This article replaces its earlier appearance in the Journal *31 (Summer 2005): 70–88, which had an incorrect formula and a missing table. The* Journal *sincerely regrets these errors.*

Reconstructing the Y-Chromosome of Joseph Smith: Genealogical Applications

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Introduction

During the last half of the nineteenth century, when the contest of authority between the Church of Jesus Christ of Latter-day Saints and the Reorganized Church of Jesus Christ of Latter Day Saints (now Community of Christ) was most intense, a key point in the RLDS attack on the LDS insistence that Joseph Smith Jr.[1] originated polygamy was the absence of fully documented children produced by his unions with about thirty plural wives.[2]

The controversy faded away in the 1980s as RLDS historians, leaders, and members generally accepted the overwhelming docu-

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[1]For simplicity's sake, we refer to him as Joseph Smith. The Jr./Sr. designations to differentiate between him and his father appear only in Figure 2.

[2]Andrew Jenson, "Plural Marriage," *Historical Record* 6 (May 1887): 233–34; Fawn Brodie, *No Man Knows My History: The Life of Joseph Smith, the Mormon Prophet,* 2d ed. rev. (1945; New York: Alfred A. Knopf, 1971),

mentary support that plural marriage originated in Nauvoo with Joseph Smith.[3] Yet even though this historical question has lost its controversial content, it has remained unanswered: Where are the children, if any, of Joseph Smith by his plural wives? One plural wife, Mary Elizabeth Rollins Lightner, stated that she knew "he had three children. They told me. I think two are living today but they are not known as his children as they go by other names."[4]

This ambiguity means that a group of families have harbored traditions, taken with various degrees of seriousness, that such-and-such an ancestor from the Nauvoo period whose mother is known to have been a plural wife of Joseph Smith may have been Joseph's child as well. These children may have included Oliver Buell (son of Presendia Huntington Buell, wife of Norman Buell), John Reed Hancock (son of Clarissa Reed Hancock, wife of Levi Hancock), Moroni Llewellyn Pratt (son of Parley P. Pratt's wife, Mary Ann Frost Pratt), Orson Washington and Frank Henry Hyde (two sons of Orson Hyde's wife, Nancy Marinda Johnson Hyde), Josephine Rosetta Lyon (daughter of Sylvia Sessions Lyon, wife of Winsor Lyon),[5] an alleged

345–46, Appendix C, 457–88; Todd Compton, *In Sacred Loneliness: The Plural Wives of Joseph Smith* (Salt Lake City: Signature Books, 1997), 4–8.

[3]For a literature review of Joseph Smith III's position, RLDS works defending the position, the key 1983 work of RLDS Church Historian Richard P. Howard in opening "the door of acceptance" toward a more professional view, and subsequent literature assimilating this revised position, see Martha Sonntag Bradley, "Out of the Closet and into the Fire: The New Mormon Historians' Take on Polygamy," in *Excavating Mormon Pasts: The New Historiography of the Last Half Century,* edited by Newell G. Bringhurst and Lavina Fielding Anderson (Salt Lake City: Greg Kofford Books, 2004), 307–8.

[4]Compton, *In Sacred Loneliness,* 12. See his summary (12-13) of possible reasons for the fewness of Joseph's children and his conclusion: "It is clear that some of his plural wives did have children by him, if we can rely on the statements of George A. Smith, Josephine [Lyon] Fisher, and Elizabeth Lightner."

[5]Josephine made an affidavit on February 24, 1915, affirming that Sylvia, on her deathbed in 1882, "told me that I was the daughter of the Prophet Joseph Smith." Ibid. 183, 681. Although this claim offers the strongest documentation, it cannot be tested by the Y-chromosome methods described in this paper because it is a father-daughter descent, rather than a fa-

child born to Fanny Alger during the Kirtland period,[6] Zebulon Jacobs (son of Zina Diantha Huntington Jacobs, wife of Henry Jacobs),[7] and an alleged son of Hannah Dubois Smith Dibble.[8]

Researchers interested in the question have had to rely on probabilities: Was a child born to a plural wife after her sealing to Joseph Smith and within eight or nine months of his death in June 1844? Were there known opportunities for cohabitation? Do later family accounts provide any support for such a hypothesis? Even shakier evidence is the possibility of physical resemblances. Fawn Brodie, for instance, published Oliver Buell's portrait with those of Joseph's four surviving sons by Emma and states that his "physiognomy . . . seems to weigh the balance overwhelmingly on the side of Joseph's paternity."[9]

This article reports a form of DNA testing, which was used to answer the question of whether a given man who has living descendants through an unbroken father-son line was or was not a son of the Prophet Joseph Smith. Based on the availability of living descendants, three separate genetic investigations into the paternity of these men have been completed.

Genetic Testing and Pedigree Completion

In recent years, the use of computer-based genealogical resources has dramatically increased our ability to access historical records. Also available are large computerized databases containing pedigree-linked information, which combine the research findings of many individuals into a format quickly and easily retrieved over the internet. With these advances, it has become increasingly evident that, although a greater amount of information is available, it can often be ambiguous. Often difficulties associated with immigration, adoption, illegitimacy, and poor research result in records that are incomplete and inconsistent. In addition, some records have been lost, destroyed,

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ther-son descent.

[6]Brodie, *No Man Knows My History,* 345.

[7]Richard S. Van Wagoner, *Mormon Polygamy: A History* (Salt Lake City: Signature Books, 1989), 48–49.

[8]Compton, *In Sacred Loneliness,* 631. This may not be a comprehensive list of those who may have believed in possible descent from Joseph Smith.

[9]Brodie, *No Man Knows My History,* 301, portrait facing 299. Unfortunately, since depictions of Joseph Smith are limited to a couple of profiles, portraits, and his death mask, this argument is not particularly strong.

or simply never kept. Genealogical research based on these sources may lead to the hypothesis of a family relationship yet provide insufficient or conflicting evidence to confidently establish the link.

In situations where there is inadequate documentation to resolve a genealogical question, genetic testing may either support or disprove the existence of specific family relationships. The Sorenson Molecular Genealogy Foundation (SMGF), a nonprofit organization located in Salt Lake City, is currently building the world's largest and most comprehensive database of correlated genetic and genealogical information. Researchers at SMGF are expanding the use of DNA testing and are developing new applications with the goal of assisting genealogists with their research. Occasionally, requests are received to work on side projects that could be used to teach about and to promote the usefulness of genetic testing to complement traditional genealogical research.

One of these studies involved the reconstruction of the Y-chromosome to assist in locating the exact birthplace of Joseph Smith's paternal third-great-grandfather, a Robert Smith of Boxford, Massachusetts, who emigrated from Lincolnshire, England in the earlier part of the seventeenth century. Although the research for Joseph Smith's ancestor is still underway, the genetic information generated from this study can also be used to answer specific questions about Joseph Smith's posterity.

DNA markers from specific regions of the Y-chromosome are particularly useful in the reconstruction of paternal genealogies because the Y-chromosome is found exclusively in males and follows a strict inheritance pattern from father to son, similar to the family surname in most western cultures.[10] Unlike the other twenty-two pairs of chromosomes, it does not include genetic material from the mother. A set of small segments (known as markers or loci) on the Y-chromosome can produce a very specific DNA profile (called a haplotype) that can uniquely identify a paternal lineage. The analysis of each of these markers yields a measurable count, or allele value, for that specific marker. For example, at location DYS391[11] on the Y-chromosome, one male may have an allele value of 10 while another may have an allele value of 11 at the same location. The entire set of these values constitutes the

[10]Mark A. Jobling, "In the Name of the Father: Surnames and Genetics," *Trends in Genetics* 17, no. 6 (June 2001): 353–57.

[11]DYS is an acronym for "*D*NA *Y*-chromosome *S*egment. The number

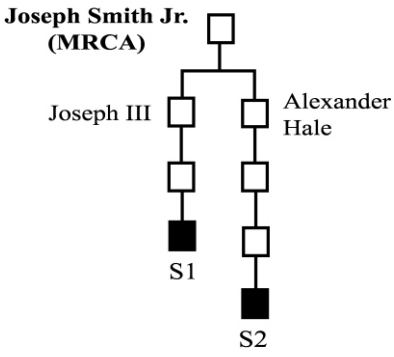

Figure 1. Pedigree chart representing the relationship of the two individuals who volunteered a DNA sample for the reconstruction of Joseph Smith's Y-chromosome haplotype. Joseph Smith Jr. is the most recent common ancestor (MRCA) on the paternal line for males S1 and S2 through Alexander Hale Smith and Joseph Smith III.

Y-chromosome haplotype for an individual and a unique genetic combination that characterizes his paternal ancestry. To increase the accuracy of Y-chromosome testing with the case studies presented in this paper, we tested each individual at twenty-four loci. Testing fewer markers would reduce the level of confidence in the results.

We reconstructed the Y-chromosome profile for Joseph Smith by obtaining genetic samples from living male descendants of two of Joseph's sons, Alexander Hale Smith and Joseph Smith III.[12] Because males receive their Y-chromosome DNA from their father essentially unchanged, it would be expected that male descendants from a common paternal ancestor would share the exact same values at all of their Y-chromosome loci. (See S1 and S2 in Figure 1.) The Y-chromosomes from the living descendants were identical, thus allowing us to infer with a high degree of confidence Joseph Smith's probable Y-chromosome haplotype. (See Table 1.)

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that follows DYS indicates a particular marker, or locus (plural *loci*) found along the Y-chromosome.

[12]Names of living sample donors are withheld because of confidentiality agreements.

TABLE 1
JOSEPH SMITH'S INFERRED
Y-CHROMOSOME HAPLOTYPE

Locus	*S1 Descendant of Joseph Smith through his son Joseph III*	*S2 Descendant of Joseph Smith through his son Alexander H.*	*Joseph Smith Inferred Y-ch. Haplotype (MRCA)*
1 DYS 19	14	14	14
2 DYS385	11, 13	11, 13	11, 13
3 DYS388	12	12	12
4 DYS389I	14	14	14
5 DYS389II	30	30	30
6 DYS390	24	24	24
7 DYS391	11	11	11
8 DYS392	14	14	14
9 DYS393	13	13	13
10 DYS426	12	12	12
11 DYS437	15	15	15
12 DYS438	12	12	12
13 DYS439	12	12	12
14 DYS447	25	25	25
15 DYS454	11	11	11
16 DYS455	11	11	11
17 DYS460	11	11	11
18 DYS461	11	11	11
19 DYS462	11	11	11
20 GAAT1B07	10	10	10
21 YCAII	19, 23	19, 23	19, 23
22 Y-GATA-A10	13	13	13
23 Y-GATA-C4	23	23	23
24 Y-GATA-H4	12	12	12

Note: We defined Joseph Smith's haplotype by DNA obtained from two living male descendants of two of Joseph's sons, Alexander Hale Smith and Joseph Smith III. All twenty-four loci of their Y-chromosome haplotypes were identical.

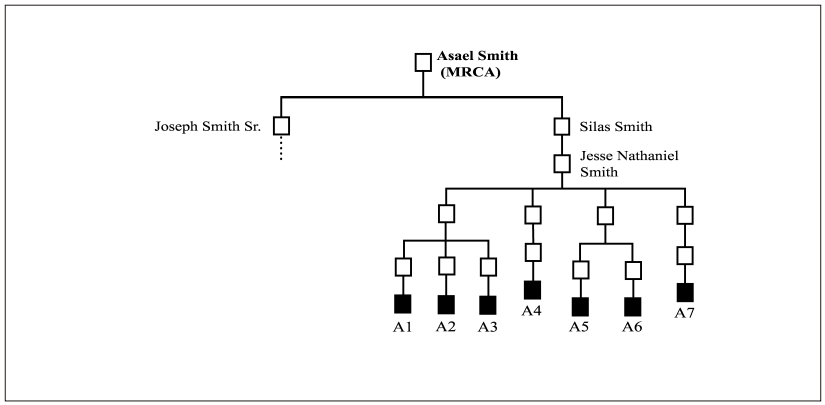

Figure 2. Pedigree chart representing the relationship of seven individuals identified in the Sorenson Molecular Genealogy Foundation database sharing a common paternal ancestor with Joseph Smith Jr. through Asael Smith, the most recent common ancestor (MRCA). These individuals have one or zero mismatches to the Joseph Smith Jr. haplotype.

To confirm that the inferred haplotype uniquely identifies Joseph Smith's lineage and does not resemble it merely by chance, we randomly selected fifty-six men surnamed Smith from the Sorenson Molecular Genealogy Foundation database and cross-typed their Y-chromosome haplotypes. Forty-nine of the fifty-six had two or more mismatched loci when compared to the Joseph Smith inferred haplotype. Standard genetic statistical studies have determined that individuals who match twenty-two out of twenty-four loci likely share a most recent common paternal ancestor approximately twenty-one generations in the past.[13]

We investigated further and found that the remaining seven individuals from the Sorenson database, who had either one or no mismatches to the Joseph Smith haplotype, shared a common paternal line with Joseph Smith through his grandfather, Asael Smith. (See A1–A7 in Figure 2.) This result also allowed us to infer the Y-chromosome haplotype for Asael Smith.

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[13]Bruce Walsh, "Estimating the Time to Most Recent Common Ancestor for the Y Chromosome or Mitochondrial DNA for a Pair of Individuals," *Genetics* 158 (June 2001): 897–912. This figure has a 95 percent confidence interval of 4.8–56.2 generations. For more information about confidence intervals, please refer to a textbook on statistics.

Although the Y-chromosome is transmitted directly from father to son, possible mutations at each of the marker loci could change the allele value at one or more loci. Rates of mutation under ordinary circumstances are well established, with an estimated average mutation rate of 0.28 percent for Y-STR loci per generation.[14] This rate indicates that a specific marker inherited along the paternal line may change at any given generation, but the probability of this occurrence is small. When these mutations do occur, they can be used to estimate how many generations separate two individuals sharing a common paternal ancestor. When taking into account the mutation rate, closely related individuals on the paternal line may possess haplotypes differing by one of twenty-four loci. Individuals having two or more differences in their haplotypes are likely to share more distant common ancestry. Given the number of generations that have passed since Joseph Smith's lifetime, it is likely that individuals with haplotypes differing by more than two loci from the Joseph Smith haplotype do not descend directly from his paternal line.[15]

While there are currently more than 2,000 surname studies using Y-chromosome testing to link family lines descending from a potential common paternal ancestor,[16] one of the first instances where this test was used to support the existence of a familial relationship was the highly publicized 1998 Jefferson-Hemings case.[17] That study, which uses analysis strategies similar to this study, demonstrated the usefulness of Y-chromosome testing in establishing a possible biological connection between two separate lineages. By testing the Y-chro-

[14]Manfred Kayser et al., "Characteristics and Frequency of Germline Mutations at Microsatellite Loci from the Human Y Chromosome, as Revealed by Direct Observation in Father/Son Pairs," *American Journal of Human Genetics* 66 (May 2000): 1580–88.

[15]As Val D. Rust, *Radical Origins: Early Mormon Converts and Their Colonial Ancestors* (Urbana: University of Illinois Press, 2004), points out, many early Mormon converts shared common ancestors and therefore were biologically related to each other. However, Y-chromosome testing identifies unique ancestors on the direct paternal line.

[16]Chris Pomery, *DNA and Family History,* retrieved April 1, 2005, from http://www.dnaandfamilyhistory.com/genetic-genealogy-leading-dna-projects.shtml.

[17]Eugene A. Foster, et al., "Jefferson Fathered Slave's Last Child," *Nature* 396 (November 1998): 27–28.

mosome of male descendants from both families, researchers were able to confirm a long-standing family rumor indicating that President Thomas Jefferson's slave, Sally Hemings, bore a child whose father was a member of the Jefferson family.

Beginning in 2003, we had the opportunity to apply this type of genetic testing to a case study of three purported sons of Joseph Smith by plural wives: Moroni Llewellyn Pratt, Zebulon Jacobs, and Orrison Smith.

The Case Study Candidates

Moroni Llewellyn Pratt

Moroni L. Pratt was born on December 7, 1844. His mother, Mary Ann Frost, was civilly married to Parley P. Pratt on May 14, 1837, and sealed posthumously to Joseph Smith on February 6, 1846.[18] Although there is no record that Mary Ann was sealed to Joseph Smith during his lifetime, family historian Robert Steven Pratt "suspects a marriage to Joseph Smith while he lived," perhaps because Parley stood as proxy for Joseph Smith during her posthumous sealing to him and because she left Parley and did not go west with his other wives.[19] Brodie also identifies Moroni as a possible child of Joseph Smith.[20]

To determine Moroni Pratt's biological father, we conducted genetic analysis on the Y-chromosomes of direct patrilineal descendants of Moroni L. Pratt, Parley P. Pratt, and Joseph Smith.

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[18]Thomas Milton Tinney, *The Royal Family of the Prophet Joseph Smith, Junior; First President of the Church of Jesus Christ of Latter-day Saints* (N.p.: Tinney-Green[e] Family Organization Publishing Company, 1973), 12, L. Tom Perry Special Collections, Lee Library, Brigham Young University, Provo, Utah, records this proxy sealing information: "GS# 183, 374—*Res.* Page 513–514 Proxy Sealings, # 3660—Joseph Smith, Junior. Sealing Date: 6 Feb 1846 at 1:30 P.M. solemnized by H.C. Kimball; Witnesses &: [meaning more than one witness] Wm. Redfield F.D. Richards—No. 19, page 3. *M.S.* #1 Mary Ann Frost, #3164, born 14 Jan 1809 at Groton, Caledonia, Vermont; #2 Parley P. Pratt, #3163, Proxy for time."

[19]Compton, *In Sacred Loneliness,* 763 note V.

[20]Brodie, *No Man Knows My History,* 345, 484.

Zebulon Jacobs

Similarly, Zebulon Jacobs, born to Zina Diantha Huntington Jacobs Smith on January 2, 1842, is recorded as a possible child of Joseph Smith.[21] On March 7, 1841, Zina was civilly married to Henry Bailey Jacobs. Nine months later, on October 27, 1841, when she was already pregnant with Zebulon, she was sealed to Joseph Smith.[22] While there is sufficient evidence to document Zina's two marriages, the paternity of her first son remains unresolved.[23] To establish Zebulon's true paternity, we generated Y-chromosome profiles from DNA samples obtained from descendants of Zebulon Jacobs and from Zina's second child, Henry Chariton Jacobs, who was born March 22, 1846.

Orrison Smith

Todd Compton argues that Fanny Alger was Joseph Smith's first plural wife.[24] The relationship began in Kirtland, Ohio, in 1833; in 1836 she moved with her family to Wayne County, Indiana. When the Alger family continued on to Missouri, she stayed behind, married Solomon Custer, and, according to Solomon's obituary, had nine children.

A Y-chromosome profile was also generated for a Smith lineage suspected to originate from Joseph Smith because of his association with Fanny Alger. Even though Compton reports that Fanny was probably pregnant when she left Kirtland in 1836,[25] there is insufficient historical evidence to show that she had a child by Joseph Smith, or that she already had a child when she married Custer. During this research work, we came in contact with an individual who believed that his ancestor, Orrison Smith, could have been a son of Joseph

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[21]Van Wagoner, *Mormon Polygamy,* 48–49.

[22]Martha Sonntag Bradley and Mary Brown Firmage Woodward, *Four Zinas: A Story of Mothers and Daughters on the Mormon Frontier* (Salt Lake City: Signature Books, 2000), 112, 114.

[23]Compton, *In Sacred Loneliness,* 72, 81.

[24]Ibid., chap. 1.

[25]According to Compton, there were rumors of a pregnancy but no reports that Fanny actually had a child at this time. Ibid., 35–36. See also Brodie, *No Man Knows My History,* 345.

TABLE 2
PARLEY P. PRATT'S INFERRED Y-CHROMOSOME HAPLOTYPE

Locus	*P1* *Descendant of Parley P. Pratt and Mary Ann Frost through son Moroni*	*P2* *Descendant of Parley P. Pratt and Mary Ann Frost through son Moroni*	*P3* *Descendant of Parley P. Pratt and Mary Wood through son Helaman*	*P4* *Descendant of Parley P. Pratt and Belinda Marden through son Lehi*	*Parley P. Pratt Inferred Y-ch Haplotype (MRCA)*
1 DYS	14	14	14	14	14
2 DYS385	11,12	11,12	11, 12	11, 12	11, 12
3 DYS388	12	12	12	12	12
4 DYS389I	13	13	13	13	13
5 DYS389II	29	29	29	29	29
6 DYS390	23	23	23	23	23
7 DYS391	11	11	11	11	11
8 DYS392	13	13	13	13	13
9 DYS393	13	13	13	13	13
10 DYS426	12	12	12	12	12
11 DYS437	15	15	15	15	15
12 DYS438	12	12	12	12	12
13 DYS439	12	12	12	12	12
14 DYS447	25	25	25	25	25
15 DYS454	10	10	10	10	10
16 DYS455	10	10	10	10	10
17 DYS460	11	11	11	11	11
18 DYS461	11	11	11	11	11
19 DYS462	11	11	11	11	11
20 GAAT1B07	10	10	10	10	10
21 YCAII	19, 23	19, 23	19, 23	19, 23	19, 23
22 Y-GATA-A10	13	13	13	13	13
23 Y-GATA-C4	23	23	23	23	23
24 Y-GATA-H4	11	11	11	11	11

Note: We defined Parley P. Pratt's haplotype by DNA obtained from four living direct-line male descendants of Moroni Pratt (P1, P2), Helaman Pratt (P3), and Lehi Pratt (P4). Note that the different mothers do not affect the Y-chromosome transmission. All four haplotypes are identical at all twenty-four loci.

TABLE 3
HAPLOTYPE COMPARISON BETWEEN JOSEPH SMITH AND MORONI PRATT

	Moroni Pratt Y-ch	*Joseph Smith Y-ch*
DYS19	14	14
DYS385	**11, 12**	11, 13
DYS388	12	12
DYS389I	**13**	14
DYS389II	**29**	30
DYS390	**23**	24
DYS391	11	11
DYS392	**13**	14
DYS393	13	13
DYS426	12	12
DYS437	15	15
DYS438	12	12
DYS439	12	12
DYS447	25	25
DYS454	11	11
DYS455	11	11
DYS460	11	11
DYS461	11	11
DYS462	11	11
GGAAT1B07	10	10
YCAII	19, 23	19, 23
Y-GATA-A10	13	13
Y-GATA-C4	23	23
Y-GATA-H4	**11**	12

Note: The two haplotypes differ at six loci, showing that the Moroni Pratt is not closely related to Joseph Smith.

Smith and Fanny Alger, according to family tradition.[26]

COMPARING THE HAPLOTYPES

We obtained a biological sample from volunteers representing

[26]Personal communication with the individual tested and with some of his close associates.

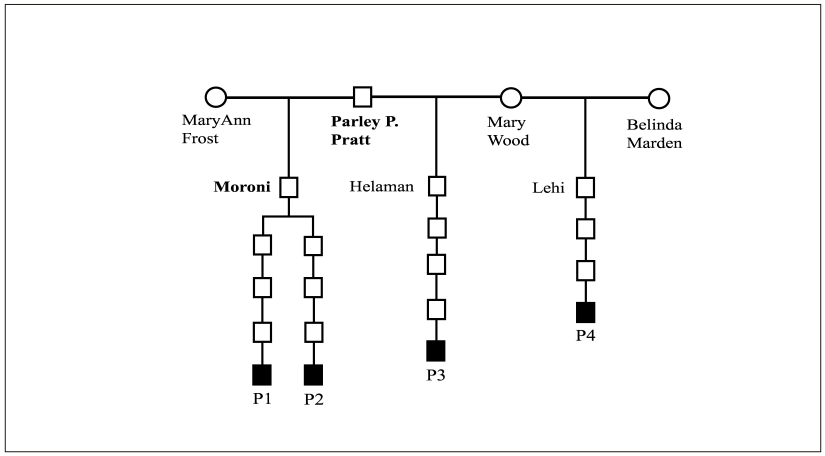

Figure 3. Pedigree chart representing individuals sharing Parley P. Pratt as their most recent common ancestor (MRCA) on their paternal line. Individuals labeled P1 and P2 have Moroni L. Pratt as their MRCA and were tested to reconstruct the Moroni Pratt Y-chromosome haplotype. Individuals labeled P3 and P4 who have Parley P. Pratt as their MRCA were also tested to reconstruct Parley P. Pratt's Y-chromosome haplotype.

each family in the study using a mouthwash rinse to collect cells from inside the cheeks. Using standard laboratory procedures, DNA was separated from the remaining cellular material.[27] Genetic profiles (haplotypes) were then generated for twenty-four markers located along the Y-chromosome[28] using ABI 3700 automated genetic analyzers and processed using ABI Genotyper and GeneScan software (Applied Biosystems, Fullerton, California).

Moroni L. Pratt

To establish Moroni L. Pratt's genetic ancestry, we constructed Y-chromosome haplotypes for male individuals descending from him (see P1 and P2 in Figure 3 and Table 2). We compared these two Pratt

[27]David J. Walsh et al., "Isolation of Deoxyribonucleic Acid (DNA) from Saliva and Forensic Science Samples Containing Saliva," *Journal of Forensic Sciences* 37 (March 1992): 387–85.

[28]Elena Bosch et al., "High Resolution Y Chromosome Typing: 19 STRs Amplified in Three Multiplex Reactions," *Forensic Science International* 125 (January 2002): 42–51.

haplotypes, which were identical to each other, with the Joseph Smith haplotype at twenty-four loci and found mismatches at six loci. (See Table 3.)

Because the calculated time to the most recent common ancestor with a mismatch of six out of twenty-four loci is approximately 100 generations,[29] Joseph Smith is excluded as Moroni Pratt's biological father. Furthermore, we collected additional DNA samples from Parley's descendants through two other sons and generated an inferred Y-haplotype for Parley P. Pratt similar to the procedure performed for Moroni Pratt. (See P3 and P4 in Figure 3 and Table 2.) The inferred Y-chromosome haplotype of Parley P. and Moroni L. Pratt were identical at all twenty-four loci, which is consistent with Parley's being Moroni's biological father.

To determine the likelihood associated with two individuals sharing the Pratt twenty-four-locus haplotype, we typed 1,180 individuals, mostly of European descent, at twenty-one of the twenty-four loci used to construct inferred Y-haplotypes.[30] Of the 1180 Y-haplotypes, 1,155 were unique,[31] including the inferred Pratt type. Since the inferred Pratt type was unique, the maximum likelihood estimate[32] shows that the probability of two random individuals sharing the inferred Pratt 21-locus haplotype is approximately $\frac{\ln \frac{1180}{1155}}{1179}$ or 1 out of 55,057.

Since Moroni L. and Parley P. Pratt share identical twenty-four-loci haplotypes, it seems indisputable, in practical terms, that Parley was indeed the biological father of Moroni Pratt.

Zebulon Jacobs

Similarly, we collected and analyzed DNA samples from male de-

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[29]Walsh, "Estimating the Time to Most Recent Common Ancestor."

[30]We used database samples compiled in advance of this study, which did not include the Y-chromosome markers designated as DYS447, DYS445, and YCAII.

[31]The presence of twenty-five individuals with Y-chromosome haplotypes matching others in the observed subset could be explained by the existence of an undocumented common paternal lineage. There is also a remote possibility of having two unrelated lineages sharing the same set of Y-chromosome markers by chance.

[32]Charles H. Brenner, *Forensic Mathematics,* retrieved April 4, 2005, from http://dna-view.com.

scendants of both Zebulon Jacobs and his brother Henry C. Jacobs. Henry C. Jacobs was born in 1846, thus excluding Joseph Smith, who was killed in June of 1844, as his possible father. Furthermore, the identity of Henry C.'s father, Henry Bailey Jacobs, has never been challenged.

We compared the Y-chromosomes of these two individuals at twenty-four loci. All twenty-four were identical, confirming that both children were fathered by the same individual, most likely Henry B. Jacobs. (See Table 4.) These two haplotypes differed at nine loci from Joseph Smith's Y-chromosome, too great a number of variations to consider a paternal relationship.

Orrison Smith

When we compared the Y-chromosome obtained from a male descendant of Orrison Smith to the Joseph Smith haplotype, we found nine differences between the two. (See Table 5.) Thus, this finding provides strong supportive—but not conclusive—evidence that Orrison Smith was not Joseph Smith's son.

However, since only one descendant of Orrison Smith contributed a DNA sample, we could not infer Orrison's Y-chromosome haplotype. It requires at least two direct male descendants to reconstruct the Y-chromosome haplotype of their most recent common paternal ancestor. A non-paternal event, such as adoption or illegitimacy, in the four generations that separate Orrison Smith from the individual tested could be responsible for the different Y-chromosome haplotype. For this reason, Orrison's Y-chromosome cannot be confidently inferred. To exclude the possibility of a non-paternity event, further DNA sampling from descendants sharing a documented genealogy with Orrison Smith's paternal line is needed.

As displayed in Table 5, the highly significant differences existing among the haplotypes of the three case studies (Moroni Pratt, Zebulon Jacobs, and Orrison Smith), when compared to the Joseph Smith inferred haplotype, identify each one as representing a separate and distinct paternal lineage. Collectively, this study provides each family with additional reliable information for evaluating suspected genealogical relationships.

Conclusion

This study demonstrates the usefulness of combining traditional genealogical resources with genetic data to illuminate questions of Joseph Smith's possible paternity of children born by plural wives.

Table 4
Haplotype Comparison for Joseph Smith and Descendants of Zebulon and Henry C. Jacobs

Locus	*Descendant of Zebulon Jacobs (b. Jan. 1842)*	*Descendant of Henry C. Jacobs (b. March 1846)*	*Joseph Smith Inferred Y-ch. Haplotype*
1 DYS19	14	14	14
2 DYS385a, b	**11, 14**	**11, 14**	11, 13
3 DYS388	12	12	12
4 DYS389I	**13**	**13**	14
5 DYS389II	**28**	**28**	30
6 DYS390	**22**	**22**	24
7 DYS391	11	11	11
8 DYS392	**13**	**13**	14
9 DYS393	13	13	13
10 DYS426	12	12	12
11 DYS437	15	15	15
12 DYS438	12	12	12
13 DYS439	**11**	**11**	12
14 DYS447	25	25	25
15 DYS454	11	11	11
16 DYS455	11	11	11
17 DYS460	11	11	11
18 DYS461	11	11	11
19 DYS462	11	11	11
20 GGAAT1B07	**9**	**9**	10
21 YCAIIa,b	**19, 24**	**19, 24**	19, 23
22 Y-GATA-A10	13	13	13
23 Y-GATA-C4	23	23	23
24 Y-GATA-H4	**13**	**13**	12

Note: The inferred Y-chromosome haplotypes for brothers Zebulon and Henry C. Jacobs are identical at all twenty-four loci but different at nine loci from Joseph Smith's inferred haplotype.

Table 5
A Comparison of Joseph Smith's Haplotype with Those of the Three Case Samples

Locus	*Moroni L. Pratt's Descendants (2)*	*Zebulon Jacobs Descendant (1)*	*Orrison Smith's Descendant (1)*	*Joseph Smith Inferred Y-ch Haplotype*
1 DYS19	14	14	14	14
2 DYS385	**11, 12**	**11, 14**	**11, 14**	11, 13
3 DYS388	12	12	12	12
4 DYS389I	**13**	**13**	**13**	14
5 DYS389II	**29**	**28**	**29**	30
6 DYS390	**23**	**22**	**25**	24
7 DYS391	11	11	**12**	11
8 DYS392	13	13	**13**	14
9 DYS393	13	13	13	13
10 DYS426	12	12	12	12
11 DYS437	15	15	**14**	15
12 DYS438	12	12	12	12
13 DYS439	12	**11**	12	12
14 DYS447	25	25	**24**	25
15 DYS454	11	11	11	11
16 DYS455	11	11	11	11
17 DYS460	11	11	11	11
18 DYS461	11	11	11	11
19 DYS462	11	11	11	11
20 GAAT1B07	10	**9**	10	10
21 YCAII	19, 23	**19, 24**	19, 23	19, 23
22 Y-GATA-A10	13	13	13	13
23 Y-GATA-C4	23	23	**24**	23
24 Y-GATA-H4	**11**	**13**	12	12

Note: This comparison is between actual Y-chromosome haplotypes for living descendants of Moroni L. Pratt, Zebulon Jacobs, and Orrison Smith and the inferred haplotype of Joseph Smith. Boldface numerals indicate the many differences among the twenty-four loci tested, demonstrating that each haplotype clearly belongs to a separate paternal line.

While some sources report Joseph Smith as the biological father of Moroni Pratt and Zebulon Jacobs through polygamous relationships, genetic testing on the Y-chromosome showed that it is unlikely that Joseph Smith fathered either of them. In addition, the Y-chromosome haplotype for the descendant of Orrison Smith, regarded by some as a possible child of Joseph Smith and Fanny Alger, was significantly different from Joseph Smith's Y-chromosome haplotype and could be confidently excluded as being part of the same lineage.

Genealogical research using the Y-chromosome has recently become popular among family historians for establishing links to common paternal ancestors for individuals sharing the same or similar surnames.[33] This study demonstrates the value of such an approach.

However, Y-chromosome testing alone does not always provide a conclusive answer for determining a particular paternal relationship. One major limitation of this approach is that a long time span can exist between descendants and a most recent common paternal ancestor. Males who share a common paternal ancestor up to ten generations in the past are expected to have identical or very similar Y-chromosome haplotypes at twenty-four loci.[34] Therefore, determining a particular paternity event is difficult without historical documentation that supports a specific ancestor or time associated with the event.[35]

In this study, we can definitely state that Moroni Pratt's father was Parley P. Pratt because the genealogical information harmonized with the genetic results.[36] Similarly, we can confidently exclude Joseph Smith as Zebulon Jacobs's father and identify Henry

[33]Jobling, "In the Name of the Father."

[34]Walsh, "Estimating the Time to Most Recent Common Ancestor."

[35]Y-chromosome testing is not to be confused with genetic paternity testing. The use of Y-chromosome testing to prove or disprove the paternity of a child who lived several generations in the past becomes more meaningful when surrounding historical events are also taken into consideration. Paternity testing does not require such documentation and is much more specific than Y-chromosome testing. However, paternity testing can be used only in cases where actual DNA samples for both the alleged parent and the child are available.

[36]The Pratt case is the strongest of the three presented in this paper. In addition to being able to reconstruct and compare Moroni Pratt's Y-chromosome haplotype, we were also able to test additional Pratt lines and reconstruct Parley P. Pratt's Y-chromosome haplotype.

Bailey Jacobs as his and his brother's likely father on the basis of combined genetic and genealogical evidence.[37] We could not identify Orrison Smith's exact paternity, even though the Y-chromosome haplotype of the descendant tested was clearly not from Joseph Smith's paternal line.

Another limitation in using Y-chromosome testing for genealogical purposes is that its application is restricted to males and their paternal lines.[38] This limitation was not an issue with the three cases presented in this study since they dealt with father-son descent. However, to explore more complex genealogical situations involving ancestors from lines other than the paternal one,[39] it will be necessary to examine additional chromosomes of the human genome.[40]

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[37]With this second case, we could determine only that both Zebulon and Henry C. Jacobs were fathered by the same man. There is no reason to doubt that their father was Henry B. Jacobs. However, we cannot completely exclude from this picture the fact that Zina Huntington, Henry B. Jacobs's wife, was eventually married as well to Brigham Young. While we can confidently exclude Joseph Smith as Zebulon's father, testing a separate Jacobs line (i.e., a male descendant from one of Henry B. Jacobs's brothers, cousins, or uncles) or testing a known descendant of Brigham Young, would eliminate any doubt about Zebulon's true parentage.

[38]Females can use the Y-chromosome genetic testing for their own family history research by asking a male relative who shares their paternal lineage to submit a DNA sample in their stead.

[39]We are currently working on the Josephine Lyon Fisher case, where Y-chromosome testing is of no help since she did not inherit it from her father (either Windsor Lyon or Joseph Smith). This case is much more complex than those presented in this paper. Hundreds of DNA samples from male and female descendants of both Josephine Lyon and Joseph Smith have been collected and are being analyzed with the objective of identifying lineage-specific markers found on the remaining twenty-two chromosomes.

[40]Sorenson Molecular Genealogy Foundation Home Page, retrieved April 4, 2005, from http://www.smgf.org.