Chapter 2
Pioneers: The Pre-1940 PhD's

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We dedicate this chapter to the memory of our dear friend Uta C. Merzbach, who mentored us both from the time we met in January 1978 until her death on June 27, 2017.

Abstract This chapter focuses on women in American mathematics during the century leading up to the founding of the AWM in 1971. In particular, it reviews results that appear in the authors' 2009 book *Pioneering Women in American Mathematics: The Pre-1940 PhD's* and in the supplementary material that can be found on the webpage http://www.ams.org/publications/authors/books/postpub/hmath-34-PioneeringWomen.pdf. To provide context for the understanding of women's early participation in American mathematics, we summarize the family backgrounds, education, and employment of the 228 women who earned doctorates before 1940. We provide details of the experiences and contributions of a number of these women.

2.1 Introduction

The Association for Women in Mathematics was founded in 1971. One hundred years earlier, Christine Ladd was twenty-three, had graduated from Vassar two years earlier, had taught at a town in central Pennsylvania for two years, and was about to take another teaching position. In 1882, Ladd *earned* the PhD degree in

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mathematics, but the degree was not *awarded* until 1926, forty-four years later, when she was seventy-eight years old. Ladd thus bookends the authors' research: she was the first woman in our study to earn a PhD and the oldest to receive the degree. This study, published in 2009, covered 228 women who received PhD's in mathematics before 1940; this includes the 224 who received PhD's from US institutions and the 4 who were US-born and received foreign degrees [3]. Our goal was to present each of them, as fully as possible, from birth to death. Material supplementary to the book that includes extensive biographies and bibliographies of all the women in the study is available online [4].

In the late 1960s, when both authors were graduate students, very few women mathematicians were visible. Some made contributions, of course, but they were generally considered the exception. We assumed that what we were experiencing was the normal state of affairs. Indeed, during the 1950s only about 5% of the PhD's in mathematics were going to women. From the 1950s onwards the percentages grew slowly to 6% in the 1960s, to 10% in the 1970s, 16% in the 1980s, 23% in the 1990s, and since the early 2000s about 30% of the PhD's in mathematics have been awarded to women.

As a result of our study we learned that both the proportion and numbers of PhD's in mathematics going to women before 1940 were much higher than what we and others had previously assumed. Ten American women earned doctorates in mathematics before 1900, with the first such degree having been awarded in 1886. The remaining 218 who earned doctorates in the first four decades of the twentieth century comprise about 14.3% of the mathematics PhD's granted to Americans in that period. This proportion is slightly higher than that earned by women in all fields in the US at that time. It was not attained again by women in mathematics until the early 1980s.

2.2   Nineteenth-Century Background

The first PhD's awarded in the United States were granted by Yale in 1861; the first of these listed as a degree in mathematics was granted to John Hunter Worrall in 1862. Also in 1862 the first foreign mathematics graduate degree was awarded to an American when the university at Jena in Germany granted William Watson, later of Harvard, a PhD. The next two PhD's in mathematics were awarded in 1872 and 1873 by Cornell and Harvard, respectively.

The Russian Sonya Kovalevskaya is generally considered to be the first woman to receive a doctorate in mathematics in modern times. She studied privately at Göttingen in Germany as she had not been allowed to attend lectures there but was awarded the degree by Göttingen in 1874. Two years later Johns Hopkins University opened with an emphasis on graduate work, but it was not open to women. Christine Ladd studied informally at Johns Hopkins from 1878 until 1882 and did the work required to earn a PhD in mathematics, but the trustees refused to award the degree.

Much happened concerning graduate education for women between 1870, when there were already substantial opportunities for women to obtain a solid

Table 2.1 Nineteenth-Century Women PhD's in Mathematics

	Baccalaureate		Doctorate	
Winifred Edgerton* Merrill	1883	Wellesley	1886	Columbia
Ida Martha Metcalf	1886	Boston U	1893	Cornell
Annie MacKinnon* Fitch	1889	Kansas	1894	Cornell
Ruth Gentry	1890	Michigan	1894	Bryn Mawr
Charlotte Barnum	1881	Vassar	1895	Yale
Agnes Baxter* Hill[†]	1891	Dalhousie	1895	Cornell
Isabel Maddison[‡]	1893	London	1896	Bryn Mawr
Elizabeth Dickerman	1894	Smith	1896	Yale
Mary Winston* Newson	1889	Wisconsin	1897	Göttingen
Leona May Peirce	1886	Smith	1899	Yale
Anne Bosworth* Focke	1890	Wellesley	1900	Göttingen

*Surname at the time of the PhD degree.
[†]Born in Canada.
[‡]Born in England.

undergraduate education in the US, and the end of the nineteenth century. About 230 doctorates were awarded to women in the nineteenth century; of these about 50 were in the natural sciences and mathematics. The leading schools giving doctorates to women in mathematics and the natural sciences were Yale, the University of Pennsylvania, Cornell, Chicago, and Bryn Mawr College. Bryn Mawr had opened as a college for women with a graduate program in 1885, and the University of Chicago opened as a coeducational institution in 1892. Both were important for women doing graduate work in mathematics.

All but 2 of the 11 women listed in Table 2.1 as having received a PhD in mathematics in the nineteenth century were from eastern universities. Those two PhD's were granted to US-born women by Göttingen. Mary Winston was one of the first three women admitted to Göttingen, the first German university to admit women, although only for graduate work.

Another two of the nine US-born women listed in Table 2.1 had done post-baccalaureate studies in Europe: Ruth Gentry attended classes at the University of Berlin and the Sorbonne; and Leona May Peirce studied at Newnham College, Cambridge.

2.3 Family Background

The families in which the 228 women grew up represent a broad range of geographic, educational, and economic backgrounds. There were not diverse ethnic backgrounds, however. The group includes one Asian, Shu Ting Liu Hsia (PhD Michigan 1930), but no other racial minorities. It was 1943 before the first African-American woman received a PhD in mathematics; Euphemia Lofton Haynes earned

her doctorate from Catholic University 29 years after having graduated from Smith College.

All but 16 of the women in our study were born in the US. The two leading states were New York (33) and Illinois (20). Both produced considerably more women than was to be expected from the population distribution in the country at the time. Apparently this reflected better than average opportunities for both undergraduate and graduate study in these states.

In general, the women in our study did not come from homes where the parents were highly educated or well off. Of those whose parents' occupations we were able to identify using census categories, just less than three quarters are divided more or less equally among the three categories: farmers, professional, and managers, while just over a quarter are made up of the combined categories of sales, service, craftsmen, clerical, and operators.

One rather extraordinary example is Gertrude Haseman (PhD Bryn Mawr 1917), who was born in 1889. Haseman was the seventh of nine children of an Indiana farm family and her mother greatly stressed the value of obtaining an education. All nine children received AB's, eight received master's degrees, and five earned PhD's.

Although few of our women came from homes where the parents were highly educated, some of these exceptions are notable. Six of the fathers earned PhD's at some point; two of these were in mathematics. Dorothy (Manning) Smiley Little (PhD Stanford 1937) was the daughter of W. A. Manning (PhD Stanford 1904); her father taught at Stanford and was her dissertation advisor. Frances Baker (PhD Chicago 1934) was the daughter of R. P. Baker (PhD Chicago 1910); her father taught at the University of Iowa.

2.4 Education

2.4.1 Undergraduate Education

The 228 women in our study did their undergraduate work at more than 100 different institutions including state universities and both large and small private colleges in the US and 8 foreign institutions. Two hundred and sixteen of the women in our study did their undergraduate work at US institutions, seven received their undergraduate degrees in Canada, and five received their pre-graduate training in Europe.

Just over half of the women attended coeducational schools and the rest single sex or coordinate colleges. The older women in our study were more likely to attend women's colleges since through the early 1900s women's colleges educated a large proportion of all college-educated women. In fact, for the women in our study, eight of the ten leading undergraduate institutions were all women's colleges in the East as shown in Table 2.2.

Table 2.2 Leading
Baccalaureate Institutions

Institution	Number of Graduates
Wellesley	17
Goucher	10
Hunter	9
Mount Holyoke	8
Vassar	7
Smith	7
Brown (Women's College)	6
Kansas	6
Wisconsin	6
Bryn Mawr	5

Wellesley College granted the most undergraduate degrees to women in our study. It opened in 1875 with a strong emphasis on mathematics and science. It was large and enrolled about 250 women when it opened. In the late 1880s and early 1890s it enrolled between about 650 and 800 women, more women than any other college in the country. During that period Helen Shafer, who had come to Wellesley as professor of mathematics in 1877, served as president of the college. Of the 17 women who graduated from Wellesley, more than half graduated by 1909. Nonetheless, the Wellesley mathematics department remained large, with between six and nine teaching faculty from the late 1890s until the late 1920s. Furthermore, with rare exceptions the department employed only women before World War II, and the faculty participated actively in the affairs of the larger mathematical community.

Goucher College in Baltimore was roughly a third the size of Wellesley and rarely had a mathematics faculty of more than two. Clara L. Bacon (PhD Johns Hopkins 1911) and Florence P. Lewis (PhD Johns Hopkins 1913) were on the Goucher faculty 1897–1934 and 1908–1947, respectively; they were the first women to receive PhD's in mathematics from Johns Hopkins after graduate courses there were officially opened to women in 1907. Goucher's close ties with Johns Hopkins were of great significance for the unusual success of its undergraduate mathematics program.

Hunter College was unlike either Wellesley or Goucher. It was a tuition-free, publicly funded, women's college with no dormitories. In 1914 it changed its name from Normal College of the City of New York to Hunter College of the City of New York and by 1916 was the largest women's college in the US. All but one of the nine undergraduate degrees granted by Hunter to these women was granted during the 1920s and 1930s when it was the leading undergraduate institution for the women in our study.

Fig. 2.1 Percent Employed
Before PhD
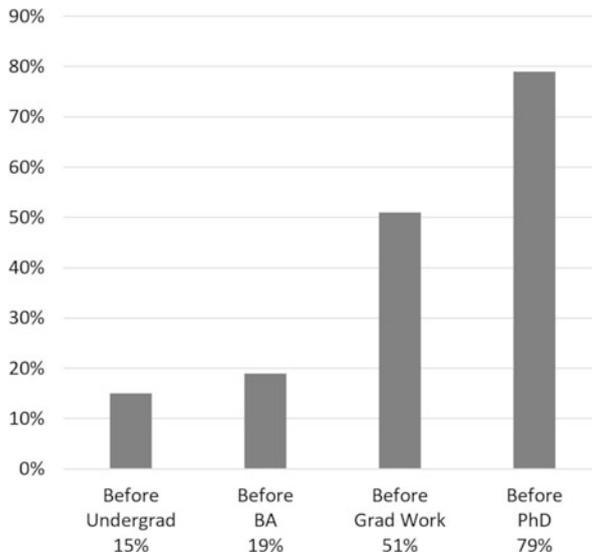
2.4.2 Graduate Education

The two principal faculty members at Goucher, Clara L. Bacon and Florence P. Lewis, did not go directly from college to graduate school. As can be seen in Figure 2.1, this is true of most of the women in our study. We also see that about fifteen percent were employed before beginning college and nineteen percent before earning the bachelor's degree.

These numbers suggest that perhaps the motivation for obtaining the PhD for many (as was likely the case for many men at the time) was to become credentialed for college or university teaching. In fact, for almost all of the Catholic sisters who received PhD's from Catholic University in the 1930s, it appears that the degree was obtained in order to upgrade the level of instruction in Catholic women's colleges, many of which were just emerging as full four-year colleges from pre-existing academies in the 1930s.

The 228 women in our study received their PhD's from 37 different institutions (34 US and 3 foreign). Only one of these, Bryn Mawr, was a women's college and it is the only school that was both a leading baccalaureate and a leading doctoral institution.

One of the reasons that the University of Chicago was the largest granter of mathematics PhD's during the first four decades of the twentieth century (see Table 2.3) was its active summer quarter that brought in outside faculty and allowed graduate students with full-time jobs an opportunity to study while earning a living. Indeed, this summer session encouraged both men and women who were already fully employed to begin or continue with their graduate program. Another reason

Table 2.3 Leading Doctoral
Institutions

Institution	Number of Graduates
Chicago	46
Cornell	21
Bryn Mawr	19
Catholic	14
Yale	13
Illinois	12
Johns Hopkins	12
Radcliffe	9
Columbia	8

was the attitude of acceptance of women, particularly by L. E. Dickson and G. A. Bliss.

This acceptance of women as dissertation students by highly regarded mathematicians was also important at other schools. Of the 100 degrees conferred by the top 4 institutions, 70 were directed by just 6 advisors: Dickson (18) and Bliss (12) at Chicago, Virgil Snyder (14) at Cornell, Aubrey Landry (13) at Catholic, and Charlotte A. Scott (7) and Anna Pell Wheeler (6) at Bryn Mawr.

2.5 Employment

After receiving their doctorates, the 228 women in our study had nearly 600 different jobs at more than 300 different institutions: academic, government, and business. As indicated in Figure 2.2, by far the largest employers were academic institutions.

In order to determine the type of employment for each of the women, we counted the job in which that woman worked the longest.

2.5.1 Women in Academia

Eight of the top ten leading employers of the women in our study were women's colleges in the East; Hunter College in New York led the list having hired nine women. Eight of these nine women were hired between 1925 and 1931 and stayed on the Hunter faculty for at least 30 years. Wellesley followed Hunter as an employer. Seven women held their main positions at Wellesley with all serving at least 25 years. All but one retired as professor emeritus. The University of Illinois (Urbana-Champaign) was the third largest employer. Illinois employed sixteen of the women in our group at various times, but most were very short term, with only four of these being employed for at least 20 years and all four retiring at the rank of associate professor.

Fig. 2.2 Type of
Employment

Academic
200 women

Non-Academic
24 women

Little or no known
employment
4 women
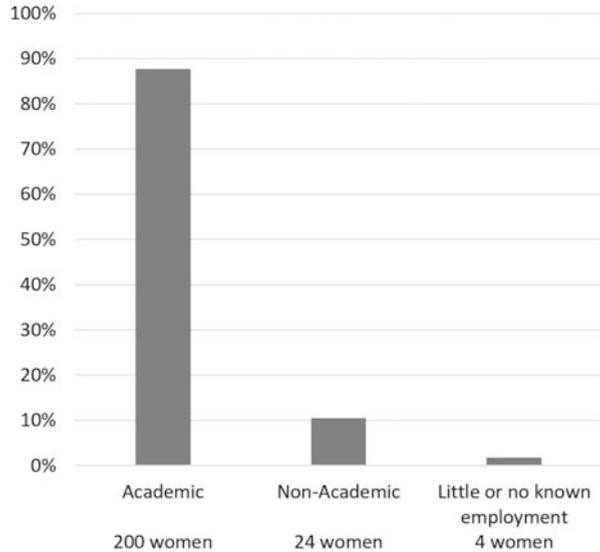
Most of the women in our study obtained academic positions at undergraduate institutions with an emphasis on teaching; they were about evenly divided between women's colleges and coed colleges or universities. More women (106) had their primary employment at coeducational institutions than at women's colleges (79), but those who taught at women's colleges had longer, more stable careers. At the women's colleges, the mean length of job was just over 30 years, whereas it was 21.5 years at coeducational schools. Overall, the smaller liberal arts colleges were generally the most supportive of women's careers.

On the other hand, institutions that had granted PhD's to the women were generally the least supportive. Just 17 of these 34 US institutions hired and retained a total of 24 of the women PhD's in faculty positions above instructor. Once employed, only 5 of the 24 ever attained the rank of professor before retirement and 2 of these 5 were at Bryn Mawr. Perhaps the most shocking situation was that of Florence Allen (PhD Wisconsin 1907) who served as instructor at Wisconsin for 43 years before being promoted to assistant professor two years before her retirement. In about 1980 a Wisconsin graduate remarked to one of the authors that she had not been aware that Florence Allen had a doctorate since, as an instructor, she was always called "Miss Allen."

Obtaining employment after receiving the doctorate was challenging for many women. The Great Depression, bias against women, and anti-nepotism practices were common barriers. The Great Depression affected nearly everyone—male or female. However, the women religious (Catholic sisters) seem to have met fewer impediments than other women in our study. One particularly striking description of the impact of the Depression was given by Elsie McFarland Buck (PhD California,

Berkeley, 1920) in response to a questionnaire collected by the Smithsonian Institution in 1980.[1]

> I was teaching and semi-starving at a very small college in Spokane,.... At any rate, we were not getting paid very much money. I [taught] my whole nine months there for $360 and a box of apples and some kitchen cleanser donated by one of the students as part of his tuition. And I was sending out something like 300 or 400 letters of application all over the country. This was in 1932... when jobs were very few and far between [2, catalog number 2006.3037.01].

The contemporary writings of department chairs describe various views about hiring women before, during, and after the Depression. In 1920 R. D. Bohannan, chairman of the department at Ohio State, wrote R. G. D. Richardson, chair of the department at Brown, with regard to hiring two women students from Brown that "Our dean (Math is in Engineering College) does not like girls. We have two girl teachers.[2] Don't think we could get him to agree on another" [8]. In February 1924 R. G. D. Richardson wrote a recommendation for thirty-year-old Marian Torrey (PhD Cornell 1924) for a position at Smith:

> The department feels that we have never had, among the twenty or more girls whom we have sent out to teach in colleges, any stronger candidate. ... If Brown University would employ women, I would not hesitate to ask President Faunce to call her here at a good salary. She would do much better than many of the men whom we have at present on our staff [8].

In 1931 F. W. Owens, chairman of the department at Penn State and husband of Helen Owens (PhD Cornell 1910), wrote to H. S. Everett about hiring Chicago students: "We have an opening for an instructor for next year to supply for a man on leave of absence. ... For this position we would prefer a Gentile and a man. While we have both Jews and women on our staff, we can not have too large a proportion of them" [6].

As hard as it was for unmarried women to get jobs, the prospects for married women were even worse. It was often the case that women's colleges did not hire married women. For example, when Wellesley opened, it was understood that if a woman on the faculty married, she was expected to resign. An exception to this view on employing women who married was held by the president of Hunter College who indicated shortly after his inauguration in 1929 that when a woman married "the only thing such a person had to do was file her married name for payroll purposes" [7, p. 127].

Only 84 (37%) of the women in our study were married at some point in their life. Of those, 30 had little or no employment, 37 had significant interruptions in

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[1]Questionnaires and other documents concerning women in our study can be found in [2]. Some items relating to women mathematicians in the mathematics collection of the Smithsonian's National Museum of American History are described online at [10].

[2]One of the "girl teachers" was then 44 years old and had received her PhD in 1909.

their careers,[3] 10 had nearly continuous careers,[4] and only 7 had continuous careers; for 4 of these 7 the marriage was not relevant.[5] The husbands of 52 of the married women had, or would get, PhD's: 34 in mathematics and 18 in other fields. For these women, implicit and explicit anti-nepotism rules often affected their careers.

Anti-nepotism practices varied from institution to institution and at different times. For example, when in 1900 Mary Winston (PhD Göttingen 1897) married Henry Newson, a mathematics faculty member at the University of Kansas, she was not permitted to join the full-time faculty but was allowed to teach in the summers. After her husband died suddenly in 1910, the Kansas mathematics department hired Marion Ballantyne White (Chicago PhD 1910) but could not hire Winston Newson because her sister Alice Winston had just accepted an appointment in the English department.

In 1931 Elizabeth Stafford (PhD Wisconsin 1930) was hired as an instructor at Wisconsin. In June 1931 she married fellow mathematician Ivan Sokolnikoff. Elizabeth and Ivan Sokolnikoff both kept their positions at Wisconsin despite a university policy that prohibited married partners from holding faculty positions. In 1932 at the end of her first year of teaching and marriage, the chair of the department wrote to the dean that "... although Mrs. Sokolnikoff is one of our best instructors and is better prepared than any other instructor to give advanced work, we have omitted her from the tentative budget for next year due to the fact that you do not feel it wise to retain the wife of a member of the Department on the staff" [1]. Until they divorced in 1947, Elizabeth Sokolnikoff either held no position or was a lecturer. That year she was appointed an assistant professor.

An explicit instance of losing a job because of anti-nepotism policy occurred in 1948. In 1936 Emily Chandler Pixley (PhD Chicago 1931) was hired by Wayne University where her husband Henry Pixley was an assistant professor of mathematics. She was a special instructor and was paid an hourly salary. In 1947 her position was changed to a full-time position as a "regular substitute assistant professor." The following April, in a memo with subject "the university policy relative to employment of man and wife," the chair of the department wrote to the dean of administration that "... while the quality of teaching will be lowered somewhat by making Mrs. [X] and Mrs. Pixley the first to go, university policy demands that this be done, and I have already made clear to those affected that this will require the termination of their services in June 1949" [9].

Whereas it was understood that married women might well have family demands, some unmarried women also had family obligations that greatly affected their careers. For example, Elizabeth Cowley (PhD Columbia 1908) resigned her position at Vassar in 1929 and moved to Pittsburgh to care for her mother. After she resigned, Cowley became a high school teacher and changed the emphasis of her

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[3]These interruptions were frequent, but not always, because of family responsibilities.

[4]For some, but not all of these women, marriage affected their professional situation adversely.

[5]Mayme Logsdon was a widow when she got her doctorate, Grace Murray Hopper was divorced early in her career, and Evelyn Wiggin Casner and Mina Rees did not marry until they were in their 50s when their careers were well established.

contributions. While on the faculty at Vassar she served on the council of the MAA[6] and reviewed two dozen books, most in French, German, Italian, or Spanish, for the *Bulletin* of the AMS; while teaching high school she was active in local and state mathematics educational organizations and wrote several articles on education.

As we saw earlier, few of the women in academia had positions that supported an active research agenda. Thus, while it is difficult to measure and describe the contributions of women whose primary task was teaching, we know that many were active in professional organizations related to mathematics and mathematics education, contributed articles and reviews to various journals, wrote books, and gave presentations at mathematics meetings. For instance, Clara E. Smith (PhD Yale 1904) served on the Board of Trustees of both the AMS and the MAA in the 1920s, was a vice president of the MAA, and co-wrote three textbooks.

Another woman in our study, Sister M. Helen Sullivan (PhD Catholic 1934), was very active in Kappa Mu Epsilon, the mathematics honor society for schools emphasizing undergraduate education that was founded by Kathryn Wyant (PhD Missouri 1929) in 1931; Sullivan served as KME's national historian and on the editorial board of its journal, *Pentagon*. She also participated in many NSF programs, e.g., as an NSF visiting lecturer and as part of the NSF sponsored College Geometry project at the University of Minnesota.

The leading producer of research papers in pure mathematics was Olive C. Hazlett (PhD Chicago 1915), who produced fifteen between 1914 and 1930, during her time at Chicago, Bryn Mawr, Mount Holyoke, and the University of Illinois. Lois Griffiths (PhD Chicago 1927) followed with thirteen, all but one while on the faculty at Northwestern University.

2.5.2   Non-academic Employment

As noted in Figure 2.2, only 24, about ten percent, of the women in our study had non-academic careers. While many were employed in the private sector, starting in the late 1930s the US government became a significant employer of these women. Four of those employed at some point by the government were particularly recognized.

Mina Rees (PhD Chicago 1931) received the President's Certificate of Merit in 1948 for her work during World War II on the Applied Mathematics Panel of the National Defense Research Committee (1943–1946). Although she continued working for the government at the Office of Naval Research until 1953, she spent most of her career at Hunter College and the Graduate School of the City University of New York, where the library now bears her name.

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[6]The MAA Council changed its name to the Board of Trustees in 1920 while Cowley was a member.

Beatrice Aitchison (PhD Johns Hopkins 1933), who worked for the Interstate Commerce Commission, the Department of Commerce, and the US Post Office, received one of the first Federal Woman's Awards given in 1961 for her work especially as a transportation economist. Her government career was made possible by her having studied economics (MA Oregon 1937) during the Depression when jobs were hard to come by.

Grace Murray Hopper (PhD Yale 1934), who retired from the Navy with the rank of rear admiral, is known for her work in the then new field of computer science. She received the Legion of Merit in 1973, the Navy Distinguished Service Medal in 1986, and the National Medal of Technology in 1991. The USS *Hopper*, a guided missile destroyer, was named for her in 1996.

Gertrude Blanch (PhD Cornell 1935) started her career in the government working for the WPA-funded Mathematical Tables Project, was later employed by the National Bureau of Standards, and ended her career at the Wright-Patterson Air Force Base. She received the Air Force's Exceptional Service Award in 1963 and the Federal Woman's Award in 1964.

2.6 Conclusions

The 228 women in our study constituted a substantial community of women who came from rather ordinary backgrounds, who were well-educated at major research universities, and whose advisors were frequently among the most distinguished in their field. Most served as undergraduate teachers since they generally were not hired by research departments. Others, too, had rich and rewarding careers, both in and outside of academia.

The following quotations give us an idea of how some of the women in our study felt about being one of these pioneers. They are among the responses of 1,025 unnamed women who earned PhD's between 1877 and 1925 that appear in a dissertation by Emilie Hutchinson[7] [5, p. 23].

> Assistant Professor / College / Ph.D. 1915–1924... "Nothing but the most earnest conviction that she could never be satisfied without a Ph.D. in mathematics would justify a woman's setting herself that end. It is a long, hard road and when the degree is obtained, she finds that all the calls for mathematics teachers are for men, and that when a woman is employed in one of the large universities she is practically always given long hours and freshman work for years, with less pay than a man would receive for the same service. If all the women could fare as well as I have fared, I'd say 'Go ahead,' but alas! such unexpected good luck does not come to many in a generation" [5, pp. 185–186].

> Professor / College / Ph.D. 1915–1924... "No woman should attempt to get a Ph.D. unless she has very good health. She is likely to be a nervous wreck otherwise. It is a strain that can hardly be described" [5, p. 170].

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[7]Of the 1,025 women questioned by Hutchinson, 371 had degrees in natural science or mathematics. Of the 371 nearly 40% were in chemistry

Fig. 2.3 Age at Death

	20s	30s	40s	50s	60s	70s	80s	90s	100s
	1	5	7	10	20	42	75	64	4
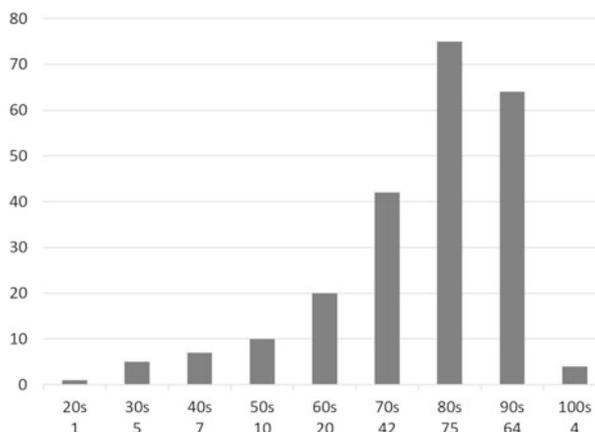
Professor / College / Ph.D. 1877–1915... "I did much more work than was required for the Ph.D. The freedom from monotony in the work in mathematics, the vision and grasp of fields of knowledge that may be interpreted through mathematics, the ideals of thought and of thinking, and the ability to interpret in conduct, relief from the turmoil of a crowded life,—all these make the Ph.D. more valuable than any professional advantage to be derived from it" [5, p. 173].

Associate Professor / College / Ph.D. 1877–1915... "I should encourage women vigorously. My personal experience has been most fortunate. Apparently I have had only the knocks needed to act as spurs. I believe there is a better opportunity for women in the profession than ever before, let one be only willing to surmount difficulties and seek real achievement" [5, p. 101].

These comments are just four of the ten quotations from PhD's in mathematics in the Hutchinson paper and appear not to reflect differing responses based on the period.

The women in our study lived remarkably long lives, with a mean age at death of 80.8 and a median age at death of 84.7 (see Figure 2.3). This is, on average, more than eleven years longer than life expectancy tables indicate. In 2009 Rosella Kanarik (PhD Pittsburgh 1934) became the fourth centenarian among the women in our study. Kanarik, the oldest and last surviving woman, died in 2014 at age 105.

Finally, to expand on what appears above and to find more biographical and bibliographical information and sources used for all of these 228 women one can consult the nearly 700-page, freely accessible *Supplementary Material for Pioneering Women in American Mathematics* [4].

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