A WAVE OF WOMEN CHEMISTS: MARY ELVIRA WEEKS AND HER UNIVERSITY OF KANSAS COLLEAGUES

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Introduction

Mary Elvira Weeks, the award-winning historian of chemistry, joined the University of Kansas Department of Chemistry faculty in 1921, and although she became the best-known woman there, she was not the only one, or the first. She came amid a wave of women chemists. It began in 1907 when the first female instructor was appointed. A second woman joined in 1911. From 1916 until 1936 there were three or more women faculty each year. A total of 13 would eventually serve from one to 22 years each. The wave crested in the late 1920s when Weeks and two others obtained the first chemistry Ph.D. degrees and assistant professorships held by women. But later, as women began to leave, no others took their place, and the wave subsided. By 1937 only Weeks remained, and then she, too, was gone. Nearly 20 years would pass before another woman got a chemistry Ph.D. and almost 40 years before one received a faculty appointment.

The rise and fall of the University of Kansas wave offers a case study of women chemists during a period the Rayner-Canhams call "the dawn and dusk of an era." It centered on the 1920s, "a zenith for academic women," including those in science, "a level of attainment that was not to be reached again until well into the second half of the twentieth century." The Rayner-Canhams infer their curve from enrollment data and anecdotal commentary. How well do Kansas' facts fit (1)?

The women in the wave were individuals, too. Why did these daughters of farmers, tradesmen and shopkeepers make the unlikely decision to go to college and study chemistry? How did personal choices shape their professional careers? We begin with Weeks and her colleagues Selma Gottlieb and Ethel Ann Jones, the first women to earn Ph.D. degrees and be appointed assistant professors. All started out as laboratory scientists, but something happened along the way, and each took a different, unexpected turn.

Mary Elvira Weeks—Early Years

Weeks (1892-1975) arrived at the University of Kansas 12 years before publishing *Discovery of the Elements*, the book that would make her famous. She had been born on April 10, 1892, in Lyons, in southeast Wisconsin. Her mother, Mary "Minnie" Elizabeth Richmond, had studied music at Lawrence University, earning an M.S. in 1873. There she met John Millard Weeks, a farmer's son studying civil engineering (2).

When Elvira, as she was known, was three, John retired from farming, and the family moved to Oshkosh, Wisconsin, where Minnie was a teacher in area schools. Elvira had been "interested in science for as long as she can remember," an interviewer reported. At Oshkosh High School, where she graduated in January 1910, "she took all the scientific courses taught," including chemistry (3).

Weeks entered nearby Ripon College, completing a B.A. with a chemistry major in June 1913. Ripon's chemistry professor, Albert F. Gilman, recommended her to J. Howard Mathews at the University of Wisconsin where she got her M.A. in 1914. Her thesis led to an article coauthored with Mathews that was published in the *Journal of the American Chemical Society*. It was her first scientific publication (4).

Two career paths were open to women in chemistry at the time: teaching and work in a government or private laboratory such as a public health agency or hospital. A third possibility, the least promising, was industrial chemistry, said to have "a more deep-seated prejudice against women" than any other field. Due to the physical nature of the work, laboratories in some industries offered women no opportunities at all—industries like mining. Ignoring these obstacles, Weeks sought an industrial position—in mining, no less. New Jersey Zinc Company, the "largest single zinc producing corporation in the world," operated a zinc oxide plant at Mineral Point, Wisconsin, and recruited chemists at the University for its laboratories in Pennsylvania and New Jersey. She landed an offer there (5).

The position did not become available until three years later, however. In the interim Weeks taught high school science, during 1914-1916 at Marseilles, Illinois, and in 1916-1917 at Cloquet, Minnesota. In the summers she enrolled at the University of Wisconsin. When she left Oshkosh for these posts her mother went with her—her father having died in 1911—and for the rest of her life Minnie stayed with Elvira as she moved about the country pursuing her career (6).

In late 1917 she finally heard from New Jersey Zinc. World War I had increased the work of industrial chemists, but so many male scientists had been called into the military that industrial laboratories were forced to hire women. Demand for zinc to make brass shell casings and to galvanize steel surged. Weeks resigned at Cloquet and started at the Franklin, New Jersey, laboratory in early January 1918. "My work," she wrote, "consists of the analysis of concentrates from the mills and samples of crushed ore to determine the percent of lime. Other chemists determine zinc, iron, manganese, silica, and moisture. We analyze fifty or sixty samples a day" (7).

A year later Carborundum Company offered Weeks a "more responsible position in Research Department" in Niagara Falls, New York. Why? Carborundum, a manufacturer of abrasives, had discovered that adding zinc oxide to the sodium silicate binder in vitrified abrasive wheels and paper sheets rendered them waterproof. This permitted wet grinding and sanding, which was dustless and yielded a smoother finish. New Jersey Zinc made zinc oxide, and Weeks had worked in their laboratory (8).

Weeks worked at Carborundum from October 1918 until December 1920, approximately. She left for reasons unknown. Possibly she was let go—the Depression of 1920-1921 made record numbers of industrial chemists unemployed, especially women chemists hired to replace men gone into the service. Or maybe she desired a university position where she could pursue a Ph.D. while supporting herself and her mother. They returned to Oshkosh where Elvira enrolled at the University of Wisconsin (9).

There she met George I. Kemmerer, an assistant professor with similar experience, having taught at the New Mexico School of Mines and done research on zinc. Now he was studying the chemistry of lakes as it affected their capacity to sustain commercial fishing. He suggested a research topic to her—calcium carbonate equilibria in natural waters (10).

In 1921 a position opened at the University of Kansas for an instructor assisting in quantitative analysis. There is no record of how Weeks and Kansas found each other, but most likely it was through a personal contact between Kansas and University of Wisconsin faculty. Her industrial and teaching experience and Mathews' recommendation were ample qualifications, and she began at Kansas on November 14. The next fall she enrolled in Kansas' graduate school (Figure 1) (11).

***Figure 1**. Mary Elvira Weeks at her desk in 1934 (11).*

In 1922 her department chair, Professor Hamilton P. Cady, wrote:

> Miss Weeks … is untiring in her attention to the students, is around practically all hours of the day going right to their desks, quizzing them as to what they are doing, and why, giving explanations where

> needed, and otherwise giving the class just what has long been needed. Both students and faculty like her.

She taught quantitative analysis throughout her career at the University of Kansas. She published *A Laboratory Manual of Quantitative Analysis*. In the 1930s she taught wet assaying, advanced quantitative analysis and advanced chemical research (12).

The research Weeks had begun at the University of Wisconsin under Kemmerer became her dissertation at the University of Kansas under Cady. In the introduction she wrote:

> In view of the great importance of carbonate equilibria in natural waters, a quantitative study of the decreasing hydrogen ion concentration of pure solutions of calcium acid carbonate and of magnesium acid carbonate during precipitation would be of value.

She did not explain what the importance was, however, or why the study would be of practical value. This was basic research—concerned with laboratory effects, not environmental ones. It was published in the *Journal of Physical Chemistry*. She pursued the topic no further, but the methodology's use of indicators reappeared later in her research. Cady approved the dissertation in June 1927, making it the second accepted chemistry dissertation by a woman at Kansas. Weeks was awarded a Ph.D. in chemistry in June and appointed assistant professor of chemistry that fall. Both accomplishments were unprecedented but were shared simultaneously with her colleague Selma Gottlieb (13).

Selma Gottlieb—Early Years

Gottlieb (1900-1988) was an accidental chemist. Starting out, she had no particular career in mind; she simply wanted to go to college. Arriving at the University of Kansas in 1918, the possibilities she found were, in her words, "like walking into a candy store … I majored in everything my freshman year" (14).

She was born on November 23, 1900, in Pleasanton, Kansas, south of Kansas City, the second of six children in the only Jewish family in town. Her immigrant parents worked at and later owned a dry goods store there. Her father "wanted us all to go to college," she said. Pleasanton High School, where Gottlieb was valedictorian in 1918, did not teach chemistry. At the University of Kansas, where she enrolled that fall, the course offerings were dazzling (15):

> I was so overwhelmed … that I chose the one course that would take the longest time to conquer: an M.D. So I began to take prerequisites for the MD, such as bacteriology, chemistry, other sciences. But then I thought that with such a large family I should get something more specific: chemistry and bacteriology.

In her junior year she declared a major in bacteriology. That would qualify her for a job in a hospital or health department. "Openings in this work are increasing," said Cora M. Downs, bacteriology instructor, in the student newspaper. But in 1921, when Gottlieb's father died and she needed a job, the only one available was in the Department of Chemistry. Since a bacteriology student took a lot of chemistry, she was able to change her major and work her senior year as part-time assistant instructor in the chemistry laboratories. "So there I was," she said (16).

She graduated with a B.A. in 1922 but found "jobs for women chemists weren't exactly hanging on trees." It was the same situation Weeks had faced: the Depression of 1920-1921 and discrimination against women. Fortunately, "my assistantship was extended, and I went on and … got a Master's degree." Her thesis, completed in December 1923 under Cady, developed data on "the hydrogen ion concentrations of various dilutions of the phosphate salts" and also described an improved method "for the calculation of the degrees of hydrolysis of the sodium salts of phosphoric acid." She received her M.A. in June 1924 (17).

The next month she became the chemist for the Kansas State Board of Health's Water and Sewage Laboratory, replacing Ethel Ann Jones. The Water Lab, as it was known, was located at the University of Kansas in Lawrence and directed and staffed by university employees. It performed inspections, analyses, and reporting on public water supplies, municipal sewage disposal plants, swimming pools and ice plants. Gottlieb resigned in September 1925 to pursue a Ph.D. degree and to accept a position as assistant instructor in chemistry (18).

A year later, in September 1926, she resigned that position to become the chemist at the Weil Research Laboratory at the Gaylord Farm Sanatorium in Wallingford, Connecticut. Her research, directed by scientists from Yale, was a program of the National Tuberculosis Association. Given her interests, the opportunity to work at the forefront of a major public health issue in a field they called "chemical bacteriology" was irresistible. But she "didn't care for" the work, which involved guinea pigs. She resigned in June 1927 and returned to Kansas (19).

Gottlieb completed her dissertation while employed in Connecticut. Entitled "An Irreversible Hydrocarbon

Cell," it was an attempt to show that, contrary to accepted doctrine, "there is no reason why … organic oxidations and reductions cannot be made to fulfill the general conditions for a voltaic cell." This topic was chosen by Cady who had recently proclaimed, "the study of the potentials of voltaic cells with organic active materials will yield important information" (20).

Using acetylene and ethylene in an apparatus similar to a hydrogen gas cell, she immediately found that indeed "a voltaic cell can be made with hydrocarbons as the active electrode agents." But the resulting voltages were highly variable, indefinite and irreproducible. "It has proven impossible to obtain consistent results," she reported, and her frustration showed. Her experiments were "fruitless" and the results "worthless." The "great variability of the results" led her to the disappointingly ambiguous conclusion that "the electrodes are probably irreversible, or at best not completely reversible." Nevertheless, Cady approved the dissertation in March 1927, three months before that of Weeks, making it the first accepted chemistry dissertation by a woman at the University of Kansas. She received her Ph.D. in June (21).

Later researchers have studied hydrocarbon cells, but none cite Gottlieb's work. Articles based on Weeks' and Jones' dissertations were published in the *Journal of Physical Chemistry*, published by the American Chemical Society (ACS). Gottlieb's was relegated to the *University of Kansas Science Bulletin*. Although *Chemical Abstracts* covered the *Bulletin*, it omitted "An Irreversible Hydrocarbon Cell" as primarily concerned with electricity and therefore out of scope. The indexes that did concern electricity, however, did not cover the *Bulletin*. Thus, the work vanished, and neither she nor Cady ever returned to the subject (22).

That fall Gottlieb was appointed both assistant professor in the Department of Chemistry and chemist in the Water Lab, and she began teaching the sanitary water analysis course. She continued in these assignments until she left the university in summer 1935 (23).

Ethel Ann Jones—Early Years

Jones (1890-1936) wanted to be a teacher, in Lawrence, at the university, in chemistry, in that order. She was born January 2, 1890, on a farm near Chanute in southeast Kansas. Three years later a sister, Bernice, was born. When the girls were 15 and 12 their mother died. A year or two later their father retired from farming and the family moved into town (24).

Chanute High School offered a course in chemistry, upgrading the laboratory with new tables and apparatus in Jones' junior year. She graduated in 1909 and enrolled at the University of Kansas intending to become a teacher. After completing her B.A. with a chemistry major in 1913, she spent the next five years teaching high school math and science in Stafford and Hutchinson, central Kansas towns. Enrolling at the university in the summers, she completed her M.A. in chemistry in June 1916. Her thesis, "Artificial Color in Food," was supervised by Professor Edgar H. S. Bailey and two men in the Kansas State Board of Health Food Laboratory, known as the Food Lab (25).

Several short-lived geographic and occupational moves followed. Midway through the 1917-18 school year Jones resigned her teaching post to become the chemist at the Water Lab. The Hutchinson paper gave the opportunity for statewide public service as justification for breaking her contract. Then, in October, after seven months in that position, she resigned to take a job as an analytical chemist in Chicago—employer unknown. This, too, lasted only a few months, and by spring 1919 she was back at the University of Kansas, enrolled in graduate school. In September Jones was teaching again, this time at the college level, as an instructor in general and analytical chemistry at Oregon Agricultural College in Corvallis (now Oregon State University). After a year there, in June 1920, she was appointed for a second time as chemist at the Water Lab in Lawrence. Three months later she became instructor in the Department of Chemistry. Twelve months after that, in 1921, she returned to the Water Lab for three more years, and then became an instructor again beginning fall 1924 (Figure 2) (26).

***Figure 2**. Ethel Ann Jones about 1928. Photograph courtesy of University Archives, Spencer Research Library, University of Kansas (26).*

In 1920 Jones was interviewed by a student reporter who explained,

> the opportunity for advanced study, together with the fact that this is her alma mater, were the reasons that

***Figure 3**. Cast, Sigma Xi production of "Ladies in Hades," 1932, including Selma Gottlieb, 5th from left; Ethel Ann Jones, 7th from left; and Mary Elvira Weeks, 9th from left. Photograph courtesy of University Archives, Spencer Research Library, University of Kansas (30).*

> she answered the 'call of Kansas' and returned to the University to teach. She hopes to do some research work this year … 'I scarcely know which is the more interesting phase of the work,' said Miss Jones. 'Both the laboratory work and teaching are pleasant to me, and I like to change from one to the other.'

She taught at the University of Kansas for the rest of her life. It seems to have been her goal all along, with the jobs in Chicago and Corvallis meant to enhance her qualifications and the moves back to Lawrence in 1918 and 1919 to maintain her visibility. From 1924 on, Jones taught inorganic chemistry with Cady, who wrote, "she is a teacher of experience and is taking hold like a veteran, and I feel sure that she will earn a fine reputation for herself. She is quiet, efficient, has a proper sense of humor and a great deal of common sense" (27).

Her dissertation investigated "The Fusion Curves for the Systems Ammonia-Propyl Alcohols, Ammonia-Butyl Alcohols." "The object of this work," she wrote, "was to apply the Phase law method" to these systems. It was supervised by Cady, a pioneer in liquid ammonia research who had taught a course on the phase law since 1907. The results were published in the *Journal of Physical Chemistry*. She received her Ph.D. in 1929 and was promoted to assistant professor in 1930 (28).

Colleagues

Weeks, Gottlieb, and Jones were on the faculty together from 1921 until 1935. In 1924 they became charter members of the University of Kansas chapter of Iota Sigma Pi, the national honor society for women in chemistry. Founded in 1902, the society was one of several groups women formed, as Rossiter explains, "to supplement their otherwise unacknowledged existence in science … a system of 'compensatory recognition.'" Among the objects of the Society were "to foster mutual advancement in academic, business, and social life" and "to stimulate personal accomplishment in chemical fields." Gottlieb was the first president; Jones and Weeks followed in later years. The chapter held annual dinners and monthly meetings "with a scientific paper as part of the program" (29).

Though not limited to chemists or to women, another science honor society, Sigma Xi, also provided opportunities for "the establishment of fraternal relations among investigators in the scientific centers." By 1924 Weeks, Gottlieb, and Jones all were members. Sigma Xi held "monthly meetings at which papers are presented by members" and occasionally entertainment as well. At the annual initiation banquet in 1932, for example, the women members, including Weeks, Gottlieb, and Jones, put on a skit confiding the discontents of famous scientists' wives (Figure 3) (30).

Department faculty joined in picnics, dinners, and receptions. They shared road trips to Kansas Academy of Science conferences where all three women presented papers. Reporting on one such expedition in 1924, Taft concluded that "these incidents … show that comradeship and cooperation could at times be achieved among a group of individualists" (31).

"We all got along quite well," said Arthur Davidson, on the Department of Chemistry faculty from 1921 until 1966 and chair from 1956-1960. "Our department always was rather unusual in this respect. First because they didn't seem to have any racial or religious prejudices," and second, "there weren't any obvious feuds or schisms within the department" (32).

First Women Chemists

Seven other women preceded Weeks, Gottlieb, and Jones at the rank of instructor, which at the University of Kansas had been considered faculty since 1905, at least. Defining a chemist as a person with a faculty appointment in the Department of Chemistry, these seven instructors were the first women chemists at the University of Kansas (33).

The first of the seven was also the first woman to obtain a chemistry Master's degree there. Florence Amanda Hedger (1879-1923) was born in Ohio but grew up on a farm in Salem, Kansas. She earned her B.A. in botany from Kansas in 1904. She taught high school science and chemistry before returning to Lawrence in 1907. For the next four years she was an instructor, assisting Bailey with Chem. 1 and Cady with inorganic, and earning her M.A. in 1908. "She was a teacher of much more than average ability and [she] tried in every way to assist the students in their work, and to bring out their native talent." In 1911 she married and left the University and the profession (34).

The two other longest-serving, most notable women instructors were Emily Victoria Berger and Agnes Anne Anderson Murray. Berger (1892-1920) was an instructor from 1914 until 1920. "Her career was shaped by the result of the remark of a friend that chemistry was too hard for a woman." Born in Iowa, she grew up in Halstead, Kansas, where her father was a harness maker. She earned her B.A. at the University of Kansas in 1914. She was in charge of the inorganic laboratory under Cady. "She has the most remarkable success in encouraging the despondent student to brace up and make good in his work." She was a promising researcher, assisting Cady in his war work on the production of helium as a balloon gas and coauthoring a paper on the solubility of helium that was read at the April 1920 meeting of the ACS in St. Louis. And then a week later she died—of appendicitis. Stunned, the Department of Chemistry dismissed classes and the university lowered the flag to half-staff. Cady and other chemistry faculty were honorary pallbearers. A scholarship bears her name (35).

Murray (1889-1963) was an instructor from 1916 until 1920. A minister's daughter, she was born in Elk City, Kansas, and grew up in Baldwin City, Kansas, obtaining her B.A. in botany at Baker University there. In 1910, using her birth name Anderson, she came to the University to work in the Food Lab. She obtained an M.A. the following year. "A Study of Compressed Yeast" was one of the first two recorded theses in chemistry by a woman at the University of Kansas. She published a paper on furfural in vinegar in the March 1914 issue of the *Journal of Industrial and Engineering Chemistry*, the first scientific publication in a national journal by a woman chemist at Kansas. Anderson married in 1914 and left the Food Lab, but two years later, using her married name of Murray, she returned as an instructor in the Department of Chemistry, leaving for good in 1920 to start a family. "Women are peculiarly adapted for work in chemistry … and no girl's college work is complete without at least one course in it," she said. "There is no reason why a woman should not be able to do most of the work a man chemist does" (36).

Three of the seven early instructors ultimately made their careers in home economics, primarily in teaching: Jean Gilbert MacKinnon, Avis Talcott and Amy Gladys Van Horn Rader. As a scientific occupation home economics came to be discounted as "women's work." But at the time "in departments of home economics have been found the best opportunities for advancement for women chemists," offering "excellent opportunities for satisfactory work, advancement and salary" with "less competition on the basis of sex." At the University of Kansas the Department of Chemistry had "always been a friend" of the Department of Home Economics: advising students, teaching chemistry prerequisites to courses on food preparation, and producing Bailey's textbooks and laboratory manuals on food chemistry. The chemistry department also operated the Food Lab where Anderson and Jones worked (37).

MacKinnon (1883-1934) was an instructor for one year, 1911-12. Born in Concordia, Kansas, her father was a hardware merchant. She received her B.A. from the University of Kansas in 1911 and a M.A. in home

economics from the University of Chicago. She made her career in that field teaching at the University of Illinois and elsewhere (38). Talcott (1883-1970) was an instructor at Kansas for two years beginning in 1915. Born in Illinois, she grew up in Des Moines, Iowa, where her father was a real estate agent. After earning a B.A. at Rockford College, she, too, studied home economics at the University of Chicago. In 1917-1919 she was an emergency home demonstration agent in Atchison County, Kansas. Later, using her married name of Wells, she was director of the Swinburne School of Household Arts in Newport, Rhode Island (39). Rader (1895-1984) was an instructor for two years, 1918-1920. She was born in Lawrence, Kansas, and grew up on farms west of town. She received her B.A. from Kansas in 1917. From 1924 until 1926, despite having two small children, she completed a M.A. in home economics. Forty years later Rader was one of a handful of graduates remembered for their teaching by Kansas' home economics department historian (40).

The last of the early instructors was Ruth Evelyn Merling (1895-1991) who served for just one year, 1921-22, after completing a B.S. at the University of Washington and a Ph.D. at the University of Illinois. She was born in Blue Rapids, Kansas, where her father was a blacksmith. After leaving Kansas, she was a chemist at E. I. du Pont de Nemours and later a chemical patent attorney at Eastman Kodak (41).

Last Women Chemists

From 1922 until 1930 the only women instructors in the Department of Chemistry at any time were Weeks, Gottlieb, and Jones. Subsequently, from 1930 through 1936, three other women served in that rank: Harriet Allyn Geer, Guita Fern Marble, and Helen Gladys Swope. They were the last of their sex ever to do so. By 1939 graduate students were replacing instructors as teaching and laboratory assistants. Geer and Marble also earned Ph.D. degrees at the University of Kansas, the last women to do that until G. Elizabeth Wilson in 1953. And Swope was the last woman appointed an assistant professor until Kristin Bowman-James in 1975 (42).

Geer (1909-1994) was born in Norwich, Connecticut, where her father was a farmer. After earning a B.A. from Smith College in 1930 she came to the University of Kansas where she was assistant instructor from 1930 until 1935 while earning her M.A. in 1932 and Ph.D. in 1935 there. Her thesis and dissertation, both advised by Davidson, concerned the solubility of nitrates. Articles based on them were published in the *Journal of the American Chemical Society*. After posts at the Yale School of Medicine and the Michigan Department of Health, she embarked on a career in chemical information at Parke, Davis. She chaired the ACS Division of Chemical Literature in 1965 (43).

Marble (1905-1994) was born and raised in Troy, Kansas, where her father was high school principal. She taught school for four years before earning her B.A. in chemistry at the University of Kansas in 1930. For the next five years she was an assistant instructor there. Her M.A. thesis (1932) and Ph.D. dissertation (1935), also at Kansas, both concerned the electrodeposition of copper, an interest of her advisor Robert Taft. Beginning in 1940 she taught analytical and physical chemistry at the Woman's College of the University of North Carolina (now UNC Greensboro), becoming associate professor in 1949 and retiring in 1970. A chemistry scholarship is named in her honor (44).

Swope (1905-1989) was born in Detroit and grew up in Chicago where her father was an express messenger. Her high school chemistry teacher "nurtured" her interest in the subject. She received a B.S. in chemistry from the University of Chicago in 1929 and was hired by the Chicago Sanitary District "because she could type and was a whiz at math." She came to the University of Kansas as the chemist in the Water Lab from 1935 to 1937, and as an instructor (1935 to 1936) and assistant professor (1936 to 1937) in the Department of Chemistry. She did graduate work at Chicago but held no advanced degrees. Her many posts over a long career included the Argonne National Laboratory from 1948 until 1963, where she was senior chemist in the Chemical Engineering Division directing disposal of radioactive wastes. She published many articles in *Sewage Works Journal* and similar titles. Her most-cited publication, however, reported work done at Kansas in which she credits a method "as worked out by Selma Gottlieb," who had preceded her in the Water Lab. Swope chaired the Women Chemists Committee of the ACS in 1962-1966 and won the Distinguished Service Award of the ACS Division of Water, Air, and Waste Chemistry in 1968 (45).

Ethel Ann Jones—Later Years

Jones' career interest had always been teaching. "She was a good teacher, a faithful and meticulous technician, a strong member of the staff," said Cady. But she was an unproductive researcher. Other than her dissertation she had no publications nor was there

any sign of research in progress. She read one paper at a Kansas Academy of Science meeting, jointly with a male colleague, but was not credited in the publication of the work. Davidson, who joined the department in 1921, recalled that "I was taken aback, really, the first few years I was here, by how much higher research was valued than teaching." Jones must have been worried, especially about how her record compared to those of her well-published female colleagues (46).

By the mid-1930s she was under growing pressure at home as well. Bernice had followed Ethel Ann to Lawrence and lived with her since 1922. Neither sister ever married. The following year their father, age 74, moved in, living with them until his death eight years later. At some point Bernice developed an unspecified "serious illness," and by winter 1935-36 "poor health" caused her to quit her job. She was then not just clingy but an "invalid" too, and Ethel Ann became responsible for her care (47).

"Brooding" over her father's death and her sister's dependency, Ethel Ann's health declined. In early June 1936 "she expressed the opinion that she had more than her share of departmental work to do," an ominous admission for a woman in an occupation dominated by men. Colleagues urged her to take some time off and rest, but she did not dare. Instead, despite feeling overwhelmed and hopeless, she kept going, completing "all the details and schedules for the laboratory work" for the summer session. Then, on June 10, she jumped to her death from the Kansas River bridge in downtown Lawrence (48).

Ethel Ann's heart was in teaching, and as a teacher, Cady said, "Professor Jones … [had] always done her work super-faithfully and to the letter." Six months later Bernice wrote, "I cannot live without my sister," and jumped from the same spot. Her will established the Ethel Ann Jones Scholarship Fund at the university's school of medicine "for the treatment of mental and nervous diseases of women" (49).

Selma Gottlieb—Later Years

In 1930-1932 Gottlieb coauthored three papers with Downs, now associate professor of bacteriology at the University of Kansas. The first two were read at the annual meetings of the Society of American Bacteriologists; the last was published in the *Journal of Infectious Diseases*. All concerned the effect of salts on the precipitin reaction, a technique for measuring antibody production. The published paper has been rarely cited, and reviews of the precipitin reaction do not mention it. The work is of interest because of the Downs' and Gottlieb's collaboration. Similarities in background and interests drew the two women together. Both had intended to obtain an M.D. but, due to financial restraints, pursued bacteriology instead. Both preferred laboratory work to teaching. And both were among the first women to earn Ph.D. degrees at Kansas—Downs in 1924 the first in any discipline, and Gottlieb in 1927 one of the first two in chemistry. Downs must have been a model and mentor as well as a colleague. Many years later, when asked what it was like to be a woman in the sciences then, Downs recalled, "I never felt that the professors discriminated against women. You were just kind of an odd ball" (50).

Between 1928 and 1935 Gottlieb published 12 papers—seven as sole author—on water quality and treatment topics: chemicals used, especially chlorine and ammonia; mineral analyses; and hardness and softening. One that attracted greater than average attention concerned "the tooth defect called mottled enamel [dental fluorosis] … known to be caused by larger than normal amounts of fluorides in the drinking-water supply of the victim." The Water Lab made fluoride determinations for the water supplies of all 329 Kansas municipalities, finding that "samples from communities reporting this defect have in all cases contained more than two parts per million of fluorides." A hundred-year review of water supplies in Kansas includes Gottlieb among those making "major contributions to improved water systems in Kansas" and cites specifically her research on fluorides (51).

In an article published in the *Journal of the American Water Works Association*, Gottlieb challenged the "amazing statement" concerning hydrogen ion concentration—an obvious fallacy, she called it—made in that journal by a male engineer. Using formulas she had worked out in her Master's thesis, she then showed how to make the calculation correctly (the engineer published no reply). She demonstrated her mathematical confidence again in "Corrections for Standard Solutions of Inconvenient Strengths," published in *Industrial and Engineering Chemistry, Analytical Edition* (52).

The most cited of all her publications concerned water only in its absence. "Dust Storms and Their Possible Effect on Health" reported on infant mortality and death rates from acute respiratory infections following the 1935 dust storms in Kansas. In recent years this work has been cited in studies on anticipated 21st century megadroughts and on the health effects of military service in Southwest Asia and Afghanistan (53).

***Figure 4**. Selma Gottlieb, right, at the 1934 Meeting of the Kansas Water Works Association and 10th Annual Three-Day Water and Sewage Works School, Lawrence, KS (55). At left is Cassandra Ritter, the Water Lab's bacteriologist (18).*

In choosing areas of research for her entries in *American Men of Science* Gottlieb skipped dental fluorosis and dust-borne respiratory infection, topics of immediate importance and lasting value. Instead, she listed only the hydrocarbon cell (her dissertation) and the precipitin reaction (her work with Downs)—two projects that, though apparent dead ends, were the most important to her (54).

Gottlieb was a member of the Executive Committee, Division of Water, Sewage, and Sanitation Chemistry of the ACS in 1934-1935. She was active in the American Water Works Association and the Kansas Water Works Association and its annual Water and Sewage Works Schools (Figure 4). She was president of the Lawrence branch of the American Association of University Women in 1933-1935 (55).

"Dust Storms" was published in 1935 as were three other papers. With four papers published the year before as well, Gottlieb was at the height of her productivity. And then one day in 1934 a mutual friend introduced her to a visiting professor of law, Milton A. Kallis, and in December they were married. The following summer Selma resigned, and the Kallises left Lawrence. They moved to Illinois, where Milton resumed his private law practice. Two children were born (56).

Selma never worked in a laboratory again, but she did not abandon the field. She continued writing for the "Abstracts of Water Works Literature" section of the *Journal of the American Water Works Association* under her professional name, Gottlieb. From 1933 until 1943 she published nearly 500 detailed abstracts of recent articles, books, symposia, or special issues of journals, many requiring translation from German or French (57).

In late 1941 the Kallises moved to Washington where, beginning in 1942, Milton was an attorney in the Justice Department. In January 1943 Selma, now using her married name, began working for the Board of Economic Warfare. "I was taken on as a chemist not to do laboratory work, but I was in a war agency that was studying the industries of the enemy countries, and I was in a unit that studied chemical industries" (58).

After the war she was an analyst in the U.S. State Department, holding progressively responsible positions in international trade analysis and policy towards Japan and the Far East. She was an advisor in the U.S. Delegation to the General Agreement on Tariffs and Trade conferences in Geneva, 1955 and 1960, and in Washington, 1964-65. She retired from the State Department in 1965 and became a consultant with the Special Representative for Trade Negotiations in the Executive Office of the President. She retired again in 1970 (59).

Selma joined the League of Women Voters of the District of Columbia, volunteering her expertise in trade policy and water analysis. In 1971 she prepared a new

edition of the League's booklet, *The Politics of Trade*. Among other activities, she served on the Potomac Basin Inter-League Committee in the 1970s, which studied pollution and sewage treatment and campaigned to clean up the Potomac River in Washington (60).

She died in a Washington area nursing home on May 10, 1988, at age 87. Her obituary headline read "Selma G. Kallis, Trade Advisor," but she is remembered here for her first career as a chemist and her lifelong concern with water quality and public health. She once said: "her interest in the field of water supply stems from her childhood in Pleasanton, Kansas, where drinking water was so scarce that, during drought, it had to be brought in by tank car" (61).

Mary Elvira Weeks—Later Years

From 1931 until 1934 Weeks published three quantitative studies of new oxidation-reduction indicators, a field developed since 1920. The first two used a method first successfully applied in 1924. All three cited a 1930 publication of the accepted theory explaining color changes in benzidine-derived indicators. The second of Weeks' papers reported the first use of the nuclear-substituted benzidine: *o*-dianisidine. She was doing novel work in an emerging field. In 1934 she was elected a Fellow of the American Association for the Advancement of Science (62).

And then one day, probably indulging her love of languages—she was "a reader of German, French, Italian, Spanish"—she found herself "visiting Professor Thurnau's class in Faust." In 1934 she said this visit, which occurred "several years ago," likely marked the time she started to work on *Discovery of the Elements*, which began to appear in January 1932 as a series of articles in the *Journal of Chemical Education*. But Harry C. Thurnau, professor of Germanic languages and literature at the University of Kansas, had taught a course on Faust since before Weeks arrived there, so her comment does not pinpoint the date. And she did not say that Thurnau's class somehow *inspired* her to write *Discovery*. In *Faust* the only substances considered elements are the classical ones, principally water and fire (63).

The real source of inspiration behind *Discovery* was Weeks' mentor Frank B. Dains, professor of chemistry at the University of Kansas. He had presented a paper on "The History of the Development of the Elements" at the Kansas City Section of the ACS in 1910. He taught the history of chemistry course beginning in 1912. And he was an avid collector of images of historical persons, laboratories, and other chemistry scenes. Aaron J. Ihde, the University of Wisconsin historian of chemistry, implies that Dains' images inspired Weeks to begin *Discovery*. But Dains also provided publications Weeks needed, either from his personal collection or those the university library acquired on his request. In *Discovery*'s foreword she credits Dains for having "furnished most of the illustrations" and for making "many helpful suggestions as to sources of material." She wrote an homage to Dains and his collections in 1935 (64).

Publication of *Discovery* was a sensation. "The chemical elements," it began, "those primeval building materials from which Nature has constructed all her varied forms, have been discovered, one by one, through the ages, by patient searchers in many lands." One sentence, and readers were hooked. So many requests were made for reprints of the original articles that the *Journal* reprinted them as a book in May 1933, the month the final article appeared. Tenney L. Davis, the MIT chemist and historian, described the scene (65):

> A copy of this book was allowed to circulate in the reviewer's class in the history of chemistry. At the end of the hour a number of students asked its price and inquired where it could be purchased. Several graduate students … saw the book, bought it, and have reported that they read it in the evening as they would read a novel. They have also been seen reading it while eating their lunch or during the gaps and periods of waiting which occur while research is in progress. That is the kind of book that it is.

The reviews were admiring. "This charming romance … is a worthy tribute to the often forgotten heroes on the important battlefield of revealing the hidden chemical elements," rhapsodized Lewis W. Mattern, a high school chemistry teacher. It "should be read not only by students of chemistry, chemists, and scientists, but by everyone from a cultural standpoint." Referring to its 363 pages, 301 illustrations and 866 bibliographic notes, Albert G. Ingalls, an editor at *Scientific American*, wrote: "This is the first time all this widely scattered data has been brought together. It is a rich mine of elementary chemical lore, informatively but most readably written and copiously illustrated" (66).

The book sold out in months and was reprinted with minor revisions in 1934 and 1935. Updated and expanded editions appeared in 1939, 1945, 1956, and 1968, and their reviewers also commended its style, thoroughness and accuracy. In 2019 the book was remembered in observance of the International Year of the Periodic Table (67).

How did Weeks feel about her sudden success? "Her Book on Elements Is Already Famous," an interview published shortly after the 1st edition sold out, does not directly say, though "She is one who seems thoroughly interested and thrilled in her work" is a hint. In showing her interviewer the plaudits she had received from around the world, she revealed her pride. She spent the next 35 years improving *Discovery*—adding newly found elements, making bibliographic sources ever more comprehensive, and correcting errors. Even when she turned over her annotated copy of "D of E" to Henry M. Leicester for major revisions in its final edition, she remained exacting about factual and bibliographic details (68).

Weeks' three papers on indicators were her last laboratory publications. She began, after her teaching duties, to pour all her energy into literary and historical work. Her entries in *American Men of Science* reflect the transition. Although she appears in the 1933 edition, she does not mention history of chemistry as an area of research until 1938. *Discovery* appears in her entries beginning in 1944 (69).

In March 1933 Weeks presented the first of five papers before the Division of the History of Chemistry of the ACS. These were among 12 biographical articles published between 1934 and 1944, including seven about men who discovered elements and one, coauthored with Dains, about a woman—Mrs. Almira H. Lincoln Phelps, author of the 1834 best-seller *Chemistry for Beginners*. In November 1936 Weeks replaced Dains as an abstractor for the "Keeping Up With Chemistry" feature in the *Journal of Chemical Education*. Beginning 1940 she taught the history of chemistry course with Dains. And in 1939 she produced the 4th edition of *Discovery* (70).

Abandoning laboratory research was perilous. According to Ihde:

> Despite the success of her writings, her department was not inclined to reward her for her literary work. Chemistry faculties were inclined to place a premium on laboratory investigations, not on historical research, no matter how well done. [Weeks] was kept on her assistant professorship for ten years before being promoted.

Ihde gives no source for this comment—probably his personal acquaintance with Weeks—but 10 years did pass before her promotion in 1937. By comparison, the only other faculty appointed as assistant professors in the 1920s who were later promoted were Arthur Davidson and Robert Taft, and they made associate professor in six years and two years, respectively. Rossiter writes: "an associate professorship was the highest rank to which most women faculty could aspire realistically, regardless of how strong their aging mentor had been or how highly acclaimed their own work was." When Weeks was promoted, "finally," as she said, she became the only woman ever at the rank of associate professor or higher in the Department of Chemistry at the University of Kansas before 1981. She would climb no further, but finally had a first all her own (71).

In 1931 Weeks became representative to the ACS Women's Service Committee (WSC, now Women Chemists Committee) from the ACS's Kansas City Section, and from 1935 until 1938 she was on WSC's national executive committee. Formed in 1927, the WSC was the first women's caucus in a professional society. Its purpose was to develop "the mutual interests of the women chemists and the American Chemical Society." While the stated aims were innocuous, simply forming a group for any purpose was, Rossiter says, "quite daring" compared to other fields that had no women's group at all. Rossiter argues that membership offered psychological support as well. In April 1936, at the ACS annual meeting in Kansas City, the University of Kansas chapter of Iota Sigma Pi arranged the Women Chemists' Dinner, at which Weeks presided. The previous fall, Irène and Frédéric Joliot-Curie had won the 1935 Nobel Prize for Chemistry, and at the dinner Weeks celebrated their achievement by writing and distributing a souvenir booklet detailing Irène's life, scientific discoveries and collaboration with Frédéric (72).

In the early 1940s Weeks, approaching 50 and the only woman left in the department, found her support network giving way. Her mother, who had lived with her since 1911, died in 1940. Dains was invalided by a stroke in 1941 and retired in 1942. And Cady died in May 1943. Meanwhile, in 1942, Neil E. Gordon, who had been editor of the *Journal of Chemical Education* when it published Weeks' original *Discovery* articles, became chair of the Department of Chemistry at Wayne University in Detroit. He had accepted the position provided he could bring with him 21,000 volumes of chemistry books and journals comprising the collection of Samuel C. Hooker, once known as "most complete chemical library in the world." He had agreed to raise private funding for its purchase, and, with contributions from many corporate donors, especially the Kresge Foundation, he did. The purchase was concluded on October 20, 1943 (73).

Gordon's vision was to update the collection and transform it into a national library service. Translations would be offered, and from his experience as editor he

knew someone who could do the work. Three months later, on January 18, 1944, Weeks submitted her letter of resignation from the University of Kansas "because of an opportunity to join the staff of the new Kresge-Hooker Scientific Library at Wayne University." At Kresge-Hooker she would be free of the expectation for laboratory research. Gordon would provide the support and encouragement Dains and Cady had offered. Her historical and literary work would be valued. And she would have a library capable of supporting it (74).

Although Weeks had intended to finish the spring semester, she moved her resignation up to March 1, likely at Gordon's urging. The parting was amicable, however. She wrote, "I shall take with me a happy recollection of my twenty-two years of teaching at the University of Kansas." Ray Brewster, department chair, returned the sentiment, writing "Miss Weeks' publications on the history of chemistry have brought great distinction both to herself and the University and we are sorry that her connection with this department has been terminated." In February she was "guest of honor at a dinner given … by the University Chemistry Department" (75).

Weeks arrived in Detroit that spring as research associate in scientific literature, employed by the Friends of the Hooker Scientific Library. She directed the translation service, performing translation of foreign-language articles, documents, patents, and letters into English and supervising assisting linguists, an assistant translator, and a secretary. Gordon, editor of the review quarterly *Record of Chemical Progress*, made her associate editor, a post she occupied until 1969. In 1948 Tenney Davis, editor-in-chief of *Chymia*, "Annual Studies in the History of Chemistry," made her a consulting editor, which she remained until 1953. And she never stopped keeping *Discovery* up-to-date. The 5th edition, "enlarged and revised," was published in 1945 (76).

In November 1946, as his health deteriorated, Charles A. Browne, Historian of the ACS, wrote Weeks asking her to help complete his history of the Society. "I believe that, with your acquaintance with the recent history of the Society and your experience in historical writing, editing, etc., you will be able to render this service without much difficulty," he wrote. Browne died two months later. His widow later told Weeks that he "was so anxious to have the History completed by a person who had not only the ability but the interest in the subject, that he considered the records of all his acquaintances before he decided to ask you to undertake it." Gordon congratulated Weeks on "this high honor" and offered "that you do this on your library time" (77).

"As originally planned," Browne wrote, "the History was to consist of twelve chapters of which only three more are to be written." Inevitably it grew, ultimately reaching in pages four times the length of Browne's nine chapters. *A History of the American Chemical Society: Seventy-Five Eventful Years* was published in 1952. Weeks' contribution, detailed in the preface, amply justified her being coauthor. Ihde praised the book's objectivity for a history commissioned by a society. "The authors have assembled a scholarly work which records the accomplishments of the Society without gloating over them. They have even given attention to the difficulties of the Society and the disagreements within its membership" (78).

One difficulty the book does not address, however, is the status of the Society's women members. Despite her years on the WSC executive committee, *History* makes no mention of women's issues. Dozens of other committees are covered, and the index lists over a thousand personal names, but neither the WSC nor Glenola Behling Rose, WSC's co-founder and chair during two of the years Weeks was on the executive committee, are mentioned.

In 1954, at age 62 and after ten years at Kresge-Hooker, Weeks retired.

> Her Detroit years were undoubtedly the most satisfying of her life. She was able to combine her love of science with her love of languages and was doing professionally what she enjoyed most. After retirement she remained in her Detroit home where she continued to do professional translation at a leisurely pace, …

and to work on new editions of *Discovery*. In 1966, as the 6th edition inventory was running out, rather than reprinting it, Weeks and William F. Kieffer, editor of the *Journal of Chemical Education*, agreed to ask Henry M. Leicester "to undertake the task of bringing the material up to date for a revised seventh edition." Leicester accepted on November 15, whereupon Weeks sent him her annotated copy of the 6th edition (79).

Ihde's review of the 6th edition, though favorable, had criticized its history of "attaching as addenda in separate chapters, material which might have been integrated into the … original chapters on the subject." In discussing revisions for the 7th edition, Weeks referred to this criticism, saying, "I value Dr. Ihde's opinion," and she was "delighted" that Leicester agreed. She called his subsequent rearrangement "a definite improvement." The reviewer in *Science* agreed, too, writing, Leicester

"has made the work a true book, in spirit as well as in format" (80).

Ihde had also criticized the increase in "subjects which pertain in only the most indirect way to the subject of the book." Here, Weeks disagreed, advising Leicester "perhaps we should explain somewhere that the scope of the book has gradually been broadened to include their discovery in all three natural realms." When Leicester completed his revision in early March 1967, Weeks sent her "heartiest congratulations." A month later the 7th and final edition came off the press. *Scientific American* called it "better than ever" (81).

In May 1967 the Division of the History of Chemistry (HIST) of the ACS honored Weeks with the Dexter Award for Outstanding Achievement in the History of Chemistry. Upon learning of the judges' unanimous decision she initially demurred, writing

> In comparison with others who have received the Dexter Prize I feel humble and unworthy … I would be happy to see this Prize awarded instead, as an encouragement, to some younger person who is still actively engaging in research in the history of chemistry.

HIST chair Martin Levey prevailed upon her to accept anyway. Illness prevented her from traveling to the ACS National Meeting in Chicago that September to receive the award. It was presented "in her home early in February 1968," instead (82).

Despite the attention Weeks gave to biography in her work, other than her entries in a few directories, she wrote not a word about herself. Her archived papers at Wayne State University include almost nothing of her personal life or of her years before Kresge-Hooker. There are only a few, brief observations by others. A University of Kansas student remembered her as "a modest, unassuming lady." An interviewer there said, "Meeting Mary Elvira Weeks on the campus you'd think her a student rather than an assistant professor of chemistry." Cady, her department chair, described her as "quiet, lady-like, efficient, and not afraid of work" (83).

Bray reports a discordant view, writing that Doris Brewster Swift, Weeks' Lawrence neighbor, "gave this summary of her childhood memories of Miss Weeks: 'Elvira was most often described as extremely timid and shy.'" Swift provides no sources of this description, however, and Weeks' professional accomplishments belie this characterization. As does Ihde (an adult contemporary), who wrote, "She was a friendly but somewhat retiring person who enjoyed a good time, but preferably with her closest friends" (84).

Ihde summed up: "by nature a retiring person, she was nevertheless equal to tasks of great magnitude," neatly capturing Weeks' character and contradictions. For example, while she lived with her mother until she was nearly 48, she dared to seek a job in a field most unwelcoming to women—mining—and moved 1,300 miles to get it. Then, less than a year later, she took a more responsible position in another industrial laboratory. Despite her quiet, lady-like demeanor, she served on the executive committee of the ACS' cautiously assertive Women's Service Committee during its early years. She abandoned promising laboratory research to take on another male preserve—the history of chemistry. She became one of just two women to win, in its first 40 years, the Dexter Award—the ultimate recognition by her peers. Then, in her self-effacing way, she deflected the honor. Her heart was in her work (when asked for her hobbies, she answered, "history of chemistry"), and the work itself was reward enough (85).

Weeks died in a Detroit area nursing home on June 20, 1975, at age 83. In 1967, upon accepting the Dexter Award, she had apologized for being unable to attend the ceremony in Chicago. She promised, however, "I shall be there in spirit among the great historians of chemistry, many of whom I have met or corresponded with" (86).

The Rise and Fall of the Wave

What started the wave of women chemists at the University of Kansas? Bailey, Cady and Dains wrote the chemistry department's history to 1923 but say nothing about women as a group. Neither does Taft, who wrote the department's history from 1900 to 1950. Explaining the rise of women chemists nationally, the Rayner-Canhams focus on their increasing participation in higher education, particularly the "peaking of enrollment in chemistry … during the 1920s." Rossiter credits more targeted struggles and strategies, such as the "patient 'infiltration' of friendly departments" in pursuit of the doctoral degrees required for faculty appointments (87).

At the University of Kansas the first women chemists had an impressive run. In 1914 the Lawrence newspaper reported that "many women are preparing themselves for research work in the sciences. Some of them become expert analytical chemists." During World War I, department chair Bailey invited more of them to study the subject. After the war, Kansas' professors reported

that "women have made good as laboratory assistants and dispensers in the department of Chemistry… If the men wish to have their jobs back they will have to compete with the women" (88).

The years 1921-1936 seemed to fulfill that promise. Of the eight new professors who joined the department, four were women. Of the 40 Ph.D. degrees awarded, five went to women. Three who held both professorships and Ph.D. degrees were Weeks, Gottlieb, and Jones. From 1930 until 1935 they comprised one-fifth of the University of Kansas Department of Chemistry faculty holding professorial titles, an extraordinarily high percentage of women in chemistry departments of the time. Patient infiltration seemed to be paying off (89).

What ended the wave? The Rayner-Canhams argue that, between the wars, forces within the profession began working against academic women chemists. They especially blame renewed discrimination and a more competitive workplace. As a result, during the Great Depression and World War II, there was a decline in the supply of eligible women—those with doctorates (90).

At the University of Kansas discrimination might explain why from 1936 to 1975 no professorial appointments were women. But from 1927 through 1939 all had been women. No explicit evidence was found that women's abilities or accomplishments were discounted or that men received preferential treatment. No comment referred to women as a separate group or was qualified by reference to sex. But an increasingly competitive workplace—the "overwhelming emphasis on research rather than teaching" described by Davidson—was plain to see. "In those days, I am sure that appointments of staff members were made almost entirely on the basis of already accomplished research rather than on the basis of teaching," he said. This favored established researchers with the prestige to attract assistants and funding—men, in other words (91).

The supply of women with Ph.D. degrees at the University of Kansas did decline—five were granted to women from 1927 through 1935, then no more until 1953. Were there, after 1936, no women in Kansas' pipeline to consider? Apparently not, judging from the production of master's degrees. The only Kansas master's awarded to women in 1930 or later who subsequently earned a Kansas Ph.D. were to Geer and Marble in 1932. There were no more through at least 1958—long after the Great Depression and World War II might have been factors. Women got no master's at all from 1939 until 1949 (92).

Women chemists were losing ground elsewhere, too. Rossiter's data from *American Men of Science* shows that between the 1921 and 1938 editions, the number of listed female chemists employed anywhere in academia increased 5 times (from 21 to 107), but those working specifically in coed colleges and universities like the University of Kansas grew only 4 times (from 7 to 27),

***Figure 5**. Department of Chemistry in 1925: Weeks, kneeling 2nd from right; Gottlieb, seated 4th from left; Jones, kneeling 3rd from left; Bailey, 3rd row standing 2nd from right; Cady, 3rd row standing 1st from right; Dains, 3rd row standing 1st from left; Davidson, 3rd row standing 4th from left. Women in hats are faculty wives. Photograph courtesy of University Archives, Spencer Research Library, University of Kansas (94).*

declining in share of total from one-third to one-fourth. Among the largest, midwestern, coeducational universities in 1938, Illinois, Iowa State, Kansas State, Nebraska, Ohio State, Wisconsin and undoubtedly others all lacked even a single female chemistry faculty member (instructor and above), while Chicago and Minnesota, like Kansas, employed just one (93).

Conclusion

Of the women in the wave, half had long careers in chemistry, several achieved distinction, and one became famous. They had prospered at the University of Kansas during the overlapping leadership of three men: Bailey, department chair from 1883 to 1918, who hired the first five women instructors; Cady, who replaced Bailey as chair, supervised Weeks,' Gottlieb's, and Jones' dissertations and appointed them assistant professors; and Dains, Weeks' mentor. The women had also profited from associating with each other—in groups formed for that purpose and in daily departmental life. In the 1930s Weeks, Gottlieb, Jones, Geer, and Marble were colleagues at Kansas, and Swope would soon follow. In the Rayner-Canham's words, "collaborative, supportive atmospheres" made for "woman-friendly environments." A photograph of the department, taken near the wave's height, is proof (Figure 5) (94).

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This article is dedicated to the memory of W. Dale Richey, the first author's mentor in chemistry at Chatham College.

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7. "Correspondence Items," *LGN*, Dec. 13, 1917, p.2. "War Service for Chemists," *Science*, **1917**, *46*, 32-33, https://science.sciencemag.org/content/47/1210/234. "Industrial Notes," *J. Ind. Eng. Chem*, **1918**, *10*(9), 757-758 on 758, ACS pubs ie50105a026. New Jersey Zinc Company, *The First Hundred Years of the New Jersey Zinc Company: A History of the Founding and Development of a Company and an Industry, 1848-1948*, The Company, New York, 1948, pp 35-37, https://archive.org/details/firsthundredyear00newj. New Jersey Zinc Company, *A Record of Accomplishment, 1848-1923: A Short History of the New Jersey Zinc Company*, The Company, New York, 1924, [p 17], HathiTrust 102360878. Quotation from "Correspondence Items," *LGN*, Jan. 17, 1918, p 2.

8. J. Eddy, "Biography–Elvira Weeks," Reporting I assignment, Department of Journalism, University of Kansas, Dec. 1930, Weeks Morgue File, UA-KSRL. The move was also announced in "Personal Notes," *J. Ind. Eng. Chem.*, **1918**, *10*(11), 950, ACS pubs ie50107a028. "More responsible position" quotation from "News of Our Neighborhood," *LGN*, Sep. 12, 1918, p 2. Carborundum Company, Improvements in Methods of Making Abrasive Articles, GB Patent 122533A, Jan. 30, 1919, https://worldwide.espacenet.com/patent/. V. L. Eardley-Wilmont, *Abrasives, Products of Canada, Technology and Application ...* pt. IV, *Artificial Abrasives and Manufactured Abrasive Products and their Uses*, Ottawa, 1929, pp 47, 78-79, HathiTrust 009220697.

9. W. Haynes, Ed., *The Chemical Who's Who*, Haynes and George, New Haven / Lewis Historical, NY, vol. 2, 1937, p 458. "News of Our Neighborhood," *LGN*, Sept. 12, 1918, p 2. "Lyons," *LGN*, Feb. 10, 1921, p 6. "Bureau of Employment of the New York Chemists' Club," *J. Ind. Eng. Chem.*, **1921**, *13*(6), 563, ACS pubs ie50138a034.

University of Wisconsin, *Catalogue*, 1920-21, p 467; 1921-22, p 701, HathiTrust 000063894. "Lyons," *LGN*, Apr. 21, 1921, p 2.

10. *Annual Register of the New Mexico School of Mines, Socorro, N.M.*, 1909-10, [p 5], HathiTrust 012305276. G. Kemmerer, "The Electrolytic Determination of Zinc in Ores," *J. Ind. Eng. Chem.*, **1910**, *2*(9), 375-377, ACS pubs ie50021a004. G. Kemmerer, J. F. Bovard and W. R. Boorman, "Northwestern Lakes of the United States: Biological and Chemical Studies with Reference to Possibilities in Production of Fish," *Bull. U. S. Bur. Fish*., **1923**, *39*, 51-140, HathiTrust 011418190. M. E. Weeks, "The Rôle of Hydrogen Ion Concentration in the Precipitation of Calcium and Magnesium Carbonates," Ph.D. Dissertation, University of Kansas, Lawrence, 1927, [p 1].

11. *Hist. Chem. Dept.*, p 48. University of Kansas, Department of Chemistry, "Department Recommendation Concerning Probable Services for 1921-1922," Elvira Weeks, Nov. 5, 1921, RG 17/22, UA-KSRL. Service Record of Elvira Weeks. *ACUK*, 1922-23, 3:23. Figure 1 from Hodgson (Ref. 3).

12. Quotation in University of Kansas, Department of Chemistry, Salary recommendations, [1922], B. C. #5, RG 17/22, UA-KSRL. *ACUK*, 1940-41, 2:34; 1937-38, 2:29, 31. M. E. Weeks, *A Laboratory Manual of Quantitative Analysis, Written for the Beginning Course in Quantitative Analysis at the University of Kansas*; Edwards Brothers, Ann Arbor, MI, 1934, *National Union Catalog, pre-1956 Imprints*, 653:216, NW 0148893, HathiTrust 000140237.

13. Weeks, Ref. 10, t. p.; quotation from [p 1]. H. P. Cady, G. Kemmerer and M. E. Weeks, "The Rôle of Hydrogen Ion Concentration in the Precipitation of Calcium and Magnesium Carbonates," *J. Phys. Chem.*, **1929**, *33*(11), 1769-1780, ACS pubs j150305a009. The first accepted chemistry dissertation by a woman at the University of Kansas was that of Selma Gottlieb, approved by Cady in March 1927. *ACUK*, 1926-27, 3:389; 1927-28, 2:25. Service Record of Elvira Weeks. The date of Weeks' assistant professorship (1921) shown in Taft, *Fifty Years* (p 33), is incorrect.

Bray mistakenly credits Weeks as the "first female faculty member" and "first female chemistry Ph.D." and asserts that "no other female would be appointed as professor of chemistry at KU until … 1975" (C. Bray, "KU's First Woman of Chemistry, Mary Elvira Weeks, A History of Our Historian," *Chemistry at the University of Kansas*, [Department of Chemistry press release], 1999, pp 1, 3, 4, https://kuscholarworks.ku.edu/handle/1808/26294). In fact, eight women preceded Weeks as members of the chemistry faculty, another woman (Selma Gottlieb) received a Ph.D. and appointment as assistant professor in chemistry at the same time as Weeks, and two more women (Ethel Ann Jones and Helen Gladys Swope) were also appointed assistant professors of chemistry before 1975.

14. Quotation from Kallis Oral History: Selma Kallis, interview by Mildred Clark, February 17–March 27, 1978, 8 digital audio (MP3) files, Selma Gottlieb Kallis Oral History, UA-KSRL., tape 1, side A, min. 17:30.

15. "News Gems," *Pleasanton (KS) Herald*, Nov. 30, 1900, p 3. U.S., Social Security Applications and Claims Index, 1936-2007, Ancestry.com. "Wanted us all" quotation from S. Jenkins, Past, Present: Recording Life Stories of Older People, St. Alban's Parish, Washington, DC, 1978, pp 86-87 at 87. "The Class of 1918 Graduates," *Pleasanton (KS) Observer-Enterprise*, May 23, 1918, p 1; *Pleasanton (KS) Herald*, May 24, 1918, p 3. The Class of 1918 comprised 11 graduates; Ref. 14, tape 1, side A, min. 19:15. "I was so overwhelmed" quotation from Ref. 14, tape 2, side A, mins. 13:20, 13:55.

16. Ref. 14, tape 1, side A, mins. 18:35, 20:20, 20:30. M. S. Stone, "Scientific Work: The Bacteriologist," in C. Filene, Ed., *Careers for Women*, Houghton Mifflin, Boston, 1920, pp 410-413, esp 410, HathiTrust 000953013. "Openings in this work" quotation from "Planning Your Future," *UDK*, Jan. 30, 1919, p 2. Service Record of Selma Gottlieb. *Hist. Chem. Dept.*, p 49. "Changes in Faculty Are All Announced," *UDK*, Sep. 19, 1921, p 3. "So there I was" quotation from Ref. 14, tape 1, side A, min. 20:30.

17. *ACUK*, 1921-22, 3:317. On p 317 the year is misprinted as 1921, c.f. "University Calendar," p 243. "Jobs for women chemists" and "my assistantship was extended" quotations from Ref. 14, tape 1, side A, min. 20:55. Service Record of Selma Gottlieb. *Hist. Chem. Dept.*, 49. "Hydrogen ion concentrations" quotation from S. Gottlieb, "Hydrogen Ion Studies in Some Phosphate Solutions," M.A. Thesis, University of Kansas, Lawrence, 1923, [p 1], https://kuscholarworks.ku.edu/handle/1808/20758. "For the calculation" quotation from ibid., p 26. *ACUK*, 1923-24, 3:343.

18. Service Record of Selma Gottlieb. Kansas State Board of Health, *Biennial Report*, 1924-1926, p 157, HathiTrust 000533617.

The Water and Sewage Laboratory was officially established by the State Board of Health in 1915, "although a small group had been doing laboratory work at the University [of Kansas] since 1890" (D. F. Metzler, "Kansas Public Water Supplies: A Century of Progress," [p 4], prepared for 1981 Meeting, Kansas Section, American Water Works Association, Dodge City, KS, Kansas Water Environment Association, http://www.kwea.net/about/history.html). "The Kansas State Board of Health … carried out cooperative investigations with the University of Kansas in the 1890's" ("Biennial Reports of the Kansas Public Health Laboratories," in Kansas, Secretary of State, *Biennial Report Covering Agencies of the Government of the State of Kansas*, 1978, p 273, https://cdm16884.

contentdm.oclc.org/digital/). A water-analysis laboratory at the University was created by the passage of the 1907 Kansas Water and Sewage Law (Kansas State Board of Health, *Bulletin*, **1907**, 3(3), 71; **1908**, *4*(4), 107; HathiTrust 000550625), under the jurisdiction of, and funded by, the State Board of Health (Kansas State Board of Health, *Biennial Report*, 1907-1908, p 78, HathiTrust 000533617). The laboratory was directed by University of Kansas chemistry department faculty until 1918 (*Hist Chem Dept*., pp 30, 40), and afterwards by University of Kansas School of Engineering faculty (Kansas State Board of Health, *Biennial Report*, 1916-1918, p 2. 1918-1920, p 2, HathiTrust 000533617. J. O. Maloney, Ed., *A History of the School of Engineering at the University of Kansas, 1868-1988*, The University, School of Engineering, 1989, pp 153-154. Taft, *Fifty Years*, 3). The staff chemist was a chemistry department employee, and included at various times Jones, Gottlieb and Swope (Service Records). Cassandra Ritter was the lab's bacteriologist from 1922 until 1956 ("Kansas Public Health Association Salutes Cassandra Ritter, MA and Mary C. Bure, RN: Samuel J. Crumbine Banquet, Topeka, KS, April 12, 1956," The Association, Topeka, 1956, [pp 2-7], https://kuscholarworks.ku.edu/handle/2271/731). Initially the laboratory was in Bailey Hall, home of the chemistry department. After a few years it was moved to Old Snow Hall, site of the Bacteriology Department (Taft, *Fifty Years*, 3. "They're Precise," *UDK*, Apr. 30, 1915, p 1). In July 1923 it was moved from Old Snow to Marvin Hall, home of the School of Engineering (Kansas State Board of Health, *Biennial Report*, 1922-1924, p 64). In 1958 it was moved to Topeka ("Water Lab Transfer From KU to Topeka Marks Chapter End," *Lawrence (KS) Journal-World*, Mar. 1, 1958, pp 1-2).

19. Service Record of Selma Gottlieb. Gaylord Farm Association, *Annual Report Concerning the Work of the Gaylord Farm Sanatorium*, The Association, Wallingford, CT, 23rd, 1927, p 30; 24th, 1928, p 32, HathiTrust 100074576. "Chemical bacteriology" quotation from T. B. Johnson, "The Chemistry of Bacteria and the Development of a Practical Technique for the Chemical Analysis of Cells," in H. B. Weiser, Ed., *Colloid Symposium Annual*, *7, June 1929*, Wiley, New York, 1930, pp 223-232 at 224. "Didn't care for" quotation from Ref. 14, tape 2, side A, min. 16:35.

20. S. Gottlieb, "An Irreversible Hydrocarbon Cell," Ph.D. Dissertation, University of Kansas, 1927. Approved March 1927, three months before resigning at Gaylord Farm; "There is no reason" quotation from p 5. "The study of the potentials" quotation from H. P. Cady, "The Chemistry of the Future," *Science*, **1927**, *65*, 1-4, at 3, https://science.sciencemag.org/content/65/1671/1.

21. Quotations from Gottlieb dissertation (Ref. 20): "a voltaic cell," p 49; "It has proven," p 44. "fruitless," p 42; "worthless," p 20; "great variability," p 14. "the electrodes are," p 44. Ibid., t.p. *ACUK*, 1926-27, 3:389.

22. H. P. Cady and S. Gottlieb, "An Irreversible Hydrocarbon Cell," *Univ. Kans. Sci. Bull*., **1929**, *19*(4), 43-52, https://archive.org/details/universityofkans19univ/page/42. E. J. Crane, Ed., *CA Today: The Production of Chemical Abstracts*, American Chemical Society, Washington, DC, 1958, p 23, HathiTrust 010164006. The indexes that covered electricity were *Engineering Index* and *Science Abstracts Sections A-Physics,* and *B-Electrical Engineering*.

23. Service Record of Selma Gottlieb. *ACUK*, 1927-28, 2:25. Gottlieb is shown as assistant professor in this and all succeeding years of *ACUK*. Her entries in *American Men of Science* also show her rank as assistant professor beginning 1927 (*American Men of Science: A Biographical Directory*, Science Press, New York, 5th ed., 1933, p 426; 6th ed., 1938, p 541; 7th ed., 1944, p 939). Her Service Record has no rank indicated in 1927-28. The rank of assistant professor does not appear there until 1930-31. The date of Gottlieb's assistant professorship (1924) shown in Taft, *Fifty Years* (p 32), is incorrect. Kansas State Board of Health, *Biennial Report*, 1926-1928, p 186, HathiTrust 000533617. *ACUK*, 1927-28, 2:25, 27. 1934-35, 2:24, 27.

24. "Notices," *Chanute (KS) Times*, Jan. 15, 1890, p 3. "Mrs. Wallace Jones Died Yesterday," *Chanute (KS) Daily Tribune*, Aug. 16, 1905, p 4.

25. "School Commenced Today," *(Chanute, KS) Sun*, Sept. 16, 1907, p 5. "Class of Naught-Nine Graduates," *Chanute (KS) Daily Tribune*, May 29, 1909, p 1. *ACUK*, 1909-10, 5:445; 1912-13, 5:494; 1913-14, 5:469; 1914-15, 12:43; 1915-16, 8:5. "Thirteen to Go to College," *Chanute (KS) Daily Tribune*, Aug. 11, 1909, p 5. H. W. Josselyn, *Survey of Accredited High Schools and Professional Directory*, Kansas State Printing Office, Topeka, 1914, p 185, HathiTrust 008898736. "Teachers for Next Year Are Assigned," *Hutchinson (KS) Gazette*, July 11, 1916, p 8. E. A. Jones, "Artificial Color in Food," M.A. Thesis, University of Kansas, Lawrence, 1916, https://kuscholarworks.ku.edu/handle/1808/19099.

26. *ACUK*, 1917-18, 1:271918-19, 8:413 "Takes Position in Lawrence," *Hutchinson (KS) Gazette*, Jan. 22, 1918, 7. "As to Your Future," *UDK*, Mar. 25, 1919, 2. The laboratory is not identified. *Chicago Chem. Bull*., **1919**, *6*(2), 30. **1919**, *6*(6), 128, HathiTrust 000530755. *Catalogue of the Oregon Agricultural College*, 1919-20, 21. https://oregondigital.org/sets/general-catalogs. Kansas State Board of Health, *Biennial Report*, 1918-1920, 230. 1924-1926, 157, HathiTrust 000533617. Service Record of Ethel Ann Jones. *Hist. Chem. Dept.*, 49. Figure 2 photograph from RG 17/22, Department of Chemistry, Photographs, 1928, UA-KSRL, persons identified on back of photograph.

27. "The opportunity" quotation from "Miss Ethel Jones," *UDK*, Oct. 20, 1920, p 2. *ACUK*, 1924-25, 1:152. "She is a teacher" quotation from University of Kansas, Department of Chemistry, "Budget Sheet for 1920-1921," RG 17/22, UA-KSRL.

28. E. A. Jones, "The Fusion Curves for the Systems Ammonia-Propyl Alcohols, Ammonia-Butyl Alcohols," Ph.D. Dissertation, University of Kansas, 1929, https://kuscholarworks.ku.edu/handle/1808/27715; quotation from p 1. A. W. Davidson, "American Contemporaries: Hamilton Perkins Cady," *Ind. Eng. Chem., News Ed*., **1939**, *17*(20), 660-661, ACS pubs cen-v017n020.p660. *ACUK*, 1906-07, 3:127; 1928-29, 3:106. H. P. Cady and E. A. Jones, "The Fusion Curves for the Systems Ammonia-Propyl Alcohols and Ammonia-Butyl-Alcohols," *J. Phys. Chem.*, **1933**, *37*(3), 303-20, ACS pubs j150345a003. Service Record of Ethel Ann Jones.

29. "History of Kalium, the Fifteenth Chapter, 1924-1930," *A History of Iota Sigma Pi: National Honor Society for Women in Chemistry*, Iota Sigma Pi, Berkeley, CA, 1937, 56-57, HathiTrust 006584399; "to foster mutual" and "to stimulate personal" quotations p 65; "with a scientific paper" quotation p 56. "Society," *LDJW*, Dec. 1, 1924, p 5. "To supplement" quotation from M. W. Rossiter, *Women Scientists in America: Struggles and Strategies to 1940*, Johns Hopkins, Baltimore, 1982, p 297. "Kalium, Fifteenth Chapter, 1924-2001," in A. T. Sherren and S. V. Vercellotti, Eds., *The Centennial History of Iota Sigma Pi: National Honor Society for Women in Chemistry Founded 1902*, Iota Sigma Pi, Covington, LA, 2005, pp 112-115.

30. H. B. Ward and E. Ellery, comps., *Sigma Xi Half Century Record and History, 1886-1936*, Union College, Schenectady, NY, 1936, pp 153, 159, HathiTrust 001453447; "The establishment" quotation from p 61; "Monthly meetings" quotation from p 148. "Society," *LDJW*, May 12, 1932, p 2.

Figure 3 photograph from RG 67/56, Sigma Xi, Box 1, Proceedings and Records of Meetings 1890-1975, University of Kansas Student Organizations Records, UA-KSRL. Another print at Weeks Papers, Box 1, Folder 8. The occasion is the Spring meeting, initiation of new members, and banquet of the University of Kansas Chapter of Sigma Xi held May 11, 1932, at the Big Six Room, Eldridge Hotel, Lawrence, KS. Some women members are performing the entertainment portion of the meeting. The skit is a take-off from the novel *Ladies in Hades: A Story of Hell's Smart Set*, by F. A. Kummer, (J. H. Sears, New York, 1928), in which Eve forms a woman's club of *femmes fatales*—Cleopatra, Delilah, Scheherazade, and others—to talk about their love affairs. The Sigma Xi women have adapted the story to "the wives of famous scientists telling their troubles to the king of Hades." Given its historical references, Weeks probably played a major role in developing the skit.

The women are all faculty at the University of Kansas, Lawrence (assistant professors except as noted). As identified by the inscription on the back of the UA-KSRL copy, they are, from left-to-right: Cornelia Mitchell Downs, associate professor of bacteriology, as Hades; Beulah M. Morrison, associate professor of psychology; Kathleen Doering (entomology); Florence L. Black (mathematics); Selma Gottlieb (chemistry); Wealthy Babcock (mathematics); Ethel Ann Jones (chemistry); Lalia Viola Walling (physiology); Mary Elvira Weeks (chemistry); and Mary Elizabeth Larson (zoology). "Fritzie" Downs plays Cerberus.

31. "Society," *LDJW*, Apr. 14, 1928, 5. Oct. 14, 1931, 2. May 20, 1932, 7. May 23, 1932, 5. Jan. 29, 1934, 5 For example: Gottlieb, 57th Annual Meeting of the Kansas Academy of Science, Apr. 11, 1925, Manhattan, KS (*Trans. Kans. Acad. Sci*., **1922-1928**, *31*, 31, JSTOR 3624103). Jones, 56th Annual Meeting of the Kansas Academy of Science, Apr. 5, 1924, McPherson, KS (*Trans. Kans. Acad. Sci*., **1922-1928**, *31*, 26, JSTOR 3624102). Weeks, 63rd Annual Meeting of the Kansas Academy of Science, Apr. 24, 1931, Lawrence, (*Trans. Kans. Acad. Sci*., **1931** *34*, 17, JSTOR 3624458). "These incidents" quotation from Taft, *Fifty Years*, 14.

32. Quotations from Arthur Davidson, interview by Tom Lewin, Summer 1985, transcript, 11-12, Oral History Project of the Kansas University Retirees Club, Endacott Society, Lawrence, http://endacottsociety.org/oral-histories/. Davidson, a Jew, claimed he never felt discrimination personally. "In fact, I would have a very difficult time of making out a case of anti-Semitism at K.U." (p 5).

33. Bailey, Cady and Dains list two other women who "served the University Chemistry Department:" Ella E. Nelson and Helene A. Thomas (*Hist. Chem. Dept.*, p 49). However, no evidence was found that either ever held faculty rank.

That instructors were faculty is shown in these statements: "The Faculty of each school is made up of the professors and heads of departments offering work in that school, together with other instructors whose work is chiefly in that school." *ACUK*, 1905-06, 1:16. "The Faculty of each school is made up of the heads of departments offering work in that school, the professors and associate professors offering courses in it, and the assistant professors and instructors who have been assigned to that Faculty." *ACUK*, 1908-09, 1:6. "The faculty of each school consists of the chancellor, the dean, and all professors, associate professors, assistant professors and instructors giving work in that school." *ACUK*, 1920-21, 1:9.

34. Obituary of Florence H. Duke, *Iola (KS) Daily Register and Evening News*, Jan. 23, 1923, p 2. Quotation from obituary of Florence Hedger Duke, *LDJW*, Jan. 17, 1923, p 2. Service Record of Florence Hedger. *Hist. Chem. Dept.*, p 34. *ACUK*, 1907-08, 3:121; 1908-09, 3:106.

Earned master's degrees by academic department can be derived from thesis lists, since a thesis was required from the time the first chemistry master's was granted in 1894 (University of Kansas, Graduate School, *Titles to Theses Presented in Partial Fulfillment of the Requirements for Advanced Degrees in the Graduate School*, The Univer-

sity, Lawrence, 1920, p 15-16, HathiTrust 100489743. B. E. Wilder, comp., *University of Kansas Graduate School Theses, 1888-1947*, University of Kansas Libraries, Lawrence, 1949, pp 150-152, https://kuscholarworks.ku.edu/handle/1808/5846. *ACUK*, 1893-94, p 78). These lists show that the first master's theses—and therefore the first master's degrees—by women, in chemistry, were dated 1911. Nevertheless, other university records show that Hedger was granted a master's in 1908, but no thesis appears in the thesis lists or elsewhere ("Degrees Conferred," *ACUK*, 1908-09, 5:361. *ACUK*, 1909-10, 5:430. *Hist. Chem. Dept.*, p 34). No explanation of this discrepancy was found. "Kitchen Shower to Florence Hedger," *UDK*, Apr. 20, 1911, p 1.

35. Service Record of Emily Victoria Berger (service excludes the Fall 1915 semester). "Her career was shaped" quotation from obituary of Emily V. Berger, *LDJW*, Apr. 22, 1920, p 3. "She has the most" quotation from *Hist. Chem. Dept.*, p 44. *Halstead (KS) Independent*, July 2, 1897, p 5. "Commencement Exercises," *Halstead (KS) Independent*, May 12, 1910, p 1. *ACUK*, 1914-15, 1:25. H. P. Cady, "Helium as a Balloon Gas," *Trans. Kans. Acad. Sci*., **1919**, *30*, 212-214, JSTOR 3624068. H. P. Cady, H. M. Elsey, and E. V. Berger, "The Solubilities of Helium," Program of the Fifty-Ninth Meeting of the American Chemical Society, St. Louis, *J. Ind. Eng. Chem.*, **1920**, *12*(5), 502, ACS pubs ie50125a032. The paper was published as H. P. Cady, H. M. Elsey, and E. V. Berger, "The Solubility of Helium in Water," *J. Am. Chem. Soc.*, **1922**, *44*(7), 1456-1461, ACS pubs ja01428a009. A note accompanied the article: "Publication has been greatly retarded by the death of Miss Berger during the progress of the work." "University Mourns Miss Berger's Death," *UDK*, Apr. 22, 1920, p 1. "Emily Berger Is No More," *Halstead (KS) Independent*, Apr. 29, 1920, p 1. She is remembered by the Emily V. Berger Scholarship Fund ("News and Notes," *Trans. Kans. Acad. Sci*., **1963**, *66*(4), 742, JSTOR 3626817). Originally, the fund endowed scholarships for women in chemistry. It was later combined to form the Watkins-Berger Scholarship for "high achieving female students" (Susan Schmidtberger, KU Endowment Association, email message to second author, July 5, 2019).

36. Service Record of Agnes A. Anderson Murray. *Hist. Chem. Dept.*, p 37. Obituary of J. W. D. Anderson, *Baldwin (KS) Ledger*, Mar. 30, 1894, p 3. "Mrs. Murray Dies After a Coronary," *LDJW*, Oct. 9, 1963, p 2. *ACUK*, 1910-11, 1:72. 1911-12, 5:413. A. A. Anderson, "A Study of Compressed Yeast," M.A. Thesis, University of Kansas, Lawrence, 1911. The other recorded master's thesis in chemistry by a woman was L. [Lillian] E. Fowler, "A Comparison of Differential Staining Methods for Various Acid-Fast Bacilli." A. A. Anderson, "An Investigation of the Presence of Furfural in Cider Vinegar," *J. Ind. Eng. Chem.*, **1914**, *6*(3), 214-215; correction: **1914**, *6*(5), 441, ACS pubs ie50063a015. Quotations from "Women Well Fitted to Study Chemistry," *UDK*, Nov. 9, 1914, p 4.

37. For home economics as "women's work," see Rossiter (Ref. 29), pp 65-70. "In departments" quotation from Bureau of Vocational Information (Ref. 5), p 9; "Excellent opportunities" and "less competition" quotations from p 17. "Always been a friend" quotation from V. J. Anderson, *The Department of Home Economics: The First 50 Years, 1910-1960*, University of Kansas, Lawrence, 1964, pp 74-75, 3. "Women Well Fitted," E. H. S. Bailey, *The Source: Chemistry and Use of Food Products*, P. Blakiston's Son & Co., Philadelphia, 1914. E. H. S. Bailey, *Laboratory Experiments on Food Products*, P. Blakiston's Son & Co., Philadelphia, 1915. *Hist. Chem. Dept.*, p 33 (photograph of Food Lab), p 41. The Food Lab was established in 1905 and located in Bailey Hall until at least 1950 (Taft, *Fifty Years*, pp 3-4).

38. "Many Changes in Faculty Are Made," *UDK*, Sep. 15, 1911, p 3 .*ACUK*, 1911-12, 1:21. *Hist. Chem. Dept.*, p 43. Service Record not found. "Death of Mr. M. McKinnon," *(Concordia, KS) Kansan*, June 25, 1903, p 1. M. Dye. *History of the Department of Home Economics, University of Chicago*, Home Economics Alumni Association, Chicago, 1972, p 119. University of Illinois (Urbana-Champaign), *Annual Register*, 1916-17, p 339, HathiTrust 000061473. "Jean G. MacKinnon Appointed Manager Union Dining Room," *(Iowa City, IA) Daily Iowan*, Sep. 26, 1929, p 1, https://dailyiowan.lib.uiowa.edu/index.php.

39. Service Record of Avis Talcott. *Hist. Chem. Dept.*, p 46. L. H. Bailey and E. Z. Bailey, comps., *RUS: A Biographical Register of Rural Leadership in the United States and Canada*, Ithaca, NY, 1925, p 650, HathiTrust 009182906. Obituary of Avis Talcott Wells, *Indiana (PA) Gazette*, Apr. 22, 1970, p 60. University of Chicago, *Annual Register*, 1917-18, p 532, HathiTrust 010308519. "Day's Doings," *Atchison (KS) Weekly Globe*, Dec. 27, 1917, p 4. D. Dewart, Ed., *Educational Institutions of New England*, Bellman, Boston, 1946. p 234, HathiTrust 006908680.

40. Service Record of Amy Van Horn Rader. *ACUK*, 1913-14, 5:499; 1917-18, 1:27. "Van Horn-Rader," *LDJW*, Dec. 21, 1917, p 5. Wilder (Ref. 34), p 107. Anderson (Ref. 37), p 18.

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76. "Dr. Mary Elvira Weeks," one page, handwritten, with note: "April 4, 1944, Newspaper Clipping, Appointed Research Associate in Scientific Literature, WSU," newspaper not identified and untitled, undated, draft press release concerning Weeks' alumni citation for work in chemistry awarded at Ripon College's Second Century Program, Nov. 1, 1947, p 3: Weeks, Mary Elvira, Wayne State University Vertical Files Collection, Walter P. Reuther Library, http://as.reuther.wayne.edu/repositories/2/archival_objects/265975. Finding Aid, "Kresge-Hooker Science Library Associates Collection," 1, University Archives, Wayne State University, http://reuther.wayne.edu/files/WSR000194.pdf. *Rec. Chem. Prog*., **1944**, *5*(1); **1969**, *30*(4). *Chymia*, **1948**, *1*; **1953**, *4*.

77. "I believe that" quotation from Charles A. Browne to Weeks, 28 Nov. 1946, Weeks Papers, Box 1, Folder 7. "Was so anxious" quotation from Louise McDanell Browne to Weeks, 26 Nov. 1948. Gordon's quotations from handwritten inscription on C. A. Browne to Weeks, 28 Nov. 1946.

78. "As originally planned" quotation from C. A. Browne to Weeks, 28 Nov. 1946, Weeks Papers, Box 1, Folder 7. C. A. Browne and M. E. Weeks, *A History of the American Chemical Society: Seventy-Five Eventful Years*, American Chemical Society, Washington, DC, 1952, HathiTrust 001486304. "The authors have assembled" quotation from A. J. Ihde, review of *A History of the American Chemical Society: Seventy-Five Eventful Years*, by C. A. Browne and M. E. Weeks, *Isis*, **1954**, *45*(1), 101-102, at 101, https://www.journals.uchicago.edu/doi/pdfplus/10.1086/348293.

79. "Her Detroit years" quotation from Ihde, "Twelfth Dexter Award" (Ref. 64), p 84. Press release (Ref. 76): p. 1, handwritten inscription "5-5-54 Resigned." No contemporary announcement of Weeks' retirement was found. "To undertake the task" quotation from William F. Kieffer to Weeks, 11 Nov. 1966, Weeks Papers, Box 1, Folder 2. Leicester to Kieffer, 15 Nov. 1966. Weeks to Leicester, 25 Nov. 1966.

80. "Attaching as addenda" quotation from A. J. Ihde, review of *Discovery of the Elements*, 6th ed, by M. E. Weeks, *Isis*, **1958**, *49*(1), 86-87 at 87, https://www.journals.uchicago.edu/doi/abs/10.1086/348647. "I value Dr. Ihde's opinion" quotation from Weeks to Leicester, 12 Dec. 1966, Weeks Papers, Box 1, Folder 2. "Delighted" quotation from Weeks to Leicester, 28 Dec. 1966. "A definite improvement" quotation from Weeks to Leicester, 16 Feb. 1967. "Has made the work" quotation from G. B. Kauffman, review of *Discovery of the Elements*, 7th ed, by M. E. Weeks, *Science*, **1968**, *162*, 111, https://science.sciencemag.org/content/162/3849/110.3.

81. "Subjects which pertain" quotation from Ihde, review (Ref. 80), p 87. "Perhaps we should explain" quotation from Weeks to Leicester, 28 Dec. 1966, Weeks Papers, Box 1, Folder 2. "Heartiest congratulations" quotation from Weeks to Leicester, 26 Mar. 1968. Advertisement, *J. Chem. Educ.*, **1968**, *45*(11), A933. "Better than ever" quotation from J. Bronowski, review of *The Discovery of the Elements*, 7th ed., by M. E. Weeks and H. M. Leicester, *Sci. Am*., **1968**, *218*(6), 139, JSTOR 24926268.

82. Martin Levey to Weeks, 23 May 1967, Weeks Papers, Box 1, Folder 2. American Chemical Society, News Service, press release, July 13, 1967, Weeks Morgue File, UA-KSRL. Copied in *50 for 50: Celebrating Fifty Years of Kenneth Spencer Research Library*, KU Libraries, Lawrence, 2018, 58, https://kuscholarworks.ku.edu/handle/1808/27302. "KU Alumna Wins Chemistry Award," *LDJW*, July 18, 1967, p 12. "In comparison with" quotation from Weeks to Levey, 27 May 1967. Levey to Weeks, 31 May 1967. "In her home" quotation from Ihde, "Twelfth Dexter Award" (Ref. 64), p 84. "Dexter Award," *Chem. Eng. News*, **1967**, *45*(29), 73, ACS pubs cen-v045n029.p070, includes photograph of Weeks. "Mary Weeks Receives Dexter Award," *Chem. Eng. News*, **1968**, *46*(9), 71, ACS pubs cen-v046n009.p067. includes photograph of Weeks receiving award from Charles Harmison.

83. *American Men of Science*, 5th ed., 1933, p1181; 6th ed., 1938, p 1506; 7th ed., 1944, p 1892; 8th ed., 1949, p 2647. Howes (Ref. 41), p 580. D. Howes, Ed., *American Women: The Standard Biographical Dictionary of Notable Women*, American Publications, Los Angeles, CA, 1939, p 957, HathiTrust 001717981. Haynes (Ref. 9), vol. 2, 1937, p 458; vol. 3, 1951, p 800; vol. 4, 1956, p 1130. "A modest unassuming" quotation from J. Goodrich, letter to the editor, *Chem. Eng. News*, **2008**, *86*(24), [p 9], ACS pubs cen-v086n024.p006. "Meeting Mary Elvira Weeks" quotation from Hodgson (Ref. 3). "Quiet, ladylike" quotation from H. P. Cady in University of Kansas, Department of Chemistry, Salary recommendations, [1922], B. C. #5, RG 17/22 UA-KSRL.

84. "Gave this summary" quotation from C. Bray, "KU's First Woman of Chemistry, Mary Elvira Weeks, A History of Our Historian," *Chemistry at the University of Kansas*, [Department of Chemistry press release], 1999, p 2, https://kuscholarworks.ku.edu/handle/1808/26294). Bray does not document the quotation. It appears at the beginning of a paragraph typographically formatted as a block quotation implying that it came from Swift's memoir *Life on Mississippi Street* (LOMS Publications, Tulsa, OK, [1992]-), however no such statement appears there. Possibly it comes from an interview of Swift, as

her name, without comment, appears in the acknowledgements section of Bray's article.

"She was a friendly" quotation from Ihde, "Twelfth Dexter Award" (Ref. 64), p 84. Ihde chaired HIST from 1962 to 1964 and won the Dexter Award in 1968, the year after Weeks.

85. "By nature" quotation from Ihde, "Twelfth Dexter Award" (Ref. 64), p 84. (Ihde repeatedly mentions Weeks' enthusiasm for languages (pp 82, 83, 84), but she never mentions it at all.) The first woman to win the Dexter Award was Eva Vivian Armstrong in 1958. "History of chemistry" quotation from Haynes (Ref. 9), vol. 2, 1937, p 458. Howes, *American Women* (Ref. 83), 1935, p 580; 1939, p 957.

86. "Famed Scientist-Author Dr. Mary E. Weeks Dies," *Detroit (MI) Free Press*, June 21, 1975, p 7C. Includes copy of photograph in "Dexter Award," *Chem. Eng. News*, **1967**, *45*(29), 73, ACS pubs cen-v045n029.p070.

The obituary includes the statement, "she willed her technical library to the Kresge-Hooker Scientific Library." In 2020, a library administrator said, "the library received a monetary donation from Weeks as well as her book collection for the Kresge-Hooker Scientific Library, which later became part of the main library collections" (Alison Stankrauff, University Archivist, Wayne State University, email message to second author, February 14, 2020).

"I shall be there" quotation from Weeks to Levey, 3 June 1967, Weeks Papers, Box 1, Folder 2.

87. Hist. Chem. Dept. Taft, *Fifty Years*. Harmony, who wrote the department's history from 1950 to 2000, says that until 1975 the department "had unsuccessfully recruited outstanding women scientists for several years," without details or explanation (Harmony, *History of the KU Chemistry Department*, p 34). "Peaking of enrollment" quotation from Rayner-Canham and Rayner-Canham, *Women in Chemistry* (Ref. 1), p 199. "Patient 'infiltration'" quotation from Rossiter (Ref. 29), p 313.

88. "Many women" quotation from "Vocational Work for Girls," *LDJW*, Mar. 18, 1914, p 6. "Great Field for Women Chemists in War Work," *UDK*, Dec. 7, 1917, p 4. *UDK*, Apr. 4, 1918, p 1. "Women have made" quotation from "Women Have Made Good in Men's Jobs on Hill," *UDK*, Jan. 16, 1919, p 4.

89. The new women professors were Weeks, Gottlieb, Jones and Swope. The men were Davidson, Kinney, White, and Taft. Data from *ACUK*. "Doctorates and Titles of Doctorate Theses Awarded from Bailey Laboratory, 1900-1950," in Taft, *Fifty Years*, 34-35.

90. M. Rayner-Canham and G. Rayner-Canham, *Women in Chemistry* (Ref. 1), pp 199-201. Rayner-Canham and Rayner-Canham, "Women in Chemistry" (Ref. 1). K. G. Everett and W. S. DeLoach, "Chemistry Doctorates Awarded to Women in the United States," *J. Chem. Educ.*, **1991**, *68*(7), 545-47, ACS pubs ed068p545.

91. "Instructional and Research Staff in Bailey Chemical Laboratory, 1900-1950," in Taft, *Fifty Years*, pp 32-33. Quotations from Arthur Davidson, interview by Tom Lewin, p 16. Rossiter (Ref. 29), pp 205-206, 216.

92. "Doctorates and Titles of Doctorate Theses Awarded from Bailey Laboratory, 1900-1950," in Taft, *Fifty Years*, pp 34-35. Wilder (Ref. 34), pp 150-152. Wilder (Ref. 42), pp 118-119.

93. Rossiter (Ref. 29), pp 172-173, tables 7.2-7.3; pp 170-`71, table 7.1.

94. "Collaborative, supportive atmospheres" quotation from Rayner-Canham and Rayner-Canham, *Women in Chemistry* (Ref. 1), p 201; "Woman-friendly environments," see index entries, p 283. Figure 5 photograph from RG 17/22, Department of Chemistry, Photographs, 1925, UA-KSRL, persons identified on back of photograph.

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