

Invisible Mending and the Turin Shroud: Historical and Scientific Evidence

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The “Shroud of Turin,” believed by many to be the actual cloth that wrapped Jesus of Nazareth after his death as recounted in all 4 gospels, has long been known in Europe, where it has been located for a minimum of 650 years. The Shroud became well-known in the Americas after 2 rounds of testing, multi-disciplinary studies in 1978 and then a carbon-dating (C-14) test in 1988. The 1978 multidisciplinary studies were performed by a mostly-American group called “Shroud of Turin Research Project” (STURP). The 1988 tests were performed by labs in Oxford, England; Zurich, Switzerland, and Tucson, Arizona. In the latter, the scientists were given samples partitioned from 1 controversial location on the cloth. They reported the results as AD 1260-1390, which seemingly excluded it from being the authentic burial shroud of Jesus. These results, for most people, indicated that the Shroud was no more than a medieval hoax. In this presentation, however, we will analyze various lines of evidence that suggest that the 1988 C-14 dating should not be considered valid. The basis of this argument is that the C-14 samples tested in 1988 are not representative of the whole cloth; they are a combination of the original 1st century material and a later 16th century repair. Thus, it remains possible that the Shroud is the actual burial cloth of Jesus.

We will consider 2 lines of evidence that support this assertion. First, one of the original STURP scientists, the late Ray Rogers, concluded, based on studies between 2002 and 2005, that the area from which the C-14 sample was taken was significantly chemically different from the rest of the cloth, suggesting 2 different types of cloth.

Second, although the Shroud visually appears to be one whole cloth and shows no obvious seams, we will analyze evidence from the study of early modern and modern textiles that show that 16th century weavers, were, in fact, capable of producing an “invisible reweave” and had a bona fide motive to do so.

Although the labs that performed the C-14 test stated that the results provided conclusive proof that the Shroud was medieval (Damon et. al, 1989, pg. 615), not everyone was as confident about their conclusions. Belgian chemist Remi Van Haelst examined the somewhat meager data from the labs and in 1991 asserted, based on the statistical analysis, the subsamples could not be considered identical. In other words, the samples came from cloths that were different from each other.

Besides Van Haest, many scientists and researchers continued their research on the Shroud, convinced that something must have gone wrong with the C-14 testing, since there was so much other evidence that favored authenticity. Many Shroud conferences continued to be held, including in Turin itself in 1998 and 2000. All the while, the idea of a reweave in the area from which the C-14 sample had been taken was being discussed in numerous articles and books (Petrosillo and Marinelli 1996:149-150; Adler as cited by Case 1996:73; Adler 1996:225; Barberis and Savarino 1998; Siliato 1998; Antonacci 1999:169-170; Jackson *et al.* 2000:288-290). (All but Jackson believed that the reweaving was a plausible explanation.) Chemist Alan Adler, a member of the STURP team, stated,

So you can talk all you want about how reproducible the date is, but you can't talk about how accurate it is. You have no way of knowing if the area you took the C14 sample from represents the whole cloth. That's an area which has obviously been repaired. There's cloth missing there. It's been rewoven on the edge. They even cut part of it off, because it was obviously rewoven on the edge. The simplest explanation why the date may be off is that it's rewoven cloth there. And that's not been tested (Case, 1996:73).

Jacque Evin, one of the participants in the 1988 testing, made a similar comment. During the videotaped Question & Answer session at the 1989 Paris Conference (Sept. 7, 1989), Evin responded to a question about a possible reweave, “I quite agree that the labs did not take the weaving techniques into account and they did not date the threads per se. . . . Thus, if the weave was rewoven with threads from modern restoration, this would be reflected in more modern results.”

Another significant comment regarding the reweave question came from the Cardinal of Turin’s scientific advisor, Piero Savarino, who acknowledged that repairs had been done routinely on the Shroud throughout its history and that if the sample had been taken from such an area “the carbon-dating results would not be reliable. What is more, the site from which the samples actually were taken does not preclude this hypothesis” (Barberis and Savarino, 1998:22).

In 2000, one of the authors of this paper (Benford), who had previously believed that the C-14 dating had been in error due to some form of radiation, had an insight that early modern repairs, not radiation, was the real reason why the C-14 dating resulted in a medieval date (Benford 2002:189-191). We then put together a paper, which was presented at the Sindone 2000 Worldwide Congress in Orvieto, Italy in August 2000 (Marino and Benford 2000). We decided to send a copy of the paper to STURP chemist Ray Rogers, who after a long absence from the study of the Shroud, had recently reentered the scene to refute some of the hypotheses in a recently-released book on the Shroud (Rogers 2001).

We also began to correspond with the textile expert Mechtild Flury-Lemberg. She was part of the Turin “Centro” that controls the Shroud and informed us that an invisible

reweave was “technically impossible” (Flury-Lemberg 2000). As she is the only textile expert in the Centro, the authorities rely heavily on her opinion. Despite her assertion, we continued to do historical research into the invisible reweave and found compelling evidence that suggested that it indeed existed and was the explanation for why the C-14 results came out as they did.

In 2001, the authors submitted their paper from 2000 to the journal *Radiocarbon*, and it was reviewed by nearly all of the major figures involved in the 1988 testing. Although the reviewers, including Evin, remarked that the main Shroud was identical to the C-14 sample area, Evin’s aforementioned quote from the 1989 Paris conference calls this into question. Another comment by Evin, still alluding to the possibility of an invisible weave, is very telling: “All people involved in the sampling and in laboratory analyses, will be very angry with these suspicions turning on so an important mistake or a misconduct,” which indicates that Evin acknowledges that the preparation for the 1988 testing was not thorough (reviewer comments sent to authors by editor of *Radiocarbon*). As many reputations were at stake, it came as no surprise that our paper was rejected by *Radiocarbon*. It is clear that politics, egos and agendas affect the search for truth about the Shroud.

In late 2002, about the same time it was revealed that the Shroud had undergone a secret restoration that summer, Rogers publicly revealed that he decided to test the reweave hypothesis. “When I saw their original report, I thought that their hypothesis was unlikely, but it could be tested with the (thread) samples I had archived ... This motivated me to look at the old samples again” (Swartzlander 2002). Rogers was also to

say that he was sure that he would be able to prove our hypothesis wrong in five minutes (Battaglia 2005).

Rogers still had custody of some of the samples from the main part of the Shroud from the 1978 testing (Rogers 2005). He also had been given in October 1979 some threads of the “Raes sample,” named for a Belgian textile expert, Gilbert Raes, who had been given some Shroud threads in 1973 to examine (Rogers 2005). The Raes sample was right next to the area where the 1988 C-14 sample had been taken. Rogers realized that a comparison of the two sets of thread would be able to disprove the reweave hypothesis. Rogers noted,

I believed that it would be easy to completely refute them. It is highly embarrassing that I could not. This is the first time I have had to present information that seemed to support what I consider to be the "lunatic fringe. However, an ethical scientist absolutely must publish accurate information no matter what the emotional implications (Rogers 2005b).

Rogers noted that the Raes sample contained both a gum/dye/mordant coating, as well as cotton fibers, none of which are found in the main part of the Shroud (Rogers and Arnoldi 2002). All of this is very compelling evidence that the area from which the C-14 sample was taken was dyed and repaired to look exactly like the rest of the Shroud.

Rogers concluded,

The combined evidence from chemistry, cotton content, technology, photography, and residual lignin proves that the material of the main part of the Shroud is significantly different from the radiocarbon sampling area. The validity of the radiocarbon sample must be questioned with regard to dating the production of the main part of the cloth (Rogers and Arnoldi 2002).

When the authors contacted *Radiocarbon* about Rogers’ findings, we received no acknowledgement or reconsideration for our paper. Given the reviewers’ previous action, this, like the original rejection, was not a surprise. It is interesting to note that up to this point, none of the labs involved in the 1988 testing has published anything in a

peer-reviewed journal attempting to refute Rogers' work. When a Russian scientist had published some material in the 1990s attempting to show that the 1532 fire had skewed the results (Kouznetsov *et al.* 1996), several of the scientists involved in the 1988 testing did publish a refutation, which was presented in the very same issue as the Russian's paper (Jull *et al.* 1996). Why hasn't this been done in the case of Rogers' work? At the very least, critics are having a hard time producing solid evidence against Rogers' findings.

In 2003, STURP image analyst, the late Jean Lorre, indicated to STURP photographer Barrie Schwartz that the Quad Mosaic photography of the C-14 sample area shows differences from the main part of the cloth, indicating differences in chemical composition (Schwartz 2003). This is supportive of Rogers' contention that the 2 different areas are significantly different and much more will be said about this in part 2 of our paper. Rogers was asked if he thought the Turin authorities had been aware that as far back as the original 1978 photographs, the area from which the C-14 sample had been taken was different from the main part of the cloth. Rogers replied, "it doesn't matter if they ignored it or were unaware of it. Part of science is to assemble all the pertinent data. They didn't even try" (Muldoon 2005:24). Schwartz added that because of the American dominance of the 1978 study, he believes they "'threatened the authority' of Turin experts" (Muldoon 2005:25).

In 2003, Flury-Lemberg's book about the restoration was published. Once again she denied that it would have been possible for an invisible reweave to have been added to the Shroud. She asserted that such a procedure would be visible on the reverse side of the

fabric (Flury-Lemberg 2003:60). New data to refute her assertion will be presented in part 2 of our paper.

Rogers' aforementioned statements were based on the comparison between the main Shroud and the Raes sample, but not between the main Shroud and an actual sample from 1988. Despite this, Rogers was confident the characteristics of the Raes sample would match those of the C-14 sample.

In December 2003, former STURP member and President, Tom D'Muhala, was able to procure for Rogers several leftover threads from the 1988 C-14 sample (Rogers 2005). This was to have huge ramifications -- Rogers would now be able to actually test his suspicion that the C-14 sample would match the Raes sample.

In 2004, a significant paper about the history of carbon-14 dating appeared in the prestigious *Journal of Research of the National Institute of Standards and Technology* (NIST). The author, a NIST Fellow Emeritus in the Chemical Science and Technology Laboratory, mentions Rogers' (and Arnoldi's) findings and concluded, "the issue of organic reactions and non-contemporaneous contamination of ancient materials can be a very serious and complex matter, deserving quantitative investigation of the possible impacts on measurement accuracy" (Currie 2004:203-204). This is an important statement given that many researchers, most with little or no knowledge of chemistry, and in many cases, little or no in-depth knowledge about the Shroud, feel eminently qualified to critique Rogers' findings but obviously are not.

In January 2005, Ray Rogers published a paper on his findings in the journal *Thermochimica Acta*. He confirmed that the C-14 sample, like the Raes sample,

contained the gum/dye/mordant coating and also cotton, suggestive of the manipulation of the C-14 area. He wrote:

Pyrolysis-mass-spectrometry results from the sample area coupled with microscopic and microchemical observations prove that the radiocarbon sample was not part of the original cloth of the Shroud of Turin. The radiocarbon date was thus not valid for determining the true age of the shroud (Rogers 2005:189).

Rogers also believed that some chemical analyses he did puts the Shroud's actual age as between 1,300 and 3,000 years old, which does encompass the time period when Jesus lived. Those who had believed the Shroud to be authentic thus had new hope that the Shroud really did wrap Jesus, while those who had thought it had been a hoax, especially those who had thought that before the 1988 dating, could not so confidently relegate the Shroud to the category of fake relics. Rogers' conclusions leave no doubt that he believed the 1988 dating was invalid, thus challenging the scientists' findings from that test, which had concluded with a 95% confidence level that the Shroud was medieval (Damon et. al, 1989, pg. 615).

Rogers' conclusion was supported by the work of microscopist John Brown, who studied some of the Raes threads and wrote,

The weave was tight enough that the application of a relatively viscous gum/mordant/dye solution did not penetrate the intersection of the threads. 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 (Brown 2005).

The first firestorm of opinion came from the Turin Centro. Monsignor Ghiberti, the Cardinal's spokesman and president of the Diocesan Commission for the Holy Shroud, told the Italian paper *Avvenire* that Flury-Lemberg "examined the Shroud with great care and has absolutely not seen any sign of added textile... the lining was also removed and

for the first time in 500 years we saw the reverse side of the cloth. There is no sign of a mend” (Muldoon 2005:24-25).

He added, “I am surprised that a specialist like Rogers can fall into such lack of precision in his article. I should expect, rather, that the C-14 dating could be rectified, but not on the basis of the patch hypothesis” (Muldoon 2005:25). Rogers, meanwhile, defended his findings and said the Turin

experts are embarrassed and protecting their reputations and that they are not experts in the correct fields. A textile expert knows all about spinning and weaving, thread counts, etc. They do not think in terms of chemistry. This was an occasion when the composition of the cloth was important (Muldoon 2005:25).

Isabel Piczek, a particle physicist and an artist, agreed with Rogers that experts need to refrain from going outside the limits of their specific expertise. Regarding an invisible reweave, she insisted that chemical analysis such as that done by Rogers is a necessity:

It is not good enough just to look (with the naked eye) for a re-woven patch. It is an *invisible* reweave, which requires microscopic and microchemical analysis (to discover). Rogers’ paper has to be accepted. New discoveries always cause lots of controversy, but (Roger’s report) should be trusted because it was published in a peer-reviewed journal (Muldoon 2005:25).

In February 2005, the Turin authorities softened their stance. The Diocesan Commission for the Holy Shroud released another statement, saying that the study of Rogers was “very interesting” and would be the basis for a future study “on the chemical characteristics of the cloth and its possible inhomogeneity” (Muldoon 2005:25).

However, while acknowledging that the C-14 sample has a dye not found on other parts of the cloth, they said the reweave “has not been confirmed by the textile experts and researchers who have examined it.”

Rogers defended his scientific findings saying that he was an esteemed expert in chemistry and that his paper in *Thermochimica Acta* was peer-reviewed and noted that

“few persons thought that the determination of the radiocarbon age could be wrong: it was difficult to convince the skeptics” (New Findings Make Scientists Discuss on the Dating of the Shroud, 2005).

Rogers, not content to rely only on his own expertise, also had consulted Anna Maria Donadoni, supervisor of the Egyptian Museum of Turin, when he had first examined the Raes sample. Rogers said he had “found a strange junction with the ends in contact between the threads, that the textile expert Gilbert Raes took in 1973.” Donadoni showed him “how the separate lengths of yarn were overlapped in the weaving of the Shroud main cloth.” Rogers continued: “The junction is completely different; moreover, it is clear that the two ends of the junction are different: one is downy and white, the other is coloured and closely twisted” (New Findings Make Scientists Discuss on the Dating of the Shroud, 2005).

At the international Shroud conference held in Dallas in September 2005, we informally presented that and additional information about the invisible reweave. Flury-Lemberg was at the conference and again maintained that an invisible reweaving would be detectable on the reverse side. At that conference, Dr. Alan Whanger presented an official paper with x-ray photos of various anomalies of the C-14 sample area (Whanger 2005). This is yet another argument that this area was different from the main part of the cloth.

We have been looking at some of the modern scientific evidence that suggests an invisible reweave exists in the Shroud. What does modern textile history tell us?

During 2005 we contacted Mr. Michael Erlich, owner and president of “Without A Trace,” which provides invisible mending services. According to Mr. Ehrlich, French

Weaving, one type of invisible reweaving, now only done on small imperfections due to its extensive cost and time, results in both front and back side “invisibility.” Ehrlich was to later say,

Today, there is a modern, time-saving technique called “inweaving: that would be invisible from the surface, but easily recognizable from the back. However, the technique used in sixteenth century Europe called “French weaving” is an entirely different matter. French weaving involves a tedious thread-by-thread restoration that is, indeed, invisible. Sixteenth century owners of the Shroud certainly had enough material resources and weeks of time at their disposal to accomplish the task (Balsiger and Minor, 2007:159).

In late 2005, the History Channel broadcast a Shroud documentary titled “Unraveling the Shroud.” As they were aware of Rogers’ findings and as the associate producer had contacted STURP documentary photographer Barrie Schwartz, there were expectations that those findings would be given the appropriate attention. Unfortunately, Rogers’ findings were allotted only about 30 seconds! Schwartz posted a review on his website and said:

Apparently, the senior producers and network executives decided somewhere during the editing process that promoting the infamous "Da Vinci" theory regarding the Shroud was an easy way to capitalize on the current Da Vinci frenzy in the media and garner higher ratings, even if the truth was completely sacrificed (Schwartz 2006).

The associate producer, Sean Heckman, sent Schwartz an apologetic email, which is worth reading and posted online at Schwartz’s website at www.shroud.com (Schwartz 2006).

In a paper published on the Internet and later updated and presented informally at the 2005 Shroud Dallas conference, we attempted to 1) characterize the state of the weaving art during the time period of the hypothesized C-14 sample-area patch; 2) describe the crucial role and passions for tapestries of the House of Savoy’s Margaret of Austria (who owned the Shroud at the time) and her nephew/ward Charles V, Holy Roman Emperor,

which would have mandated an expert restoration to the Shroud following the removal of the large corner pieces; 3) to posit a plausible scenario illustrating how and why the invisible mending on the Shroud took place around AD 1531, including new evidence as to why the undocumented repair took place, who was the overseer of the work, and what became of the missing corner pieces (Benford and Marino 2002; updated 2005). As we will present in part 2, recent data has caused us to revise some of our previous historical assumptions.

CONCLUSION

There is compelling scientific and historical evidence that the patch theory is very plausible. Various textile experts have said that the technique to invisibly weave a patch existed in the 16th century. The owners of the Shroud in the 16th century, a wealthy and royal family, had the means to have the Shroud meticulously repaired. Ray Rogers and others have found physical and chemical evidence supporting the patch theory. Critiques against Rogers' findings seemed to be steeped in something less than valid scientific argumentation and an objective search for truth. Rogers' own admission that he hated to have to agree with the authors is an indication that he found the evidence compelling and is an indication of his scientific integrity.

To date, no one has published any papers in peer-reviewed journals refuting Rogers' findings. Clearly, the case for an invisible reweave in the C-14 area of the Shroud has compelling historical and scientific evidence. In the companion part 2 paper, we will provide new evidence garnered from an unpublished and little-known STURP study, along with other observations that provide additional highly-compelling support for both Rogers' conclusions and our theory.

References:

Adler, Alan: 1996. "Updating Recent Studies on the Shroud of Turin." In M.V. Orna (Ed.), *Archaeological Chemistry: Organic, inorganic and biochemical analysis* (pp. 223-228) ACS Symposium Series, vol. 625. Washington, DC: American Chemical Society.

Antonacci, Mark. 1999. The Resurrection of the Shroud. New York: M. Evans & Company, Inc.

Ball, Philip. 2005. "To know a veil." January 28. Accessible at www.nature.com/news/2005/050124/full/050124-17.html .

Balsiger, David W. and Michael Minor. 2007. The Case for Christ's Resurrection. Orlando: Bridge-Logos.

Barberis, Bruno and Seter Savarino. 1998. *Shroud, Carbon Dating and Calculus of Probabilities*. London: St. Paul's.

Battaglia, Franco. 2005. "Certainly Not Medieval!..." *Il Giornale*, February 2. Accessible at www.shroud.it/ILGIOR-4.HTM .

Benford M. Sue. 2002. Strong Woman: Unshrouding the Secrets of the Soul. Nashville: Source Books.

Benford, M.S and Joseph G. Marino. 2002. "Historical Support of a 16th Century Restoration in the Shroud C-14 Sample Area. With special contribution by Robert Buden, President, Tapestries & Treasures." Accessible at www.shroud.com/pdfs/histsupt.pdf .

----- 2005. "New Historical Evidence Explaining the "Invisible Patch" in the 1988 C-14 Sample Area of the Turin Shroud." Accessible at <http://www.shroud.com/pdfs/benfordmarino.pdf> .

Brown, John L. "Microscopical Investigation of Selected Raes Threads From the Shroud of Turin." Accessible at www.shroud.com/pdfs/brown1.pdf .

Case, T.W.: 1996. The Shroud of Turin And The C-14 Dating Fiasco: A Scientific Detective Story. Cincinnati: White Horse Press.

Currie, L.A. 2004. "The Remarkable Metrological History of the Radiocarbon Dating [II]" in *Journal of Research of the National Institute of Standards and Technology*, 109:2:185-217. Accessible at <http://hbar.phys.msu.ru/gorm/dating/histC14.pdf> .

Damon, P.E., D.J. Donahue, et. al. 1989. "Radiocarbon Dating of the Shroud of Turin." *Nature* 337:611-615. Accessible at <http://www.shroud.com/nature.htm> .

Flury-Lemberg, Mechthild. 2000. Personal communication. November.

----- . 2003. Sindone 2002: Preservation. Torino: Opera
Diocesana Preservazione Fede.

Hansen, George P. 1992. "CSICOP and the Skeptics: An Overview." *The Journal of the American Society for Psychical Research*, 86(1):19-63. Accessible at <http://www.tricksterbook.com/ArticlesOnline/CSICOPoverview.htm> .

Jackson, John P., Keith E. Propp and David R. Fornof. 2000. "On the Scientific Validity of the Shroud's Radiocarbon Date." Proceedings of the 1999 Shroud of Turin International Research Conference—Richmond Virginia. Glen Allen, Virginia: Magisterium Press.

Jull, A.J.T., D.J. Donahue and P.E. Damon. 1996. "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. *Journal of Archaeological Science*, 23(1):157-160.

Kouznetsov, D.A., A.A. Ivanov and P.R. Veletsky. 1996. "Effects of Fires and Biofractionation of Carbon Isotopes on Results of Radiocarbon Dating of Old Textiles: The Shroud of Turin." *Journal of Archaeological Science*, 23(1):109-122.

McCulloch, J. Huston. 2005. "The Vinland Map -- Some 'Finer Points' of the Debate. Accessible at <http://www.econ.ohio-state.edu/jhm/arch/vinland/vinland.htm> .

Marino, Joseph. 1989. "The Shroud of Turin and the Carbon 14 Controversy." *Fidelity*, February, pp. 35-47.

Marino, Joseph and Sue Benford. "Evidence for the Skewing of the C-14 Dating of the Shroud of Turin Due to Repairs." *Sindone 2000 Worldwide Congress*, Orvieto, Italy, San Severo: Gerni Editori, pp. 57-64. Also accessible at <http://www.shroud.com/pdfs/marben.pdf> .

Meacham, William. 1986. "Radiocarbon Measurement and the Age of the Turin Shroud: Possibilities and Uncertainties." Accessible at www.shroud.com/meacham.htm .

----- . 1988. "Turin Shroud Dated to 200-1000 A.D. in Secret Testing." Press release from October 19.

Muldoon, Shena. 2005. "Was the Dating a Hoax?" *Inside the Vatican*, 13:2 (March), pp. 23-25.

"New Findings Make Scientists Discuss on the Dating of the Shroud." 2005. Zenit Press Agency article. Accessible at <http://www.shroud.it/ZENIT-4.HTM>

Petrosillo, Orazio. 1994 "The Holy Shroud: Authentic After All? *Inside the Vatican*, May, pp.48-50.

Riggi di Numana, Giovanni: 1988. Rapporto Sindone. Milano: 3M Edizioni. English translation by John D'Arcy (unpublished).

Rogers, Ray. 2001. "Comments on the 'Resurrection of the Shroud' by Mark Antonacci." Accessible at <http://www.shroud.com/pdfs/rogers.pdf> .

----- . 2005. "Studies on the radiocarbon sample from the shroud of turin." *Thermochimica Acta* 425: 189-194. Accessible at <http://www.shroud.it/NEWS.HTM> .

----- . 2005b "Ghiberti's pronouncement on my analyses." Accessible at <http://www.shroud.it/ROGERS-5.PDF> .

Rogers, Ray and Anna Arnoldi. 2002. "Scientific Method Applied to the Shroud of Turin: A Review". Accessible at www.shroud.com/pdfs/rogers2.pdf .

Schwartz, Barrie. 2004. Details for this are currently only on a private Internet page accessible only to members of the Shroud Science group, of which one of the authors (Marino) is a member.

----- . 2006. Shroud Documentary Reaches New Lows - A Personal Review of the Recent History Channel Program. January 21. <http://www.shroud.com/latebrak.htm> .

Schwalbe, L.A. and R.N. Rogers. 1982 "Physics and Chemistry of the Shroud of Turin: A Summary of the 1978 Investigation." *Analytical Chimica Acta*, 135:3-49.

Secrets of the Dead. Case File: Shroud of Christ? Interview. Accessible at www.pbs.org/wnet/secrets/case_shroudchrist/p_interview.html .

Siliato, Maria Grazia. 1998. *Contre-enquête sur le saint Suaire*. Plon. (Excerpt in English available to authors via a private Internet group.)

Swartzlander, Emily. 2002. "Shroud of Turin tests are flawed, say researchers." August 22. Originally accessible at www2.dailycamera.com/bdc/state_news/article/0,1713,BDC_2419_1337125,00.html. Article no longer online but authors have paper copy.

Van Haelst, Remi: 1991. "Radiocarbon Data Indeed Manipulated." *Shroud News*, December, No. 68:5.

Whanger, Alan and Mary Whanger. 2005. Radiological Aspects of the Shroud of Turin (Excerpt).” Accessible at www.shroud.com/pdfs/Whanger.pdf .