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Review: A History of Mathematics in the United States and Canada (Vol. 1), by David Zitarelli

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David Zitarelli, *A History of Mathematics in the United States and Canada, Volume 1: 1492 – 1900* , Providence, Rhode Island: MAA Press, an imprint of the American Mathematical Society, 2019.

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In the spring of 2018, David Zitarelli delivered an 800-page manuscript to the American Mathematical Society, covering the history of mathematics in the United States and Canada from 1492 to 1930. Sadly, the author died on December 2, 2018 before editing of the manuscript had been completed. The volume under review represents the portion of that history up through the end of the 19th century. It is mentioned in a preface to the book that a second volume covering the years 1900 – 1930 will be published in the future.

There are several works that discuss the history of mathematics in the United States, but I am not aware of any comprehensive history of mathematics in Canada. The Zitarelli volume does look at Canadian topics, such as the mathematics instruction at the Collège du Québec and the University of Toronto. Nevertheless, the history of mathematics in America forms the bulk of this work. One can hope that the second volume will look at the important role of the 1924 International Congress of Mathematicians held in Toronto. The first ICM held in North America, not counting the Chicago Congress of 1893.

What are some of the other works on the history of mathematics in America and how does the Zitarelli volume compare to them? Here are four representative works that we will use in this review.

1. Florian Cajori, *The Teaching and History of Mathematics in the United States*, published 1890.

2. David Eugene Smith and Jekuthiel Ginsburg, *A History of Mathematics in America Before 1900*, published 1934.

3. Karen Hunger Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1876 – 1900: J. J. Sylvester, Felix Klein, and E. H. Moore*, published 1994.

4. Steve Batterson, *American Mathematics 1890 – 1913: Catching up to Europe*, published 2017.

These four volumes, along with Zitarelli, cover similar time periods, with all of them ending before World War I.

In Cajori, the main focus is on mathematics instruction and mathematics departments up to the late 19th century. Mathematical textbooks of this period are also discussed. Cajori looks at self-taught mathematicians (e.g., Nathaniel Bowditch). This is also an important theme in Zitarelli. Cajori also has an interesting section on circle-squarers in 19th century America. These are amateur mathematicians who claim to have found a compass and straightedge construction of a square whose area equals a given circle (which is impossible, of course).

Smith's work is more of an overview of the history, totaling 200 pages. For example, the 1893 Chicago Congress and the subsequent lectures by Felix Klein in Evanston, Illinois are discussed in three pages in Smith. The same topic takes up 70 pages in Parshall and Rowe, while Zitarelli devotes 20 pages. The organization of Smith is similar to that of Zitarelli, dividing the history into Colonial, pre-Civil War and post-Civil War periods.

The Parshall and Rowe history starts with a chapter on American mathematics from 1776 to 1876. The bulk of the work deals with the following topics.

1. The English mathematician J. J. Sylvester's time at Johns Hopkins University (discussed in two chapters).
2. Felix Klein and the American mathematicians who went to Germany to study with Klein and other German faculty such as David Hilbert, Max Noether and Sophus Lie (discussed in two chapters).
3. The 1893 Chicago Congress and Evanston Colloquia (discussed in two chapters), and E. H. Moore and the University of Chicago department (discussed in one chapter).

This volume does an excellent job in describing how mathematical research develops in the United States and the influences that nurtured that research.

Batterson's work has a similar goal to that of Parshall and Rowe, the development of mathematical scholarship in the United States. After setting the stage with the American "colony" that developed around Klein in the University of Göttingen, Batterson discusses scholarship in 19th century America. An interesting chapter follows on the influential college presidents, Charles Eliot of Harvard and Daniel Coit Gilman of Johns Hopkins, who contributed to a broadening of disciplines taught and an emphasis on faculty scholarship in American academic institutions. Batterson then turns to the main theme of this work, the significance of William Fogg Osgood, Maxime Bôcher and E. H. Moore in the advancement of mathematical research in America. There is also a chapter on the birth and role of the American Mathematical Society.

All of these works are important for understanding American mathematics in the 19th century. How does the work of Zitarelli compare to these other histories?

Zitarelli's work has a larger scope than the other books. It begins in 1492 with Columbus, who used mathematics for navigation. The first European mathematician to visit the North America is Thomas Harriot, who accompanied Walter Raleigh as a surveyor in a 1585 voyage to Roanoke Island. The colonial period is thoroughly covered, with the first two chapters devoted to this era.

The most distinctive feature of Zitarelli's book is the portrayal of the people being discussed. The writing in this work exhibits a personal touch that can be quite endearing. For example, in the colonial era, the first mathematician of note is the Harvard professor Isaac Greenwood, who authored the first mathematical text published in America, the *Arithmetick Vulgar and Decimal* of 1729. Here is the description of Greenwood in Zitarelli "Isaac Greenwood is surely America's first mathematician. … His public lectures on the work of Isaac Newton were very popular, yet he never became a productive scientist because he was dogged by alcohol. In spite of the demon rum, or perhaps because of it, Greenwood exerted a profound influence on some of his students." [8, pp. 36-37]

In the colonial period, we also see discussion of mathematics at the early colleges (Harvard, Yale, and the College of William and Mary). The Indian College is included in this discussion. Affiliated with Harvard, the Indian College offered undergraduate education for Native Americans. The discussion of the Indian College, not mentioned in the other histories, gives a greater context to the history.

After the colonial period, Zitarelli moves on to the era from 1800 to 1876. The author considers mathematics faculty and curriculum at various colleges (such as Harvard, Yale, West Point, Naval Academy, University of Virginia, and University of Toronto). Also, a number of textbooks of the period are examined, including those by Nicholas Pike, Jeremiah Day, Samuel Webber, John Farrar, and Charles Davies.

Farrar is little remembered today, but he was important in this time period for his translations of French textbooks by Lacroix, Bézout, Legendre, and Bourdon. He also translated Euler's *Elements of Algebra* (written in German). Due to overwork, Farrar developed severe eye problems, which in turn led to other severe health problems. Zitarelli [8, p. 139] goes to some length to describe the help that his wife gave him during this time. "A dozen years after her husband's death, Eliza Farrar wrote *Recollections of Seventy Years* (1865), a collection of anecdotes that today provide glimpses into her life in England and France between 1783 and 1819. That work enlivened her husband's sickroom for the last 14 years of his life." Such description does not increase our knowledge of Farrar's mathematical contributions, but again shows the personal touch that Zitarelli's work displays.

The antebellum period also saw the beginnings of scientific societies and mathematical journals. This work looks at emerging societies such as the American Philosophical Society (and its *Proceedings* and *Transactions*), the American Academy for the Advancement of Science (and its *Proceedings*), and the American Academy of Arts and Sciences (and its *Memoirs* and *Proceedings*). These societies gave mathematicians opportunities to publish. American journals devoted to mathematics included the *Mathematical Companion, Mathematical Correspondent, Mathematical Diary, Mathematical Monthly* (not the journal we know today), *American Journal of Mathematics*, and *The Analyst*.

These journals would all be considered inferior by today's standards, but were important outlets for 19th century American mathematicians. They had a heavy emphasis on giving problems for the reader to solved, but *The Analyst* did publish several articles by G. W. Hill, one of the most important American mathematicians in the century. Henri Poincaré wrote the introduction to the *Collected Mathematical Works* of Hill. He expressed a certain disdain for American journals such as *The Analyst* (although he expressed great admiration for Hill himself). Poincaré talks about journals "where amateur mathematicians propose their small problems and indulge themselves in the elegance of their solutions, for example, "The Analyst"." [6, p. ix] This shows the obstacles that confronted American mathematicians of the time in becoming part of the international research community.

Zitarelli looks at various applications of mathematics from the colonial period up through Civil War. Applications that are discussed include the following:

1. Surveying, as illustrated by figures such as George Washington, the African – American Benjamin Banneker, Andrew Ellicott, Ferdinand Hassler, and Alexander Dallas Bache.
2. Almanacs, which gave essential astronomical data in this time, were produced by Thomas Brattle, Benjamin Franklin, and Simon Newcomb.
3. Navigation is seen through the work of Nathaniel Bowditch.
4. Cryptology is discussed through its use in the Revolutionary War and the Civil War. For example, Zitarelli tells of the time when George Washington came in possession of an encrypted letter [8, pp. 89 – 91]. He gave the letter to

Elbridge Gerry (of gerrymander fame) and Samuel West. Their decryption led to the capture and hanging of the traitor Benjamin Church.

5. Statistics is given a thorough examination. A section is given to the history of the American Statistical Association, which was founded in 1839, and early American statisticians [8, pp. 153 – 160]. Zitarelli looks at figures such as Lemuel Shattuck, who produced a census of Boston in 1845, James DeBow who organized the federal 1850 census, and Francis Amasa Walker, who led the 1870 and 1880 federal censuses before becoming the president of M.I.T.

Zitarelli's examination of the variety of applications in American mathematics is unique among the histories mentioned above. It should be mentioned that Smith does touch on almanacs and even astrology [7, pp. 10 – 14] and has a short section on surveying [7, pp. 42 – 43].

The final part of the book covers the same era as Parshall and Rowe. Zitarelli considers the roles of the graduate programs run by Sylvester, Klein, Moore, and Hilbert. In general, Parshall and Rowe give an excellent description of what happened in these graduate programs, while Zitarelli gives more information on what happened to students after graduation. For example, with regard to William Pitt Durfee who got a PhD from Johns Hopkins, Parshall and Rowe merely say that Durfee "took a professorship at teaching-intensive Hobart College in Geneva, New York in 1884, became Dean in 1888, and dropped from the research ranks." [5, p. 145] Zitarelli gives a more thorough description of Durfee's career after receiving his doctorate in 1883, "One year later, he was appointed professor and chair of mathematics at Hobart College in Geneva, NY, a position he held until his retirement in 1929. After only four years at Hobart, he was appointed dean of the faculty, the first person to hold that position at an American liberal arts college. He served in this administrative position until 1925, and was the college's acting president on four different occasions." [8, pp. 258-259] Parshall and Rowe discuss the mathematics that Durfee worked on at Hopkins in some detail, while Zitarelli gives a more complete picture of the Durfee's professional life. Zitarelli then goes on to discuss Durfee's son, Walter Hetherington Durfee, who obtained a PhD in mathematics from Cornell and then, like his father, taught at Hobart College for decades.

A theme that appears throughout Zitarelli's history is the figure of the "rugged individualist". This is the archetype of the self-reliant, resourceful, and self-motivated American. The phrase itself seems to originate from a speech of Herbert Hoover, who himself was a self-made millionaire. How does Zitarelli apply this archetype to the mathematics of 19th century America? Before the rise of mathematics departments in the later 19th century, individuals interested in mathematics had to overcome various obstacles: limited access to education, limited availability of mathematical texts, few companions with similar interest, and labor-intensive occupations, such as farming.

Such individuals who still went on to do work mathematics were certainly resourceful and self-motivated. Zitarelli discusses a number of such "rugged individualists", for example, David Rittenhouse, Benjamin Banneker, John Ewing, Nathaniel Bowditch, Orson Pratt (a leading Mormon theologian), Artemas Martin, Kelly Miller (the first African-American to attend graduate school in mathematics), and Susan Johnson (an African-American woman who was the daughter of enslaved parents).

Another focus of this work are women who pursued graduate level study in mathematics during the 19th century. Nearly 30 such women are discussed [8, pp. 393 – 410]. Many of these women receive no mention or only a passing reference in the other histories. Some of the women who are passed over in the other histories, but find a place

in Zitarelli, include Ida Metcalf, Agnes Baxter, Anna Palmie, Winifred Edgerton, Charlotte Barnum, Elizabeth Dickerman, Martha Carey Thomas, Ella Williams, and Ada Maddison. They all have a story worth telling and Zitarelli is to be commended for bringing them to light. It must be said that Parshall and Rowe do a thorough job of discussing the women who studied in Germany with Felix Klein, in particular, Mary Winston and Grace Chisholm, see [5, pp. 239 – 253].

For all the excellent qualities of this text, mention must be made of several niggling editing issues that may have been resolved if the author had lived. Most of these do not detract from the overall quality of the work, but one wishes that they had been corrected. Here is a sampling of such small errors.

p. 279-80. Mentions that Osgood's *Lehrbuch der Funktionentheorie* "was regarded as the classic treatise on the theory of functions of a real variable." While Osgood does open his text with a discussion of functions of a real variable, the vast majority of the work is devoted to functions of a complex variable (and it is this part of the work that for which it was renowned).

p. 281. Zitarelli gives the well-known story of the MIT professor Frederick Woods giving a lecture on geometry. At one point an audience member said, "That is not geometry" to which Bôcher responded, "It is what Klein calls geometry." No reference for the story is given, but it comes from Osgood's obituary of Bôcher, which Zitarelli does reference in other places.

p. 285. "Like William Osgood before him, Harry Tyler ended up completing his dissertation at Erlangen instead of Göttingen." The problem is that Tyler's PhD was completed in 1889, while Osgood finished in 1890. Also, it was Tyler who convinced Osgood to leave Göttingen and to join him at Erlangen (Parshall and Rowe, pp 232 – 233).

p. 383. Discusses Roland Richardson's study of American doctorates, but no reference is given.

p. 409. Leona May Peirce is said to have taught for 28 years after retirement from the family business at the age of 65. This is unlikely, since Peirce dies at the age of 91. In reality, after retiring in 1928, Peirce actually taught until 1937 (which Zitarelli had stated on p. 311).

p. 460. In the references, mention is made of the 1987 article *Women in the American mathematical community: the pre-1940 Ph.D.s* by Judy Green and Jeanne LaDuke. However, no mention is made of their 2009 AMS book *Pioneering Women in American Mathematics: the Pre-1940 PhD's*.

p. 474. In the Index entry for Yale University, it is indicated that Yale is mentioned on pages 147 – 402, which is not the case.

In summary, this work studies the colleges, societies, and above all, the individuals who created the mathematical community of the United States and Canada in the 19th century. The breadth of coverage in terms of the variety of mathematicians and areas of mathematics discussed, distinguishes this work from other histories. Any reader would gain much insight from reading Zitarelli's excellent text.

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