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Women in American Mathematics: A Century of Contributions*

JUDY GREEN AND JEANNE LADUKE

Women were a part of the young and vigorous American mathematical community at the time of the founding of the Society. Indeed, throughout the past one hundred years, women have made contributions to mathematics through their research, their teaching, their service to the professional associations, and their participation in the mathematical activities of the larger society. While women have consistently maintained a presence within American mathematics, their numbers and their influence have not increased steadily over the years. Before World War II the growth of the community of American women mathematicians roughly paralleled that of the larger mathematical community, and the number of women who contributed to mathematics was substantial. In the 1940s the war had a dramatic effect on the professional lives of mathematicians, both men and women. Even though women continued to earn Ph.D.'s, the explosive growth of graduate education for men that followed the war eclipsed the participation of women. Thus, the proportion and visibility of women declined significantly during the early

*This article expands upon remarks made by the authors at a panel sponsored by the Association for Women in Mathematics at the Centennial Celebration of the AMS, 9 August 1988. The texts of the talks given at the panel appear in LaDuke et al. 1988.



Portrait of Winifred Edgerton Merrill, oil on canvas by Helena E. Ogden Campbell, presented to Columbia University in 1933.
(Photograph courtesy of Columbia University in the City of New York, Office of Art Properties)

postwar decades. Finally, after again sharing in the growth of mathematics during the 1960s, women attained a self-awareness and cohesiveness in the early 1970s. Since then, it has been difficult not to recognize their numbers and their steady, and sometimes striking, contributions to mathematics.

Throughout the last one hundred years there have been so many women involved in mathematics, and in such diverse ways, that there is no possibility of a comprehensive treatment here. In particular, the names mentioned in this article are nowhere near an exhaustive roll of the women who have made significant contributions.

THE FIRST FIFTY YEARS

By 1888, the year in which the Society was founded, American women were already active in mathematics. At Wellesley College there was a strong, and entirely female, mathematics department. One of its graduates, Winifred Edgerton Merrill, had received her Ph.D. *cum laude* in mathematics from Columbia University in 1886, the first American woman to be granted a Ph.D. in mathematics. Bryn Mawr College had been in existence for three years and from its outset had offered fellowships for graduate study in mathematics. Charlotte Scott, who had received a doctorate in mathematics from the University of London, was head of the Bryn Mawr department of mathematics.

While Scott and Edgerton were, in 1888, the only two women in the United States with doctorates in mathematics, Christine Ladd-Franklin had been admitted to Johns Hopkins University ten years earlier on the recommendation of J. J. Sylvester. She had published extensively, including three articles in the *American Journal of Mathematics*, and had completed a dissertation in the algebra of logic under Charles Sanders Peirce in 1882.¹ Because the Johns Hopkins trustees were unwilling at that time to confer a degree on a woman, Ladd-Franklin's Ph.D. was not conferred until 1926.²

For the first two and one-half years the New York Mathematical Society had no women members, but the desire to publish a journal, the *Bulletin*, provided impetus for a major membership drive. Hence, in 1891, the first six women joined the NYMS. The first, admitted in May of that year, was Charlotte Scott of Bryn Mawr, a distinguished geometer who became one of the most active and recognized women in the early history of the Society, serving on the Council (1894–1897 and 1899–1901) and as vice-president

¹It was published in 1883 in *Studies in Logic by Members of the Johns Hopkins University*. Boston: Little, Brown & Co.

²She was offered an honorary doctorate by Johns Hopkins in recognition of her work in color perception, but insisted on receiving instead the doctorate she had earned in 1882. See "Woman Ph.D. . . ." 1926.

(1906). The other five were: Mary E. Byrd of Smith and Mary Watson Whitney of

Vassar, both astronomers; Susan Jane Cunningham, a professor of mathematics and astronomy at Swarthmore; Ellen Hayes, an early graduate of Oberlin who was professor of mathematics at Wellesley; and Amy Rayson, who taught mathematics and physics at a private school in New York City.³ Women not only joined the Society, but they participated actively in its meetings. The first paper presented by a woman, "An orthomorphic transformation of the ellipsoid," was read at the October 1892 meeting by Ella C. Williams, a new member and teacher in a private school in New York, who had studied at Bryn Mawr, Cornell, Michigan, Newnham College at Cambridge, and privately with H. A. Schwarz at Göttingen.

In connection with the World's Columbian Exposition, an International Mathematical Congress was held in Chicago in 1893,⁴ the year after the University of Chicago had opened. Among the forty-five whose names appear on the official register of the Chicago congress are four women. The listing includes Achsah M. Ely, B.A., professor of mathematics, Vassar College, and three graduate students: Charlotte C. Barnum and Ida M. Schottenfels, who had spent the previous year at Yale; and Mary Frances Winston, who had just completed a year as honorary fellow at the University of Chicago. Barnum, a Vassar graduate, remained at Yale to become, in 1895, the first of three women to receive Ph.D.'s in mathematics from Yale before 1900.⁵ Schottenfels studied at the University of Chicago after the Congress and received a master's degree in 1895. Although she never received a Ph.D., she was, throughout the first decade of the twentieth century, a regular contributor to sessions at Society meetings and published, mainly in the area of finite groups, in the *Bulletin*, the *Annals*, and the *Monthly*. She continued presenting papers to the Society into the early 1930s. Before her year at Chicago, Winston had studied at Wisconsin, where she earned a bachelor's degree, and at Bryn Mawr. In 1897 she received a Ph.D. *magna cum laude* as a student of Felix Klein at Göttingen, having been one of the first three women who were officially admitted as regular students in a university administered by the Prussian government.⁶

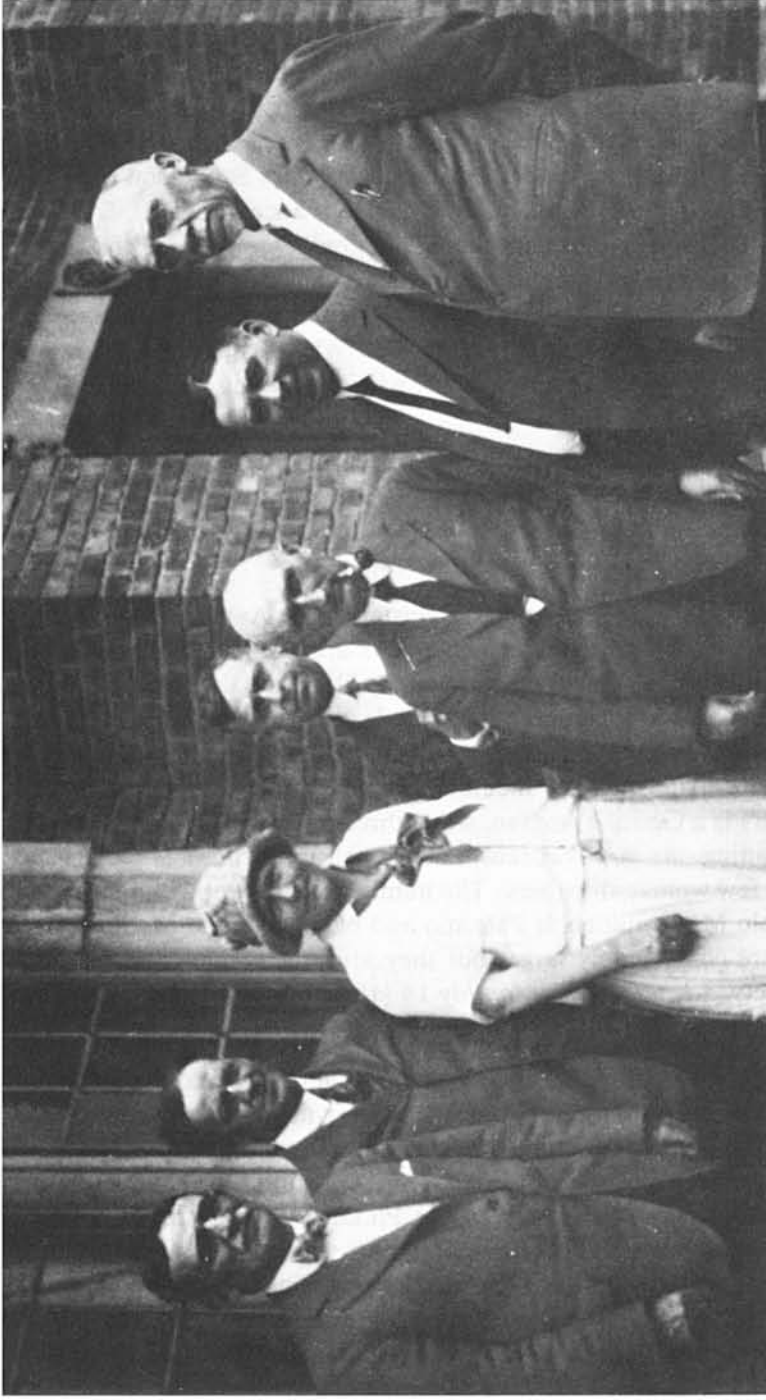
In the first decade of the new century there were eighteen new women Ph.D.'s in mathematics. Included among these is Mary E. Sinclair, who in

³Biographical details about the twenty-two women who joined the Society in the nineteenth century can be found in Whitman 1983.

⁴This Congress was a precursor of the International Congresses that have been held on a regular basis since the 1897 congress in Zürich.

⁵For more information on early American women who earned Ph.D.'s in mathematics see Green and LaDuke 1987.

⁶Although Sofia Kovalevskaia received a Ph.D. from Göttingen in 1874, she was never officially a student there.



Members of the Chicago Mathematics Department Faculty, mid-1920s: (1 to r) E. H. Moore; G. A. Bliss; Mayme I. Logsdon, Ph.D. Chicago 1921; L. E. Dickson; W. D. MacMillan; F. R. Moulton; H. E. Slaught.
(Photograph courtesy of the University of Chicago Mathematics Department.)

1908 became the first of twenty-two women to receive Ph.D.'s in mathematics from the University of Chicago before 1930.⁷ Sinclair worked in the calculus of variations and spent her teaching career at Oberlin, becoming professor and head of the mathematics department there. Also among the earliest women to receive Chicago Ph.D.'s were three other mathematicians of distinction: Anna J. Pell (1910), Mildred Leonora Sanderson (1913), and Olive Cleo Hazlett (1915). Although Sanderson, a student of L. E. Dickson, died in 1914 just a year after completing her graduate work, her thesis, which was published in the *Transactions*,⁸ was a fundamental contribution to the theory of modular invariants and covariants. In 1915 Dickson described her as his most gifted pupil. Both Pell (later Pell Wheeler) and Hazlett had productive careers that included significant participation in and recognition by the Society.

During the early years of the twentieth century membership in the AMS increased, from 347 in 1900 to 630 in 1910 (Pitcher 1988, 2). In 1912 an item in the Notes and News section of the *Monthly* compared American and European mathematical society membership:

According to the latest Annual Register of the American Mathematical Society about 50 of the 668 members are women. It is interesting to observe that the American Mathematical Society has a much larger per cent. of women members than the leading mathematical societies of Europe. According to the latest register of the German mathematical society ... only 5 of its 759 members are women; and only one of these 5 members is a German woman, while three of them are Americans and the remaining one is a Russian. The French mathematical society has also very few women members. The numbers of the women members of the Circolo Matematico di Palermo and of the London Mathematical Society are considerably larger but they are much smaller than in our own society. (*Amer. Math. Monthly* 19 (1912): 84)

When the Mathematical Association of America was organized in 1915 in Columbus, Ohio, women were welcomed and involved. About twelve percent of the more than one thousand charter members were women, and they represented a variety of institutions. The two largest contingents were seven women from Wellesley and six from Iowa State College of Agriculture. Helen A. Merrill, who had received her Ph.D. from Yale in 1903 and was chairman of the department of mathematics at Wellesley from 1916 until 1932, was particularly active in the new association. She served as associate editor of the *Monthly* (1916–1919), was an early member of the Executive Council (1917–1920), and became vice-president in 1920.

⁷The Chicago department, under the leadership of E. H. Moore, was a leading center of graduate education in mathematics in this country until the early 1930s.

⁸Volume 14, 1913, pp. 489–500.

During the decade of the 1920s the two women who were most visible as scholars and as members of the Society were Anna Pell Wheeler and Olive C. Hazlett. Pell Wheeler, whose work and career have been detailed in Grinstein and Campbell (1982), spent from 1911 to 1918 at Mount Holyoke College and the remainder of her career at Bryn Mawr, where she succeeded Scott in the leadership of the department. She published in the area of functional analysis, directed seven Ph.D. dissertations at Bryn Mawr, served on the Council of the AMS (1924–1926), and was the first woman both to give an AMS invited address (1923) and to give the Colloquium lectures (1927). Hazlett, like Sanderson a student of Dickson, worked in the area of modular invariants and in linear associative algebras. After spending a year as a post-doctoral fellow at Harvard, she took a position at Bryn Mawr in 1916, and in 1918 moved to Mount Holyoke at the same time that Pell Wheeler made the opposite move. Although an associate professor at Mount Holyoke, she accepted a reduction in rank in 1925 in order to move to the more research oriented environment of the University of Illinois. She was a cooperating editor of the *Transactions* from 1923 to 1935 and served on the Council of the AMS from 1926 to 1928. Of the many papers she published, one was contributed to the 1924 Toronto International Mathematical Congress and another, at the beginning of a two-year Guggenheim fellowship period in Italy, Switzerland, and Germany, to the 1928 Bologna International Congress of Mathematicians.⁹

From 1924 to 1935 Caroline E. Seely served with Hazlett as a cooperating editor of the *Transactions*. She also was an assistant editor of the *Bulletin* from 1925 to 1934. Seely, a 1915 Columbia Ph.D. who studied with Edward Kasner, published in the area of integral equations throughout her career. She was employed by the AMS from 1913 to 1934. As clerk to the secretary of the AMS, she was responsible for much of the operation of the Society. Her contributions were such that, in response to her tendered resignation, J. R. Kline wrote to the Council in the fall of 1934: “The committee used all efforts within the dignity of the Society to secure the withdrawal of this resignation, but without success” (Hildebrandt Papers).

Besides Scott, Hazlett, and Pell Wheeler, only two women participated on the governing boards of the Society during its first half century: Florence P. Lewis served on the Council of the AMS (1921–1923) and Clara E. Smith served on the 1923 Board of Trustees. Lewis received her Ph.D. from Johns Hopkins in 1913 in algebraic geometry under Frank Morley and spent her entire career at Goucher College. She was on the faculty throughout the period 1912 to 1928, during which time nine women graduated from Goucher

⁹For more details about the work and careers of Hazlett, Pell Wheeler, and several of the other women mentioned in this article see Green and LaDuke n.d.

who later received Ph.D.'s in mathematics.¹⁰ Clara E. Smith received her Ph.D. from Yale in 1904. She spent her career at Wellesley and coauthored textbooks with her colleague Helen A. Merrill. Like Merrill, Smith was active in the MAA. She served on its Board of Trustees (1923–1926) and as vice-president (1927). Although the number of women who participated in the Association on a national level before World War II was not large,¹¹ the group of women who participated in the governance of the sections was both large and diverse.

Even though a substantial number of women in the 1920s attained satisfaction and influence through their research, their teaching, or their roles within the professional societies, certain restrictions and limitations were understood. Examples of the perceptions of some women with degrees in mathematics may be gleaned from responses to questions in a study conducted in the late 1920s of women with Ph.D.'s. An assistant professor of mathematics in a college reported that

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 freshmen 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. (Hutchinson 1929, 185–186)

A woman who had received her Ph.D. before 1915 had the following observations:

I am convinced that women have a special aptitude for mathematics as often as men but practically it is a very difficult line for women to pursue with financial success or even with intellectual satisfaction unless she [*sic*] has private means. . . . A few women's colleges and an occasional co-educational college seem to give the best chance of teaching. Certain universities are particularly unfair to women mathematicians. . . . A woman desiring to teach mathematics would do well to study surveying and engineering in order to break the force of the tradition that women do not understand such branches. (Hutchinson 1929, 206–207)

¹⁰Another student of Morley, Clara L. Bacon, Ph.D. 1911, was also on the Goucher faculty during this period.

¹¹Elizabeth Carlson (1927–1931) and Helen B. Owens (1936–1938) served as associate editors of the *Monthly*; Elizabeth B. Cowley served on the Executive Council (1918–1921), Mary E. Sinclair served on the Board of Trustees (1936–1939), and Mayme I. Logsdon served on the Board of Governors (1940–1942).

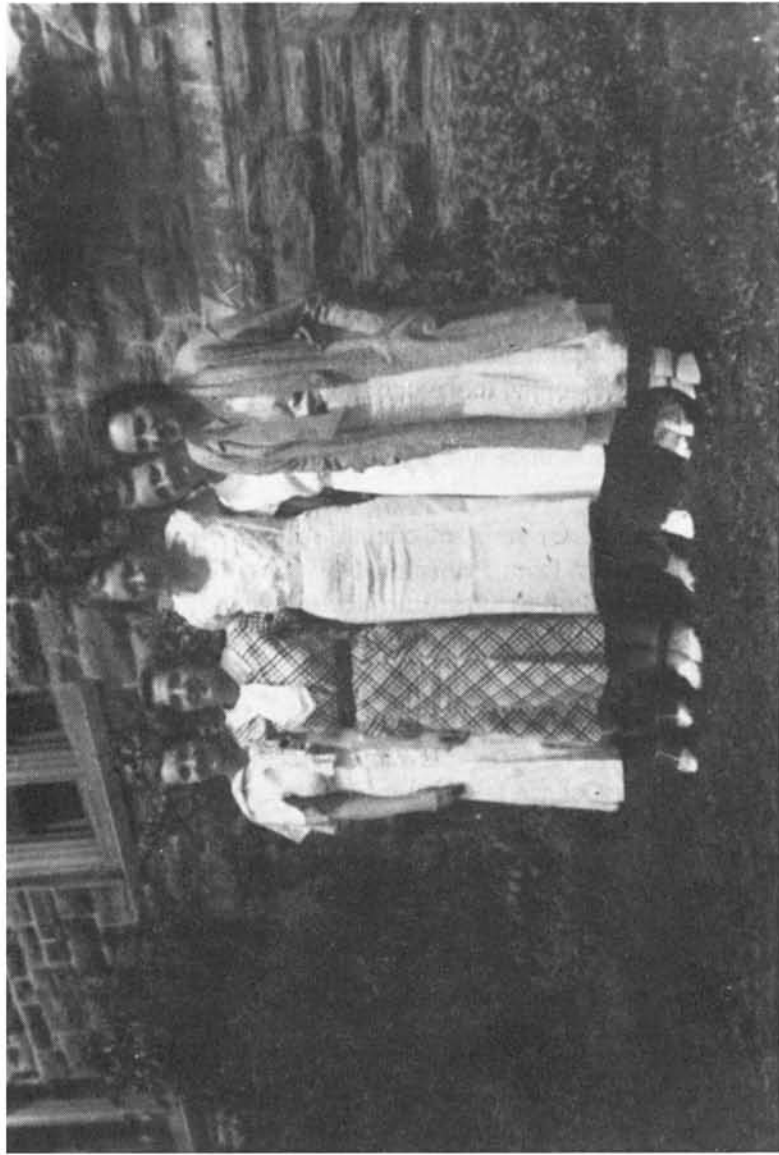
Some aspects of the early 1930s were of significance for mathematicians in general and for women in particular. The depression had devastating consequences for those seeking jobs. The beginning of the School of Mathematics at the newly founded Institute for Advanced Study created a new type of research institute. Mabel S. Barnes, a 1931 Ph.D. from Ohio State University whose first position was a temporary one at a teachers college in Nebraska, recently commented about that period, "In 1933 there were no jobs at all for men or women." She continued:

Even in remote Nebraska I heard about a place called the Institute for Advanced Study opening in far away Princeton. I applied for admission and was accepted. For some years the School of Mathematics was the only School of the Institute and was housed with the mathematics department in Fine Hall at Princeton. Soon after I arrived the Director of the School of Mathematics took me aside and warned me that Princeton was not accustomed to women in its halls of learning and I should make myself as inconspicuous as possible. However, otherwise I found a very friendly atmosphere and spent a valuable and enjoyable year there. . . .

At the end of that year there were, of course, still no jobs. Six men and I from the Institute and from Princeton University took a special qualifying exam to be taken on as substitutes for mathematics teachers on leave from New York City high schools. (LaDuke et al. 1988, 7)

There were several women among the European refugees whose arrival in the 1930s enriched mathematics in America while temporarily exacerbating the job shortage. One of these refugees was Emmy Noether. From the time of her arrival at Bryn Mawr College in 1933 until her death in the spring of 1935, Noether was the focus for intellectual activity for some of the most promising young women in mathematics. Fellowships from Bryn Mawr provided postdoctoral support for Grace Shover (Quinn), Olga Taussky (Todd), and Marie Weiss to work with Noether there in 1934–35. Quinn, who had been a student of C. C. MacDuffee at Ohio State, later spent the major portion of her career on the faculty at American University. Taussky-Todd, who came from Europe to work with Noether, returned there at the end of the year. She emigrated to the United States after World War II to work at the National Bureau of Standards and later became professor at California Institute of Technology.¹² Marie Weiss, who had been a National Research Council Fellow from 1928 to 1930, worked actively in algebra and was a professor at Newcomb College, Tulane, until her death in 1952. Ruth Stauffer (McKee), already a graduate student at Bryn Mawr at the time of Noether's arrival, worked with Noether until her death. McKee received her Ph.D. in

¹²See Taussky-Todd 1985 for more details about her career.



Graduate students and postdoctoral fellows at Bryn Mawr, June 1935: (l to r) Grace Shover, Ph.D. Ohio State 1931; Frances Rosenfeld; Marie Weiss, Ph.D. Stanford 1928; Ruth Stauffer, Ph.D. Bryn Mawr 1935; Olga Taussky, Ph.D. Vienna 1930.

(Photograph courtesy of Grace Shover Quinn.)

1935 and later was employed by a research agency of the Pennsylvania state legislature.

A less well known aspect of the 1930s was the influx of a large number of women religious into graduate schools. Even before 1930 Sister Mary Gervase, in 1917, and Sister Marie Cecilia Mangold, in 1929, had received Ph.D.'s from Catholic University. During the 1930s there was a move to upgrade the quality of Catholic women's colleges. In that decade seventeen women religious earned Ph.D.'s in mathematics, and most subsequently taught in Catholic women's colleges, often assuming major administrative positions. Twelve of these seventeen women received their degrees from Catholic, all as students of Aubrey Landry in algebraic geometry.

During the 1930s many mathematicians found nonacademic employment. This sometimes utilized their mathematical backgrounds in surprising ways. For example, in 1938 the Mathematical Tables Project was begun in New York under the administration of the WPA. Two major figures in this project were Gertrude Blanch, a Cornell Ph.D. in mathematics, and Ida Rhodes. The original project required the direction of about 130 people, mostly high school graduates, who produced volumes of mathematical tables without the use of machines more sophisticated than calculating machines. The mathematics involved in this project was early, pre-computer, systems analysis. After working at the Institute for Numerical Analysis at UCLA, Blanch spent the last 14 years of her career as senior mathematician at the Aerospace Research Laboratories at Wright-Patterson Air Force Base. Rhodes moved with the Mathematical Tables Project to the National Bureau of Standards, from which she retired after years as an expert machine language coder and influential trainer of many who became pioneers in computer software.

Evidence of the presence and visibility of women mathematicians in the prewar years can also be seen by their participation in major professional meetings. The 1936 International Congress at Oslo attracted a strong contingent of women; the list of attendees includes 17 women among the 87 AMS members from North America. The semicentennial celebration of the Society at Columbia in 1938 again inspired attendance and involvement of women; 47 of the 419 members who registered for the event were women. While the work of women scholars was noted in some of the addresses, none of the major addresses were given by women.

WORLD WAR II AND THE POSTWAR PERIOD

The advent of World War II introduced major changes in the life and activities of mathematics departments in this country. For example, the total number of Ph.D.'s granted in the United States and Canada dropped from an average of just under one hundred a year in the late 1930s and early 1940s to a low of twenty-eight in 1945. Meanwhile, teachers of college mathematics

were desperately needed for training programs for the Army and Navy. In 1943, the government estimated that approximately 250,000 trainees would be sent to a selected group of about 300 colleges and universities; and it was estimated that at least 2500 teachers of mathematics would be required for the various programs ("The Problem . . ." 1943). In some cases women who had not been permitted to take positions because of anti-nepotism rules were pressed into service. For example, Helen Owens, a 1910 Cornell Ph.D., whose husband was head of the mathematics department at Pennsylvania State College, finally obtained a position there in the early 1940s.

Even though many women found teaching opportunities at this time, such employment tended to terminate towards the end of the war. In 1944 a department head at a women's college who was seeking a new faculty member was advised, "I suggest you write Professor Coble; he has several girls teaching mathematics in the emergency and these are being let out. There must be a good many institutions such as Minnesota, Wisconsin and Kansas where similar things have happened" (Richardson Papers).

The war also produced major changes in the careers of some individuals. For example, Grace Murray Hopper, a Yale Ph.D. (1934), had been teaching at Vassar when she joined the US Naval Reserve and was assigned to the Bureau of Ordnance Computation Project at Harvard. While there she developed programs for the Mark I computer. Subsequently, through her contributions to the development of higher programming languages, she became known as a pioneer in that field. After years of service with UNIVAC and the US Navy, she retired from the latter with the rank of rear admiral.

With some exceptions, the 1940s and 1950s were not a hospitable period for women in American mathematics. While the total number of mathematics Ph.D.'s awarded in the 1950s was three times the number granted in the 1930s, women did not participate in this postwar growth. In fact, roughly the same number of women earned degrees in the 1950s as in the 1930s. The percentage of Ph.D.'s going to women fell from more than fourteen percent during the first four decades of this century to a low of five percent in the 1950s.

While the number of women annually obtaining advanced degrees did not increase in the 1940s and 1950s, the visibility of women in the mathematical community generally declined dramatically. In the 1940s, for example, about three percent of the abstracts in the *Bulletin* were by women. In the 1940s and 1950s no women were on the Council of the AMS, and, with the exception of one who was on the Board of Trustees in the 1950s,¹³ none were on major

¹³Mina Rees served as a trustee from 1955 to 1959. She was the first woman on the Board of Trustees since 1923, when Anna J. Pell and Clara E. Smith served as two of the original thirty-one trustees.



Grace Murray Hopper, Rear Admiral Ret., while still captain in August 1981.
(Photograph courtesy of the Smithsonian Institution.)

committees. On the other hand, half of the members of the entertainment committee for the International Congress in Cambridge in 1950 were women.

An indication of the extent of the influence of one woman on the field of mathematics during and after the years of World War II can be seen in a resolution adopted by the Council of the AMS at its annual meeting in December 1953. It reads in part:

The very striking and brilliant contributions made by pure (non-military, non-applied) science, not least of these by mathematics, to the winning of World War II is well known. It was clearly seen by the government and those responsible for the armed services that a large scale fostering by the U.S. government of fundamental research, the basis of all research, was unavoidable. . . . Needless to say as the purest of all sciences, mathematical research might well have lagged behind in such an undertaking. That nothing of the sort happened is beyond any doubt traceable to one person — Mina Rees. Under her guidance, basic research in general, and especially in mathematics, received the most intelligent and wholehearted support. No greater wisdom and foresight could have been displayed and the whole postwar development of mathematical research in the United States owes an immeasurable debt to the pioneer work of the Office of Naval Research and to the alert, vigorous and farsighted policy conducted by Miss Rees. (*Bull. AMS* 60 (1954): 134)

Mina Rees, who received her Ph.D. from the University of Chicago in 1931, was on the faculty at Hunter College until she became technical aide to Warren Weaver on the Applied Mathematics Panel of the National Defense Research Committee during World War II. After her service with the Office of Naval Research she returned to Hunter as dean of the faculty and later became president of the Graduate Center of City University of New York. In 1962 the MAA honored Rees with its first Award for Distinguished Service to Mathematics, and in 1983 the National Academy of Sciences bestowed upon her one of its most prestigious honors, its Public Welfare Medal. These are only two of the many ways she has been recognized for her work.

In 1949 Evelyn Boyd Granville became the first black woman to receive a Ph.D. in mathematics. She earned her degree from Yale University as a student of Einar Hille. Marjorie Lee Browne, a student of G. Y. Rainich, received her Ph.D. from the University of Michigan early in 1950. The third Ph.D. earned by a black woman was awarded posthumously by the University of Pittsburgh to Georgia Caldwell Smith in 1961 (Kenschaft 1981, 593). Six others followed during the 1960s.¹⁴

¹⁴See Kenschaft 1981 and Vivienne Malone-Mayes's contribution to LaDuke et al. 1988, 8–10, for fuller discussions of the participation of black women in mathematics.

Women remained active in the national and sectional leadership of the MAA in the postwar years. In the decade following World War II four different women served on the Board of Governors and four served as associate editors of the *Monthly*. Starting in 1957 there have been only two years in which no women were on the Board of Governors, and as early as the 1960s there were usually at least two women serving as vice-president or governor and often three.¹⁵

In contrast to the MAA, the leadership of the AMS conferred little responsibility or recognition upon women. Cathleen S. Morawetz, an applied mathematician at the Courant Institute, was, in 1969, only the second woman to be invited to address any AMS meeting since Emmy Noether in 1934.¹⁶ Although in 1971 Mary Ellen Rudin, a set-theoretic topologist at the University of Wisconsin, began a term on the Council of the AMS, she was the first woman member in over forty years.

In the 1960s the American mathematical community experienced dramatic growth. The number of mathematics Ph.D.'s granted annually by schools in the United States was almost four times as large at the end of the decade (over 1100) as it had been at the beginning (under 300) (National Research Council 1978, 12). The increase for women was not quite as rapid, growing from 19 in 1960 to 63 in 1969. The total number of Ph.D.'s in mathematics granted to women by American universities during the 1960s (about 400 or six percent of the total) was roughly equal to the total number granted to women before 1960.¹⁷

THE 1970S AND AFTER

The growth of the mathematical community that characterized the 1950s and 1960s continued only a few more years, peaking in 1972 when over 1300 Ph.D.'s in mathematics were granted (National Research Council 1978, 12). After a period of decline the annual number of Ph.D.'s granted stabilized at nearly 800 in the middle 1980s, a level first attained in 1965. The pattern for women was somewhat different. The growth was slower during the 1960s, but there was no subsequent decline. Moreover, the proportion of women among new Ph.D.'s has been above sixteen percent since 1983, a level previously reached only in the 1930s.¹⁸

¹⁵Only one woman served as an associate editor of the *Monthly* during the 1960s.

¹⁶Olga Taussky-Todd delivered an invited address in 1959.

¹⁷These figures were obtained by collating the results of the authors' research with data from the Doctorate Records File, which is maintained by the Commission on Human Resources of the National Research Council.

¹⁸Tables summarizing the sex, race, and citizenship of recipients of new doctorates appear in the October issues of the *Notices of the AMS* each year from 1973 to 1979 and in the November issues in subsequent years.

At the same time that the number of mathematicians was increasing, the status of women was becoming an issue in the academic disciplines. Women in professional organizations were beginning to organize caucuses and task forces. In the mathematical community the Association for Women in Mathematics was founded at the 1971 winter meetings after Joanne Darken, then an instructor at Temple University, suggested the formation of a women's caucus.¹⁹ The purpose of AWM was to encourage the participation of women in mathematics. Particular goals included promoting the concerns of women within the Society and the Association and increasing the number of women among the leadership of the AMS.

In April 1971 the AMS Committee on Opportunities in Mathematics for Disadvantaged Groups, which had been formed in 1969, recommended the establishment of a separate Committee on Women in Mathematics. The committee was formed with the following charge:

to identify and to recommend to the Council those actions which in their opinion the Society should take to alleviate some of the disadvantages that women mathematicians now experience and to document their recommendations and actions by presenting data. (Pitcher 1988, 292)

In 1973 this committee, chaired by Cathleen Morawetz, recommended several measures designed to encourage the participation of women in mathematics. The Council adopted some of them. One recommendation resulted in the publication in August 1973 of a Directory of Women Mathematicians. The committee remained in existence until 1974 at which time a joint AMS-MAA committee was formed.

Mary W. Gray, soon to become the first chair of AWM, was particularly active in a campaign to pressure the Society to open Council meetings to all members of the Society. She also advocated the adoption of nomination by petition of candidates for some offices of the Society. Council meetings were opened in 1971, and nomination by petition was adopted in 1972. Several candidates, both male and female, who had been nominated by petition, were elected to the Council during the 1970s. At the same time, the nominating committee of the Society began to nominate women mathematicians to the Society's elective offices with some regularity and has continued to do so. Thus, the virtual exclusion of women from leadership positions in the Society gradually came to an end. Mary Gray, who served a term on the Council from 1973 to 1975, was nominated in 1975, by petition, and was elected as the second woman vice-president of the Society. Nomination by petition has fallen into relative disuse, but the representation of women within the leadership of the AMS has remained significant. Since 1972 the number of

¹⁹In addition to Joanne Darken, those present at the inception of AWM included Mary W. Gray, Judy Green, Diane Laison, and Gloria Olive.

women officers or members-at-large of the Council has been at least three and as high as eight. At all times since 1976 one of the five trustees of the Society has been a woman.

Although women served as assistant or cooperating editors of AMS research journals from the mid-1920s to the mid-1930s, the first woman to serve as editor of an AMS journal was Barbara L. Osofsky, an algebraist at Rutgers University, who became editor of the *Proceedings* in 1974. During the period 1976 to 1987 the annual membership of editorial boards of AMS journals rose from 58 to 133. The number of women among these members fluctuated between 3 and 8.²⁰ The 1985 change in the bylaws of the Society that restricted the membership of the Council to exclude all future editors except for chairs of editorial committees has had the effect of reducing the representation of women on the Council since no woman has been designated the chair of an editorial committee since the change went into effect.

In 1973 Barbara Osofsky became the first woman to address a national meeting of the AMS by invitation since Anna Pell Wheeler gave the Colloquium lectures in 1927. In 1980 Julia B. Robinson became the second woman to deliver the Colloquium lectures; in 1985 Karen Uhlenbeck became the third. Cathleen Morawetz delivered the fifty-fourth Gibbs lecture in 1981, the first by a woman. At the AMS centennial celebration in 1988, Karen Uhlenbeck, the only woman among eighteen invited speakers, delivered the address, "Instantons and their relatives," at the Symposium on Mathematics into the Twenty-First Century. Despite such precedents, the incidence of women as invited speakers at AMS meetings and AMS sponsored conferences remains extremely low. AMS statistics show that there were only between twenty-five and thirty women who were invited speakers at any AMS meeting, either national or regional, in the period 1978 to 1987. ("Statistics on Women Mathematicians . . ." 1988, 1065). Programs for the semiannual joint meetings for the same period show that the MAA invited about the same number of women to address national meetings as were invited to address all meetings of the Society.

The MAA has continued to appoint woman to editorial positions. Since 1972 at least one associate editor of the *Monthly* has been a woman; often there have been several. However, no woman has yet served as editor since the *Monthly's* inception in 1894. Similarly, women have been involved on the editorial boards of the Association's two newer publications, *Mathematics Magazine* and *College Mathematics Journal*. Although the *College Mathematics Journal* has not yet had a woman as editor, Doris J. Schattschneider was editor of *Mathematics Magazine* from 1981 to 1985.

²⁰These numbers include both editors and associate editors. See "Statistics on Women Mathematicians . . ." 1986–1988 for more detail.

The MAA inaugurated its first woman president, Dorothy Bernstein, in 1978 and will inaugurate its second woman president when Lida Barrett takes office in 1989. Bernstein, a student of J. D. Tamarkin at Brown, worked in the area of partial differential equations. She taught for most of her career at the University of Rochester and at Goucher College. Barrett, a topologist in the tradition of R. L. Moore and a student of J. R. Kline at the University of Pennsylvania, is now Dean at Mississippi State University.

Julia Robinson served as the first woman president of the AMS from 1983 to 1984. In 1948 Robinson earned her Ph.D. at the University of California, Berkeley, as a student of Alfred Tarski. Her work in recursive function theory, carried out while she held no regular position, provided a major component of the solution to Hilbert's tenth problem. She was elected to the National Academy of Sciences in 1975, the first woman mathematician to be so honored. Subsequently, she was appointed professor at Berkeley. In 1983 Robinson became the first woman mathematician to receive a MacArthur Foundation Fellowship.²¹ She died in 1985.²²

While much smaller than the Society or the Association, AWM has also contributed to the increased visibility of women as active research mathematicians. In January 1974 Louise Hay presented the first mathematical talk, "Indices of Turing Machines," at a national AWM meeting. The annual Emmy Noether Lectures began in 1980.²³ In 1982 the AWM sponsored a symposium to honor Emmy Noether's one hundredth birthday. Its second symposium was held in 1985 in cooperation with the Mary Ingraham Bunting Institute of Radcliffe College and dealt with the legacy of Sonia Kovalevskaja.²⁴ The AWM newsletter has featured numerous historical articles on women mathematicians and their mathematics. Several of these have been precursors of more formal contributions to the growing literature on the history of women in mathematics.²⁵

In 1984, Julia Robinson and Linda Rothschild, the presidents of the AMS and AWM, respectively, accepted a citation from the MAA which reads in part:

The struggle is not over: the Women's Movement has not achieved all of its goals. But the achievements have been so great and the benefits

²¹Karen Uhlenbeck followed Robinson as the second woman mathematician to receive a MacArthur Foundation Fellowship and the second woman mathematician to be elected to the National Academy of Sciences.

²²See Reid 1986 for further details about Robinson.

²³Short biographies of the first nine Emmy Noether lecturers and titles of their lectures appear in Association for Women in Mathematics 1988.

²⁴The proceedings of these symposia appear as Srinivasan and Sally 1983 and Keen 1987.

²⁵Most of the literature deals with individual women mathematicians. For example, Grinstein and Campbell 1987 contains selections on forty-three women mathematicians, including some of those mentioned in this article.

to society so obvious that it is right to pause to acknowledge and honor the many women who have blazed the trail.

The Women's Movement in mathematics has been especially strong. Many women — and more than a few men — have worked hard and effectively to convince women that they have potential for excellence in mathematics and that they should receive recognition and rewards commensurate with their achievements . . .

Women have achieved prominence in research, teaching, writing, and editorial responsibilities, and have risen to the highest levels of leadership in mathematical organizations. Public recognition for these achievements has inspired other women to make full use of their abilities, in mathematics as in all affairs, with pride and confidence. The Board of Governors of the Mathematical Association of America recognizes and honors their many contributions. ("MAA Gives Special Recognition . . ." 1984)

Although the citation explicitly addresses only the recent achievements of the women's movement in mathematics, those achievements are part of a continuous tradition of women in American mathematics that goes back more than a century.

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