

Two sheets of data of unknown origin with presumed results of the 1988 radiocarbon dating of the Shroud of Turin

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This is article of May 2013 is the translation, with slight adjustments, of an article (in Italian) that was published on the Internet in January 2013 [3]

A documentary with the title "La Notte della Sindone" (The Night of the Shroud) has been released in Italy in October 2012. It has been directed by Francesca Saracino and produced by Paolo Monaci. It is available in DVD.

The authors of the documentary had claimed that they had obtained unpublished "raw data" of the results of the 1988 radiocarbon dating of the Shroud of Turin. In the documentary, two data sheets are shown which are similar to Table 1 and Table 2 of the 1989 report in *Nature* [1] with the results of the dating.

A comparison of the tables of the documentary with the tables of *Nature* reveals some differences in the numbers provided. But the documentary does not tell anything about the provenance of these unpublished tables and we do not know what meaning to attribute to the data they contain.

The tables appear on the screen for a few moments only and without any comments or explanations but can be copied after stopping the film. Below I show the values in the tables. (The ages are always expressed in years BP.)

At the time 01:01:18 there is a Table with the title:

Table 1: Basic Data Supplied by the Laboratories (in years bp)

This is similar to Table 1 of the report in *Nature* [1], which has the title:

Table 1: Basic Data (individual measurements)

The table in *Nature* contains the results for the individual measurements as received at the British Museum in London from the laboratories.

At the time 59:06 of the documentary there is a table with the title:

Table 2: Summary of Mean Radiocarbon Dates (in years bp)

This is similar (with some data lacking) to Table 2 of *Nature* which has the title: Table 2 Summary of mean radiocarbon dates and assessment of interlaboratory scatter

The table in *Nature* gives the means within each laboratory and the interlaboratory means.

We denote by D1 and D2 the tables of the documentary and by N1 and N2 the tables of *Nature*. In the comparisons below, the data of *Nature* are in blue colour so as to distinguish them at a glance from the data of the documentary. Comparing the tables of the documentary with the corresponding tables of *Nature*, we can see that many data are the same but there are also some discrepancies for the data of Arizona and in particular for the data of Zurich.

Warning. The documentary gives no indication about the origin or context of the two tables. The two sheets, as they are shown on the screen, do not have a header, nor any stamps or signatures or dates. Thus we do not know where they come from nor do we know the circumstances in which they were written. It is to be hoped that the authors of the documentary will supply some information thereabout. The tables might really be sheets of data that were originally sent to London by the labs and were subsequently modified in the version as published in *Nature*. Or they might be sheets written down by anyone for any reason and without any value as documentation. Therefore in this article I report and compare the data but I leave the interpretation open and do not draw any conclusions. Only if the authors of the documentary are willing to disclose the origin of the tables, or if it is possible to obtain information through other channels, then we will consider the matter again and if possible we can draw some deductions. I will update this article if there are new elements.

It should be noted, however, that even with the data of the unpublished tables, the result of the radiocarbon dating would remain essentially the same.

§1. The data of Table D1

Chart 01 contains the data of Table D1 which is shown in the documentary at time 01:01:18.

CHART 01: Table D1

	Turin	Nubia	Thebes	Provence
Arizona	591±30	906±48	1827±47	724±42
	690±35	970±56	2030±43	778±88
	606±41	813±50	1949±55	764±45
	701±33	980±38	1972±37	603±38
		878±37	2126±46	825±44
Zurich	733±61	890±59	1984±50	739±63
	722±56	1036±63	//	676±60
	635±57	923±47	//	760±66
	617±47	909±47	1855±49	583±47
	595±46	863±47	1903±49	649±47
	651±27	916±26		665±31
Oxford	795±65	980±55	1955±70	785±50
	730±45	915±55	1975±55	710±40
	745±55	925±45	1990±50	790±45

(The order of Zurich and Oxford is inverted with respect to the Table in *Nature*.)

In the data for Zurich, the sixth row has the means of the other values in each column. These means are repeated in Table D2 and we do not consider them for the moment.

§2. The data of Table N1

Chart 02 contains the data of Table N1 taken from Table 1 of the *Nature* report.

CHART 02: Table N1

	Turin	Nubia	Thebes	Provence
Arizona	591±30	922±48	1838±47	724±42
	690±35	986±56	2041±43	778±88
	606±41	829±50	1960±55	764±45
	701±33	996±38	1983±37	602±38
		894±37	2137±46	825±44
Oxford	795±65	980±55	1955±70	785±50
	730±45	915±55	1975±55	710±40
	745±55	925±45	1990±50	790±45
Zurich	733±61	890±59	1984±50	739±63
	722±56	1036±63	//	676±60
	635±57	923±47	//	760±66
	639±45	980±50	1886±48	646±49
	679±51	904±46	1954±50	660±46

§3. Table D2

Chart 03 contains the values of Table D2 which is shown in the documentary at time 59:06. (Here too, the order of Zurich and Oxford is inverted with respect to N2.)

In the Table, as presented in the documentary, there are three references to Notes which are not visible because they should be in the bottom half of the page which is not shown. We hope that the authors of the documentary will publish also the Notes.

The last row of the table has the values of the weighted mean of the means of the three laboratories for each sample.

CHART 03: Table D2

	Turin	Nubia	Thebes	Provence
Arizona	646±31	927±32	1995±46	722±48
Zurigo	651±27	916±26	1913±38	665±31
Oxford	750±30	940±30	1980±35	755±30
w. mean	681±33	926±17	1960±23	713±20

§4. Table N2

Chart 04 contains the values of Table N2 taken from Table 2 of *Nature* (where there are a few more data).

CHART 04: Table N2

	Turin	Nubia	Thebes	Provence
Arizona	646±31	927±32	1995±46	722±43
Oxford	750±30	940±30	1980±35	755±30
Zurich	676±24	941±23	1940±30	685±34
w. mean	681±33	926±17	1960±23	713±20

The fourth row has the values of the weighted mean of the means of the three laboratories for each sample. (In the table as in *Nature*, the weighted means are in the fifth row while in the fourth row there are the simple means.)

§5. Differences between D1 and N1

For Arizona there are differences in the data of Nubia e Thebes. There are no differences for Turin and Provence (apart from a minimal difference for one age of Provence).

For Zurich there are differences for all the four samples in the last two measurements.

For Oxford there are no differences.

§6. Arizona: Differences between D1 and N1 for Nubia and Thebes.

Chart 05 compares the Arizona data of D1 and N1 for Nubia and Thebes. (As

always, the data of *Nature*, here of N1, are in blue colour.)

The data for Nubia in D1, with respect to N1, have all the ages shifted by 16 years in the sense of younger ages. Analogously the ages of Thebes are all shifted by 11 years in the sense of younger ages. The values of sigma (quoted error) are the same.

These differences are no longer present for the means in Table D2 which are the same as calculated from the data of N1.

CHART 05: Differences between D1 and N1 for Arizona

Arizona / Nubia:		Arizona / Thebes:	
D1	N1	D1	N1
906 ± 48	922 ± 48	1827 ± 47	1838 ± 47
970 ± 56	986 ± 56	2030 ± 43	2041 ± 43
813 ± 50	829 ± 50	1949 ± 55	1960 ± 55
980 ± 38	996 ± 38	1972 ± 37	1983 ± 37
878 ± 37	894 ± 37	2126 ± 46	2137 ± 46

§7. The differences for the data of Zurich

For each of the four samples, Zurich, as stated by the laboratory, has worked in two cycles as follows. They have divided the sample into two halves. A first half was further divided into three portions that have been dated in the first cycle after having undergone various cleaning treatments. In the second cycle, after about one month, the other half of the sample was divided into two portions that were dated after having undergone various cleaning treatments. (Note 1)

Note 1

One can see a photomontage that was published in 2005 in *ETH Life International*, an online weekly of news about the activity at the Polytechnic of Zurich.

<http://archiv.ethlife.ethz.ch/e/articles/sciencelife/turin.html>

It is in an article by Michael Breu titled "Not fake after all?".

The website is the official one of the Polytechnic (ETH Zürich = Eidgenössische Technische Hochschule Zürich).

One sees the photos of the whole Turin sample, of the two halves into which it was divided, and of the three portions obtained from the first half, with indicated the weights of all the fragments. Unfortunately there are not the fragments obtained from the second half and the respective weights are not indicated. Hopefully the data will be published also for the subsamples of the second cycle.

In the *Nature* report, for each result of Zurich it is specified if the subsample came from the first or the second half of the sample. Out of the five data of each Zurich sample in Table N1, the first three values of the column are those of the first cycle, i.e. they come from the first half of the sample, while the last two values are those of the second cycle and come from the second half of the

sample. For Thebes the first cycle has only one value because two fragments of textile were lost during the cleaning procedure.

Comparing D1 with N1 for Zurich, one finds that for each sample the data of the first cycle (the first three values, or the first one for Thebes) are the same, while the data of the second cycle (the last two values of each sample) are always different both for the age and for the sigma (quoted error). We now see the data in detail.

§8. Zurich: comparison between D1 and N1

Chart 06 compares the data of D1 and N1 for Zurich. For each sample, the first column has the data of D1 and the second column (in blue) has the data of N1. In the third column there is the difference between N1 and D1 where a plus sign indicates that *Nature* has an older age

CHART 06: Comparison between D1 and N1 for Zurich

Zurich / Turin			Zurich / Nubia		
733 ± 61	733 ± 61	0	890 ± 59	890 ± 59	0
722 ± 56	722 ± 56	0	1036 ± 63	1036 ± 63	0
635 ± 57	635 ± 57	0	923 ± 47	923 ± 47	0
617 ± 47	639 ± 45	+22	909 ± 47	980 ± 50	+71
595 ± 46	679 ± 51	+84	863 ± 47	904 ± 46	+41
Zurich / Thebes			Zurich / Provence		
1984 ± 50	1984 ± 50	0	739 ± 63	739 ± 63	0
//	//		676 ± 60	676 ± 60	0
//	//		760 ± 66	760 ± 66	0
1855 ± 49	1886 ± 48	+31	583 ± 47	646 ± 49	+63
1903 ± 49	1954 ± 50	+51	649 ± 47	660 ± 46	+11

We can see the for the last two values of each sample, that is for the second cycle, all the ages of D1 are younger with respect to N1.

§9. Zurich: comparison between first and second cycle

Already in the *Nature* report the ages of the second cycle, that is of the last two values of each sample, were somewhat younger, in the average, with respect to the first cycle. In D1 the difference is accentuated. Chart 07 shows for each sample the difference between the mean of the ages of the first cycle (the first three values, or the first one for Thebes) and the mean of the ages of the second cycle (the last two values). (These are simple means.) The first row is calculated from D1, the second from N1.

All the differences are in the sense of older ages for the first cycle.

CHART 07: Differences between the means of the first and second cycle for Zurich

	Turin	Nubia	Thebes	Provence
D1	91	64	105	109
N1	38	8	64	72

For D1 the differences are marked and extended to all the samples. If these were real data, they might suggest a systematic effect.

For Turin the two values of the second cycle have a weighted mean of 606 ± 33 . This age is even younger than the mean of the ages of Arizona, 646 ± 31 , which is the youngest among the three laboratories. This does not imply that the value 606 ± 33 would be incompatible with the presence of the Shroud at Lirey around 1350 AD. The value 606 on the calibration curve is positioned around 1380 AD, but the profile of the calibration curve in that century is anomalous and a 95% interval would extend about from 1290 to 1410.

§10. Zurich: Comparison between D1 and N1 for the scatter of results.

The scatter of the Zurich results is greater in D1 than in N1, as can be seen in Chart 08 by comparing the values of the standard deviation. For all the samples the values of the standard deviation in D1 are larger than in N1.

CHART 08: Values of the standard deviation in D1 and N1 for Zurich

	Turin	Nubia	Thebes	Provence
D1	62.99	66.42	65.20	71.16
N1	45.46	60.59	50.21	50.35

§11. Zurich: Comparison between D1 and N1 for the extremes.

Analogously, also the difference between the extremes, that is between the oldest and the youngest age for each sample, is always greater for the data in D1, as can be seen in Chart 09.

CHART 09: Difference between the extremes in D1 and N1 for Zurich

	Turin	Nubia	Thebes	Provence
D1	138	173	129	177
N1	98	146	98	114

§12. Comparison between D2 and N2

United in the same Chart 10 there are the values of the means for D2 and N2. As always, the data of *Nature* are in blue colour.

The first three pairs of rows show the means of the various measurements within each laboratory. The last pair of rows shows the means of the means of the three laboratories. All the means are weighted, as usual, with weights proportional to the inverse of the squared quoted errors.

CHART 10: Comparison between D2 (black) and N2 (blue)

	Turin	Nubia	Thebes	Provence
Arizona	646±31 646±31	927±32 927±32	1995±46 1995±46	722±48 722±43
Zurich	651±27 676±24	916±26 941±23	1913±38 1940±30	665±31 685±34
Oxford	750±30 750±30	940±30 940±30	1980±35 1980±35	755±30 755±30
w. mean	681±33 689±16	926±17 937±16	1960±23 1964±20	713±20 724±20

For Arizona the values of D1 and N1 are the same, apart from a small difference in the sigma of the mean for Provence (48 vs. 43). For Nubia and for Thebes, the means in D2 have not been calculated from the results in D1 but from results equal to those in N1. For the calculation of the means of Arizona, the sigmas have been widened with respect to the values of the quoted errors, as was necessary because the results for the ages had a scatter greater than it was compatible with the quoted errors. I have considered this aspect in §19 of [2]. The precise method followed by Arizona for the calculation of the means has not been stated in the *Nature* report and we cannot know whence comes the small difference (48 vs. 43) for the error of the mean for Provence.

For Zurich the means in D2 are the same that had already been given in D1. For the calculation of the values of D2 the results in D1 have been used and therefore all the values of D2 are different from those of N2. In particular, for Turin in D2 the mean of the measurements of Zurich gives an age which is 25 years younger with respect to *Nature*. The effect on the final mean among the three laboratories for Turin is an age eight years younger than in *Nature*.

For Oxford the values of D2 and N2 are the same, as to be expected because also the data of D1 and N1 are the same.

It is to be noted that in D2 for Zurich the value of the last row for the mean of

the means has been calculated by using the values as obtained from the values in D1. Therefore whoever has done the calculations for D2 was in this condition: for Zurich he/she had available the data of D1 (different from N1); for Arizona the data as in N1 (different from D1); and for Oxford the data which are the same in D1 and in N1. It is a strange mix.

§13. Recalculation (with a multiplier) of the means of Zurich from the data of D1

I have calculated by the usual method the weighted means of Zurich from the data of D1. Chart 11 has in the first row the values of D2 and in the second row (in red) the values I have calculated:

CHART 11: Comparison between the means of D2 and the means as calculated from D1

Turin	Nubia	Thebes	Provence
651±27	916±26	1913±38	665±31
649.84±23.44	915.35±22.96	1913.06±28.48	664.49±24.51

One sees that the differences in the values of the mean are small and can be explained by more drastic roundings in the calculations as performed for D2. Instead the differences in the values of the sigma of the mean are larger and induce to think that a multiplier has been used. For the calculation of the mean with the application of a multiplier to the quoted error, see §16 in [2]. Thus I have calculated again using a multiplier based on the chi-square test of homogeneity and have had confirmation.

CHART 12: Calculation of the multipliers for Zurich

	1	2	3	4	5	6	7
	chi-2	df	p	multipl.	before	after	D2
Turin	5.4962	4	0.2400	1.1722	23.44	27.47	27
Nubia	5.1375	4	0.2734	1.1333	22.96	26.02	26
Thebes	3.4591	2	0.1773	1.3151	28.48	37.45	38
Provence	6.6445	4	0.1559	1.2888	24.51	31.59	31

Chart 12 shows the calculation of the values of the sigma of the mean, for each sample, with the method of the multiplier (see §16 and §25 in [2]).

Column 1: value of the chi-square from the data of D1.

Column 2: number of degrees of freedom.

Column 3: value of p (significance) for the chi-square test.

Column 4: multiplier as calculated by dividing column 1 by column 2 and taking the square root.

Column 5: sigma of the mean as calculated from the data of D1 without the multiplier.

Column 6: sigma of the mean with the multiplier, as calculated by multiplying column 4 by column 5.

Column 7: sigma of the mean as shown in D2

From the comparison of column 6 and column 7 we see that the recalculated values (in red) are very similar to the values of D2. The small differences can be attributed to different roundings during the calculations. We deduce that in D2 the values of the sigma of the mean for each sample, for Zurich, have been obtained by widening the quoted errors with the application of a multiplier based on the chi-square.

As one can see from column 3, all the values of p for the significance of the chi-square test of homogeneity are well higher than the conventional limit of 0.05 and therefore according to common usage it would not be necessary to apply the multipliers. I think that it is a good rule to apply them also for these values of p because one obtains a confidence interval which is wider and thus more prudent.

References:

[1] P.E. Damon et al: Radiocarbon Dating of the Shroud of Turin. *Nature*, 337, 16 February 1989, 611-615

<http://www.shroud.com/nature.htm>

[2] G.M. Rinaldi: La statistica della datazione della Sindone. (Aprile 2012)

http://sindone.weebly.com/uploads/1/2/2/0/1220953/nature_statistica.pdf

[3] G.M. Rinaldi: *La Notte della Sindone*, il documentario di Francesca Saracino
Parte II – Due fogli di dati di provenienza ignota (Gennaio 2013)

http://sindone.weebly.com/uploads/1/2/2/0/1220953/notte_parte2bis.pdf