DEBORA DYER MAYER
Conservator of Art & Historic Artifacts on Paper

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CONSERVATION REPORT

OWNER: L. David Roper
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Date: January 7, 2005
Ref. # 05-02

OBJECT: Paper wrapper stuffed around a tooth contained in an acorn-shaped gold trinket. The tooth is thought to belong to Ben Franklin (1706-1790), pulled before his death and passed down in the family to his 5th great grandchild Jean Marie Pergrin. The tooth was on loan to D. Roper for DNA analysis.

FIBER SAMPLE: A fragment of the wrapper was sent to Debora Mayer for paper fiber analysis.

PURPOSE: Document the type of fibers used in wrapper and to determine if the wrapper could have been made prior to or around Franklin's death.

FIBER ANALYSIS

General Observations and Procedure

The paper wrapper is wrinkled and crinkled like crepe paper. The paper has an unusual lemon yellow color. The color is not typical for writing or printing papers, especially of the 18th C. There are blue and red specks on the paper surface, which may be corrosion products or other debris. Several small samples (the size of a pinhead) were removed from the fragment, transferred to a clean microscope slide and teased apart in water. The sample was examined with polarized light microscopy at 100-600 times magnification with Cargille meltmount as the mounting media to look at the optic properties of the fibers, and then with Graff's C-Stain to review color reactions with the indicator stain.

The paper is made from bast fibers, probably either linen (flax fibers) or from hemp. The fibers are heavily beaten. Macrofibril stands are abundant. The beating of the fibers produces a paper that is thin yet tough as the fibrils bonds with one another. Cross markings or nodes across the fiber diameter were present in many fibers, a key diagnostic feature of bast fibers. All fibers stained pink-red in Graff C stain confirming the presence of "rag" (non-lignin containing) fibers such as linen. The fiber ends were cut (part of the pulping process). The fibers were generally 0.5- 1.0 mm long.

There may be a trace amount of cotton fibers present as well. Due to the heavily beaten nature of the fibers it was difficult to positively identify all the fibers. It is likely that the beating of the fibers has flattened the fibers contributing to the fibers appearing like cotton. Cotton is a high cellulose containing fiber and would also stain red with Graff C stain. The issue of the presence of cotton is important regarding dating. Cotton has been available since ancient times but uncommon in western paper prior to the invention of the cotton gin in 1791.

Conclusion

The wrapper is made with bast fibers that have been heavily beaten. Based on the fiber content the paper could have been made during Franklin's time. It could also have been made later. Flax and other bast fibers are still in use today although generally only in high-grade specialty papers. A similar tissue wrapper manufactured at a later date would most likely be made with straw fibers (after 1800) or with wood pulp (after mid 19th century.) The unusual yellow color of the paper was not addressed.

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Debora Dyer Mayer

DIGITAL IMAGES OF THE FIBERS FOUND IN THE TISUE WRAPPER USED TO STUFF B. FRANKLINS TOOTH IN THE GOLD ACORN

Debora D. Mayer

January 8, 2005

The photomicrographs were taken with a Leica DMRX polarizing microscope with the kind support of the Strauss Center for Conservation Analytical Department, Harvard University Art Museums, Harvard University, Cambridge, MA.

Image #683
400x magnification of a bundle of bast fibers. There are approximately 12-15 fibers clumped together. The fibers naturally have a slight tan tone.

Image # 702
400x magnification of the beaten bast fibers. The fiber positioned in the center in a horseshoe shape is identifiable as a bast fiber, especially by the cross marks that are visible when the polarizing filters are crossed as shown in image #704. The tangled masses of fiber strands are macrofibrils.

Image #704
Same fiber sample as image #702 with the polarization filters crossed in the microscope. With crossed polarization the field of view darkens and the nodes and marks across the fiber are more apparent. In addition, the rainbow polarization colors seen with bast fibers, such as flax or linen are visible. (Note the field of view should be a dark gray but photographed blue.)

Image #693
630x magnification of a single fiber photographed with crossed polarization. With crossed polarization the field of view darkens and the nodes and marks across the fiber are more apparent. In addition, the rainbow polarization colors seen with bast fibers, such as flax or linen are visible. The thick cell wall and narrow lumen are also visible. (Note the field of view should be a dark gray but photographed blue.)

Image #713
400x magnification of fibrillated (heavily beaten) bast fibers stained red with Graff C stain. Graff C stain is a chemically reactive indicator stain that stains high cellulose containing fibers red. Beating of the fiber during manufacturing causes the fibril structure to peal away and form hair-like fiber threads. Extreme beating can flatten the otherwise cylindrical bast fibers and making positive identification difficult.

Image #727
630x magnification of mechanical damage to the bast fiber, probably occurring from the beating process in pulp preparation. The fiber has been stained red with Graff C stain.