30 for the sample of Oxford, 676±24 for the sample of Zurich. The relative value of chi-squared is 6.4 and the significance level is 5<sup>247</sup>.

Even Van Haelst, like other scholars<sup>248</sup>, expressed many doubts on the statistical analysis published in *Nature*<sup>249</sup>. Analyzing the 12 average dates in Table 2 of *Nature* by the ANOVA method, he concluded: "The calculated F value 4,7 is larger than 4,2, the critical F value for 2-9 degrees of freedom"<sup>250</sup>.

Brunati points out that with a chi-square of 6.4, the significance level is 4.07, not 5. But in reality the average of Tucson is 646±17; with this value the chi-squared becomes 9.13 and the significance level drops to 1.04%, which are unacceptable values for homogeneity of measurements published. Brunati, who suspected a deliberate and manifest manipulation of data, did not receive satisfactory answers from the British Museum and from the laboratories despite the letters sent them<sup>251</sup> and the publication of numerous articles in the course of the

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<sup>245</sup> E. BRUNATI, *I conti non tornano!*, in *Il Telo* 3 (1997), pp. 14-16, on p. 15.

<sup>246</sup> P.E. DAMON *et al.*, *Radiocarbon dating of the Shroud of Turin*, op. cit., p. 613.

<sup>247</sup> *Ibid.*

<sup>248</sup> R. P. JOUVENROUX, *Intervalles de confiance et datation radiocarbone du Linceul de Turin*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 189-205; M.-C. VAN OOSTERWYCK-GASTUCHE, *La Sindone e il radiocarbonio. Una sentenza contestata: l'età medievale della Sindone*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., pp. 1-9; B.J. WALSH, *The 1988 Shroud of Turin radiocarbon tests reconsidered*, in *Proceedings of the 1999 Shroud of Turin International Research Conference, Richmond, Virginia*, op. cit., pp. 326-346.

<sup>249</sup> R. VAN HÆLST, *Aumentano i dubbi sulla datazione radiocarbonica*, in *Collegamento pro Sindone*, January-February 1990, pp. 27-37; R. VAN HÆLST, *Rappresentazione grafica dell'analisi statistica dei dati della datazione radiocarbonica della Sindone*, in *Collegamento pro Sindone*, March-April 1990, pp. 11-17; R. VAN HÆLST, *La datazione radiocarbonica della Sindone rivista con il nuovo modello IEM-EEM*, in *Collegamento pro Sindone*, September-October 1991, pp. 48-50; R. VAN HÆLST, *Onestà scientifica*, in *Collegamento pro Sindone*, September-October 1991, pp. 52-53; R. VAN HÆLST, *La datazione della Sindone veramente manipolata*, in *Collegamento pro Sindone*, May-June 1992, pp. 30-33; R. VAN HÆLST, *Il vero significato di "livello di significatività 5%" per una datazione medievale della Sindone*, in *Collegamento pro Sindone*, September-October 1992, pp. 35-38; R. VAN HÆLST, *Un "caveat" (avvertimento) riguardante la datazione radiocarbonica della Sindone*, in *Collegamento pro Sindone*, November-December 1994, pp. 41-43; R. VAN HÆLST, *Radiocarbon dating of the Shroud of Turin - Critical analysis statistics «Nature» data*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 207-218; R. VAN HÆLST, *New light on the radiocarbon dating of the Shroud*, in *Sindone e Scienza - Bilanci e programmi alle soglie del terzo millennio*, op. cit., pp. 1-4; R. VAN HÆLST, *The Shroud of Turin and the reliability of the 95% error confidence interval*, in *Proceedings of the 1999 Shroud of Turin International Research Conference, Richmond, Virginia*, op. cit., pp. 321-326; R. VAN HÆLST, *The radiocarbon dating of the Shroud*, in *Sindone 2000*, op. cit., Vol. I pp. 93-99; R. VAN HÆLST, *Radiocarbon dating the Shroud of Turin*, in *Collegamento pro Sindone Internet*, October 2002, <http://space.tin.it/scienza/bachm/VHAELST6.PDF>

<sup>250</sup> R. VAN HÆLST, *A critical review of the radiocarbon dating of the Shroud of Turin. ANOVA - a useful method to evaluate sets of high precision AMS radiocarbon measurements*, op. cit., pp. 267-273.

<sup>251</sup> E. BRUNATI, *I conti non tornano!*, op. cit., pp. 14-16.

years<sup>252</sup>. Also Van Haelst did not have adequate answers to his questions<sup>253</sup>. Jull admitted: “This is a bad level. Normally, with such a result, I make the measures again”<sup>254</sup>.

Brunati’s calculations were confirmed by two professors of Statistics at *La Sapienza* University of Rome, Livia De Giovanni and Pierluigi Conti<sup>255</sup>. In addition, four scientists from different universities stressed the heterogeneity of the media for the dating of the Shroud cloth. Relying on their calculations, it must be considered as likely the presence, in the analyzed piece of cloth, of an environmental contamination, which has acted in a non-uniform, but linear way, adding a systematic effect that is not negligible<sup>256</sup>.

## **Conclusions**

The heavy shadows thrown on the whole course of radiocarbon dating of the Shroud were never dissipated. Not all the procedures followed for the completion of the radiocarbon test were regular. The history of the events and of the traumas suffered by the relic make it a difficult object, whose radiocarbon dating cannot provide reliable data. The analyzed sample, because of its peculiar characteristics, was not representative of the whole sheet. Consequently, according to the radiocarbon dating performed in 1988, it cannot be definitely stated that the manufacture of the Shroud should be placed in the middle of the fourteenth century.

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<sup>252</sup> E. BRUNATI, *Incongruenze nei rapporti illustranti la datazione della Sindone*, in *L'identification scientifique de l'Homme du Linceul: Jésus de Nazareth*, op. cit., pp. 349-357; E. BRUNATI, *Dobbiamo convincerci che il risultato del passaggio conclusivo del rapporto su "Nature" è stato falsificato*, in *Collegamento pro Sindone*, May-June 1993, p. 50-56; E. BRUNATI, *A proposito di errori nel rapporto sulla datazione*, in *Collegamento pro Sindone*, May-June 1997, p. 34-39; E. BRUNATI, *Altro che rammendi! La datazione della Sindone è tutta un falso*, in *Collegamento pro Sindone Internet*, May 2005, <http://www.sindone.info/BRUNATI1.PDF>; E. BRUNATI, *La corrispondenza con "Radiocarbon" sulla datazione della Sindone*, in *Collegamento pro Sindone Internet*, February 2006, <http://www.sindone.info/BRUNATI2.PDF>

<sup>253</sup> R. VAN HÆLST, *Una domanda per la verità*, in *Collegamento pro Sindone*, July-August 1990, pp. 45-47; R. VAN HÆLST, *La datazione al radiocarbonio rivista dagli esperti*, in *Collegamento pro Sindone*, July-August 1991, pp. 44-48; R. VAN HÆLST, *Il British Museum alla fine aprirà i suoi archivi sindonici?*, in *Collegamento pro Sindone*, July-August 1993, pp. 29-33.

<sup>254</sup> B. PERRIER, *Qui a peur du Saint Suaire ?*, op. cit., p. 131.

<sup>255</sup> M. TOSATTI, *Inchiesta sulla Sindone*, Piemme, Casale Monferrato (AL) 2009, pp. 14-34 e 193-196.

<sup>256</sup> M. RIANI - G. FANTI - F. CROSILLA - A.C. ATKINSON, *Statistica robusta e radiodating della Sindone*, in *Sis-Magazine*, March 31, 2010, <http://www.sis-statistica.it/magazine/spip.php?article177>; G. FANTI - F. CROSILLA - M. RIANI - A.C. ATKINSON, *A robust statistical analysis of the 1988 Turin Shroud radiocarbon dating results*, in *Proceedings - International Workshop on the Scientific approach to the Acheiropoietos Images*, op. cit., pp. 249-253, <http://www.acheiropoietos.info/proceedings/RianiWeb.pdf>

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