

THE PROBABLE GENETIC SIGNATURE OF EDWARD¹ RIGGS, IMMIGRANT TO ROXBURY, MASSACHUSETTS, IN 1633

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The genetic, or Y-chromosome DNA, signature of Edward¹ Riggs, a 1633 immigrant in the Great Migration^[1] to Roxbury, Massachusetts, is formally established on 67 markers.^[2] The importance of the signature of Edward¹ Riggs, or any immigrant (or any ancestor for that matter), is that a simple matching test against it determines whether a living male is a direct male-line descendant.^[3]

Another use of signatures is determination of relationships, or lack thereof, between immigrants (or ancestors) of the same surname. This paper is a companion to one that established the genetic signature of Thomas¹ Riggs, also a 17th-century immigrant to Massachusetts.^[4] A surprising finding is that Thomas¹ and Edward¹ Riggs must have been related during genealogical time,^[5] despite neither (sub)family of descendants having been aware of it.^[6] The relationship is formally established here and used not only to complete the derivation of the signature of Edward¹ Riggs but also to determine the two markers in the signature of Thomas¹ Riggs left unresolved in the companion paper. A review of genetic genealogy theory and practice appears in the companion paper, hence is not repeated here.

METHOD

The basic method employed^[7] can be described as pushing each marker value—i.e., the marker's repeat count—"up the descent tree" from living

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¹ Robert Charles Anderson, *The Great Migration Begins: Immigrants to New England, 1620–1633*, 3 vols. (Boston, NEHGS, 1995), 3:1583–85, Edward Riggs.

² Alvy Ray Smith, "The Y-DNA Signature of Edward Riggs of Roxbury," *New England Ancestors* 6:3 (Summer 2005):46–48, presents Edward's genetic signature on 25 markers only, and does not prove the descents necessary to establish it rigorously.

³ Strictly speaking, a matching test is definitive if negative—a mismatch implies non-descendancy—whereas a positive match means that the living male is a descendant of the putative ancestor *or* both descend from a common ancestor.

⁴ Alvy Ray Smith, "The Probable Genetic Signature of Thomas¹ Riggs, Immigrant to Gloucester, Massachusetts, by 1658," *Register* 164 (2010):85–94.

⁵ Roughly, that relatively recent human history of several centuries during which genealogical records have been kept more-or-less continually. Genealogical time is definitely less than historical time, and minute compared to biological time.

⁶ Alvy Ray Smith and Robert Charles Anderson, "Proposed Hawkshead, Lancashire, Origins of Edward¹ Riggs of Roxbury, Massachusetts, and Thomas¹ Riggs of Gloucester," *The American Genealogist* 82 (2007):120–29.

⁷ Called the method of maximum parsimony (fewest number of mutations required to explain a change); see Joseph Felsenstein, *Inferring Phylogenies* (Sunderland, Mass.: Sinauer Associates, 2004), 1–9. A tutorial example appears in the companion paper.

descendants, whose genetic signatures are known, toward the ancestor, applying at each person a simple mutation-minimizing probability argument to decide the value of the marker to be passed on up the tree. The algorithm consists of repeated applications of the following two rules at each point in a descent tree, working from the descendants up the tree toward the ancestor:

1. A father with only one son (no branching) is assumed to have the same marker value as his son. If the son's marker value is (un)certain, then so is the father's.
2. A father at a branch point is assumed to have the value derived from the values of his sons that minimizes mutation probabilities. If this is (un)certain, then the father's value is (un)certain.

The approach adopted in the companion paper is to “triangulate” on the signature of Thomas¹ Riggs using genetic evidence from living descendants as widely separated, genealogically speaking, as possible—namely descendants from two sons of Thomas¹ Riggs. That approach cannot be used here because Edward¹ Riggs had only one son reaching maturity, Edward² Riggs (also an immigrant to Roxbury in 1633). The actual approach taken is to establish the signature of Edward² by triangulation and push it, with rule 1, up the tree to Edward¹. This results in two uncertainties in Edward¹'s signature, which are resolved by applying the rules above *outside* Edward¹'s direct family, using the Thomas¹ Riggs signature derived in the companion paper.^[8] Happily this technique also resolves two uncertainties that remained in Thomas¹'s signature in the companion paper.

The following two descents are established using classic genealogy. Under each is that person's YDNA test result on 67 markers.^[9] The doubly underlined letters mark departures of an individual's signature from the Edward¹ Riggs signature established in the final section:

A Riggs (*Samuel Homer*¹⁰, *Charles Oral*⁹, *Samuel Davis*⁸, *Ransom*⁷, *Jeremiah*⁶, *Ebenezer*⁵⁻⁴, *Samuel*³, *Edward*²⁻¹):

lXnknplllmmCsijkyosCooqkjswooqrKLllkiophjjhkjlupjllohlwtmlkmmkll

B [Frederick Wheeler¹¹] Riggs (*Frederick Wheeler*¹⁰, *Joseph Cowles*⁹, *Norman*⁸, *Joseph*⁷, *Miles*⁶⁻⁵, *Joseph*⁴, *Edward*³⁻¹):

lXnknplllmmCsijkyosCoooqkjswooqrJLllkiophjjhkjlupjllohlwtmlkmmkll

Contributors A and B have Edward² Riggs as their MRCA (most recent common ancestor), so they are used to establish the probable genetic signature of Edward², which is then extended to Edward¹. The genealogical proofs below have only enough detail to prove father-son descent at each generation. Statements of

⁸ This is known as use of an outgroup to root a tree (Felsenstein, *Inferring Phylogenies* [note 7], 4; Wikipedia, Phylogenetic tree, at en.wikipedia.org/wiki/Phylogenetic_tree).

⁹ Using the space-saving code for repeat counts: a = 1, . . . , z = 26, A = 27, . . . , Z = 52, and the ordering established by the testing company FamilyTreeDNA. See www.familytreedna.com (accessed 15 March 2010) for details. The letter notation permits the use of the notation {qr} to mean the value “q or r”, for example, in case of uncertainty.

parentage have been omitted since the sources cited vary, for instance, as to whether mothers are named, either with or without maiden names.

PROOFS OF DESCENT

A recent article by Robert Charles Anderson and the author has reestablished the early generations of the Edward¹ Riggs family.^[10] Therefore, the father-son relationships established in that paper are indicated below by an asterisk (*) by the son's name. Proofs are supplied only for later generations not proved in that paper.

1. EDWARD¹ RIGGS married at All Saints Church, Nazeing, Essex, 16 September 1618, **ELIZABETH HOLMES**.

2 i. EDWARD² RIGGS*, bp. Nazeing 17 Oct. 1619.

2. EDWARD² RIGGS (*Edward¹*) was baptized in Nazeing 17 October 1619, and married **ELIZABETH** _____.

3 i. SAMUEL³ RIGGS*, b. say 1642.

4 ii. EDWARD RIGGS*, b. say 1652.

3. SAMUEL³ RIGGS (*Edward²⁻¹*) was born say 1642, and married **SARAH BALDWIN**.

5 i. EBENEZER⁴ RIGGS*, b. Derby, Conn., [15 Octo?]ber 1678.

4. EDWARD³ RIGGS (*Edward²⁻¹*) was born probably in Milford, Connecticut, say 1652, and married **MARY** _____.

6 i. JOSEPH⁴ RIGGS*, b. Newark, N.J., about 1676.

5. EBENEZER⁴ RIGGS (*Samuel³, Edward²⁻¹*) was born in Derby, Connecticut, [15 Octo?]ber 1678, and married **LOIS HAWKINS**. On 4 June 1712, Lois Riggs, administratrix of Ebenezer's estate, was appointed guardian of his children including Ebenezer.^[11]

7 i. EBENEZER⁵ RIGGS, b. Derby 15 April 1707.

6. JOSEPH⁴ RIGGS (*Edward³⁻¹*) was born in Newark, New Jersey, about 1676, and married **SARAH** _____.^[12]

8 i. MILES⁵ RIGGS*, b. Essex Co., N.J., say 1705.

¹⁰ Robert Charles Anderson and Alvy Ray Smith, "The Genealogy of Edward¹ Riggs of Roxbury, Massachusetts, Revisited," *The Genealogist* 23 (2009):131–73, corrects significant errors.

¹¹ New Haven, Connecticut, District Probate, 4:594.

¹² Warren Patten Coon, "Gravestone Records from Old Burying Ground, Orange, Essex County," *Genealogical Magazine of New Jersey* 4 (1928):159.

7. **EBENEZER⁵ RIGGS** (*Ebenezer⁴, Samuel³, Edward²⁻¹*) was born in Derby 15 April 1707, and married **RACHEL PECK**.^[13]

9 i. **JEREMIAH⁶ RIGGS**, b. Derby 1 July 1750.

8. **MILES⁵ RIGGS** (*Joseph⁴, Edward³⁻¹*) was born in Essex County, New Jersey, say 1705, and married **ELIZABETH WHITNEY**.^[14]

10 i. **MILES⁶ RIGGS**, b. Conn. 1748.

9. **JEREMIAH⁶ RIGGS** (*Ebenezer⁵⁻⁴, Samuel³, Edward²⁻¹*) was born in Derby 1 July 1750, and married **ANNE WOODRUFF**.^[15]

11 i. **RANSOM⁷ RIGGS**, b. Conn. 6 March 1789.

10. **MILES⁶ RIGGS** (*Miles⁵, Joseph⁴, Edward³⁻¹*) was born in Connecticut in 1748,^[16] and married **ABIGAIL (COWLES) MILLS**.^[17]

12 i. **JOSEPH⁷ RIGGS**, b. Norfolk, Conn., 2 Feb. 1780.

11. **RANSOM⁷ RIGGS** (*Jeremiah⁶, Ebenezer⁵⁻⁴, Samuel³, Edward²⁻¹*) was born in Connecticut 6 March 1789,^[18] and married **SARAH TREMAIN**.^[19]

¹³ Barbour Collection of Connecticut Vital Records, citing Derby Vital Records, 2:23 (birth); Derby Land Records, 7:256 (marriage).

¹⁴ Barbour Collection of Connecticut Vital Records, citing Stamford Vital Records, 1:45, Miles Riggs to Elizabeth "Whitnee." Elizabeth "Wriggs" was a widow by 5 August 1754 [Norwalk, Connecticut, Deeds, 11:185], and her second husband was David Rockwell [Norfolk, Connecticut, District Probate, 2:131, 146].

¹⁵ Barbour Collection of Connecticut Vital Records, citing Derby Land Records, 7:256 (birth); William C. Sharpe, *History of Oxford: Part First, Church Records, Births, Marriages, Deaths, Etc. Part Two, Sketches and Records* (Seymour, Conn.: Record Print, 1885), 29.

¹⁶ Danbury, Connecticut, District Probate, 2:146, "october the 26th AD 1762 Miles Riggs Son to miles Riggs Dec^d. being of age [i.e., 14] for the Choise of a Gardain [*sic*] and having made Choise of his Father in Law David Rockwell of Ridgfield in s^d District to be his Gardain." S. Whitney Phoenix, *The Whitney Family of Connecticut*, 3 vols. (New York: Bradstreet Press, 1878), 1:49, has Miles born in Norwalk, Connecticut, 20 May 1748, and four of his younger siblings born in Stamford, Connecticut.

¹⁷ Barbour Collection of Connecticut Vital Records, citing Norfolk Vital Records, 1:10; Frederic W. Bailey, ed., *Early Connecticut Marriages as Found on Ancient Church Records Prior to 1800*, 7 parts (New Haven, Conn.: Bureau of American Ancestry for Family Researches, 1896–1906; repr. Baltimore: Genealogical Publishing Co., 1976), 1:65; Joseph Eldridge and Theron Wilmot Crissey, *1744-1900, History of Norfolk, Litchfield County, Connecticut* (Everett, Mass.: Massachusetts Publishing Co., 1900), 549–51, interview with Norman⁸ Riggs in March 1900.

¹⁸ Mary A. Barnett, "Of the Riggs Family from Their First Parents of America," *Franklin Democrat*, Franklin, Indiana, 9 December 1898, 3, transcribed in David G. Richardson, "Search for Data on Sarah Tremain, Wife of Ransom Riggs" (Marietta, Ga., 1991) [bound typescript, FHL 929.273 T72tr], "Jeremiah Riggs was married to Miss Anna Woodruff, in Litchfield, Conn., in 1768 or '69. To them were born nine children, five sons and four daughters: Ester, Samuel, Jeremiah II, Susan, Anna, Clarrissee, Ransom, Lorin, and Harvey." Mary A.⁹ (Barnett) Barnett (*Sophonid⁸, Ransom⁷, Jeremiah⁶*) cites her uncle Merrit Woodruff⁸ Riggs (*Samuel⁷, Jeremiah⁶*)

In 1850 “Ransom” Riggs, 61, born in Connecticut, resided in Johnson County, Indiana, with Sarah and Samuel D. Riggs, 31, born in New York.^[20]

13 i. SAMUEL DAVIS⁸ RIGGS, b. N.Y. 2 Dec. 1818.

12. JOSEPH⁷ RIGGS (*Miles⁶⁻⁵, Joseph⁴, Edward³⁻¹*) was born in Norfolk, Connecticut, 2 February 1780, and married **ANNIS CLARK**.^[21]

In 1850 Annis Riggs, 62, born in Connecticut, resided in Norfolk in the household of Norman Riggs, 35, born in Connecticut, with Mercy, 25, born in New York, and Joseph, 1, born in Connecticut.^[22]

14 i. NORMAN⁸ RIGGS, b. Norfolk 10 May 1816.

13. SAMUEL DAVIS⁸ RIGGS (*Ransom⁷, Jeremiah⁶, Ebenezer⁵⁻⁴, Samuel³, Edward²⁻¹*) was born in New York 2 December 1818,^[23] and married **ESTHER BAUGHMAN**.^[24]

In 1880 Samuel D. Riggs, 61, a farmer born in New York of a father born in Connecticut, resided in Pulaski County, Indiana, with his wife Esther.^[25] In 1900 Mrs. Esther Riggs, 52, widow, resided in Pulaski County with son Charles, 16, born June 1883 in Indiana of a father born in New York.^[26]

15 i. CHARLES ORAL⁹ RIGGS, b. Pulaski Co. 18 June 1883.

14. NORMAN⁸ RIGGS (*Joseph⁷, Miles⁶⁻⁵, Joseph⁴, Edward³⁻¹*) was born in Norfolk, Connecticut, 10 May 1816, and married **MERCY/MARY M.** _____.^[27]

In 1860 “Normand” Riggs, 44, born in Connecticut, resided in Norfolk with Mary M., 35, born in New York, Joseph, 11, born in Connecticut, and “Ann S.,” 72, born in Connecticut.^[28]

16 i. JOSEPH COWLES⁹ RIGGS, b. Norfolk 24 July 1848.

(1800–1870): “From this man’s work, we have received much of our information for constructing this work.”

¹⁹ “Family Bible Record of Ransom and Sarah Tremain Riggs,” in Bess Sellers Johnson, *Family Bible Records of Johnson County, Indiana* (Franklin, Ind.: Alexander Hamilton Chapter D.A.R., 1930) [FHL 850,415], 149–50, “Ransom Riggs, Sr. Mar. 6, 1789 – Jan. 16, 1863” and “Ransom Riggs and Sarah Tremain, Mar. 30, 1814.”

²⁰ 1850 U.S. Census, Ninevah Township, Johnson County, Indiana, roll 155, p. 141.

²¹ Barbour Collection of Connecticut Vital Records, citing Norfolk Vital Records, 1:11; Eldridge and Crissey, *History of Norfolk* [note 17], 551.

²² 1850 U.S. Census, Norfolk, Litchfield County, Connecticut, roll 42, p. 161.

²³ Ransom and Sarah Tremain Riggs Bible Record [note 19], under “Their children”: “Samuel Davis Riggs, Dec. 2, 1818 – Oct. 22, 1896.”

²⁴ Pulaski County, Indiana, Marriages, C:172, Samuel D. Riggs to Easther [*sic*] Baughman.

²⁵ 1880 U.S. Census, White Post Township, Pulaski County, Indiana, roll 305, p. 258A.

²⁶ 1900 U.S. Census, White Post Township, roll 399, p. 90.

²⁷ Eldridge and Crissey, *History of Norfolk* [note 17], 551; Phoenix, *Whitney Family of Connecticut* [note 16], 1:378, has her name as Mercy Matilda Cowles.

²⁸ 1860 U.S. Census, Norfolk, Litchfield County, Connecticut, roll 82, p. 827. Ann S. was surely Annis, Norman’s mother, who resided with him in the 1850 census, then aged 62.

15. CHARLES ORAL⁹ RIGGS (*Samuel Davis⁸, Ransom⁷, Jeremiah⁶, Ebenezer⁵⁻⁴, Samuel³, Edward²⁻¹*) was born in Pulaski County, Indiana, 18 June 1883,^[29] and married **MEDA/META SALTWADEL/SALTWELL**.^[30]

In 1920 Charles O. Riggs, 36, born in Indiana of a father born in New York, resided in Pulaski County with wife Meda and son Samuel H., 6, born in Indiana.^[31] In 1930 Charles O. Riggs, 46, born in Indiana of a father born in New York, resided in Pulaski County with wife Meta and son “Homer S.,” 16, born in Indiana.^[32]

17 i. SAMUEL HOMER¹⁰ RIGGS, b. Pulaski Co. 7 Aug. 1913.

16. JOSEPH COWLES⁹ RIGGS (*Norman⁸, Joseph⁷, Miles⁶⁻⁵, Joseph⁴, Edward³⁻¹*) was born in Norfolk, Connecticut, 24 July 1848.^[33] He married **NETTIE E. WHEELER**.^[34]

In 1880 Joseph C. Riggs, 30, born in Connecticut of Connecticut natives, resided in Norfolk with his wife Nettie E., 22, and his son Fred W., 5/12, born Jan. [*sic*] in Connecticut. Two dwellings away was Norman Riggs, 64.^[35]

18 i. FREDERICK WHEELER¹⁰ RIGGS, b. Norfolk 9 Dec. 1879.

17. SAMUEL HOMER¹⁰ RIGGS (*Charles Oral⁹, Samuel Davis⁸, Ransom⁷, Jeremiah⁶, Ebenezer⁵⁻⁴, Samuel³, Edward²⁻¹*) was born in Pulaski County, Indiana, 7 August 1913,^[36] and married **LUCILLE _____** [wife’s maiden name suppressed].

i. A¹¹ RIGGS [living].

18. FREDERICK WHEELER¹⁰ RIGGS (*Joseph Cowles⁹, Norman⁸, Joseph⁷, Miles⁶⁻⁵, Joseph⁴, Edward³⁻¹*) was born in Norfolk, Connecticut, 9 December 1879, and married **MARGUERITE IRENE FAY**.^[37]

²⁹ *World War I Draft Registration Cards, 1917–1918*, on *Ancestry.com*, Charles Oral Riggs, nearest relative Meta Riggs [cites FHL 1,613,146]; *U.S. World War II Draft Registration Cards, 1942*, on *Ancestry.com*, Charles O. Riggs [cites FHL 2,369,897]. All accesses to *Ancestry.com* made 22 April 2009.

³⁰ Pulaski County, Indiana, Marriages, G:248-49, certificate has Charles O. Riggs to Meda A. Saltwadel, 26 April 1911, but license has her as Meta A. Saltwell.

³¹ 1920 U.S. Census, Cass Township, Pulaski County, Indiana, roll 461, p. 11, sheet 3A.

³² 1930 U.S. Census, Salem Township, Pulaski County, Indiana, roll 623, p. 237, sheet 5A.

³³ Barbour Collection of Connecticut Vital Records, citing Norfolk Vital Records, 2:49, “[Riggs] Norman, had s. [], b. July 24, 1848.” The 1850 census of Norfolk [note 22], lists Norman with only one child, a son Joseph, age 1.

³⁴ Information provided by a living person; source suppressed.

³⁵ 1880 U.S. Census, Norfolk, Litchfield County, Connecticut, roll 100, p. 82D.

³⁶ *Social Security Death Index*, on *Ancestry.com*, Samuel H. Riggs, SSN 306–18–2238.

³⁷ Norfolk, Connecticut, Births, Deaths, Marriages [FHL 1,503,193], 5:12; *World War I Draft Registration Cards* [note 29], “(Wife) Marguerette [*sic*] Irene Riggs” [FHL 1,684,519]; *U.S. World War II Draft Registration Cards* [note 29], contact “Margarett [*sic*] I.” [FHL 2,251,892].

In 1930 Frederick W. Riggs, 51, born in Connecticut to Connecticut natives, resided in Hampden County, Massachusetts, with his wife Margaret I., 50, son Frederick W. Jr., 11, born in Massachusetts, and mother Nettie E. Riggs, 72.^[38]

- i. B [FREDERICK WHEELER¹¹] RIGGS JR., b. Springfield, Mass., 28 Nov. 1918, d. 20 Jan. 2009.^[39]

GENETIC SIGNATURE OF EDWARD¹ RIGGS

To simplify the derivation of the signature of Edward¹ Riggs, notice that the signatures of both contributors agree at 65 of the 67 markers.^[40] Therefore Edward²'s signature is already determined as follows (a comma represents an undetermined marker at the beginning of the derivation):

lxnknpIIImmCsijkkysCoo,qkjswooqr,LIlkiophjjhkjluwpjllohlwtmIkmkklI.

So a contributor's signature will be represented only at the two problematic markers, at locations 24 and 34, respectively, as shown here.^[41]

A: q K
B: o J

Consider marker 24. Apply rule 1 from the method section to push the q up the descent tree from living descendant A to Samuel³ and to push the o up from B to Edward³. Since Edward² was the father of Samuel³ and Edward³, apply rule 2 to Edward² to determine that his marker 24 most likely had value {oq}—that is, it had value “o or q,” there being insufficient data to choose between the two. A similar argument shows that his marker 34 most likely had value {JK}.

Summarizing, the two problematic markers evaluate to {oq}{JK}, respectively. Reinserting these values into the 67-marker string yields the following signature for Edward² Riggs:

lxnknpIIImmCsijkkysCoo{oq}qkjswooqr{JK}LIlkiophjjhkjluwpjllohlwtmIkmkklI.

As a measure of robustness of the derived signature, consider the following additional proved descents, the proofs of which have been omitted for brevity:

C Riggs (*LaVerne A.*¹¹, *Leo Albert*¹⁰, *Franklin A.*⁹, *Harpin*⁸, *Gideon*⁷, *John*⁶, *Joseph*⁵, *John*⁴, *Samuel*³, *Edward*²⁻¹):

lxnknpIIImmCsijkkysCooqqkjswooqrKLlIkiophjjhkjluwpjllohlwtlIkmkklI

D Riggs (*Harold Clinton*¹¹, *William E.*¹⁰, *Ebenezer Clinton*⁹, *Hezekiah*⁸, *Abner*⁷, *John*⁶⁻⁵, *Ebenezer*⁴, *Samuel*³, *Edward*²⁻¹):

lxnIlpIIImmCsijkkysCooqqkjswooqrKLlIkiophjjhkjluwpjllohlwtmIkmkklI

³⁸ 1930 U.S. Census, West Springfield, Hampden County, Mass., roll 908, p. 134, sheet 7B.

³⁹ Birth certificate, West Springfield, Massachusetts, recorded 1 May 1941. His death was reported by his daughter in email to the author dated 20 January 2009.

⁴⁰ In this study the rightmost 30 markers are useful, particularly marker 46.

⁴¹ The rearrangement of markers 22–25 discussed in the companion paper is not required here as the markers are already arranged for maximum matching.

These signatures do not change the derived signature for Edward² Riggs nor do they resolve the two uncertainties. The reader can check that contributors A and B form the minimum subset of the four contributors that could have been used for the derived signature, as it appears so far.

This signature for Edward² Riggs is the best that can be derived if restricted to the given data from his descendants. Surprisingly, information from a different data group (an outgroup) can be used to resolve the two uncertainties in the Edward² Riggs signature *and* the two remaining uncertainties in the Thomas¹ Riggs signature in the companion paper. Compare the signature of Edward² Riggs to that of Thomas¹ Riggs, the latter representing the outgroup, where the six mismatched markers at locations 23, 24, 32, 34, 36, and 46 are doubly underlined:

lxnknplllmmCsijkkysCoo{oq}qkjswooqr{JK}Lllkiophjjhkjluwpjllohlwtmlkmmkll
lxnknplllmmCsijkkysCooqqkjswoo{qr}rKL{lm}lkiophjjhjjluwpjllohlwtmlkmmkll.

Assume there was an MRCA for these two. Since Edward² descended from Edward¹ Riggs, this amounts to assuming that Edward¹ Riggs and Thomas¹ Riggs had an (unknown) MRCA in England before either immigrated. It is not a requirement of this argument that the MRCA existed within genealogical time, but it will be demonstrated that such a recent MRCA was likely.

Push the six problematic markers above up the descent tree, using rule 1, toward the MRCA of Edward² Riggs and Thomas¹ Riggs. Then apply rule 2 six times to see that their MRCA most likely had the values {op}qqKl{jk} for these markers, respectively. The result is that the MRCA of both Edward² (hence Edward¹) and Thomas¹ most likely had this signature:

lxnknplllmmCsijkkysCo{op}qqkjswooqrKLllkiophjjh{jk}jluwpjllohlwtmlkmmkll

which is undetermined only at markers 23 and 46. But these markers have values o and k, respectively, for all contributors to Edward²'s signature. Use rule 1 to push these values up the tree to Edward² and then on up to Edward¹ Riggs, thus resolving the immigrant Edward¹'s signature on all 67 markers to this probable result:

lxnknplllmmCsijkkysCooqqkjswooqrKLllkiophjjhkjluwpjllohlwtmlkmmkll.

Let this be called the "Edward¹ Riggs modal signature," the desired signature.

Similarly the "Thomas¹ Riggs modal signature" from the companion paper, its desired signature, can now be redefined as

lxnknplllmmCsijkkysCooqqkjswooqrKLllkiophjjhjjluwpjllohlwtmlkmmkll

since all contributors to his signature have values p and j on markers 23 and 46, respectively. A consequence of this analysis is that values p and j on these markers flag the Thomas¹ Riggs subfamily (of the unknown MRCA) and values o and k there flag the Edward¹ Riggs subfamily. It cannot be determined from the given data which of the two values on each of the two markers is the older.

Another consequence is that the Edward¹ Riggs and Thomas¹ Riggs modal signatures match on 65 of 67 markers and therefore the two immigrants were likely to have had an MRCA in genealogical time.

In this case the two signatures, for Edward² and Thomas¹ Riggs, each had unresolved markers only where the other had resolved markers. This fortunate circumstance permitted us to establish the genetic signature of immigrant Edward¹ Riggs (and immigrant Edward² Riggs) and to remove the two uncertainties in the previously published signature of immigrant Thomas¹ Riggs.

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