A ‘Coptic’ tunic of the Egyptian Museum of Turin: Stylistic Attributions and Accelerator Mass Spectrometry Radiocarbon Dating

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Abstract

Dating archaeological textiles based solely on visual qualities can produce uncertain results. While much can be determined by examining weave structure, fibers and decorative motifs, the general dearth of extant examples for comparison, as well as lacuna in the historical record can result in the mislabeling of a textile’s period of construction. Advances in scientific research can now determine age with ease, minimal sampling and accuracy. This paper will present the conservation treatment of a Coptic tunic from the Egyptian Museum of Turin which was originally stylistically attributed to 10-12th century AD yet radiocarbon dating revealed it was actually 500 years older. The strategy for choosing samples and the procedure for measurement will be discussed including examples of earliest uses of 14C-dating in Textile Conservation.

The research was carried out in 2014 as part of a Master Thesis in the Conservation of Cultural Heritage at the University of Turin. Initially, the tunic was dated using standard art-historical criteria. Bibliographic research was conducted to compare the weave structure and pattern of the tunic - carefully studied and digitally reconstructed using vector drawing software AutoCAD - with that of other similar fragments present in museums and private collections. In the literature similar fragments were generally dated to 10-12th centuries. However, in light of recent radiocarbon dating to fifth to sixth centuries of three similar textile fragments at the Louvre, Abegg-Stiftung and Katoen Natie collections, radiocarbon dating was pursued too for the Turin tunic. The analysis was carried out at the INFN-LABEC (LAboratorio di Tecniche Nucleari per l’Ambiente e I BEni Culturali) in Florence using a 3 MV Tandem accelerator. The tunic was determined to have been produced between 415 and 560 AD during the full Byzantine period.

1. INTRODUCTION

1.1 Coptic Textiles

The tunic of the Egyptian Museum of Turin, the object of this study, is an example of a "Coptic textile," a vast, multifaceted and colorful category, which includes textiles from clothes and furnishing fabrics found in burial environments in Egypt from Roman times to the medieval period (from the first century BC to the 13th century AD). Coptic textiles cannot be identified as belonging to a specific historical period since their production took place over more than a millennium and therefore reflect a variety of different traditions. In fact, Egypt, after the Pharaonic era and the three century-long Hellenistic Ptolemaic period (331-30 BC), became the focus of conquest of several foreign empires: the Roman (30 BC to 395 AD), Byzantine (395 AD - 642 AD) and Islamic (642-1500 AD).

The origins of the term Coptic is rather vague. It was derived from the word used by the Islamic conquerors to indicate indigenous ‘Christian’ Egyptians. In the case of so-called ‘Coptic textiles,’ the word mainly refers to specific stylistic features. Coptic textiles were constructed using the skilled weaving techniques of the era of the Pharaohs yet introduced wool. Whereas flax had previously been favored for plain weave fabric, wool was easier to dye and thus preferred for the colorful Coptic decorations [De Moor et al 2008, Guidotti 2014]. Their pattern designs, colors, embroidery and figurative scenes were subject to change. However, it is necessary to highlight that, for more than a millennium, Coptic textiles were little influenced by technical or artistic change. They generally show uniformly characteristic elements in their material and weaving technique. Most of them were a tapestry woven with a vertical or horizontal loom using wool or linen threads.
Textiles were also frequently decorated with tiny linen or wool threads - supplementary flying threads -, in which a second shuttle was used to insert an extra flax weft thread into the fabric creating a delicate pattern [Guidotti 2014, De Jonghe and Verheeken-Lammens 1993].

1.2 Coptic textiles: Chronological attribution problems
The major European and North American ‘Coptic’ textile collections of the first millennium AD were formed between the second half of the 19th and the first decades of the 20th century by artifacts with unknown provenance, which came from the antiquarian market or directly from unscientific excavations. Archaeology in the late 19th century was not the science we know today and information related to all contextual dating evidence, such as provenance, excavation data or extensive comparative material, was definitely not collected. Therefore, traditionally the dating of a Coptic textile was primarily established by comparing its iconography and style with that of other media whose date is known - such as architecture, paintings, sculptures, mosaics, other textiles, and painted mummy shrouds [Nigro and Persegati 2000, pp 5-51]. However these methods are vague and they often depend on the observer’s subjective opinion. Tunic 17490 is an excellent example of disparities amongst scholarly reviews: several art historians have attributed the complex decoration of its clavus and tabulae to a wide period range of eight centuries, from the fourth century to the 13th AD. For this reason, the result of the radiocarbondating carried out at the INFN-LABEC in Florence was crucial. The results obtained have great value and justify the application of 14C analysis as a tool to assess dating, which does not always corroborate stylistic or typological estimates.

1.3 The Tunic 17490 of the Egyptian Museum of Turin
The fragmentary tunic, Inv. 17490, (Figure 1) was found in Egypt in a funerary context, probably during the second half of the 19th century. It was donated by the Cairo Egyptian Museum to the Egyptian Museum of Turin between 1888 and 1903, when the director of the Turin Museum was Prof. Ernesto Schiaparelli. In the Museum Archive [ASTO], next to the inventory number of the tunic, Schiaparelli reported its origin as: ‘from the necropolis recently excavated at Deir Mara Ghirghis’, between Thebes and Gomula. This note is the only information we have regarding the excavation context and provenance of the artifact. This tunic is unusual for its very large size and consists of two fragments of fabric, corresponding to its front and back, with decorative bands (clavus) and rectangular ornaments (tabulae). It was a simple garment draped around the body, which did not require special tailoring skills in its construction. It was woven in shape on a vertical loom in a single rectangle of cloth with sleeves, folded in two at the shoulders, with an opening at the center to allow the passage of the head. The vertical sides were sewn. For the deep study of the material and the construction of the textile, the research team used video-, optical-, and scanning electron microscopy (SEM-EDX). This revealed a fine and complex weave technique. The monochrome tapestry background was woven with 2 ply S-twist undyed wool yarn, with geometric designs and other decorations on the breastplate. The two vertical clavus and the four rectangular tabulae were inserted during the construction of the tapestry background using a white fine 2 ply S-twist linen yarn and 2 ply S-twist wool yarns in four different brilliant colors: purple, orange, green and red (Figure 3). Non-invasive dye analysis screening by portable fiber optics UV-Vis diffuse reflectance spectrophotometry (FORS) supported by the multi-spectral analysis in false-color infrared 950 nm (950 nm I.R. FC) has identified two of the natural dyes used to obtain the various shades. In particular, it highlighted the presence of red dyes from the roots of plants of the Rubiaceae family, collectively indicated as madder, and blue was obtained by vat dyeing with woad, Isatis tinctoria, or indigo, Indigofera [Cardon 2007]. It was not possible to identify the yellow dye because those particular flavonoids are not identifiable with only FORS spectra [Boselli and Picollo 2009 p. 4]. The yellow (probably Weld, Reseda luteola, which was largely employed as a source of yellow dyes in the Coptic textiles [Cabrera and Rodriguez 2005]) was combined with the red and the blue to obtain the orange, the purple and the green. The smallest, most refined details were made with an undyed white linen supplementary ‘flying thread’. The braid embroidery, the decorative thick Z-twist cords on the vertical edges, the supplementary weft fringes on the bottom and the two frogs make the artifact particularly valuable because of its high quality and rarity. Typological comparisons showed that the decorative motifs of the tunic were repeated frequently in mosaics, textiles, sculptures, paintings, etc., not only in Roman, Byzantine and later Islamic Egypt, but also throughout the Mediterranean. The iconography of the decoration is characterized by the repetition of (a) basic geometric patterns, consisting of 44 richly decorated octagonal rosettes and well over 1200 endless knots with three windings, (b) plant motifs, such as flowers, leaves and fruit, (c) human figures, including dancers, mythological figures such as cherubs or Nereids riding monstrous animals, and (d) small birds and eagles. Overall, it displays a rigid symmetry and fills every empty space.

1.4 Condition and Conservation treatment
The full conservation treatment and the diagnostic analysis were carried out in 2013 at the ‘Restoration and Conservation Centre La Venaria Reale’ during a Master thesis project [Ferrari 2013].
The tunic was structurally weak, with many losses in particular on the shoulder, the back and the breastplate. It was heavily stained from burial, particularly on the back where the dark staining is roughly in the shape of the body. SEM-EDX analysis of two samples of wool fibers taken in correspondence with organic stains revealed the high presence of silicon, aluminum – probably derived from the terrain of the burial ground – and phosphorus, presumably originating from decomposition products of the body. Other dark stains, appearing as localized spots, were investigated by X-ray fluorescence (XRF), which detected chalky- and earth-based components: iron oxides including Zn, Cu and Ag. It may be hypothesized that the presence of these metals, especially silver, is due to contact with precious heirlooms placed near the body of the deceased or in the folds of the dress, as was common at that time. SEM-EDX also revealed the condition of the fibers, which have longitudinal and transverse lesions probably due to aging, mechanical load and traction (Figure 3).

We know also that a few invasive restoration works were carried out over time, the last one probably in the early 1960s, during which a silk voile fabric was adhered to the back of the tunic using several coats of starch glue, identified with micro chemical tests (Lugol) and Fourier transform infrared spectroscopy (FTIR). The conservation treatment of the tunic that was carried out is described in detail in Ferrari 2013, Ferrari et al. 2014. The treatment was strictly focused on preserving original material, in line with the principles of ‘minimal intervention’. The choice of methods of cleaning (with a rigid gel and enzyme poultice), consolidation, and support was determined not only by the weakness of the artifact, but also by its huge dimensions and its future life within the museum. The tunic is now exhibited inside of a glass case in the Coptic section of the Egyptian Museum of Turin.

1.5 AutoCAD Mapping
We used the Vector Graphic Software AutoCAD not only for the precise and detailed study of the magnified decorative pattern, but also for an accurate reconstruction of the tunic, to be used for didactic and informative purposes (Figure 2). The AutoCAD diagram is now located next to the fabric inside the showcase of the Museum.

The reconstruction was based also on comparisons to similar tunics preserved in other Coptic textile collections. In order to recreate its original shape, we produced a paper pattern of the two fragments on a scale of 1:1, a detailed study of the decorative pattern, a graphic reconstruction of the deep folds identified with raking light and a mapping of the bodily fluids present throughout.

As a result, we found that the original size of the tunic was considerable: approximately 260 cm wide and 160 cm high, excluding the sleeves, a total of more than four square meters of fabric. In the graphic reconstruction it was possible to complete the breastplate, the neckline, the two tabulae on the shoulders and the width of the sleeves. There are not enough elements to be able to trace the length of the sleeves and the split for the passage of the head.

![Figure 1: The fragment of the front (A) and the back (B) of the Tunic 17490 of the Egyptian Museum of Turin](image1)

![Figure 2: Reconstruction of the tunic with Vector Graphic Software AutoCAD.](image2)

![Figure 3: Wool and flax threads analysis using Optical Microscopy (left column) and SEM-EDX (right)](image3)
2. METHODS

2.1 Chronological attributions of the tunic based on stylistic features

Before proceeding with the radiocarbon analysis, we conducted an extensive bibliographic comparative study with other similar Coptic textiles preserved in different collections in order to determine the age of the tunic (Table 1 – Clavus, Tabulae and Breastplate). The first catalog consulted was that of the Louvre Museum drafted in 1964 by the curator and Egyptologist, Pierre Du Bourguet (1910-1988) [Du Bourguet 1964], which attributed the decorative motifs present also on Tunic 17490 to the 11th to the 13th century AD, well into the Islamic period.
About that particular pattern he wrote: “This style, far from Greek Realism or Syrian exuberance, was characterized by the presence of purely decorative motifs repeated with monotonous regularity and treated with a concern to fill every single empty space. At first sight they appeared to me as very close to Muslim art. (...) The same decorative geometrical motifs and the same shape of the flowers with eight lobes are frequent in mosques, especially after the Tulunid (969-1174 AD) and Mamluk periods (1252-1517). The hypothesis of a chronology after the 10th century was accepted. The geometrical pattern with all possible combinations and the octagonal shapes are characteristic of the Muslim period which extends from the 9th to the 13th century, and are absent in the Hellenistic and Syriac periods. Egyptian and Kirsan bindings, the pattern on the Ibn Toulon mosque walls (19th century), the ceiling of the Sultan Qalaoun mosque (14th century), and 15th century carpets show it abundantly” [Du Bourguet 1958].


In Table 1, fragments of Coptic textiles with similar colors, materials, weaving techniques and designs, are compared with the details of Tunic 17490 drawn using CAD. This table clearly shows the history of tunics attributed through academic and art historical analysis. In 1994, L. Del Francia Barocas [Del Francia Barocas 1994] gave a different attribution than that mentioned above. She studied the archaeological artworks excavated in Antinoe between the 1938 and 1939, which she attributed to some time from the fifth century to the first half of the seventh century AD, thanks to fragments of papyrus found in the excavation context. She noted that many of that kind of geometric pattern existed before of the Islamic period, contrary to what was commonly believed, and she overturned the Du Bourguet dating to almost 4-5 centuries earlier. Barocas in fact dated the textile fragment Inv. 32 from the Museo dell’Alto Medioevo of Rome collection to the seventh to eighth century AD. Its pattern is evidently similar to the pattern of Tunic 17490. Also, J. Trilling [Trilling 1982] attributed a very similar textile to the fourth century AD, and the authors of the catalog ‘Coptic Textiles of The Tove Alm Collection’ [Sconci 2001] dated similar fragments to the fourth and fifth century AD.

This shows how much the chronological attribution of the tunic in question varies depending on academic interpretation, and it can change over a very broad time span between the fourth and 13th centuries AD. For this reason, we decided that it would be helpful for the purpose of the study to integrate the bibliographical research with the results of the radiocarbon dating.

2.2 Chronological attribution of the tunic based on $^{14}$C-dating of stylistically related fragments

Since roughly the 1990s, several institutions, including Katoen Natie in Antwerp (Belgium), Abegg-Stiftung in Riggisberg (Switzerland), and the Musée du Louvre in Paris (France), have carried out many radiocarbon investigations on archaeological textiles that are stylistically and technically similar to the tunic we studied in our own investigation. In particular, three were important for this study [Van Strydonck 2004, Schrenk 2004, Van Strydonck and Benazeth 2014] (Table 2). Their results show that the three textiles are much older than previously estimated before by stylistic attributions, and should in fact be traced back to the period from the fifth to the seventh century AD. An interesting case is represented by textile fragment E 32346, belonging to the Louvre Museum Collection, shown in Table 2, Figure A, which, stylistically, is extremely similar to tunic 17490. The Louvre fragment was dated twice, the first time by the Saclay laboratory (France) in 1957-58, during the early days of the $^{14}$C method (result: 620±120 AD) [Du Bourget 1957, Delibrias et al. 1964]. The second time was by the Leibniz Labor für Altersbestimmung und Isotopenforshung in Kiel (Germany) in 2013, 55 years later (result: 540-640 with 95.4% probability). Mark Van Strydonck and Dominique Bénazeth published this second $^{14}$C result [Van Strydonck and Bénazeth 2014], which was important because it reappraised the stylistic attribution of the Turin tunic by several centuries.

| TABLE 2 |
|-----------|-----------|-----------|
| A- Louvre Museum | B- Katoen Natie | C- Abegg-Stiftung |
| Fragment E 32346 | Fragment Inv. 581/DS18S | Fragment Inv. 147 |

<table>
<thead>
<tr>
<th>Du Bourguet attribution</th>
<th>$^{14}$C dating: 11th-12th Century AD</th>
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<tr>
<td>$^{14}$C dating:</td>
<td>620±120 AD (620±120 AD)</td>
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<tr>
<td>Serby age (1956-58):</td>
<td>620±120 AD (95.4% prob)</td>
</tr>
<tr>
<td>Van Strydonck and Benazeth (2014)</td>
<td>540-640 AD (95.4% prob)</td>
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<tr>
<th>Stylistic attribution</th>
<th>$^{14}$C dating: 11th-12th Century AD</th>
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</thead>
<tbody>
<tr>
<td>$^{14}$C dating:</td>
<td>620±120 AD (95.4% prob)</td>
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<tr>
<td>Van Strydonck and Benazeth (2014):</td>
<td>540-640 AD (95.4% prob)</td>
</tr>
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</table>
2.3 Controversies in ¹⁴C-dating
Furthermore, the two authors Van Strydonck and Bénazeth, [Van Strydonck and Bénazeth 2014] presented other issues related to textiles and radiocarbon dating:

- **Skepticism of art historians about the new ¹⁴C-dating**: for many decades, until the beginning of the 21st century, several art historians rejected ¹⁴C as a dating tool for Coptic textiles only because the results did not support their chronological framework based on typological comparison.

- **Sample dimensions**: at the beginning, the radiocarbon method technique required an enormous amount of the material and therefore it was very destructive to precious and beautiful textiles. It is incredible to notice how much material of the Louvre fragment was destroyed in the ¹⁴C analysis of 1957-58 (highlighted in black and white in Table 2, Figure A), and it is also important to highlight that despite the fact this analysis is destructive, some people were willing to sacrifice some fabric to test the ¹⁴C method. Another significant case of a textile being completely destroyed during radiocarbon dating analysis is a fragment of the silk burial shroud from Rayy, Persia (Figure 4). The Philadelphia Museum of Art restored the shroud in 2015, and the Metropolitan Museum of Art of New York requested it for a major exhibition on Seljic art [Canby et al. 2015 p. 297]. Dr. Erich Schmidt excavated the shroud in Rayy in 1935, and it came to form part of the PMA collection in 1951. The shroud was radiocarbon-dated in 1962 by the Texas Bio Nuclear Radiocarbon Dating Lab, and the analysis required the sacrifice of a 28-gram sample, corresponding to an enormous fragment of 82 by 78.5 cm (the result was 985 AD ± 50 years) (Figure 4-5). Now the sample amount required for an AMS ¹⁴C counting analysis is very small, about 12-15 mg of textiles.

2.4 AMS radiocarbon dating
This entire procedure was carried out at the INFN laboratory in Florence (LABEC, LAboratorio di Tecniche Nucleari per I BEni Culturali).

2.4.1 Sampling strategy
Since the knowledge of the object and its conservation history is clearly fundamental for obtaining accurate ¹⁴C ages, we drew up diagrams of the tunic, relating to the materials, weaving techniques, conditions, and previous restorations, in order to collect two optimal samples of about 15 mg each of undyed and purple wool fibers (Venaria 1 and Venaria 2). The ecru wool sample, Venaria 1, was cut from the fringe on the bottom of the tunic. The purple wool sample, Venaria 2, was already separated from the tunic but also belonged to the fringe. We selected sampling areas according to 3 requirements: (1) the good condition of the fiber, (2) original, unaltered fiber (3) and the absence of material or substances used during previous restoration – for example, the starch glue present on the back of both fragments, which would have required a more aggressive strategy for the chemical pre-treatment of the samples, with a consequent greater loss in mass. We selected the samples in agreement with and under the supervision of the head conservator of the tunic as well as of other art historians and archaeologists. Collecting more than one sample of thread reduced the possibility of ambiguous results.

2.4.2 Pretreatment ABA
Before proceeding with the AMS measurement, each sample was thoroughly cleaned both in a mechanical and chemical way to more effectively remove possible contaminations to ensure that only the primary carbon of interest would be analyzed. Since the datable materials are heterogeneous (wool-leather-wood etc.) and since
each sample has unique characteristics, such as their condition, there are no standard procedures for the pre-
treatment, which has to be adapted to each particular case. In the case of textile fibers, a so-called ABA
 treatment (acid-base-acid) is generally used. It consists of a succession of baths in acid solutions (1M HCl), in a
 base solution (0.1M NaOH), and in acid again (1M HCl). This bath in acid solution functions to remove any
 traces of carbonates, and the bath in a base solution removes organic material [Fedi et al. 2007]. In the specific
case of the wool thread of the tunic, we preferred to keep the samples in the NaOH 0.1M solution for only 10
 min to avoid the partial denaturation of the keratin and the eventual loss in mass of the sample.
In summary, the two samples were pretreated with the following procedure:
• incubation in 1M HCl at about 80°C for 1 hr,
• incubation in 0.1M NaOH at room temperature for 10 min,
• incubation in 1M HCl at about 80°C for 1 hr
• drying in an oven at 100°C for about 12 hr.
Afterwards, samples were accurately analyzed using the line of Accelerator Mass Spectrometry (AMS) at INFN-
LABEC, where a 3MV accelerator is installed.
The pretreated samples were combusted in an elemental analyzer (CN Thermo Flash11120). Then, the CO2 was
converted to graphite – solid carbon - by reaction with hydrogen, in the presence of iron as a catalyst. The
graphite samples obtained were pressed into pellets and then placed in the AMS source for the
\(^{14}\text{C}\) measurement. From each sample, two different fractions were graphitized.

3 RESULT AND CONCLUSION
The conventional radiocarbon age obtained for the two samples are 1645 ± 50 years and 1515 ± 40 years before
present (BP), respectively. The calibration was obtained using OxCal v.4.2. and IntCa113 [Reimer et al. 2013].
The results are summarized in Table 3, Figure 6 (sample Venaria 1) and 7 (sample Venaria 2).

<table>
<thead>
<tr>
<th>Sample</th>
<th>(^{14}\text{C}) Conc. (pMC)</th>
<th>(^{14}\text{C}) Age BP</th>
<th>Cal. Date (68.2%)</th>
<th>Cal. Date (95.4%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venaria 1</td>
<td>81.49±0.49</td>
<td>1645±50</td>
<td>AD 355-455 (53%)</td>
<td>AD 320-540 (69%)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>AD 490-530 (15%)</td>
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<tr>
<td>Venaria 2</td>
<td>82.83±0.37</td>
<td>1515±40</td>
<td>AD 430-455 (8%)</td>
<td>AD 425-695 (95%)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>AD 470-490 (8%)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>AD 530-605 (52%)</td>
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</tbody>
</table>

Since the two samples were collected from the same artifact, the two radiocarbon age can be combined in order
to determine the best estimated age of the tunic (Figure 8). This is obviously possible only if the two ages were
not significantly different from a statistical point of view. The result is showed in Table 4 and Figure 8.

<table>
<thead>
<tr>
<th>Table 4</th>
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<tr>
<td>Cal. Date (68.2%)</td>
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<td>AD 425 – 540</td>
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These analyses revealed that the tunic belongs to the period between the fifth and sixth century AD – 415-560
AD, with a 95.4% probability – thus proving that the textile is much older than expected based solely on
assessments of historical artistic criteria. The analyses showed the necessity of \(^{14}\text{C}\) dating to obtain a more
accurate dating of Coptic textiles.
4 BIBLIOGRAPHY

ASTO, Soprintendenza Speciale al Museo delle Antichità Egizie di Torino, Il Versamento, Mazzo 7, Fascicolo 1


Peter I (1976) Textilien aus Ägypten. In: Museum Rietberg Zurich, Museum Rietberg Publisher. p.102


Rutschowscaya MH (1990), Tissus Coptes, Adam Biro Ed. Parigi. p.73

Sconci MS (2001) Stoffe Copte. La collezione Tove Alm,Soprintendenza per I Beni Artistici e Storici di Roma
