REVIEW

Edited by **Gerald B. Folland**
Mathematics Department, University of Washington, Seattle, WA 98195-4350

R. L. Moore: Mathematician and Teacher. By John Parker. Mathematical Association of America, Washington, DC, 2005, xiv + 387 pp., ISBN 0-88385-550-X, $36.95.

Reviewed by **David E. Zitarelli**

What was life like in mathematics one hundred years ago? Certainly the year 1905 was not as revolutionary for mathematics as it was for physics, when Albert Einstein published five landmark papers that culminated in the special theory of relativity. The nearest ground-breaking development for mathematics in that decade was probably the introduction of a new integral in 1902 by Henri Lebesgue, though in retrospect David Hilbert's 1900 address posing twenty-three problems was also a landmark. The United States had not experienced any dramatic events in mathematics since the opening of the University of Chicago in 1892, yet 1905 might well be regarded as a watershed between two entirely different periods in its history. The earlier era centered on programs at new universities (notably Johns Hopkins, Clark, and Chicago) founded with a mission of employing and training research scholars; the later age became decentralized, with a host of universities moving in the direction of these trendsetters. 1905 was also a defining year for Robert Lee Moore (1882–1974), the subject of the book under review, who advanced from student to professional mathematician. However, while some recent Ph.D.'s were able to pluck plums from universities with research missions, Moore was relegated to one that aspired to reach the upper ranks but lacked resources to achieve such status. At least he fared better than most of Sylvester's graduates twenty-five years earlier who settled into positions at liberal arts colleges and had little time to pursue original investigations.

Before turning to the biography at hand, I will provide some context by sketching what life was like in the American mathematical community a hundred years ago and introducing some of the major players. (See [**2**] for a detailed snapshot of this community during the period 1891–1906.) For one thing, there was but one professional mathematical organization, the American Mathematical Society (AMS). Founded in 1888, it initially consisted of a group of mathematicians from New York City but expanded into a national organization in 1894. Ten years later its list of officers reflected this national character, with President W. F. Osgood at Harvard, Vice Presidents Charlotte Angas Scott and Irving Stringham at Bryn Mawr and Berkeley, respectively, and Secretary F. N. Cole at AMS headquarters at Columbia. At the midpoint between 1888 and 1894 the Society established its journal of record, the *Bulletin*.

A perusal of *Bulletin* issues from the fall of 1905 and spring of 1906 provides an overall portrait of professional activity in mathematics at the time. Some of those activities will remind a twenty-first-century mathematician of activities today, while others will seem, well, a hundred years old. At that time the *Bulletin* published research/expository articles, and the three issues from the fall of 1905 exhibit an impressive depth and breadth by mathematicians scattered throughout the east and parts of the midwest and far west. Topics included conics, Arzelà's condition, Galois fields, linear groups, dynamics, hypercomplex numbers, group theory, and loxodromes. In addition, the *Bulletin* carried book reviews that were every bit as detailed as those today, evaluating classroom textbooks as well as works on cutting-edge research. The reviewers included Oswald Veblen (Chicago), O. D. Kellogg (Harvard), and Earl Hedrick (Missouri), who in 1915 presided over the organizational meeting for the founding of the Mathematical Association of America and became its first president. The *Bulletin* also gives an indication of the rise of respect in France for work being done in America: an appeal by Gaston Darboux for abstracts of papers written in American journals for publication in the *Bulletin des sciences mathématiques*.

Three American mathematics journals published only research articles at that time. The 1905 volume of the *American Journal of Mathematics*, founded at Johns Hopkins in 1878, included two papers by L. E. Dickson (Chicago) and one each by Luther Eisenhart (Princeton), G. W. Hill (New York), G. A. Miller (Stanford), C. L. E. Moore (MIT), and Virgil Snyder (Cornell). The 1905 issues of the *Annals of Mathematics*, then published at Harvard but earlier at Virginia and since 1911 at Princeton, included respectable papers by Harvard luminaries Maxime Bôcher and E. V. Huntington. The four 1905 issues of the *Transactions of the AMS*, which had appeared for the first time only in 1900, included thirty-eight papers by twenty-nine authors, of which only one was coauthored. The leading contributors were E. V. Huntington and the indefatigable L. E. Dickson with three papers each. The Americans G. A. Miller, Oswald Veblen, and E. J. Wilczynski (Berkeley) had two papers each, as did the Frenchman M. Fréchet (Paris) and the Scot J. H. M. Wedderburn (who was visiting Chicago), but undoubtedly the biggest name to appear was Henri Poincaré (Paris). Does this mean that American mathematics had achieved international status by this time? Not entirely: notice the absence of Germans. While A. Loewy (Freiberg) wrote an article on substitution groups, his name hardly resonates with Klein, Hilbert, and Minkowski. Even this MONTHLY, then published privately by B. F. Finkel, included research articles by G. A. Miller and N. J. Lennes (Chicago) in its August-September issue.

Thus, in some respects the life of the mathematical community was not too different in the fall of 1905 from the fall of 2005, but in others the differences were radical. Almost all universities and colleges at the time continued to emphasize a liberal arts education at the expense of the sciences, and fifteen- to twenty-one-hour teaching loads precluded serious research. Perhaps the biggest difference from then to now was the size of the community. The accompanying table cites attendance figures and the number of papers presented at five notable AMS meetings held in the fall of 1905.

Date	Type of Meeting	Attendance	Papers delivered
September	Summer AMS	28	23
September	San Francisco Section	17	11
October	125th New York City	30	8
December	18th Chicago Section	19	18
December	12th Annual AMS	66	22

The report on the annual meeting notes that the attendance of sixty-six "exceeded all previous meetings." Incidentally, reports of those meetings listed new members, one of whom was Vito Volterra. Although the combined attendance of the two December meetings was only eighty-five, a third session on mathematics took place simultaneously, Section A of the American Association of Arts and Sciences, which included eleven papers on mathematics in addition to the retiring presidential address by Alexander Ziwet (Michigan). All in all, then, one can conclude that about a hundred active mathematicians attended these three meetings. The corresponding figure has exceeded four thousand at each joint meeting held so far in the twenty-first century. (Of course transportation to meetings is much easier today. Nonetheless, a forty-fold increase in the 1900 population of seventy-six million would result in a U.S. population today of three billion!)

Up until 1905 many American mathematicicans had received their advanced training in Europe; for example, Kellogg and Hedrick were both students of Hilbert. The American dependence on foreign training was also reflected in the listing in the *Bulletin* of courses offered at European universities. But this was about to change: the production of Ph.D.'s in America was on the rise, and the flow of American students to universities abroad would soon slow to a trickle. The November 1905 *Bulletin* listed the twenty-one people who had received their Ph.D.'s in that year; an accompanying table of doctorates awarded in prior years showed that this was the largest number in any year up to that point.

One of those listed was R. L. Moore (RLM hereinafter). The biography by John Parker does not dwell on this watershed year, nor does it supply the kind of details about the American mathematical scene that we have cited to set the tone. But Parker, an English journalist, provides an engaging introduction to the life and times of this captivating figure. In fact, an appendix on the Moore genealogy unveils family ties not only to U.S. Presidents Zachary Taylor and Grover Cleveland and president of the Confederacy Jefferson Davis, but also to such European kings as Alfred the Great of England and Henry I of France. Moreover, the book paints a vivid portrait of Dallas, Texas, at the time Moore was born there in 1882, with frequent parallels between events surrounding Moore and more recent historical incidents, such as the location of the feed and grocery store operated by his parents in relation to the spot where President John F. Kennedy was assassinated in 1963.

Until now the primary source on Moore has been the 1972 work by Traylor [**4**]. The present biography by Parker leans heavily on [**4**] but brings it up to date by describing events that occurred after that and by adding material that was not available in 1972. The remainder of this new book consists of a chronological account of RLM's life and work, beginning with his student days, continuing through his emergence as a curmudgeon research mathematician, and ending with his status as a local icon in a state filled with figures who required ten-gallon hats to match their egos. Little mathematics will be found here, as might be expected in view of the author's background. However, for the reader interested in events surrounding mathematics in America through about 1970, rather than developments in the subject itself, this book provides an excellent overview. In the rest of this review I highlight some aspects that I found particularly appealing.

The biography begins with the three phases of RLM's education. Scant attention is paid to the private school he attended, the Waldemar Malcolmson Academy, but the author cites Malcolmson's letter recommending the fifteen-year-old Moore for admission to the fledgling University of Texas. "He takes special pleasure in the study of mathematics in many cases solving, without aid, the most difficult propositions in an original manner" (p. 11). The operative phrase here, *without aid*, is prophetic, and suggests the first principle of the Moore Method.

Next, Parker moves to G. B. Halsted, the professor of mathematics at the University of Texas. Universities then had but one professor in each department, yet the staff at Texas was impressive during RLM's enrollment, consisting also of L. E. Dickson, H. Y. Benedict, and T. M. Putnam. A specialist in geometry, especially non-Euclidean geometry, Halsted recognized Moore's prodigious talent at once, believing he had discovered a new János Bolyai. The two would develop a close friendship that would last until Halsted's death in 1922. Ironically, Halsted's relentless promotion of Moore for a faculty position at Texas, fueled by RLM's novel proof of a redundancy in the geometry of Hilbert, became the last straw in Halsted's strained relationship with the regents and led to his firing.

The final stage in RLM's education began when he accepted a fellowship at the hotbed of exploration and discovery—the University of Chicago—in 1903. (Halsted had suggested that Moore study under Hilbert at Göttingen if he could afford it, and it is tempting to speculate on how his teaching methods might have been altered by Hilbert's outdoor blackboard and Sunday hikes.) By that time L. E. Dickson had joined the staff of E. H. Moore (EHM), Oskar Bolza, and Heinrich Maschke. The setting was perfect for RLM, who plunged right into the revision for publication of the doctoral dissertation of Oswald Veblen; the two remained friends for the rest of their lives. Veblen stayed at Chicago another two years while RLM completed his degree, and thirty years later RLM gave unequivocal credit to him for serving as his dissertation advisor, though EHM also played an important role. Whereas EHM's department stressed original investigations into mathematics, effective teaching was valued equally. His colleagues G. A. Bliss and L. E. Dickson recalled, "He believed in the exercise of individuality in class room instruction, and he gave his colleagues unlimited freedom in the development of their class room methods" [**1**, p. 89]. Overall, throughout all three stages of his education, RLM was fortunate to encounter powerful personalities who would influence the teaching style he would ultimately adopt—Malcolmson at the Dallas Lyceum, Halsted at Texas, and EHM at Chicago.

After RLM completed his dissertation on the foundations of geometry, he accepted a position at the University of Tennessee, an institution wishing to hop on the research bandwagon, but it was wrong for him, and a disagreement with the department head caused him to leave after only one year. Of more importance were lifelong lessons learned from a year spent in isolation. For one thing, he did not immediately revise his dissertation for publication, possibly because he was working on an axiomatization of arithmetic. As many of us discover after leaving graduate school, doing research involves very hard work over sustained periods that include long intervals in which the amount of progress is less than epsilon. The fallow period that RLM endured left him depressed and doubtful of his desire and capacity for work. Even the ensuing two years at Princeton did not see him publish original investigations, though his dissertation saw the light of day. That period was followed by three years at Northwestern, whose early history is discussed in the book.

Then Moore, age twenty-nine, accepted an instructorship at the University of Pennsylvania, which supplied a supportive environment in which the demands of his teaching method were tolerated and the productivity of his research rewarded. His nine years there, 1911–20, are detailed in this MONTHLY [**5**], along with his first dozen years at the University of Texas at Austin, 1920–32. At Texas Moore directed the dissertations of two outstanding mathematicians, R. L. Wilder and G. T. Whyburn, but economic hardships during the 1930s limited his doctoral production, with Burton Jones the most prominent student to graduate under him during this decade. Parker points out various ways in which the arch-conservative Moore opposed the New Deal of President Roosevelt during this period. He certainly opposed the WPA, and more than likely would not have approved of the WPA program of hiring human computers to perform scientific calculations, a practice recently described in an informative book by David Grier [**3**]. Nonetheless, during Moore's two-year presidency of the AMS (1937–38), the Society sponsored a successful fifty-year celebration and set the stage for publishing *Mathematical Reviews*, accomplishments that seem to have drawn scant attention.

By about 1940 Moore viewed his primary occupation as the supervisor of dissertations. He continually honed his method of teaching, which produced such stalwarts as Gail Young, R. H. Bing, Edwin Moise, Richard Anderson, and Mary Ellen Rudin in the 1940s. We learn from Parker that in 1946 graduate students became employed as teaching assistants rather than instructors, a change RLM vehemently opposed.

The biography introduces all of these figures, painting them as real people, not just authors of impressive lists of papers. There are also detailed accounts of political squabbles at the University of Texas, including the separation of mathematics into pure and applied departments. This division was not along lines these names might suggest. For instance, Harry Vandiver and Moore had a falling out that sent Vandiver scrambling to the third floor of the building, where the applied mathematics department was housed, a rather curious refuge for a number-theory specialist.

The last chapter in the book presents many aspects of the intrigue surrounding RLM's final years at Texas. He had accepted modified service upon reaching age seventy in 1953, a designation he all but ignored, teaching five or six courses a semester amounting to a fifteen-hour load. He also refused to honor other changes in the graduate program, like requiring doctoral qualifying exams: the biography asserts, "He believed the only criterion needed for getting a doctorate was the demonstrated ability to do publishable research" (p. 316). Ironically, this philosophy would have kept him in good stead at Princeton, whose practice of giving uniform exams to undergraduates had caused many bitter arguments during his 1906–08 tenure there. However, the new dean of the College of Arts and Sciences, John R. Silber, a tough Texan who would later become embroiled in various controversies as president of Boston University, felt that the presence of Moore hindered the recruitment of new faculty and sought to remove him. His proposal that Moore and two other close colleagues should be retired was accepted by the board of regents, resulting in RLM's termination in June 1969 at age eighty-six, in spite of a feverish battle waged by a group of former Moore graduate students. That group produced a book in RLM's defense known as *The Green Book* but officially titled *Concerning Dean John R. Silber and the Proposed Dismissal of Professor R. L. Moore*—to little avail. Even though RLM's competitive spirit was legendary, he consistently avoided situations that might have smacked of self-promotion, and consequently he did not attend the dedication ceremony for Robert Lee Moore Hall in October 1973. (However, the Archives of American Mathematics, which are housed at the University of Texas at Austin, contain a gracious handwritten letter from Moore expressing his thanks to the regents for this action.) He suffered strokes the following May and June, and succumbed to brain damage on October 4, the day before the first anniversary of the dedication of the building named in his honor.

Much of the book is given to the Moore Method of teaching, particularly chapter 16. It is telling that Moore's students were entirely successful in other branches of mathematics beyond his own brand of topology. Indeed, the Moore Method has even produced impressive results in applied mathematics. The paper [**5**] notes the success of the political scientist G. H. Hallett, Jr., RLM's third student at Penn. The Parker biography provides details of John Worrell's work on the NASA mission to Mars and notes the accomplishments of two others at entirely different installations, Burton Jones at the Harvard Underwater Sound Laboratory during World War II and, more recently, John Green at DuPont's Haskell Laboratory for Toxicology and Industrial Medicine.

The book is liberally laced with photos, and the editors are to be commended for minimizing the number of gremlins that appear. Nonetheless, I will point out several numerical infelicities. First, Halsted was not J. J. Sylvester's first doctoral student at Johns Hopkins (p. 21); Thomas Craig was. J. R. Kline directed eighteen dissertations, not thirteen (footnote 16 on page 102). Harry Vandiver received an honorary degree from Penn in 1945, not a year later (p. 122, repeated on p. 227). Texas did not begin producing Ph.D. students in mathematics in 1923 (p. 238); Goldie Prentis Horton was first, earning her degree in 1916 under Milton Brockett Porter. Moore was sent packing from Texas almost seventy years after Halsted met the same fate, not sixty (p. 324). And, finally, the Legacy of R. L. Moore Project hosted a session on the Moore method at the Joint Meetings in New Orleans in 2001, not 2000 (p. 332).

Although Moore certainly had his personal failings, all of which receive fair treatment here, his example continues to bear relevance. At a recent symposium I found myself in the company of two eminent mathematicians. Upon hearing that one had declared at a certain age that he would no longer take any further doctoral students, because his brand of mathematics was out of fashion, the other, a colleague of mine, nodded in agreement and asserted that he might no longer accept students after his present three graduate. I balked, citing Moore's example and asserting, "As long as you are still effective in teaching students *how to do mathematics* while still *maintaining the highest standards*, the particular subject matter is irrelevant." Only time will tell if Moore's legacy will continue to grow in such a direction.

REFERENCES

1. G. A. Bliss and L. E. Dickson, Biographical memoir of Eliakim Hastings Moore: 1862–1932, in *Biographical Memoirs*, vol. 17, National Academy of Sciences, Washington, D.C., 1936, pp. 83–102.
2. D. D. Fenster and K. H. Parshall, A profile of the American mathematical research community: 1891–1906, in *The History of Modern Mathematics*, E. Knobloch and D. E. Rowe, eds., Academic Press, San Diego, 1994, pp. 179–227.
3. D. A. Grier, *When Computers Were Human*, Princeton University Press, Princeton, 2005.
4. D. R. Traylor, *Creative Teaching: The Heritage of R. L. Moore*, University of Houston, Houston, 1972.
5. D. E. Zitarelli, The origin and early impact of the Moore Method, this MONTHLY **111** (2004) 465–486.

Temple University, Philadelphia, PA 19122
zit@temple.edu