

Drummond, London, 1943.

18. J. F. G. Druce, "The Chemical News", *J. Soc. Chem. Industry*, 1932 (16 December), 1031. Also Anon., "A Self-styled Faculty of Science", *Nature*, 1932, 130, 603-4; and "College and Faculty Dissociations", *ibid.*, 1932, 130, 692-3.

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OLD CHEMISTRIES

A "Lost" Silliman Chemistry Text

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Published in 1866, *Principles of Modern Chemistry* by Benjamin Silliman, Jr. and George F. Barker, has gone unnoticed by chemical historians (1). This extremely rare text was the first American work to present the "new chemistry" of the 1860s. An examination of the volume reveals it to be a revision of the first section of Silliman's famous text, *First Principles of Chemistry*.

Silliman and Barker each authored a well-known chemistry text. Silliman's *First Principles of Chemistry* (2) went through 50 "editions" and sold 50,000 copies between 1847 and 1875 (3). Barker's *A Text-Book of Elementary Chemistry, Theoretical and Inorganic* (4) had 13 "editions" from 1870 to 1891, sold 10,000 copies the first five years, and was translated into Japanese, Arabic and French (5). Despite the prominence of these two authors, however, their co-authored text has remained "lost" (6). The following review examines this rare volume and its relationship to the two authors' well-known texts.

Modern Chemistry was published by Theodore Bliss and Co. of Philadelphia - the same publisher as Silliman's *First Principles*. Although it never mentioned *First Principles* by name, the preface of *Modern Chemistry* left no doubt that it was intended as a revision of Silliman's text. It explained that the section on physics, "which has heretofore occupied the first portion of the work", was being omitted (7). Part I of Silliman's *First Principles* was indeed titled "Physics". The preface to *Modern Chemistry* also spoke of "earlier editions" and of T. Sterry Hunt's organic section (8):

It is appropriate that the atomic system should appear in this book, since many of its leading principles have been taught in its pages for

PRINCIPLES
OF
MODERN CHEMISTRY.

ARRANGED
ON THE
ATOMIC SYSTEM OF NOTATION.

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PART I.
CHEMICAL PHILOSOPHY.

PHILADELPHIA:
THEODORE BLISS & CO.
1866

the last fourteen years. Professor T. Sterry Hunt, the author of the Organic Chemistry in the earlier editions, was one of the first laborers in this field ... while the progress of fourteen years has changed the general aspect of chemistry, the student will recognize in these pages many of the principles laid down in former editions.

Subtitled, "Part I. Chemical Philosophy", the 100 pages of *Modern Chemistry* were to replace the briefer and outdated, "Part II. Chemical Philosophy" section of Silliman's *First Principles*. The prime purpose of the new edition was the introduction of the "atomic system of notation" into inorganic chemistry as had already been done with organic. The old dualistic system of expressing inorganic formulas ($\text{CaO}\cdot\text{SO}_3$) was to be replaced by the simplest atomic formula (CaSO_4). Classification by the "theory of types" and the resulting system of "equivalence" were recommended as less complex and more easily remembered by introductory students.

The "new chemistry" of the 1860s was a reform of equal importance to Lavoisier's "new chemistry" of the 1790s. During the first half of the 19th century, facts and theories accumulated faster than they could be systematized. Earlier combining atomic weights were inconsistent with Avogadro's law of equal volumes and the Dulong and Petit relationship for

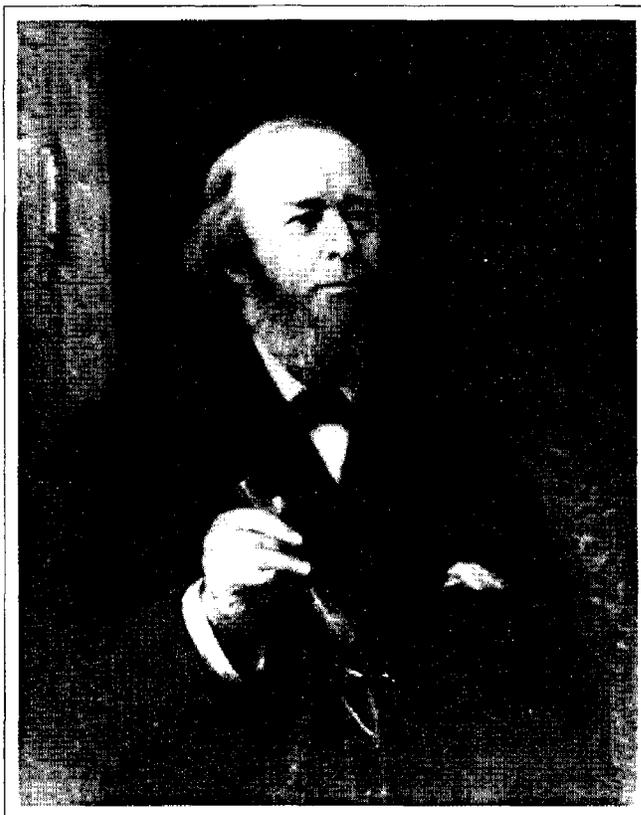
atomic heats. It was recognized that the accepted formula for water, HO (with H = 1 and O = 8), should be replaced with H₂O (with H = 1 and O = 16). In an effort to clarify inconsistent atomic weights and chemical notation, a conference of chemists was called at Karlsruhe, Germany, in 1860. About 140 prominent chemists attended. With Dumas presiding, they sought to correlate the contributions of Gay-Lussac, Avogadro, Berzelius, Dumas, Dulong and Petit, Gerhardt and others. Cannizzaro championed Avogadro's hypothesis that equal volumes of gases at the same temperature and pressure contain the same number of molecules. He argued that contradictions could be overcome by considering elemental gas molecules to be diatomic and by doubling some atomic weights. Although the delegates did not pass a resolution, Cannizzaro's recommendations were soon accepted (9).

The resulting new chemistry involved several important reforms:

- * Some atomic weights were doubled.
- * Dualistic formulas were replaced by molecular formulas. Compounds like CO₂ and SO₂ had formerly been called acids and had led to the dualistic concept of a salt as an additive combination of a base with an acid - i.e., CaO·CO₂ or CaO·SO₂.
- * A new nomenclature was needed for the new formulas. Thus carbonate of lime (CaO·CO₂) in the dualistic system became calcium carbonate (CaCO₃) in the new system and sulfurous acid (SO₂) became simply sulfur dioxide.
- * Concepts of valence and types resulted from the new organization.

These changes soon appeared in European textbooks and were widely accepted by 1865. In spite of its limited use, Silliman and Barker's *Modern Chemistry* was the first American text to explain the new system. Though several existing American texts added appendix chapters on the new system and some adopted the new atomic weights, Barker's 1870 *Text-Book* was the first widely-used American text totally based on the new system (10).

Benjamin Silliman, Jr. (1816-1885) followed the scientific path of his celebrated father, Benjamin Silliman, Sr. (1779-1864), who was the first Professor of Chemistry at Yale (11). The younger Silliman served as his father's assistant both before and after his graduation from Yale in 1837. He also joined his father in editing the *American Journal of Science and Arts*, a responsibility he continued for his lifetime. In 1842 he began an applied chemistry school that ultimately became Yale's Sheffield Scientific School, an accomplishment one biographer described as "the most important achievement of his life" (12). Except for a period from 1849 to 1853, when he was Professor of Medical Chemistry at the University of Louisville, Silliman spent his entire career at Yale. When his father retired in 1853, the younger Silliman succeeded him, teaching classes in the Academic Department and the Medical School, as well as in the Scientific School. He also became increasingly involved in industrial consulting. His 1855 report



Benjamin Silliman Jr. (1816-1885)

on Pennsylvania oil played an important role in the growth of the eastern petroleum industry. In 1864 he visited California for field investigation of mining interests. His optimistic report on California oil potential contradicted conclusions of Josiah D. Whitney, who headed the California State Geological Survey. Whitney and his former assistant, William H. Brewer, by then a Yale professor, mounted a vicious attack on Silliman that continued until 1874 (13).

The first edition of Silliman's *First Principles of Chemistry* was published in 1847. Although it had 50 so-called "editions", there were really only three different revisions - the content and pagination changing in 1848 (2nd ed.) and in 1852 (25th ed.). Around 1856, Silliman supplemented his text with two editions of a syllabus, *Synopsis of Lectures on Chemistry Delivered in Yale College*. In 1859, he wrote of desires for a major revision (14):

The Chemistry I mean to make a compound [sic] of the excellences of Fourier, Stockhardt and my own book. If the mixture is adroitly made I shall be able to concoct a better book for students than now exists.

George F. Barker (1835-1910) was a student under Silliman at the Yale (later Sheffield) Scientific School in 1856-58

and acted as Silliman's assistant the final year (15). After graduation, he served two years as assistant to John Bacon, Professor of Chemistry at the Harvard Medical School. He received his M.D. degree from Albany Medical College in 1863 while at the same time serving as professor of chemistry in that institution. After spending a year as Professor of Natural Science at Western University of Pennsylvania, he returned to Yale in 1865 as Demonstrator of Chemistry in the Yale Medical School. The 1866-67 Yale College catalog listed Barker as "Assistant to Professor Silliman".

From February 1867 until February 1868, while Silliman made another trip to California, Barker taught Silliman's chemistry classes at Yale (16). Barker apparently used *Principles of Modern Chemistry* as a supplement to Silliman's text. The copy in the author's possession contains a student's handwritten margin note, "Feb. 20th 1867". Some margin notes were trimmed when the volume was later bound. This would suggest that the original issue had a paper cover. The extreme rarity of the imprint could be explained by the fact that it was used for only one Yale class.

A contemporary biographer gave Barker credit for the book (17):

Early in the spring of 1866 Professor Barker wrote the first part of a text-book, intended as a new edition of Silliman's "Chemistry." In this book, the modern nomenclature and notation appeared in a text-book for the first time in this country. The theory of types was made use of as a basis of classification, and the book was used with the senior class in Yale College.

Any plans to continue the revision of Silliman's *First Principles* were abandoned. Barker incorporated the new chemistry concepts into his own text, brought out in 1870. Silliman's text continued to be published until 1875 with no changes from the 1852 copyright. As a result of continued attacks by Whitney and Brewer, Silliman resigned from Yale College and the Sheffield Scientific School in 1870. He retained his positions with the Medical School and the *American Journal of Science and Arts* until his death. Barker was Professor of Physiological Chemistry and Toxicology in the Yale Medical School from 1867 until 1873, when he moved to the University of Pennsylvania as Professor of Physics. His subsequent career was as physics professor and researcher, industrial consultant and expert court witness.

Silliman, in his 1874 *American Contributions to Chemistry*, omitted any mention of *Modern Chemistry* under his own name or under Barker's name. He did, however, insert an interesting comment about his *First Principles* in which he claimed that "the fundamental ideas of the so-called 'New Chemistry' were first distinctly brought out in a text-book in the organic portion prepared by Dr. Hunt" (18). This claim was very similar to the sentence about Hunt in the preface of *Modern Chemistry* quoted above.

Modern Chemistry contained five chapters:

- I. Introduction (matter, force, province of chemistry, laws of chemism, composition of matter)
- II. Nomenclature (simple and compound radicals, binary and ternary compounds, basicity of acids)
- III. Combining weight (law of combination, atomic and molecular weights, equivalence of radicals)
- IV. Notation (symbols of radicals and compounds, theory of types, reactions, stoichiometry)
- V. Chemical Physics (cohesion, crystallography)

Although the preface stated that "we have placed a series of problems at the end of such sections as require them", no problems were present in the volume. Indeed, chapter heads were continued on the same page as the last line of the preceding chapter in such a manner as to suggest printing from unfinished galley type. The 45 figures were all in the discussion of crystallography.

A comparison of *Modern Chemistry* with Silliman's *First Principles* and Barker's *Text-book* reveals very little similarity with either. The format of numbered paragraphs and the degree of complexity were similar to Silliman's text, but no identical passages have been found. *Modern Chemistry* was



George F. Barker (1835-1910)

much more detailed than the brief sections on theory and crystals in *First Principles*. Barker's *Text-book* had a more elementary, outline format and also failed to exhibit any identical passages with *Modern Chemistry*. A full-page "Electro-chemical Series" was identical, but the discussions were not the same.

It is not clear how Silliman and Barker shared the authorship of *Modern Chemistry*. The preface used the plurals "our" and "we" in referring to the authors. At that time, however, Silliman was heavily involved in the California oil controversy and other consulting work. Since Barker was more interested in the new chemistry, he probably did most of the writing - a method quite common with junior authors of today's texts.

References and Notes

1. B. Silliman and G. F. Barker, *Principles of Modern Chemistry arranged on the Atomic System of Notation. Part I. Chemical Philosophy*, Theodore Bliss & Co., Philadelphia, 1866, 100 pages. The *National Union Catalog* lists only one holder, Columbia University. The author has obtained a microfilm of that volume. Louis Kuslan, a knowledgeable Silliman biographer, states that he has seen an uncataloged copy in the Yale archives (personal communication).
2. B. Silliman, Jr., *First Principles of Chemistry for the Use of Colleges and Schools*, H. C. Peck & Theodore Bliss, Philadelphia, 1850, 480 pages.
3. B. Silliman, *American Contributions to Chemistry*, Collins, Philadelphia, 1874, p. 96.
4. G. F. Barker, *A Text-Book of Elementary Chemistry, Theoretical and Inorganic*, C. C. Chatfield & Co., New Haven, 1870, 342 pages.
5. W. Miles, *American Chemists and Chemical Engineers*, American Chemical Society, Washington, D.C., 1976, pp. 23-24.
6. The title is not listed in H. C. Bolton's *A Select Bibliography of Chemistry* or other bibliographies. It is not among any list of publications in Silliman biographies. The only source located which does mention the title is E. Thomson, "George Frederick Barker", *Proc. Am. Phil. Soc.*, 1911, 50, xxiv, in a list of publications by Barker.
7. Reference 1, p. vi.
8. *Ibid.*, p. [v]. Fourteen years earlier would have been 1852, which agrees with Hunt's last revision of the organic section for Silliman's *First Principles*.
9. For details of the Karlsruhe congress, see: A. J. Ihde, "The Karlsruhe Congress: A Centennial Retrospect", *J. Chem. Educ.*, 1961, 38, 83-86; A. Findley, *A Hundred Years of Chemistry*, Duckworth and Co., London, 1948, pp. 40-45; A. J. Rocke, *Chemical Atomism in the Nineteenth Century*, Ohio State, Columbus, OH, 1984, Chap. 10; and C. De Milt, "Carl Weltzien and the Congress at Karlsruhe", *Chymia*, 1948, 1, 153-169.
10. C. Eliot and F. Storer's *A Manual of Inorganic Chemistry* (Printed for the Authors, Boston, 1867) used the new system, but retained some of the dualistic formulas; J. P. Cooke incorporated the new system in writing his *First Principles of Chemical Philosophy* (Welch, Bigelow, and Co., Cambridge, 1868); J. Porter's *Principles of Chemistry* (A. S. Barnes, New York, 20th edition, 1868) added a 77-page section at the end of his former edition. He explained in the preface: "To meet the demand for a text-book containing the later theories of Chemical Philosophy, the publishers have extended the former edition so as to embrace a new part giving a complete exposition of the modern theories, together with numerous exercises in the new nomenclature."; H. E. Roscoe's *Lessons in Elementary Chemistry* (Wm. Wood, New York, 1868), the first American edition of the 1867 British work, used the new system throughout; S. W. Johnson published a five-page pamphlet, *Chemical Notation and Nomenclature, Old and New ...* (John Wiley & Son, New York, 1871), which was to accompany his edited American editions of Fresenius' texts; J. Johnston's *Manual of Chemistry* (Charles Desilver, Philadelphia, 8th edition, 1871) placed a 12-page appendix on the new system in his unchanged former edition; J. D. Steele's *Fourteen Weeks in Chemistry* (A. S. Barnes, New York, 1868) was revised to contain the new chemistry in 1873, but the old version was also continued for several years.
11. Reference 5, pp. 438-440; reference 14, pp. 159-205; E. H. Thomson in C. C. Gillespie, ed., *Dictionary of Scientific Biography*, Vol. 12, Scribner's, New York, 1975, pp. 434-437.
12. J. P. Cooke, "Benjamin Silliman", *Proc. Am. Acad. Arts Sci.*, 1885, 20, 523.
13. For a discussion of the oil controversy, see: G. T. White, *Scientists in Conflict: The Beginnings of the Oil Industry in California*, Huntington Library, San Marino, 1968. Whitney and Brewer claimed that Silliman was compromising scientific precision for lucrative consulting fees. When an oil sample proved to be fraudulently "salted" with eastern oil, the attack upon Silliman was intensified. Several Silliman biographers have concluded that he was too trusting of his associates and that his brother-in-law may have been responsible for the deceit.
14. Quoted in L. I. Kuslan, "Benjamin Silliman, Jr.: The Second Silliman", in L. G. Wilson, *Benjamin Silliman and His Circle*, Science History Publications, New York, 1979, p. 179.
15. Reference 5, p. 23; Thomson, reference 6, pp. xiii-xxix; Anonymous, "Biographical Notice of George F. Barker", *Pop. Sci. Monthly*, 1879, 15, 693-697; E. F. Smith, "George Frederick Barker", *Am. Jour. Sci.*, 1910, 180, 225-232; Anonymous, "George Frederick Barker", *Sci. Am.*, 1887, 57, 231-232.
16. Silliman's 1867 California trip is widely documented. He left in time to be in California by early March and in August he wrote Yale President Woolsey that he would not be able to be back for the fall term and asked that Barker take his classes. (Reference 13, pp. 131 and 135.)
17. Reference 15, *Pop. Sci. Monthly*, p. 694.
18. Reference 3, p. 96.

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