program in chemistry, but had had to settle for being a candidate for a second bachelor's degree (Rossiter, reference 12, pp. 30-31).

12. M. W. Rossiter, *Women Scientists in America. Struggles and Strategies to 1940*, Johns Hopkins, Baltimore, MD, 1982.

13. Lombard University, a Universalist college and theological school, merged with Knox College during the Depression. We thank Carley R. Robison, Knox College, for this information.

14. *Catalogue of the Officers and Students of Lombard University, Galesburgh, Illinois, for the Year Ending June 18, 1884.*

15. Personal communication from Robert J. Endecavageh, Unocal Corporation, Los Angeles.

16. Anon., "College of Medicine", *Ariel* (College of Medicine, University of Minnesota), **1897**, *20 , No. 33(June)*, 34.

17. For a discussion of the precarious position of women scientists in academia at this period, and Ellen Swallow Richards' experiences in particular, see Rossiter, reference 12, Chapter 3, "Women's Work in Science".

18. Linton, however, was hardly putting aside chemistry for any "soft" alternative; even in 1896, two decades or so after the first of the pioneering generation of women students (including some Americans) had made their way into the medical schools of Switzerland and France, setting out to get an M.D. was no small challenge for a woman.

19. Anon., "Dr. Laura Linton Dies at Rochester", obituary in *Minneapolis Journal*, **1915**, *April 2*.

20. It was about this time that Ellen Swallow Richards was founding the field of Home Economics, and stressing the importance of dietary studies (Rossiter, reference 12, p. 69). It is tempting to postulate some influence from the older woman's thinking on Linton's undertakings.

21. Anon., "Useful Life is Ended", obituary in *Rochester Post and Record*, **1915**, *9 April*.

22. See Rossiter, reference 12, chapter 3, and also L. B. Arnold, *Four Lives in Science. Women's Education in the Nineteenth Century*, Schocken Books, New York, 1984, especially Chapter 6.

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OLD CHEMISTRIES

John Penington's "Chemical and Economic Essays"

William D. Williams, Harding University, and Wyndham D. Miles, Gaithersburg, MD

1990 marks the bicentennial of a unique early American chemistry book. When John Penington's *Chemical and Economical Essays* (1) was published in 1790, George Washington was in the second year of his presidency. The contemporary chemist, James Cutbush, called Penington's work "the first chemical book published in the United States" (2). That statement is not literally true. While there were American imprints on chemistry prior to 1790, Penington's *Essays* may be labeled the first full-size book devoted only to chemistry (3). In addition to reviewing Penington's *Essays*, this paper will present some unpublished material from a journal he kept while studying in Europe.

John Penington was born in Philadelphia on 29 September 1768, the son of Edward and Sarah Penington (4). A dedicated, disciplined young man, he packed considerable experience into a short 25-year lifetime. In addition to writing America's first chemistry book, he was the founder and president of America's first chemical society and, 70 years before Pasteur, devised a method of heat-preserving milk. Penington grew up in a period when Philadelphia was the center of governmental, intellectual and scientific activity. Since his family appears to have been well-to-do, he probably associated with people we would now regard as historically famous.

Comments in his book suggest that Penington was involved in industrial chemistry as a youth. His interest in chemistry may have been initiated by the family-owned sugar works (5). In one of the later essays, written as he neared graduation from medical school, he remarked that he had "now in some measure left chemistry as a profession." He also indicated prior chemical experience by referring to "the path I have trodden" when describing sulfuric acid production (6).

As a medical student at the College of Philadelphia, Penington studied chemistry under Benjamin Rush in the winter of 1788-89 (7). This was the last year that Rush taught chemistry; he was succeeded by Casper Wistar, who offered the course from 1789 till 1791. Penington's intense interest in chemistry may have led him to also attend Wistar's lectures in 1789-90. In dedicating his *Essays* to Wistar, Penington wrote (8):

To CASPER WISTAR, JUNIOR, M.D. AND PROFESSOR OF CHEMISTRY in the College of PHILADELPHIA, The Friend and Patron of CHEMICAL INQUIRIES IN AMERICA, These Essays are inscribed, by His sincere friend and pupil, JOHN PENINGTON. Philadelphia, May 25, 1790.

In a newspaper article on the history of chemistry in Philadelphia, James Cutbush reported Penington's activities in the first American chemical society (9):

During the spring of the year 1789, in consequence of the efforts of the late Dr. J. Pennington [sic], a chemical society was formed, and the doctor was elected to the presidency; whose duty it was to deliver discourses on chemical subjects. This was performed with great ability; each subject was illustrated by experiments, with much

success on the part of the president and with considerable benefit to the members of the society.

In the preface of *Essays*, Penington explained that his book began in 1789 as a series of articles in the *Columbian Magazine*. When asked to contribute "useful hints and recipes," he chose rather to "illustrate the connection between rational chemistry and many of the useful arts." The articles were discontinued after only four were published because they had such a restricted readership (10). The printer, however, offered to publish the extended series in book form. It is remarkable that the 21-year old Penington was able to accomplish this task while simultaneously completing his medical education, which included research and the writing of a dissertation.

The 200-page book, bound in calf and costing one dollar (11), contained 17 topical essays and an appendix. The appendix was a reprint of Penington's M.D. thesis. Some essays have a textbook-like character and exhibit thoughtful explanations which suggest that Penington would have been a good teacher. Most of the essays, however, were devoted to industrial processes and emphasized the value of chemistry to society. If Penington were expressing his views in today's terms, he would be a strong advocate of R&D. A recurring theme was the admonition for the artisan and the scientist to unite their efforts in the laboratory. He argued that the artisan did not understand why he performed certain operations, while the theorist could explain the science, but lacked the talent to manipulate the process. This theme was expressed on the title page with the quotation, "It is a pity so few chemists are dyers, and so few dyers chemists."

The following letter by President Thomas Jefferson endorsed Penington's emphasis on practical chemistry (12):

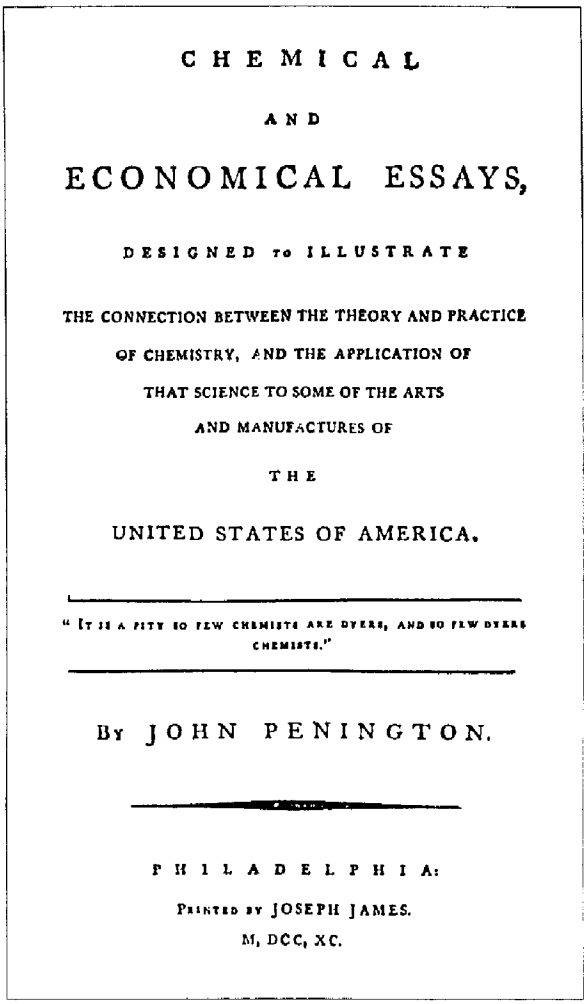
Monticello, August 1805

Of the importance of turning a knowledge of chemistry to household purposes, I have been long satisfied. The common herd of philosophers seem to write only for one another. The chemists have filled volumes on the composition of a thousand substances of no sort of importance to the purpose of life; while the arts of making bread, butter, cheese, vinegar, soap, beer, cider, &c. remain unexplained. Chaptal has lately given the chemistry of wine making; the late Dr. Pennington [sic] did the same for bread, and promised to pursue the line of rendering his knowledge useful in common life; but death deprived us of his labors. Good treatises on these subjects should receive general approbation.

TH: JEFFERSON

Patriotic comments were scattered among Penington's essays. He berated Americans for believing that imported articles were better than those made in America and he challenged American manufacturers to produce products equal to foreign ones. He repeatedly emphasized that a given chemical is the same whether made in America or imported. Penington apparently had access to a laboratory. He conducted his own research on purifying aqua-fortis (nitric acid), the use of pig-nuts in dyeing, and a fractional crystallization technique on salts of alkalis and marine (hydrochloric) acid. In the essay on the defense of the doctrine of phlogiston, he carefully reviewed the work of Stahl, Lavoisier, Priestley, Cavendish, Black, Bergman and Fourcroy. He spoke of his own experiments and concluded with his own modified theory of phlogiston.

He referred to Nicholson's *Philosophy*, Bergman's *Essays*, the *Edinburgh New Dispensatory*, and Fourcroy's *Elements of Natural History and Chemistry*. Two plates of Black's furnaces, taken from the *Edinburgh New Dispensatory*, and a table were mentioned in the text. These plates, however, were not present in the three copies of the book that we have examined. They had been included in the original *Columbian Magazine* articles. Although Rink (13) lists plates in his citation of this imprint, we are not sure whether they were present in any copy of the book.



CHEMICAL

AND

ECONOMICAL ESSAYS,

DESIGNED TO ILLUSTRATE

THE CONNECTION BETWEEN THE THEORY AND PRACTICE

OF CHEMISTRY, AND THE APPLICATION OF

THAT SCIENCE TO SOME OF THE ARTS

AND MANUFACTURES OF

THE

UNITED STATES OF AMERICA.

"IT IS A PITY SO FEW CHEMISTS ARE DYERS, AND SO FEW DYERS CHEMISTS."

BY JOHN PENINGTON.

PHILADELPHIA:

PRINTED BY JOSEPH JAMES.

M, DCC, XC.

Penington received his M.D. degree in June 1790. His *Inaugural Dissertation on the Phœnomena, Causes and Effects of Fermentation* was the first thesis at the medical school printed in English rather than the customary Latin. The introduction explained that Franklin and Rush favored a modern language and that many scientific terms would not translate into Latin. A footnote quoted Dr. Rush as complimenting Penington's conclusions on fermentation and noted that Rush "adopted it and publicly taught it, with acknowledgments to the author" (14). This dissertation was reprinted as the appendix in Penington's *Essays*.

Two weeks after his graduation, Penington sailed for Europe, where he studied medicine and chemistry for two years in Edinburgh and Paris. Both Rush and Wistar had taken M.D. degrees at Edinburgh and had studied chemistry under Joseph Black. They probably had advised Penington to follow their path.

A journal that Penington kept while in Europe has survived (15) and is the source of the following information. He left Philadelphia on 17 June 1790 and landed at Greenock on 14 July. He presented letters of introduction from Wistar and Rush to Joseph Black. He dined frequently with Black, discussing many chemical topics, including the doctrine of phlogiston. He recorded that Black "professes to believe in the antiphlogistic doctrine of calcination" and "thinks that the phlogistians have adopted too many suppositions." While Penington did not indicate that he debated the topic with Black, he did strongly defend the phlogiston explanations at several scientific meetings. He spent time with fellow American, John Redman Coxe, who was also studying in Edinburgh, but soon decided to avoid Coxe because he found him to be "selfish and impertinent." He visited with Henry Moyes, the blind lecturer on chemistry, who had presented a series of chemical lectures in the United States in 1785-86. During the fall and winter of 1790-91 he attended lectures at the university. In his spare time he carried out chemistry experiments, attended the theater, visited chemical works and mines, and attended scientific meetings. In the summer of 1791 he went to Paris, where he spent time sightseeing and attending the lectures of Fourcroy and Brogniart. The journal ended in France on 19 August 1791.

Penington's work on bread, which Jefferson's letter mentioned, was the subject of an entry in the journal (15):

November 6, [1790] - With much pleasure I found in the No. of The Encyclopedia published today, that my ideas on the raising of bread have been adopted.

He was probably referring to conclusions reached in his *An Inaugural Dissertation*. He had concluded that, contrary to the then accepted explanation, yeast bread was not raised by fermentation. He described experiments proving that no vinous spirit (alcohol) could be distilled from a sample of rising dough. He found that it took more than 16 hours for true fermentation to furnish appreciable fixed air (carbon dioxide). Furthermore, he could cause bread to rise with dough made with natural carbonated water or with dough containing sodium carbonate crystals and hydrochloric acid. While these experiments and conclusions were sound, his explanation of what did cause the bread to rise was curious (16):

Yeast is a fluid containing a large quantity of fixed air, or aerial acid ... as soon as the yeast is mixed with the dough, heat is applied; this extricates the air in an elastic state, and as it is now diffused through every particle of dough, every particle must be raised.

His method of preserving milk was described in a letter from Edinburgh to Benjamin Rush. He had prepared the milk before leaving on the month long voyage across the Atlantic and found it "as good at the end of the passage as when first put up." His process was given (17):

Boil new milk with its own weight of loaf sugar for three quarters of an hour, stir gently during the operation and pour it, warm, into clean bottles.

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This same letter gave an interesting comment on Penington's professors (17):

Alas, dear sir, I despair of meeting a Rush, or a Wistar, here, it is not the character of the professors at Edinburgh, to take the youthful inquirer by the hand and accompany him in the road of true knowledge. Pride and reserve prevail among the professors, idleness and dissipation in the generality of the students, and for want of proper company, I have hitherto retreated to books and a solitary walk.

Penington returned to Philadelphia in 1792 and began a medical practice. His interest in chemistry continued, however, as evidenced by an announcement about potash which appeared in July 1793. Signed by Penington, Rush, Wistar, David Rittenhouse, James Huchinson and Benjamin Say, this article endorsed the Hopkins process for preparing potash and pearlash (18).

During the dreadful yellow-fever epidemic of 1793, when one fifth of the population of Philadelphia died, Penington continued to attend patients until he also succumbed. His death on 20 September 1793 was lamented in a letter written that same day by Benjamin Rush: "Poor Dr. Penington is no more. His death was occasioned by his going out too soon after his recovery." Rush later wrote (19):

I must here pay a tribute to respect to the memory of my much loved friend Dr. Penington, who adopted the new remedies as soon as they were mentioned to him. His expanded mind was not cast in a common mold. It vibrated in unison with truth the moment it came in contact with it.

A local newspaper eulogized (20):

Had the present malignant fever deprived the city of Philadelphia of the genius, knowledge, and virtue of this one excellent physician and citizen only, it would be a calamity to be deplored for many, many years to come.

If Penington had lived, he might very well have become Professor of Chemistry at the University of Pennsylvania. Benjamin Rush exercised a prime influence upon the appointments to that position. Rush's nominations of Joseph Priestley, James Woodhouse and John Redman Coxe were readily accepted by the Board of Trustees (21). As a close friend and protegé of Rush, Penington might have been nominated. Unfortunately, no portrait or other likeness of Penington appears to have survived.

References and Notes

1. J. Penington, *Chemical and Economical Essays, Designed to Illustrate the Connection Between the Theory and Practice of Chemistry, and the Application of that Science to Some of the Arts and Manufactures of the United States of America*, J. James, Philadelphia, 1790. This book is briefly described in E. F. Smith, *Old Chemistries*, McGraw Hill, New York, 1927, p. 18.

2. J. Cutbush, *A System of Pyrotechny*, C. F. Cutbush, Philadelphia, 1825, p. 184.

3. Sections on chemistry were present in an American edition of the British work, W. Nicholson, *Introduction to Natural Philosophy*, 2 Vols., Dobson, Philadelphia, 1788. B. Rush, *Syllabus of a Course of Lectures on Chemistry*, (no pub., Philadelphia, 1770, 48 pp.; 2nd Ed., [1774], 40 pp.; 3rd Ed., 1783, 39 pp.) was a pocket-size pamphlet. Four short pamphlets on chemical topics also predated Penington's *Essays*: B. Rush, *Several Methods of Making Salt-petre*, W. & T. Bradford, Philadelphia, 1775, 12 pp.; B. Rush, et al., *The Process for Extracting and Refining Salt-petre*, Bradford, Philadelphia, 1776, 8 pp.; [A. Lavoisier], *The Art of Manufacturing Alkaline Salts and Potashes*, [Philadelphia], [1785], 50 pp.; H. Moyes, *Heads of a Course of Lectures on the Philosophy of Chemistry and Natural History*, [1786], 15 pp. There were several printings of Moyes' *Heads* in the different cities he visited.

4. *Appleton's Cyclopedia of American Biography*, Vol. 4, Appleton, New York, 1887, p. 711. This reference also contains a biography of Penington's father and grandfather. The Penington family papers are in the Historical Society of Pennsylvania collections. The name of John's mother is from family notes in his journal, Reference 15.

5. G. Tselos and C. Wickey, *A Guide to the Archives and Manuscript Collections in the History of Chemistry*, The Center for the History of Chemistry, Philadelphia, 1987, p. 128.

6. Reference 1, p. 145 and 148.

7. J. Penington, *An Inaugural Dissertation, on the Phoenomena, Causes and Effects of Fermentation*, J. James, Philadelphia, 1790, p. 24.

8. Reference 1, dedication page.

9. J. Cutbush, *Philadelphia Weekly Aurora*, **1816**, *6 (6 February)*, 413-414. This entire article, on the history of American chemistry up to 1816, is reproduced in W. Miles, "Early American Chemical Societies," *Chymia*, **1950**, *3*, 95-113.

10. J. Penington, *Columbian Magazine*, **1789**, *3*, 459-464, 525-531, 577-582, 643-646, 693-695.

11. Penington's *Essays* was reviewed in *Columbian Magazine*, **1791**, *5*, 108-110, 179-183.

12. T. Ewell, *Plain Discourses on the Laws and Properties of Matter: Containing the Elements or Principles of Modern Chemistry*, Brisban & Brannan, New York, 1806, p. 8.

13. E. Rink, *Technical Americana. A Checklist of Technical Publications Printed before 1831*, Kraus International, Millwood, N.Y., 1981, p. 78.

14. Reference 7, p. 20. A review of Penington's dissertation appeared in *The Universal Asylum and Columbian Magazine*, **1790**, *IV, No. 6 (June)*, 377-378. It stated that this thesis was the "first in English" and described Penington: "though a young man, has acquired a considerable knowledge of chemistry. This seems to be his favorite science, and to it much of his time has been devoted."

15. J. Penington, *Common Diary from July 14, 1790 till Oct. 1 of the same year*. This unpaginated manuscript, located in the Library of the Historical Society of Pennsylvania, is in three parts and continues until 14 August 1791.

16. Reference 7, p. 22.

17. A.L.S., J. Penington to B. Rush, 3 August 1790. Library Company of Philadelphia.

18. *Gazette of the United States*, Wednesday, 3 July 1793. The entire announcement is reproduced in W. Miles, "Benjamin Rush, Chemist," *Chymia*, **1953**, *4*, 37-77. The Hopkins process, dated 1 July 1790 and signed by George Washington, was the first patent issued in the United States. See H. M. Paynter, "The First U.S. Patent", *Amer. Heritage Invent. Techn.*, **1990**, *6(2)*, 18-22.

19. L. H. Butterfield, *Letters of Benjamin Rush*, American Philosophical Society, Vol. 2, Princeton, 1951, pp. 672, 698.

20. *The Federal Gazette*, **1793**, *(20 September)*. Quoted in Miles, reference 18.

21. W. Miles, reference 18, pp. 72-75.

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CHEMICAL ARTIFACTS

The Apparatus Museum at Transylvania University

George M. Bodner, Purdue University

In March, 1775, Colonel Richard Henderson purchased 20 million acres from the Cherokees in an unsettled region of the British colony of Virginia then known as "Kan-tuck-ee" and hired Daniel Boone to mark a permanent trail into this territory (1). In May of the same year, the legislature that was assembled to organize a government for the new country voted to name it "Transylvania" (literally: across the woods), perhaps because the Romans had used this name to describe a region of eastern Europe that also lay beyond a great forest (2).

When news of this purchase reached the Virginia assembly, it was declared illegal because this body had reserved the right to extinguish Indian title to lands within its borders. Between 1775 and 1800, however, 150,000 people crossed through the Cumberland Gap and traveled down Boone's Wilderness Road into the region that the Virginia assembly eventually established as "Kentuckee county".

One of the problems colonists faced was that of preserving

Dr. Robert Peter

their British cultural heritage. To do this, they turned to the schools (3). This might explain why the Virginia assembly took time in May, 1780 - during a period when their highest priority was the threat of British invasion following the fall of Charleston - to charter the establishment of Transylvania Seminary, which would serve as a spearhead of learning in the wilderness (1). Transylvania thereby became the 16th college established in the United States and the first established west of the Allegheny Mountains.

In 1789, the school was moved to Lexington, the commercial center of the region, and on 22 December 1798, it was merged with the Kentucky Academy to form Transylvania University. At their first meeting, the board of trustees of the new university established several colleges, including a Medical Department staffed by Doctor Samuel Brown, Professor of Chemistry, Anatomy, and Surgery, and Doctor Frederick Ridgely, Professor of Materia Medica, Midwifery, and Practice of Physic.

In 1799, Professor Brown was authorized to use $500 to import books and other items for instruction in the Medical College. Another $800 was allocated in 1805 for the purchase of apparatus for teaching natural philosophy, which included chemical apparatus and a galvanic battery. The Board of Trustees, in a public announcement that fall, proudly proclaimed the arrival of this apparatus, as well as additions to the college library, which now totaled some 1300 volumes.

In 1816, the trustees made an offer to Dr. Thomas Cooper to become the first professor of chemistry. The salary, however, was purposefully set so low that he would refuse the offer, which he did. In 1818, Professor Charles Caldwell arrived from the Medical School at the University of Pennsylvania.