

DATING THE TURIN SHROUD—AN ASSESSMENT

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ABSTRACT. An assessment is made of the credibility of the radiocarbon dating of the shroud of Turin. The quoted final results produced a calibrated calendar age range of AD 1260–1390 for the linen of the Turin shroud at a 95% confidence level. The measurements were carried out independently in three accelerator mass spectrometry (AMS) laboratories located at the University of Arizona, Tucson, Arizona, USA, Oxford University, Oxford, England, and ETH-Hönggerberg, Zürich, Switzerland with assistance for certification and data analysis provided by the British Museum. The author concludes that, although the procedures followed differed substantially from those recommended at a workshop organized by the Pontifical Academy of Sciences, the results are credible. Although of negligible scientific value, they represent a major public triumph for the AMS method of carbon dating. However, many doubts have been raised, both real and fanciful, concerning the validity of the results and these are discussed. It is suggested that steps should be taken to conserve the shroud and that permission should be given for its examination by experts in medieval art.

In a paper presented at the 13th International Radiocarbon Conference held in Dubrovnik, Yugoslavia, June 20–25, 1988 (Gove 1989) the author reviewed the background and the status at that time of the project to radiocarbon date the Turin shroud. Of the three laboratories located in England, Switzerland and the USA only the latter at the University of Arizona had submitted its data at that time to the British Museum. Measurements were still in progress at the other two in Zurich, Switzerland and Oxford, England. In that paper concern was expressed about changes that had been made in the original dating protocol (Gove 1987) dictated by Turin ecclesiastical authorities but ultimately accepted by the three laboratories chosen by the Archbishop of Turin, Cardinal Ballestrero or, more accurately, by his science advisor, Professor Luigi Gonella, of the Turin Polytechnic.

Since then the final results have been published (Damon *et al* 1989). The reported result is that the flax from which the shroud's linen was woven was harvested between AD 1260 and 1390 at a confidence level of 95% (a mean of AD 1325 with a 33-year standard deviation). The agreement between the three laboratories for the shroud sample and the three control samples was within about one standard deviation. The possibility was raised by the author and many others that one of the laboratories might produce an outlier result, as was the case for an interlaboratory comparison carried out in 1986 (Burleigh, Leese & Tite 1986) involving these three laboratories and three others. One outlier among three cannot be statistically eliminated as it can among 6 or 7. Fortunately, this situation did not occur. Furthermore, the author is as sure as it is possible to be that there was absolutely no collusion between the three laboratories before they submitted their results to the British Museum. This belief must be widely shared since, among the many reasons advanced for disbelieving the results, no one has suggested such collusion as a possibility.

Turning now to the reasons that have been advanced for doubting the results, they are many and varied. Perhaps the most troublesome one is the fact that all three laboratories received a sample from essentially the same place on the shroud, and all likely would use essentially the same cloth cleaning procedures. This would mean that any contamination that is not removed by such cleaning procedures will equally affect all three measurements making them in agreement but wrong (Gove 1989). In the event, however, rather different cleaning procedures were employed by and within the three laboratories, ranging from ultrasonic cleaning to much more rigorous and thorough cleaning techniques (Damon *et al* 1989). Experts in the field do not know of any contamination that would not be removed by one or other of the cleaning procedures used. Even if it did exist in the form of contemporary organic carbon, which is one way the apparent age can be reduced, 64% of the shroud sample would have to be such contamination and only 36% of 2000-year-old carbon to change the measured date from the first century AD to the 14th century. Visible inspection by the author of the shroud sample received by Arizona before it was cleaned made it clear that no such gross amount of contamination was present.

It has been argued (Maloney 1989) that a more subtle form of contemporary carbon contamination may have occurred during the fire the shroud was subjected to in 1532. To quote Maloney,

Worse yet, when the cloth was folded into 48 layers and stored in the silver reliquary in Chambery, France, this corner (from which the samples for radiocarbon dating were removed) lay precisely in the area where the super-heated water settled when the fire was doused to save the Shroud. Silver melts at 960 degrees centigrade so the Shroud must have been subjected to 'pressure-cooker conditions' which would have dissolved any contaminants and transport them into the very molecular structure of the flax fibers. In the words of retired British textile expert John Tyrer, the carbon 14 content of the Shroud would have been 'topped up' and make it appear younger than other evidence suggests it to be.

Exactly how Maloney knows the location of the sampled area when the shroud was lying folded in its silver chest in 1532 is not stated. In any case, if the contamination were carbon that was contemporary in 1532, the mixture would have to be 86% carbon dating from the year 1532 to only 14% dating to the year zero. One does not have to be a molecular biologist to recognize the absurdity of this "topping up" notion.

Despite this, at an International Conference on the Shroud and Iconography held in Bologna, Italy May 6–7, 1989, C Haberman reported in *The New York Times* of June 11, 1989 that a group of "specialists" concluded that contamination of the cloth over the years, including damage from a fire in 1532, could have undermined the tests. No details for the basis of this conclusion were given in the news report but one suspects that it was arguments like those outlined above that prevailed. Ockham's razor is increasingly frequently employed (Malone 1989) to argue the Turin shroud dates to well before the 14th century but surely the simplest, albeit the dullest, conclusion to reach is that the shroud's age is its historic age which is what the carbon date tells us.

The same *New York Times* article states that an unnamed French monk charged that the British Museum official who coordinated the radiocarbon measurements substituted snippets of 14th century cloth for the postage-size shroud samples. The only time the samples removed from the shroud in the Sacristy at Turin Cathedral on the morning of April 21, 1988 were out of the sight of representatives of the three laboratories was when they were taken to the adjacent Sala Capitolare to be divided and sealed inside numbered stainless steel containers (Donahue, pers commun June 1989). During this time only the representative of the British Museum and the Archbishop of Turin were present (Damon *et al* 1989). In addition to this charge by the unnamed French monk, serious questions have been raised by R Halisey (pers commun Aug 14, 1989) as to why the sampling of the shroud and the sealing of the samples took place in two separate locations since that opens the possibility that a substitution could have been made of the shroud samples. This sample sealing procedure was apparently not videotaped although all the other operations were (Damon *et al* 1989). Despite this inexplicable contretemps, it seems probable that the Archbishop would detect such a substitution except in the unlikely event the British Museum official was inclined to perpetrate such a fraud and was capable of the requisite legerdemain. Equally unlikely but at least more plausible would be the substitution of snippets of first century cloth for the shroud samples. In any case, the distinctive 3 to 1 herringbone twill weave of the shroud could not be matched as the British Museum officials discovered when they attempted to find such for control samples. It was actually fortunate that the shroud samples were, in fact, identifiable both to preclude the possibility of substitution and for other reasons discussed below.

Along these same lines is the claim that the 10mm x 70mm strip, cut from the edge of the shroud just above the place where a sample had been removed in 1973, contained stitching threads or possibly pieces of the backing cloth of much later than first century vintage. Not only would this have been spotted by the two textile experts present but subsequent examination by members of the dating laboratories would have instantly revealed such extraneous material. All the laboratories examined the textile samples microscopically and removed any foreign material. Another argument has been made (G Hoyas, pers commun May 2, 1989) that the part of the shroud from which the sample was

cut had possibly become worn and threadbare from countless handlings and had been subjected to medieval textile restoration. If so, the restoration would have had to be done with such incredible virtuosity as to render it microscopically indistinguishable from the real thing. Even modern so-called invisible weaving can readily be detected under a microscope, so this possibility seems unlikely. It seems very convincing that what was measured in the laboratories was genuine cloth from the shroud after it had been subjected to rigorous cleaning procedures. Probably no sample for carbon dating has ever been subjected to such scrupulously careful examination and treatment, nor perhaps ever will again.

Although the original protocol (Gove 1987) specified the shroud and control samples were to be distributed to the laboratories in such a way as to ensure that the laboratories were not aware of the identities of the individual samples, the unique weave of the shroud made it instantly identifiable. The only way to have circumvented this would have been to unravel all four samples and to cut them into small pieces, too small, if possible, to identify which were warp and which weft threads. In the case of the shroud, these two classes of thread are of quite different denier. At the Turin workshop, this procedure was considered and wisely rejected since it would have risked the possibility that the cloth might be destroyed in the more rigorous cleaning procedures. In retrospect, it turned out to be important that the shroud samples were initially identifiable to the laboratory scientists so that the possibilities of contamination and reweaving of the kind discussed above could be shown to be out of the question. The arguments often raised, eg, by Maloney (1989) that radiocarbon measurements on the shroud should be performed blind seem to the author to be lacking in merit. It was never suggested that any other types of measurements on the shroud such as those carried out in 1978 be blind, so why should the only measurement that ever made any sense, *i.e.*, carbon dating, be subjected to this requirement? Since the three laboratories obtained the same date for the shroud without collusion and since the AD 1325 date could not have been the one hoped for by all the senior scientists at the three laboratories, lack of blindness in the measurements is a rather insubstantial reason for disbelieving the result.

One of the arguably more fanciful possibilities for the radiocarbon date of the shroud being in error has been advanced by T J Phillips (1989) of the High Energy Laboratory of Harvard University, Cambridge, Massachusetts (pers commun March 17, 1989). He has pointed out that the resurrection of Christ as described in the Bible was a unique physical event that was not accessible to direct scientific scrutiny. One cannot quarrel with that statement. He goes on to argue that since the image on the shroud appears to be a scorch, it suggests that the body on it radiated light and/or heat. From this he suggests the possibility that "it may also have radiated neutrons, which would have irradiated the shroud and changed some of the nuclei to different isotopes by neutron capture. In particular, some ^{14}C could have been generated from ^{13}C ." This could have changed its apparent age from 1st century to 14th century AD. Phillips advances no theories as to how any biological process can produce intense heat or light, much less neutrons, even thermal ones. He does not remark on the astonishing coincidence between the date this ghostly neutron irradiation produced and the known historical date of the shroud ca AD 1353, nor does he note that, since the neutron intensity from such a hypothetical source must vary with distance from the source, the piece of cloth selected was at just the correct distance to produce the historical date. A piece closer to the image, on the Phillips' hypothesis, would have produced an even more recent date. Had such a result been obtained from the AMS radiocarbon measurement, it would certainly have strengthened Phillips' speculation but would have astonished most of the rest of the scientific community. An elegant answer to Phillips was provided by R E M Hedges (1989). One interesting suggestion that Phillips (1989) made is that this same burst of neutrons would have produced other long-lived radioisotopes such as ^{36}Cl through neutron capture on stable ^{35}Cl . The problem is that chlorine is not a natural component of flax and, if present, would probably arise from contamination through the centuries. The radioisotope ^{36}Cl can also be produced by the interaction of high-energy neutrons from, eg,

cosmic rays with calcium. The AMS laboratory at the University of Rochester has the most experience with measuring ^{36}Cl in natural samples. Even in the unlikely event that Professor Gonella, in his capacity of science advisor to the Archbishop of Turin, were to request that Rochester undertake a ^{36}Cl measurement on the shroud, the offer would be declined.

When the author first read the report of the dating results (Damon *et al* 1989) he was struck by the fact that senior scientists at 2 of the 3 laboratories involved in the measurements, namely Oxford and Zurich, did not have direct control of the samples from cloth to ion source since, "after combustion to gas, the samples were recoded so the staff making the measurements did not know the identity of the samples." Hence, it appears that, at these two laboratories, no assurance can be given that no substitution occurred after the samples arrived in those two laboratories. Amazingly enough, it is implied in the report on the shroud dating (Damon *et al* 1989) that this added to the credibility of the result because, at least in these two laboratories, the measurements were carried out blind. On the contrary, this was an invitation to produce discordant results. Fortunately, however, the agreement in the measurements among the three laboratories precludes the possibility that any improprieties occurred.

The *New York Times* article (Haberman 1989) suggested that even the chief shroud scientist in Turin, Professor Luigi Gonella, found the shroud dating results credible. He is quoted as saying he "had no scientific reason to think the testing was inaccurate" but then went on to say "Even the law of gravity may turn out tomorrow to be in error." If he is implying that there is about as much chance that the shroud measurements are wrong as that law of gravity is in error, then he is very confident in the results indeed.

There are doubtless some whose religious beliefs have been profoundly affected by their exposure to the Turin shroud and choose not to believe the results. The writer, Ian Wilson, who has authored two books on the shroud (1978, 1986) as well as many articles, and who is presently President of the British Turin Shroud Society, is one such believer. He was apparently converted to Catholicism by his studies of the shroud. He was quoted in this same *New York Times* article as saying, "Until somebody can show me how the image was made—the carbon dating, for reasons we don't know, may be in error." This emphasizes the need to have real art experts, particularly those familiar with medieval art, examine the shroud as will be discussed below. Wilson is certainly not alone in continuing to believe, despite the radiocarbon results that the Turin shroud is Christ's shroud. The Rev Felice Cavaglia, pastor of the Turin Cathedral where the object is stored, is mentioned in the *New York Times* article as saying that after eight months since radiocarbon showed it to be inauthentic, the shroud retains its allure for believers that it is Christ's shroud. In that same article, even Pope John Paul II is quoted as still believing it is a relic and not merely an icon. The author's fear that if the shroud date was much more recent than the first century AD, it might affect some people's religious beliefs, was apparently unfounded. It is another remarkable example of "Plus ça change plus c'est la même chose."

W S A Dale (1987) of the Department of Visual Arts, University of Western Ontario, London, Ontario, Canada, in a study of Christian art concluded that, if the image on the shroud were an artistic representation of the crucified body of Christ, it was an icon dating from the 11th century. Comparing it with Christian art through the centuries, he asserts it was unlikely to have been created earlier than AD 969 or later than AD 1169. He remarks on the striking similarity between the frontal image on the Turin shroud and the Epitaphios of Milutin Ures in the Museum of Church Art in Belgrade, Yugoslavia. Although this dates from between 1282 and 1321 (the latter being amazingly close to the measured mean date for the shroud of AD 1325), he argues that similar *epitaphios sindons* go back to early in the 11th century. Dale (pers commun Aug 11, 1989), who published this study before the radiocarbon measurements had been made, considers the possibility that the artist who created the shroud of Turin may have used this Belgrade icon as a model, or for that matter, that the artist who created it may have been the shroud artificer himself to be exceedingly unlikely. In his view, both artists were influenced by depictions of the crucified body of

Christ layed out for burial that date back to the 11th century. In any case, the radiocarbon date proves that the shroud image was almost certainly created by the hand of man most likely in the first half of the 14th century. Aside from the question of preservation of the shroud, discussed below, the most important question to be settled is how the image on the shroud was created and, if possible, by whom. A panel of medieval art experts selected by the Archbishop of Turin with advice from art experts in the Vatican should be given an opportunity to thoroughly examine the shroud using whatever scientific non-deleterious methods that are required to establish the nature of the image.

To the author, one of the most fascinating aspects of the radiocarbon date is the fact that the person who created the image must have been known to the person believed to be the shroud's original owner, Geoffry I de Charny, the French knight who allegedly first announced its existence ca 1353. He died in battle ca 1356 without revealing how and from whom he had obtained it. According to R W Kaeuper (pers commun Aug 29, 1989), de Charny was the exemplar of a medieval knight. He was a literate man and a rigid believer in chivalry. He is the author of the only book on chivalry up to that time ever written by a layman. A 15th century copy of the manuscript of this book exists in Brussels and copies of it can be found in a few libraries in the USA. A translation of the book from the medieval French is presently being undertaken by the noted British scholar, Elspeth Kennedy, of Oxford University, and when published, will contain an historical introduction by Kaeuper. Although the shroud is apparently nowhere mentioned in the book, one cannot but think that somewhere in the records of de Charny's time there must be some mention of the origin of the shroud.

It is also considered possible that the private papers of the former king of Italy, Umberto II, presently in the possession of his widow may contain information as to the origin of the Turin shroud. King Umberto II was the previous owner of the shroud, although it was confiscated from him by the Italian government after his banishment from Italy following the second World War. Upon his death on March 18, 1983, his will bequeathed the shroud to the Vatican and Pope John Paul II is its legal owner.

Finally, turning to the question of conservation, the Turin shroud is still a very valuable and precious artifact and is certainly worth preserving. It has been pointed out (Gove 1989) that its custodial treatment both in France and in Turin since its existence was first revealed in ca AD 1353 has been less than exemplary. It was involved in a serious fire in Chambery, France in 1532 and is presently stored in an environment lacking both temperature and humidity control. A sizeable piece of the main body of the shroud was removed in 1973 for examination by a Belgian textile expert and the whereabouts of this piece was so poorly monitored that, although it was allegedly returned to Turin, it was considered too suspect to be used for carbon dating. It was considered necessary to remove another piece very close to where this 1973 sample was taken for the recent radiocarbon measurements. In 1978 a group of scientists who were, almost without exception, convinced that the shroud was indeed Christ's burial cloth was permitted to bathe the shroud in potentially damaging electromagnetic radiation of various frequencies including ultra-violet and X-radiation all with the alleged purpose of performing scientific tests that might confirm its authenticity as Christ's shroud. On the whole, these tests turned out to be inconclusive. There is even serious talk of permitting this same group to perform similar tests at even higher electromagnetic power in addition to other measurements. One of these is determining the ratios of the 2 stable isotopes of carbon (which has already been carried out for another reason by two of the carbon dating laboratories) and the 3 stable isotopes of oxygen which it is claimed will reveal whether the flax from which the shroud's linen was woven grew in a warm, cold, wet or dry climate! Rather than permitting such questionable scientific forays on the shroud by self-appointed "experts," what is needed is dispassionate advice from real experts on how best to conserve the shroud and then from medieval art experts on how, and if possible, by whom the image was created. The latter can await the apparent gestation period of the Vatican which appears, at least on matters concerning the Turin shroud, to be of the order

of a decade or so but the former—the actions to be taken to ensure conservation—certainly cannot.

Accelerator mass spectrometry, first developed at the University of Rochester's Nuclear Structure Research Laboratory in 1977 (Purser *et al* 1977; Bennett *et al* 1977) and now widely practiced in many laboratories throughout the world, has achieved its greatest public success to date in establishing that the Turin shroud is of medieval origin and certainly not the burial cloth of Jesus Christ. Although few would rejoice in this particular result, it is an impressive example of the power of the accelerator-based carbon dating technique. Without it the measurement might never have been made. Whether that is a good thing or not only history can decide.

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