ALICE CHILDS

Finding a Genetic Network of Descendants of the Unknown Father of William Munford Stubbs

16 November 2020

Objective

The objective of this research project was to use clustering tools to identify a possible cluster of descendants of William Munford Stubbs' unknown biological father or grandfather. William was born 23 June 1858 in Hethel, Norfolk, England, to Ann Munford. William married Isabelle Margaret Gavin 18 June 1875 in Parowan, Iron County, Utah, and died 3 April 1934 in Parowan, Iron, Utah.

Limitations:

- The test-taker's autosomal DNA matches that might help solve the objective will be at least 3rd cousins. Because of recombination, some of the descendants of William's father won't show up as matches.
- Descendants of William's father's other children, if he had any, will be half-cousins because they will have a different mother than William does. These possible half-relationships need to be taken into account, because these matches will share a lower amount of DNA than do full cousins.
- William's father may have had no other children, meaning William's grandfather's descendants will have to be used. They will be 4th cousins, who will share less DNA and have a greater chance of recombination, leaving more cousins who may not show up as matches.
- Descendants of William's father or grandfather may not have had their DNA tested.
- Family lore points to the possibility that William's father's last name was not Stubbs. Y-DNA is passed down from a father only to his sons and finding a direct patrilineal could

point to a possible surname. However, candidates for Y-DNA testing may decline the test, and if taken, the test may prove inconclusive.

- DNA matches may not have family trees and may not respond to communication, making genealogical records that could corroborate DNA evidence unavailable.
- Once a genetic network is created and possible candidates for William's father identified, available genealogical records may not be able to pinpoint the exact location Ann Munford and William Munford Stubbs' father in 1857 when William would have been conceived.

Results Summary

- Created a timeline of known events for the life of William Munford Stubbs' mother, Ann Munford.
- Correlated known information from traditional genealogy records for Ann Munford and hypothesized that she was likely living in the Hethel/Wymondham area in Norfolk, England at the time her son William was conceived.
- Confirmed genetic connections between the test taker and other descendants of William Munford Stubbs.
- Generated clusters of DNA matches belonging to the Stubbs family using the *Leeds Method*, *MyHeritage AutoClusters*, and *Genetic Affairs AutoCluster*.
- Evaluated DNA matches in each cluster to determine common ancestors. No unknown common ancestors emerged.
- Determined that Match 14, who has his DNA at both *Ancestry* and *MyHeritage*, would be a good match to use for a more in-depth analysis of the DNA evidence.
- Analyzed the tree of Match 14 and determined that he does not share another common ancestor with the test taker, confirming that he is a good match to use for further analysis
- Used the *Genetic Affairs Auto-Segment* analysis to determine which segments Match 14 shares with other matches.
- Concluded that a segment of Chromosome 19, shared with the test taker, Match 14, and one other match, was likely inherited through William's mother, Ann Munford.
- Discovered a cluster of six matches (Cluster 27) that triangulate on the same segment of chromosome 12, suggesting a common ancestor.

- Built Quick Trees for two of the matches in Cluster 27. No common ancestor emerged, but one line needs to be completed. Contacted the remaining matches in this cluster to learn more about their trees. No answers to these messages have been received. Concluded that learning about the common ancestors for this cluster might lead to the unknown father of William Munford Stubbs.
- Identified another match that triangulates on a different segment of chromosome 12. This match does not have a tree and was contacted to learn more information. He has not yet responded to the message.
- Generated a network diagram using Gephi. Identified the common ancestors for all but one cluster, the teal cluster.
- Analyzed the trees of DNA matches in the teal cluster to attempt pedigree triangulation, but no common ancestors emerged. Determined additional research is needed to discover the ancestors for this cluster of matches.
- Noted a small section of the Stubbs cluster on the network diagram that didn't appear to have an ancestor in common with the test taker and concluded that this part of the cluster might lead to William Munford Stubbs' unknown father.
- Concluded that building more trees for DNA matches in the clusters that are associated with the Stubbs line, noting the surnames and locations associated with these matches, and Y-DNA testing are the next steps for making progress for the next objective, which will be to determine the identity of William Munford Stubbs' unknown biological father.

Background Information

Prior to commencing the research on any genealogy objective, it is important to analyze existing sources and gather clues that will aid in the research. For a DNA project involving unknown parentage, locating two people in the same time and place is essential. By determining the location of William Munford Stubbs' mother Ann Munford at the time her son William was conceived, DNA connections can be correlated with the geographical location of possible fathers to narrow down likely candidates. Known facts that will help locate Ann Munford are summarized in the table below:

Table 1: A Chronological Timeline of Known Events for Ann Munford

Date	Event	Location	Source
24 April 1833	Birth	Costessey, Norfolk, England	Catholic Baptism Record[a]
28 April 1833	Baptism	Costessey, Norfolk, England	Catholic Baptism Record[a]
1841	Residence	Cossey, Norfolk, England	1841 England and Wales Census[b]
1851	Residence	Heigham, Norfolk, England	1851 England and Wales Census[c]
1851	Baptism into LDS Faith	Wymondham, Norfolk, England	"From the Waves of the Past" Biography[d]
1858	Birth of son William	Hethel, Norfolk, England	Birth Registration[e]
1861	Ann's Residence	Kingston, Wimbledon, Surrey, England	1861 England and Wales Census[f]
1861	Son William's Residence	Kingston, Kingston, Surrey, England	1861 England and Wales Census[g]

[a] St. Walstan's Roman Catholic Church (Costessey, Norfolk, England), Anna Mumford, birth, 24 April 1833; digital image, *FamilySearch* (https://familysearch.org : accessed 25 September 2020), database, profile for Ann Munford, KWJX-FG1.

[b] "1841 England and Wales Census," digital image, *FamilySearch* (https://familysearch.org : accessed 5 April 2020), Norfolk > Cossey > image 4 > household of Robert Munford; citing PRO HO 107, The National Archives, Kew, Surrey.

[c] "1851 England and Wales Census," digital image, *FamilySearch* (https://familysearch.org : accessed 5 April 2020), FHL microfilm #101795679, image 723, Ann Munford in the household of Robert Horne; citing PRO HO 107, The National Archives of the UK, Kew, Surrey.

[d] "From the Waves of the Past: The Munford History for Ann Munford," *FamilySearch* (https://familysearch.org : accessed 13 April, 2020), memory attached to profile for Ann Munford, KWJX-FG1.

[e] General Register Office, United Kingdom, Hethel, Humble Yard, Henstead, Norfolk, no. 241, birth registration for William Munford, 23 June 1858; digital copy held by Alice Childs, Highland, Utah.

[f] "1861 England and Wales Census," digital image, *FamilySearch* (https://familysearch.org : accessed 5 April 2020), FHL microfilm #101795679, image 723, Ann Munford in the household of Robert Horne; citing PRO HO 107, The National Archives of the UK, Kew, Surrey.

[g] "1861 England and Wales Census," digital image, *FamilySearch* (https://familysearch.org : accessed 5 April 2020), FHL microfilm #101795679, image 723, Ann Munford in the household of Robert Horne; citing PRO HO 107, The National Archives of the UK, Kew, Surrey.

Continued on p. 5

Date	Event	Location	Source
1863	Immigration	London to New York	Passenger List[h]
1863	Migration	Florence, Nebraska to Salt Lake City, Utah	LDS Pioneer Database[i]
1864	Marriage	Parowan, Utah	"From the Waves of the past" Biography[d]
1870	Residence	Parowan, Utah	1870 U.S. Census[j]
1922	Death	Parowan, Utah	Iron County Death Certificate[k]

[h] "New York, Passenger and Crew Lists (including Castle Garden and Ellis Island), 1820-1957," database with images, *Ancestry* (https://ancestry.com : accessed 24 April 2020), entry for Ann Mumford, age 29, arrived New York, New York, 1863 on *SS Amazon* from London; Date > 1863, July > 20 > image 5, entry 201.

[i] "Pioneer Database, 1847-1868," database, *The Church of Jesus Christ of Latter-Day Saints* (https://history.churchofjesuschrist.org/overlandtravel/pioneers/41450 : accessed 25 September 2020), profile for Ann Munford, Samuel D. White Company, 1863.

[j] 1870 U.S. Census, Iron County, Utah, population schedule, Parowan, page 291 (stamped), page 17 (penned), dwelling 124, family 122, Ann Gunn in the household of George Gunn; digital image, *FamilySearch* (https://familysearch.org : accessed 25 September 2020); citing NARA microfilm publication M593, Roll 1610.

[k] Iron County, Utah, death certificate no. 36 (30 April 1922), Ann Munford Gunn; digital image, *FamilySearch* (https://familysearch.org : accessed 26 April 2020), "Utah Death Certificates, 1904-1964," Iron > Parowan > 1922 > image 11.

After summarizing the evidence, Ann Munford's known residences were analyzed to determine where she might have been living in the year before the birth of her son William. Ann lived in Heigham Hamlet in the city of Norwich, Norfolk, England at the time the 1851 census was enumerated.[1] Heigham is a historical place that no longer exists. An 1851 map overlaying a modern map shows that Heigham was near modern-day Heigham Grove, Norwich, Norfolk:[2]

[1] "1851 England and Wales Census," digital image, *FamilySearch* (https://familysearch.org : accessed 5 April 2020), FHL microfilm #101795679, image 723, Ann Munford in the household of Robert Horne; citing PRO HO 107, The National Archives of the UK, Kew, Surrey.

[2] "England Jurisdictions, 1851," *FamilySearch* (https://www.familysearch.org/mapp/ : accessed 10 October 2020), Parishes in Norfolk > Heigham.

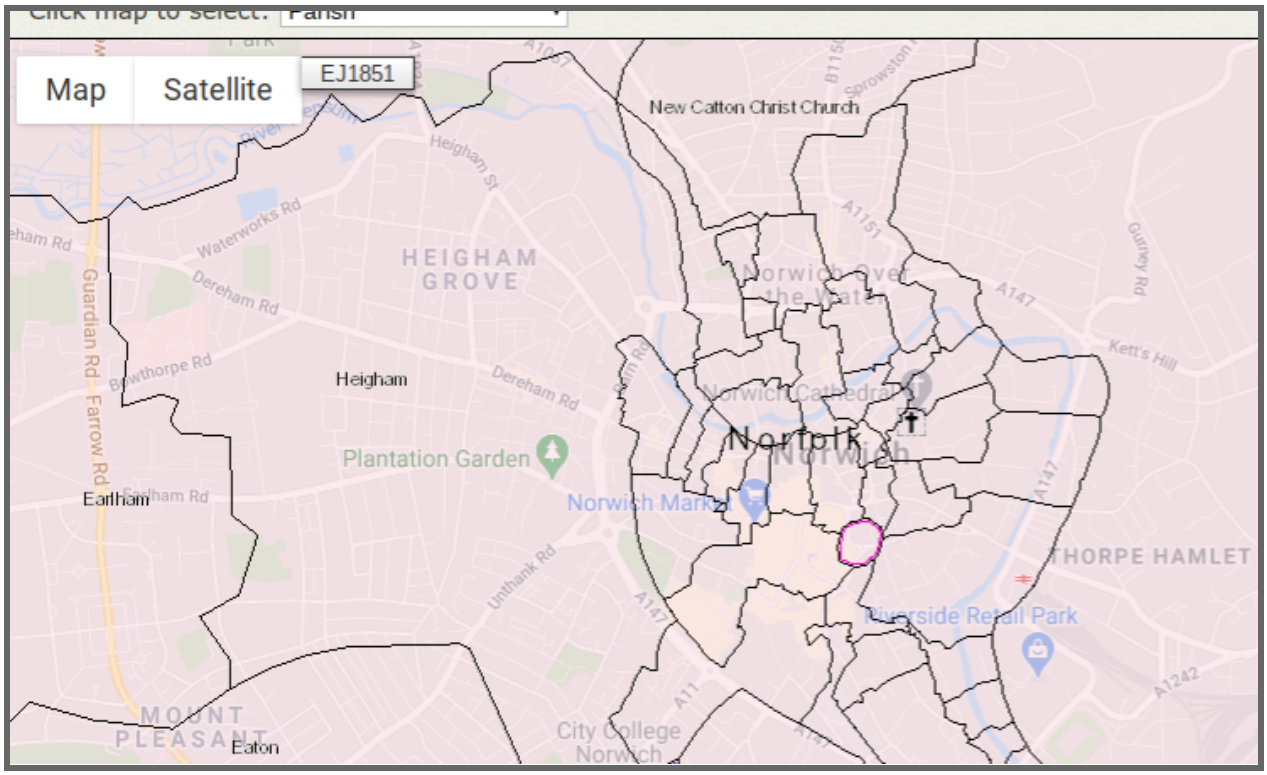

Figure 1: An 1851 Map Overlaying a Modern Map of the Heigham Area

As can be seen on the modern map below, Heigham is near Ann's birthplace of Costessey. Ann's parents were living in Wymondham, about 10 miles away, in 1851. A history of the Munford family states that Ann, her parents, and several family members were baptized as members of the Church of Jesus Christ of Latter-Day Saints in the Wymondham branch in 1851.[3] In 1858, Ann's son William was born in Hethel.[4] His birth record states that she was a resident of Hethel, just 3.6 miles from Wymondham.[5]

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[3] "From the Waves of the Past: The Munford History for Ann Munford," *FamilySearch* (https://familysearch.org : accessed 13 April, 2020), memory attached to profile for Ann Munford, KWJX-FG1.

[4] General Register Office, United Kingdom, Hethel, Humble Yard, Henstead, Norfolk, no. 241, birth registration for William Munford, 23 June 1858; digital copy held by Alice Childs, Highland, Utah.

[5] General Register Office, United Kingdom, Hethel, Humble Yard, Henstead, Norfolk, no. 241, birth registration for William Munford, 23 June 1858; digital copy held by Alice Childs, Highland, Utah.

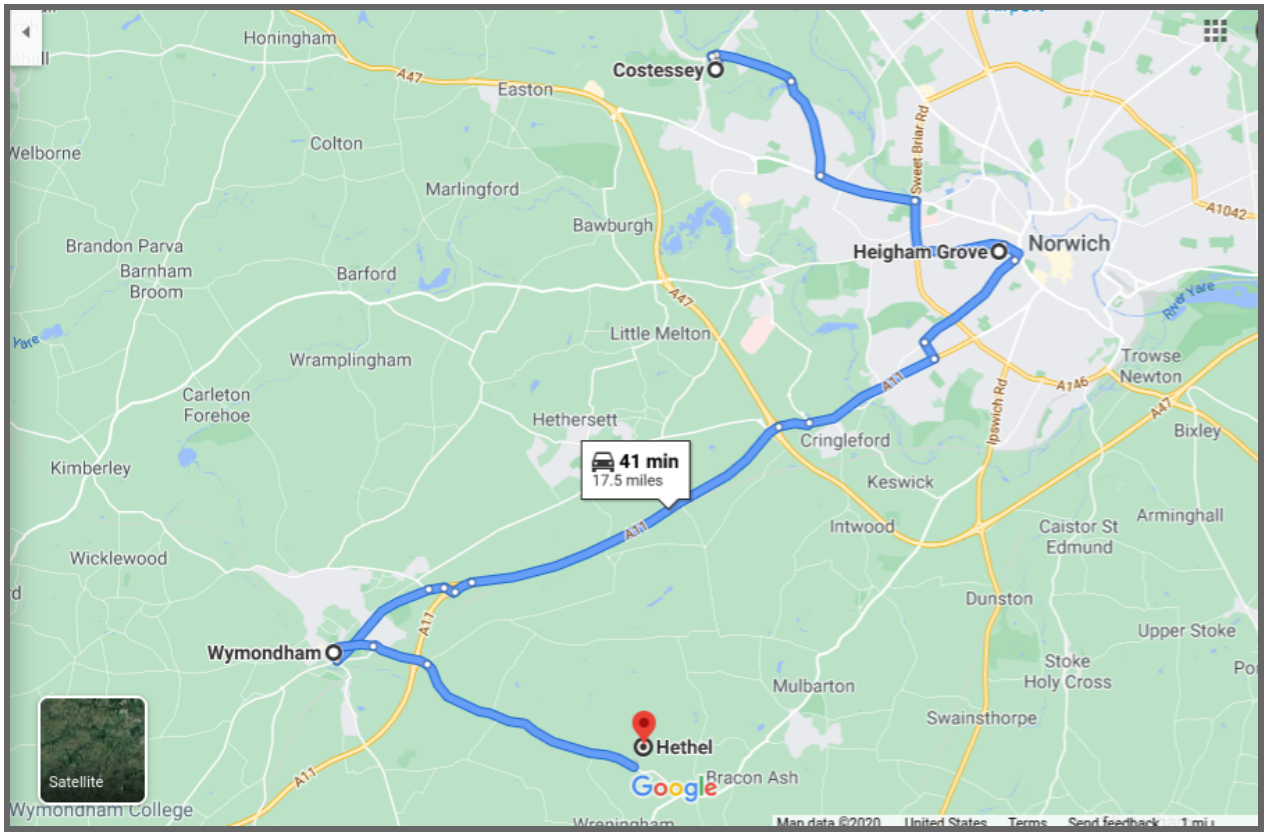
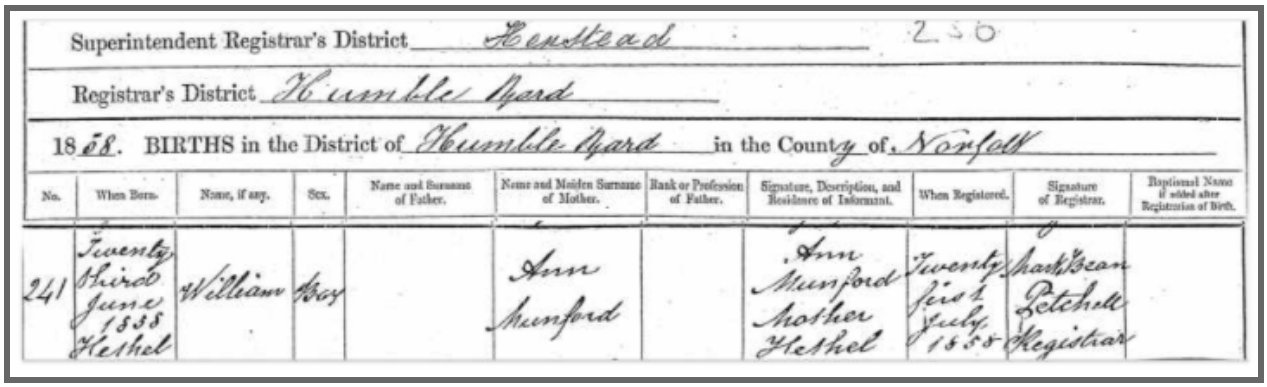


Figure 2: The Residences of Ann Munford and her Parents

The analysis of the residences of Ann Munford and her parents point to the hypothesis that she was living in the Wymondham/Hethel area the year prior to William's birth. Her reported membership in the Wymondham LDS Branch community, her parents' residence in Wymondham, and her 1858 residence in Hethel all support this hypothesis.

Another item to note from existing records is William's surname. On his birth record, no surname is listed for William. No father is listed either, but Ann Munford of Hethel is listed as his mother:



Superintendent Registrar's District Henstead 256

Registrar's District Humble Yard

1858. BIRTHS in the District of Humble Yard in the County of Norfolk

No.	When Born	Name, if any	Sex	Name and Surname of Father	Name and Maiden Surname of Mother	Rank or Profession of Father	Signature, Description, and Residence of Informant	When Registered	Signature of Registrar	Baptismal Name if added after Registration of Birth
241	Twenty Third June 1858 Hethel	William	Boy		Ann Munford		Ann Munford Mother Hethel	Twenty first July 1858	Mark Bean Peachell Registrar	

Figure 3: Birth Record for William Munford[6]

On the 1861 England and Wales census, William's surname is listed as Munford:

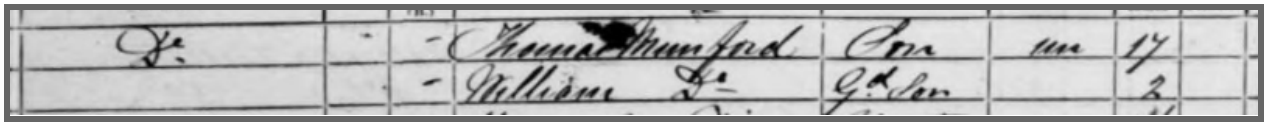


Figure 4: 1861 England and Wales census for William Munford[7]

When immigrating to the United States, Ann was listed as a spinster, and her son William was listed with her surname, Mumford [*sic.*].

Figure 5: 1863 Passenger List for Ann and Wm. Mumford.[8]

On the 1870 census, William is listed with the surname of his stepfather, George Gunn:

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6 *General Register Office,* United Kingdom, Hethel, Humble Yard, Henstead, Norfolk, no. 241, birth registration for William Munford, 23 June 1858; digital copy held by Alice Childs, Highland, Utah.

7 "1861 England and Wales Census," digital image, *FindMyPast* (https://findmypast.com : accessed 5 April 2020), Wimbledon, p. 11, William Munford in the household of Robert Munford; citing PRO HO 107, The National Archives of the UK, Kew, Surrey.

8 "New York, Passenger and Crew Lists (including Castle Garden and Ellis Island), 1820-1957," database with images, *Ancestry* (https://ancestry.com : accessed 24 April 2020), entries for Ann and Wm. Mumford, ages 29 and 4, arrived New York, New York, 1863 on SS Amazon from London; Date > 1863, July > 20 > image 5, entry 201.

Figure 6: 1870 U.S. Census for Wm. Gunn[9]

The 1880 U.S. census is the first record on which William's surname is listed as Stubbs, or Stubs, as it is spelled on this record. His initial of M likely stands for Munford. Reordering of first and middle names and initials is common on historical records:

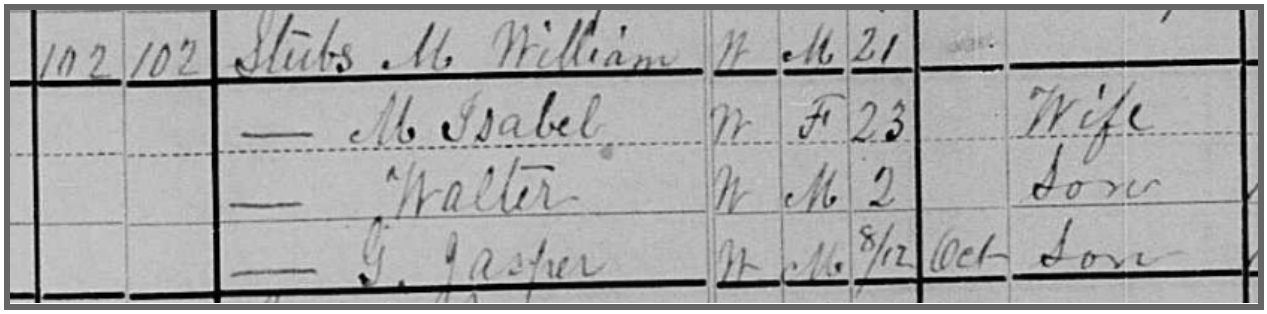

Figure 7: 1880 U.S. Census for M. William Stubbs[10]

The sudden appearance of the surname Stubbs in 1880 fits with family lore that William may have adopted that surname later in life. So, the identification of William's unknown father will involve identifying a possible surname and then narrowing down potential candidates with that surname.

A study of people with whom Ann might have associated could provide clues to the identity of William Munford Stubbs' unknown father. There are various records available in Norfolk during

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[9] 1870 U.S. Census, Iron County, Utah, population schedule, Parowan, page 291 (stamped), page 17 (penned), dwelling 124, family 122, William Gunn in the household of George Gunn; digital image, *Ancestry* (https://ancestry.com : accessed 25 September 2020); citing NARA microfilm publication M593, Roll 1610.

[10] 1880 U.S. Census, Iron County, Utah, population schedule, Parowan, enumeration district (E.D.) 21, page 358 (stamped), page 11 (penned), dwelling 102, family 102, M. William Stubs; digital image, *FamilySearch* (https://familysearch.org : accessed 16November 2020); citing NARA microfilm publication T9, Roll 1336.

this time period. Perhaps the most significant will be church records for the Wymondham Branch and the 1851 and 1861 censuses in Wymondham and Hethel.

DNA Background Information

Y-DNA is passed down almost unchanged from father to son for many generations. Having the results of a Y-DNA test could point to a surname for William Munford Stubbs' father, which could then be used in further DNA analysis. Two potential Y-DNA testers were identified and both were contacted and invited to take a Y-DNA test. As of the date this report was written, neither has responded to the request. Future research could focus on identifying additional Y-DNA testers and inviting them to test. The results might provide a surname for William along with potential common ancestors that could lead to the discovery of his unknown father.

In addition to Y-DNA passed down along the male line, all humans inherit autosomal DNA that can be used to help confirm relationships on the family tree and to discover unknown ancestors. Autosomal DNA (atDNA) is made of twenty-two pairs of chromosomes. One of each pair comes from the subject's mother, and the other comes from the subject's father. Before being passed down to the next generation, atDNA undergoes recombination, which means two copies of the chromosomes might exchange one or more pieces of DNA This process makes it challenging to determine the origin of inherited segments, but the results of atDNA testing can be used to estimate ethnicity and to identify segments of DNA shared by two or more individuals. The amount of DNA shared is used to determine possible genealogical relationships.[11] Because of recombination, atDNA is only useful in determining unknown ancestors about six generations removed from the test taker.

The Test Taker's DNA was first tested at *AncestryDNA*.[12] The raw DNA data was then downloaded from *Ancestry* and uploaded to *MyHeritage* to expand the number of matches available for analysis for this project. *AncestryDNA* has a larger pool of test takers than do other testing companies, and DNA matches for the test taker that descend from all but one of

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[11] Blaine T. Bettinger and Debbie Parker Wayne, *Genetic Genealogy in Practice*, (Arlington, Virginia : National Genealogical Society), 7.

[12] "*Ancestry* DNA Results for [Test Taker]," *AncestryDNA* (https://ancestry.com/dna : accessed 6 November 2020).

the children of William Munford Stubbs and his wife Isabelle Margaret Gavin were identified among the test-taker's shared matches at *Ancestry*.[13] No descendants of William and Isabelle's son Jasper G. Stubbs were identified. Children Chester R. Stubbs and Hazel Stubbs died prior to reaching adulthood.

The amount of shared DNA between the test taker and the other descendants of William Munford Stubbs was analyzed using the *Shared cM Project*, a tool that provides relationship probabilities for the amount of DNA shared by two individuals, measured in centimorgans (cM).[14] The analysis concluded that the amount of shared DNA between these matches fits within the predictions set forth by the *Shared cM Project* for their documented relationships. This analysis provides valuable evidence for the generational links from the test taker and each of the DNA matches listed back to the common ancestors William Munford Stubbs and Isabelle Margaret Gavin. These relationships are illustrated in the chart on the next page:

[13] "Ancestry DNA Matches for [test-taker]," *AncestryDNA* (https://ancestry.com/dna : accessed 6 November 2020), descendants of William Munford Stubbs and Isabelle Margaret Gavin, predicted 2nd cousins-2nd Cousins once removed, sharing 122-170 cM with [test-taker].

[14] Blaine Bettinger and Johnny Perl, "The Shared cM Project 3.0 tool v4," DNA Painter (https://dnapainter.com/tools/sharedcmv4 : accessed 6 November 2020), average shared cM for 2C and 2C1R.

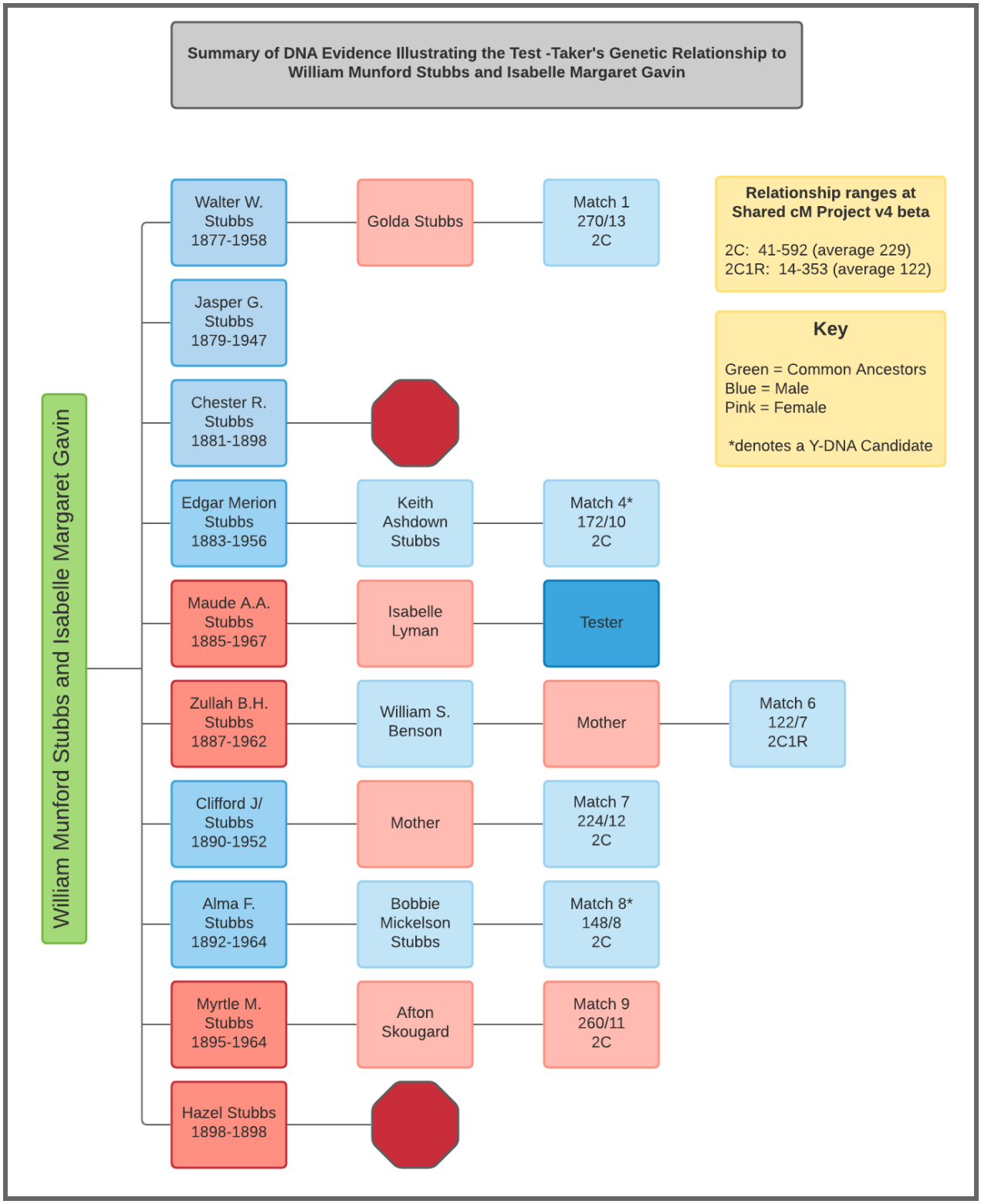

Figure 8: Summary of Genetic Relationships Between the Test Taker and Other Descendants of William Munford Stubbs

Genetic relationships between the Test Taker and each of the other descendants of William Munford Stubbs shown above provide evidence that William Munford Stubbs is indeed the Test Taker's great-grandfather. These matches create a genetic network that can be used to discover the identity of William's unknown father. The unknown father is the Test Taker's great-great grandfather. Accordingly, the Test Taker and each of his second cousins illustrated in Figure 3 above will have inherited approximately 6.25% (about 425 cM) of William's father's DNA.[15] Other descendants of William's unknown father will be 3rd-4th cousins with the second cousins in the genetic network created above and will likely share an average of 35-73 cM of inherited DNA with the Test Taker and his second cousins on the Stubbs line.[16]

Analyzing the shared matches between the Test Taker and these second cousins will identify some of the 3rd and 4th cousins, extend the genetic network, and possibly lead to the unknown biological father of William Munford Stubbs.

Findings and Analysis

Various companies have created tools to help sort DNA matches into clusters by analyzing shared matches. The matches in each cluster are likely to share a common ancestor. It is important to remember that "while everyone in a cluster matches the test-taker, not everyone matches each other. The MRCA between the test-taker and any match may vary. The generational level of the clusters may vary as well. For example, one may be on the maternal grandmother's line, while another may be on the paternal grandfather's line."[17] With these limitations in mind, a few different clustering tools were chosen to begin the process of creating a genetic network for the unknown father of William Munford Stubbs.

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[15] "Free DNA and Relationship Chart," digital image download, *Legacy Tree Genealogists* (https://www.legacytree.com/dna-relationship-chart : accessed 14 November 2020), 6.25% DNA inheritance from great-grandparent.

[16] Blaine Bettinger and Johnny Perl, "The Shared cM Project 3.0 tool v4," *DNA Painter* (https://dnapainter.com/tools/sharedcmv4 : accessed 5 October 2020), average shared cM for 3rd -4th cousins.

[17] "Genetic Affairs AutoCluster Analysis for [test-taker]," *Genetic Affairs* (http://geneticaffairs.com/features-autocluster.html : accessed 20 May 2020), cluster 8, 61 members, report privately held by Alice Childs.

The Leeds Method

The Leeds method is a way to cluster close DNA matches and separate them into grandparent lines. It is a quick and simple manual method that is a good starting point to begin the process of creating genetic networks. The Leeds Method is performed by analyzing DNA matches for a test taker that share between 90-400 cM of DNA. This amount of shared DNA falls within the relationship range for 2nd-3rd cousins. The key for this method is to not include anyone with whom the test taker shares two grandparents (first cousins).[18]

By listing the 2nd and 3rd cousins of the Test Taker for this project and analyzing their shared match list, the Test Taker's *Ancestry* DNA matches were divided into four clusters representing descendants of each ancestral line. A portion of the spreadsheet is shown below. The complete spreadsheet is included in the documents folder that accompanies this report.[19]

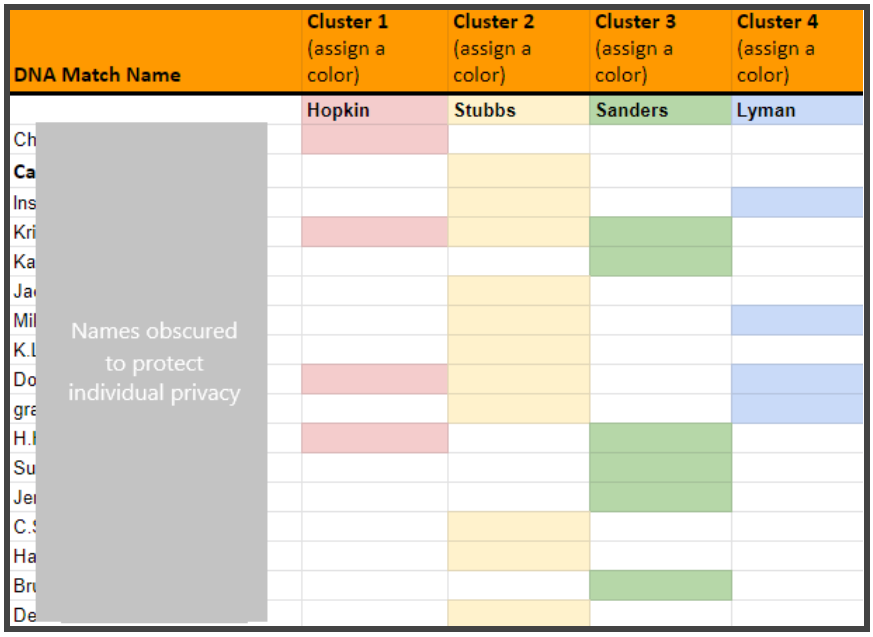

Figure 9: Snapshot of the Leeds Method Worksheet for the Test Taker's AncestryDNA Matches

[18] Dana Leeds, "The Leeds Method," (https://www.danaleeds.com/the-leeds-method/ : accessed 9 November 2020).

[19] Alice Childs, "Leeds Method Cluster Analysis for [Test Taker], created 5 May 2020, privately held by Alice Childs, Highland, UT.

As can be seen from the spreadsheet above, a number of matches belonging to the Stubbs line emerged through the Leeds Method analysis. These matches were designated as belonging to the maternal line with a magenta-colored dot using *Ancestry's* colored dot system. Additionally, those matches for whom the most recent common ancestor (MRCA) could be identified were given additional colored dots. The key to those dots is included at the top of the Test Taker's *AncestryDNA* match list.[20] Because the objective of the next phase of this research project will be to identify the unknown father of William Munford Stubbs, matches with no trees or unidentifiable MRCA's were messaged via the *Ancestry* messaging system.

MyHeritage AutoClusters

MyHeritage offers its own clustering tool that uses the DNA data from DNA kits held by their company. The *MyHeritage* AutoCluster analysis for the test-taker resulted in ten clusters.[21] The evaluation of each cluster resulted in common surnames on matches' trees and likely point to most recent common ancestors (MRCA's) for each group:

Table 2: MyHeritage AutoClusters, Cluster 8

Cluster	Maternal or Paternal	Surnames on Trees
1	Maternal	Lyman
2	Paternal	Sanders
3	Paternal	Pedersen/Sandersen
4	Maternal	Ward/Parker/Lyman
5	Paternal	Hopkin
6	Maternal	Phelps
7	Maternal	Phelps/Lyman
8	Maternal	Munford/Stubbs

[20] "*Ancestry* DNA Matches for [Test Taker]," *AncestryDNA* (https://ancestry.com/dna : accessed16 November 2020), Groups tab.

[21] "*MyHeritage* AutoCluster Analysis for [Test Taker]," *MyHeritage DNA* (https://myheritage.com/dna : accessed 29 April 2020), DNA matches sharing between 45-350 cM, report privately held by Alice Childs, Highland, UT.

9	Paternal	Sanders
10	Paternal	Sanders

Cluster 8, the Munford/Stubbs cluster, was determined to be the cluster of DNA matches that is related to William Munford Stubbs.[22] Five DNA matches were included in this cluster. These matches are a part of the genetic network of William Stubbs descendants. Only two, Match 10 and Match 14, have trees associated with their DNA Tests. These two matches were analyzed further and will be discussed later in this report. In an attempt to identify the MRCA for the other three matches in this cluster, the matches were messaged using the *MyHeritage* messaging system, but have not yet responded. Future attempts will be made to contact these matches.

Table 3: Cluster 8, My Heritage AutoClusters

DNA Match	Shared cM	# of Segments	Longest Segment	Relationship:MRCA
10	51.1	4	24.9	H3C:Ann Munford and William's stepfather George Gunn
11	200	13	42.5	Unknown
12	191.7	9	37.2	Unknown
13	125.8	8	25.5	Unknown
14	148.5	9	34.1	2C1R:William Munford Stubbs and Isabelle M. Gavin

Genetic Affairs AutoCluster

Genetic Affairs Auto-Cluster is another tool used to organize DNA matches into groups that likely represent branches of a test taker's family.[23] Until a few months ago, the *AutoCluster*

[22] "MyHeritage AutoCluster Analysis for [test taker]," *MyHeritage DNA* (https://myheritage.com/dna : accessed 29 April 2020), cluster 8, Matches 10, 11, 12, 13, and 14, report privately held by Alice Childs.

[23] "AutoCluster Concepts," *Genetic Affairs* (https://geneticaffairs.com/features-autocluser.html : accessed 9 November 2020).

analysis was available for DNA profiles from *AncestryDNA,* and the test taker's *Ancestry* DNA kit was used to perform this analysis while it was still available. An analysis of these clusters identified one cluster, Cluster 8, that went back to common ancestors William Munford Stubbs and Isabelle Margaret Gavin.[24] This cluster includes 61 members. The significantly higher number of DNA matches in this cluster as compared to the *MyHeritage* cluster is likely due to the fact that *Ancestry* has a much larger pool of test takers.

Genetic Affairs takes the AutoCluster analysis one step further by identifying common ancestors and reconstructing genealogical trees based on the trees of DNA matches from *AutoCluster* clusters.[25] This tool is designed to lead to the discovery of unknown parents through pedigree triangulation, meaning the identification of common ancestors among shared DNA matches. The *Auto-Trees* for Cluster 61 each led back to one of three sets of common ancestors: William Munford Stubbs and Isabelle Margaret Gavin, William's mother Ann and her second husband George Gunn, and William's maternal grandparents Robert Munford and Lydia Morphew. The fact that Ann's brother married George Gunn's niece further complicates the relationships on these *AutoTrees*, but the conclusion from the *AutoTrees* analysis is that no match that was found in Cluster 8 on the *Genetic Affairs AutoCluster* report goes back to an unknown father for William Munford Stubbs. Perhaps the matches that would go back to him don't have trees associated with their accounts. Without the matches' trees, *Genetic Affairs* can't create an AutoTree.

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[24] "Genetic Affairs AutoCluster Analysis for [test-taker]," *Genetic Affairs* (http://geneticaffairs.com/features-autocluster.html : accessed 20 May 2020), DNA matches sharing between 35-250 cM, cluster 8, 61 members, report privately held by Alice Childs, Highland, UT.

[25] "AutoTree for Clusters from the Genetic Affairs AutoCluster Analysis for [test-taker]" *Genetic Affairs* (https://www.geneticaffairs.com/features-autotree.html : accessed 9 November 2020), DNA matches sharing between 35-250 cM, cluster 8, report privately held by Alice Childs.

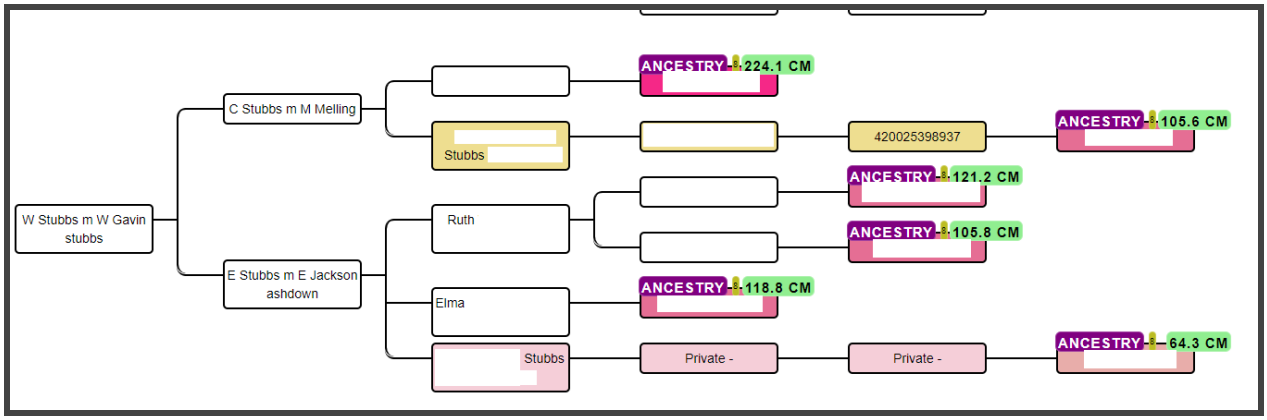

Figure 10: Sample of an AutoTree Created from the Test Taker's AutoClusters at Genetic Affairs

It was noted during the analysis of both *AutoClusters* that one DNA match in William Munford Stubbs' genetic network, Match 14, is a match at both *Ancestry* and *MyHeritage.*[26] The test taker and this DNA match descend from common ancestors William Munford Stubbs and Isabelle Margaret Gavin. Their documented relationship of 2C1R fits within the parameters set forth by the Shared cM Project (range: 14-353 cM, average: 122 cM).[27]

[26] "Ancestry DNA Matches for [Test Taker]," *AncestryDNA* (https://ancestry.com/dna : accessed 9 November 2020). predicted 3rd-4th cousins, sharing 136 cM, 9 segments with Match 14.

"MyHeritage DNA Matches for [Test Taker]," *MyHeritage DNA* (https://myheritage.com/dna : accessed 9 November 2020), predicted 2C-2C1R], sharing 148.5 cM, 9 segments with Match 14.

[27] Blaine Bettinger and Johnny Perl, "The Shared cM Project 3.0 tool v4 beta," *DNA Painter* (https://dnapainter.com/tools/sharedcmv4-beta : accessed 30 October 2020), shared cM range and average for 2C1R.

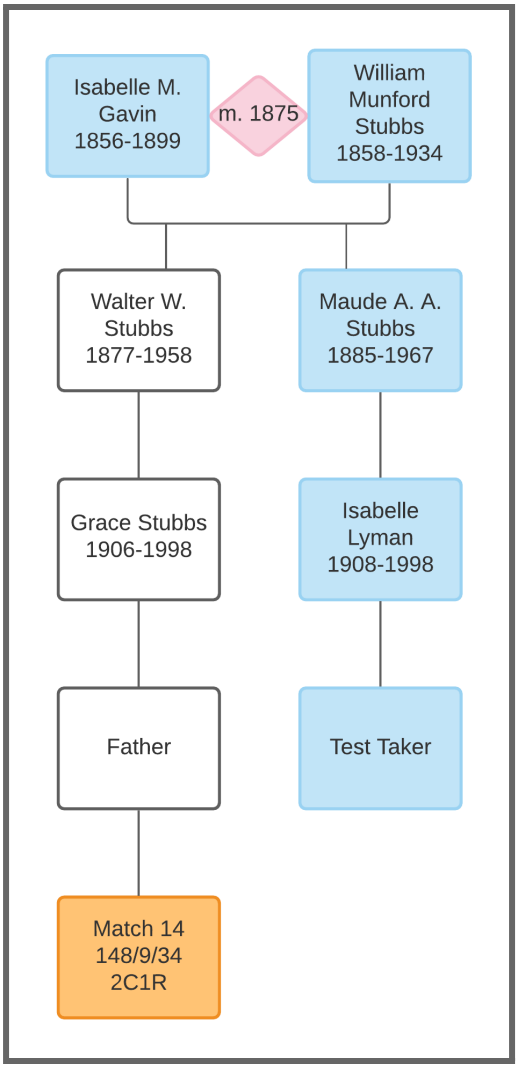

Figure 11: Test Taker's relationship to Match 14

Because Match 14 has DNA data at both sites, it was determined that he would be a good match to use for further DNA analysis.

When analyzing DNA matches, it is necessary to determine whether the DNA they share might have been inherited from more than one common ancestor. Having established William Munford Stubbs and Isabelle M. Gavin as one set of common ancestors, the remaining ancestors on Match 14's *Ancestry* tree were examined to rule out additional MRCA's.[28] This task was accomplished by looking up each of Match 14's ancestors at the 2x great-grandparent

[28] "Public Member Trees," *Ancestry* (https://www.ancestry.com/family-tree/tree/87237200/family/pedigree : accessed 30 October 2020), [Match 14's] Family Tree, managed by [Match 14], undocumented data.

level on the *FamilySearch* tree using the test taker's daughter's profile. The "View My Relationship" feature was then used to determine whether Match 14's ancestors were related to the Test Taker. Two of Match 14's ancestors, William Isom and Lucinda Stratton, showed a relationship. However, the common ancestors between these persons and the Test Taker were ten or more generations removed from the Test Taker, making it unlikely that a significant amount of autosomal DNA could be pinpointed as having been passed down from these ancestors.

Genetic Affairs AutoSegment Analysis

Having determined that Match 14 and the test taker were significantly related only through their common ancestors William Munford Stubbs and Isabelle Margaret Gavin, a *Genetic Affairs* AutoSegment analysis was used to help identify chromosome segments that were passed down from William Munford Stubbs' unknown father to the test-taker, Match 14, and their DNA matches who share those segments. According to explanatory information from *Genetic Affairs,* "AutoSegment organizes matches into clusters that likely represent branches of your family. Everyone in a cluster will likely be on the same ancestral line, although the MRCA between any of the matches and between you and any match may vary. The generational level of the clusters may vary as well. One may be your paternal grandmother's branch, another may be your paternal grandfather's father's branch."[29] The information from *Genetic Affairs* also emphasizes that "an overlapping segment as calculated is not proof of a triangulating segment!" This meant that after identifying AutoSegment clusters that include Match 14, it would be necessary to carefully study each match in the cluster to determine who the common ancestor(s) might be. Using the Chromosome Browser at *MyHeritage* to look for triangulating segments would add additional evidence for likely common ancestors.

A *Genetic Affairs* AutoSegment Analysis was requested using the Test Taker's *MyHeritage* DNA

[29] "Genetic Affairs AutoSegment Analysis for [test taker]," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020]); report generated using MyHeritage DNA data, 25-250 cM, report privately held by Alice Childs.

results.[30] Match 14 was found in four of the sixty-five AutoSegment clusters included in the *Genetic Affairs* AutoSegment report, as shown in the table below: Each will be discussed in detail in the paragraphs following the table.

Table 4: Genetic Affairs AutoSegment Clusters That Include Match 14

Cluster	# of Members	Match ID #'s	Common Ancestors	Matching Segment
13	5	**14**, 21, 22, 23, 24	Unknown (no triangulation)	Chromosome 10 ~ 18 cM 7,304,291 - 14,717,099
16	8	12, **14,** 25, 26, 27, 28, 29, 30	Unknown. Triangulation with only one match, #12, who has no tree	Chromosome 12 ~ 18 cM 4,842,536 - 12,828,320
27	7	**14**, 15, 16, 17, 18, 19, 20	Unknown	Chromosome 12 18.3 cM 48,237,109 - 66,864,291
28	2	10, **14**	Ann Munford	Chromosome 19 18.8 cM 5,148,1570 - 56,762,676

Cluster 13

The first *AutoSegment* cluster that Match 14 appears in is Cluster 13, along with five other matches.[31] They each overlap on segments on Chromosome 10. However, using the *MyHeritage* Chromosome Browser revealed that none of these matches triangulate with the Test Taker and Match 14 on Chromosome 10, suggesting that the segment the Test Taker shares with Match 14 occurs on one side of the segment and the segment shared with the other matches occurs on the other side. This would mean that Match 14 is not related to both the test

[30] "Genetic Affairs AutoSegment Analysis for Test Taker]," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020]); report generated using *MyHeritage* DNA data, 25-250 cM, minimum overlap 15 cM, report privately held by Alice Childs.

[31] "Genetic Affairs AutoSegment Analysis for [Test Taker," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020), cluster 13; report generated using *MyHeritage* DNA data, 25-250 cM, report privately held by Alice Childs.

taker and these matches through a common ancestor.[32] Because there was no triangulation, the matches in this cluster will not be analyzed further at this time.

Cluster 16

The second AutoSegment Cluster in which Match 14 appears is Cluster 16.[33] There are nine matches in this cluster and they all overlap on a segment of Chromosome 12. However, only one of the matches, Match 12, triangulates with Match 14 and the test taker on this segment.[34] Their shared segment is 22.9 cM long.

Match 12 does not have a family tree linked to his account. He was contacted in an attempt to determine who the MRCA for Match 12, Match 14, and the Test Taker is. Match 12 also appears in Cluster 17 with 9 other people.[35] However, he does not triangulate on this segment with the Test Taker and any other member of the cluster.[36]

Cluster 27

DNA Match 14 also appears in Cluster 27, along with six other DNA matches.[37] The DNA segment on which these matches all overlap occurs on another segment of chromosome 12. Utilizing the *MyHeritage* Chromosome Browser revealed that six of the seven matches in this

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[32] "What are triangulated segments in the Chromosome Browser — One-to-many?" *MyHeritage* Help Center (https://faq.myheritage.com/en/ : accessed 30 October 2020), DNA > DNA Tools.

[33] "*Genetic Affairs* AutoSegment Analysis for [Test Taker]," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020), Cluster 16; report generated using *MyHeritage* DNA data, 25-250 cM, report privately held by Alice Childs.

[34] "*MyHeritage* Chromosome Browser--One to Many," *MyHeritage DNA* (https://myheritage.com/dna : accessed 30 October 2020), [Test Taker], Match 14, and Match 12, sharing one triangulated segment of 22.9 cM.

[35] "*Genetic Affairs* AutoSegment Analysis for Elden Sanders," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020]), Cluster 17; report generated using *MyHeritage* DNA data, 25-250 cM, report privately held by Alice Childs.

[36] "*MyHeritage* Chromosome Browser--One to Many," *MyHeritage DNA* (https://myheritage.com/dna : accessed 30 October 2020), [Test Taker] and DNA matches in *Genetic Affairs AutoSegment* Cluster 17, no triangulated segments.

[37] "*Genetic Affairs* AutoSegment Analysis for [Test Taker]," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020]), Cluster 27; report generated using *MyHeritage* DNA data, 25-250 cM, report privately held by Alice Childs.

cluster triangulate with the test taker on a 17.8 cM segment of chromosome 12, again suggesting a common ancestor.[38] None of these matches has a complete tree at *MyHeritage*, so it was impossible to determine who a common ancestor might be. Two of the matches, Match 15 and Match 20, have provided enough information on their trees that it was possible to build out their trees to try to discover a common ancestor. The other matches have no trees and were messaged via the *MyHeritage* messaging system in order to learn more.

Match 15 and Match 20 were added as hanging branches to the William Stubbs DNA tree at *Ancestry*.[39] Quick trees were built, and no common ancestor or common surnames emerged. One of Match 15's lines needs to be extended back another generation to see if a connection can be made.

Cluster 28

Cluster 28 includes only two members, Match 10 and Match 14.[40] They overlap on a segment on chromosome 19. The *MyHeritage* Chromosome Browser shows that they also triangulate with the Test Taker on the same segment.[41] The triangulated segment length is 18.8 cM. A triangulated segment suggests a common ancestor, and the tree of Match 10 shows that she

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[38] "*MyHeritage* Chromosome Browser--One to Many," *MyHeritage DNA* (https://myheritage.com/dna : accessed 30 October 2020), [Test Taker], Match 14, Match 15, Match 16, Match 17, Match 18, and Match 20, 1 triangulated segment.

[39] "Private Member Trees," *Ancestry* (https://www.ancestry.com/family-tree/tree/170442557/family?cfpid=232242333416 : accessed 2 November 2020), William Stubbs DNA Tree, managed by Alice Childs, profile for Match 15, undocumented data.

"Private Member Trees," *Ancestry* (https://www.ancestry.com/family-tree/tree/170442557/family?cfpid=232242384008 : accessed 2 November 2020), William Stubbs DNA Tree, managed by Alice Childs, profile for Match 20, undocumented data.

[40] "*Genetic Affairs* AutoSegment Analysis for Elden Sanders," *Genetic Affairs* (https://members.geneticaffairs.com/autosegment : accessed 29 October 2020]), cluster 28, [Test Taker], Match 14, and Match 10 overlapping with 24.9 cM on chromosome 19; cluster generated using MyHeritage DNA data, 25-250 cM, report privately held by Alice Childs.

[41] "MyHeritage Chromosome Browser--One to Many," *MyHeritage DNA* (https://myheritage.com/dna : accessed 30 October 2020), Elden [Test Taker], Match 14, and Match 10, 1 triangulated segment.

descends from William's mother Ann Munford and William's stepfather George Gunn.[42] This means the common ancestor for this cluster is Ann Munford. Because William's descendants have no genetic connection to George Gunn, it is likely that the triangulated segment on chromosome 19 was inherited from William's mother, Ann Munford Gunn.

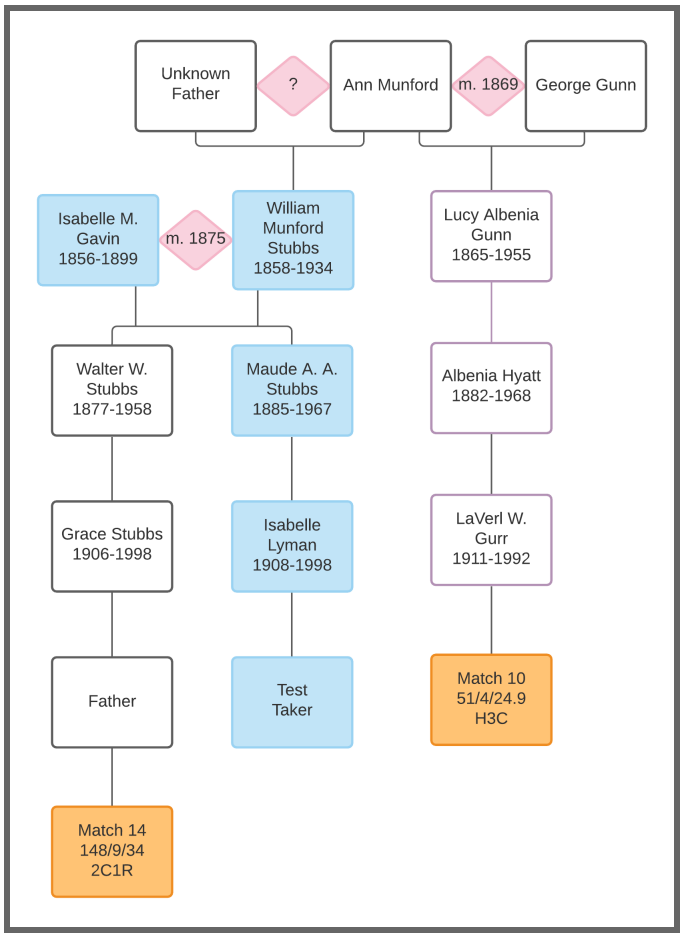

Figure 12: Relationships between Test Taker, Match 14, and Match 10

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42 "What are triangulated segments in the Chromosome Browser — One-to-many?" MyHeritage Help Center (https://faq.myheritage.com/en/ : accessed 30 October 2020), DNA > DNA Tools.

"Thompson Family Tree," *MyHeritage* (https://www.myheritage.com/pedigree-tree-556009591-1500001/thompson?familyTreeID=1&kitId=3E598084-6E65-4081-9456-76EB0D431675 : accessed 30 October 2020), managed by [Private], undocumented data.

Tree-Building to Find MRCA's

Being able to build out the trees of each DNA match who triangulates on segments with the Test Taker and Match 14 will likely lead to common ancestors for these individuals. Aside from the segment shared between Match 10, Match 14, and the test taker on Chromosome 19, it is impossible to predict whether the triangulated segments were inherited from William Munford Stubbs' mother or his father until the trees are built. If William Munford Stubbs and his wife Isabelle M. Gavin are the MRCA's for these groups of people, the triangulating segments could also have been inherited from Isabelle's parents.

Gephi Genetic Network Diagram

Another way to cluster matches and visualize them in a different way is by using a network diagram. This type of diagram is designed to show interconnections between a set of entities, or in this case, DNA matches.[43] Each match is represented by a "node." Connections between nodes are represented through links. A program called *Gephi* was used to generate a network diagram using the test taker's *Ancestry* DNA matches with a shared cM range between 15 and 250 cM.[44] Once the graph was generated, each cluster of matches was analyzed to determine common ancestors for the cluster. Surnames associated with each cluster are illustrated below:

[43] "Network Diagram," *from Data to Viz* (https://www.data-to-viz.com/graph/network.html#:~:text=Network%20diagrams%20 : accessed 9 November 2020).

[44] Alice Childs, "Gephi Network Graph for [Test Taker]," generated using [Test Taker's] *AncestryDNA* matches sharing 15 - 250 cM, privately held by Alice Childs, Highland, UT.

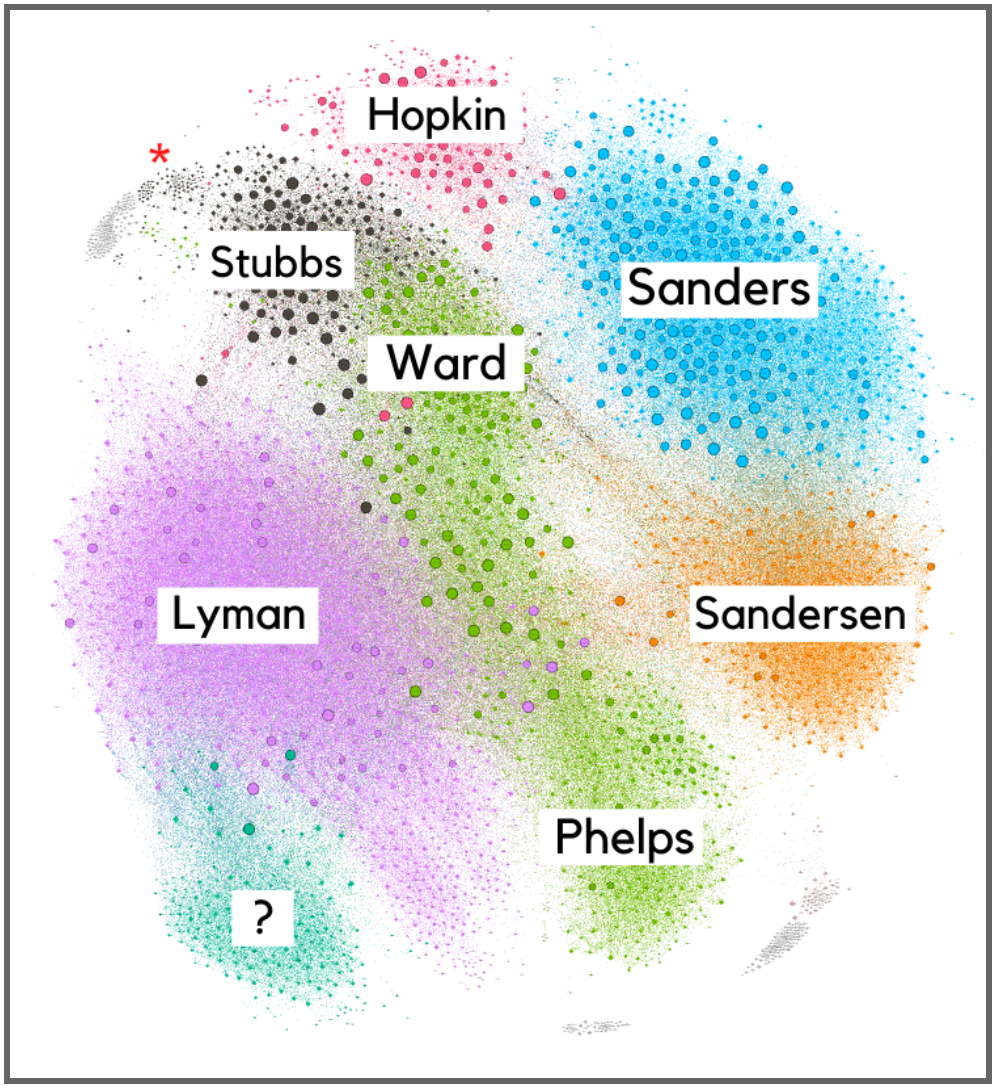

Figure 13: Genetic Network Graph for [Test Taker] Illustrating Surnames of Ancestors in Each Cluster

The Hopkin, Sanders, and Sandersen clusters belong to the Test-Taker's paternal line, with the Stubbs, Ward, Phelps, and Lyman clusters belonging to the maternal line. The only unidentifiable cluster was the teal group on the lower left of the diagram. A common ancestor could not be discovered. Several matches in this cluster do have very extensive trees, and pedigree triangulation between these matches was attempted with no success. Because of the links between the teal group and the Lyman cluster, it is likely that these two clusters are interconnected, and further research can be conducted to analyze the links between them.

Another area of interest is marked with a red asterisk at the top of the black Stubbs cluster. These matches don't appear to have a common ancestor either, and their connections to the

Stubbs descendants make it possible that they may descend from William's paternal line. They could also descend from William's wife Isabelle Gavin's line. Future research will focus on the identification of a common ancestor for these two groups of people.

Conclusions

The objective for this research project was to use clustering tools to identify a possible cluster of descendants of William Munford Stubbs' unknown biological father or grandfather. William was born 23 June 1858 in Hethel, Norfolk, England to Ann Munford. William married Isabelle Margaret Gavin 18 June 1875 in Parowan, Iron County, Utah and died 3 April 1934 in Parowan, Iron, Utah.

The research was very successful in creating clusters of DNA matches that can now be further analyzed in the next research session to discover the identity of William Munford Stubbs' unknown father. *The Leeds Method*, *MyHeritage AutoClusters*, and *Genetic Affairs AutoCluster* identified groups of matches that appear to descend from William Munford Stubbs. A *Genetic Affairs AutoSegment* analysis led to the identification of a segment of Chromosome 19 that was likely passed down through William Munford Stubbs' mother Ann Munford. A group of triangulating matches on a segment of Chromosome 12 can be further analyzed to discover a common ancestor. Another match that triangulates with key DNA Match 14 has been contacted in an attempt to determine the MRCA shared between him, the Test Taker, and Match 14.

Finally, a network graph was generated using the Test Taker's *AncestryDNA.* Common ancestors were found for the members of all clusters but one, which might be connected to the Lyman line. Another subsection of the Stubbs cluster on this graph like it might belong to the unknown father of William Munford Stubbs. A further study of the matches in this cluster could lead to the unknown father of William Munford Stubbs.

The clusters of DNA matches identified during this research session can now be further evaluated. Contacting DNA matches, building out trees for those matches that have incomplete trees, listing surnames and locations to look for overlap, and Y-DNA testing will all provide additional evidence to help solve this mystery.

Suggestions For Future Research

- Search the Wymondham Branch records to see if the father of William Munford Stubbs is recorded:
    - Record of members, 1848-1887, FHL microfilm #87039, items 26-27. DGS #8095925.
- Continue attempting to contact DNA matches that belong to the Stubbs genetic network in an effort toward successful pedigree triangulation.
- Continue building out trees of DNA matches in Cluster 27 of the *Genetic Affairs AutoSegment* report to try to discover a common ancestor.
- Begin an in-depth analysis of the matches in the teal group and the small subset of the black Stubbs group on the Gephi network diagram, noting surnames and locations. Build trees as needed in an attempt to discover a common ancestor for the groups.
- Once surnames and locations have been recorded, look for repeating surnames and locations near Hethel and Wymondham in Norfolk. Use *G-Works* at DNAGedcom.com to look for other instances of these surnames on matches' trees.
- Identify additional Y-DNA test candidates and contact them to ascertain their willingness to participate in Y-DNA testing.
- Contact other descendants of William Munford Stubbs and ask them to share their match lists.