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Abstract: Historians have often speculated if Joseph Smith had any children with his plural wives. The strongest case for a child born through one of Joseph Smith's polygamous unions is that of Josephine Lyon, born on February 8, 1844, in Nauvoo, Illinois, to Sylvia Sessions, who was sealed to Joseph Smith. Because of previous limitations in DNA analysis, her paternity could not be verified through science until recently. This report summarizes the steps that were taken to establish the biological paternity of Josephine Lyon through the analysis of autosomal DNA from descendants of both Joseph and Josephine. Based on the data presented in this study, it appears that Joseph Smith was not the father of Josephine Lyon.



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Using Science to Answer Questions from Latter-day Saint History

The Case of Josephine Lyon's Paternity

Ugo A. Perego

DNA testing has been employed to study the ancestry and posterity of Joseph Smith Jr., founder of the Mormon movement. Thanks to information found on the paternally inherited Y chromosome, for example, researchers have been able to establish a likely Irish origin for the Smith line.¹ Y chromosome testing has also been helpful in resolving a number of paternity cases involving men who were allegedly sons of Joseph through polygamous unions. To date, all of the tests for these candidates have borne negative results.²

However, the strongest case for a child born through one of Joseph Smith's plural marriages is that of Josephine Lyon, born on February 8, 1844, in Nauvoo, Illinois. Because Josephine did not receive the Y chromosome from her biological father, her paternity could not be verified through science until recently. Josephine's mother, Sylvia Sessions, was sealed to Joseph Smith even though she was legally married to (but likely separated from) Windsor P. Lyon. Details about Sylvia Sessions's unions to both men—particularly to Smith—are highly debated among

1. Ugo A. Perego, "Joseph Smith DNA Revealed: New Clues from the Prophet's Genes" (lecture, FairMormon Conference, Sandy, Utah, August 7–8, 2008), <http://www.fairmormon.org/perspectives/fair-conferences/2008-fair-conference/2008-joseph-smith-dna-revealed-new-clues-from-the-prophets-genes>.

2. Ugo A. Perego, "Joseph Smith, the Question of Polygamous Offspring, and DNA Analysis," in *The Persistence of Polygamy*, ed. Newell G. Bringhurst and Craig L. Foster (Independence, Mo.: John Whitmer Historical Association, 2010), 233–56.

historians.³ This is probably due to the affidavit Josephine Lyon signed in 1915, in which she stated:

Just prior to my mother's death in 1882 she called me to her bedside and told me that her days on earth were about numbered and before she passed away from mortality she desired to tell me something which she had kept as an entire secret from me and from others but which she now desired to communicate to me. She then told me that I was the daughter of the Prophet Joseph Smith, she having been sealed to the Prophet at the time that her husband Mr. Lyon had was out of fellowship with the Church.⁴

The purpose of this report is to summarize the steps that were taken to establish the biological paternity of Josephine Lyon through the analysis of autosomal DNA from descendants of both Joseph Smith and Josephine Lyon.

Genetics: Autosomal DNA

The standard human has twenty-three pairs of chromosomes, which are tightly packed inside the nucleus of each cell and referred to as the nuclear DNA. The twenty-third pair is the sex chromosomes: a combination of YX would result in male offspring, while an XX pair would produce a female. The Y chromosome in the YX set is received exclusively from the father, and it is the genetic segment that was used to resolve a number of cases involving alleged sons of Joseph Smith through polygamous unions.⁵ The remaining twenty-two pairs of chromosomes are called autosomes (thus the name *autosomal* DNA), and they are the blueprint of our lives, containing instructions for our growth, function, and development.⁶ We receive one set of chromosomes from our

3. Brian C. Hales, "The Joseph Smith—Sylvia Sessions Plural Sealing: Polyandry or Polygyny?" *Mormon Historical Studies* 9, no. 1 (Spring 2008): 41–57.

4. Brian C. Hales and Laura H. Hales, "Sylvia Sessions," *Joseph Smith's Polygamy*, 2017, <http://josephsmithspolygamy.org/plural-wives-overview/sylvia-sessions>.

5. Ugo A. Perego, Natalie M. Myres, and Scott R. Woodward, "Reconstructing the Y-Chromosome of Joseph Smith: Genealogical Applications," *Journal of Mormon History* 31, no. 2 (Fall 2005): 42–60; Ugo A. Perego, Jayne E. Ekins, and Scott R. Woodward, "Resolving the Paternities of Oliver N. Buell and Mosiah L. Hancock through DNA," *John Whitmer Historical Association Journal* 27 (2008): 128–36.

6. Mitochondrial DNA is a genetic marker not found in the nucleus (and therefore not part of the twenty-three pairs of chromosomes). It is found in organelles called mitochondria in the extranuclear fluid of the cell.

father and the other from our mother. Therefore, at each new generation, 50 percent of autosomal DNA from the previous generation is preserved, while the other 50 percent is lost. Consequently, each child carries half of their father's and half of their mother's DNA and approximately 25 percent of each of their grandparents' DNA, 12.5 percent of their great-grandparents', and so on.

DNA is measured in centiMorgans (cMs) and is inherited in segments.⁷ In humans, one cM corresponds to about one million base pairs⁸ on average, and our genomes contain an estimated 6,800 cMs. We can use the average percentage of inherited autosomal DNA (we inherit 50 percent from each of our parents and pass on 50 percent to our children) to calculate approximately how much shared DNA we would expect to observe between two closely related individuals. In a parent/child relationship, for example, we would expect to observe approximately 3,400 shared cMs, an uncle/nephew pair would have around 1,700 shared cMs, and so on.⁹

Because of the continued halving at each generation, autosomal DNA testing for genealogical purposes is limited to investigating family relationships within the past five or six generations. Beyond that, the amount of shared inherited genetic segments becomes too small and is no longer feasible to use to trace it back to specific ancestors.¹⁰ This means that although we can be genealogically related to all of our ancestors, we carry genetic segments for only a few of them. In fact, it is

7. "CentiMorgan," International Society of Genetic Genealogy (ISOGG) Wiki, last modified January 2, 2019, <http://isogg.org/wiki/CentiMorgan>.

8. "Base pairs" are pairs of nucleotides that are connected together with hydrogen bonds. In base pairing, nucleotides on one DNA strand bond with complementary nucleotides on a parallel strand, forming the double helix structure of the DNA. The order of these nucleotides determines a person's genetic code.

9. Similar values are also reported at "Autosomal DNA Statistics," ISOGG Wiki, last modified September 3, 2018, http://isogg.org/wiki/Autosomal_DNA_statistics. The difference between the figure reported in this article and the data reported in the ISOGG Wiki page is that the former is based on empirical data observed in approximately 22,000 pairs of close relatives and the latter is a straightforward statistic based on 6,800 cMs found in humans that are halved at each generation.

10. Christopher Phillips and others, "SNPs as Supplements in Simple Kinship Analysis or as Core Markers in Distant Pairwise Relationship Tests: When Do SNPs Add Value or Replace Well-Established and Powerful STR Tests?" *Transfusion Medicine and Hemotherapy* 39, no. 3 (2012): 202–10.

estimated that individuals bear autosomal DNA from only about 20 percent of their 1,024 ancestors who lived at the tenth-generation level.¹¹

Genealogy: Descendants of Joseph Smith and Josephine Lyon

Joseph Smith was born in 1805, and Josephine Lyon was born in 1844. Based on the inheritance properties of autosomal DNA, their children and grandchildren would have inherited approximately 50 percent and 25 percent of their DNA, respectively. Joseph Smith had nine biological children with his first recorded wife, Emma Hale. Four sons lived to adulthood, but only two of them, Joseph III and Alexander Hale, have a living biological posterity.¹² These two sons would also be half siblings to Josephine Lyon, if Joseph Smith was in fact her father. All children and grandchildren of Joseph Smith are deceased. A small number of great-grandchildren were still alive at the time of this project and agreed to contribute a DNA sample. It is estimated that these great-grandchildren would carry on average 12.5 percent of Joseph Smith's autosomal DNA.

Josephine gave birth to ten children, with seven surviving to adulthood.¹³ Descendants from six of these seven children donated DNA samples to the current study, including Josephine's only surviving grandchild (who has approximately 25 percent of Josephine's autosomal

11. "How Many Genetic Ancestors Do I Have?" The Coop Lab, Population and Evolutionary Genetics, UC Davis, November 11, 2013, <https://gcbias.org/2013/11/11/how-does-your-number-of-genetic-ancestors-grow-back-over-time>.

12. "Joseph Smith Pedigree Chart," The Joseph Smith Papers, accessed November 11, 2019, <https://www.josephsmithpapers.org/back/joseph-smith-pedigree-chart>; Fred E. Woods, "The Cemetery Record of William D. Huntington, Nauvoo Sexton," *Mormon Historical Studies* 3, no. 1 (2002): 136; Almira Mack Covey to Harriet Mack Whittemore, February 24, 1842, Whittemore Family Papers, Bentley Historical Library, University of Michigan, Ann Arbor; Jacob Scott to Mary Scott Warnock, March 24, 1842, Community of Christ Library-Archives, Independence, Mo.; see also Linda King Newell and Valeen Tippetts Avery, *Mormon Enigma: Emma Hale Smith*, 2d ed. (Urbana: University of Illinois Press, 1994), 103. Although the Nauvoo sexton's record appears to group the entries listed on its first page under the heading "1839," many of these individuals died well after 1839; the entry for an unnamed infant gives no date or age at time of death. See Jannalee Rosner, "What Happened to Joseph and Emma Smith's Children?" *LDS Living*, October 17, 2015, <https://www.ldsliving.com/What-Happened-to-Joseph-Smith-and-Emma-s-Children/s/80310>; Michael Kennedy, "Joseph and Emma's Family," *Ensign* 48, no. 2 (February 2008): 39–41.

13. "Josephine Rosetta Lyon," FamilySearch, accessed October 20, 2019, <https://www.familysearch.org/tree/person/details/KWJC-GJH>.

DNA). The rest of her participating descendants are mostly great- and great-great-grandchildren, carrying approximately 12.5 percent and 6.25 percent of Josephine's autosomal DNA, respectively.

This investigation was extremely time sensitive, since the technology to address this case study became available only in the past fifteen years, and Joseph Smith and Josephine Lyon's surviving posterity who carry a sufficient amount of informative autosomal DNA to verify the alleged relationship are elderly and will not be around forever.

Materials and Methods

A total of fifty-six participants agreed to take part in the current study. These individuals were selected based on their relationship to either Joseph Smith Jr. or Josephine Lyon, with the objective of obtaining two balanced datasets for genetic comparison. During the selection process, particular attention was placed on the number of generations separating the living descendant to the ancestor of interest and on the spread or degree of separation among these descendants. The main objective in following these principles was to build a dataset of individuals carrying enough autosomal DNA from either Joseph Smith or Josephine Lyon to confidently demonstrate or exclude a biological connection between the two families.

The final dataset of the completed results used in this study follows:

- twenty-one descendants of Joseph Smith: eight through Alexander Hale and thirteen through Joseph III (five great-grandchildren of Joseph Smith, eleven great-great-grandchildren, and five great-great-great-grandchildren)
- six descendants of Hyrum Smith, used as controls
- twenty-two descendants of Josephine Lyon: one grandson, eighteen great-grandchildren, and three great-great-grandchildren
- seven descendants of other relatives of Josephine Lyon, used as controls

The majority of samples collected for this study were processed by 23andMe, a California-based commercial company offering direct-to-consumer (DTC) genetic testing.¹⁴ Although 23andMe is a commercial enterprise, its DNA samples are processed using a customized chip

14. Anne Wojcicki, "Power of One Million," *23andMe Blog*, June 18, 2015, <http://blog.23andme.com/news/one-in-a-million>.

produced by Illumina,¹⁵ a leading biotechnology firm that serves governments, as well as academic and private laboratories worldwide. 23andMe also has an extremely qualified scientific advisory board of highly respected researchers.¹⁶ A small number of samples were processed at Family Tree DNA and Ancestry.com, as needed. Both companies utilize similar technologies to 23andMe, so the results can be compared even though they were acquired through different laboratories. Once the processing was completed, the raw data was downloaded from each processor's website and submitted to the third-party, open-source database GEDmatch for analysis.

Results

Autosomal DNA comparison was performed and is summarized in six tables available in the supplemental online material, published on the FSI Genetics website.¹⁷ These tables include data from Joseph Smith's family, Hyrum Smith's six descendants, and Josephine Lyon's family. A positive linear correlation was observed for each family line because closer Smith relatives and closer Lyon relatives showed higher amounts of shared cMs and vice versa. Family members related to the individuals listed at the top of each table are listed in order of cMs observed, from largest (top) to smallest (bottom). Data listed in the six tables strongly support the correctness of the genealogical data provided, thus demonstrating that Joseph Smith's five great-grandchildren and Josephine's grandson are indeed related to everyone else within their respective family group who participated in the study. The degrees of relationship observed in this study among the different participants range from parent/child and full siblings to third cousins twice removed. For a small

15. "Autosomal DNA Testing Comparison Chart," ISOGG Wiki, last modified April 13, 2019, http://isogg.org/wiki/Autosomal_DNA_testing_comparison_chart.

16. "Research," 23andMe, accessed May 31, 2019, <https://research.23andme.com/research>.

17. See the tables in the report of this case study published in *Forensic Science International: Genetics*: Ugo A. Perego and others, "Resolving a 150-Year-Old Paternity Case in Mormon History Using DTC Autosomal DNA Testing of Distant Relatives," *Forensic Science International: Genetics* (2019), 1–7, [https://www.fsigenetics.com/article/S1872-4973\(19\)30066-3/fulltext#secoo40](https://www.fsigenetics.com/article/S1872-4973(19)30066-3/fulltext#secoo40).

number of the more distant familial relations, the observed amount of shared cMs was zero, which was an expected observation.¹⁸

Once the genealogical information of each of the two families was supported by the autosomal DNA analysis, the next step was to compare the DNA of each of Joseph Smith's great-grandchildren with that of Josephine's surviving grandson (carrying approximately 25 percent of her DNA). At the half second-degree cousin relationship, which the five descendants of Joseph Smith allegedly share with Josephine Lyon's grandchild, one would expect to observe an average of 106.25 shared cMs for most, if not all pairs. But none of the five Smiths shared any amount of autosomal DNA with Josephine's grandchild. On the other hand, when DNA comparisons were performed within each family group, the observed range for each set when 106.25 cMs were expected was 27.7–177.5 shared cMs, with a measured average of 107.46 shared cMs. Therefore, the observed absence of shared autosomal DNA between Josephine's grandson and Joseph Smith's five great-grandchildren indicates that the five Smiths are probably not biologically related to Josephine's grandson.

This was further corroborated when autosomal DNA from Josephine's grandson was compared to the DNA of Lyon relatives, who bear no apparent close relationship to the Smith family. Four of these relatives shared a significant amount of autosomal DNA with Josephine's grandson, with the amount of shared DNA ranging from 19.8 to 117.5 cMs. The absence of shared DNA between Josephine Lyon's grandson and Joseph Smith's five great-grandchildren, together with a significant amount of autosomal DNA shared by Josephine's grandson and four other relatives of Windsor Lyon, further indicates that Josephine was not related to the Smith but to the Lyon family.

Conclusions

In 1915, Josephine Lyon recorded that in 1882, her mother, Sylvia Sessions, told Josephine that Joseph Smith was her father. Historical records show that at some time Joseph was sealed to Sylvia, but the timing is not known. Whether it was before or after Josephine's conception in May of 1844 is uncertain. Neither is the type of sealing—whether for eternity only or for time and eternity—currently verified. In light of the genetic

18. For more details on observed and actual ranges of centiMorgans among known relatives, see Blaine Bettinger, "August 2017 Update to the Shared cM Project," *The Genetic Genealogist*, August 26, 2017, <https://thegeneticgenealogist.com/2017/08/26/august-2017-update-to-the-shared-cm-project>.

approach presented in this study, it appears that Josephine did not share a biological tie with the founder of The Church of Jesus Christ of Latter-day Saints. Although a reconstruction of Joseph Smith's and Josephine Lyon's DNA through their descendants will never provide the same level of accuracy that DNA obtained directly from Joseph and Josephine could (a true paternity test), data presented in this study is consistent and offers the strongest evidence to date toward clarifying the alleged father/daughter relationship of Joseph Smith and Josephine Lyon. Based on this analysis, it appears that Joseph Smith did not father Josephine and that perhaps what Sylvia Sessions told her daughter has a different meaning than the biological relationship many historians have assumed. It will now be their job and challenge to help us clarify the statement, keeping in mind this additional piece of genetic evidence in their future research of Joseph Smith's practice of polygamy.

Ugo A. Perego holds a PhD in genetics and molecular science. He is currently the director of the Rome Institute Campus of Religion, a coordinator for Seminaries and Institutes for central Italy and Malta, a visiting scientist at the University of Pavia, Italy, and an adjunct instructor at Salt Lake Community College. From 1999 to 2012, he was a senior scientist for the Sorenson Molecular Genealogy Foundation in Salt Lake City, where this project first began in collaboration with Dr. Scott R. Woodward. This is a summary report from the original article, "Resolving a 150-Year-Old Paternity Case in Mormon History Using DTC Autosomal DNA Testing of Distant Relatives," *Forensic Science International: Genetics* 42 (2019): 1–7, [https://www.fsigenetics.com/article/S1872-4973\(19\)30066-3/fulltext](https://www.fsigenetics.com/article/S1872-4973(19)30066-3/fulltext).