# COTTON IN RAES/RADIOCARBON THREADS: THE EXAMPLE OF RAES #7



***With a contribution by Prof. Giulio Fanti.***

**This article is dedicated to the memory of Sue Benford**

## I) INTRODUCTION: THE CONTEXT

In 1973, Gilbert Raes, a textile expert, was allowed to cut a small sample of the Turin Shroud. The sample included a part of the main piece (Piece 1: 40mm.x13mm.) and of the side-strip (Piece 2: 40mm.x10mm.) as well as the sewing thread that joined the two pieces together. He found that "*in some of the preparations from the warp as well as from the weft of Piece 1, traces of cotton fibers were observed*"[2]. From this observation, it was widely assumed that Raes Piece 1 was representative of the main part of the Shroud: the Shroud appeared to be basically linen (flax fibers) with "traces of cotton" of *Gossypium herbaceum* variety. In October 1976, Gilbert Raes sent back his samples to Turin.

In 1978, as member of the STURP team and professional chemist at Los Alamos National Laboratory (LANL) until 1988, Raymond Rogers took 32 adhesive-tape samples from all areas of the Shroud (some were from the Holland backing cloth and patches). In 1979, he received 14 yarn segments of the Raes sample from Prof. Luigi Gonella. The Raes threads were photographed and labeled from Raes #1 to Raes #14. According to Rogers, it is likely that all of them were from Piece 1 of the Raes sample. Finally, on December 12, 2003, Rogers received "*samples of both warp and weft threads that had been taken from the radiocarbon sample by Professor Luigi Gonella before it was distributed for dating. He [Prof. Gonella] reported that he excised the threads from the center of the radiocarbon sample. A "chain of evidence" has been maintained on those threads, and it is certain that they were truly removed from the radiocarbon sample*"[3].

In 1988, the radiocarbon dating of the Shroud (1260-1390 A.D.) was performed on a single small strip (10 mm x 70 mm) cut from just above the previously removed Raes sample[4].

In 2000, for the first time, Joseph Marino and Sue Benford provided some evidences that "*the Shroud has literally been patched with medieval material from the 16th century, in the C-14 sample itself*"[5].

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[1] MD, France, member of ShroudScience Group (SSG), mailto:hthib@free.fr

[2] Gilbert Raes: "The textile study of 1973-1974". *Shroud Spectrum International*. 1991. N°38/39.

[3] Raymond N. Rogers: « A Chemist's Perspective on the Shroud of Turin » (page 65). Barrie Schwortz, Editor and Publisher- July 2008- Available on: http://www.lulu.com ID: 2982136.

[4] P.E. Damon, D.J. Donahue and al.: "Radiocarbon Dating of the Shroud of Turin", *Nature*, 337: 611-615 (1989). Available at www.shroud.com/nature.htm

Given the material he had at the time (the Raes threads as well as some of the 1978 STURP sticky-tapes), Rogers first thought that he could easily demonstrate the falsity of this hypothesis. However, after many hours of studies, he first reported "supportive comments on the Benford-Marino '16th century repairs' hypothesis"[6] and finally, just before his death, published his most famous paper on the subject in a peer-reviewed journal[7]. He concluded that: "*the combined evidence from chemical kinetics, analytical chemistry, **cotton content**, and pyrolysis/ms proves that the material from the radiocarbon area of the shroud is significantly different from that of the main cloth. The radiocarbon sample was thus not part of the original cloth and is invalid for determining the age of the shroud*". Although this paper is not mainly focused on the question of cotton, there are many other published and unpublished papers of Rogers leading with the problem of cotton. They will be cited below in the discussion part of the present paper.

After the death of Raymond Rogers, on March 8, 2005, his samples, digital files and papers were kept under the custody of his wife and Barrie Schwortz. One of the files found describes the Raes threads. For Raes #1, we can read: "*Splice! (…). On 2/2/05, it was transferred into the custody of Roland Schulze of LANL for ESCA/XPS and Auger analyses. Also present were Cyril O'Piel and Bob Villarreal*". For Raes #7 and Raes #14, it is written: "*sent to John Brown*". John Brown, an expert in microscopy, wrote a paper about these two threads with many photographs that fully confirmed Rogers' findings[8]. Then, the samples were sent back to Barrie Schwortz.

In August 2008, at the Conference on the Shroud of Turin held in Columbus, Ohio, a"special presentation" was scheduled. In fact, the results of the LANL studies on Raes #1, Raes #7 and Raes # 14 were presented by Robert Villarreal from the LANL[9]. As written above, Raes #1 was at LANL when Rogers died. Many months later, the analyses were performed. Given the surprising results obtained on this thread, LANL also received Raes #7 and Raes #14 from Barrie Schwortz for the same analyses. The results were presented at the Conference.

One of their most surprising results was that the Fourier-transform Infrared (FTIR) spectra of the three threads as well as the spectra of 27 individual fibers were that of cotton and not flax (linen). The conclusion was: "*the results of the FTIR analysis on all three threads taken from the Raes sampling area (adjacent to the C-14 corner) led to the identification of the fibers as cotton and*

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[5] Joseph G. Marino and M. Sue Benford : « Evidence for the skewing of the C-14 dating of the Shroud of Turin due to repairs ». 2000. www.shroud.com/pdfs/marben.pdf For a recent chronological review of the evidence for the anomalous nature of the C-14 sample area, see: http://www.shroud.com/pdfs/chronology.pdf

[6] BSTS, *Shroud Newsletter* 54, 28-33 (2001).

[7] Raymond N. Rogers : « Studies on the radiocarbon sample from the Shroud of Turin » *Thermochimica Acta*. Vol.425, Issue 1-2, 20 January 2005, Pages 189-194.

[8] John L. Brown : « Microscopical Investigation of Selected Raes Threads from the Shroud of Turin" http://www.shroud.com/pdfs/brown1.pdf

[9] Data obtained from the PowerPoint LANL Presentation.

*definitely not linen (flax)*". Another important discovery was that Raes #1 was truly a splice (under high vacuum the thread separated in two parts) and that a brown "crust" detached from the thread. FTIR analysis from this crust showed that it contained many cotton fibers embedded in a resin-like matrix, possibly a terpene-based resin.

From all the data, and particularly from the results of LANL, it appears that the problem of cotton in Raes/radiocarbon threads is of paramount importance.

During the Columbus Conference, I obtained directly from Robert Villarreal the Raes #7 thread in the presence of Barrie Schwortz, Sue Benford and Joseph Marino. This was documented by photographs (Barrie Schwortz) and an agreement was signed. Raes #7, as received, was in a small glass vial labeled "7".

The aim of this study is to provide new data regarding the cotton in Raes #7 thread and to discuss the signification of these findings in connection with previous claims.

## II) POLARIZED-LIGHT MICROSCOPY OF THE OUTER PART OF RAES # 7 THREAD.

Raes #7 (R7), as received, was about 1 cm. in length and was very tight.

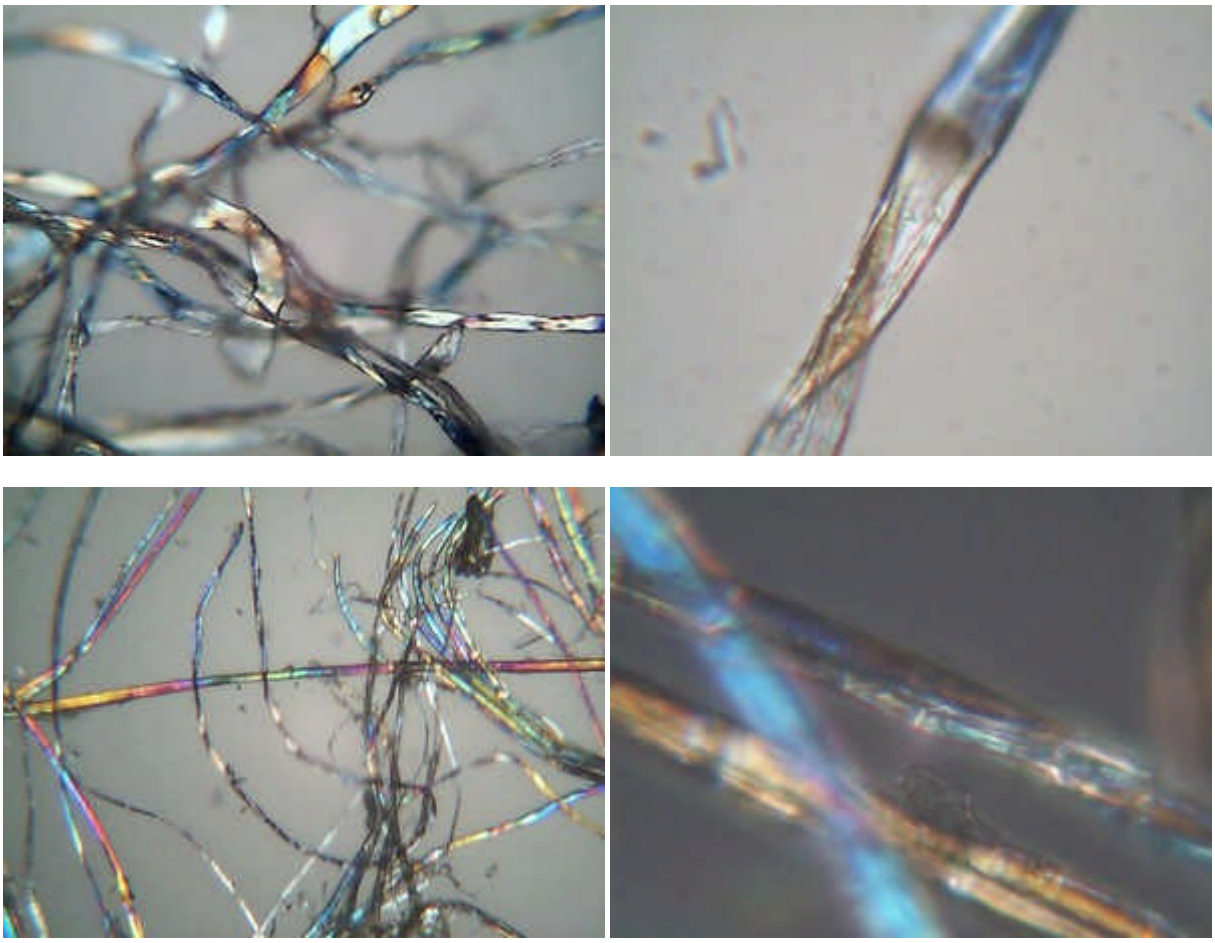
A preliminary examination with a 40x magnification "pocket microscope" in reflected light showed that it was similar to the thread as seen in Brown's paper[10]. In particular, I was able to see easily the "*yellow-brown coating with the exception of indented regions which are white*" (from Brown's paper, p.2). According to John Brown and Rogers, R7 is a weft thread and the indented regions are at the intersection with the warp threads.

The first observation with the polarized-light microscope showed me that the thread seemed to be homogeneous, except one or two different fibers emerging from the thread. It looked like a linen thread. Where was the cotton, if any?

I decided to carefully remove some external fibers with a needle. Individual fibers as well as small groups of fibers were put on three glass slides: R7A (four locations on the slide: R7A1 to R7A4), R7B (four locations on the slide: R7B1 to R7B4) and R7C (a single group of fibers).

I had also two controls: threads from pure modern cotton gauze and threads from modern unbleached traditional Estonian woven linen (Fig.1).

[10] In Ref. 7



**<u>Fig.1</u>: modern cotton fibers (top), modern unbleached linen (flax) fibers (bottom). The circular fiber in the middle (bottom left) is in fact cotton (contamination) found in the modern linen thread.**

Modern cotton is easy to recognize: flat fibers with thicker borders and many reversals. Flax fibers are generally rounded and show typical transversal dislocation bands (X and V shape) which are easily seen "at extinction" under polarized light.

<u>Fiber identification in Raes #7 (R7):</u>

Looking at the slides, the situation appeared more complex. While flax fibers were generally easy to recognize, I found some other fibers which were different from flax but also not exactly similar to modern cotton. They were more or less flat with no typical dislocation bands and grey in color. While changing the polarization of the light, their color was varying from bright white to brown or blue color in some parts. Very few reversals could be seen in those fibers. Briefly, they were more similar to cotton than to flax but very different from modern cotton.

Many photographs were sent to textile experts[11]. They agreed that there are some cotton fibers in the sample and that cotton fibers found in R7 are from the "Old World" (possible species: Gossypium herbaceum or Gossypium arboreum).

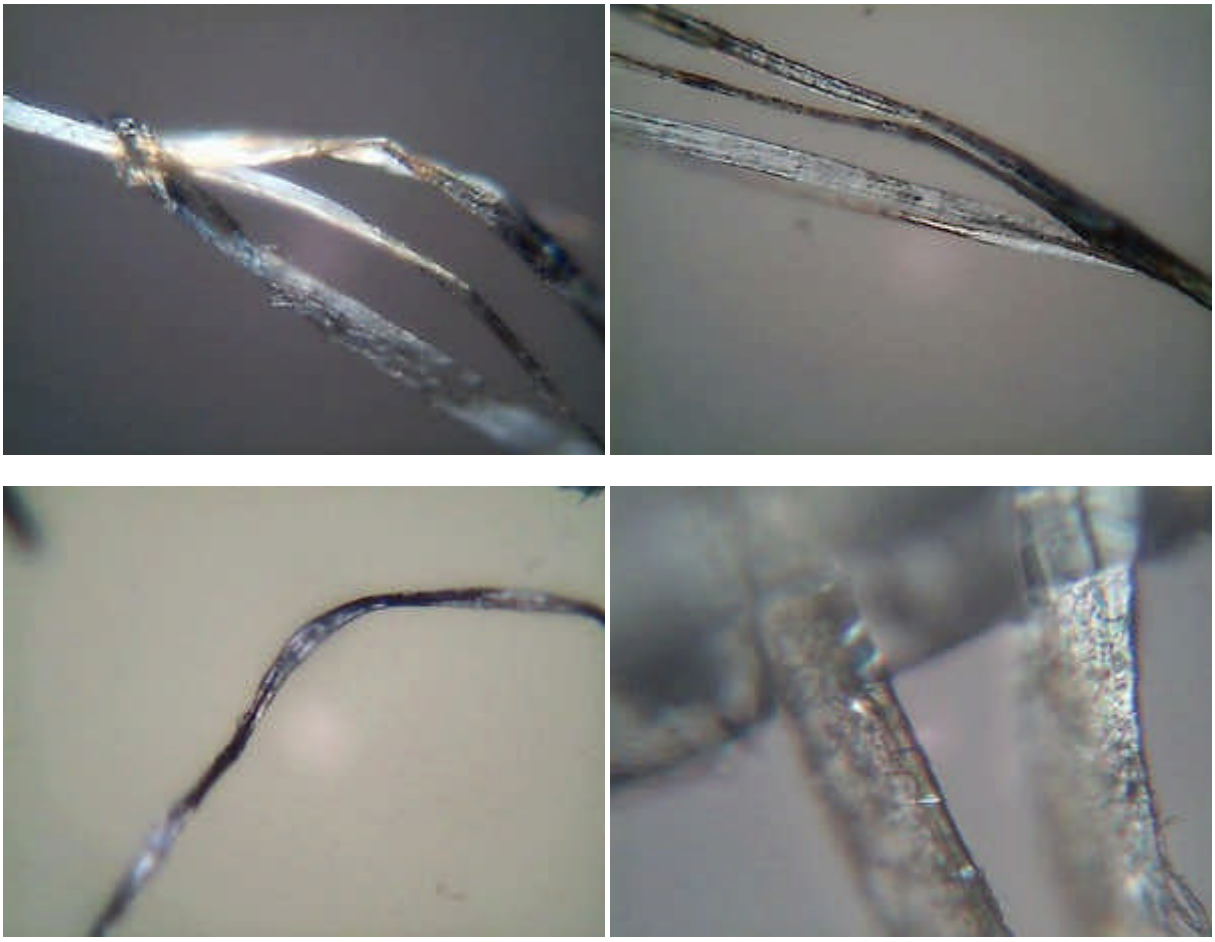
[11] Dr. Jana Jones, Department of Ancient History, Macquarie University, Sydney, Australia, who also showed the photographs to Dr. Ron Oldfield, Senior Research Fellow, Dept of Biological Sciences, Macquarie University, Sydney, Australia.

They added that this kind of cotton can be sometimes confused with flax and that:
*"(…) the identification of cotton is most easily made by a lack of extinction in the polarizing microscope. Cotton, between crossed polars in the microscope, is distinguished by remaining more or less bright in all orientations. Flax, as a typical fibre, will extinguish orthogonally, ie. appear dark when it is oriented parallel to the directions of the polars. A flax fibre will have changing intensities when the stage is rotated, but there will be four dark positions in a 360° stage rotation."*

In addition to the shape of the fibers (at high resolution), I also applied this criterion ("lack of extinction") in order to distinguish modern cotton, "old cotton" and flax fibers.
I decided to count the number of flax and cotton fibers on each of the slides. Very small pieces of fibers (broken fibers) as well as long fibers were found, so that this count is necessarily an approximate count of the true number of fibers.
The result is shown in the following table:

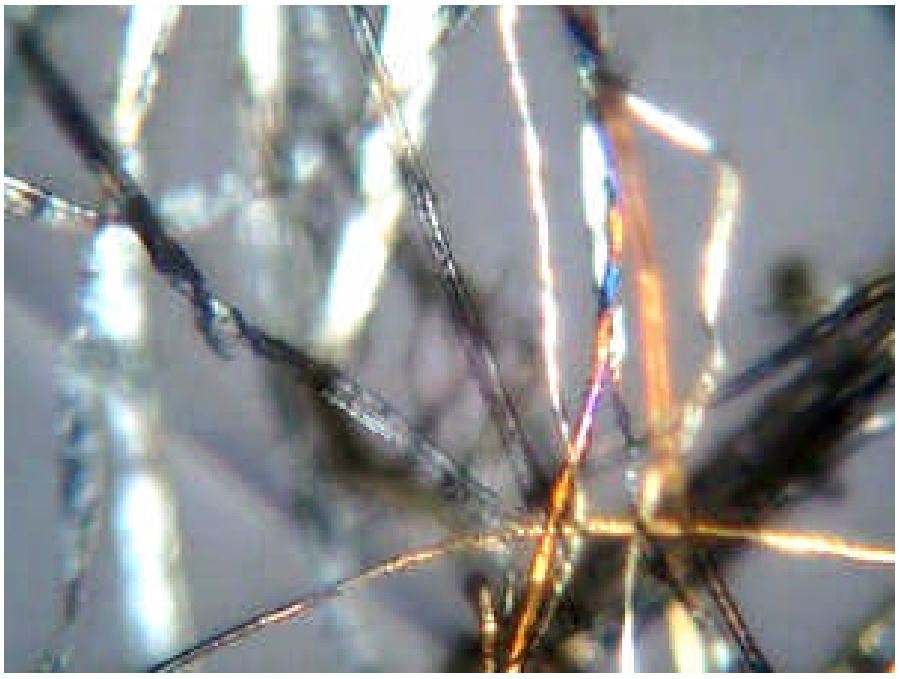
| **SAMPLE** | **COTTON** | **FLAX** | **COMMENTS** |
|---|---|---|---|
| R7A1 | 0 | 1 long | In addition, several small pieces of both cotton and flax fibers |
| R7A2 | 6 (group)<br>4 small | 0 | See Fig.2 |
| R7A3 | 1 small | 3 long | 1 modern cotton<br>See Fig.3 |
| R7A4 | 8 (group)<br>1 small | 6 long (first end)<br>20 long (second end) | See Fig.4 |
| **TOTAL R7A** | **20** | **30** | **14/20 cotton fibers gathered in groups** |
| R7B1 | 0 | 2 | |
| R7B2 | 2 + 1 small | 2 | |
| R7B3 | 1 small | 2 | 1 long cotton (dyed? , modern?) |
| R7B4 | 0 | 7 | |

| | | | |
|---|---|---|---|
| **TOTAL R7B** | **4** | **13** | |
| **TOTAL R7C** | **0** | **+/- 30** | |
| **TOTAL R7 OUTER PART** | **23 COTTON** | **73 FLAX** | |



**<u>Fig.2 cotton fibers in R7A2</u>.Top: group of fibers. Bottom left: individual cotton fiber. Bottom right: very high resolution: the "flax-like" thick border (with some "transversal bands") of the cotton fiber is often found in cotton (even modern).**

**Fig.3: R7A3. Top: small piece of cotton fiber. Middle: part of the same fiber showing the typical features of cotton. Bottom: modern cotton (contamination) found in R7A3. The difference is obvious.**



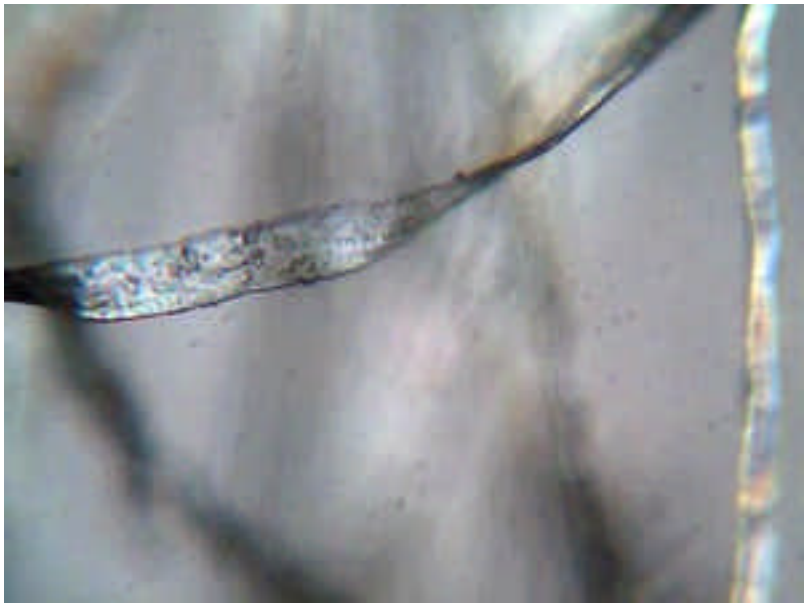


**Fig.4: R7A4. Top: Low resolution: all the white fibers are cotton, while the fibers on the right are flax. The two groups are partially mixed. Middle: High resolution showing clearly cotton. Bottom: very high resolution photograph showing one of the cotton fibers with one reversal.**

**Conclusion**: there are many cotton fibers in the outer part of R7. However, it must be noticed that the total number of cotton fibers (23/96=24%) is certainly an overestimation because 1) it is difficult if not impossible to count exactly the number of fibers gathered in groups 2) many of the cotton fibers are small and certainly come from long cotton fibers which had been broken (perhaps during the handling process: cotton fibers are obviously more brittle than flax fibers).

Another important fact is that cotton fibers were often found gathered in some locations, forming bundles or "nodes". This may explain why in some samples there is no cotton fiber at all (R7C), while in other samples there are many cotton fibers. In R7A4, for example, there are clearly two separated groups of fibers (cotton and flax) which are partially mixed together. In order to fix the ideas and if we don't count the short broken cotton fibers, there is about 28% of cotton in R7A (14/50), 12% in R7B (2/17) and no cotton in R7C (0/30). **The total amount of "complete" cotton fibers in the outer part of R7 is therefore about 15%.**

The third important point is that this "old cotton", even if it is found in the outer part of the thread, is clearly not a contamination. It is part of the thread. All cotton fibers are similar and from the same species and are very different from modern cotton (only 2 modern cotton fibers was found in this part).

Continue to Part 2