

RACHEL LLOYD: EARLY NEBRASKA CHEMIST

Mary R. S. Creese and Thomas M. Creese, University of Kansas

The lead editorial in the University of Nebraska student newspaper for June 9, 1894 concerned the resignation of chemistry professor Rachel Lloyd (1):

[Dr. Lloyd] has seen develop, largely by her efforts and under her eye, one of the largest chemical laboratories in the West. She has seen her lecture rooms crowded by enthusiastic students of all courses and departments. She leaves in Lincoln many warm, social friends, but it is by the students that her absence will be most keenly felt ... She is one of those instructors who stands not only for a science or a language, but for ideals and all higher culture. We can ill afford to lose one of these, for their name is by no means legion ...

In all likelihood Lloyd was the first American woman to take a Ph.D. in chemistry and the first to hold a full professorship in any science at a co-educational state university. She was in Nebraska for only seven years, her career being cut short by failing health, but the time was one of development and opportunity, and her contributions to the university and the regional agricultural community were notable. Her story has remained elusive, however; her early life unknown, and the question of how she got her chance in Nebraska, a matter of special interest to students of the history of women in chemistry, has gone largely unasked.

When Lloyd joined the faculty in 1887 the University of Nebraska had been in operation for only sixteen years (2). Student numbers had increased from twenty regular students in the first year (1871-72) to 334 (3). Most of the chemistry classes during the first ten years were taught by the professor of natural sciences, Samuel Aughey, a clergyman like many of the early faculty, who had little formal scientific training but a vast amount of miscellaneous knowledge, tremendous energy, and unbounded optimism in the future of Nebraska. In 1882

the first well-trained chemist, H[enry] Hudson Nicholson, was hired. The son of Wisconsin farmers, Nicholson had taken an A.M. at Lawrence College in



Rachel Lloyd
(University of Nebraska Archives)

Appleton, Wisconsin, in 1872 and was to supplement his chemical education with further studies throughout the 1880's at Harvard Summer School and the Universities of Heidelberg and Berlin (4). His description of the facilities awaiting his arrival at Lincoln is graphic (5):

[Equipment] consisted of a plain pine table on the top of which was a rack of bottles. In one corner of the room was a cupboard for supplies and in the upper part of the room, near the ceiling, was installed a barrel tank for the water service. There were numerous bottles, jugs, demijohns and carboys—mostly empty and unlabeled [sic]—scattered about the room, and various packets and bottles of chemicals, generally open and unmarked, stuffed in the cupboards. Of reference books, journals, or even texts, there were none ...

Fortunately he brought with him his private collection of apparatus.

In the fall of 1883, 295 students, more than ninety percent of those on the campus, requested chemistry courses. Nicholson's laboratory could accommodate twenty (6). The urgent need for more laboratory space led to the construction of a chemistry building, the second structure on the campus, which opened in the fall of 1886. Additional teaching staff being also essential, Nicholson proposed Rachel Lloyd, whom he had known as a fellow student at Harvard Summer School in 1880 and 1883 (7). Although Lloyd was well-qualified (she had completed her doctoral studies early in 1887) the Nebraska faculty nominating committee hesitated to recommend "unconditionally" the hiring of a woman chemist, and so her initial appointment was a one-year position as acting associate professor of analytical chemistry (8). The need for a second chemist was quickly becoming even greater than the rapid expansion of the undergraduate chemistry classes dictated. With the passage by the federal government of the Hatch Act in 1888, moderate federal support for experimental undertakings at the state Agricultural Experiment Station became available. Consequently the work of the station, which was carried out by the university faculty members, was also increasing; Lloyd joined the staff as assistant chemist as soon as she arrived in Lincoln.

Who was this pioneer among early women chemists? She was born in the small community of Flushing, in eastern Ohio, January 26, 1839, the second daughter in the Quaker farming family of Robert and Abby (Taber) Holloway (9). The Holloways were of English ancestry. Of the four children, she was the only one who survived past infancy, and her childhood and youth were marked by one tragedy after another. Her mother died when she was five and her father when she was twelve, leaving only her step-mother, Deborah (Smart) Holloway. She acquired some early education at the Friends' school in Flushing, and in 1859, at the age of twenty, married Franklin Lloyd, a Philadelphian of Quaker background, who worked as a chemist with

the firm of Powers and Weightman. Little more than six years later Franklin Lloyd was dead. Their two children had pre-deceased him, both dying in infancy (10). Rachel Lloyd then spent some time in Europe and when she came back, turned to teaching as a way of earning a living. Her first position was at the Chestnut Street Female Seminary in Philadelphia (11).

She also continued her education: starting in 1875, she spent six of the following eight summers at Harvard Summer School, which had begun in 1874 and offered courses of intensive instruction in botany, chemistry, and geology tailored to the needs of college and high school teachers. Lloyd studied botany during two summers and chemistry all six (12), specializing in advanced analysis and organic chemistry; latterly she also collaborated with the course organizer, Charles Mabery, in a research project on the synthesis of substituted acrylic acids. The work was reported in three substantial joint papers in the *American Chemical Journal* (13). In 1883 she became professor of chemistry at the newly opened Louisville School of Pharmacy for Women in Louisville, Kentucky, and instructor at Hampton College, a small liberal arts college for women, established in Louisville in 1877 (14).

Lloyd's ambitions reached beyond teaching in a small college, however. In 1885 she resigned from her Louisville positions to continue her studies and went to the University of Zürich, which had been open to women since the 1860's. Thanks to her already considerable laboratory experience, she completed her dissertation research in two years (under the direction of Russian-born chemist Victor Merz) and received her degree in 1887 (15). She was then forty-eight. The spring and early summer of 1887 she spent in London, at the Royal College of Science (South Kensington) and the School of Mines. From there she accepted the Nebraska offer.

The work for which she became noted was her part in a systematic examination of the economic feasibility of the production of beet sugar in Nebraska (16), a multi-year research and development project carried out by the staff of the Agricultural Experiment Station. Preliminary trials of beet culture conducted by the station in 1873-74 had given discouraging results. Yields of beet per acre from a test plot on the university farm had been disappointing, and the State Board of Agriculture had decided against continuing the experiment, despite the more hopeful outlook of the university's professor of agriculture, S. R. Thompson (17).

By the late 1880s, however, Nebraska's farmers were becoming somewhat more prosperous; prospects for the introduction of new crops were more favorable, and a modest but dependable amount of federal funding

was available to help support experimental work on the project. Furthermore, Nicholson was especially interested in sugar beets. Obtaining a variety of seed from the U.S. Department of Agriculture (18), and from France and Germany, where the beet industry was already well established, he distributed it to farmers throughout the state who were willing to raise test plots while keeping records of the important variables; these included type of soil and seed, weather conditions, cultivation procedures and yields per acre. Lloyd, who had seen at first hand the success of the crop in Europe, shared Nicholson's enthusiasm for looking into the possibility of beet culture in Nebraska. She undertook responsibility for the laboratory work the project entailed—the determination of the sugar content of the raw product. For this she was provided with some student assistance, but she carried out much of the laborious analytical work herself (19). Preliminary tests on the 1888 crop gave encouraging results, and by the end of the following year the data she had accumulated provided a convincing demonstration of the potential of the industry in Nebraska. Cultivation costs and yields per acre were reasonably satisfactory, and despite the difficulties caused by inexperience and periods of unfavorable weather, a number of farmers began to take a serious interest in sugar beets. Steps were taken to scale up the operation and establish a sugar factory. Enterprising citizens of the Grand Island community guaranteed a certain acreage of beets, and the first refinery was established there in 1890 by the Oxnard brothers, sugar technologists with experience in both France and the United States (20). Encouraged by a bounty offered by the state for Nebraska-produced sugar, the Oxnards opened a second factory a year later in Norfolk (21). In 1892 the university started a Sugar School, one of only two in the country and the only one dealing with beet sugar technology. The instruction offered included a course in elementary chemistry as well as special work in the chemical control of sugar factory operations (22).

Considerable pride was taken in the success of the Experiment Station's sugar beet work, the university catalog published in 1899 claiming that (23):

No state in the Union has made a more thorough research into the many questions relating to the growth of the sugar beet, and its manufacture into sugar than has Nebraska, and no small portion of the solution of these questions has been carried on under the provisions of the Experiment Station Act, and by means of the funds coming from the general government...

Three of Lloyd's reports on the project appeared as part of the Experimental Station's "Sugar Beet Series" (24).

In 1891, with her health beginning to fail, partly because of overwork, Lloyd gave up her position as assistant chemist at the station. She continued to carry a full teaching load at the university however; and, in 1892, while Nicholson had seven months' leave for an extensive tour of sugar factories and beet farms in Germany and France, she probably served as acting head of the chemistry department. Although she taught her share of more advanced courses (25), she frequently conducted both lecture and laboratory sections of the large, lower-level classes, and so had contact with most of the students who came through her department (26). She took pains to meet the undergraduates in less formal settings as well, being an active member of the Camera Club and one of four faculty who were members of the popular Scientific Club (27).

During the 1890s and the following decade a remarkable number of women chemists joined the Nebraska Section of the American Chemical Society. Indeed, women were much more prominent in that section than in any other local section in the country. Lloyd herself joined the national society in 1891, being the first woman member admitted (except for Rachel Bodley who was given her largely honorary membership at the formation of the society in 1874). The second was Nebraska graduate student and chemistry instructor Rosa Bouton, who joined in 1893 (28). Lloyd's presence on the Nebraska faculty can hardly have failed to be a major source of encouragement for the women chemistry students.

Following her resignation in 1894 she returned to the Philadelphia area, where she still had Lloyd relatives. She died six years later at the age of sixty-one, March 7, 1900, in Beverly, New Jersey.

Although she came to the work late (at the age of forty-eight), and had to leave after only seven years, Lloyd occupied a senior faculty post in what was soon to become an important educational institution at a key period in its development. Manley gives a picture of the Lincoln campus at the time that is especially interesting, because, along with other early faculty who were well known and long remembered in Nebraska, Rachel Lloyd is mentioned by name (29). Noting that the decade of the nineties is in many ways the most interesting period in the history of the University of Nebraska, those years having seen its transformation from a small frontier college into a major institution, Manley goes on:

...visitors to the campus were impressed by the earnest attitude of students and faculty. An air of purpose permeated the buildings, and the ornate iron fence which surrounded the campus after 1891

seemed to proclaim that no outside distractions would be permitted to intrude upon those laboring within. University Hall and the newer buildings were thronged with students pursuing a wide range of academic and practical courses. Professor H. H. Nicholson and a brilliant woman professor, Rachel Lloyd, who had joined the faculty in 1888 [sic], presided over the Chemical Laboratory. Newly built Grant Hall symbolized the land-grant university's devotion to the citizen soldier-scholar. And in Nebraska Hall, the home of the Industrial College, labored "the four busy B's — Bessey, Bruner, Brace and Barbour, whose names are household words in Nebraska."

At least three special advantages helped Lloyd get her position: first, she brought exceptional academic qualifications (as well as considerable teaching experience) to the job market in 1887, seven years before the first woman received a Ph.D. in chemistry from an American university (30); secondly, she had a close personal and professional contact with Nicholson, made during her summers at Harvard in the early 1880s, and he was in a position to make a strong case in her favor (31); thirdly, she joined the Nebraska faculty just when there opened a window of opportunity, at a time of expansion but before the growing importance of the institution made the promotion of a woman chemist to a senior faculty position less likely (32).

Lloyd's character had been formed in a hard school; rather than bending under the misfortunes of her youth, however, she seems to have developed remarkable inner strength and fortitude. Her friend and teacher Charles Mabery remarked in an obituary on her great force of character and attractive personality as well as her energy and the breadth of her cultural interests (33). These were important qualities, perhaps essential, for a woman "outsider" making her way into nineteenth century academic science. Lloyd became a leader in several ways — in taking the initiative of going to Europe for doctoral training as early as 1885 (34), in securing a senior appointment on the chemistry faculty of a state university in 1887, and in taking a major role in an extensive and far-reaching agricultural research and development project before the turn of the century. Like her fellow chemist Ellen Swallow Richards of MIT (35), Lloyd holds a special place in the history of women chemists in America.

ACKNOWLEDGMENTS

This work was supported in part by the National Science Foundation, Washington, D.C., Grant No. DIR-8907758, and by the University of Kansas General Re-

search Fund, allocation #3179-xx-0038. We are most grateful to the following archivists for their help: Joseph G. Svoboda, Lynn Beideck-Porn, and Michele Fagan, University of Nebraska; Margaret L. Glavaris, St. Clairsville Public Library, St. Clairsville, Ohio; Barbara S. Meloni and Kathleen A. Markees, Harvard University; Olivia M. Frederick, Environmental and Community Development Department, Jefferson County, Louisville, Kentucky; Nancy Speers, Friends Historical Library, Swarthmore College. We would also like to thank especially Howard Ephraim Stratton and Lewis Stratton, of Flushing, Ohio, for information about the Holloway family. Quotations from *The Hesperian*, Manley's *Centennial History*, and Crawford's "These Fifty Years," are made with permission from the University of Nebraska.

REFERENCES AND NOTES

1. *The Hesperian*, 1894, No. 27, 9 June, 2. The writer was Willa Cather, later to become famous for her novels of pioneer life in Nebraska. She was then an undergraduate at Lincoln and managing editor of the student newspaper.
2. The university received its charter from the state legislature in 1869, only two years after Nebraska became a state. Although endowed by the Morrill Land-Grant College Act of 1862, its establishment was not greeted with unanimous approval, certain factions in the state being of the opinion that Nebraska at that time needed a university "about as much as a cat needs two tails." Instruction was first offered in 1871 (see Robert N. Manley, *Centennial History of the University of Nebraska*, vol. 1, University of Nebraska Press, Lincoln, 1969, especially p. 14-17, quotation from p. 17).
3. Reference 2, p. 29, 91-92. The total enrollment figure for the first year was 130, but 110 were students in the preparatory department.
4. *Who Was Who in America*, vol. 1., A. N. Marquis Co., Chicago, 1943, p. 897. Information about Aughey came from reference 2, p. 23, 42-43.
5. H. H. Nicholson, quoted by Manley, reference 2, p. 82.
6. *Ibid.*, p. 82.
7. General Catalogue, "Summer Courses of Instruction in Chemistry, Botany and Geology." Harvard University, 1880, p. 221, 1883, p. 245.
8. Board of Regents Papers, February-April 1892, University of Nebraska archives. Lloyd became full professor the following year.
9. Olin E. Holloway, *Genealogy of the Holloway Families*, [n.p.], Knightstown, IN, 1927, p. 215-216; William Wade Hinshaw, *Encyclopedia of American Quaker Genealogy*, compiled by T. W. Marshall, Ann Arbor, Michigan, 1936—, vol. 4, p. 533.

10. Richard Louis Lloyd, "A Record of the Descendants of the Immigrant Robert Lloyd of Merion," [n.p.], ca. 1947 (excerpts provided by the Friends Historical Library of Swarthmore College).
11. This school was founded in 1850 by Mary L. Bonney and Harriet L. Dillaye, themselves graduates of Emma Willard's Troy Female Seminary in Troy, New York. By 1882 it was one of the oldest girls' finishing schools in America and was attended by girls from all over the country. After relocation in the Ogontz mansion in 1883, it became the Ogontz School for Young Ladies (information from Terrie Smith, University Relations, Ogontz Campus, Pennsylvania State University, Abington, PA).
12. Reference 7, student lists for 1875-77, '79, '81, and '83.
13. R. Lloyd and C. F. Mabery, "On the diiodobromacrylic and chlorbromacrylic acids," *Am. Chem. J.*, **1881-82**, *3*, 124-129; "Dibromiodiacrylic and chlorbromiodiacrylic acids," *ibid.*, **1882-83**, *4*, 92-100; "On ?- and ?-chloridibromacrylic acids," *ibid.*, **1884-85**, *6*, 157-165.
14. Catalogue, 1883-84, Louisville School of Pharmacy for Women (Filson Club: Historical Society, Louisville, Kentucky); 1885 Louisville City Directory (Caron's). Hampton College was founded by Lydia D. Hampton, a graduate of the New Jersey State Normal School, Trenton, New Jersey, who was a fellow student of Lloyd's at Harvard in the summer of 1880 (see John William Leonard, Ed., *Woman's Who's Who of America*, 1914-1915, The American Commonwealth Co., New York, 1914, p. 210, entry for Lydia Hampton Cowling).
15. Lloyd's dissertation research on the conversion of phenols to amines appeared in *Ber. Dtsch. Chem. Ges.*, **1887**, *20*, 1254-1265 ("Ueber die Umwandlung höherer Homologen des Benzolphenols in primäre und sekundäre Amine").
16. See Ann T. Tarbell and D. Stanley Tarbell, "Dr. Rachel Lloyd (1839-1900): American Chemist," *J. Chem. Educ.*, **1982**, *59*, 743-744; reference 2, p. 140; Glenda Peterson, "Rachel Lloyd made Beet Crop Success," *Sunday Journal and Star*, Lincoln, 1982, 24 October.
17. Robert Platt Crawford, "These Fifty Years" (Circular 26 of the Agricultural Experiment Station, University of Nebraska), University of Nebraska Press, Lincoln, 1925, p. 24-25.
18. Harvey W. Wiley, chief chemist at the U.S. Department of Agriculture from 1874 until 1913, strongly supported efforts to introduce the sugar beets into the United States, making seed available and assisting in analytical work as well (see "The Beet Sugar Story," United States Beet Sugar Association, Washington, D.C., 1959, p. 17).
19. Methods for sugar analysis were already fairly standardized by the 1880's. The procedure which Lloyd most likely would have followed was outlined by Tarbell and Tarbell (reference 16): a sample of finely divided, well-mixed beet pulp was digested with aqueous lead acetate solution, the resulting mixture filtered, and the optical activity of the filtrate, a measure of the sucrose content, determined by polarimetry. Reducing sugar content would also have been estimated (by reduction of Fehling's solution) as well as the percentage of sugar in the total solids, or coefficient of purity, the factor which indicated the overall ease with which white sugar could be produced (see R. A. McGinnis, ed., *Beet Sugar Technology*, Reinhold Publishing Corp., New York, 1951, p. 95-98).
20. Reference 17, p. 102. The Grand Island, Nebraska, factory was the third successful beet sugar factory in the U.S.
21. Soil and climatic conditions in the Norfolk district proved unfavorable for the production of beets with a high sugar content, and in 1905 this factory was closed and the equipment moved to Lamar, Colorado (reference 19, p. 16).
22. Reference 17, p. 102-103.
23. Anon., quoted by Crawford, reference 17, p. 101. In 1988, 100 years after Lloyd carried out her preliminary analytical work, the Nebraska sugar beet crop was valued at almost \$57 million (U.S. Department of Agriculture, Agricultural Statistics, 1990, U.S. Government Printing Office, Washington, D.C., 1990).
24. Rachel Lloyd, "Experiments in the Culture of Sugar Beet in Nebraska," 1890 (1 April), 1891 (15 April), 1892 (1 March) (University of Nebraska archives).
25. She also offered direction in research projects, as did Nicholson.
26. For example, in Nicholson's Department Report for the year ending 7 June 1893, Lloyd is listed as teaching eighty-eight students in Chemistry I and III during the first semester, and seventy-nine in Chemistry II and IV during the second. The only classes larger than hers were those in the preparatory division (Board of Regents Papers, 1893, University of Nebraska archives).
27. *Sombrero* [University of Nebraska Year Book], 1892, p. 165, 169. The Scientific Club, organized in 1890, had no fewer than ninety-seven members by 1892.
28. See the membership lists in the *Journal of the American Chemical Society*, Proceedings, for 1891 to 1910. As well as Lloyd and Bouton, Nebraska women chemists active in the local section included Mary Louise Fossler (B.S., 1894, A.M., 1898), Mariel Gere (B.S., 1895, A.M., 1899), Mariette Gray (B.S., 1895) and Rachel Corr (B.S., 1898, A.M., 1906); they were followed a few years later by Mabel Hartzell, Mildred Parks, and Mamie Short.
29. Reference 2, p. 111-112.
30. Charlotte Roberts (Yale, 1894) and Fanny Hitchcock (University of Pennsylvania, 1894) were the first women to receive doctorates in chemistry from American universities (see Walter Crosby Eells, "Earned Doctorates for Women in the Nineteenth Century," *Bulletin, American Association of University Professors*, 1956, *42*, No. 33, 644-651).
31. Lloyd's warm friendship with Nicholson, eleven years her junior, and his wife Jennie is made clear by the fact that the Nicholsons named their third child Rachel Lloyd.
32. Lloyd's appointment to the Nebraska faculty was probably early enough to avoid the full impact of the general reaction to the perceived threat of "feminization" of the

sciences, a reaction which set in during the 1880s and 1890s (see Margaret W. Rossiter, *Women Scientists in America. Struggles and Strategies to 1940*, The Johns Hopkins University Press, Baltimore, 1982, Introduction, p. xvii). Two other women chemists, Rosa Bouton and Mary Fossler, followed Lloyd on the early Nebraska faculty. Bouton, however, after seven years of teaching in the chemistry department (1891-98), was asked to take on the task of establishing the university's School of Home Economics; Mary Fossler became an instructor in the chemistry department in 1899 and was promoted to assistant professor of chemistry and associate professor of physiological chemistry nine years later. She held these positions until she moved to the University of Southern California in 1919. Admittedly, both Bouton and Fossler had A.M. degrees rather than Ph.Ds., and although lack of a doctorate was not a major barrier for men (Nicholson had an A.M.) it probably spelled a greater disadvantage for women.

33. C. F. Mabery, "Professor Rachel Lloyd, Ph.D., Zürich," *J. Am. Chem. Soc.*, **1901**, *23*, 84.

34. A number of American women scientists took doctoral degrees in Germany and Switzerland in the 1890's, but except for the botanist Emily L. Gregory (later of Barnard College), who received a Ph.D. from the University of Zürich in 1886, Lloyd would appear to have been the first American woman scientist (excluding physicians) to take a European doctorate.
35. Richards was instructor of sanitary chemistry at MIT from about 1883 until her death in 1911.

ABOUT THE AUTHORS

Mary R. S. Creese, a chemist, is an Associate at the Hall Center for the Humanities, and Thomas M. Creese is Associate Professor of Mathematics, both at the University of Kansas, Lawrence, KS 66045. They are working on joint projects in the history of women in 19th-century science.

American Chemists and Chemical Engineers

Volume 2

Wyndham D. Miles and Robert F. Gould, Editors

269 New biographical sketches, each fully referenced by 40 contributors. Includes many early chemists who started teaching "natural science," which later branched into chemistry, physics, botany, and so on; 37 born before 1800; 10 college presidents; 14 original ACS members; 4 charter members of AIChE; 19 who saw Civil War service; 7 historians of chemistry.

360 pages, including 67-page name and subject index.

Price: \$23.00, postpaid in US and Canada. Additional \$2.00 elsewhere.

Name: _____

Address: _____

Send to:
Gould Books
20 Forest Brook Rd.,
Guilford, CT 06437