THE QUEST FOR QUERCITRON

REVEALING THE STORY OF A FORGOTTEN DYE

by

Heather Nicole Hansen

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Approved: ____
Linda Eaton, B.A. Hon.; D.T.C.
Director of Collections & Senior Curator of Textiles, Winterthur Museum

Approved: ____
J. Ritchie Garrison, Ph.D.
Director of the Winterthur Program in American Material Culture

Approved: ____
George H. Watson, Ph.D.
Dean of the College of Arts and Sciences

Approved: ____
Charles G. Riordan, Ph.D.
Vice Provost for Graduate and Professional Education

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This work is dedicated to the memory of my father

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has been the incentive for its completion.

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Quercitron is a natural dye derived from the inner yellow bark of the black oak tree. Significant because it is one of only two natural dyes with a known discoverer, quercitron receives merely a passing mention in sources of dyeing and printing history, textile design, economic history, and scientific texts. Edward Bancroft discovered quercitron in 1771, received a British patent controlling the distribution of the dye for a period of fourteen years in 1775, and had the patent extended for an additional fourteen-year term in 1785. He introduced the dye to printers in his 1794 manual *Experimental Researches Concerning the Philosophy of Permanent Colours*. When his patent expired in 1799, quercitron was in high demand among calico printers and the "drab style" prints produced by the dye dominated the textile markets. Generally this is the extent of the quercitron story. This study fills the gaps in the literature by examining the reaction to quercitron from Bancroft's contemporaries and comparing the dye to other yellow sources. It investigates processes of production, printing, and distribution of quercitron and explores the relationships and networks of people involved in these processes. Finally this study challenges the notion that natural dyes disappear after the invention of synthetic dyes beginning in 1856. It illustrates quercitron's evolution and longevity in the dyeing and printing industry.

Chapter 1

INTRODUCTION

Native to the United States, black oak trees are scattered across the eastern seaboard between the Atlantic Ocean and the Mississippi River, ranging from Maine to Georgia. These trees conceal a layer of yellow bark between the dark outer bark and the heartwood. Significant beyond its vibrant yellow hue, Edward Bancroft patented this inner bark as a dye called *quercitron* in 1775. Although the dye is fairly obscure today, it affected textile printing technology, impacted industries both domestic and abroad, and created a new colorway in textiles fashionable for clothing and furnishings from the 1780s through the 1830s. The question remains: how did this happen? While a variety of sources refer to quercitron, it only receives a passing mention. Why is so little known about a dye that is so widely referenced?

Besides cudbear, quercitron is the only other natural dye with a known discoverer.[1] In 1771, American-born Edward Bancroft (1744–1821) first discovered the coloring properties of three trees: American hickory, red mangrove, and black oak.

[1] Cudbear, a lichen dye was discovered by Dr. Cuthbert Gordon in Scotland and patented in 1766. See K.G. Ponting, *A Dictionary of Dyes and Dyeing* (London: Bell & Hyman Ltd.,1981), 48.

Of these, the black oak bark proved the best colorant, and Bancroft named it *quercitron* from the Latin *Quercus citrine—Quercus* for oak and *citrina* for its lemon-yellow color.[2] In order to preserve his interest in the dye, Bancroft acquired an English patent in 1775 to control the distribution of the bark.[3] A veritable Renaissance man, Bancroft pursued research in the fields of medicine, natural history, and chemistry. Although several biographies discuss Bancroft's life, none, except a brief article by Sidney Edelstein, discuss Bancroft's dye to any extent.[4] How did Bancroft discover quercitron. and how did he obtain and market it for British consumption?

Quercitron's discovery coincided with the industrialization of the textile industry and the development of modern chemistry. This intersection of events made dyes that could be obtained in substantial quantities and that produced permanent colors highly regarded. Because of its useful properties, quercitron became the yellow dye of choice for English calico printers in the late eighteenth century. The years between Bancroft's discovery in 1771 and the expiration of his patent in 1799

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[2] Arthur McNalty, "Edward Bancroft, M.D., F.R.S., and the War of American Independence," *Proceedings of the Royal Society of Medicine*, Vol. 38 (June 1944): 9.

[3] Patents allowed inventors or discoverers a period of time to profit from their discoveries by granting them authority and control over their property. The period could be extended by re-applying to Parliament and having both the House of Commons and the House of Lords approve the application.

[4] Sidney Edelstein, "Historical Notes on the Wet-Processing Industry IV: The Dual Life of Edward Bancroft," *American Dyestuff Reporter* 43 (1954): 712–13, 735, also

witnessed a growing interest among dyers and calico printers in the use of quercitron. With the expiration of Bancroft's patents, interested parties gained unrestricted access to quercitron bark, allowing for widespread printing of the colorway known as the drab style. This style was characterized by its varied shades, ranging from lemon to mustard, olive to chocolate, and honey to amber.[5] Textile historians generally pinpoint the expiration of Bancroft's patent in 1799 as the launch of the drab style's popularity, but printers had to know about quercitron in order for its popularity to gain momentum. Is this date of introduction correct, and how long did quercitron's popularity last?

Dyers and printers used quercitron on wool, silk, cotton, and linen fibers. [6] This study focuses on quercitron's sudden proliferation and widespread use in the cotton

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published as "The Dual Life of Edward Bancroft" in *Historical Notes on the Wet-Processing Industry* (New York: Dexter Chemical Corporation, 1972), 25–27.

[5] Peter Floud, "The Drab Style and the Designs of Daniel Goddard," *The Connoisseur,* Vol. 139 (June 1957): 234.

[6] Dyeing involves coloring fleece, yarn, or fabric with one color. Printing entails the application of a pattern or a design on fabric via the impression of an incised wood block, copper plate, or roller onto the surface of the fabric. According to *The Book of Trades; or, Library of the Useful Arts,* published in 1807 as a children's book: "The art of the dyer consists in tingeing cloth, stuff, or other substance, with a permanent colour which penetrates the substance of it. Dyeing differs from bleaching, which is not the giving a new colour, but brightening an old one. It differs also from painting, printing, or stamping, because the colours in these only reach the surface." See Peter Stockham, ed., *Early American Crafts and Trades*(New York: Dover Publications, 1976), 125–26, for the unabridged replication of Part I of the work as published by

printing industry. While nineteenth-century dye manuals, including Bancroft's *Experimental Researches*, describe procedures for dyeing wool and silk with quercitron, very little evidence of this practice has been found.

In order to understand the environment of the eighteenth-century textile industry, it is necessary to document some of the historical events leading up to the time. During the seventeenth century, the East India Company began importing brightly colored printed fabrics from India. Until then, sophisticated, multicolored fabrics were only available as expensive woven fabrics. Feeling threatened by these imported printed cottons, representatives from England's woolen and silk industries petitioned for an act of Parliament to ban the importation of printed fabrics. This only made the printed fabric more desirable, leading merchants and artisans to import plain cotton and experiment with their own printing techniques. Quercitron gained recognition because of its ability to produce multiple, distinctive colors from a single dye bath.

The industrialization of the cotton printing industry resulted in many inventions and discoveries. Claude-Louis Berthollet's introduction of chlorine as a bleaching agent in 1786 sped up the bleaching process, which previously took months to achieve the same effect through exposure to the sun. In 1770, Thomas Bell of

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Jacob Johnson, *The Book of Trades; or, Library of the Useful Arts* (Philadelphia and Richmond, 1807).

Glasgow, Scotland, began printing textiles using flat, engraved plates first with a flat press and then later applying pressure to flat plates with a roller press. Fifteen years later, Bell, with the assistance of Adam Parkinson of Manchester, invented the roller-printing machine for printing textiles. Use of an engraved copper cylinder rather than a flat copperplate allowed a textile printer to impart a design with greater speed and uniformity, thereby improving efficiency. The new technology also required new dyes that were conducive to the processes. How was quercitron suitable to the technology?

Quercitron appears to be a color that is hidden in plain sight. Many sources allude to its importance and its ubiquity in late eighteenth- and early nineteenth-century textiles, but until now, quercitron has not been investigated thoroughly. This study will explore quercitron's diffusion and historical significance. Through analysis of dyeing and printing manuals, examination of extant drab style prints, and investigation of networks involved in quercitron's production and dissemination, this thesis will reveal the secrets of quercitron, the forgotten dyestuff.

Chapter 2

HISTORY OF QUERCITRON SCHOLARSHIP

A variety of sources mention quercitron, ranging from dyeing and printing manuals, to scientific, technological history, and design publications, yet no one has ever written a comprehensive study about it. This chapter discusses the types of publications that address quercitron dye, and identifies the gaps in these studies.

Bancroft Historiography

While Edward Bancroft is not the focus of this study, his role as the discoverer of quercitron makes him an intrinsic part of its story. Few primary sources exist on Bancroft. In 1899, Benjamin Franklin Stevens exposed Bancroft's career as a double-agent for the American colonies and the British government in his publication *Facsimiles of Manuscripts in European Archives Relating to America, 1773–1783*.[7] Enraged by this revelation, Bancroft's grandson, General William C. Bancroft, destroyed most of his grandfather's personal papers. However, Bancroft's exposure as a spy also led to a barrage of biographies discussing his life. These biographies tend to

[7] Benjamin Franklin Stevens, *Facsimiles of Manuscripts in European Archives Relating to America, 1773–1783* (London: Malby & Sons, 1889–95).

divide into two categories: those focusing on his political career and those concentrating on his medical/scientific endeavors. All treat the two endeavors in isolation. Only Sidney Edelstein's "The Dual Life of Edward Bancroft" explores Bancroft's profession as a discoverer and exporter of a dyestuff.[8] Focusing on his political career, Bessie Boies first wrote about Bancroft's spy career in her unpublished master's thesis.[9] In 1924, Samuel Flagg Bemis thoroughly explored Bancroft's espionage and published Bancroft's Carmathen memorial, in which he appealed for reinstatement as an informant after the British government deemed his information unnecessary.[10] C.A. Browne first discussed Bancroft's scientific interests and his published findings as presented in *Natural History of Guiana* and *Experimental Researches Concerning the Philosophy of Permanent Colours)* in a 1937 article, "A Sketch of the Life and Chemical Theories of Dr. Edward Bancroft."[11] Sir Arthur McNalty provided the most complete bibliographic overview of Bancroft's life,

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[8] Edelstein, "Historical Notes," 712–13, 735.

[9] Bessie Boies, "Edward Bancroft: A British Spy," Master's thesis, University of Chicago, 1908.

[10] Samuel Flagg Bemis, "British Secret Service and the French-American Alliance," *The American Historical Review*, Vol. 29, No. 3 (April 1924): 474–95.

[11] C.A. Browne, "A Sketch of the Life and Chemical Theories of Dr. Edward Bancroft," *Journal of Chemical Education* (March 1937): 103–7.

but his 1944 article left something to be desired since he failed to footnote any of his sources.[12] Edelstein's 1954 article also lacked references.

In 1959, Julian Boyd created a stir in the academic community by theorizing in a series of three articles in the *William and Mary Quarterly* that Bancroft murdered Silas Deane with an overdose of laudanum.[13] Boyd's evidence, however, was based on speculation of Bancroft's familiarity with different poisons. By 1973, Godfrey Tryggve Anderson and Dennis Kent Anderson provided a biography of Bancroft contextualized in the eighteenth century medical atmosphere providing a broader sense of what it meant for Bancroft to be a doctor.[14] In "The Death of Silas Deane: Another Opinion," they offered a rebuttal to Boyd's accusations and provided the medical opinions of seven physicians who diagnosed Deane's demise as a stroke or acute attack after years of suffering from chronic disease, possibly tuberculosis.[15]

Recently two 2009 publications provide new perspectives about Bancroft. Stanley Finger examined Bancroft's experience in Guiana and explored his

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[12] McNalty, "Edward Bancroft," 7–15.

[13] Julian Boyd, "Silas Deane: Death by a Kindly Teacher of Treason?" *William and Mary Quarterly*, Vol. 16, No. 2 (April 1959): 165–87,Vol. 16, No. 3 (July 1959): 319–42, and Vol. 16, No. 4 (October 1959): 515–50.

[14] Godfrey Tryggve Anderson and Dennis Anderson."Edward Bancroft, M.D., F.R.S., Aberrant Practitioner of Physick" *Medical History* Vol. 4 (1973): 356–67.

experiments with electricity in “Edward Bancroft’s ‘Torporific Eels.’”[16] In a chapter titled “Fugitive Colours: Shamans’ Knowledge, Chemical Empire and the Atlantic World,” professor and historian James Delbourgo analyzes three phases of Bancroft’s career as a naturalist, political informant, and philosophical chemist through the lenses of intercultural exchange of knowledge and sensory perception.[17] Delbourgo focuses on Bancroft’s seamless transitions through disparate occupations and locations, finally viewing Bancroft’s career as a whole, rather than scrutinizing fragments.

Interestingly, no one has ever written a full bibliography of Bancroft’s life. This work looks at another aspect of his life, his dye discovery and his experiments with the dyestuff quercitron.

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[15] Godfrey Tryggve Anderson and Dennis Anderson, “The Death of Silas Deane: Another Opinion,” *The New England Quarterly*, Vol. 57, No. 1 (March 1984): 98–105.

[16] Stanley Finger, “Edward Bancroft’s ‘Torporific Eels,’” *Perspectives in Biology and Medicine,* Vol. 52, No. 1 (Winter 2009): 61–79.

[17] James Delbourgo, “Fugitive Colours: Shamans’ Knowledge, Chemical Empire and the Atlantic World,” in *The Brokered World: Go-Betweens and Global Intelligence*, 1770-1820, ed. Simon Schaffer et al (Science History Publications, 2009), 271-320.

Bancroft's Experimental Researches

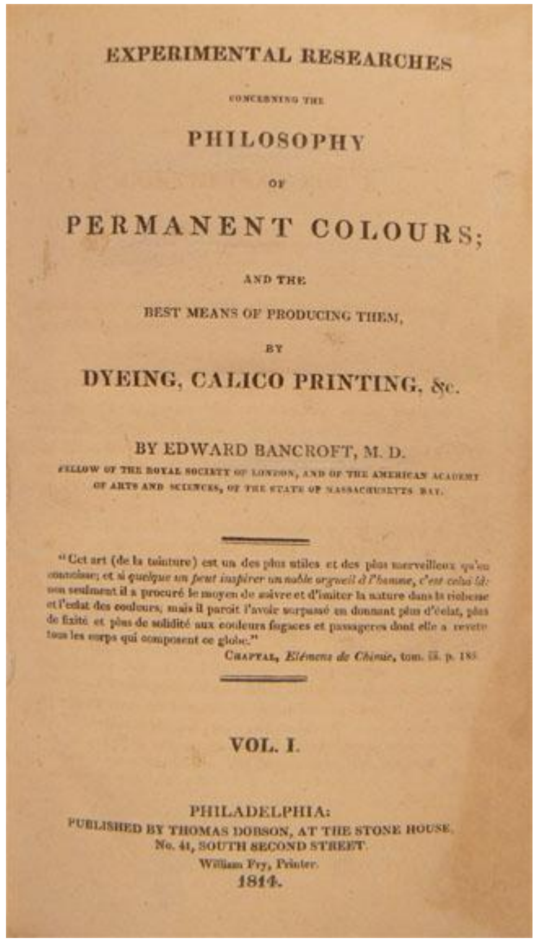
Edward Bancroft first introduced quercitron in his book *Experimental Researches Concerning the Philosophy of Permanent Colours*,[18] a manual describing his observations and experiments as well as the printing and dyeing techniques associated with his patented dye (Figure 1). *Experimental Researches* explained quercitron's useful characteristics for calico printers and dyers, highlighting its potency, its ability to create multiple colors, and its receptivity to bleaching.[19] Published in London in 1794, the first edition of *Experimental Researches* consisted of one thousand copies. Bancroft published a second edition in London in 1813 and an American edition in Philadelphia in 1814. This work marked the first significant English study on dyeing and dyestuffs and conveyed the prevailing chemical knowledge of the time by adopting contemporary nomenclature and theoretical principles. Its significance as an important resource for understanding the development of the commercial dye industry and the evolution of natural colorants at a time when

[18] Edward Bancroft, *Experimental Researches Concerning the Philosophy of Permanent Colours; And the Best Means of Producing Them, by Dyeing, Calico Printing, etc.* Vol. 1 and 2 (Philadelphia: T. Dobson, 1814).

[19] Thomas Cooper states: "Dr. Bancroft's book was principally intended to promote the sale and the use of this drug [quercitron], which he has a patent for importing into England; and doubtless, it has proved a valuable acquisition to the dyer and the printer."; see Thomas Cooper, *A Practical Treatise on Dyeing and Callicoe Printing* (Philadelphia: Thomas Dobson,1815), 18. These characteristics are addressed in Chapter 2, "Quercitron and Its Color Competitors."

technological change was rampant should not be underestimated. Most important, *Experimental Researches* introduced quercitron and its coloring potential to the world, and serves as the centerpiece of this study.[20]

[20] Other contemporary dyeing and printing manuals provide insight into the reception of quercitron among practitioners and chemists during the late eighteenth and early nineteenth centuries. They are discussed in depth in Chapter 2.


EXPERIMENTAL RESEARCHES

CONCERNING THE

PHILOSOPHY

OF

PERMANENT COLOURS;

AND THE

BEST MEANS OF PRODUCING THEM,

BY

DYEING, CALICO PRINTING, &c.

BY EDWARD BANCROFT, M. D.

FELLOW OF THE ROYAL SOCIETY OF LONDON, AND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, OF THE STATE OF MASSACHUSETTS BAY.

"Cet art (de la teinture) est un des plus utiles et des plus merveilleux qu'on connoisse; et si *quelque un peut inspirer un noble orgueil à l'homme, c'est celui là*: non seulement il a procuré le moyen de suivre et d'imiter la nature dans la richesse et l'eclat des couleurs; mais il paroit l'avoir surpassé en donnant plus d'éclat, plus de fixité et plus de solidité aux couleurs fugaces et passageres dont elle a revetu tous les corps qui composent ce globe."

CHAPTAL, *Elémens de Chimie*, tom. III. p. 18

VOL. I.

PHILADELPHIA:
PUBLISHED BY THOMAS DOBSON, AT THE STONE HOUSE,
No. 41, SOUTH SECOND STREET.
William Fry, Printer.
1814.

Figure 1. Title Page of *Experimental Researches Concerning the Philosophy of Permanent Colours*, Edward Bancroft, 1814.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Bancroft discovered quercitron during an active time in scientific inquiry, when scientists and philosophers contributed to the emergence of modern chemistry. The study of dyes and color was a part of the developing scientific culture focused on advancing, refining, and standardizing practices in chemistry. During this period, a desire to order and classify knowledge prompted the development of comprehensive studies and manuals on dyes and dyeing. Authors organized content by color, fiber, or the physical properties of the dyestuffs, according to the contemporary categories of natural history (mineral, vegetable, animal). French dyers categorized colors into "grand" or "petit teint"; greater or lesser dyes distinguishing permanent from fugitive colors.[21] Governmental regulations enforcing the use of permanent colors required French chemists to carefully assess colorants and their properties. Three French chemists became pioneers in experimenting with textile dyes, each specializing in color application to a different fiber. Jean Hellot (1685–1766) specialized in wool, Pierre Joseph Macquer (1718–1784) was an expert in silk dyeing, and Placide-Auguste Le Pileur d'Apligny (1750–1775) was an authority on cotton.[22]

During the twelfth through the seventeenth centuries, dyeing was a secretive practice with techniques heavily protected within workshops and guilds. By the eighteenth century, Enlightenment thinkers wanted to expose traditional methods and experiment to make improvements and standardize results. New dye manuals had to

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[21] Cooper, *Practical Treatise*.

[22] Each of these French experts contributed a book regarding their fiber specialization: Jean Hellot, *L'art de teinture des laines et des etoffes de lain en grand et petit teint* (Paris: Widow Pissot, Jean-Thomas Herissant and Pisot fils 1750) ; Pierre

strike a careful balance between theory and practice, addressing concepts of pure versus applied chemistry in order to appeal to scholars of chemistry as well as commercial dyers and printers.[23] Many of Bancroft's contemporaries criticized his work for being too theoretical and not useful to the practical dyer.[24] Bancroft deliberately placed himself between the scientists and the practical dyers in an attempt to make his findings accurate and useful to both audiences.

Manuals continued to reference quercitron and competing yellow dyes twenty to thirty years after Bancroft's introduction. Matthew Atkinson's 1844 publication *The Family Director* employed black oak bark in dye recipes for black, snuff brown,

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Joseph Macquer L'art de la teinture en soie (Paris: Didot,1763); Placide-Auguste Le Pileur, l'art de la teinture des fils de cotton (Paris, 1776).

[23] Pure chemistry focuses on theory whereas applied chemistry is the study of principles as well as analytical instruments.

[24] In his *Practical Treatise on Dyeing and Callicoe Printing,* Thomas Cooper explains, "Bancroft… has published a very valuable treatise, but not a practical one. The history and description of the drugs used, and the theory that pervades the book, is excellent. I know of no book on the subject, however, that is original, practical and English"; Cooper, *Practical Treatise*, iii. Clinton Gilroy shares Cooper's opinion in his own *Practical Treatise in Dyeing and Calico Printing,* stating, "Dr. Bancroft's work…is of little or no use in the dye-house being too exclusively theoretical, at the same time that it is too immethodical, and full of inexcusable repetitions. It is a complete wilderness of words, often without definite meaning or the least applicability to the subject in hand"; Clinton G. Gilroy, *Practical Treatise on Dyeing and Calico-Printing Including the Latest Inventions and Improvements Also a Description of the Origin, Manufacture, Uses, and Chemical Properties of the Various Animal, Vegetable, and Mineral Substances Employed in These Arts* (New York: Harper & Brothers Publishers, 1846), viii.

London smoke, olive brown, London brown, yellow, and his dark and light drabs. [25] Atkinson also provided substitutions for black oak bark, such as hickory bark, peach leaves, or apple bark.[26] He asserted, "all that is necessary is to adopt whatever bark is preferred, in place of that described in the receipt. Nature has supplied us so liberally with materials for the yellow dye, that we are sometimes as a loss to make choice from among them."[27] Ultimately, the discovery of chrome yellow, a mineral dye first introduced in the 1830s, diminished quercitron's use. William Partridge's 1834 publication *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk* [28] became one of the earliest sources to document the use of chrome yellow. His book provided dyers and printers with multiple sources of yellow dye to meet their needs. Partridge's publication discussed chrome yellows and oranges as well as black oak. In 1846, Clinton Gilroy published *A Practical Treatise in Dyeing and Calico-Printing,*

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[25] Matthew Atkinson, *The Family Director Designed as a Help to Those Who Are Supplying Themselves in Whole or in Part with Woolen Goods of Their Own Manufacture Containing Plain Directions for Washing Wool, Colouring Wool, Woolen Yarn and Flannel and Mixing Colors also Directions for Carding, Spinning, Weaving, Fulling and Finishing* (Carrollton: John Hudson 1844)**.**

[26] Atkinson, *Family Director*, 20.

[27] Atkinson, *Family Director*, 20.

[28] William Partridge, *A Practical Treatise on Dying of Woollen, Cotton, and Skein Silk, the Manufacturing of Broadcloth and Cassimere: Including Recipes for Lac Reds and Scarlets, Chrome Yellows and Oranges, and Prussian Blues on Silks, Cottons, and Woollens* (New York: William Partridge, 1834).

followed by Edward Andrew Parnell's plagiarization of Gilroy's work three years later.[29] Both authors stated,

> Bark was extensively used in the dye-house for many years for the purpose of dyeing yellow, and almost completely superseded the use of fustic both from its beauty and also its cheapness: but its use for that purpose has been superseded by the chromate of potash. Its principal use *now* in the best French as well as English and Scotch establishments is to form the ground for *browns*, and for dyeing *green* upon light muslin cloth.

These sources confirm the enduring use of traditional natural dyestuffs like quercitron in the midst of new dye sources.

By the 1870s, a marked shift occurred in the content of dye manuals with the promotion of both natural and synthetic dyes. In a practice started by the eighteenth-century French dyers, scientists extracted the coloring components of natural dyes to form purer, more potent dyes; these extracts were marketed with new names. For instance, Richard Gibson's 1873 *American Dyer* introduced *flavine* or *quercetin*, a concentrated quercitron extract.[30] In 1882, F.J. Bird produced *The American Practical Dyer's Companion*, which presented both natural and synthetic colors. In his preface, he remarked, "The old methods, or standard colors, obtained from woods, roots, barks,

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[29] Gilroy, *Practical Treatise in Dyeing and Calico-Printing*; Edward A. Parnell, *A Practical Treatise on Dyeing and Calico Printing* (London: Taylor, Walton, and Maberly, 1849), 20.

[30] Richard Gibson, *The American Dyer: A Practical Treatise on the Coloring of Wool, Cotton, Yarn, and Cloth, in Three Parts… Embracing in All over 200 Recipes*

etc. and the new methods, or aniline colors, will here be found treated upon, and as far as practicable or desirable, set side by side, or closely following each other, so that the merits of both can be seen at a glance."[31] Historically, scholars assumed that synthetic dyes immediately replaced natural dyes upon their discovery; however, these manuals illustrate the continuity and importance of natural dye use despite the discovery and additions of new colorants.[32] Although the production of innovative synthetic colorants marked a dramatic shift in the dye industry, it noteworthy that some natural dyes, like quercitron, found new life in concentrated forms and were thereby able to compete with their synthetic counterparts.

The History of Calico Printing Design

The rise of industrialization and mass production in the nineteenth century brought about dramatic changes in the dye industry, but by the end of the century, a growing interest in anti-industrialism began to emerge. Adherents to the Arts and Crafts

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for Color and Shades and over Ninety-Four Samples of Colored Wool and Cotton Waste & c. (Central Falls, R.I.: E. L. Freeman, 1873), 37, 49.

[31] F.J. Bird, *The American Practical Dyer's Companion* (Philadelphia: H.C. Baird, 1882), iii.

[32] Karen Diadick Casselman, "Praxis and Paradox: The Culture of Natural Dyes in Britain, 1750-1900," *Textile: The Journal of Cloth and Culture*, Vol. 7, Iss. 1 (March 2009), 6–27. Casselman writes, "Chemical dyes did not replace natural dyes in the third quarter of the nineteenth century, as is often stated to be the case." (9)

movement perpetuated this feeling by promoting handcraftsmanship. Designer William Morris (1834–1896) led this movement, and in 1875, he partnered with chemist and commission dyer Thomas Wardle (1831–1909) to produce designs using traditional methods of block printing and natural dyes. After studying four centuries of dyeing history, they adopted Indian influences in design and process for most of their prints.[33] Just as early dye manuals sought to straddle both worlds of practical application and scientific investigation, so did Morris and Wardle, combining natural colorants and traditional methodologies with modern experimentation. Morris's work also stands as a testament to the continuity in the use of natural dyestuffs in the late nineteenth century; despite the availability of synthetic colorants, the demand for the palette produced by natural dyes was very much still in demand.

While the Arts and Crafts movement promoted a return to natural dyes and handcrafted materials, artists, designers and collectors also sought inspiration from historic designs. During the turn of the twentieth century, an interest in Britain and America's colonial past promoted the re-creation and emulation of historical interiors from the late seventeenth and eighteenth centuries. In 1923, collecting expert MacIver

[33] Dr. Brenda King, *Thomas Wardle and William Morris*, http://emu.man.ac.uk/emuwebwag/objects/common/webmedia.php?irn=20789 (accessed August 1, 2010).

Percival wrote *The Chintz Book* as a sourcebook for Colonial Revival design.[34] Percival also contributed to *Connoisseur* magazine three articles that promoted an awareness of English printed cottons, discussed their production and provided uses for them.[35] Characterized by widespread admiration of American colonial and British Georgian design, the Colonial Revival prompted the reclamation of historical motifs in architecture and interiors. Reproducing and using printed cottons or chintzes was one method employed to create idealized twentieth-century interpretations of a colonial aesthetic environment. Percival explains, "I have written this little book about them [chintzes] mainly for lovers of old furniture who like to see their treasures in the setting best suited to them, because for certain kinds of furniture the right chintz is undoubtedly the most successful background."[36] Percival did not discuss the technology or dyes used in the original or recreated chintz, since his focus was primarily on design.

Four years after the publication of Percival's book, the Metropolitan Museum of Art opened an exhibit entitled *Painted and Printed Fabrics* with an accompanying

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[34] MacIver Percival, *The Chintz Book* (London: William Heinemann, Ltd. 1923).

[35] MacIver Percival, "A Book of Printed Cottons," *Connoisseur*, vol. L (January 1918); MacIver Percival, "How Cottons Were Printed in the Eighteenth Century," *Connoisseur,* vol. LIV (May 1919), MacIver Percival , "How the Old Chintzes Were Used," C*onnoisseur*, vol. LXV (April 1923).

[36] MacIver Percival, *The Chintz Book,* London: William Heinemann, Ltd. 1923), v.

catalog that addressed the cotton printing industry.[37] This exhibition and catalogue fostered widespread public interest in the beauty, history, and techniques of printed fabrics during the early twentieth century. In 1935, designer Frank Lewis published *English Chintz from the Earliest Times until the Present Day*.[38] This limited edition publication of five hundred copies featured several black-and-white plates of exemplary historic and contemporary English chintzes. However, it failed to depict any drab style quercitron prints. All of these texts fulfilled the public's interest in French, English, and American textile design, which translated into historically inspired furnishing fabrics and reproduction chintzes within twentieth-century homes. However, quercitron was missing from the picture.

The 1950s

Many scholarly contributions regarding the history and process of English cotton printing occurred in the 1950s. Ada Longfield initiated this wave of interest in her March 1949 *Burlington Magazine* article.[39] She stated, " Since the development of the

[37] Henri Clouzot, *Painted and Printed Fabrics: The History of the Manufactory at Jouy and Other Ateliers in France, 1760-1815* (New York, 1927).

[38] Frank Lewis, *English Chintz from the Earliest Times until the Present Day* (Benfleet, Eng.: F. Lewis Ltd., 1935).

[39] Ada K. Longfield, "Some Eighteenth-Century Advertisements and the English Linen and Cotton Printing Industry," *The Burlington Magazine*, Vol XCI, No. 552, (March 1949): 71–73.

English linen and cotton printing industry has not, as yet, been exhaustively studied from the historical side, it is hoped that the data incidentally contained in the following extracts may prove useful to those interested in the subject." During a time without digitized, keyword searchable historic newspaper databases, Longfield meticulously combed through aged newsprint. She undoubtedly attracted attention to the topic of calico printers and published two more articles for the *Burlington Magazine* in 1953 and 1960.[40] She was followed by Geoffrey Turnbull, who published *The History of the Calico Printing Industry of Great Britain* in 1951 and by Muriel Clayton and Alma Oakes who produced the 1954 article "Early Calico Printers around London."[41] Finally this growing interest in English cotton printing manifested in a 1955 exhibition entitled *English Chintz: Two Centuries of Changing Taste*, curated by Peter Floud, Keeper of Circulation at the Victoria and Albert Museum (V&A). The exhibition was sponsored by the V&A and was displayed at the Cotton Board, Color Design, and Style Center at Manchester. In conjunction with the exhibition opening, Floud wrote a

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[40] Ada K. Longfield, "William Kilburn and the Earliest Copyright Acts for Cotton Printing Design," *The Burlington Magazine*, Vol. XCV, No. 604, (July 1953): 230–33; Ada K. Longfield, "More Eighteenth-Century Advertisements and English Calico Printers," *The Burlington Magazine*, Vol CII, No. 684, (March 1960): 112–14.

[41] Geoffrey Turnbull, *The History of the Calico Printing Industry of Great Britain* (Altrincham: J. Sherratt, 1951). A lengthy history, this book details the relationship between English printers and French designers. Muriel Clayton and Alma Oakes, "Early Calico Printers around London," *The Burlington Magazine*, Vol. XCVI, No. 614, (May 1954): 135–39.

series of articles unveiling recent research into the development of English wood-block textile printing. His article “The Drab Style and the Designs of Daniel Goddard” revealed quercitron prints he found in early nineteenth-century furnishing fabric sample books at the V&A, which he dated to the expiration of Bancroft’s monopoly.[42] Floud’s work was a significant example of the original research that gained international attention. Floud visited museums in America, including Winterthur Museum, and as a result of discovering many examples of English printed cottons, he curated a second exhibition in 1960.[43] Tragically, Floud died before its completion, yet patrons such as Henry Francis du Pont advocated that the V&A proceed with the exhibition. In 1970, Winterthur textile curator Florence Montgomery published research from her collaboration with Floud in *Printed Textiles: English and American Cottons and Linens, 1700–1850*.[44] Her work remains an essential source within the field. Nearly twenty years later, in 1989, Mary Schoeser and Celia Rufey updated this scholarship in *English and American Textiles from 1790 to the Present*.[45] Both these

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[42] Peter Floud, “The Drab Style and the Designs of Daniel Goddard,” *Connoisseur* 139 (June 1957): 234–39.

[43] *English Chintz: English Printed Furnishing Fabrics from Their Origins until the Present Day* exhibited at the Victoria and Albert Museum (London: H.M.S.O., 1960).

[44] Florence Montgomery, *Printed Textiles: English and American Cottons and Linens, 1700–1850* (NewYork: Viking Press, 1970).

[45] Mary Schoeser and Celia Rufey, *English and American Textiles from 1790 to the Present* (New York: Thames and Hudson, 1989).

works focused primarily on furnishing fabrics and discussed general technological movements of textile manufacturing. These studies provided important illustrated surveys of printed textiles, and while they mentioned quercitron and the drab style, they were far from comprehensive in their examination.

Chemical and Dye History

While interest in textile design flourished in the twentieth century, attention to chemical history, including the study of individual dyes and their history, also gained popularity. In 1963, C.M. Meller and D.S.L. Cardwell published "Dyes and Dyeing 1775–1860" in the *British Journal for the History of Science*.[46] Their article established a set of general questions to situate dye technology and history within the evolution of Western industrialization and to understand the intrinsic links between natural dyestuffs and the textile industry. Meller and Cardwell prompted questions relating to the general picture of the "age of natural dyestuffs."[47] They promoted serious inquiry into the history of dyestuffs and created a methodological framework

[46] C.M. Meller and D.S.L. Cardwell, "Dyes and Dyeing, 1775–1860," *British Journal for the History of Science* Vol.1, No. 3 (1963): 265–79.

[47] The age of natural dyestuffs was considered the period of time prior to 1856, when William Henry Perkin discovered the first synthetic dyestuff, mauve. However, Karen Diadick Casselman notes in her article "Praxis and Paradox" that modern revisionary scholarship recognizes that natural dyes continued to be used after the introduction of synthetic dyes, so in fact the age of natural dyestuffs continues through today.

for examining that history. Their work was groundbreaking and remains pertinent to the study of dye history today.

Kenneth Ponting published *A Dictionary of Dyes and Dyeing* in 1980.[48] Ponting was a dye house manager for his family's woolen textile business and former director of the Pasold Research Fund, which continues to support research in economic textile history. His book detailed and documented dye history from the oldest craft traditions to modern synthetic and chemical dyes. Ponting's work provides preliminary information about dyes and their history while Mellor and Cardwell present a methodological framework and important questions for scholars to pursue. Together they create a springboard for further dye history studies.

Craft Revival

A rising interest in home crafts and self-sufficiency in the 1960s and 1970s marked a craft dyeing revival. Rita Adrosko, curator emeritus of textiles at the National Museum of American History, wrote *Natural Dyes in the United States.*[49] The first section of Adrosko's book documented eighteenth- and nineteenth-century

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[48] Kenneth Ponting, *A Dictionary of Dyes and Dyeing* (London: Bell & Hyman Limited, 1981).

[49] This source was subsequently reprinted: Rita Adrosko, *Natural Dyes and Home Dyeing: A Practical Guide with Over 150 Recipes* (New York: Dover Publications, 1971).

dyes, including quercitron, while the second section provided dye recipes and instructions taken from Margaret Furry and Bess Viemont's "Home Dyeing with Natural Dyes," an article originally issued in 1935 as a guide for producing inexpensive colors during the Depression.[50] Adrosko intended the recipes to be used as an experimental foray into craft dyeing. J.N. Liles published his 1990 book with the same intention of providing a background history on dyestuffs and offering instructions for reproducing historic recipes.[51] Designer and educator Joyce Storey, unique in her understanding of production as well as design, contributed to the existing dialogue on the craft revival by providing a history of the techniques and instructions on how to adapt them to contemporary use.[52]

Spurred by a desire to literally return to one's roots, many dyeing publications during this period presented modern "how-to" manuals for obtaining color from natural materials.[53] It is noteworthy that craft dyers called for reprints of many historic

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[50] This is a revision of the United States Department of Agriculture Miscellaneous Publication No. 230, issued in December 1935.

[51] J.N. Liles, *The Art and Craft of Natural Dyeing: Traditional Recipes for Modern Use* (Knoxville, TN: Univesity of Tennessee Press, 1990).

[52] Joyce Storey, *The Thames and Hudson Manual of Textile Printing* (New York: Thames and Hudson, 1985); Joyce Storey, *The Thames and Hudson Manual of Dyes and Fabrics*, (London: Thames and Hudson, 1978).

[53] Examples of these publications include Karen Leigh Casselman, *Craft of the Dyer* (New York: Dover Publications, 1980) and Rita Buchanan, *A Dyer's Garden: From Plant to Pot Growing Dyes for Natural Fibers* (Loveland, Colo.: Interweave

dye manuals during this time. This renewed interest in natural dyeing and historical practice resulted in the 1973 reprint of Elijah Bemiss's 1815 edition of *The Dyer's Companion* and the 1977 reprint of J. and R. Bronson's *The Domestic Manufacturer's Assistant and Family Directory in the Arts of Weaving and Dyeing*, originally published in 1817.[54] Though Bemiss's and the Bronsons' texts do not refer to quercitron by name, both sources mention "yellow oak bark" as an alternative to fustic, a dye wood from South America.[55] These historical reprints document the growing interest expressed by modern dyers in replicating historic dye recipes and techniques.

Interest in the history of dyestuffs and textile printing continues to grow. Recently, several scholars conducted case studies on single dyes. Gosta Sandberg examined indigo, a blue dyestuff produced from plants in the genus *Indigofera*, in

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Press, 1995) and most recently Jenny Dean, *Colors from Nature: A Dyer's Handbook* (Kent, Eng.: Search Press, 2009).

[54] Elijah Bemiss, *The Dyer's Companion Third Enlarged Edition with a New Introduction by Rita Adrosko* (New York: Dover Publications, 1973), unabridged republication of the second edition of Elijah Bemiss, The Dyer's Companion (New York: Evert Duyckinck, 1815) and J. and R. Bronson, *Early American Weaving and Dyeing: The Domestic Manufacturer's Assistant and Family* Directory in the Arts of Weaving and Dyeing with a New Introduction by Rita Adrosko (New York: Dover Publications, 1977), unabridged and slightly corrected republication of J. and R. Bronson, *The Domestic Manufacturer's Assistant and Family Directory in the Arts of Weaving and Dyeing* (Utica, New York:William Williams, 1817.

[55] Fustic is explored in depth in Chapter 2.

Indigo Textiles: Technique and History.[56] In 2000, Robert Chenciner assessed madder, an ancient red dye produced from the roots of *Rubia tinctoria*.[57] Likewise, Amy Butler Greenfield's 2005 publication traced the exchange of cochineal, a red dyestuff produced from insects native to South and Central America, between Aztec natives and the Spanish and Dutch explorers. [58]

These studies investigated red and blue dyestuffs, however yellow dyes have yet to be examined. The only assessment of quercitron has been Willi and Fred Gerber's two articles for *Shuttle, Spindle and Dyepot*, both entitled "Quercitron, The Forgotten Dyestuff, Producer of Clear, Bright Colors."[59] Although brief, these articles focused exclusively on the history and use of quercitron and include their experiments with the dyestuff. The Gerbers were the first to recognize quercitron's importance and lack of attention.

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[56] Gosta Sandberg, *Indigo Textiles: Technique and History* (Asheville, N.C.: Lark Books, 1989).

[57] Robert Chenciner, *Madder Red: A History of Luxury and Trade: Dye Plants and Pigments in World Commerce and Art* (London and New York: Rutledge Curzon, 2005 and ca. 2000).

[58]Amy Butler Greenfield, *A Perfect Red: Empire, Espionage and the Quest for the Color of Desire* (New York: HarperCollins Publishers, 2005).

[59] Willi Gerber and Fred Gerber, "Quercitron: The Forgotten Dyestuff, Producer of Clear, Bright Colors," *Shuttle, Spindle, and Dyepot*, Vol 5 (Issue 1 and 2):25–27; 87–90.

The recent revival of dye history and comprehensive studies on individual dyes provide this study with models for examining quercitron dye. This thesis continues the work of the Gerbers and builds upon the work of other scholars by further documenting quercitron's significance and Bancroft's role in developing the dyestuff.

Economic History of Dyes

In recent decades scholars examined the history of dyes and textile printing by exploring economic implications of development and production. David Jeremy's 1981 publication assessed the social, economic, and political factors that influenced the adoption and adaptation of British textile technology by American manufacturers during the Industrial Revolution. [60] In the same year, Stanley Chapman and Serge Chassagne published a comparative and collaborative study of two famous textile-manufacturing families, the Peels of Lancashire, England, and the Operkampf of Jouy, France, reflecting wider issues in the European economic growth from 1780 to 1830.[61] Robert Fox and Agusti Nieto-Galan edited *Natural Dyestuffs and Industrial Culture in*

[60] David Jeremy, *The Transatlantic Industrial Revolution: The Diffusion of Textile Technologies between Britain and America, 1790* –1830s (North Andover, Mass.: Merrimack Valley Textile Museum; Cambridge, Mass.: MIT Press, 1981).

[61] S.D. Chapman and S. Chassagne, *European Textile Printers in the Eighteenth Century A Study of Peel and Oberkampf* (London: Heinemann Educational Books Ltd, 1981).

Europe, a publication originating from a 1996 workshop on the history of natural dyestuffs held at Oxford.[62] It discussed the geographical distribution, sources, skills, markets, economics, mechanization, politics, and chemistry in relation to the industries associated with natural dyestuffs.[63] Recently, in 2009, Dr. Alexander Engel, Chair of Economic and Social History at Gottingen University, published *Colors of Globalisation: The Origin of Modern Markets for Dyes, 1500–1900*, which analyzed the evolution of dye markets and the transfer of power from consumers to producers in the marketplace.[64] These texts explore the wider economic impact of dyes in Europe and inspired this study on the economic implications of quercitron in America.

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[62] Robert Fox and Agusti Nieto-Galan, eds., *Natural Dyestuffs and Industrial Culture in Europe, 1750–1880* (Canton, Mass.: Watson, 1999).

[63]Nieto-Galan also wrote *Colouring Textiles: A History of Natural Dyestuffs in Industrial Europe* (Dordrecht; Boston; London: Kluwer Academic Publishers, 2001). It represented yet another example of a study of dyestuffs and the individuals engaged in the production and application of dyes in the eighteenth and nineteenth centuries, during the early period of industrialization

[64] Alexander Engel, *Colors of Globalisation: The Origin of Modern Markets for Dyes 1500–1900*, diss. (Frankfurt: Campus University Press, 2009). He presented some of his findings at a 2009 conference:“Into the Blue: Trying to Sell Indian Indigo in Traditional and Modern European Markets, 1780–1910,” at *Understanding Markets: Information, Institutions, and History*, conference sponsored by Hagley Museum and Library and the German Historical Institute, Friday October 30, 2009.

Interdisciplinary Perspectives

In much the same way that their color saturates fabric, natural dyes have permeated various academic fields. Current scholarship on dyeing and printing emphasizes an interdisciplinary, global perspective. In 2007, Dominique Cardon published *Natural Dyes: Sources, Tradition, Technology and Science*.[65] Cardon made scientific and technical viewpoints accessible and intended her text as a resource for anyone with a personal or professional interest in dyes. Likewise, Judith Hofenk de Graaff attempted to create a straightforward resource with a scientific and analytical focus aimed at conservators and scientists.[66] These texts document the current interest in presenting modern scientific explanations for the color properties of natural dyes while revealing a new iteration of dye scholarship.

A steady undercurrent of interest in dye history continues to persist among amateurs and professionals alike. In 2009, Karen Diadick Casselman assessed the current state of dye scholarship, stating, "The current dialogue is generally a discussion among specialists who are more concerned with the chemistry of natural

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[65] Dominique Cardon, *Natural Dyes: Sources, Tradition, Technology, and Science* (London: Archetype Publications Ltd., 2007). It is an updated and enlarged English translation of her 2003 French publication.

[66] Judith Hofenk de Graaff, *The Colorful Past Origins, Chemistry and Identification of Natural Dyestuffs* (Riggisberg: Abegg-Stiftung; London: Archetype, 2004).

dyes than the discrete analysis of language, cultural value, or meaning."[67] Casselman calls for more comprehensive studies of dyes that explore historical impact rather than chemical processes. This study responds to the need for such an accessible, historical analysis.

Scholars continue to discover untapped textile design resources. In 2005, Philip Sykas surveyed six different archives in North West England, identifying their holdings of pattern books.[68] The resulting publication exposed these assets to textile scholars, providing a cache of previously undiscovered fabrics for scholars to examine. While Peter Floud, Florence Montgomery, Mary Schoeser, and Celia Rufey focused on printed cotton furnishing textiles, Sykas uncovered dress fabrics, silks, wools, and wovens, revealing new materials for investigation. Sykas's publication was instrumental in identifying samples beneficial to this study, thereby illustrating the use of quercitron in apparel as well as furnishing fabrics.

Just as the materials used to create dyestuffs transformed with the passage of time, so has the scholarship addressing the subject. Today, the current climate in dye scholarship is one of recovery and revision, with scholars reaching back in the

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[67] Karen Diadick Casselman, "Praxis and Paradox: The Culture of Natural Dyes in Britain, 1750-1900" *Textile: The Journal of Cloth & Culture* Vol 7 Iss. 1 March 2009 (6-27).

[68] Philip Anthony Sykas, *The Secret Life of Textiles Six Pattern Books in North West England* (Bolton, Eng: Bolton Museums, Art Gallery, and Aquarium, 2005).

chronicles of history to understand broader stories of expansion, economics, and trade while also magnifying the importance of understanding individual dye materials. This study contributes to the current dialogue by challenging prevailing notions, discrediting myths, and introducing new evidence about a versatile yet little understood yellow dyestuff called quercitron. Although dye histories have often overlooked quercitron, it occupies an important place in dye and textile printing history as a color that inspired a fashion for drab and a color that transcended the barrier between natural and synthetic. This study places quercitron within the context of American production of the raw material, its use within the English cotton printing industry, and evolution and symbiosis from a natural extract to a synthesized chemical—thus revealing its intrinsic importance in the development and transformation of the commercial dyeing and printing industry.

Chapter 3

QUERCITRON AND ITS COLOR COMPETITORS

The color yellow has captured imaginations throughout the ages and continues to do so. A color of contradiction, yellow is both bright and light, intense and delicate.[69] For centuries, yellow colored and enhanced objects and surroundings in everyday life.[70] It is a color abundant in nature that can be extracted from a number of natural sources. Some of these sources include weld (*Reseda luteola),* fustic (*Chlorophora tinctoria*), onion (*Allium cepa),* heather (*Erica vulgaris*), yarrow (*Achillea millefolium*), Persian berries (*Rhamnus saxatilis*), sawwort (*Serratula tinctoria*), dyer's broom (*Genista tinctoria*), osage orange (*Maclura pomifera*), and

[69] For nineteenth-century observations about the color yellow, see Edward Andrew Parnell, *A Practical Treatise on Dyeing and Calico Printing* (London: Taylor, Walton, and Maberly, 1849), 324.

[70] Roman philosopher Pliny the Elder documents one example of this in his *Natural History*. He wrote, "Lutei video honorem antiquissimum in nuptialibus flammeis totem feminis concessum," or "I see the most ancient honor of yellow is given entirely to women for their wedding veils"; see *The World of Roman Costume*, ed. Judith Lynn Sebesta and Larissa Bonfante (Madison: University of Wisconsin Press, 2001), 152. Edward Bancroft cites this quote by Pliny at the beginning of his yellow chapter in *Experimental Researches*, Vol II, 71.

tumeric (*Curcuma longa*).[71] When Scottish flower painter Patrick Syme tried to distill each naturally occurring color to its component parts, he named no less than fourteen distinct yellows.[72] Faced with many choices, nineteenth century dyers and printers longed to find a "perfect" yellow, both clear and bright, that would satisfy all of their needs; colorfastness, potency, and inexpensiveness. While many yellow sources were available in the early nineteenth century, three dyes dominated in the dyeing and printing industries: weld, fustic, and quercitron. This chapter examines the properties of each of these colorants and documents the deliberations of nineteenth century dyers, printers, and chemists in their quest for the perfect yellow. It also discusses how quercitron was received in the industry, providing a glimpse into the history and evolution of this dyestuff.

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[71] This list includes mostly European and American yellow dye sources. For a more complete picture of yellow dye sources, including Eastern yellow dyes, see Cardon, *Natural Dyes*, chaps 5 and 7.

[72] Patrick Syme, *Werner's Nomenclature of Colours with Additions Arranged so as to Render It Highly Useful to the Arts and Sciences*… (Edinburgh: James Ballantyne & Co., 1814), 32–36. Syme modified mineralogist Werner's work as a standard for colors obtained from nature. The source lists 108 of the most common naturally occurring colors. His list of yellows includes: Sulphur, Primrose, Wax Yellow, Lemon, Gamboge, King's Yellow, Saffron, Gallstone, Honey, Straw, Wine, Sienna, Ochre, and Cream. Syme's work provides insight into the historical perception of the nuances of color.

Weld

Of all the dyes used to create a yellow hue, weld was the most ancient. In use since prehistoric times, dyers prized this annual or biennial plant for its durable yellow color and its local abundance throughout Europe.[73] The entire plant produced dye, imparting a yellow color to silk, wool, cotton, and linen (Figure 2). The mordants alum and tartar fixed the color to the fabric and prevented it from washing out.[74] However, by the nineteenth century, the expansion of the textile industry required large quantities of inexpensive, potent dyes, and weld lacked the color concentration of comparable yellows. Weight for weight, weld produced less colorant than fustic or quercitron, requiring more weld plants to achieve the same depth of color as the yellow dyewoods.[75] Bancroft explained the weight comparison, noting, "The quercitron bark …will generally yield as much as eight or ten times its weight of the

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[73] Cardon, *Natural Dyes*, 175. According to Cardon, "Weld for yellows and greens was the equivalent of dyer's madder for red: an indispensible dyestuff used by all early civilizations of Europe and the Mediterranean" (168).

[74] Alum is the common name for aluminum sulfate, aluminum ammonium sulfate, or aluminum potassium sulfate, probably the most popular mordant known for brightening colors. Tartar or cream of tartar is potassium hydrogen tartrate or partially neutralized tartaric acid in the form of a salt. Mordants are metal salts that act as a bond between the dye and the substrate to be dyed. A mordant has an affinity for both materials and allows the dye to become permanently fixed to the fiber. Jenny Dean and Karen Diadick Casselman, consultant, *Wild Color: The Complete Guide to Making and Using Natural Dyes* (New York: Watson and Guptill Publications, 1999), 36.

[75] Dean , *Wild Color*, 119.

weld plant, and as much as about four times its weight of the chipped old fustic."[76]

Although weld was locally available in England, fustic and quercitron were easier to transport by ship as milled bark contained in hogshead barrels. Bancroft promoted quercitron as a better alternative to weld. In one argument favoring quercitron, Bancroft wrote,

> Weld requires the growth of nearly two summers before it comes to maturity, and the crop is besides liable to fail from so many causes that it cannot be a desirable object of agriculture in Great Britain. Indeed it will not come to maturity in the northern parts of this island, and the expense of transportation is so great, by reason of its bulk, that the calico printers of Lancashire, Carlisle, Glasgow, & c. could not have exercised their art, either so advantageously or so extensively as they have done if my discovery of the properties of Quercitron bark…had not come to their relief, and moreover afforded them other important benefits.[77]

According to Bancroft, weld's reign as the primary yellow had lapsed, and two other dyes were vying for succession.

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[76] Bancroft, *Experimental Researches*, Vol. II, 87.

[77] Bancroft, *Experimental Researches*, Vol. II, 72.

Figure 2. Weld Plant Specimen
Photograph by author.

<u>Fustic</u>

During the nineteenth century, the name *fustic* referred to two different dyestuffs. Obtained from the heartwood of a shrub, young fustic, also called Venetian sumac (*Cotinus coggygria*), is indigenous to southern and central Europe. Its color is derived from the heartwood but was fugitive, meaning that it was not colorfast. Old fustic, or Dyer's mulberry (*Chlorophora tinctoria* or *Morus tinctoria*), is a large tree with a yellowish bark from the west coast of Central America. Introduced to Europe during the sixteenth century, old fustic once grew throughout the Caribbean and South America, but today it is scarce due to overharvesting.[78] Like young fustic, the heartwood produced a yellow color, however unlike young fustic, old fustic was colorfast and capable of imparting color on fabric without a mordant. Old fustic produced brownish shades of yellow that could appear muddy. Adding animal glue to the dye bath to bind the tannin would clear the color and result in a brighter, better yellow on the fabric. While old fustic was colorfast, the brownish tinge produced a less desirable yellow (Figure 3). Old fustic may have been abundant, but it was not the ideal choice for meeting the needs of dyers and printers. Thomas Cooper stated, "A dyer needs only weld, quercitron, and fustic (old fustic) Indeed the latter might be discarded, for it is a dull and fugitive color, and not much cheaper here, if at all, than our native quercitron, which is now the staple yellow of Europe"[79]

[78] Cardon, *Natural Dyes*, 196; Dean, *Wild Color*, 82.

[79] Cooper, *Practical Treatise* , 305.

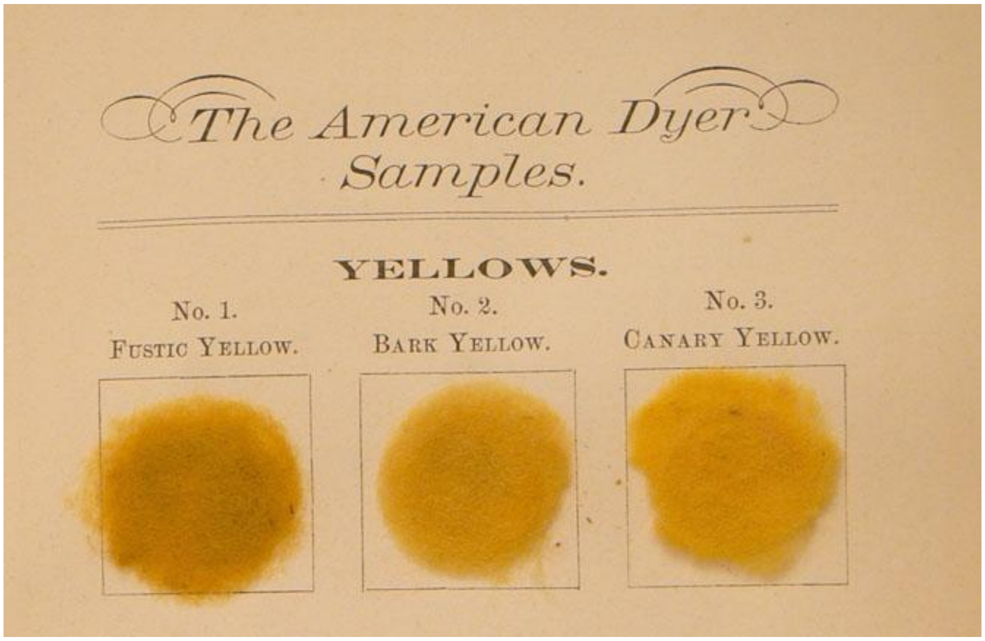

Figure 3. Fustic and Quercitron Samples from *The American Dyer*, Richard Gibson, 1873.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Quercitron

In 1775, Edward Bancroft first introduced quercitron, a dyestuff derived from *Quercus velutina*, a large deciduous North American oak. The inner bark, or cambium layer, produced the color rather than the heartwood or outer bark (Figure 4).

Figure 4. Cross Section of Black Oak. Courtesy, Peter Follansbee.

According to Bancroft, quercitron was the answer to calico printers' needs for a clear, bright, and inexpensive yellow dye. However, Bancroft's discovery was not met with complete trust or enthusiasm in the industry. Suspicious that his ulterior motive was to promote the dye for his own profit, contemporary dyers and printers also tested and commented on quercitron's utility. Two of Bancroft's contemporaries commented on the advantages and disadvantages of each dye.

Claude-Louis Berthollet (1748–1822) was a French chemist who worked with Antoine Laurent de Lavoisier (1743–1794), known as the "father of modern chemistry," to devise a system of chemical nomenclature.[80] In 1785, Berthollet introduced "oxygenated muriatic acid," or chlorine, as a bleaching agent in the dyeing process. Six years later, he wrote *Eléments de l'art de la teinture*, [81] a treatise documenting the history and the chemical theory of dyeing, the attributes of different fibers, and his innovations in bleaching. Translated as *Elements of the Art of Dyeing and Bleaching* in 1791, this widely influential manual had successive English translations in 1821 and 1841, German in 1792, and Spanish in 1795.[82] Like Bancroft,

[80] Chemical nomenclature was first reformed in Antoine Laurent de Lavoisier's *Méthode de Nomenclature Chimique* in 1787, creating universal names of chemical compounds allowing scientists of different nationalities to communicate and eliminating any doubt as to which compound a chemical name refers to. Today chemical nomenclature is kept up to date by IUPAC, the International Union of Pure and Applied Chemistry.

[81] Claude-Louis Berthollet, *Eléments de l'art de la teinture* (Paris: Chez Firmin Didot, 1791).

[82] These different publications include: C.L. Berthollet, *Elements of the Art of Dyeing*, tr. W. Hamilton (London: S. Couchman, 1791); *Elements of the Art of Dyeing, Containing the Theory of Dyeing in General as far as it Respects the Properties of Colouring Substances* (Edinburgh, 1792); *Handbuch des Färbekunst*, tr. J.F.A. Göttling (Jena, 1792); *Elementos del arte de tenir*, tr. D. Garcia Fernandez (Madrid: Imp. Real, 1795); *Elements of the Art of Dyeing*, tr. A. Ure (London: Th. Tegg, 1821 and 1841).

Berthollet offered a combination of theory and practice. Both authors issued second editions of their works in order to contribute new ideas and discoveries.[83]

Philadelphia calico printer Thomas Cooper (1759–1839) offered a dissenting chemical perspective. An English lawyer, scientist, and philosopher, Cooper immigrated to the United States with his mentor, Joseph Priestley, and taught chemistry at Dickinson College, University of Pennsylvania, and South Carolina College.[84] Although he was a professor of chemistry, Cooper was not a chemist. Instead, he was a knowledgeable practical dyer who gained experience in dyeing and printing as a partner in the Manchester firm of Baker, Teasdale, Bridges, and Cooper. He described his experience in his 1815 publication *Practical Treatise on Dyeing and Callicoe Printing*, noting, “I have dyed every colour upon cotton with my own hands heretofore, and that not by way of experiment but for the market.”[85] Published two years after Bancroft’s second edition, Cooper thought of his work as a practical supplement to Bancroft’s. Less concerned with experimental practices and new innovations, Cooper focused on commercial textile production and put his colleagues’

[83] For further comparison of Berthollet and Bancroft’s dye textbooks, See Agusti Nieto- Galan, “From the Workshop into Print: Berthollet, Bancroft, and Textbooks on the Art of Dyeing in the Late Eighteenth Century,” *Communicating Chemistry Textbooks and Their Audiences 1789–1939*, ed. Anders Landgren and Bernadette Bensaude-Vincent (Canton, Mass.: Science History Publications, 2000).

[84] “Thomas Cooper,” *Encyclopedia Dickinson*, http://chronicles.dickinson.edu/encyclo/c/ed_cooperT.htm (accessed June 10, 2010).

theories and findings into practice. A compilation of others' discoveries and observations, Cooper's manual listed recipes and techniques that met with his approval. Although Cooper was a practical dyer, he acknowledged the importance of having a firm understanding of chemical theory in the dye workshop, stating,

> The art of dyeing is yet in its infancy. No one but a good chemist, who is at the same time a good dyer, can form any judgment of the very many ascertained points that yet remain in this art. I have felt this at almost every page of this work, it is in dyeing, as in all other branches of knowledge, a man must know much before he is aware of how ignorant he is.[86]

Cooper's perspective centered on achieving color for commercial sale rather than scientific experimentation.

Collectively, Bancroft, Berthollet, and Cooper's manuals illustrated the atmosphere of textile color studies during the turn of the nineteenth century. Their commentaries create a significant historical debate about the usefulness of quercitron dye in comparison to weld and fustic and reveal the preferences of yellow dyestuffs in the early nineteenth-century dyeing and printing industries. While these authors may have intended their manuals for a limited audience, their research and techniques influenced scientists and artisans alike.

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[85] Cooper, *Practical Treatise*, x.

[86] Cooper, *Practical Treatise*, viii.

One or More Dyes?

Quercitron, weld, fustic: each yellow dye offered its own unique shade, which satisfied, either alone or in combination, dyers' needs. Weld was clear and bright with a slight greenish tint, while fustic had an opaque brownish tinge. In contrast, quercitron featured a warm and buttery hue. Sometimes dyers combined multiple color sources to obtain desirable qualities. In one preparation for a yellow dye, Cooper recommended,

> These drugs may be mixed in any proportion you choose, as fustic with weld, or quercitron with either of them. Weld furnishes upon the whole the best color; next to that quercitron bark; which considering its richness and fastness of colour, is upon the whole the cheapest drug. Mixed with fustic, quercitron greatly improves the colour. It would be a saving for full fast yellows to use two pounds of weld and a quarter pound of quercitron.[87]

While Cooper suggested mixing all three for optimum effect, Bancroft discouraged this practice. Instead, he advocated manipulating the properties of one dyestuff in order to improve the reproducibility of a dye recipe and the predictability of the results. He explained,

> There is, indeed, so much difficultly in always producing the exact shades of colour which dyers are required to imitate, that the use of *various* materials for obtaining *similar* effects must always prove highly inconvenient. A few drugs occupying but little space, rich in colouring matters, capable of being always obtained, as well as extensively applied by saddening and otherwise diversifying their respective colours, are to the dyers most needful and useful: by being constantly occupied with a few such drugs, they acquire that degree

[87] Cooper, *Practical Treatise*, 171–72.

> of dexterity and certainty the use and management of them, which alone can prevent disappointment in the nice operations of this art.[88]

In another case, Bancroft discouraged mixing weld and quercitron, noting,

> Some calico printers, not acquainted with the best methods of employing the bark, have thought proper to join with it a little of the decoction of weld. I cannot, however, recommend this practice, because in truth, the bark, when properly used, wants no such assistance, and because the colouring matter of the weld does not take permanently without a greater degree of heat than ought to be employed with the bark. It moreover occasions a much greater stain upon the unprinted parts, and at the same time degrades the madder reds and purples, (where these colours have been previously dyed,) much more than the bark.[89]

It is clear that Bancroft valued the ability to replicate colors exactly. By applying the fundamentals of the scientific method to his studies, Bancroft advocated recipes that enabled color replications that would not vary drastically from piece to piece. In contrast, Cooper provided general rather than specific color observations. Bancroft's experiments and studies systematized dyeing procedures in order to demystify the seemingly magical act of creating color. Following in the footsteps of the French scientists, Bancroft advocated for consistency, rigor, and exacting calculations in order to record new findings and guarantee predictable results for each dye bath.[90]

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[88] Bancroft, *Experimental Researches* , Vol. II, 83.

[89] Bancroft, *Experimental Researches*, Vol. II, 142.

[90] See Chapter 1 for the methods of French scientists.

A Heated Debate

While Bancroft promoted consistency in dye recipes, he also advocated the desirable qualities of quercitron. Bancroft pointed out some of weld's limitations such as the requirement of higher heat than quercitron to fix the color on fabric and weld's tendency to stain unprinted areas and degrade madder reds and purples. By commenting on weld's setbacks, Bancroft highlighted two valuable characteristics of quercitron. Quercitron lent itself to a tepid dye application and would not stain unprinted areas in calico printing. According to Bancroft,

> The most essential difference between these vegetables [quercitron and weld], respects the degree of heat by which their several colours are most permanently fixed upon linen or cotton; that of weld requiring at least a scalding, if not a boiling, heat to render it lasting, whilst the bark colour, as has been already observed, proves most durable when applied in water but little more than blood-warm.[91]

Since fabrics accepted quercitron dye at a cooler temperature, its use expended less time, effort, and energy, and color was imparted faster. While the application of quercitron with a mordant permanently fixed the dye to fabric, application without a mordant resulted in little to no coloring effect. Even if the dye unintentionally colored a background, it could easily be removed. This unique attribute of quercitron marked another time-saving benefit for printers that weld lacked; quercitron would not stain

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[91] Bancroft, *Experimental Researches*, Vol. II, 139.

unprinted (unmordanted) backgrounds. Cooper observed, “It [quercitron] is a good, a permanent, and a cheap dye; not quite so bright, and not quite so permanent however as weld. But for common calicoes and chintzes, and for patterns that are quickly wanted in the market, it is preferred to weld, or wold [sic] because the stain given to the white part of the piece, is sooner discharged on the bleach-green.”[92] Bancroft and Cooper agreed that these were attractive qualities for dyers and printers; however, French scientist Berthollet dissented.

In his second volume, Berthollet remarked that quercitron’s application in tepid water was indicative of poor quality. He stated, “Quercitron ought undoubtedly to be considered as a very useful substance in dyeing; yet the attempts which we know to have been made with the precautions prescribed by Bancroft especially in reference to the temperature of the bath, seem to prove that the color derived from it is inferior in permanence to that producible from weld.”[93] Perhaps offended by this statement, Bancroft responded directly in a footnote in his second edition:

> After thus bearing testimony to its utility, he [Berthollet] intimates a belief, that the colour which it [quercitron] affords is not so lasting as that of weld. But if there should be, as has sometimes appeared probable, some little foundation for such a belief, the difference is much more than compensated by the great advantage which the quercitron possesses of producing no discoloration to the grounds, or parts intended to remain white, sufficient to require a similar exposure on the grass by which the weld yellows always suffer, and are often

[92] Cooper, *Practical Treatise*, 18.

[93] Berthollet, *Elements*, 234.

> greatly injured, particularly in winter, when the bleaching process is often necessarily continued several months.[94]

To be certain, Bancroft insisted, "And if the quercitron yellow has at any time been found less durable than that of the weld, it can only have been so, through some defect in the mode of dyeing; at least if there was none in the mordant."[95]

While Bancroft and Cooper were like-minded in their penchant for printing with quercitron, Berthollet still favored weld for its superior colorfastness. Regardless of personal preference, these contemporary discussions illustrate the universal awareness of new discoveries in the printing and dyeing industry and the further advancement of such discoveries through peer review. The following sections delineate specific characteristics dyers and printers sought when searching for a source of yellow.

Potency

Printers prioritized potency when determining the most effective and useful yellow dye source. In the second edition of his manual, Bancroft wrote, "The

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[94] Bancroft, *Experimental Researches*, 138. It is interesting to note that Bancroft prescribes a method of sun bleaching over Berthollet's chlorine bleaching technique. While Berthollet is responding directly to Bancroft's discoveries, the reverse is not true. One wonders if Bancroft deliberately ignored this technique because it didn't support his case for quercitron, or if it had not yet been adopted in the English printing process.

[95] Bancroft, *Experimental Researches*,Vol. II, 138.

Quercitron bark… will generally yield as much colour as eight or ten times its weight of the weld plant, (*Reseda luteola*, Linn.) and as much as about four times its weight of the chipped old fustic (*Morus tinctoria*, Linn.).”[96] Although skeptical at first, Bancroft’s contemporaries tentatively agreed that quercitron had a high potency despite Bancroft’s probable exaggeration. Cooper admitted,

> When quercitron bark is used instead of weld, Bancroft prescribes at the utmost, but eighteen pounds of bark to one hundred pounds of cloth, or of yarn. The quercitron I know goes far in point of colour, but it must be very choice to produce a full colour with a quantity so small. If for eighteen pounds we read twenty-five, I do not think there will be reason to complain of the alteration.[97]

Cooper doubted that an eighteen percent ratio of quercitron to undyed fiber would provide adequate color. Instead, he thought that increasing the concentration of quercitron would create a more desirable color, and he proposed twenty-five percent quercitron to undyed material for full color. Cooper also alluded to different grades of quercitron bark. The quality likely differed from one shipment of bark to another and was a variable that affected the degree of potency. Bancroft pointed out this discrepancy in quality by specifiying the components and ratios of the bark. He stated,

> “they will separate partly into stringy filaments or fibres, which last yield but about half as much colour as the powder, and, therefore, care should be always taken to employ both together, and as nearly as possible in their natural

[96] Bancroft, *Experimental Researches* , Vol II, 87.

[97] Cooper, *Practical Treatise*, 305–6.

> proportions, otherwise the quantity of colour produced may either greatly exceed or fall short of what is expected."[98]

In his own recipes, Cooper recommended, "If you use fustic, take something more than weight for weight of the wool; if quercitron bark, take one third the weight; or from that to one half; if weld, use three pounds of it to a pound of wool."[99] Although Cooper's recipes were smaller in scale than Bancroft's, the ratios were comparable. Quercitron was unquestionably more potent.

Imitating Weld

Weld seemed to produce the "gold standard" color to which all other yellow dyes were compared. Since weld had been used since ancient times, dyers and printers were accustomed to using it and were hesitant to switch to an unfamiliar alternative. This makes quercitron's immediate adoption all the more remarkable. Deeply invested in promoting quercitron, Bancroft thought if quercitron could not surpass weld as the superior yellow, he would find a way to imitate it. It is impossible to ascertain the precise characteristics that made weld so highly valued by calico printers and dyers, but Bancroft came close in his description:

[98] Bancroft, *Experimental Researches*, Vol. 2, 87.

[99] Cooper, *Practical Treatise*, 171.

> The yellows given in this way [application of alum first, then dye and chalk with quercitron]… approach nearly to those given by weld with the common preparation of alum and tartar and are in every respect as durable; though it must be confessed, that they have less of the lively greenish, or lemon hue, for which the weld yellows are particularly valued: this however, may be readily and cheaply obtained, in the *utmost perfection*, from quercitron bark, by means which will hereafter be explained [overdye with indigo].[100]

Later Bancroft advised,

> And indeed all the possible shades of *pure bright yellow* may be given, with the utmost ease and certainty by only varying the proportions of these ingredients. But where it is expedient to give that *lively, delicate greenish tinge*, which, for certain purposes is so much admired, and which the weld alone has been supposed capable of giving, white argol, or tartar, must also be employed with the bark, murio-sulphate of tin, and alum, in different proportions, according to the particular shade intended to be given.[101]

The addition of chemical modifiers to the dye bath acidified the buttery quercitron yellow to take on the characteristic greenish tinge of the well-known weld yellow.

Quercitron: A Dye of Many Colors

Quercitron had an ultimate attribute that could not be imitated by other yellow dyes. Quercitron was a chameleon. Bancroft wrote, "It is capable *alone* of producing more cheaply, all, or very nearly all, the effects of every other yellow dyeing drug; and

[100] Bancroft, *Experimental Researches,* Vol. 2, 93.

[101] Bancroft, *Experimental Researches,* Vol. 2, 97.

moreover, some effects which are not attainable by any other means yet known."[102] When quercitron was paired with different metal salts or mordants, which bonded the color to the fabric, different distinct colors could be produced, thereby transforming the fabric into an array of colors from a single dye application (Figure 5).

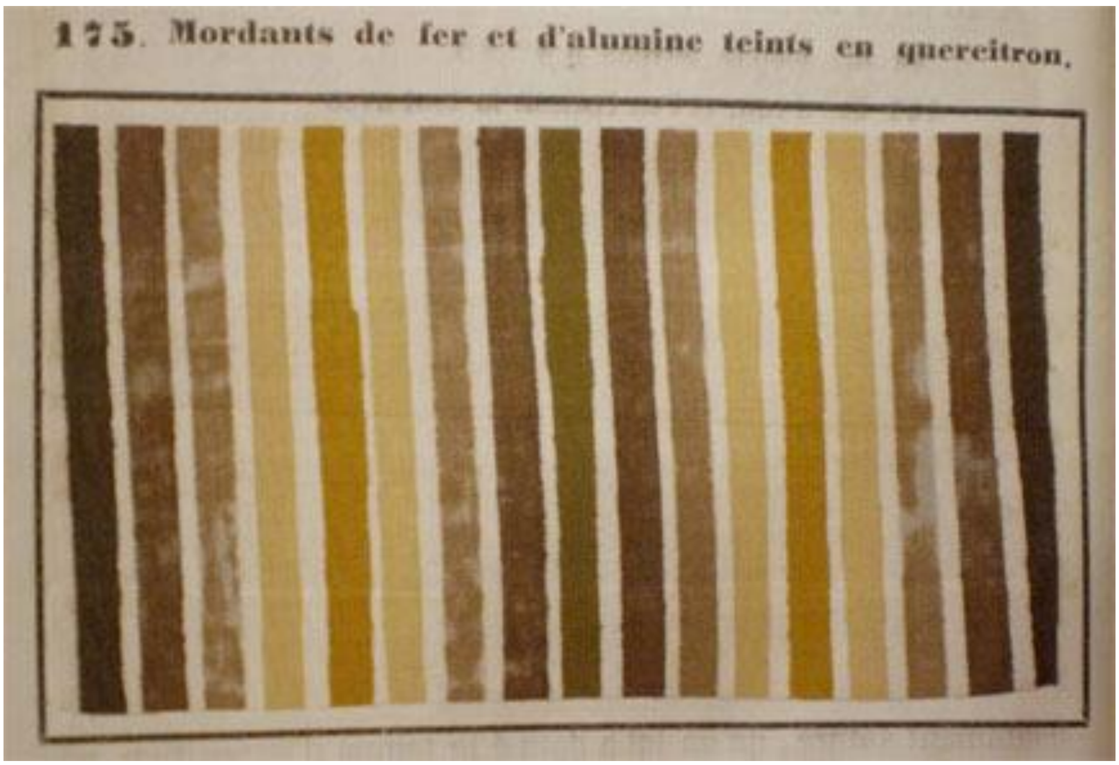

Figure 5. Quercitron Palette from *Traité théorique et pratique del'impression des tissues*, J. Persoz, 1846. Plate 175.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

[102] Bancroft, *Experimental Researches,* Vol. 2, 87.

Bancroft described some of the distinctive colors of the quercitron palette,

> The bark produces a good bright yellow with the aluminous mordant, and a drab colour with the iron liquor; and that both together, mixed in different proportions, produce different shades of olive and olive-brown colours. And that if a strong decoction of galls be added to the iron liquor and the mixture applied in the same way to linen or cotton, it will by dyeing with the bark, produce a black sufficiently fixed, though inclining a little to a brownish hue. By means therefore, of the aluminous mordant and the iron liquor, three very distinct colours besides the black, are obtained from quercitron bark.[103]

The most familiar buttery quercitron yellow is produced when the dye reacts with alum (Figure 6).

[103] Bancroft, *Experimental Researches*, Vol. 2, 132–33,

Figure 6. Sample of Quercitron Dyed with Alum Mordant from *Traité théorique et pratique del'impression des tissues*, J. Persoz, 1846. Plate 193.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Bancroft provided detailed and nuanced color descriptions in his manual, thereby asserting the significance of these important traits. In another description he wrote, "Alumine, or the earth of alum, precipitated by clean potash, and repeatedly washed in pure water, being boiled with quercitron bark, readily united with its colouring matter, and produced a yellow inclining very much to the golden, or, as it is called the *yolkey* hue."[104] In addition, copper paired with quercitron produced gold, tin created orange, and iron yielded a dove gray or an olive green. Depending upon the concentration of the mordant, lighter or darker intermediate colors were produced.

The vivid colors produced by the quercitron palette for printed fabrics became known as the drab style. The modern understanding of the word *drab*, referring to colors that are faded or dull in appearance, is incongruous with these bright and lively prints. A derivation of the word *drab* is helpful in exploring the meaning of the term during the nineteenth century.

According to the Oxford English Dictionary, the word *drab* had multiple meanings. During the nineteenth century, drab was defined as a heavy woolen cloth, a pure or undyed cloth, or cloth ranging in color between light brown and yellowish brown.[105] The word did not assume the connotation of dull until the 1880s.

The reaction of quercitron dye with different mordants to produce distinctive colors was possible with only one other dye: the red, brown, and purple producing madder plant (*Rubia tinctoria*) (Figure 7).

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[104] Bancroft, *Experimental Researches*, Vol. 2, 91.

[105] "Drab,"*Oxford English Dictionary*, www.dictionary.oed.com (accessed June 13, 2010).

Figure 7. Madder Palette from *Traité théorique et pratique del'impression des tissues*, J. Persoz, 1846. Plate 197.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

The method of producing multiple colors by printing different mordants on fabric subjected to a single dye bath was known as the *madder style,* and the process revolutionized the printing industry. Therefore, dyes that could be applied in this manner proved valuable. Previously, multiple colors could only be produced through multiple dyebaths, followed by printing, ageing, dunging, dyeing, and clearing.[106] Combining the madder and quercitron palettes produced vibrant pairings of red and yellow (Figure 8). The discovery and widespread promotion of murals uncovered at the excavation of the Roman ruins at Pompeii popularized this colorway known as Pompeian colors (Figure 9).

Figure 8. Madder and Quercitron Printed Together from *Traité théorique et pratique del'impression des tissues*, J. Persoz, 1846. Plate 399.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

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[106] For a more complete description of this process, see Bide, "Secrets of the Printer's Palette," 83–121.

Figure 9. Pompeian Print, 1969.3090. Courtesy, Winterthur Museum.

Bancroft explained the process,

> In many cases, madder colours are mixed in the same piece with those of the bark; but in these the madder ought first to be dyed on a separate course of work, in which the mordant or mordants are printed only so far as the madder colours are intended to extend; and the piece being then dried, cleansed, and dyed with the madder, and afterwards whitened with branning and bleaching, are to be calendered, and made ready to receive a second course of mordants for the bark, in which the pieces are to be printed, dried, cleansed, &c. as just mentioned.[107]

[107] Bancroft, *Experimental Researches,* Vol. 2, 132.

The madder style vastly decreased the time and effort necessary to produce a rainbow of colors. The process of "penciling" indigo or painting a reduced indigo solution onto fabric added blue to the designs. The indigo solution would immediately oxidize to a permanent blue on a white background or a green on a yellow dyed surface (Figure 10). These processes made prints faster and cheaper to produce, providing popular and fashionable colorways to a wide audience.

Figure 10. Print with Penciled Indigo, Bannister Hall Printworks.
Courtesy, John Lewis Textile Archive (Cummersdale Design Collection).

Bancroft encouraged supplementing cochineal with quercitron to produce glorious orange colors. Cochineal (*Dactylopius coccus*) is derived from the carminic acid contained in female beetles that feed on opuntia cactus native to South and Central America, cochineal was an expensive commodity. Making the red dye on an industrial scale required thousands of these insects. According to Bancroft, "By using very small proportions of cochineal with the bark, murio-sulphate of tin, &c. the colour may be raised to a beautiful orange, and even to an aurora. Madder also employed in this way, raises the Quercitron yellow, but the effect is less beautiful than with cochineal."[108] This was yet another innovative way to produce popular coveted colors.

Quercitron's Initial Decline

Quercitron adapted to changing technologies by conforming to the steam style printing of textiles. Working in the steam style, printers applied colors directly onto fabrics rather than printing the mordants first and producing color by a subsequent dye bath. Dye and mordant were applied as a paste in one step, and exposure to steam formed an insoluble complex, thus fixing the color on the fabric. Its popularity did not last long, and by the middle of the nineteenth century, this process had been replaced

[108] Bancroft, *Experimental Researches*, 101.

by chrome yellow, a mineral dye.[109] Chrome yellow was colorfast on cotton and employed a new, faster technique known as the raised style. In the raised style process, lead salts printed on the fabric ‘raised’ the yellow color by passing through a vat of potassium dichromate and producing lead chromate.[110] Even though chrome yellow succeeded quercitron as the perfect yellow, printers continued to use both dyestuffs contemporaneously.

The Evolution of Quercitron

The use of quercitron prevailed after the introduction of synthetic dyes. In addition to its ground bark form, dyers and printers obtained it in various extracted states.[111] The following section discusses the different types of extracts, how they were formed, and their uses.

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[109] For more information on the process and development of the steam style, see Martin Bide, “Secrets of the Printer’s Palette Colors and Dyes in Rhode Island Quilts,” *Down by the Old Mill Stream Quits in Rhode Island*, ed. Linda Welters and Margaret T. (Ordonez: Kent State University Press 2000), 108–9.

[110] Ponting, *Dictionary of Dyes and Dyeing*, , 37; Bide, “Secrets of the Printer’s Palette,”, 110–11.

[111] Cardon, *Natural Dyes*, 202.

Quercitrin

Michel Eugene Chevreul (1786–1889), director of the Gobelins tapestry works, was the first chemist to extract quercitrin.[112] He found quercitron bark contained two primary components: a tannin, which was named *quercitannic acid*, and a yellow colorant, which he named *quercitrin*. Chevreul began extracting dyes in 1808, when he isolated the coloring matter in brazilwood and logwood. Of the yellows, he extracted quercitron first, and followed with fustin from fustic in 1831 and finally lubolin found in weld.[113] He extracted quercitrin by boiling quercitron bark and letting the solution stand, which allowed quercitrin's pale yellow, fine laminated crystals to form. English scientist Dr. Frederick Crace Calvert discussed the formation of these extracts in great detail in 1876.[114]

[112] Michel Eugene Chevreul was also the author of *Lessons on the Application of Chemistry Relating to Dyeing* (Paris: Manufacture des Gobelins, 1828-1831). He was one of the founders of organic chemistry, established the law of simultaneous contrast by observing color interactions, and lived to be over 100.

[113] Ponting, *Dictionary of Dyes and Dyeing*, 36.

[114] Frederick Crace Calvert, *Dyeing and Calico Printing: Including an Account of The Most Recent Improvements in the Manufacture and Use of Aniline colours. Illustrated with Wood Engravings and Numerous Specimens of Printed and Dyed Fabrics* (Manchester: Palmer & Howe; London: Simpkin and Marshall, 1876).

Quercetin

According to Calvert, Rigaud discovered quercetin.[115] He boiled quercitrin with water containing ten percent sulfuric acid and named the resulting decomposition product quercetin, which was accompanied by glucose. Today some people take quercetin as a dietary supplement because it is an antioxidant and has antihistamine and anti-inflamatory properties.[116] Quercetin is a type of flavonoid, or a yellow plant produced coloring component. Although quercetin is contained in many plants, it is named after the source from which it was discovered—Bancroft's black oak. Other sources of quercetin include apple tree bark, onion, St. John's wort, or heather.[117] By extracting elemental coloring components from plants, scientists revealed that many of these dyes contained the same colorants. Today this fact presents a challenge for conservation scientists and textile historians who are often unable to identify exactly which plants were responsible for coloring a specific textile. Yellow dyes are

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[115] Rigaud seems to be a dye scientist lost to history. Besides Calvert, no other sources reference him or his discovery. Not even a first name could be found to retrieve him from anonymity.

[116] "Quercetin," *University of Maryland Medical Center Complementary Medicine*, http://www.umm.edu/altmed/articles/quercetin-000322.htm (accessed July 15, 2010).

[117] Hofenk de Graaff, *Colorful Past*, 190.

particularly difficult to identify since so many yellow sources exist. As a result, scientists continue to study these dyes in order to unlock their secrets.[118]

Besides black oak, heather (*Erica vulgaris*) was another plant source of quercetin. In April of 1815, an editorial printed in many American newspapers entitled "Extract of Letter from Liverpool, received in N.Y. dated December 24," denounced quercitron as the premier yellow dye and supplanted it with heather. The letter proclaimed, "American quercitron bark is now done for; they (the manufacturers) have now fully ascertained that the tops of heath or heather is an excellent substitute being a beautiful permanent yellow."[119] This incited protest from American readers, and a response was printed in the Charleston South Carolina *City Gazette:*

> Sir- Having read in your paper of yesterday an extract of a letter from Liverpool mentioning that American Quercitron bark "*is now done for,*" I beg to state the following facts, which may prevent a temporary inconvenience to the consumer and a loss to the shipper, should the information alluded to be

[118] Current research on dye identification is focused on comparing flavonoids through gas-chromatography-mass spectroscopy (GC-MS); see Maria Perla Colombini et al., "Color Fading in Textiles: A Model Study on the Decomposition of Natural Dyes," *Microchemical Journal*, Vol. 85, No. 1 (2009): 174–82. For analysis of degradation products, see Ester Ferreira et al., "Photo-Oxidation Products of Quercetin and Morin as Markers for the Characterisation of Natural Flavonoid Yellow Dyes in Ancient Textiles," *Dyes in History and Archaeology: Papers Presented at the 18th Meeting Brussels, 1999*, ed. Jo Kirby, Vol. 18 (London: Archetype Publcations, Ltd., 2002) 63–72. Winterthur's Scientific Research and Analytical Lab recently acquired an LC MS system that will enable future dye identification.

[119] "Extract of a Letter from Liverpool received in N.Y. dated December 24." *American Watchman*, April 26, 1815, Vol. 7, Issue 597, 3, Newsbank/Readex America's Historical Newspapers Database.

> acted upon. About twenty years back, a near relative of the writer of this discovered that *Mountain Heath* was a good substitute for *Strawweld* (the article at the time used in dyeing yellow) in all *common* styles of pattern; since that period, the Quercitron Bark was introduced, and found much superior to any other dye stuff previously known- the late war having advanced it from about 30s to 30l. per cwt. rendered it too high for general use, which induced the original inventor of the Heath Dye to make experiments, in which he succeeded so far as to produce a color very nearly equal to the Bark Yellow; but I must state what the Liverpool writer is ignorant of, that the very *fuel* required to extract the coloring matter from the former, would amount to more money than the entire cost and expense of the latter, when reduced to the former peace price. The American merchants may then, with safety, continue to export the Quercitron bark.[120]

The Charleston citizen W.G. was right in refuting the Liverpool author's declaration because quercitron continued to be used. In fact, in the case of Scottish tartans in which indigenous dyes, such as heather, were assumed responsible for yellow, the opposite was found true, and imported dyes including quercitron were detected.[121]

Flavin

Another derivative of quercitron, called flavin, was the next commercially successful yellow dye (Figure 11 illustrates samples of flavin and chrome). Flavin was

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[120] "Quercitron Bark, to the Editor of the City Gazette," Charleston S.C. *City Gazette*, April 20, 1815, Vol. 35, Issue 11269, 2, Newsbank/Readex America's Historical Newspapers Database.

[121] See Anita Quye et. al., "An Historical and Analytical Study of Red, Pink, Green and Yellow Colors in Quality Eighteenth and Early Nineteenth Century Scottish Tartans," *Dyes in History and Archaeology: Papers Presented at the Annual Meeting*, Vol. 19 London: Archetype Press, (2003), 1–12.

the commercial name for a quercitron extract composed of a mixture of both quercitrin and quercetin. One method of preparation involved boiling one hundred parts ground quercitron bark with three hundred parts water and fifteen parts sulfuric acid. Once cooled, this mixture was poured onto a woolen filter, and the collected paste was washed to remove traces of acid, then dried and ground.[122] This concentrated powder was twelve to twenty times more potent than the quercitron bark from which it derived. On the topic of flavin, English dye scientist Dr. Frederick Calvert wrote in 1876,

> Within the last twenty years a preparation of quercitron bark has been imported into this country from America under the name Flavin; it varies greatly, however in composition, being sometimes nearly pure quercitrin, whilst other samples contain only quercetin… Flavin therefore, is in some cases the product of the decomposition of quercitrin, the natural glucoside of the bark, by the action of an acid, and stands in the same relation to it that garancin does to madder. It is easy to understand why it is so much cheaper for the dyer and calico printer to use this product than the bark itself, and also why it gives brighter colours. The quantity of colouring matter in flavin as compared with bark, is as sixteen to one or 1 oz. of flavin is equal to 1 lb, of bark. It is now manufactured in England, but the quality is not so good as that imported from America, probably owing to the latter being prepared from the fresh wood.[123]

[122] Cardon, *Natural Dyes*, 202.

[123] Calvert, *Dyeing and Calico Printing*, 260.

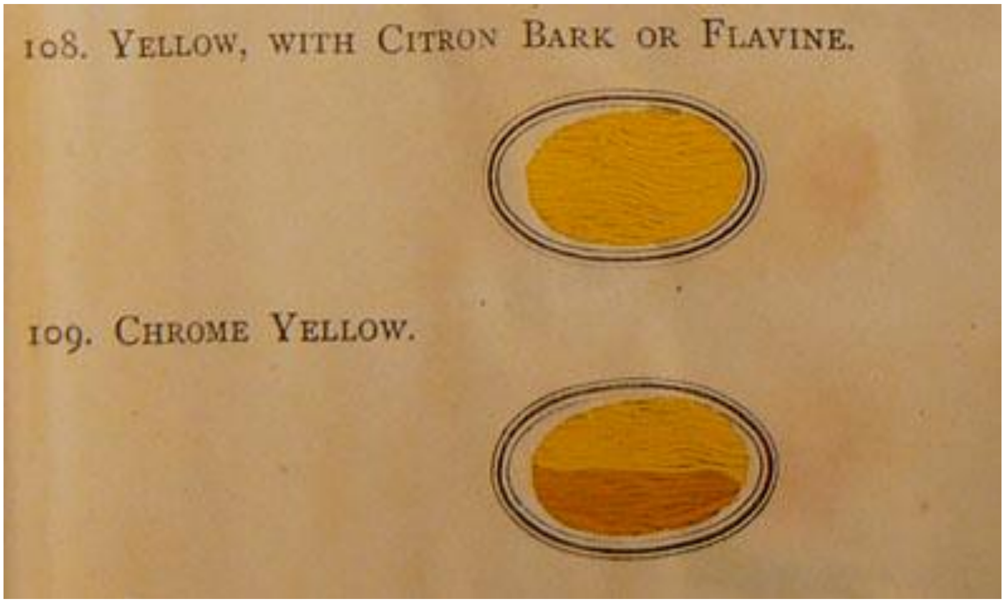

Figure 11. Flavine and Chrome from *The Secrets of the Art of Dyeing Wool, Cotton, and Linen*, E.C. Haserick, 1869.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Forty-four years later in 1920, Joseph Merritt Matthews made similar remarks on the dyestuff, which had not changed except for the addition of an "e" at the end of its name, now called flavine. In his *Application of Dyestuffs to Textiles, Paper, Leather and Other Materials*, Matthews described flavine as, "a very pure dry extract of the coloring matter of the Quercitron bark. The best varieties contain a large proportion of quercetin, and yield yellows of great brightness."[124] He also reported that by 1920, "Quercitron is not much used in this country for the dyeing of textiles, but it still has considerable vogue in calico printing and leather dyeing."[125] The revival of natural dyes of printed cotton during the same time implies that printers were still using quercitron in reproductions of original nineteenth-century drab-style prints.

Six years earlier, quercitron had come to America's rescue during World War I. Germany had cornered the worldwide market on coal-tar synthetic dyes, and Americans faced a dye crisis due to the German embargo on dyes and the British blockade.[126] While American chemical companies scrambled to develop coal-tar dye technology on the home front, the use of natural dyes was revived, and quercitron was in high demand for dyeing khaki and olive drab uniforms and tent cloth. In 1916, over one million pounds of quercitron extract were used by three companies for coloring

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[124] Joseph Merritt Matthews, *Application of Dyestuffs to Textiles, Paper, Leather and Other Materials* (New York: John Wiley & Sons, Inc., 1920; London: Chapman & Hall Ltd., 1920), 500.

[125] Matthews, *Application*, 500.

[126] William Haynes, *American Chemical Industry, Volume III: The World War I Period: 1912–1922* (New York: Van Nostrand Company, Inc., 1945), 225-226.

uniforms and tent cloth.[127] Most recently, quercitron had another name change and today it is known as Natural Yellow #10.[128]

Quercitron, A Phoenix Rising from the Sawdust

While quercitron's use ebbed and flowed and its appearance transformed over time, it is undeniable that Bancroft's dye has made a tremendous impact on the printing and dyeing industries. Bancroft's promotion in his *Experimental Researches,* caused quercitron to replace weld (a dye that had been used in Europe for hundreds of years) because quercitron was easier, faster, and cheaper to use. Through his multitude of experiments and the precision of his studies, Bancroft showed how adaptable black oak bark could be when combined with mordants or chemical modifiers. With the production of quercitron, dyers and printers finally had a yellow that was everything they wanted: colorfast, potent, readily available, and capable of producing a range of permanent hues without staining undyed backgrounds. In his conclusion, Bancroft wrote,

> I have, however, thought it incumbent on me to omit nothing in any degree likely to afford useful information respecting a new dyeing drug, first brought

[127] Haynes, *American Chemical Industry*, 233.

[128] "Quercitron," Conservation and Art Material Encyclopedia Online (Boston: Museum of Fine Arts), http://cameo.mfa.org/materials/record.asp?key=2170&subkey=7721&Search=Search&MaterialName=flavin&submit.x=0&submit.y=0 (accessed July 16, 2010).

> into use by my exertions, and which, without them, would, probably, have remained unknown as a dyeing drug for ages to come:- a drug which has already produced important benefits, especially to the art of calico printing in Great Britain; and is likely hereafter to benefit other European nations, as well as the United States of America, in an eminent degree. The consumption has, indeed, hitherto been small, compared to the probable future increase; but it has been large, considering the short time since its properties were first made known, and the immense difficulties which attend the introduction of all new dyeing drugs. But though the quercitron bark has been employed only of so short a time, I flatter myself that the account which I now offer of its properties and uses, will prove much more complete than any yet given of the properties and uses of any other dyeing drug, even among those which have been known for many ages.[129]

It seems that Bancroft was fully aware of the impact that his discovery had made. However, as he wrote of its adaptability, even he could not have predicted the incredible longevity and transformation of quercitron throughout the years. Although its use has ebbed and flowed, transforming from bark to extract to dietary supplement, quercitron prevails even into the twenty-first century.

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[129] Bancroft, *Experimental Researches*, Vol. II, 162-163.

Chapter 4

THE DISCOVERY AND CONTROVERSY OF QUERCITRON

Quercitron is unique because it is one of only two dyes whose discoverers are known. Dr. Cuthbert Gordon discovered a Scottish lichen dye he named *cudbear* in 1766.[130] While Gordon simply patented his dye, Bancroft published experiments demonstrating quercitron's usefulness and encouraged its quick adoption in the printing industry making quercitron the most sought after yellow dye in the late eighteenth century. This chapter briefly explores the man behind the dye and describes the series of events that lead to the expiration of Bancroft's patents and caused the explosion of quercitron colors on printed fabrics. An evaluation of the events that occurred between Bancroft's discovery in 1771 and the lapse of his patent in 1799 provides a better understanding of Bancroft's colorful character and how quercitron became a key component in printing and dyeing during the late eighteenth and early nineteenth centuries.

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[130] Ponting, *Dictionary of Dyes and Dyeing*, 48. Dr. Gordon issued his patent in 1766 and named the lichen dye after his mother's maiden name and his first name, Cuthbert.

Edward Bancroft's Early Years

The analysis of Bancroft's experience and character contextualizes and reveals how quercitron came into existence. Edward Bartholomew Bancroft was born in Westfield, Massachusetts, on the ninth of January, 1744. His father, Edward (1718–46), died when he was two years old, the same year that Edward's brother, Daniel, was born.[131] Four years later, their mother, Mary Ely (1717–61), married David Bull, and the family moved to Hartford, Connecticut, where Bull established the Bunch of Grapes tavern.[132] Bancroft attended Groton, where he was a student of Silas Dean, a recent Yale graduate and future politician and diplomat. In 1760, Edward chose Bull to be his legal guardian, and Bull likely funded his education and travel abroad.[133] At the age of sixteen, Bancroft was apprenticed to Dr. Thomas Williams, who practiced medicine in Lebanon, Connecticut; however, in 1763, he abandoned his apprenticeship

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[131] Herman Ely, *Records of the Descendants of Nathaniel Ely, The Emigrant Who Settled First in Newtown, Now Cambridge Mass, Was One of the First Settlers in Hartford, also Norwalk Conn., and a Resident of Springfield, Mass*. (Cleveland, Ohio: Short and Forman, 1886), 18, 33.

[132] George Dunkelberger writes that Bull's tavern was the most noted tavern in Hartford, located at the intersection of Asylum Street and the west side of Main in George Dunkelberger, *An Early History of St. John's Lodge*, No. 4, A.F. & A.M. Hartford, Connecticut 1762-1937 To Commemorate the 175th Anniversary of Constitution (Hartford, Conn., 1937), 47.

[133] Notes from J.M. Bancroft, Bloomfield, N.J., the Edith Bancroft Ashmore Collection, Pennsylvania Historical Society Library, Philadelphia.

due to “Insults received, a Haughty disposition, and a Roving Fancy.”[134] The young Bancroft traveled to Dutch Guiana, where he became a doctor for a wealthy plantation owner named Paul Wentworth. Derived from the native Arawak Indian word meaning “many waters,” Guiana was a Dutch province growing in population and economic significance.[135] Adventurers and fortune seekers sought out the busy region, which included the colonies of Essequibo, Berbice, Demerara, and Surinam. Bancroft’s patron, Paul Wentworth, was such an opportunist. He married a wealthy widow and inherited her large sugar plantation, “Klienhope,” on the Demerara river.[136] Speculators established coffee, sugar, and cotton plantations supported by an influx of West African slaves along Guiana’s rivers. Bancroft easily secured his position as a plantation doctor despite his youth and inexperience since doctors and physicians were in high demand. While in Guiana, he collected information on and observed the surrounding environment. Bancroft returned to Hartford and Boston in August of

[134] Anderson and Anderson, “Edward Bancroft, M.D.,”, 356. This article also describes how the eighteenth-century process of training physicians consisted primarily of apprenticeship. Anyone could become a doctor. Those with the ability and funds (like Bancroft) pursued training in Europe; the quote comes from a letter from Bancroft to Dr. Thomas Williams, December 21, 1763, Edith Bancroft Ashmore Collection, Pennsylvania Historical Society Library, Philadelphia, cited from Stanley Finger, “Edward Bancroft’s ‘Torporific Eels,’”, 65.

[135] Finger, “Edward Bancroft’s ‘Torporific Eels,’”, 65.

[136] Gordon E. Kershaw, “Paul Wentworth,” American National Biography Online, http:/www.anb.org/articles/01/01-00947.html, (accessed 26 November 2010).

1766, and by May 1767, he moved to London to become an apprentice at the highly respected St. Bartholomew's Hospital. There he observed medical practices and likely studied under Dr. William Pitcairn, to whom he dedicated his first book.

While Bancroft's various occupations may seem dissimilar to one another today, in the eighteenth century, they all fell under the subject of natural philosophy. Natural Philosophy, the precursor of modern science, embodied the study of nature in all dimensions, focusing on the structure and function of all natural objects.[137] In this context it is not surprising that Bancroft and his contemporaries studied medicine, natural history, and dye chemistry as interrelated topics. Additionally, eighteenth-century remedies were plant-based, and some tree barks had medicinal properties. Perhaps in a search for a new bark cure, Bancroft found a dye instead.

Edward Bancroft: Author and Scientist

In 1769, at the age of twenty-five, Bancroft assembled his notes about Guiana into a book entitled *An Essay on the Natural History of Guiana*, describing the history, geography, government, climate, plant and animal life, minerals, and inhabitants of the

[137] See *Origins of Modernity: Natural Philosophy*, online exhibition by the Library at the University of Sydney Australia, http://www.library.usyd.edu.au/libraries/rare/modernity/natphi.html, accessed November 14, 2010.

region. [138] He addressed the colonization of the new region, including observations of slavery on the Guiana plantations. The book was structured as a series of four letters written to his brother and was advertised as "an account of the unknown productions from an almost unknown country."[139] The book satisfied a desire in Europe for accounts of exotic locales and appealed strongly to those interested in trading or settling in the area. Considered travel literature today, Bancroft's *Essay on the Natural History of Guiana* became an important eighteenth-century natural philosophy text. In 1770, Bancroft adapted his work into a three-volume, semifictional, moral allegory. Entitled *The History of Charles Wentworth*, the novel was named after Bancroft's patron, Paul Wentworth.[140] In his novel, Bancroft used his observations in Guiana as a backdrop for his tale of an English surgeon's apprentice. Although Bancroft's novel was fictional, his nearly verbatim descriptions of Guiana (lifted from *An Essay on the Natural History of Guiana)* and the fact that he based his title character on a real

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[138] Edward Bancroft, *An Essay on the Natural History of Guiana, in South America Containing a Description of Many Curious Productions in the Animal and Vegetable Systems of that Country, Together with an Account of the Religion, Manners, and Customs of Several Tribes of Its Indian Inhabitants Interspersed with a Variety of Literary and Medical Observations in Several Letters from Gentleman of the Medical Faculty During His Residence in That Country* (London: T. Becket, 1769).

[139] Edward Bancroft, "Advertisement," *Essay on the Natural History of Guiana*.

[140] Edward Bancroft, *The History of Charles Wentworth Esq. In a Series of Letters, Interspersed with a Variety of Important Reflections Calculated to Improve Morality and Promote the Economy of Everyday Life* (London: T. Becket, 1770).

person imply that the novel may have been based on his real experience.[141] Also in 1770, Bancroft married Penelope Fellows (1749–84), daughter of William and Penelope of Shropshire, England. The couple would go on to have five children.[142]

Topics discussed in *An Essay on the Natural History of Guiana* ranged from Bancroft's discovery and explanation that electricity generates an eel's shock to the observation of a red dye the natives used to color their cotton hammocks to a detailed account of the Woorara, or Indian Arrow Poison, samples of which he brought to England.[143] Bancroft's experiments with electric eels were timely and piqued the interest of another researcher of electricity—an agent in London named Benjamin Franklin who represented the colony of Pennsylvania. In the same year that Bancroft published his *Essay on the Natural History of Guiana*, Franklin published his

[141] For a detailed analysis of *The History of Charles Wentworth*, see James Delbourgo, "Fugitive Colours: Shamans' Knowledge, Chemical Empire and the Atlantic World," in *The Brokered World: Go-Betweens and Global Intelligence*, 1770-1820, ed. Simon Schaffer et al (Science History Publications, 2009), 292-294.

[142] Edward and Penelope's children were: Edward Nathaniel (1772–1842), Samuel Forester (1774–99), Julia Louisa (b.1776), Maria Frances (b. 1778), and Catherine Penelope (b. 1784); see Herman Ely, *Records of the Descendants of Nathaniel Ely: The Emigrant Who Settled First in Newtown, Now Cambridge Massachusetts* (Cleveland: Short and Forman, 1885), 33.

[143] Sir Arthur MacNalty, "Edward Bancroft, M.D., F.R.S., and the War of American Independence," *Proceedings of the History of Medicine*, Vol 36 (June 1944) 7–15.

Experiments and Observations on Electricity.[144] This commonality likely initiated their sustained friendship.

In 1769, Franklin wrote to Dr. James Lind at Edinburgh University recommending Bancroft as a medical student. While there is no evidence that Bancroft attended Edinburgh, both his brother, Daniel, and his son, Edward Nathaniel, were students there.[145] On May 20, 1773, Bancroft was unanimously elected to the Royal Society based on Franklin's recommendation and the widespread appeal of his paper "On Producing and Communicating Colors," which he presented on May 6.[146] Bancroft finally earned his M.D. degree in 1774 from Marischal College of Aberdeen University. His attendance at Aberdeen is unlikely. It is more probable that he attained

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[144] Benjamin Franklin, *Experiments and Observations on Electricity, Made at Philadelphia in America, by Benjamin Franklin, LLD and FRS, To Which Are Added, Letters and Papers on Philosophical Subjects. The whole Corrected, Methodized, Improved and Now first collected into one volume…* (London: Printed for David Henry; and sold by Francis Newberry, 1769. 1769 was a big year for research in electricity because Joseph Priestley also published his *History and Present State of Electricity with Original Experiments. The Second Edition Corrected and Enlarged* (London: Printed for J. Dodsley, J. Johnson, and J Payne…, and T. Cadell, 1769).

[145] Anderson and Anderson, *Abberant Practitioner of Physick*, 360; Finger, "Edward Bancroft's 'Torporific Eels,'" 74. Daniel studied at Edinburgh University 1769–70, and Edward Nathaniel attended 1794–95.

[146] McNalty, "Edward Bancroft," 9. Bancroft was elected by Nevil Nankelyne, John Walsh, Benjamin Franklin, James Stuart, W. Watson, Dan Solander, William Hewson, and John Petty, according to a copy of Bancroft's Certificate of Election, Edith Bancroft Ashmore Collection, Historical Society of Pennsylvania Library, Philadelphia. Chapter 4 discusses William Hewson as a probable connection between Bancroft and American printer John Hewson.

his diploma in absentia by leveraging his experience in Guiana and St. Bartholomew's, obtaining letters of support from other physicians, and paying tuition.[147] Due to his interest and experiments with dyestuffs, Bancroft also became the chief dye expert for the East India Company, analyzing their dye samples from India and helping the company introduce lac dye.[148] Thanks to introductions made by Benjamin Franklin and acceptance into fellowships, such as the Royal Society and the Medical Society of London, Bancroft became well connected in the fields of science and medicine. Professionals created these societies as a means for communicating research, experiments and ideas between interested parties and Bancroft surely took advantage of the opportunities. Sir Arthur McNalty writes, "Bancroft had much personal charm and had many distinguished friends. Among these may be mentioned, Sir John Pringle, Joseph Priestley, and John Coakley Lettsom."[149] Bancroft also knew Dr. Jan Ingenhousz (1730–99), a doctor and natural philosopher from the Netherlands who was a fellow in the Royal Society and conducted research regarding inoculation,

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[147] Bancroft was recommended for his degree at Aberdeen by reputable doctors George Forsythe and John Coakley Lettsom, see Anderson and Anderson, *Abberant Practitioner of Physick*, 361–62.

[148] MacNalty, "Edward Bancroft," 9.

[149] MacNalty, "Edward Bancroft," 9. Sir John Pringle (1707–82) was a Scottish physician known as the "father of military medicine, Joseph Priestley (1733–1804) was an English clergyman and natural philosopher, and John Cloakley Lettsom (1744–1815) was an English physician, quaker abolitionist, and philanthropist who founded in 1773 the Medical Society of London (of which Bancroft was a member).

electricity and plant respiration.[150] These important contacts would prove to be beneficial for Bancroft as he pursued his research in quercitron dye.

In addition to being a doctor, Bancroft was also a political commentator. During the same year he published his *Essay on the Natural History of Guiana*, Bancroft published *Remarks on a Review of the Controversy between Great Britain and Her Colonies*, arguing for the inherent rights of the colonies.[151] Between 1774 and 1777, Bancroft wrote anonymous articles concerning politics, science, and medicine to London's *Monthly Review*.[152]

Edward Bancroft, Spy

With the onset of the American Revolution, Franklin and Silas Dean (Bancroft's former teacher), served as American ambassadors in Paris. They chose Bancroft to serve as their secretary, and he became a secret emissary, sharing with his

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[150] Charles Creighton, "Ingen- Housz, Jan (1730–1799)," rev. Patricia Fara, *Oxford Dictionary of National Biography*, Oxford University Press, 2004, (http://www.oxforddnb.cm/view/article/14388 (accessed November 6, 2010).

[151] Edward Bancroft, *Remarks on the Review of the Controversy between Great Britain and Her Colonies* (London, 1769; reprinted New London, Conn.: T. Green, 1771).

[152] According to Anderson and Anderson, the reviews of this journal were published anonymously; however, they were signed or initialed in manuscript for founder and editor Ralph Griffiths, whose files are preserved; Anderson and Anderson, *Abberant Practitioner of Physick*, 362.

employers the information he learned from officials in London. As secretary, he was privy to Franklin and Dean's efforts to convince France to join with America as an ally. His privileged position also made him a target for British intelligence, and soon British agent and novel namesake Paul Wentworth recruited Bancroft to spy on the Americans. Bancroft effectively became a double agent, betraying both sides. Defending this decision, Bancroft later confided in a memorial to the Marquis de Carmerthen, Secretary of State for Foreign Affairs in 1784,

> I had then resided near ten years, and expected to reside the rest of my life in England; and all of my views, interests, and inclinations were adverse to the independency of the colonies, though I had advocated some of their claims, from a persuasion of their being founded in justice. I therefore wished, that the government of this Country, might be informed, of the Danger of the French interference, though I could not resolve to become the informant. But Mr. Paul Wentworth, having gained some general knowledge of my journey to France, and of my intercourse with Mr. Deane, and having induced me to believe, that the British Ministry were likewise informed on this subject, I at length consented to meet the then Secretaries of State, Lords Weymouth and Suffolk, and give them all the information in my power; which I did, with the most disinterested views…. It had been my original intent to stop after this first communication; but having given the first notice of a beginning intercourse, between France and the United Colonies, I was urged on, to watch and disclose the progress of it, for which purpose, I made several journeys to Paris, and maintained a regular correspondence with Mr. Deane, through the couriers of the French government. And in this way, I became entangled and obliged to proceed in a kind of business, as repugnant to my feelings, as it had been to my original intentions.[153]

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[153] "Edward Bancroft, Estimable Spy," Central Intelligence Agency, Center of the Study of Intelligence, https://www.cia.gov/library/center-for-the-study-of-intelligence/kent-csi/vol5no1/html/v05i1a07p_0001.htm (accessed June 24, 2010).

Evidently, once he engaged in duplicitous dealings, it was impossible to extricate himself and imperative that neither side know about his actions.

When Silas Deane decided to return to America, he suddenly became ill and died before his ship, the *Boston Packet*, left the port of Deale. Since Bancroft was his physician, some scholars speculate that he may have poisoned Deane to prevent him from divulging Bancroft's wartime actions.[154] It is certain that Deane was very dependent upon Bancroft. In a letter to Lord Sheffield in 1787, he notes, "I rely more on my friend Bancroft's opinion than on that of almost any physician. He knows my habits and temper, he has given up all thoughts of my embarking [for America] in my present state, and until I can recover some degree of strength proportionate to the voyage."[155] While Bancroft may have been responsible for Deane's death, it is impossible to determine definitively.

Bancroft's career as a spy remained unknown until 1889, when the British government released secret documents belonging to Lord Auckland, assistant to Lord Suffolk of British Intelligence. These papers were made accessible to scholars through

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[154] Julian Boyd, editor of the Thomas Jefferson papers at Princeton University believes that Bancroft was responsible for Deane's death in the early afternoon of September 23, 1789. See Julian Boyd, "Silas Deane: Death by a Kindly Teacher of Treason?" *William and Mary Quarterly*, Vol. 16, No. 2 (April 1959): 165–87;Vol. 16, No. 3 (July 1959): 319–42; and Vol. 16, No. 4 (October 1959): 515–50.

[155] G.L. Clark, *Silas Deane: A Connecticut Leader in the American Revolution* (New York, 1913), 246–47.

the publication of Benjamin Franklin Stevens's *Facsimiles of Manuscripts in European Archives Relating to America, 1773–1783*, published in the late nineteenth century, and an increased academic interest in the enigmatic Edward Bancroft resulted.[156]

The Discovery of Quercitron

Socially and politically, Bancroft led a busy life, but his contribution to the printing and dye industry remains underappreciated. Bancroft first observed the coloring properties associated with the inner bark of the American black oak tree in 1771. He had studied the bark of three North American trees but determined that quercitron was the most important. While many dye resources acknowledge Bancroft's discovery and patenting of quercitron dye between 1775 and 1785, they fail to explore the specifics of his process and innovation. In May of 1771, Bancroft appealed to the Royal Society of the Arts to provide financial assistance for his discovery. Founded in 1754, the Royal Society of the Arts awarded monetary prizes to encourage studies of arts, manufactures, and commerce. Bancroft's letter provides important insight into why he set out to find a dye:

> In an Essay on the *Natural History of Guiana*… I mentioned a substance with which the Indians in that Country stain their cotton hammocks of a red colour.

[156] Benjamin Franklin Stevens, *Facsimiles of Manuscripts in European Archives Relating to America, 1773–1783* (London: Malby & Sons, 1889–95).

> This circumstance soon produced several applications for engaging me to undertake the Discovery of an article so much wanted by the printers of linen and cotton; and with then I complied as I had before proposed to myself another Excursion to south and north America in pursuit of Natural knowledge, from which I am but lately returned. But though my searches after the red were unsuccessful I have nothwithstanding discovered a cheap vegetable growing spontaneously and in great plenty in his Majesties American colonies which is capable of producing great advantages in the art of dyeing.[157]

Initially, Bancroft promoted the dye as an additive to make a more permanent black on linen and cotton, but he also noted, “I have likewise to inform you that the vegetable which I have discovered is besides capable of communicating several cheap and lasting colours on linen and cotton which are not otherwise to be given to them; of them I inclose [sic] you specimens” (Figure 12).[158] In particular, he commented that sample number seven, “resembles the Colour of the Nankin cottons except that it is more beautiful and lasting and it will be uncommonly cheap, it will enable the Manufacturers of Great Britain not only to imitate but excel that Commodity.” He further noted that the other colors “will be highly useful as they must enable the dyers of this kingdom to give an agreeable variety of cheap and lasting colours to Janes,

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[157] Letter from Edward Bancroft of Golden Square about dyeing cotton, 20/5/1771, Royal Society of the Arts, London (hereafter Bancroft letter, RSA).

[158] Bancroft letter, RSA.

fustians, and other cotton manufactures."[159] Bancroft knew that he had found something significant.

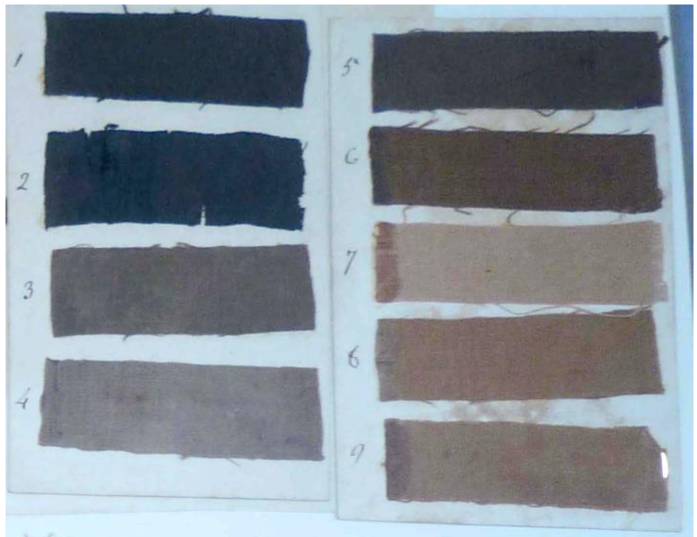

Figure 12. Samples from Bancroft's Letter to the Royal Society of the Arts
Courtesy, Royal Society of the Arts, London.

In 1775, after petitioning for rights to his discovery, Bancroft received an English patent for quercitron dye, which was no small feat.[160] The English patent system required prohibitively expensive fees and complex administrative

159 Bancroft letter, RSA.

160 A patent grants exclusive rights to an inventor for a limited time in exchange for disclosing the invention to the public. It prevents other people or entities from using or distributing the invention without permission from the inventor.

procedures.[161] As a result, patents were accessible only to the privileged few who possessed the monetary means or the political connections to obtain them. Likely exploiting his political associations (or leveraging his career in espionage for a favor from the King), Bancroft successfully obtained his patent. With the patent, the English government granted Bancroft the sole right to export and supply the dyestuff to England for a period of fourteen years and excluded others from using or distributing quercitron bark. This gave Bancroft a monopoly, allowing him complete control over prices and supply.

In autumn of 1775, while in England, Bancroft received his first shipment of twenty tons of quercitron bark from his brother Daniel, who resided in Philadelphia at the time.[162] According to Bancroft, he never profited from this shipment. He recalled, "Of the Quercitron Bark then imported, nearly the whole was sold to Mr. Arbuthnot, at that time the most eminent and ingenious Calico Printer in this kingdom; but he

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[161] For more information on the British patent system, see B. Zorina Khan, *Economic History of Patent Institutions*, http://eh.net/encyclopedia/article/khan.patents (accessed October 16, 2010).

[162] Edward Bancroft, "Facts and Observations Briefly Stated in Support of an Intended Application to Parliament" London, 1798, 4. Eighteenth Century Collections Online. Gale. University of Delaware Library. http://find.galegroup.com/ecco/infomark.do?&contentSet=ECCOArticles&type=multipage&tabID=T001&prodId=ECCO&docId=CW3305304274&source=gale&userGroupName=udel_main&version=1.0&docLevel=FASCIMILE. (accessed June 21, 2009). See Chapter Four for more information about Daniel Bancroft.

became insolvent before any thing had been paid for it."[163] Bancroft probably chose Arbuthnot as his first recipient as an expression of thanks for supporting his appeal to the Royal Society of the Arts.[164] Noted by Charles O'Brien for his "elaborate and well executed" pattern for Queen Charlotte, Arbuthnot was apparently less successful in "chemick printing," which led to the forfeit of his estate.[165] On March 25, 1779, the *St. James Chronicle* announced the auction of Arbuthnot's property, "among which is a large Quantity of American yellow Bark, which, if not superior, is an excellent Substitute for Weld."[166] While the sale represented a loss for Bancroft, it significantly marked the first documentation of quercitron in Great Britain. Before Bancroft could arrange for another shipment, England placed an embargo on the colonies, preventing any trade or commerce during the Revolution.

By 1785, Bancroft had yet to benefit from his dye monopoly. He submitted an appeal, and Parliament renewed the patent for fourteen years in England, Wales,

[163] Bancroft "Facts and Observations," 3-4.

[164] Letter from John Arbuthnot of Ravensbury to Mr. Samuel Moore about the tests on Mr. Bancroft's dyed calico, April 4, 1772, Royal Society of the Arts, London.

[165] Charles O'Brien, *British Manufacturers' Companion and Calico Printers' Assistant* (London: Printed for the author, 1792), n.p.

[166] Ada Longfield, "More Eighteenth-Century Advertisements and English Calico-printers," *The Burlington Magazine*, Vol CII, No. 684 (March 1960): 112–14. Longfield notes that John Arbuthnot later recovered from financial crisis and became Inspector General for the Irish Provinces of Leinster, Munster, and Connaught for the Trustees of the Linen Board in Ireland (113).

Berwick-Upon-Tweed, and Scotland.[167] The use of the bark facilitated and promoted calico printing, especially in Lancashire, Scotland, and other northern parts of the kingdom. According to Bancroft, "During the year 1791, 230 tons of quercitron bark were used in Great Britain.[168] That same year, Tench Coxe, Commissioner of Revenue for the Treasury Department, reported 2,876 hogsheads of ground oak bark exported from Pennsylvania alone.[169] It represented the third largest export from any state that year.[170] Just twenty years after Bancroft's initial discovery, quercitron bark was clearly in high demand.

Quercitron's Reception in the United Kingdom

In 1792, an act of Parliament was passed "allowing the importation of Quercitron or Black oak bark without the regard to price of common Oak Bark."[171] In

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[167] In Britain, patents could only be extended through an act of Parliament, and the inclusion of Scotland or an extension of the term required additional fees. See B. Zorina Khan, *Economic History of Patent Institutions*, http://eh.net/encyclopedia/article/khan.patents (accessed October 16, 2010).

[168] Bancroft, "Facts and Observations," 9.

[169] Tench Coxe, *Abstract of Goods, Wares, and Merchandize Exported from Each State from 1 October, 1791 to 30th September 1792*, Downs Collection of Manuscripts and Printed Ephemera, Col 245, Winterthur Library. Since 1 hogshead = 1,000 lbs and 2,000 lbs = 1 ton, Coxe reported 1,438 tons exported from Pennsylvania.

[170] Coxe, *Abstract of Goods*, 2.

[171] Bancroft, "Facts and Observations," 10.

order to preserve the market for British oak, Great Britain ceased the importation of American oak. Quercitron dye had to be excluded from the prohibition since British printers demanded it. Eighteen prominent English calico printing businesses wrote a letter to support the act that stated:

> We whose names are hereunto subscribed. Being Dyers and Calico Printers in the country palatine of Lancaster do from our personal knowledge, certify, and declare, that the Bark, known by the name of Quercitron Bark, which we believe was first made known and brought into use in this kingdom, for dying, Calico Printing, &c. by Dr. Bancroft has been highly useful in those arts as well from the properties which it possesses, as from his not having confined the use thereof to a few particular persons; which by the act of parliament made in the 25th year of his majesty's reign, we are informed he might have done, to the exclusion of others, And we believe, that if the said barks were to be withheld from general use in this kingdom, either by shutting the ports against the importation thereof, in consequence of a diminution of the price of British Oak Bark, or by the exercise of any right vested in the said Dr. Edward Bancroft by the said act, great inconvenience would arise, and particularly to those concerned in the business of calico printing.[172]

It is evident that quercitron made a strong impact on the calico printing industry in Great Britain and that companies would not stand for any deprivation of the dyestuff. Peel, Yates and Co., one of the businesses that signed the petition, was based in Lancashire and involved in milling, printing, and warehousing. The Peel family operated one of the largest calico printing companies in England, earning notoriety for copying or interpreting prints from high-end printers in London and quickly and

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[172] Bancroft, "Facts and Observations," 10–11.

cheaply reproducing them for the masses. They were also one of the first companies to sell directly to American merchants.[173] According to Bancroft, "Similar letters were signed by all the calico printers in and near Carlisle (probably Bannister Hall near Preston), by those at Wigton in Cumberland, and by the house of William Sterling [sic] and Sons at Glasgow."[174] William Stirling and Sons formed a printworks in Cordale along the Leven and a dyeworks and bleachfield at Dalquhurn beginning in 1770. They employed approximately 600 people. [175] The size of their business provides an idea of the volume of quercitron they potentially used. While it is evident that a variety of prominent printing establishments were reliant on the dye, the petition also reveals the success of Bancroft's marketing of quercitron dye; his published treatises and his influential connections quickly and efficiently spread the word about the benefits of this yellow dyestuff.

Despite its quick and immense popularity in the industry, the exportation of quercitron bark was dramatically reduced after 1792 due to a lack of shipping space across the Atlantic. This was a direct result of the scarcity of corn in Europe at the end

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[173] For a more detailed economic history of the Peels, see S.D. Chapman, *European Textile Printers in the Eighteenth Century: A Study of Peel and Oberkampf* (London: Heinemann Educational Books Ltd, 1981).

[174] Chapman, *European Textile Printers*, 10–11.

[175] See Archibald Clow and Nan Clow, *The Chemical Revolution: A Contribution to Social Technology* (Philadelphia: Gordon and Breach Science Publications, 1992), 225.

of the eighteenth century due to the Napoleonic Wars, which necessitated greater grain exportation from America. Although quercitron was packed into hogsheads to maximize efficiency and space, the influx of American grain limited cargo space for other commodities, including quercitron. Consequently, the acquisition of quercitron bark became more difficult and costly. Bancroft explained,

> It became difficult to get the Quercitron bark brought hither on any terms; and impossible to do it without a very *great increase* in the price of freight; which, in consequence of the war, has ever since continued; and has amounted in *all cases* to more than double, and in some to nearly *four times* as much, as I had before *usually paid*.[176]

Although the demand for quercitron dye persisted among printers and dyers, export limitations prevented Bancroft from supplying the quantities needed. He complained,

> "The advance on the price of freight on one hand, and the additional cost of Bark in America on the other, and while the consumers continued to be supplied with it by me at the lowest price at which it ever has been sold here, I have sustained a diminution of profit, and in effect an absolute loss of more than six thousand pounds upon the Bark which I have furnished to consumers in this kingdom only since the war began."[177]

Feeling that the supply was not meeting the demand and believing Bancroft responsible, printing and dyeing firms were eager to eliminate Bancroft's monopoly. The industry was further motivated to curb Bancroft's domination of the dyestuff due

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[176] Bancroft, "Facts and Observations," 20.

[177] Bancroft, "Facts and Observations," 20.

to a belief that he was making a 300 percent profit.[178] Firms began violating Bancroft's patent in 1784 by arranging quercitron shipments of their own from America. Yates, Peel & Co. partnered with prominent Philadelphia merchants Warder, Parker & Co. to obtain a quercitron supply independent of Bancroft.[179] Printing had become one of the most powerful industries in Great Britain and was nearly impossible to dispute or defeat. Not only were Lancashire printers violating Bancroft's patent, but they quickly and deliberately copied designs as well (Figures 13 and 14 illustrate a popular design known as Lane's Net and a quercitron copy by Bannister Hall).[180]

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[178] Bancroft, "Facts and Observations,"12.

[179] Bancroft, "Facts and Observations," 6. It is interesting to note Yates, Peel & Co. not only violated Bancroft's patent but also copied printing designs, specifically designs by William Kilburn, a printer at Wallington in Surrey. See Longfield, "William Kilburn,", 230–33.

[180] For more information on design copyright violations see Longfield, "William Kilburn," 230–33.

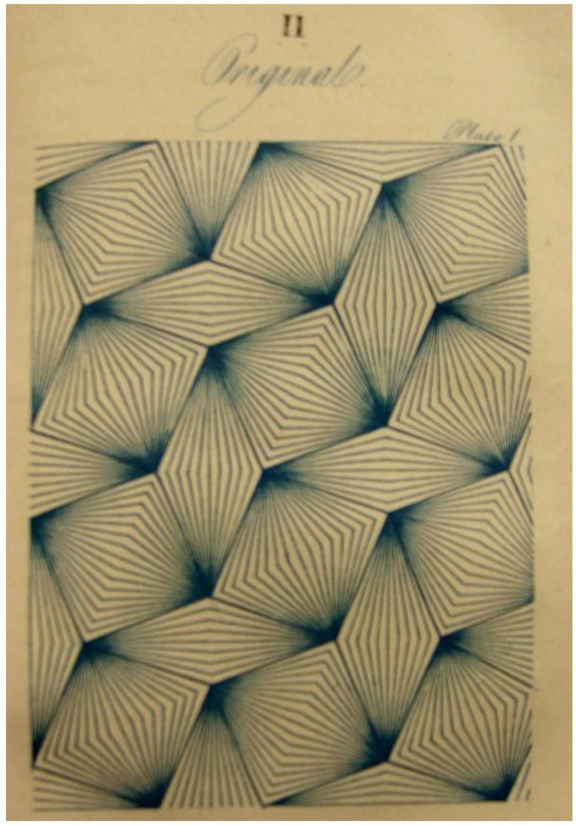

Figure 13. Lane’s Net Design from *A Treatise on the Copyright of Designs for Printed Fabrics,* J. Emerson Tennent, 1841.
Courtesy, The Winterthur Library: Printed Book and Periodical Collection.

Figure 14. Lane's Net Design from the Bannister Hall Sample Book
Courtesy, John Lewis Textile Archive (Cummersdale Design Collection)

Bancroft's Patent Expires

Although Bancroft submitted an appeal in 1798 entitled "Facts and Observations Briefly Stated in Support of An Intended Application to Parliament," Parliament declined to renew Bancroft's patent. His renewal application passed in the House of Commons, but it was defeated in the House of Lords due to petitions from northern manufacturers. Bancroft was no match for the powerful printing industry. Their financial influence controlled Parliament and effectively caused his loss of control. Bancroft lamented, "I was left with very little remuneration for the labours of a great part of my life; excepting the consciousness of having done good to many persons who appeared to be neither sensible, nor grateful for it."[181] As demand for quercitron continued to soar after Bancroft's patent expired, the price increased threefold over what Bancroft had charged.[182]

In 1799, the expiration of Bancroft's patent instigated an explosion of the drab style in English chintzes. [183] Dyeing and calico printing companies now had unrestricted access to the dyestuff and began freely importing their own quercitron supplies in order to produce the popular color palette. Designs on furnishing fabrics became dominated by quercitron's lemon yellows, dove grays, and golden hues. Patterns and samples from Bannister Hall—a printworks from Preston, Lancashire, operating from 1799 to 1840—indicate the almost exclusive production of drabs from 1803 until 1810.[184] The vivid yellow, orange, olive, and gold colorways of the drab style provided beautiful contrast for pattern designers to produce both naturalistic foliate designs as well as bold geometrics. The novelty, brightness, and variety of designs made these prints fashionable among consumers.

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[181] Bancroft, *Experimental Researches*, 85.

[182] Sidney Edelstein, "The Dual Life of Edward Bancroft," *Historical Notes on the Wet-Processing Industry* Dexter Chemical Corporation, 1972 (26).

[183] The drab style is discussed in Chapter 2.

[184] Design and fabric samples are contained in the Stead McAlpin Archives in Cummersdale, England. Special thanks to the Alan Cook and Alan James for showing me the extensive collection of designs, samples, and order books.

Bancroft's Legacy

Although he lost control over his dye distribution when his patent expired, Bancroft continued to experiment and publish. In 1813, he reissued his *Experimental Researches Concerning the Philosophy of Permanent Colour*, first published in 1794.[185] The new edition included a second volume containing the results of thousands of Bancroft's dye experiments.

Bancroft died at his home in Margate on September 8, 1821. Bancroft could no longer afford the lavish lifestyle once provided by his patent earnings. In a letter to his son's widow, he wrote, "my expenses in spite of my best efforts amount to a considerable sum. Have been entirely taken from the little which I have been able to lay up & which is now so reduced that I cannot help feeling great uneasiness."[186] Ironically, Bancroft's immense contribution to the printing industry played an important role in making the firms powerful enough to overthrow his patent. Quercitron transformed the industry by making beautiful bright fabrics quickly, cheaply, and effectively for consumers, contributing to the vast capital that made printing one of the most powerful and influential industries in the world.

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[185] Edward Bancroft, *Experimental Researches Concerning the Philosophy of Permanent Colours and the Best Means of Producing Them,* 2d ed. (London, 1813).

[186] Edward Bancroft to Mrs. Samuel Bancroft, June 20, 1802, Edith Bancroft Ashmore Collection, Pennsylvania Historical Society, quoted in Anderson and Anderson, "Edward Bancroft, 365.

Chapter 5

QUERCITRON PRODUCTION, NETWORKS, AND DISTRIBUTION

Most scholars interested in the story of quercitron focus on the activities of English calico printing factories when Bancroft's patent expires and quercitron use becomes prevalent. Few explore the source of the dye, where it comes from, and how it is produced.[187] This chapter illustrates quercitron's significance on both sides of the Atlantic, shifting the focus from the large printing manufactures in Lancashire to the bark mills along East Coast American tributaries as well as the fledgling textile printing businesses emerging in the new republic after the Revolution. It also explores the transatlantic networks that fostered quercitron distribution as well as the competing markets that opposed it.

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[187] Only three sources acknowledge Wilmington, Delaware, as the first distribution point for quercitron: J. Leander Bishop, *A History of American Manufacturers from 1608 to 1860…*(Philadelphia: E. Young & Co. London; Sampson Low, Son & Co., 1864); J. Thomas Scharf, *The History of Delaware, 1609–1888* (Philadelphia: L.J. Richards, 1888); and Adrosko, *Natural Dyes and Home Dyeing*.

Production

Black oak trees dot the East Coast landscape from Canada to Georgia. By the late eighteenth-century, these trees dominated the forests and served as raw material for important early American industries such as logging, tanning and saw-milling. Matthew Atkinson, author of the *Family Director*, provides perhaps the most detailed description of how the bark was harvested from these trees. He explained,

> It should be carefully selected in the woods, and taken off those trees that afford bark of the richest yellow color which is easily ascertained by cutting through the bark. The best time to take it off is in May. It should be cleared of all the dead part, retaining for use that part only which is soft and growing. This should be put up and carefully protected from wet and dirt until fully dry and then reduced to a fine powder, which is easily done, the inner bark being quite soft. In this state, by the aid of Murio Sulphate of Tin, Alum, and Tartar every shade from the richest and most beautiful orange yellow, down to the clearest and most delicate Lemon tinge, may be produced in their greatest possible degree of perfection.[188]

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[188] Atkinson, *Family Director*.

In August of 2009, I had the opportunity to harvest my own quercitron when a black oak tree fell on the Winterthur property (Figure 15).

Figure 15. Winterthur Black Oak August, 2009.
Photograph by Cheryl Lynn May.

With the wood still green, I easily chiseled away the black outer bark to reveal the bright yellow inner bark meant for dyeing. Surprisingly, this layer was merely a quarter-inch–wide ring on the 200-year-old-tree. Coming from a tree nearly three feet in diameter, the dyewood represented a relatively small percentage of the total wood. Using a tool called a spud or peeling iron, I peeled away the ochre-colored speckled bark from the heartwood (Figure 16).

Figure 16. Bark Removal
Photograph by Sarah Parks.

In the way that butter is sliced with a knife, the bark easily separated from the wood in thin flat strips. When the wood was freshly cut, the bark was easy to remove; but when I tried again a week later, it was a much more difficult task. I wondered why Atkinson recommended harvesting in the spring, but after attempting it myself, it became apparent that harvesting would be easier when the tree was entering an active growing cycle rather than when it was dormant. Working with two-foot-tall chunks of the tree trunk, I was able to harvest enough bark to fill two gallon-sized Ziploc® bags—more than enough with which to conduct dye experiments.

My harvesting experience gave me a small taste of the process, but historically the bark from the entire tree would be harvested. First, the oak was felled and the branches removed. The bark would be ringed or scored to divide it into four-foot-wide sections. Then the bark would be removed with a spud in one whole piece, creating a cylinder of bark all the way around the tree.[189] These shells of bark would be transported to mills to be dried and ground. Bancroft further described the process,

> The epidermis, or exterior blackish coat of this bark, affords a yellow colouring matter, which, however, is less pure, and more inclined to a brownish hue, than that of the other coats or parts; and it ought, therefore, to be separated by shaving. When this is done, and the remaining cellular and cortical parts are ground by mill-stones, they will separate partly into stringy filaments or fibres, which last yield but about half as much colour as the powder, and, therefore,

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[189] Harry B. Weiss and Grace M. Weiss, *Forgotten Mills of Early New Jersey* (Trenton: New Jersey Agricultural Society, 1960), 35.

> care should be always taken to employ both together, and as nearly as possible in their natural proportions, otherwise the quantity of colour produced may either greatly exceed or fall short of what is expected.

As Bancroft explained, the bark was milled to a powder after it was shaved and dried. In powder form, the bark was more soluble in water. Bark mills came in different forms and evolved over time. They were horse-, water-, and steam-powered in accordance with the developing technology. Some mills used the friction of horizontal stones similar to a gristmill. Edge-runner mills utilized runner stones with a corrugated grinding surface that ran on their edge in a circular trough (Figure 17).

Figure 17. Bark Stone, Newlin Mill, Glenn Mills, PA.
Photograph by Helena Richardson.

These stones, powered by horse or ox were typically five feet in diameter and seven inches wide. Eventually grinders with rotating iron teeth similar to modern coffee grinders replaced stones (Figure 18).[190]

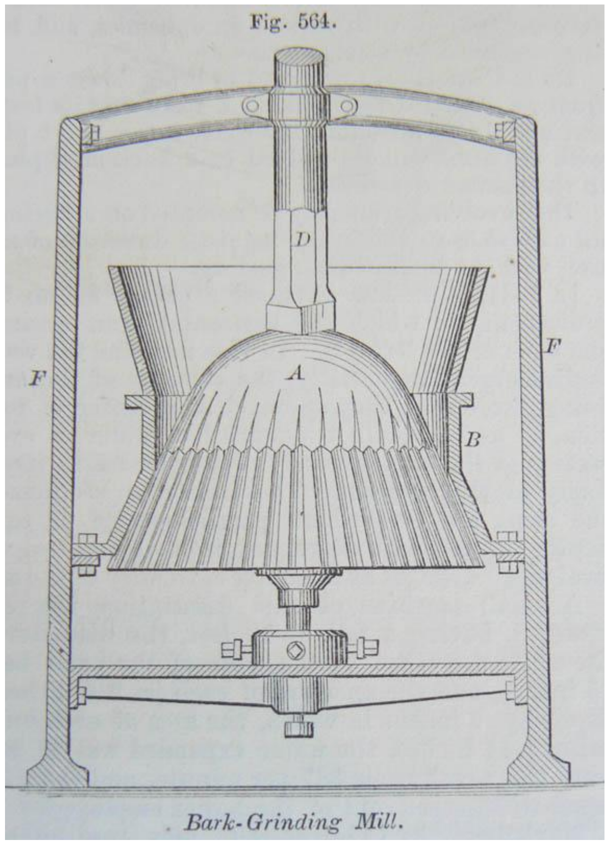

Figure 18. Bark Grinding Mill from *Knights American Mechanical Dictionary*, 1873. Courtesy, Hagley Museum and Library.

[190] Weiss, *Forgotten Mills*, 36.

Throughout the nineteenth century, inventors applied for patents to improve the grinding capabilities of these mills and further develop the preparation of dye bark (Appendix I). The first United States patent was issued in 1790. Between 1790 and July 13, 1836, patents were not given numbers, but 9,957 patents were issued. On July 13, 1836, most of the early patents were destroyed in a catastrophic fire in the U.S. patent office.[191] An 1813 broadside advertising the transfer of patent rights from Cornelius Tobey to Luther Gale describes, "This mill is of cast-iron, and its motion is in some degree similar to a coffee mill. It is put in motion by a horse or by water. It grinds the Bark even and fine, and with more facility than any other, and is allowed by the most competent judges, to be superior to any other in use" (Figure 19).[192]

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[191] A list of early patents can be found online at: "List of All U.S. Patents and Patentees, 1790-1829, http://www.ipmall.info/hosted_resources/PatentHistory/poinvtrs.htm. (accessed July 16, 2010).

[192] Luther, Gale, *C. Tobey's Patent Barkmill: Important Notice to Tanners and Others* (New York: John C. Totten, 1813), broadside, Hagley Museum and Library, Wilmington, Del.

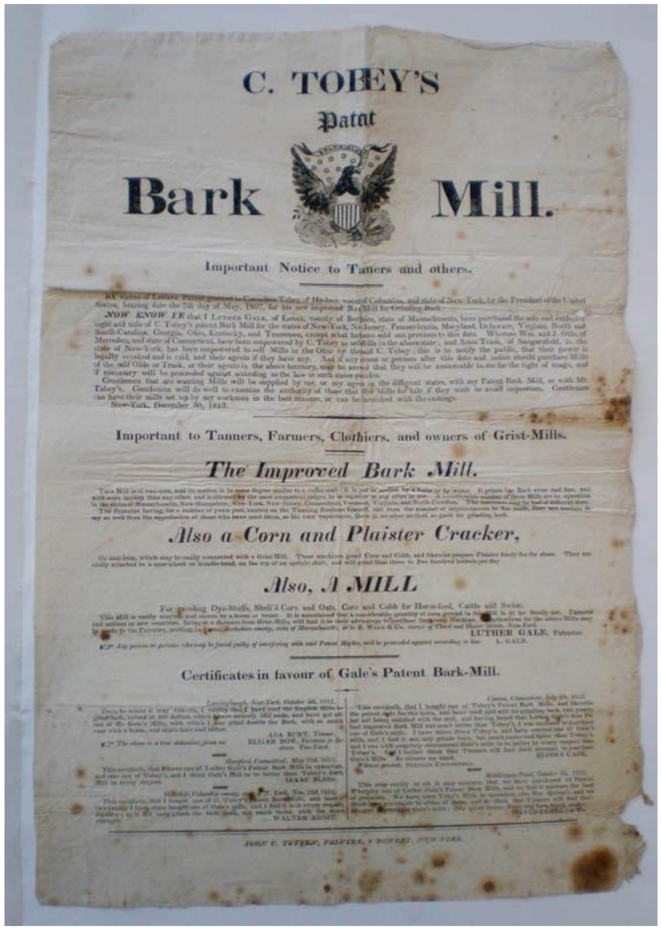

Figure 19. Broadside, C. Tobey's Patent Bark Mill.
Courtesy, Hagley Museum and Library.

With the aid of a blender, I ground my dried bark, which separated into filaments and powder components, exactly as Bancroft described. Performing the harvesting process allowed me to test the advice of period manuals, get a complete appreciation for the amount of dye one tree produced, and experience the sweat equity involved in processing a dye.

Interconnected Industries

Wilmington, Delaware, has the distinction of being the first location where quercitron distribution commenced, but few have investigated this important fact. Renowned for their gunpowder and flour mills, Delaware millers also processed bark on or near these famous mill sites. Milling was an important industry along the Brandywine Creek and other tributaries surrounding Wilmington. Using water wheels, manufacturers harnessed the power of waterways flowing towards the Delaware River to power their machinery. According to George Gibson "Delaware laws incorporating manufacturing organizations were often very broad and authorized the corporation to manufacture cotton, wool, grain, plaster, paper, iron, flax and whatever it wished to add or substitute."[193] Many companies incorporated a variety of manufactures into a single company and frequently processed raw materials for finished products at the same site. Often tanning and bark milling were combined.

Most famous among the Brandywine mills was the DuPont gunpowder mill established in 1803. In addition to gunpowder, the DuPont Company also operated

[193] George Gibson, "The Delaware Woolen Industry," *Delaware History* Vol. 2, No. 2 (October 1966) 89.

cotton and woolen mills and established a tannery in 1815.[194] Managed by Pierre Samuel du Pont's secretary, Alexandre Cardon de Sandrans, the tannery included a bark mill that filled the business's need for tannin to process hides and provided quercitron for the dye trade.[195] One of their best customers from 1820 to 1822 was a Philadelphia merchant named Robert E. Griffith. This is likely the same Griffith who joined with Warder, Parker & Co., of Philadelphia in 1784 to evade Bancroft's patent by exporting bark to Peel, Yates & and Co. of Manchester, England, without Bancroft's knowledge or consent.[196] In 1814, Robert E. Griffith advertised 100 hogsheads of first-quality quercitron bark for sale in *Poulson's Daily Advertiser*. [197] Philadelphia Japanner and gilder William Smith listed John Vaughan Esq. as the executor of his will but appointed Griffith as his successor if Vaughan was unable to act.[198] This indicates that Vaughan and Griffiths's paths crossed in Philadelphia as well as in Wilmington at the DuPont Company.

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[194] Peter C. Welsh, "A. Cardon and Company, Brandywine Tanners, 1815–1826, With Notes on the Early History of Tanning in Delaware," *Delaware History* Vol. 7, No. 2 (September 1958).

[195] Welsh, "A. Cardon & Company,", 139.

[196] Bancroft, "Facts and Observations," 6.

[197] "Quercitron Bark" *Poulson's Daily Advertiser,* Philadelphia, May 25, 1814, vol. XLIII, issue 11703, 2, Newsbank/Readex, America's Historical Newspapers.

[198] F. Edward Wright, *Abstracts of Philadelphia County, Pennsylvania Wills*, 1820–1825 (Westminster, MD: Heritage Books, Inc. 2007), 91.

By the time the DuPont Company established their own tannery, leather tanning was an established industry in Delaware, and quercitron bark, rich in tannins, was an important ingredient for preserving hides. In 1693, William Penn informed the committee of the Free Society of Traders that his grant, which included Delaware and Pennsylvania, contained plenty of bark for tanneries.[199] The vast oak forests located in Delaware's Kent and Sussex counties supplied much of the bark that was harvested in the spring and transported to mills. Alexandre Cardon, supervisor of the DuPont tannery paid Joseph Oliver of Milford, Delaware, $23 per ton of shaved bark and then sold it for $42 a ton after grinding it at their Brandywine bark mill.[200] Many tanners sold the surplus bark they did not use; however, the increased demand in Britain began to deplete bark sources in America and caused some consternation among the tanners. In 1791, Congress received and read petitions on behalf of tanners who asked for relief from inconveniences caused by the erection of mills to grind tanner's bark for

[199] Peter Welsh, "A Cardon & Co. Brandywine Tanners, 1815–1826, With Notes on the Early History of Tanning in Delaware," *Delaware History,* Vol. 8, No. 2 (Sept 1958), from Albert Cook Myers ed., *Narratives of Early Pennsylvania, West New Jersey and Delaware, 1630–1707* (New York: Charles Scribner's Sons, 1912). In Penn's letter to the Society of Traders, he wrote, "your tannery hath plenty of bark…" (241).

[200] Welsh, *Brandywine Tanners*, 140.

exportation.[201] The average price of the bark rose to $10.00–$13.00 a cord from $3.00–$4.50 a cord in previous years. In response, a committee suggested an increase on the duty of leather shoes in attempt to monetarily assist tanners. This solution could not provide them with the bark they needed. Tanners in Philadelphia began advertising to pay generous prices for all types of bark, including spanish oak, white oak, chestnut oak, and hemlock bark to make up for the deficit of quercitron.[202]

By 1832, twenty quercitron manufacturers were located throughout Delaware, from Brandywine to Seaford (Appendix II). It became the fourth largest industry in New Castle County and was associated with the three largest industries in Kent County.[203] Unlike the 1820 manufacturer's census, the 1832 McLane Report included a survey allowing businesses to record specific details about their industry. It is important to note that no other state listed quercitron production, let alone such a large industry within their state. Characteristic of other quercitron manufactories in Delaware, Joseph Oliver recorded in his questionnaire that his Kent County factory, in

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[201] J. Leander Bishop, *A History of American Manufacturers from 1608 to 1860: Exhibiting the Origin and Growth of the Principal Mechanic Arts and Manufactures*…. Vol. II (Philadelphia: Edward Young, 1864), 43.

[202] "Bark," *The Pennsylvania Gazette*, January 22, 1794, Accessible Archives.

[203] *Documents Relative to the Manufactures in the United States and Transmitted to the House of Representatives by the Secretary of Treasury*, 1833 vol.2, hereafter referred to as the McLane Report. Documented in a report to Congress about the chief

operation since 1815, was water-powered. He noted that the bark was shipped to New York and Philadelphia and exported for consumption in Great Britain, France, Russia, and Germany.[204] Annually he produced 15,000 tons of quercitron bark valued at $60,000 and employed fifty men.[205] In the same county and established in the same year, Alexander Murphy was an example of a miller engaged in multiple manufactures. He ran a water-powered woolen and bark mill.[206] Peter F. Causey's Sussex County bark manufactory in Milford produced linseed oil in addition to quercitron bark at his water-powered mill. Established in 1828, Causey processed 250 tons of first-quality quercitron bark annually. He reported that since the establishment of his factory, prices for bark had decreased from $36 to $22 per ton.[207] In New Castle County, Thomas Crawford's tannery, established in 1829 on the White Clay Creek, produced 175 tons per annum.[208] These few specific examples exemplify the different

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manufactures in each state, these results were referred to as the McLane Report, after the secretary of treasury who compiled it.

[204] McLane Report, 673–74.

[205] McLane Report, 682.

[206] McLane Report, 672.

[207] McLane Report, 696.

[208] McLane Report, 744.

types of manufacturers and the different scales of businesses involved in quercitron milling in all three of Delaware's counties.

Daniel Bancroft

Quercitron's discoverer, Edward Bancroft, is a mysterious individual, but even more so is his brother, Daniel. Like Edward, Daniel Bancroft (1746–96) was born in Westfield, Connecticut, and pursued a career as a physician, studying medicine at Edinburgh University from 1769 to 1770.[209] While Edward embarked on a voyage to Guiana, Daniel lived vicariously through his brother's letters.[210] Several authors discuss Edward Bancroft's various pursuits, but only one addresses the life of Daniel.[211] Wilmington gossip Elizabeth Montgomery provides an enlightening account of Daniel's life in her memoir entitled *Reminiscences of Wilmington: Familiar Village Tales Ancient and New*. Montgomery recounts that as a loyalist during the Revolution, Daniel Bancroft had an itinerant life as a British army surgeon. During the war he spent time in Georgia, South Carolina, and Nova Scotia. After the war, the Bancroft

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[209] Anderson and Anderson, "Edward Bancroft," 360.

[210] Bancroft's *An Essay on the Natural History of Guiana* was published as a series of four letters to his brother Daniel.

[211] Some of these authors include: Anderson and Anderson, "Edward Bancroft," , 356–67; MacNalty, "Edward Bancroft," 7–15;, and Edelstein, "Historical Notes," 712–13.

brothers renewed their correspondence and Edward informed Daniel about his quercitron exportation scheme. Montgomery wrote, "Dr. D.B.'s speedy removal [from Nova Scotia] to the United States was urged, where he must travel over the land and select the most eligible location for the exportation of the *Black Oak Bark*, for the yellow dye."[212] Initially Daniel settled in Philadelphia with his wife, Mary, and two daughters, Eliza and Harriet; however, the urging of an acquaintance named John Vining convinced him to explore Delaware as a residence.[213] According to Montgomery, "He acquiesced- and he accompanied Mr. Vining to Wilmington. These two gentlemen soon rode over the state, and his months of laborious research, and wanderings were here crowned with success."[214] Daniel's decision to settle in Wilmington sealed the city as the first quercitron center in the United States.

Daniel Bancroft established a permanent residence in Wilmington on the corner of Third and West streets. Montgomery remembers, "In 1786 or 1787, Dr. D.B. occupied the house on Quaker Hill, now in possession of Benj. Ferris, and engaged

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[212] Montgomery, *Reminiscences*, 358.

[213] Daniel and Mary also had three other children: An only son named Edward Augustus, born in 1785, who only lived a year; Mary Ann (1788–1865), who was born in Wilmington, Delaware; and Amelia Louise, born in November 1793, who only survived a month. Abraham Ernest Helffenstein, *Pierre Fauconnier and His Descendants: With Some Account of the Allied Valleux* (Philadelphia: S.H.Burbank &Co., 1911), 126.

[214] Montgomery, *Reminiscences*, 360.

largely in the exportation of the bark. His mind was to [sic] much absorbed in scientific works to bend to business, for which he had no tact."[215] Montgomery described Daniel's character and how it affected the brother's commercial venture:

> He was easily imposed on; plausible and flattering promises often drew from him large sums of money in advance for bark, which proved a failure- not having had a proper inspection, his shipments were made and condemned in England. Such remissness had to be accounted for on this side of the Atlantic and proved a heavy loss. On the other side great profits flowed in streams to benefit the importation there.[216]

Obviously Daniel was not the best choice as business partner for his brother, causing him a large loss in profit. This is the likely reason that Edward chose John Vaughan Esq. as his agent in America instead. Although Daniel lacked the business acumen of his brother, he is responsible for putting Wilmington on the map as his chief port of operation. Living in Wilmington for only a decade, Daniel's presence was brief. Daniel Bancroft died in Philadelphia in 1796 at a dinner party hosted by his brother's agent, John Vaughan Esq.[217]

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[215] Montgomery, *Reminiscences*, 360.

[216] Montgomery, *Reminiscences,* 361

[217] Montgomery, *Reminiscences,* 362.

Networks and Connections

While in Wilmington, Daniel fostered relationships with many prominent Delawareans and Philadelphians, a network that historian John Munroe calls the "Philadelawareans."[218] Elizabeth Montgomery unwittingly reveals these networks in her memoirs, recounting that Mr. Vining convinced Daniel to settle in Delaware:

> By invitation of Daniel Heath, Esq., they were nearly two months guests at his hospitable mansion.[219] In his tour, the Dr. was accompanied by a gentleman from each section of this State. In the mean time, Mr. and Miss Vining made a visit to Mr. Heath's family; as Dr. D. B.'s pursuits were a theme of conversation, Mr. V, became interested and advised the Dr., before he decided on a permanent situation, to visit Delaware.[220]

The Mr. Vining and Miss Vining to whom Montgomery alludes were the charming brother and sister pair John and Mary Vining of Dover, Delaware. John Vining was a

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[218] John Munroe, "The Philadelawareans: A Study in the Relations between Philadelphia and Delaware in the Late Eighteenth Century," *The Philadelawareans and Other Essays Relating to Delaware* (Newark: University of Delaware Press, 2004), 29–51. According to Munroe, "Social contacts and family relationships linking Delaware and Philadelphia were so numerous that rare was the Delawarean who did not have friends or relatives in the metropolis" (36).

[219] Daniel Heath was one of the wealthiest individuals living in his community of Townsend, Delaware, owning 5,000 acres, forty-seven slaves, and two dwellings. A one-room, one-story, log residence owned by Heath was nominated for the National Register of Historic Places in December 1989. See Bernard L. Herman et al., "Dwellings of the Rural Elite in Central Delaware, 1770–1830," Center for Historic Architecture and Engineering, College of Urban Affairs and Public Policy, University of Delaware, 1989. http://dspace.udel.edu:8080/dspace/bitstream/19716/1524/3/CHAD6.pdf.txt. This one-room log cabin is unlikely to be the "hospitable mansion" that Montgomery refers to.

[220] Montgomery, *Reminiscences*, 360.

Continental Congressman of Delaware, a Federalist Party member, and served in the Delaware general assembly as well as the United States House of Representatives and Senate. His sister was a friend of elite Philadelphians Peggy Chew and Sally Shippen. John suffered an early death in 1802 at the age of forty-three, and Mary became accountable for the care of his children. An Irish refugee, Archibald Hamilton Rowan, who settled in Wilmington and briefly ran a calico printworks, portrayed Mary Vining after the family tragedy in a letter to his wife. He described, “She is never happy unless when talking of the Compte de Lucerne, the Duc de Biron, and other French nobles who were here during the revolution. She wears rouge from her chin to her head, I believe, and is about fifty.”[221] Mary Vining was one of the many interesting people Daniel Bancroft encountered.

Montgomery refers to Edward Bancroft’s agent, John Vaughan, as another individual in Daniel’s network. At least three John Vaughans lived in the region at the same time as Daniel, but Edward’s agent was distinguished from them by his esquire title.[222] Although it is uncertain what duties Vaughan performed as Edward’s agent, it is clear that he was a close family friend:

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[221] Munroe, “The Philadelawareans,” 37; from *Autobiography of Archibald Hamilton Rowan* (Dublin: Thomas Tegg and Co., 1840), 301.

[222] A Dr. John Vaughan (1775–1807) lived in Delaware and witnessed the 1802 yellow fever epidemic in Wilmington. His papers are located in the Downs Collection

> The elder son of Dr. E.B. of London [Edward Nathaniel Bancroft], had traveled through the United States, and was on a visit to his uncle, and one of the bridal party [for Daniel's daughter, Eliza's wedding]. At the close of the year, he was to sail for England. John Vaughan, Esq., of Philadelphia, was his father's agent, and gave a dinner party before he embarked. His uncle was a guest, and sat down to table apparently in perfect health. Ere its viands were carved, he fell in an apoplectic fit, and when he was raised from the floor his pulse ceased to beat, and the lamp of life to burn.[223]

John Vaughan (1756–1841) was a noteworthy gentleman. Probably best known for his affiliation with the American Philosophical Society, he was elected a member in 1784, became secretary in 1789, treasurer in 1791, and served as the society's first librarian in 1803.[224] He held the positions of treasurer and librarian until his death. In their bibliographic essay, Roy Goodman and Pierre Swiggers describe Vaughan, noting, "The picture that contemporaries or near-contemporaries have left us of John Vaughan is that of an extremely active philanthropist, eager to promote useful knowledge and willing to help all those visiting the country."[225] Vaughan collected

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of Manuscripts and Printed Ephemera, Winterthur Library. Another John Vaughan (dates unknown) was a ship builder in Kensington, outside Philadelphia.

[223] Montgomery, *Reminiscences*, 305.

[224] Whitfield J. Bell, "John Vaughan," http:///www.anb.org/articles/20/20-01418.html, American National Biography Online. Feb. 2000 (accessed November 26 2010).

[225] Roy Goodman and Pierre Swiggers, "John Vaughan (1756–1841) and the Linguistic Collection in the Library of the American Philosophical Society," *Proceedings of the American Philosophical Society*, Vol. 138, No.2 (June 1994): 254–55.

important manuscript material related to the early history of the Society and especially to its founder, Benjamin Franklin. Also like Franklin, Vaughan was instrumental in acquainting scientific minds through correspondence or personal introductions. He hosted famous Sunday breakfasts and attended the Wistar Parties, formal evening gatherings of intellectuals. While not a scholar himself, Vaughan was a great enabler for others' work. He likely encountered Bancroft at the same time he met Franklin in France, while working as a wine merchant in Bordeaux. Beyond the American Philosophical Society, Vaughan was a member of various local societies and institutions. He served as vice consul of Portugal, Sweden, Norway, and Austria. He was secretary and treasurer of the Philadelphia Chamber of Commerce, a director of the Insurance Company of North America, and of the Delaware Insurance Company. His role as an agent of the E.I. du Pont de Nemours Company was probably linked with his responsibility to Bancroft. Extremely influential, John Vaughan deserved commemoration, but the discovery upon his death that he mingled his own finances with those of the Philosophical Society tarnished his reputation. As a result, no one ever published a bibliographic memoir of John Vaughan Esq.

The American Philosophical Society, much like the Royal Society in London, was a significant outlet for scientific contemporaries to share their research and network with one another. While neither Edward nor Daniel were members, they connected with several individuals who were. American Philosophical Society member John Dickinson (1732–1808) was a lawyer and politician from Dover, much like John Vining. He was a Pennsylvania delegate in the Continental Congress and was a member of the Constitutional Convention. As Delaware's wealthiest farmer, Dickinson is probably best known for writing *Letters from a Farmer in Pennsylvania* condemning the Townshend Acts in 1767.[226] He was also known as a Quaker abolitionist who freed his own slaves in 1777. At some point during his retirement, amid the small social circle of Wilmington, he met Daniel Bancroft. In 1791, John Dickinson wrote a letter to his friend Humphrey Marshall, introducing Bancroft:

> My Esteemed Friend:-
> Dr. Daniel Bancroft having a demand, from Europe, for some samples in Natural History, described in thy book, wishes thy acquaintance. I therefore beg leave thus to introduce him; being well assured it will give thee pleasure to pay attention to a gentleman engaged in such pursuits, as well as to serve our native land, by rendering the products, with which it is so eminently blessed, more known in other parts of the world; an office that perhaps may communicate benefits to distant regions, and generations yet unborn.
> I am thy sincere friend,
> John Dickinson
>
> Wilmington, October 29th, 1791.[227]

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[226] John Dickinson, *Letters from a Farmer in Pennsylvania, to the Inhabitants of the British Colonies* (London: J. Almon, 1768).

[227] William Darlington, *Memorials of John Bartram and Humphry Marshall with Notices of Their Botanical Contemporaries* (Philadelphia: Lindsay & Blakiston, 1849), 566–67.

Humphrey Marshall (1722–1801) was a botanist with a garden and arboretum in Marshallton, Pennsylvania. He was also a cousin of John Bartram (1699–1777), a famous American botanist and explorer.[228] Bartram served as the North America Royal Botanist for George III from 1765 until his death, a position for which he was recommended by Benjamin Franklin. In this role, Bartram provided seeds and plants to the Royal Collection at Kew Gardens as well as Oxford and Edinburgh botanical gardens.[229] Humphrey Marshall wrote *Arbustrum Americanum: The American Grove,* in 1785, dedicating the work to Benjamin Franklin and members of the American Philosophical Society. [230] Although Marshall's work does not include quercitron or *Quercus velutina*, Marshall does include the tree discovered in Georgia by his cousin John and named by his nephew William, called *Franklinia Altamaha* in honor of

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[228] John Bartram was considered the "greatest natural botanist in the world" by Linnaeus. Bartram traveled extensively in eastern North America collecting plant specimens and documenting his findings in two books: John Bartram, *Observations on the Inhabitants, Climate, Soil, Rivers , Productions, Animals, and Other Matters Worthy of Notice, Made by Mr. John Bartram in his Travels from Pennsylvania to Onondaga, Oswego and the Lake Ontario in Canada* (London: J. Whiston and B. White, 1751), and John Bartram, *Diary of a Journey through the Carolinas, Georgia, and Florida 1765–66,* annotated by Francis Harper (Philadelphia: American Philosophical Society, 1942–43).

[229] Whitfield Bell, "John Bartrum (1699–1777)," *Patriot Improvers, Biographical Sketches of Members of the American Philosophical Society, Vol. 1 1743–1768*. (Philadelphia: APS, 1997), 48–62.

[230] Humphrey Marshall, *Arbustrum Americanum: The American Grove An Alphabetical Catalogue of Forest Trees and Shrubs, Natives of the American United States…*Philadelphia: Joseph Cruikshanks, 1785.

Benjamin Franklin.[231] These associations demonstrate the interwoven nature of the scientific and intellectual community in early America. Bancroft became enmeshed in this community through his connections with Franklin and Vaughan, using his brother Daniel as his representative across the Atlantic.

Five years after he introduced Daniel Bancroft to Humphrey Marshall, John Dickinson wrote another letter of introduction to Marshall, this time acquainting him with Irish revolutionary Archibald Hamilton Rowan.[232] Dickinson writes,

> My Dear Friend:
> Archibald Hamilton Rowan, for whom I have a particular esteem, has been requested by his excellent wife, from whom he is so unhappily banished, to send her a collection of American seeds; and it will afford me a great deal of pleasure, if I can assist him in making it….
> Thy sincere friend,
> John Dickinson
> Wilmington, November 1st, 1796

Archibald Hamilton Rowan (1751–1834) arrived in America as an exile in 1795. A leader of the Dublin Society of the United Irishmen, Rowan escaped Ireland to avoid charges of high treason and began living a very public and social life in Wilmington. Rowan decided to take up a productive pursuit as he passed his time in the United

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[231] "Humphrey Marshall," http://www.amphilsoc.org/exhibits/nature/marshall.htm (accessed July 16, 2010).

[232] William Darlington, *Memorials of John Bartrum and Humphry Marshall with Notices of Their Botanical Contemporaries* (Philadelphia: Lindsay & Blakiston, 1849), 567.

States, and upon the recommendation of Wilmington grain miller William Poole, Rowan purchased a calico-printing works on the Brandywine River.[233] In March 1797, Rowan wrote a letter declaring his new occupation: "You will find by the papers that accompany this, that I am no longer a gentleman, but a printer and dyer of calicoes, and yet I do not think I disgrace my family, unless industry be a disgrace."[234] Although he lacked previous experience in calico printing, Rowan immersed himself in the trade. In his *Autobiography,* he recounts experimenting with a bleaching recipe provided by practical dyer and author Thomas Cooper.[235] Rowan's printworks operated from April 1797 until June 1799, when he closed the works due to competition from British manufacturers. Rowan explains, "We found the generality of our customers had received intimidation from the British riders, that if they found American prints in their stores, they must make up their accounts with their British correspondents immediately; and this not being perfectly convenient to the American

[233] William Drummond, ed., *The Autobiography of Archibald Hamilton Rowan* (Shannon: Irish University Press, 1972). The papers of William Poole (1769–1829) are located at the Delaware Historical Society, Wilmington, Del. His son, John Morton Poole (1812–79), was a machinist who worked with Joseph Bancroft, a cotton miller along the Brandywine as well as Poole's brother-in-law. Extensive genealogical research yields no connections among Edward and Daniel Bancroft and Joseph Bancroft.

[234] Drummond, *Autobiography of Archibald Hamilton Rowan,* 308.

[235] Drummond, *Autobiography of Archibald Hamilton Rowan,* 313. For more information on Thomas Cooper, see chaps. 1 and 2.

trade, we were left without work."[236] British manufacturers and merchants clearly felt threatened by the calico prints that Americans were beginning to produce.

Although his business lasted only three years, samples of Rowan's designs and prints still exist. The Joseph Downs Collection of Manuscripts and Printed Ephemera at the Winterthur Library stores Rowan's pattern book of over 140 calico printing designs, and three textile fragments are in the Delaware Historical Society collection.[237] Drab-style colors dominate the existing designs (Figures 20, 21, 22 show examples).

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[236] Drummond, *Autobiography of Archibald Hamilton Rowan*, , 313.

[237] For a closer examination of Rowan's Pattern Book, see Kathleen Kiefer's unpublished study "Archibald Hamilton Rowan's Pattern Book A Preliminary Technical and Stylistic Analysis," 1994. Joseph Downs Collection of Manuscripts and Printed Ephemera, Winterthur Library.

Figure 20. Designs from Rowan Sample Book of Designs for Printed Cotton, Col. 50, 66x141.
Courtesy, The Winterthur Library: Downs Collection of Manuscripts and Printed Ephemera.

Figure 21. Designs from Rowan Sample Book, Col. 50, 66x141.
Courtesy, The Winterthur Library: Downs Collection of Manuscripts and Printed Ephemera.

Figure 22. Design from Rowan Sample Book, Col. 50, 66x141.
Courtesy, The Winterthur Library: Downs Collection of Manuscripts and Printed Ephemera.

One textile fragment at the Delaware Historical Society features alternating stripes of cascading lacey leaves and oak leaves, acorns with blossoms in lemony yellows, golds, and browns characteristic of the quercitron palette (Figure 23).

Figure 23. Rowan Textile Sample, 1895.008.
Courtesy, Delaware Historical Society.

Splashes of green were added by penciling indigo over yellow. The depicted motifs and the color palette of this print bears close resemblance to an English drab-style print design called "Royal Oak and Ivy," commissioned by Richard Ovey for Banister Hall printworks in 1799 (Figure 24).[238]

[238] Montgomery, *Printed Textiles*, 152.

Figure 24. Royal Oak and Ivy, 1958.0078.003.
Courtesy, Winterthur Museum.

This illustrates that Rowan was producing fashionable designs at the same time that similar English designs were produced. Since Rowan traveled in the same circles as Daniel Bancroft, it is possible that they were acquainted. Whether or not they knew each other, evidence in the prints and designs shows that Rowan was using quercitron at his printworks and that he was creating prints that responded to current market demands.

Evidence suggests that calico printers near Philadelphia used quercitron as well. In the spring of 1775, Thomas Bedwell, a bankrupt calico printer from London and John Walters announced in the *Pennsylvania Packet* the establishment of a linen printing manufactory on Germantown Road in Philadelphia.[239] Bedwell and Walters had a strained partnership. Two years later, in 1777, Walters advertised that he was quitting the business; by 1782, they reunited as business partners, jointly advertising in Philadelphia newspapers. No longer engaged in calico printing, Walters and Bedwell offered, "Drawing of every kind, engraving, prints coloured and copper-plate printing" as well as portrait miniatures, hair work, and wall paper manufacture.[240] From his occupations involving various types of printing, Bedwell was an accomplished draftsman, engraver, and experimenter. In August 1791, with John Biddis, Bedwell

[239] Montgomery, *Printed Textiles*, 88–89.

patented a process for making bark extract for tanning and dyeing. Its association with both tanning and dyeing indicates that the bark extract was most likely quercitron bark. Bedwell later improved upon the extraction process with William Mitchell, issuing a subsequent patent in 1803.

Bedwell was not unique in his use of quercitron. Evidence suggests that John Hewson (1744–1822), the most famous early American calico printer known for his intricate woodblock designs, was using quercitron. Hewson was the son of a London woolen draper and gained calico printing skills working for Talwin & Foster, a prominent printworks at Bromley Hall near London.[241] According to his daughter, Sarah Alcock, Hewson's extreme political views prompted his parents to seek help from the ubiquitous Benjamin Franklin, who suggested he relocate to the American colonies.[242] Hewson's connection to Franklin is likely through surgeon William Hewson (1739–74), whose wife, Mary (Polly) Stevenson (1739–95), was close friends

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240 Advertisement, *Independent Gazetteer* (Philadelphia), July 5, 1783, Issue 88, page 4, Newsbank/Readex, America's Historical Newspapers Database. Montgomery, *Printed Textiles*, 89, 91.

241 Ken Milano, "John Hewson: Kensington's Revolutionary War Hero,"Historical Society of Pennsylvania, Philadelphia, http://www.hsp.org/default.aspx?id=497 (accessed July 17, 2010).

242 Sarah Alcock, *A Brief History of the Revolution with a Sketch of the Life of John Hewson* (Philadelphia: By the author, 1843).

with Franklin.[243] William Hewson was elected a member of the American Philosophical Society in 1769 and elected into the Royal Society in 1770. Beginning in 1772, he maintained a school of anatomy at 36 Craven Street, London, England. William was among the members who elected Edward Bancroft into the Royal Society in 1773. With these shared associations through Franklin and William Hewson, it seems possible that John Hewson and Edward Bancroft, both the same age, knew each other. John Hewson arrived in Philadelphia in 1774 and soon after established his own calico printing works. There he produced exquisitely detailed block printed textiles for a period of thirty-six years, and when he retired in 1810, he passed the factory to his son, John Hewson Jr. John Hewson Sr. was well known for his high-quality prints and for his heroism as a militia member during the Revolution. He was captured by British troops in April 1778, but by autumn of the same year he escaped and reestablished his printworks that the British had destroyed. In 1789, Hewson received a medal from the

[243] To date, direct genealogical ties between John and William are uncertain. Quilt scholar Barbara Brackman declares that the evidence seems too strong to be a coincidence. See Barbara Brackman, *John Hewson: Legend & Life*, online publication: published by the author, 2009 http://www.barbarabrackman.com/2b%20Hewson%20Life.pdf (accessed October 6, 2010). Polly Stevenson Hewson and Franklin became friends when Franklin boarded at her mother's house during extended stays in London. After the death of William, Franklin convinced Polly to move to Philadelphia. They remained friends throughout their lives. Her papers including her correspondence with Franklin reside at the American Philosophical Society, Philadelphia.

Pennsylvania Society for the Encouragement of Manufactures and the Useful Arts for the best specimen of calico printing, a testament to his printing skills.[244]

Today, thirty-one Hewson-attributed printed examples are extant, consisting of handkerchiefs, spreads, and a variety of quilts with patchwork and appliquéd prints.[245] These fabrics feature classical urns, birds, flowers, and butterflies in pink, red, blue, yellow, ochre, brown, and black (Figure 25).

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[244] Montgomery, *Printed Textiles*, 93.

[245] According to quilt historian Barbara Brackman, see http://barbarabrackman.blogspot.com/2009/11/hewson-textiles-and-cuestas-lists.html (accessed October 6, 2010).

Figure 25. Hewson Counterpane, 1963.0048.
Courtesy, Winterthur Museum.

Close examination reveals that Hewson likely created these colors from a process called the madder style, perhaps using both madder and quercitron dyes in the printing process.[246] Hewson's drab-colored palette and the associations with William Hewson and Benjamin Franklin make the connection between Hewson, Bancroft, and quercitron seem possible. Only the analysis of dye from Hewson specimens can confirm or refute this suspicion.

International Relationships/Networks

Bancroft's relationships illustrate the transatlantic nature of eighteenth-century transactions, whether intellectual or mercantile. Familial connections were a key component to fostering international relationships, and Edward was not unique in using his brother as a representative on the opposite side of the ocean. The company of Warder, Parker & Co in Philadelphia is another good example. Through their familial connection to Warder and Dearman in London, the Philadelphia firm became aware of the demand for quercitron bark in Great Britain and usurped Bancroft's patent by exporting it without his permission.[247] Another patent-violating company—Peel, Yates & Co.—sold prints directly to American merchants such as the Wistar merchant family of Philadelphia, with transactions recorded in ledgers and order books that

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[246] For a more detailed description of this process, see the section, Quercitron and Madder: Pompeian Colors in Chapter 2.

[247] For further discussion of family members involved in long-distance commercial networks, see David Hancock, *Citizens of the World: London Merchants and the Integration of the British Atlantic Community, 1735–1785* (Cambridge: Cambridge University Press, 1995).

illustrate these dealings. On July 1, 1785, the Wistars ordered a variety of prints, including purple ground cottons some small spots & flowers others with running sprigs & branches as well as chocolate and pompadour and olive grounds. They also ordered fancy 2 and 3 color prints, calicos and chintzes.[248] A year later on July 4, 1786, the Wistars ordered prints using four-digit numbers, presumably corresponding to samples. By February 1788, the Wistars wrote, "As from the above Directions & the patterns sent you must have a good idea of such cottons calicoes & chintzes as will add up you are at liberty to add any new Figs that are similar to out Patterns and Descriptions so as to make the amount of the invoice not to exceed £500s/g."[249] More detailed descriptions in the early orders ensured that the Wistars would get the prints that they wanted, but as their business relationship progressed, the Wistars entrusted Peel, Yates & Co to make decisions for them since the company now knew what they liked.

Shipping records also illustrate international relationships. Collection 245 in the Downs Collection at Winterthur reveals sixty years of Liverpool prices. Associated companies or representatives tracked the prices and duties and listed notes on the response of items so that merchants could adjust their shipments accordingly.

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[248] Wistar order book Col. 94 56x7.10, Downs Collection of Manuscripts and Ephemera, Winterthur Library (hereafter Wistar order book).

[249] Wistar order book.

Appendix III lists the prices of quercitron over this sixty-year period. Record books and price sheets are not the only artifacts of the transatlantic quercitron network. A dress in the New Castle Historical Society collection from the 1820s bears a unique pattern of black outlined zig-zags, brown coral-like clusters, and yellow stars enclosed in a delicate wreath on a striped muslin ground (Figure 26).

Figure 26. Dress, 1900.281.1 a,b.
Courtesy, New Castle Historical Society.

This pattern exactly matches a sample from Lancashire printer Thomas Comstive's sample book, dated December 27, 1823, in the Bolton Museum, Lancashire (Figure 27).

Figure 27. Comstive Sample Book, Sample Third from the Bottom.
BOLMG: 1983.42.2.IND Copyright Bolton Council. From the collections of Bolton Library & Museum Services.

The dress and sample book are evidence of the quercitron industry coming full circle. American mills ground the bark for English printers, who created designs for the American market. The dress also signifies quercitron printing in apparel rather than exclusively in furnishing fabrics.

Quercitron's story centers around networks of people who processed and distributed an important dyestuff with a tremendous impact on industrial technology and popular style. This industry involved the exchange of materials and ideas through networks of scientists, botanists, millers, and merchants. Influential individuals such as Benjamin Franklin and John Vaughan Esq. played significant roles by fostering important connections. Sometimes family played a role in these networks, while other partnerships were built on trust. This study brings the industry full circle and broadens its significance. American milled oak bark was shipped across the Atlantic for use in the expanding British printing industry and then it returned to America in the form of brightly printed fabrics. In some cases the dye never left the United States as innovative American printers began producing quercitron prints just as technically proficient as their British counterparts. Sometimes quercitron caused friction among industries that competed for the bark. By exposing process, highlighting the individuals involved, and exploring the results of its use, this examination recovers quercitron's significance from its scholarly neglect.

Chapter 6

CONCLUSION: THE QUEST FOR QUERCITRON: REVEALING THE STORY OF A FORGOTTEN DYESTUFF

Who could have predicted that the inner bark of an oak tree would change the face of the nineteenth century British calico printing industry? Edward Bancroft was the driving force behind this occurrence. Captivated by his yellow bark dye, Bancroft promoted quercitron through his dyeing and calico-printing manual entitled *Experimental Researches*. The book included thousands of experiments proving quercitron's facility in the dyeing and printing industries and sparked debates among his contemporaries over the best yellow dye. Bancroft embraced many pursuits in his lifetime, including medicine, natural history, novel writing, and spying, but his dye experiments sustained his fascination even in his later years. Quercitron was his brightest promise for income and posterity, and the loss of its monopoly was likely his greatest disappointment. Although Bancroft felt that he never gained adequate compensation for quercitron's introduction and distribution, his legacy endures in his *Experimental Researches* and the numerous vibrant drab-style printed cottons that survive.

Quercitron's impact seemed immediate and short lived, a mere blip on the dye radar, however this study uncovers and asserts the continuity of its use. Quercitron is remarkable because it suddenly appeared in 1771 and was quickly adopted in an industry founded upon secrecy and tradition. It supplanted weld, a leading source of yellow for hundreds of years and satisfied a need in the printing industry by producing multiple, bright, distinctive colors from the same dye, thus hastening the production process and adapting to new technology. In the beginning of its use, it was potent, cheap, and arrived in vast quantities, but within twenty years, supplies diminished and the technology changed. Although quercitron was succeeded by chrome yellow, its use persisted. Patents continued to be issued in the United States for improved milling, processing, and extraction of the dye. Scientists isolated the individual coloring components, quercitrin and quercetin, and extracted them, creating a purer colorant marketed as flavin that was used through the middle of the twentieth century. Interest in natural sources and sustainability has yet again turned our attention to this remarkable dye. Today it is available from dye suppliers for small-scale craft dyeing.[250]

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[250] Aurora Silk, owned by Cheryl Colander in Portland, Oregon, and Maiwa, in Vancouver, British Colombia, Canada, both offer quercitron, or black oak, among their natural dyeing supplies.

Surviving printed textiles illustrate the significance of quercitron use in the nineteenth-century English textile industry, but the origins of this dye have long been forgotten. It is important to remember that black oaks once covered the eastern United States and are still scattered throughout its forests. Water-powered mills once ground bark to a powder that was used for tanning leather or was shipped across the Atlantic. Enterprising American textile printers used quercitron, and rare traces of these manufacturers' brief existence serve as compelling testimony to its use. Examples with American provenances are rare, and many more are likely still waiting to be discovered. Tools utilized in quercitron production are associated with other manufactures, including tanning and milling, but it is essential that the quercitron industry not be forgotten since it played an integral role in the development of the fledgling early American economy.

Besides Bancroft, many individuals were involved in the production and distribution of quercitron. His brother, Daniel chose Wilmington, Delaware, as the ideal location to begin operations for milling and distributing the dyestuff. Edward's agent, John Vaughan Esq., played an important role in connecting him with the American scientific community, which overlapped with his scientific contemporaries in England, all of whom were connected through the renowned Benjamin Franklin.

Although some may consider the drab style or quercitron palette garish today, the lemony hues contrasting with olive-green, orange, and gold produced exciting and popular prints during the period. The distinct colors were used to create visual illusions of projection and recession into space. They depicted natural subjects in a perfect palette for autumnal leaves, and many prints, whether intentionally or inadvertently, illustrated the oak leaves and acorns of their source. Aesthetics play an integral and essential part in this study. By recounting the opinions in dye manuals, one can better understand the evaluations that they used to determine a perfect yellow. Surviving quercitron prints convey the excitement that occurred when one dye produced many colors and illustrate how adept designers were at using the palette and how skillfully the printers translated it to fabric.

Dyes and dyeing are subjects relevant to various fields and disciplines, including textile history, economics, political history, and the history of science and technology. This study illustrates how one dye has made a lasting impact in all of these areas. Previously, quercitron has been overshadowed by other natural dyes, but this examination finally sheds light on this remarkable, versatile dye.

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APPENDIX I

LIST OF PATENTS IMPROVING UPON THE PREPARATION OF DYE BARK
From a List of All U.S. Patents and Patentees 1790-1829, http://www.ipmall.info/hosted_resources/PatentHistory/poinvtrs.htm. (accessed July 12, 2010).

BIDDIS, JOHN ET AL; MAKING EXTRACT OF BARK; PHILADELPHIA PA 10 AUG 1791

BEDWELL, THOMAS ET AL; MAKING EXTRACT OF BARK; PHILADELPHIA PA 10 AUG 1791

MARKLEY, JOHN; GRINDING BARK; PA 19 JUL 1794

BEDWELL, THOMAS; FORMING A YELLOW COLOR; PHILADELPHIA PA 20 APR 1796

DOWNING, SAMUEL; EXTRACT OF BARK FOR DYING; TRENTON NJ 12 JUN 1801

WARREL, JACOB; MACHINE FOR CUTTING AND GRINDING BARK; 17 MAR 1802

DOWNING, SAMUEL; EXTRACTING ESSENCE OF BARK FOR DYING; TRENTON NJ 19 APR 1802

BEDWELL, THOMAS ET AL; MODE OF EXTRACTING BARKS ETC FOR DYING; 7 JUN 1803

MITCHELL, WILLIAM ET AL; MODE OF EXTRACTING BARKS ETC FOR DYING; 7 JUN 1803

BENGER, THOMAS; PREP. OF QUERCITRON (BLACK OAK BARK) FOR EXPORT OR HOME USE; 25 JAN 1804

PRYOR, THOMAS W.; BARK MILL; PHILADELPHIA PA 21 MAY 1805

WHIPPLE, SYLVESTER G.; MODE OF APPLYING BARK FOR HATS ETC; HALLOWELL, KENNEBEC CO MA 17 APR 1807 HALLOWELL LATER IN MAINE

TOBEY, CORNELIUS; MACHINE FOR GRINDING BARK; HUDSON NY 7 MAY 1807

PEASE, OBADIAH, ET AL; MACHINE FOR GRINDING BARK, ETC; NORFOLK CT 18 MAR 1808

DONALDS, ASHER, ET AL; MACHINE FOR GRINDING BARK, ETC; NORFOLK CT 18 MAR 1808

PILSBURY, PAUL; MACHINE FOR GRINDING BARK; NEWBURY MA 22 SEP 1808

HARPER, N.; QUERCITRON, OR BLACK OAK BARK; FRANKFORT PA 30 OCT 1810

GALE, LUTHER; BARK MILL; BERKSHIRE CO MA 20 MAR 1811

LYON, JOSEPH; MODE OF PREPARING QUINCITRON OR BLACK OAK BARK FOR EXPORT; PHILADELPHIA PA 1 JUL 1811

RICHARDSON, JOSEPH ET AL; GRINDING AND PACKING BARK; 6 JUN 1812

STOUT, BENJAMIN ET AL; GRINDING AND PACKING BARK; 6 JUN 1812

FESSENDEN, WILLIAM GREENE; OBTAINING EXTRACTS FROM BARKS; WALPOLE NH 20 OCT 1812

CHURCHMAN, CALEB ET AL; BARK MILL; UPPER CHICHESTER PA 16 JUL 1813

MARTIN, GEORGE, JR ET AL; BARK MILL; UPPER CHICHESTER PA 16 JUL 1813

OLDS, JARED; BARK MILLS; MERIDEN, NEW HAVEN CT 18 APR 1814

BROAD, AARON; CUTTING DYE STUFFS, BARKS, ETC; LITCHFIELD CT 9 JUN 1814

ANDREWS, JAMES; MACHINE FOR PREPARING QUERCITRON; PHILADELPHIA PA 15 JUL 1816

ELLIOTT, JAMES; MODE OF PREPARING QUERCITRON BARK; PHILADELPHIA PA 20 AUG 1822

APPENDIX II

List of Proprietors of Bark Mills and their locations in Delaware as listed in *Documents Relative to the Manufactures in the United States Collected and Transmitted to the House of Representatives by the Secretary of the Treasury*, 1833. Vol. 2 Manufactures, Returns from the State of Delaware. aka McLane Report Doc. No. 308 A general and condensed view of the information obtained in relation to Manufactures in each of the counties of New Castle, Kent, and Sussex in the state of Delaware.

Brandywine-	Benjamin Webb- Bark mill, not in use
	Benjamin Ferris- cotton mill, abandoned
Stanton-	Stapler & Craig- Bark mill
	George Platt- Merchant flour. Bark.
Red Clay Creek-	William Atkins- Merchant and grist. Bark
White Clay Creek-	Samuel Stroud- Merchant mill
	Meeter- paper mill
	Rankin Grist Mill. Bark Mill.
Smyrna-	Alexander V. Murphy- cotton and woolen, fulling, bark
	B.A. Crawford-Bark
	George Stedham- Bark
Little Duck Creek-	Pennywell & Sipple- Bark Mill
Frederica-	Charles Stedham Carding machine, bark mill
	Joseph Smithers- bark
Milford-	Joseph E. Clunn- Bark Mill
	Peter F Causey
Millsborough-	Simon K. Wilson Wool Carding, bark mill
Milton -	Joseph Maul- Bark Mill
Seaford-	Solomon Prettyman- Bark mill
Lewestown-	Shepherd Houston Bark mill

APPENDIX III

Prices Current at Liverpool
A List of Quercitron Prices Compiled from Shipping Records
Col 245. Downs Collection of Manuscripts and Printed Ephemera

Date	**Type**	**Price**	**Duty**	**Remarks**	**Accession Number**
22 Aug 1797	No Quercitron bark listed				92 x 147
14 February 1804	Quercitron bark	10/ a 7/0f	6 ½ d		
8 August 1809 Lodges & Tooth	Quercitron bark	22s a 56s cwt.	8d		74 x 44
24 March 1810 Lodges & Tooth	Quercitron bark	40/ a 84/ cwt.	8d		74 x 45
21 February 1811 Lodges & Tooth	Quercitron bark	22s a 50s	8d		74 x 46
15 August 1812 Lodges & Tooth	Quercitron bark	28/ a 46/	8d		74 x 47

5 October 1812 Lodges & Tooth	Quercitron bark	28/ a 46/	8d		74 x 48
30 September 1824 George M. Woolsey Liverpool	Quercitron bark cwt New York and Philadelphia	 10/ a 12/ 13/ a 13/6	0 2 0	good, Philadelphia is wanted for export and the stock of the quality is low	91 x 15.3a
30 November 1824 George M. Woolsey to messrs. A + JM Woolsey + Co. consigners of goods + Wm Thompson	Quercitron bark cwt New York and Philadelphia	 10/ a 12/6 12/ a 14/		Little enquiry	91 x 15.3b
24 Sept 185					61 x 62
Trieste 1 September 1855 D.P.Dulith & Co.	Bark, Quercitron	3 ¾ to 6 1/2	S5 D 6		1971 x 179.26

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Tennent, James Emerson, Sir, 1804-1869.
A treatise on the copyright of designs for printed fabrics: with considerations on the necessity of its extension: and copious notices of the state of calico printing in Belgium, Germany, and the states of the Prussian commercial league by J. Emerson Tennent.
London: Smith, Elder and Co., 1841.
{Plate II: Lane's Net Design}

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