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2016

The Estimation of Germ Line De Novo Mutation Rates of Extended Sets of Y-STR Haplotypes to Aid in the Differentiation of Male Biological Relatives in Criminal Investigations

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THE ESTIMATION OF GERM LINE *DE NOVO* MUTATION RATES OF EXTENDED SETS OF Y-STR HAPLOTYPES TO AID IN THE DIFFERENTIATION OF MALE BIOLOGICAL RELATIVES IN CRIMINAL INVESTIGATIONS

by

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A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Science in Forensic Science
in the Department of Chemistry
in the College of Sciences
at the University of Central Florida
Orlando, Florida

Fall Term
2016

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ABSTRACT

An important forensic application for Y-chromosome Short Tandem Repeats (Y-STRs) is finding paternal lineages to help link families through genetic genealogy, since Y-STR haplotypes represent the information from a non-recombining lineage [1]. The power of Y-STR haplotyping to identify male-line related men is accurate even when they are disjointed by many generations, allowing deep-rooted family studies [2]. Most Y-STRs have slippage mutation rates on the order of $1x10^{-3}$ or lower [3]. For example, even after seven generations it was possible to recognize that five male-line descendants of two paternal cousins of the U.S. President Thomas Jefferson share the same Y-haplotype found in one male-line descendant of Eston Jefferson, who was Sally Hemings's son. Sally was one of the president's slaves and it was determined through this study that President Jefferson was the father of Eston [4].

To detect blood relationships among male-line relatives, the Y-STRs in "first generation" commercial multiplex systems include 12-17 loci. Y-chromosome STRs have value also in the forensic identification of male DNA from sexual assault cases. However, the commercial systems do not allow personal individualization. During the 'IV Brazilian DNA and Forensics Seminar' in Cuiabá, Brazil, in 2012, a case of multiple sexual assault of a 10 year old girl was reported [5]. Police investigation had indicated the rapist as the girl's father and/or two paternal uncles. The crime circumstances required biological evidence confirmation. Special cases like this could be elucidated by DNA analysis from cervicovaginal post-coital semen. However, STRs in autosomal, X, or mitochondrial chromosomes would be inefficient due to the biological relationships between the victim and the suspects. In addition, even with differential DNA extraction from cervicovaginal post-coital samples, the female cells could be the major

contributor and preclude a conclusive result. Mayntz-Press et al. were able to obtain Y-STR profiles from semen collected in extended post-coital interval [6], but in this Brazilian case the Y-STRs in current "first generation" commercial multiplex systems would have limited, if any, utility because the suspect perpetrators are paternal brothers. In order to obtain discrimination among the brothers, it would be necessary to use a larger number of Y-STRs or to use a selection of Y-loci with higher than average slippage mutations with the hope that a germline meiotic mutation will have occurred in at least one of the brothers.

The mutation rates and characteristics of human Y-chromosomal microsatellites are consistent with those of autosomal microsatellites, indicating that the general mutational mechanism of microsatellites is independent of recombination [7]. An ultra-high discrimination (UHD) Y-STR multiplex DNA typing system with 14 non-core Y-STR loci was developed and tested in 2007 [8]. A new panel of rapidly mutating (RM) Y-STRs composed of 13 markers with mutation rates above 1×10^{-2} divided into three multiplexes was published in 2012 [9]. In 2015, these RM loci were streamlined into a single multiplex to analyze all 13 loci simultaneously [10]. In addition, there are now available "second generation" Y-STR multiplex kits such as Promega's PowerPlex® Y23 (PPY23), which contains an extended set of Y-STR loci including six highly informative loci and two loci with higher than average mutation rates. Taking the three multiplexes together and removing extra copies of loci that are found in more than one multiplex (as well as the adjustments to the multiplexes for optimization in this study), there are 40 unique Y-STR loci. This forty-locus combined panel, referred to as the "Masker Set" in this study, represents a powerful tool to separate closely related males.

Considering the particular regional genetic structure of the South Brazilian population, related male pairs have been studied to identify the mutability, rates, and characteristics of Y-STRs and their forensic implications. In the present work, the 40 Y-STR loci of the "Masker Set" have been tested to identify the rate of discriminative slippage mutations in the following paternally connected male pairs from the South Brazilian population: 99 grandfather-grandson (GF-GS), 103 uncle-nephew (U-N), and 140 brothers. The goals of this study were to: describe the characteristics and frequency of germ-line mutations at 40 Y-STR loci; define the differences in mutation rates between and within loci; determine repeat gain and loss rates; and identify the most informative loci to discriminate related males. These goals were achieved and it was determined that using the 40-locus "Masker Set" panel, male relative pairs could be separated by at least one mutation 53% of the time for GF-GS pairs, 62% of the time for U-N pairs, and 54% of the time for brother pairs. The fifteen most discriminating Y-STR loci recommended for use in a multiplex to differentiate paternally related males are: DYF399S1, DYF403S1A, DYS612, DYS518, DYS547, DYS449, DYF404S1, DYS389II, DYS627, DYS526B, DYS508, DYF387S1, DYS458, DYS576, and DYS403S1B.

To my husband, Jordan, for his loving support in my academic endeavors and life;

and to my family, Paul, Diane, and Victoria Pettofrezzo, for their love and

encouragement to follow my dreams and be the best I can be.

ACKNOWLEDGMENTS

I would like to first of all thank Dr. Jack Ballantyne for being my research advisor and instructor during my graduate studies and for allowing me to work in your laboratories to do cutting-edge forensic research and gain so many skills. Thank you also to Dr. Erin Hanson for everything you do to keep the laboratories running, for reviewing much of my data, and for helping me in so many things along the way. Dr. Eda Koculi and Dr. Dmitry Kolpashchikov deserve recognition for serving on my thesis committee. I would like to recognize Clarice Sampaio Alho who has done previous work relevant to this study for providing the samples and allowing me to use them in this project. Lastly, thank you to all of the participants who gave blood samples which provided the means to complete this study.

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LIST OF ABBREVIATIONS

AB   Amplification blank

bp   Base pairs

BSA   Bovine serum albumin

C.I.   Confidence interval

DNA   Deoxyribonucleic acid

DP   Discriminative potential

F, FSP   Son sample label

GF-GS   Grandfather-grandson

ISP   Uncle sample label

Min.   Minutes

ng   Nanograms

NGS   Next-generation sequencing

PCR   Polymerase chain reaction

PSP   Grandfather sample label

PUCRS   Pontifícia Universidade Católica do Rio Grande do Sul (Porto Allegre, Brazil)

PPY23   PowerPlex® Y23 system (Promega)

RM	Rapidly mutating
RM-12plex	Rapidly-mutating multiplex (modified for this study)
RNA	Ribonucleic acid
Sec.	Seconds
STR	Short tandem repeat
UHD	Ultra-high discrimination multiplex
U-N	Uncle-nephew
Y-STR	Y-chromosome short tandem repeat
μL	Microliter

CHAPTER ONE: INTRODUCTION

In recent years, DNA analysis has become a widely accepted technique for use in identifying individuals for various purposes, including criminal matters. Human DNA and the genes within it that code for life and all of its functions are packaged into twenty-three pairs of chromosomes that can be found in every cell of the body (except for the gametes, sperm and eggs, which only contain one copy of each of the pairs of chromosomes) [11]. Therefore, the cells are known as diploid in regards to the pairs of chromosomes, while gametes are known as haploid. One of the twenty-three pairs codes for an individual's gender and they are known as the sex chromosomes. If a person has 2 X chromosomes, they are genetically a female, while a person with an X and a Y chromosome is genetically a male. The Y chromosome is much smaller than the X chromosome, as seen in Figure 1. The remaining twenty-two pairs of chromosomes are called autosomal.

During meiosis, the DNA is copied and the cell is divided twice to prepare for sexual reproduction. Throughout this process, genetic recombination can occur between and within the chromosomes, leading to new combinations of genetic material [11]. This requires homology, or sequence similarity, between the chromosomes and due to the size difference in the sex chromosomes, this recombination does not occur apart from the pseudoautosomal regions (PAR regions) at the chromosome ends [11,12]. Therefore, the male DNA contained within the Y chromosome is faithfully passed down to males within the same family from generation to generation.

Within DNA there are coding regions, which contain genes, and non-coding regions, sometimes referred to as "junk DNA" [11]. The coding regions are the "code" of DNA that is

used to make the proteins necessary for life. Non-coding DNA is no longer believed to be purely "junk DNA", as it can be transcribed into various types of RNA, among other things [13,14]. The functions of non-coding DNA are still being uncovered, but one important application that is already in use is in the field of forensics.

Short tandem repeats (STRs) are sections of non-coding DNA which contain a short sequence of base pairs that is repeated a variable number of times. These repeat units are typically 2-7 base pairs in length (with 4 being the most commonly used in forensics) and they can repeat under various motifs from simple to compound to complex [11]. Simple repeats have identical repeat units while compound repeats contain two or more simple repeats. Complex repeats can have multiple different repeat units and lengths and can also have intervening DNA sequences that can vary. An example of a simple repeat and the variation possible between individuals is shown in Figure 2.

STRs can also be found on the Y chromosome (referred to as Y-STRs) and can be used to identify male DNA. These are particularly useful in cases of sexual assault where the female DNA may be in such an excess that it precludes identification of the male DNA profile [15]. The differential extraction technique, which allows the separation of sperm from vaginal material using a preferential lysis, was developed to address this scenario [16]. However, using Y-STRs allows for the isolation of the male DNA without the extra burdens of this type of extraction and the failures of it. Y-STRs are also used widely for paternity testing. Since the sex chromosomes are non-recombining, they can be used to link paternally-related males through many generations [2].

However, DNA (and therefore, STRs and Y-STRs) is not always perfectly replicated to be passed on to the next generation. Errors can occur, although they are rare, and these are called DNA mutations [17]. The human body contains a remarkable DNA repair system that can correct many DNA replication errors [18]. The type of mutations studied here involve the addition or loss of a repeat unit in a STR or more rarely, multiple repeat units. This type of mutation is not recognized as detrimental since it does not affect the coding for life. It can be repaired by the DNA repair system, but the system is not able to correct every mutation and some will get through.

The strand slippage stepwise mutation model is the widely accepted mechanism for how these repeat mutations occur [19,20], and it is applicable to both autosomal microsatellite DNA and DNA from the sex chromosomes, including Y-STRs. This indicates that the mutations are not recombination dependent, since the sex chromosomes do not undergo recombination [7]. Strand slippage mutations are due to the processivity of the DNA polymerase, the enzyme which replicates DNA. When the enzyme reaches its processing limit and falls off during strand extension, the DNA strands have a chance to separate or "breathe" and one of the strands can loop out before they re-anneal and the polymerase re-attaches [17]. During this "breathing", slippage can occur on the new strand being synthesized, resulting in a repeat gain, or it can occur on the template strand, which results in a repeat loss. This is typically only by one repeat unit, but it can occur with multiple repeat units, though it is usually observed much less commonly. A diagram of this mutation model is shown in Figure 3. Mutations by a non-integer number of repeat units are very rare and were not observed in this study [21].

The Y-STRs utilized in forensics and other fields are typically those with low mutation rates on the order of 1×10^{-3} or lower in order for them to be observed to be faithfully passed down between generations of paternally related males, and therefore to be effective in linking individuals [3]. Because of this, Y-STRs have proven to be useful in genetic genealogy as well as the forensic identification of male DNA in sexual assault cases [1]. Since they are non-recombining, they are able to link men that are separated by many generations [2]. In a famous historical study, Foster et al. found that a male-line descendant of Sally Hemings's son Eston Jefferson shared the same Y-haplotype as five different male-line descendants of U.S. President Thomas Jefferson's two paternal cousins [4]. Sally was one of President Jefferson's slaves and it was rumored that he was Eston's father, which this study utilizing Y-STRs was able to show.

"First generation" commercial Y-STR kits such as Promega's PowerPlex® Y [22] and Applied Biosystems' Yfiler® [23] included 12-17 loci that could detect blood relationships among male-line relatives. About a decade later, 'next (or second) generation' commercial Y-STR kits were released, such as Promega's PowerPlex® Y23 system [24] and Applied Biosystems' Yfiler® Plus kit [25]. In these kits not only were the number of loci increased to more than 20, but some loci with higher than average mutation rates were included. These kits have dramatically increased the effectiveness of Y-STR analysis, but certain types of cases continue to provide significant challenges. For example, in 2012, at the 'IV Brazilian DNA and Forensics Seminar' in Cuiabá, Brazil, they reported on a case dealing with multiple sexual assault of a 10 year old girl in which the police suspected the child's father and/or her two paternal uncles [5]. This posed a dilemma as the Y-STRs would not be able to differentiate between these brothers if the cervicovaginal post-coital semen was analyzed. The Principal

Investigator on this project was involved with a different case out of Argentina where there was a female victim and the suspects included her son, husband, and her husband's father, all of the same male genetic lineage (Jack Ballantyne, personal communication). These individuals were not able to be distinguished by standard Y-STRs. The locus DYS19 was one of the standard loci examined and it was found that there was a deletion, which is fairly rare, but this was also shared by all three suspects, so it provided no differentiation power.

Based on these examples, among others, there is a need to develop a selection of Y-chromosome loci with higher than average slippage mutations which could be used to discriminate among biological male relatives in criminal investigations. Others in the forensic DNA community have begun research on this issue in the last few decades in an effort to compile mutation rates for commonly used Y-STRs and to examine new Y-STRs for those with higher mutation rates. For example, father-son samples from the South Brazilian population (the same population used in the current study) were examined for the PowerPlex® Y23 loci in 2014 to determine the mutation rates of the loci in this kit [26]. They found an overall average mutation rate of 3.768×10^{-3} and that all of the mutations were observed at only seven of the twenty-three loci in the multiplex. In a similar study published in 2009, 2,913 father-son pairs from Texas were examined at the 17 Y-STR loci in the AmpFlSTR® Yfiler® multiplex kit [27]. These relatives were from three different populations: African American, Caucasian, and Hispanic. The mutation rates were found for each locus, for each population group, and overall. They were also able to relate the mutation rates to the length of the repeat unit, the relative length of alleles at a locus, and the absolute number of repeats, finding that longer alleles within a locus and those with higher numbers of repeats at any locus are more likely to mutate. Research on the

subject of Y-STR mutability and its application towards a future of male individualization is still currently being conducted in laboratories across the world.

In efforts to further the data that is available on Y-STR mutability and achieve the goal of male individualization, this study was conducted of male relative samples from a South Brazilian population including 99 grandfather-grandson (GF-GS) pairs, 103 uncle-nephew (U-N) pairs, and 140 brother pairs. Three multiplex systems were examined to determine their mutability for male biological relatives: an ultra-high discrimination (UHD) multiplex of 14 non-core loci; Promega's PowerPlex® Y23 (PPY23), a commercial "second generation" multiplex with an extended set of Y-STR loci; and a new rapidly mutating (RM) 13-locus panel with mutation rates above $1x10^{-2}$. The three multiplexes together give a unique combination of a total of forty Y-STR loci (the "Masker Set"), a large and powerful set of loci that has not been previously examined (see Table 1 for the loci of each multiplex and the "Masker Set", and Table 2 for loci characteristics such as repeat motif and allele range). The goal was to determine the loci that have the most discriminative potential and to then recommend the most promising loci for inclusion in a multiplex which could be potentially commercialized and used in achieving male individualization.

CHAPTER TWO: METHODOLOGY

FTA™ Samples

The sample set used in this project consisted of blood samples donated from familial relatives including 99 grandfather-grandson pairs, 103 uncle-nephew pairs, and 140 brother pairs (see Table 3). The samples had been previously collected from the South Brazilian population and were provided by Clarice Sampaio Alho of Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS), Porto Allegre, Brazil. They were collected from an area of Brazil known as Rio Grande do Sul which was colonized by Portuguese, German, and Italian immigrants in the 18th century [26]. The biological familial relationships between samples were previously confirmed with autosomal STR analysis using the AmpFlSTR® Identifiler® PCR Amplification Kit from Applied Biosystems (Clarice Sampaio Alho, personal communication).

Figure 4 provides a visual of the relationships between the male relatives in the form of a family tree. It also shows the labelling used for the samples: PSP for grandfathers, ISP for uncles, and F or FSP for the sons. The samples were labelled in Portuguese based on the words filho (F) for son, pai (P) for father, irmão (I) for brother, and suposto (S) for alleged. The samples were named as "alleged" before the genetic relationships were confirmed and the naming was not revised following the confirmation for the purpose of consistency. The white box with "SP" and a line through it represents the fathers who were not examined in this study. The samples were stored as punches from Whatman™ FTA™ paper blood spots in 0.6 mL tubes at room temperature.

FTA™ Lysis/Purification

The samples were processed using the Whatman™ FTA™ DNA purification protocol (see Figure 5) with some modifications to optimize the procedure for this study. To prepare the samples for DNA analysis, a 1.2 millimeter diameter disk was punched from the dried blood sample using a Harris micro punch and placed in a 0.6 mL tube. This was done for the positive and negative FTA™ controls, while the male relative samples had already been previously punched and placed in 0.6 mL tubes for storage.

To wash the sample, 200 microliters (µL) of Whatman™ FTA™ Purification Reagent was added to the tube and it was manually mixed, then incubated for five minutes at room temperature. The reagent was completely removed with a pipette and discarded. This wash was repeated twice for a total of three washes. A 200 µL aliquot of nuclease-free water was added to the tube to rinse the sample (instead of TE^{-1} buffer, as the original protocol states) and the tube was incubated for five minutes at room temperature. Then, the reagent was completely removed with a pipette and discarded. This rinse was repeated for a total of two nuclease-free water rinses.

The disks were then allowed to dry at room temperature in a biological safety cabinet with the tube caps open. The amount of time the disks were dried varied from 16 to 68 minutes for the UHD samples, 3 to 60 minutes for the PPY23 samples, and 12 to 30 minutes for the RM samples. The drying step is optional and the drying time does not affect the results of PCR. PCR amplification was then done directly after drying or the samples were stored in a -20°C freezer for up to 1 week before amplification.

PCR Amplification

The FTA™ samples were amplified with three different methods after being lysed. The first amplification method was the Ultra High Discrimination (UHD) multiplex developed previously by Dr. Ballantyne's laboratory [8]. The second method was the commercial kit by Promega called PowerPlex® Y23 (PPY23). Finally, the samples were amplified with the rapidly mutating (RM) loci in a single multiplex developed by Alghafri et al. [10], which was modified and optimized for this study. The modified multiplex used in this study is referred to as the RM-12plex. The conditions of each multiplex amplification had to be optimized for use with the FTA™ samples by adjusting the reaction volumes, components, PCR cycle numbers, etc. These modifications are described in the following sections for each multiplex. All amplifications were run on an Applied Biosystems GeneAmp™ PCR System 9700.

Ultra-High Discrimination (UHD) Amplification

The loci amplified with this multiplex can be found in Table 1, with the forward and reverse primers for each locus combined into a primer mix made according to Table 4. Locus-specific information and primer sequences are given in Table 5. Locus DYS446 from the original paper [8] was no longer being used in this multiplex. The primer volume for locus DYS607 was doubled from 0.3 µL of each primer to 0.6 µL to improve detection at this locus. This resulted in the total primer mix volume increasing from 11.73 µL to 12.33 µL. These values are highlighted in Table 4.

The original multiplex [8] used a 25 µL reaction, but in this study the reagents were scaled down to a 7 µL amplification. All of the components used in the UHD 7 µL amplification are given as follows with their amount added per sample: 0.7 µL dNTPs, 0.7 µL 10X PCR

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Buffer II, 0.7 µL MgCl$_2$, 0.112 µL bovine serum albumin (BSA), 0.28 µL Taq Gold, 3.4524 µL pre-made primer mix, and 1.0556 µL sterile millipore water.

The previous volumes were multiplied by the number of samples being amplified plus and additional one or two to account for pipetting errors and the components were added to a Master Mix. The primer mix was made prior to the amplification and stored in aliquots in a -20°C freezer. It was thawed and then heated in a heat block at 95°C for 3 minutes to activate it before being added to the Master Mix. The Master Mix was then vortexed and briefly spun down, before 7 µL was added to each tube, followed by the dried sample disk.

The controls used with this amplification were: a positive male FTA™ sample, M2(+), and a negative blank FTA™ control, M2-EB.

The amplification program was run as follows: 95°C-11min.; 25 cycles: 94°C-30sec., 56°C-90sec. (+0.2°C/cycle), 72°C-60sec.; 60°C-60min.; 4°C-hold. The cycle number was reduced to 25 cycles from the original 32 cycles.

PowerPlex® Y23 (PPY23) Amplification

The loci amplified with this multiplex can be found in Table 1. The forward and reverse primers for each locus in this kit were combined into a primer mix by the Promega Corporation. The concentrations and volumes are proprietary.

This multiplex uses a 25 µL reaction, but in this study the reagents were scaled down to a 5 µL amplification. The components used in the 5 µL PPY23 amplification are given as follows with their amount added per sample: 3.5 µL amp grade water, 1.0 µL PPY23 5X Master Mix, 0.5µL PPY23 10X Primer Pair Mix.

Volumes were multiplied by the number of samples being amplified plus an additional one or two for pipetting errors and the components were added to the Master Mix. The Master Mix was then vortexed for 5-10 seconds and 5 µL was added to each tube, followed by the dried disk.

The controls used were: a positive male FTA™ sample, M2(+); a negative blank FTA™ control, M2-EB; a positive amplification control of known type, 2800M; and an amplification blank, AB. For the 2800M control, 1 µL of 5 ng/µL control DNA was added instead of a sample disk and for the AB tube, 1 µL of amplification grade water was added in place of a disk.

The amplification program was as follows: 96ºC - 2 min; 24 cycles: 94ºC - 10 sec, 61ºC - 1 min, 72ºC - 30 sec; 60ºC - 20 min; 4ºC – hold. The company recommends 26 cycles when using DNA punches as in this study, but encourages laboratories to find the optimal cycle number based on the specific study being conducted. For this study, 24 cycles was ideal for amplification and profile interpretation based on testing with FTA™ control samples.

RM-12plex Amplification

The loci amplified with this multiplex can be found in Table 1, with the forward and reverse primers for each locus combined into a primer mix made according to Table 6. The primer sequences for each locus are given in Table 7. Locus 627 from the original multiplex [10] was removed due to its proximity to DYS518 that could interfere with calling the alleles at these loci. However, this locus is present in the UHD multiplex, so it caused no detriment to remove it.

The multiplex by Alghafri et al. [10] uses a 15 µL reaction, which was also used in this study. However, for optimization with the FTA™ samples, bovine serum albumin and Taq Gold

had to be added to the reaction in place of some water. The components used in the RM-12plex amplification are given as follows with their amount added per sample: 7.5 µL Qiagen Multiplex Master Mix, 1.5 µL pre-made primer mix, 0.72 µL BSA, 1.0 µL Taq Gold, 3.28 µL RNase-free water.

Volumes were multiplied by the number of samples being amplified plus an additional one or two for pipetting errors and the components were added to a Master Mix. The Master Mix was vortexed and briefly spun down, and then 14.0 µL was added to each amplification tube followed by the sample disk.

The controls used were: a positive male FTA™ sample, M3(+); a negative blank FTA™ control, M3-EB; a positive amplification control of known type, 9948; and an amplification blank, AB. For the 9948 control, 1 µL of 1 ng/µL control DNA was added instead of a sample disk and for the AB tube, 1 µL of RNase-free water was added in place of a disk.

The amplification program was as follows: 95ºC – 15 min; 30 cycles: 94ºC – 30 sec, 55ºC – 45 sec (+0.2 ºC/cycle), 72ºC – 90 sec; 72ºC – 45 min; 4ºC – hold. The cycling conditions were optimized from the original conditions [10] using FTA™ control samples.

<div align="center">Dilutions</div>

Following the amplification, the RM-12plex samples had to be diluted due to profile saturation. All samples were serially diluted to a 1:25 dilution from a 1:5 dilution with nuclease-free water. If a sample pair contained a mutation and still showed pull-up artifacts in the 1:25 dilution, the samples with pull-up were further diluted to 1:125 and re-injected. A few samples still showed pull-up peaks in the 1:125 dilution and were further diluted to 1:625.

Detection/Analysis

The amplified products were stored initially in a refrigerator, but it was determined that the sample punch would absorb the reaction mix over time. If these samples needed to be injected after the reaction mix had been absorbed, they were reconstituted with 10 µL of sterile water for UHD samples or 5 µL of sterile water for PPY23 samples. They were then incubated at 37⁰C for 5 minutes before re-injection. No RM-12plex samples had to be re-constituted. Sample storage and integrity in a -20⁰C freezer was tested with FTA™ control samples and after validation, all future FTA™ amplification products were stored in the freezer.

The amplification products were separated and detected by capillary electrophoresis on an Applied Biosystems 3130 Genetic Analyzer using: 9.7 µL Hi-Di™ formamide and 0.3 µL GeneScan™ 500 LIZ™ dye Size Standard for UHD samples; 10.0 µL Hi-Di™ formamide and 1.0 µL CC5 ILS 500 Y23 for PPY23 samples; and 9.6 µL Hi-Di™ formamide and 0.4 µL GeneScan™ 600 LIZ™ dye Size Standard for RM-12plex samples. The electropherograms were viewed and analyzed with the software GeneMapper version 4.0.

The sample profiles were then manually compared for each pair to determine if any mutations existed. Example summary tables of sample profiles for the UHD, PPY23, and RM-12plex multiplexes are given in Table 8, Table 9, and Table 10 respectively with the electropherograms for these samples shown in Figure 6 and Figure 7, Figure 8 and Figure 9, and Figure 10 and Figure 11. They show male relative pairs from each type of relationship set in this study (GF-GS, U-N, and Brothers) and have mutations highlighted with darker shading. The mutations were categorized by the number of repeat units gained or lost in the mutation (one-step vs. two-step vs. three-step) and then summed for each locus in the study. The totals for each

relationship group, multiplex, and overall were also determined. Some loci were present in more than one of the multiplexes studied. The samples were cross-checked between the multiplexes at each of these loci as a way to ensure accuracy of the profiles. The duplicates were removed when determining the total mutations.

Statistical Analysis

Mutation rates are typically calculated for an individual marker and are often per generation. In this study, not only were the mutation rates calculated for each locus, but multi-locus mutation rates were calculated for each relationship group and multiplex, using the 40 loci of the "Masker Set", by summing the individual mutation rates of each locus. The mutation rates were calculated per meiotic event by dividing the number of mutations by the number of meioses for each locus, relationship group, multiplex, and overall. The GF-GS samples are separated by 2 meiosis events, while uncles and nephews are separated by 3 and brothers are separated by 2 (see Figure 4). Therefore, we would expect the U-N samples to have the most discrimination, while the brother and GF-GS samples should have less total mutations, but should be similar to each other.

Some samples did not give complete profiles, but were verified for the alleles that were present in the sample. These could be used to compare the alleles at the given loci for the pair. However, for the loci that did not give alleles, the total number of meioses had to be adjusted to account for the samples that were not able to be compared. The total values are given in Table 3 for the number of unique pairs and the total number of meiotic events, broken down for each relationship group. Table 11 shows the adjusted number of meiotic events for each multiplex based on the number of sample pairs that gave profiles. Table 12 shows the adjusted number of

meiotic events based on the number of sample pairs that gave alleles at a specific locus for each of the 40 loci in the "Masker Set" separated by relationship group. A "-" symbol was used for loci that did not require adjustments from the total meiotic number. These adjusted values were used for the mutation rate calculations.

The loci with the highest mutation rates, the most discriminative for differentiating male relatives, were determined as a recommendation to be developed commercially in a kit that can be used for male individualization when necessary. Many other comparisons of the mutation rates were made using the individual locus mutation rates and summing them for different circumstances, such as: whether loci from commercial kits or "in-house" multiplexes were more discriminative; whether RM or non-RM loci gave more discrimination; the relationship between one-, two-, and three-step mutations; and comparing repeat gains to repeat losses.

In addition to the individual locus mutation rates and multi-locus mutation rates, the discriminative potential could be determined for each relationship group when using the 40-locus "Masker Set" panel. This was done by counting the number of sample pairs separated by at least one mutation in the 40 Y-STR loci of the "Masker Set" and comparing it to the total number of sample pairs in the relationship set. This percentage of relative pairs that could be discriminated by at least one mutation when the 40-locus "Masker Set" was used was termed the "Discriminative Potential" (DP) and was calculated for each relationship set (GF-GS, U-N, Brothers).

For all of the total mutation rates and DP values determined, a 95% confidence interval (C.I.) was also calculated using the McCallum Layton Confidence Interval Calculator for Proportions [28]. As mentioned above, some samples did not give complete profiles and the

total number of meioses had to be adjusted to account for this. When calculating the 95% C.I.s,

the lowest adjusted value for the number of meioses in a set was used as the sample size since

this would provide the largest, and therefore most conservative, confidence interval. For

instance, in the grandfather-grandson relationship set, the total number of meioses was 198.

However, for some loci the number of meioses was adjusted to 196 or 192 due to missing sample

alleles. Therefore, when calculating the 95% C.I. for the total multi-locus mutation rate of the

GF-GS samples, 192 was used as the sample size to give the most conservative C.I. This

principle was applied to all C.I.s calculated.

CHAPTER THREE: RESULTS

The number of mutations between pairs of relatives were counted for each locus in the 40-locus Y-STR "Masker Set" across all relationship groups and the total mutation rates were calculated per meiosis. The mutation rates were also calculated for 1-step, 2-step, and 3-step mutations. Mutations by a non-integer number of repeat units are rare [21] and were not observed in this study.

Table 1 shows the loci by multiplex and the "Masker Set". Table 2 shows the characteristics of the "Masker Set" loci including the repeat motif and allele range with the UHD data (highlighted in blue) taken from Hanson and Ballantyne [8], the PPY23 data (highlighted in green) taken from the STRBase Y-STR Fact Sheet [1], and the RM data (highlighted in yellow) taken from Ballantyne et al. [9]. In Appendix C, the summary mutation data tables can be found for all samples, sorted by relationship group and sets of loci.

Mutation Rates by Relationship Set

Across the three relationship groups, the total mutation rate per meiosis for the 40 Y-STR loci in the "Masker Set" was fairly similar: 0.36 for grandfather-grandson, 0.36 for uncle-nephew, and 0.43 for brothers (see Table 13). The rate per meiosis should be equal no matter what relationship is being analyzed if the same loci are used, so these values tend to confirm that expectation. The small differences between the groups can be accounted for within the confidence intervals for these values.

The more meaningful comparison to look at is whether the uncle-nephew relationship set, whose members are separated by three meiotic events, would have a higher likelihood of being

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differentiated by a mutation between a pair of relatives than the grandfather-grandson or brother pairs, which are only separated by two meiotic events (see relationship diagram in Figure 4). This was found by looking at the average number of mutations per the number of pairs. Therefore, the multi-locus mutation rate of total number of mutations per total number of meioses was multiplied by the number of meioses per pair to obtain the average mutation rate per pair for each relationship group. According to Table 13, this gives an average mutation rate per pair of 0.72 for grandfather-grandson, 1.1 for uncle-nephew, and 0.86 for brothers. The hypothesis is fulfilled that uncle-nephew pairs, which are separated by more meiotic events, are more likely to be differentiated by a mutation at the loci examined than grandfather-grandson or brother pairs. This makes sense as the more separated the relatives are genealogically, the more chances there are for a mutation to occur.

Mutation Rates by Multiplex

The mutation rates per meiosis were also compared between the three multiplexes used in this study. As seen in Table 14, the rapidly mutating multiplex (RM-12plex) was the most discriminating, as was expected, with a mutation rate of 0.25. The UHD and PPY23 sets both gave mutation rates of 0.10. The loci in the UHD multiplex are theoretically more discriminative, so these would be expected to give a higher mutation rate, but since the PPY23 kit has more loci (23 versus 13), even though each one individually is less discriminative, overall the multiplex still matches the discrimination power of the UHD loci. Therefore, one could choose to either use an "in-house" multiplex (UHD) that requires more validation but is cheaper, or purchase the commercial PPY23 kit which requires less validation but is more expensive, and obtain the same discrimination capability. The best option for the differentiation of paternal

relatives, however, would be for a company or a crime laboratory to create a new multiplex with the most discriminative Y-STR loci that could be marketed for use in differentiating male relatives in criminal cases or other applicable scenarios. The following sections will cover the mutation rates by loci and the recommended loci to include in a commercial multiplex such as the one suggested.

Commercial Kits versus "In-House" Multiplexes

The discriminative capacity of loci found in commercial kits can be compared to that of those found in non-commercial or "in-house" multiplexes. A locus was considered to be commercial if it was included in the PPY23 multiplex, since this kit is sold commercially. In addition, four loci from the RM-12plex were included in the commercial loci since they are found in the commercially sold Yfiler® Plus kit: DYF387S1A/B, DYS449, DYS518 and DYS627. Therefore, the commercial loci group includes loci across three different groups of discriminating capacity: rapidly mutating, ultra-high discriminating, and "standard" loci (see the following section). All other loci were considered non-commercial as they were part of "in-house" multiplexes and not sold commercially in any kits.

As shown in Table 15, the loci that are not available in commercial kits gave a slightly higher mutation rate per meiosis than those in a commercially sold kit (0.21 vs. 0.17). This is to be expected, as the non-commercial multiplexes such as UHD and RM were designed to be more discriminative than standard multiplexes. However, the PowerPlex® Y23 kit does include "six highly informative loci…[and] two rapidly mutating Y-STR loci," so these contribute to the higher mutation rate for loci found in commercial kits [29].

Rapidly Mutating (RM) versus Non-RM Loci

The loci were divided into two categories based on whether they were considered to be rapidly mutating or not. This was based on whether they were part of the RM multiplex and known to have higher mutation rates from previous studies. The non-RM loci were then further broken down into highly discriminative loci or "standard" loci. Loci were considered highly discriminative if they were part of the UHD multiplex and/or if they were added beyond the loci found in the original 2004 Yfiler® kit. All other loci in PPY23 that were also in the original PowerPlex® Y 2003 and Yfiler® 2004 multiplexes were considered "standard".

The categories for the loci of RM, highly discriminating, and "standard" do not directly correspond to the RM multiplex, the UHD multiplex, and the PPY23 multiplex, respectively. This is due to the overlap of loci between multiplexes, such as rapidly mutating loci in the UHD and PPY23 multiplexes and the highly discriminative loci added to the PPY23 multiplex. Therefore, comparing the loci by these groupings is valuable to determine if the mutation rates for each category match with the expected results: RM loci with the highest mutation rates, highly discriminative loci with the next highest, and "standard" loci with the least discrimination ability.

When the mutation rates were compared for these groupings of the loci, the RM loci gave a higher mutation rate (0.27) than the non-RM loci (0.12), as expected (see Table 16). However, a somewhat unexpected result was that the "standard" loci gave a slightly higher mutation rate than those deemed "highly discriminating" (0.064 versus 0.053). The "standard" loci did not produce any 2- or 3-step mutations between the paternal relatives though, only 1-step mutations. The highly discriminating loci, on the other hand, did have a pair of two-step mutations, so this

could be considered more discriminating than the "standard" loci even though the overall mutation rate per meiosis was slightly lower.

Mutation Rates Overall Summary

The mutation rates for each locus for 1-step, 2-step, and 3-step mutations as well as the total rates are given in Table 17. Overall, when taking into account all loci in the "Masker Set" and all relationship pairs used in this study (excluding those that did not have a call for both samples at a particular locus), the total mutation rate per meiotic event was found to be 0.38, as shown in Table 18. This was broken down into 1-, 2-, and 3-step mutations, with further discussion about this found in the following section.

This mutation rate is applicable to paternally related male relatives of the groups: grandfathers-grandsons, uncles-nephews, and brothers within the population of study. However, we predict that similar results would be likely for other paternally related male populations separated by two or three meiotic events.

Step-wise Mutation Frequencies: 1- vs. 2- vs. 3-Step

The mutations between the male relatives were broken down into 1-, 2-, and 3-step mutations. No mutations were observed that were a difference of 4 or more repeat units between the relatives. In determining the number of steps for a mutation, the most conservative value was chosen if there were multiple reasonable possibilities, which would include up to a 3-step mutation. Therefore, the assumption was used that a 1-step mutation is more likely to be encountered than a 2-step mutation, which is subsequently more likely to be seen than a 3-step mutation. This is based on previous data as well as the slippage mutation model theory [19].

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As an example, for the uncle-nephew samples labelled 1834/12, the two uncle samples (ISP1 and ISP2) had a 15, 17, and 18 allele at the locus DYF403S1A, while the nephew sample (F) only had a 15 and 18 allele at the same locus. The 17 allele the uncles possessed could have reasonably mutated to either the 15 or the 18 allele the nephew possessed, which would be a two- or one-step mutation, respectively. The one-step mutation to the 18 allele is assumed over the two-step possibility to the 15, since it is more likely and therefore more conservative for mutation calculations. The profiles for these samples can be seen in Figure 12 (ISP1), Figure 13 (ISP2), and Figure 14 (F) as a demonstration.

It can be seen from the resulting mutation rates found in Table 18, that one-step mutations are the most common, giving a mutation rate per meiosis of 0.36. Two-step mutations were almost sixteen times less common to observe than one-step mutations with a mutation rate per meiotic event of 0.023. Mutations of three steps were observed even less, about ten times less than two-step mutations, with a mutation rate of only 0.0025. Of the 342 male relative pairs and 787 meioses examined in this study, only two 3-step mutations were observed among the 40 Y-STRs, both of which were found within the loci unique to the RM multiplex (and both in the blue channels). These can be found at locus DYS547 for the grandfather-grandson pair 0322/12 and at locus DYF399S1 for the uncle-nephew pair 1279/12. The RM-12plex profiles for these samples can be viewed in Figure 15 and Figure 16 for the grandfather-grandson pair, and in Figure 17 and Figure 18 for the uncle-nephew pair. Overall, the conclusion based on prior knowledge and the resulting mutation rates is that 1-step mutations are much more common than 2, which are much more common than 3.

Repeat Gain versus Loss Rate

For the mutations between the male relatives, it could also be determined whether the step-wise mutation was a gain of a repeat unit(s) or a loss. This could only be done for grandfather-grandson and uncle-nephew pairs, since it is known which generation came first. For the pairs of brothers, without the father's profile, one is unable to distinguish between mutations that are a gain of a repeat unit(s) or a loss. The mutation rates for the GF-GS and U-N pairs across all loci, after being split for gains and losses, are shown in Table 19. They are also divided into their step-wise mutations.

For both relationship groups, it is clear that repeat gains are much more common than repeat losses. For grandfather-grandson pairs, the gains were observed almost twice as often as losses. For the uncle-nephew pairs, separated by three meiotic events, the gains were almost 1.3 times more frequent than the losses. The gain to loss ratio for each group is fairly consistent. Overall, the total repeat gain mutation rate to repeat loss mutation rate ratio is 1.5:1. Therefore, we can conclude that in these population groups, stepwise mutations that are a gain of a repeat unit, or two or three repeat units, occur 1.5 times more often than mutations that are a loss of one to three repeat units. These results are contradictory to the findings of other studies and the accepted scientific knowledge in the field. This contradiction is further expounded upon in the Discussion section.

It is also worthwhile to compare the breakdown of the stepwise mutations when considering repeat gains and losses. For the one-step mutations, the rates are similar to the overall rates, since the majority of the mutations are one-step. As stated before, the gains are observed almost two times as often as the losses for the grandfather-grandson one-step mutations

and about 1.4 times more frequently for the one-step uncle-nephew mutations. However, the two- and three-step mutations tell a different story. For the grandfather-grandson pairs, all of the two- and three-step mutations observed were repeat losses, with no repeat gains observed if the stepwise mutation involved multiple repeat units. This was also the case for three-step mutations in the uncle-nephew group. However, for the uncle-nephew two-step mutations, there were both repeat gain and repeat loss mutations. The mutation rate for two-step repeat losses was about two times higher than that for repeat gains, though. Therefore, it seems that when a stepwise mutation is observed between two relatives: one-step repeat mutations are about twice as likely to be repeat gains as losses and multiple repeat unit mutations are almost always losses instead of gains. More research would need to be conducted on this to form a definitive conclusion due to the low number of multi-step repeat mutations, especially three-step, observed in this study. For further commentary on how these results relate to previous findings and established knowledge on this topic, please see the Discussion section.

Observed versus Published Mutation Rates by Locus

It was of interest to compare the mutations observed in this study to the mutation rates that have been published for each locus. The published mutation rates were obtained from Ballantyne et. al [30] for all loci except DYS607, which was retrieved from Burgarella and Navascués [31]. No mutation rate data was available for locus DYS527A/B. A table of the observed mutations and published rates can be found in Table 20. A graph of this data is given in Figure 19, with no data point included for DYS527A/B. The trend line shows a positive correlation between the published mutation rate and the observed number of mutations, which

confirms expectations. The mutation rates for each locus vary between studies due to sample size, population, etc.

Discriminative Potential by Relationship Group

For each relationship set (GF-GS, U-N, Brothers), the number of sample pairs separated by at least one mutation in the 40 Y-STR loci of the "Masker Set" was counted. This value was then compared to the total number of sample pairs in the relationship set in order to find the percentage of relative pairs that could be discriminated by at least one mutation when the 40-locus "Masker Set" was used. This percentage was termed the "Discriminative Potential" (DP) and was determined to be 53% for grandfather-grandson pairs, 62% for uncle-nephew pairs, and 54% for brothers. The DP values for each relationship set along with the total number of pairs, the number of pairs with at least one mutation, and the 95% confidence interval for the DPs can be found in Table 21.

Since grandfather-grandson and brother pairs are each separated by two meioses, the discriminative potential for these groups should be fairly similar. The uncle-nephew samples are genealogically separated by three meiotic events, so more discrimination potential would be expected for this group (see Figure 4). The results confirm these trends and can likely be extended to other paternal male relatives separated by two or three meioses. Based on this study, if a pair of male relatives separated by two meiotic events was examined at the 40 loci of the "Masker Set", there would be just over a 50% potential to discriminate them by at least one mutation. Similarly, if the pair had three meioses between them, discrimination by at least one mutation would be expected over 60% of the time.

Most Discriminative Loci

Based on the overall mutation rates at each locus (see Table 17), the loci were divided into groups of "low discrimination ability", "somewhat discriminative", and "highly discriminative". The mutation rates for each group were chosen around reasonable numbers where gaps occurred in the data and are as follows: 0.0000-0.0049, 0.0050-0.0099, and 0.010-0.061, respectively. The loci divided into these groups can be viewed in Table 22. Therefore, any locus with a mutation rate above 0.010 was deemed highly discriminative, and since this only included 15 loci which is a reasonable number for multiplexing, it was also selected as one of the most discriminative loci for recommendation for use in a commercial male individualization multiplex kit. All fifteen of these loci can be found in Table 23.

Note on RM-12plex Locus DYF403S1A

In this study, there were cases of reproducible sample peaks at locus DYF403S1A of the RM-12plex that were different alleles between samples in a pair, but which were not counted as a mutation in order to be most conservative for the mutation rate. They are likely not genuine germline mutations based on observation of the peak morphology, etc., but further study would be needed to determine if they are germline, somatic, or technical artifacts. This was the case for the following samples: GF-GS: 2014/12-F and PSP, 4104/11-F and PSP; and U-N: 3497/11-F, ISP2, ISP3, and 4171/11-FSP1, ISP1. (The sample peaks were reproduced for the GF-GS samples 2014/12, but not reproduced for the other samples, as the pattern was recognized.)

The electropherograms of the sample profiles for grandfather-grandson samples 4104/11 F and PSP are included in Figure 20 and Figure 21 respectively, to show an example of this

phenomenon. For sample F, the grandson sample, the alleles at locus DYF403S1A are 10, 13,

17, and the peak at about 349 base pairs. For the grandfather PSP sample, the alleles are 10, 13,

17, and a peak around 353 base pairs. Therefore, the last peaks separated by 4 bp could be a

potential mutation, but was not counted as one since it cannot be confirmed whether it is genuine

and if so, whether it is germline or somatic.

A listing of the samples with these type of potential, uncalled mutations and the allele

calls at locus DYF403S1A can be found in Table 24 for reference.

CHAPTER FOUR: DISCUSSION

This study produced valuable information about the mutability of many Y-STRs currently used in commercial multiplexes and those that have the potential to be more discriminative due to higher mutation rates. It was determined that of the three paternal relationship groups studied, the mutation rate per meiosis was highest for brothers, followed by uncle-nephew pairs and grandfather-grandson pairs, the two of which had almost identical mutation rates. When the average mutation rate per pair was calculated, the anticipated result of increased mutation rates as the meiotic separation between the relatives increased was observed. The uncle-nephew pairs were separated the most genealogically, by three meioses, and showed the highest mutation rate per relationship pair, while the grandfather-grandson pairs and brothers were only separated by two meiotic events and showed lower, but similar mutation rates.

Of the three multiplexes examined, the rapidly mutating (RM) 12-loci multiplex provided the best discrimination between the relatives, as expected. The PPY23 multiplex gave the next highest mutation rate, which was significantly less than the RM-12plex, and was followed closely by the UHD multiplex. The most discriminating loci in the UHD multiplex were: DYS449, DYS627, DYS508, and DYS576. For the PPY23 commercial kit, the most discriminative loci were: DYS389II, DYS458, and DYS576. The loci from the RM-12plex with the highest mutation rates were: DYF399S1, DYF403S1a, DYS612, and DYS547. All of these loci were included in the recommended loci for male individualization along with more from the RM multiplex that provided high mutation rates.

When comparing the loci from this study that are available in commercial multiplexes (such as PowerPlex® Y23 or Yfiler® Plus) against those only included in laboratory "in-house"

multiplexes, the non-commercial loci gave more discrimination than the commercial kits. This is as expected since the commercially sold multiplexes were not made up of as many highly discriminating or rapidly mutating loci because their purpose was not for differentiating male relatives. The non-commercial multiplexes such as UHD and RM-12plex, however, were designed using more discriminating loci with higher mutation rates with a goal toward future male individualization.

Similarly, the loci were divided into rapidly mutating (RM) vs. non-RM loci, with the non-RM loci being further divided into highly discriminating and "standard". The RM-loci gave mutation rates more than twice as high as the non-RM loci, while the highly discriminating and "standard" loci gave about the same mutation rates. In fact, the "standard" loci gave slightly higher discrimination than the "highly discriminating" loci, so it does not seem that the "highly discriminating" loci are very effective in differentiating paternal relatives.

The overall mutation rate per meiotic event for all samples and loci in this study was 0.38. This value should be applicable to any set of paternally related males separated by two or three meioses when examining the "Masker Set" loci. This total rate was broken down into one-step, two-step, and three-step mutations and it was determined that one-step mutations are much more likely than two-step, which are subsequently much more likely to occur than three-step mutations. No Y-STR repeat mutations of more than three steps were observed in this study. These results support the strand slippage mutation model [19], which is the generally accepted mechanism for STR mutation in the scientific community.

In this study, mutations that were a gain of a repeat unit(s) were much more common than repeat losses. It was also determined that when the mutation was by more than one repeat

unit, it was much more likely to be a repeat loss than a gain. No test for significance was done to evaluate these results due to a somewhat small sample size and limited population, and further study would be needed to determine if these conclusions are generally true or not. Since previous findings and generally accepted knowledge is that repeat gains and losses are about equally as likely, the differences observed in this study may be due to sampling variation. According to the stepwise mutation model [20], when the newly synthesized DNA strand loops out during replication, there is an extra repeat added for a mutation gain. The repeat loss mutation occurs when the template strand loops out. In vivo, these scenarios are about equally as likely. It would not make sense evolutionarily if gains were more common than losses since this would require alleles to continue increasing in length infinitely, and vice versa. Therefore, it can be concluded that sampling variation likely contributed to the observed repeat gain and loss contradiction when comparing the results of this study to others.

The mutations observed in this study were compared to published mutation rate data [30,31] for each locus and it was determined that the values generally aligned. As the (published) mutation rates for loci increased, the number of mutations observed in this study tended to increase as well, which would be expected. When the 40-locus "Masker Set" panel was used for analysis, male relative pairs could be separated by at least one mutation approximately 53% of the time for GF-GS pairs, 62% of the time for U-N pairs, and 54% of the time for brother pairs. This shows that paternally related males separated by two or three meiotic events could be distinguished more than half the time if the "Masker Set" is used to analyze the samples. This finding is very useful as standard Y-STR loci used in commercial and "in-house" multiplexes are not typically able to separate male relatives. These results could help to solve

many criminal cases in which paternal relatives are suspects, but cannot be distinguished by standard Y-STR DNA analysis methods.

The loci with the highest mutation rates per meiosis in this study would be considered the most discriminative loci for separating paternally related males. Fifteen Y-STR loci were selected based on their mutation rates for recommendation for use in a multiplex to potentially differentiate paternally related males and achieve male individualization through Y-STR DNA analysis. The loci, from highest to lowest mutation rate were: DYF399S1, DYF403S1A, DYS612, DYS518, DYS547, DYS449, DYF404S1, DYS389II, DYS627, DYS526B, DYS508, DYF387S1, DYS458, DYS576, and DYS403S1B. It would be very useful to incorporate these highly discriminative loci into a commercial or "in-house" multiplex that could be used for cases where the suspects include paternal male relatives. Commercialization of a Y-STR male relative differentiation multiplex based on these results would allow for more widespread use and would hasten its incorporation into the forensic laboratory setting and criminal casework. These loci could also be included in next-generation sequencing (NGS) kits, which are able to co-multiplex hundreds of amplicons simultaneously. As the future of forensic analysis is potentially headed towards NGS, the findings of this study about the discrimination potential of these loci could be very useful if they are incorporated.

CHAPTER FIVE: CONCLUSIONS

The purpose of this study was to collect data on the mutability of a large, unique set of 40 Y-STRs (the "Masker Set") among paternally related males. Access to intergenerational samples from different types of confirmed male lineages along with the extended set of Y-STRs examined for their mutability makes this study unique and valuable. It was done with the goal of identifying loci that are most useful in discriminating male relatives for the purpose of encouraging the development of a commercial multiplex kit which could be used for male individualization when needed in criminal cases or other matters. It was successful in determining that the following set of fifteen loci would be highly useful in differentiating paternally related males (from highest to lowest mutation rates): DYF399S1, DYF403S1A, DYS612, DYS518, DYS547, DYS449, DYF404S1, DYS389II, DYS627, DYS526B, DYS508, DYF387S1, DYS458, DYS576, and DYS403S1B. It was also determined that the loci of the "Masker Set" can differentiate male relatives separated by two meiotic events more than 50% of the time and those separated by three meiotic events over 60% of the time.

The other goals of this study were to: describe the characteristics and frequency of germ-line mutations at new Y-STRs; define the differences in mutation rates between and within loci; and determine the repeat gain and loss rates. These objectives were also completed within this study. It was determined that one-step mutations are much more common than two-step, which are subsequently much more common than three-step mutations. Another finding was that repeat gains are overall about twice as common as repeat losses, but that losses are more common when the mutation is by more than one repeat unit. This does not align with the results of other studies

on Y-STR mutation direction and may be due to sampling variation. Further study would need to be conducted to test the significance of this finding.

Y-STRs are very valuable for the forensic identification of male perpetrators, but the methods need to be extended so that males from the same paternal line are able to be differentiated, as that has become necessary in some criminal cases. This study helped contribute to the body of knowledge available about the mutability of Y-STRs and how this information can be applied for forensics. It is hoped that the recommended loci will be used to develop a commercial multiplex and will be incorporated into NGS platforms based on this study and other Y-STR mutability studies in order to achieve male relative differentiation and in the future, complete male individualization with Y-STR DNA analysis in criminal cases and other applications.

APPENDIX A: FIGURES
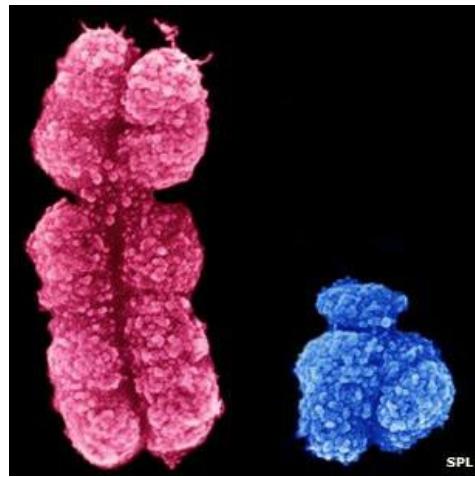
Figure 1: The X (pink, left) and Y (blue, right) sex chromosomes [32].
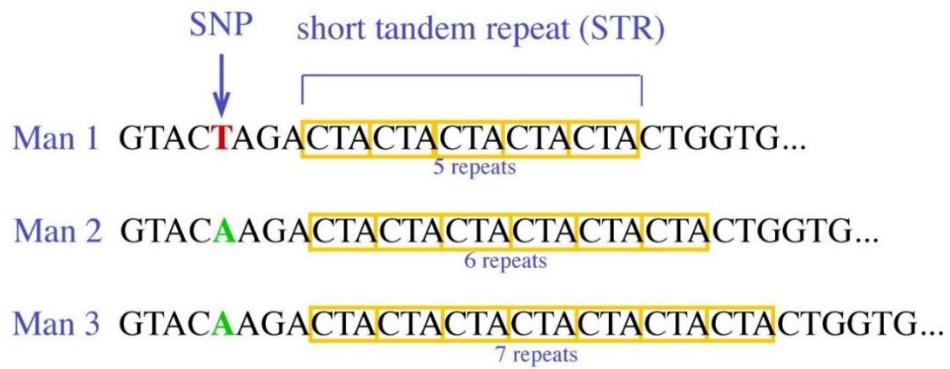
Figure 2: Short tandem repeat (STR) example [33].
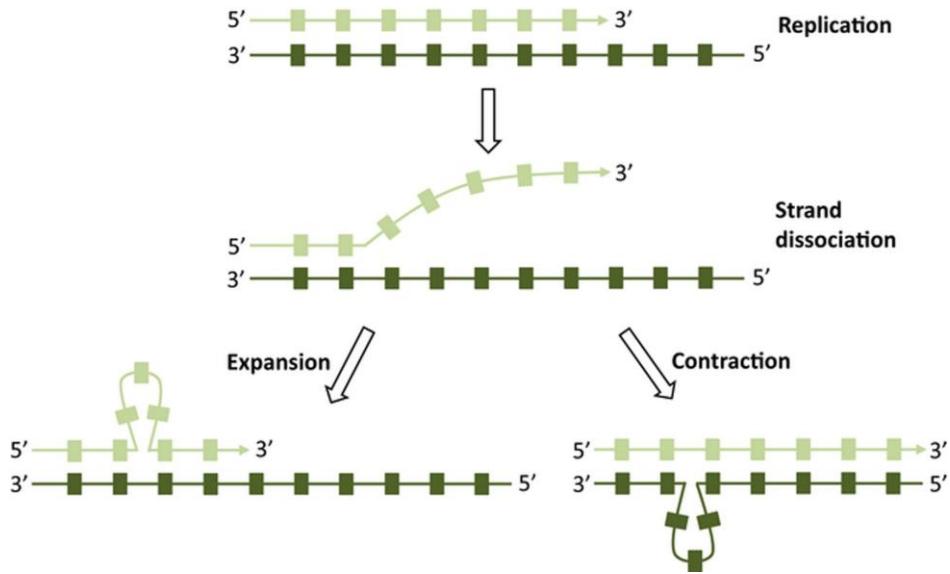
Figure 3: Strand slippage mutation model for DNA replication [34].
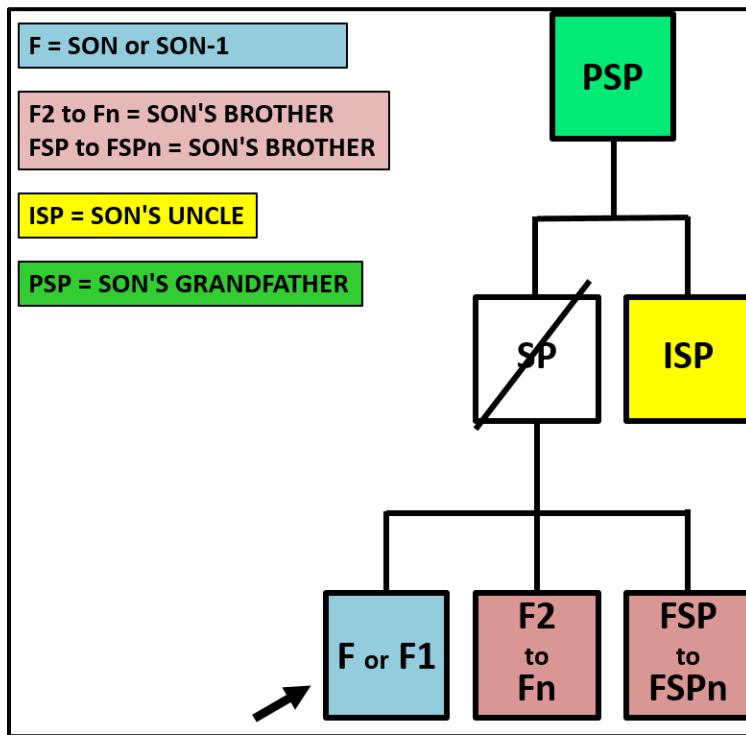
Figure 4: South Brazilian Relationship Samples and Labelling (image created and provided by Clarice Sampaio Alho of PUCRS).
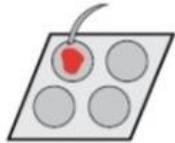
Figure 5: Whatman™ FTA™ DNA purification protocol [35].

Figure 6: Brother 1 UHD Profile with Mutations at DYS576 and DYS508.
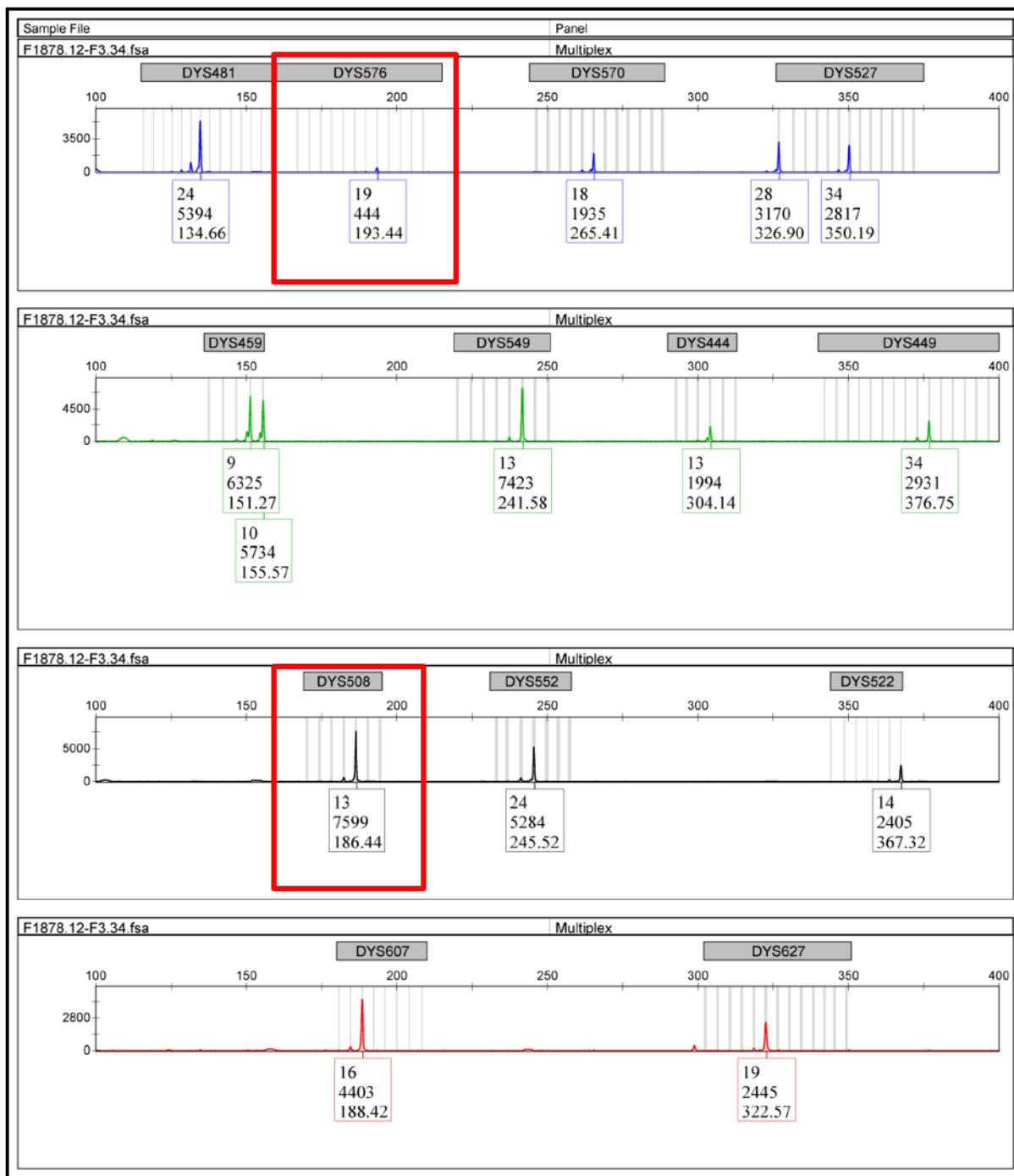
Figure 7: Brother 2 UHD Profile with Mutations at DYS576 and DYS508.
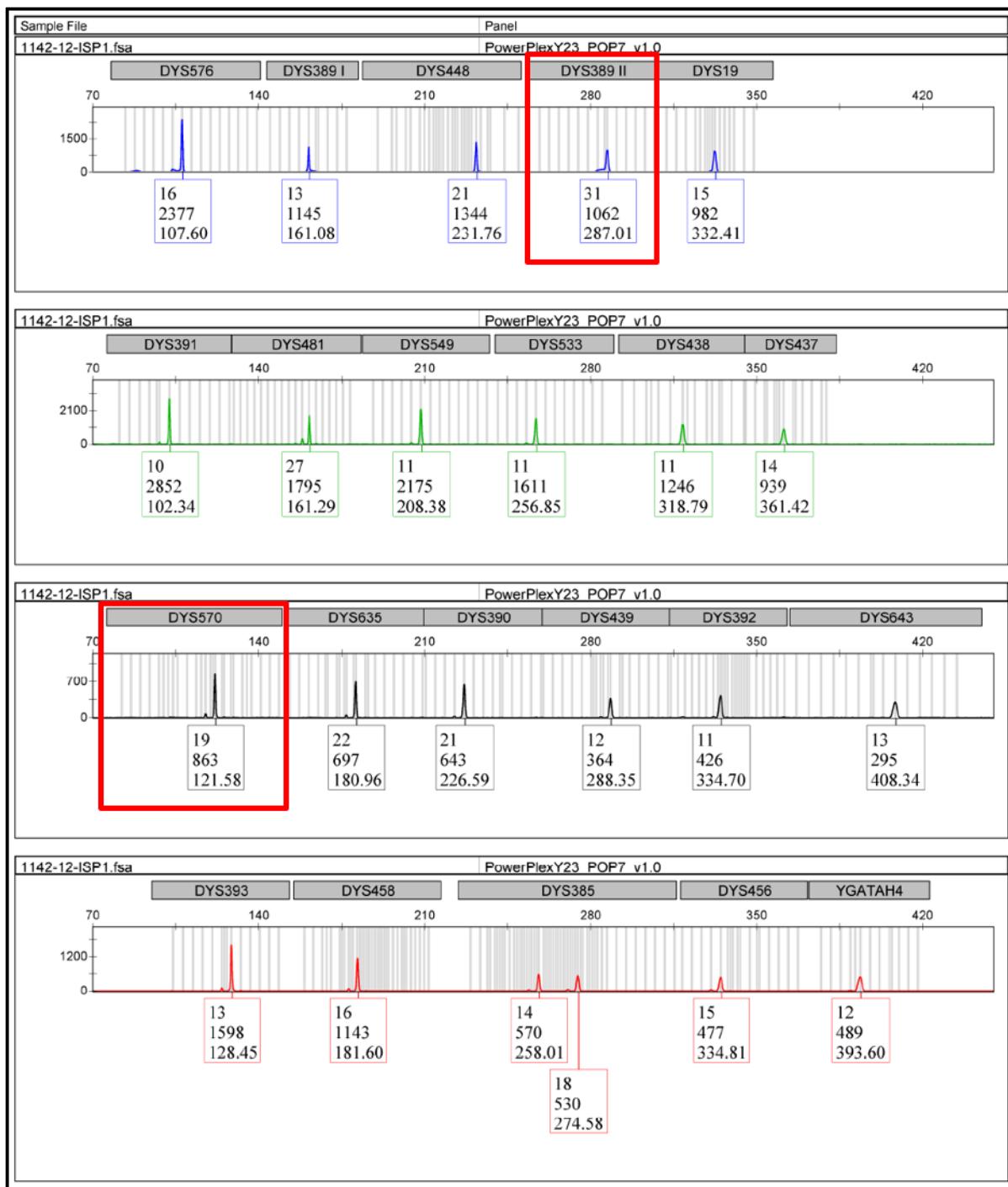
Figure 8: Uncle PPY23 Profile with Mutations at DYS389II and DYS570.
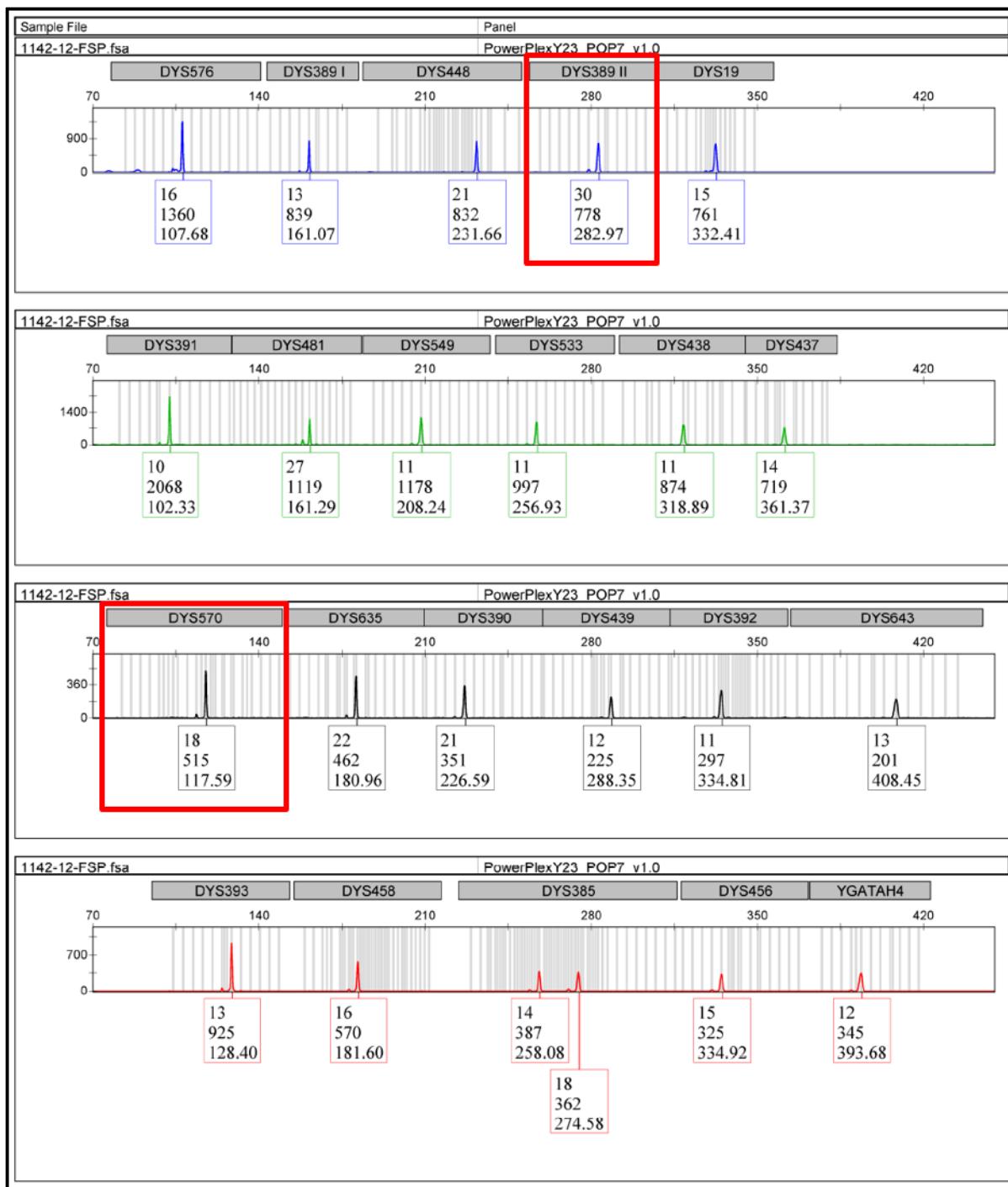
Figure 9: Nephew PPY23 Profile with Mutations at DYS389II and DYS570.
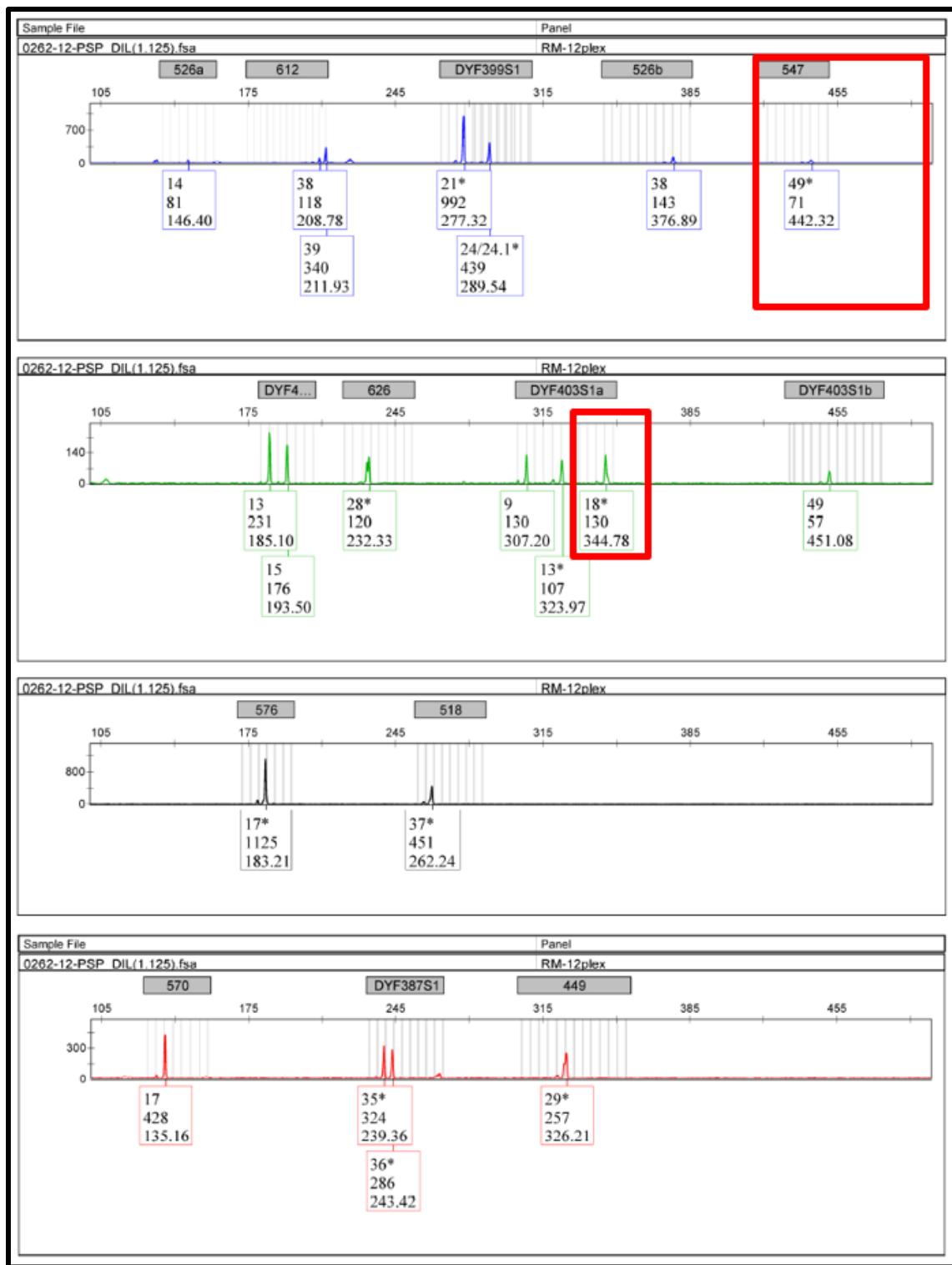
Figure 10: Grandfather RM-12plex Profile with Mutations at DYS547 and DYF403S1a.
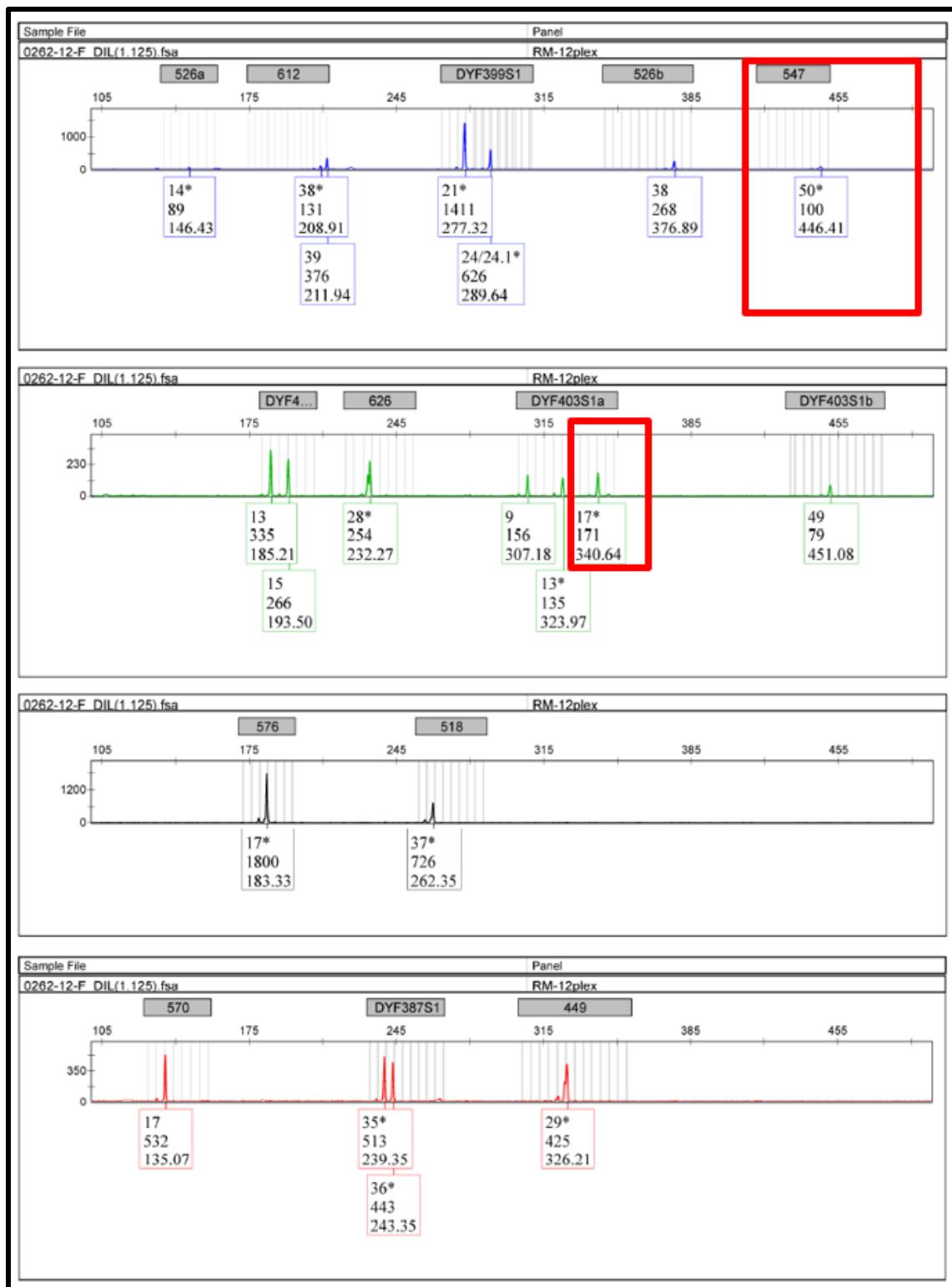
Figure 11: Grandson RM-12plex Profile with Mutations at DYS547 and DYF403S1a.
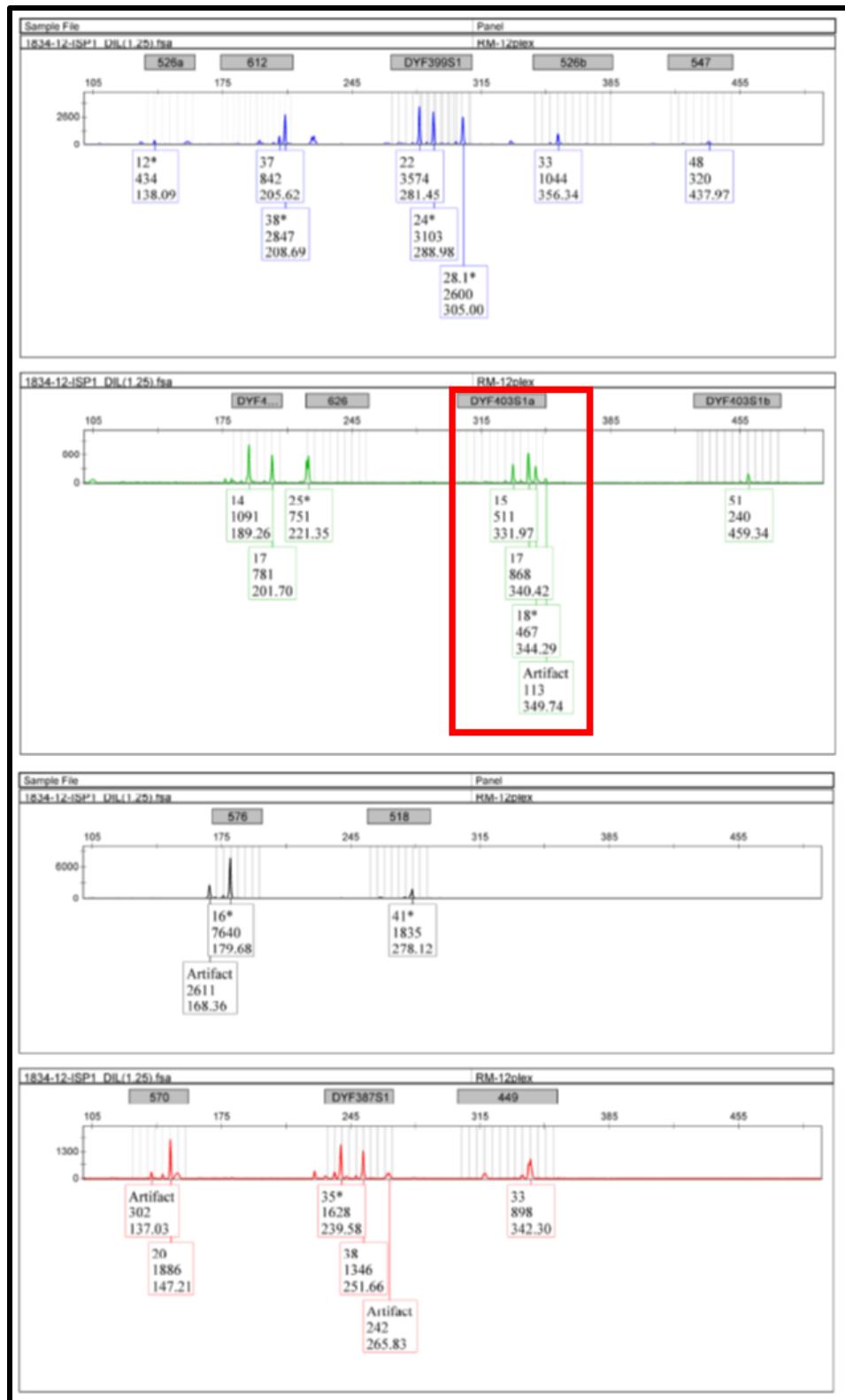
Figure 12: Uncle 1834/12-ISP1 sample highlighting locus DYF403S1a.
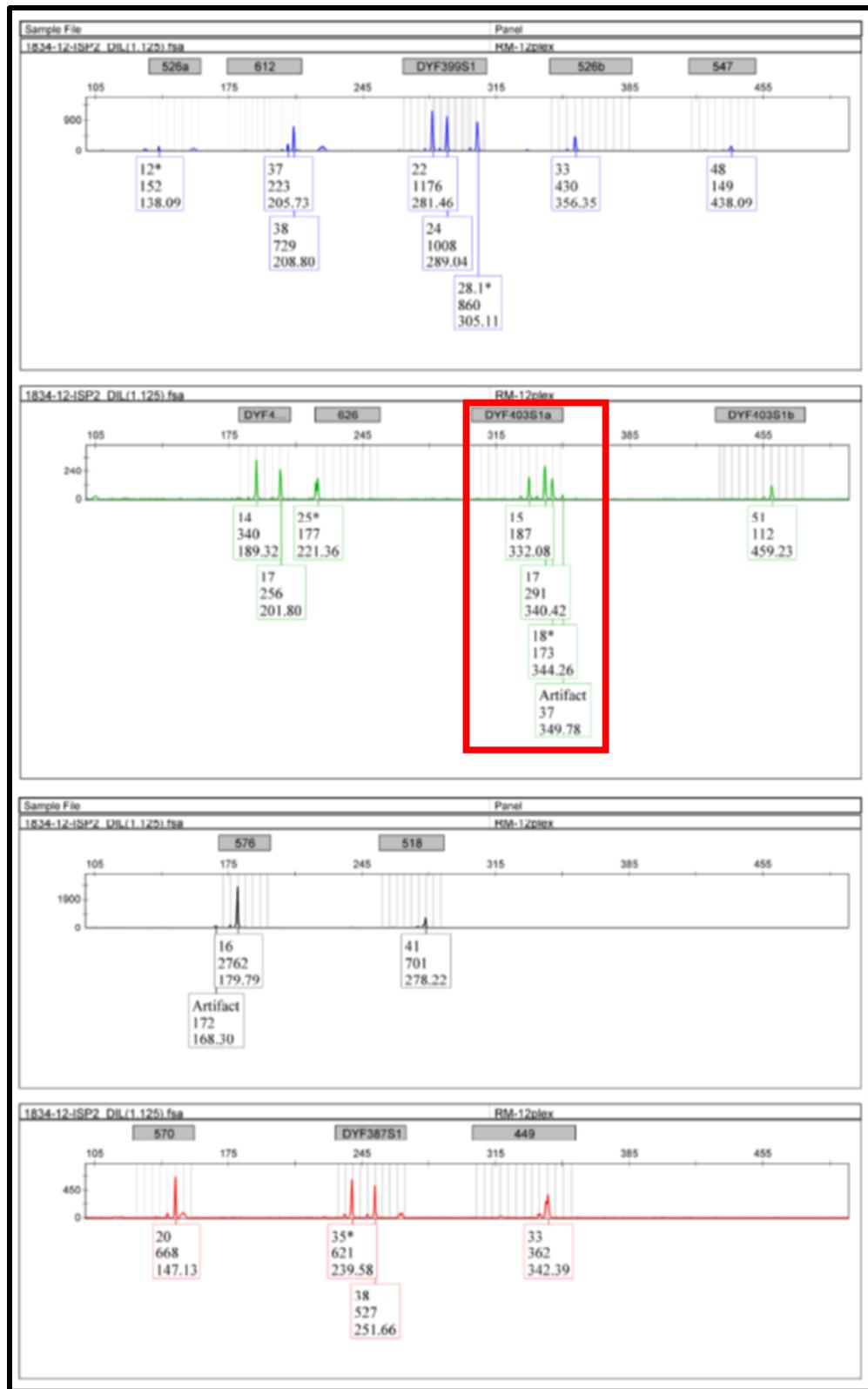
Figure 13: Uncle 1834/12-ISP2 sample highlighting locus DYF403S1a.

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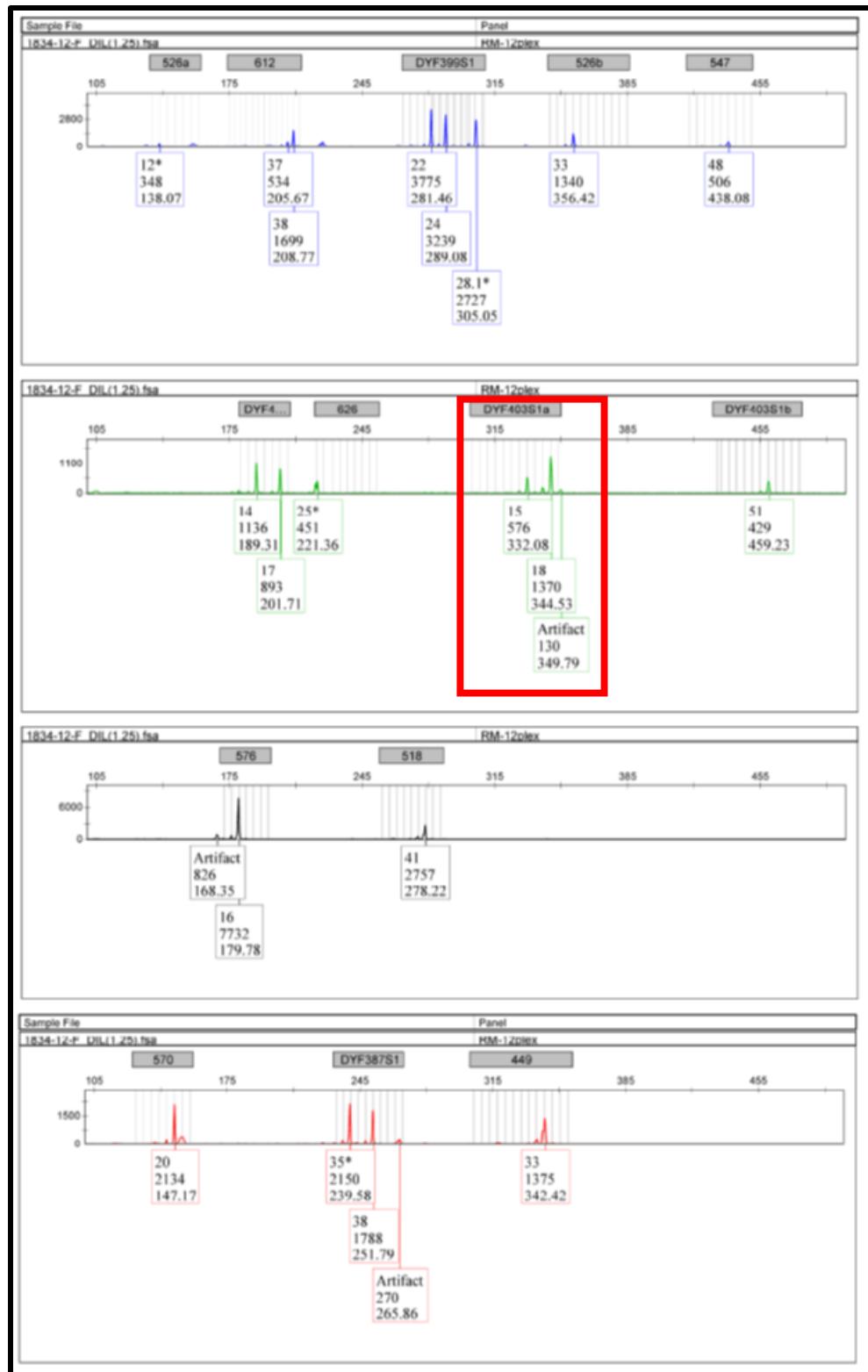
Figure 14: Nephew 1834/12-F sample highlighting the mutation at locus DYF403S1a with two options for the number of repeats that mutated.
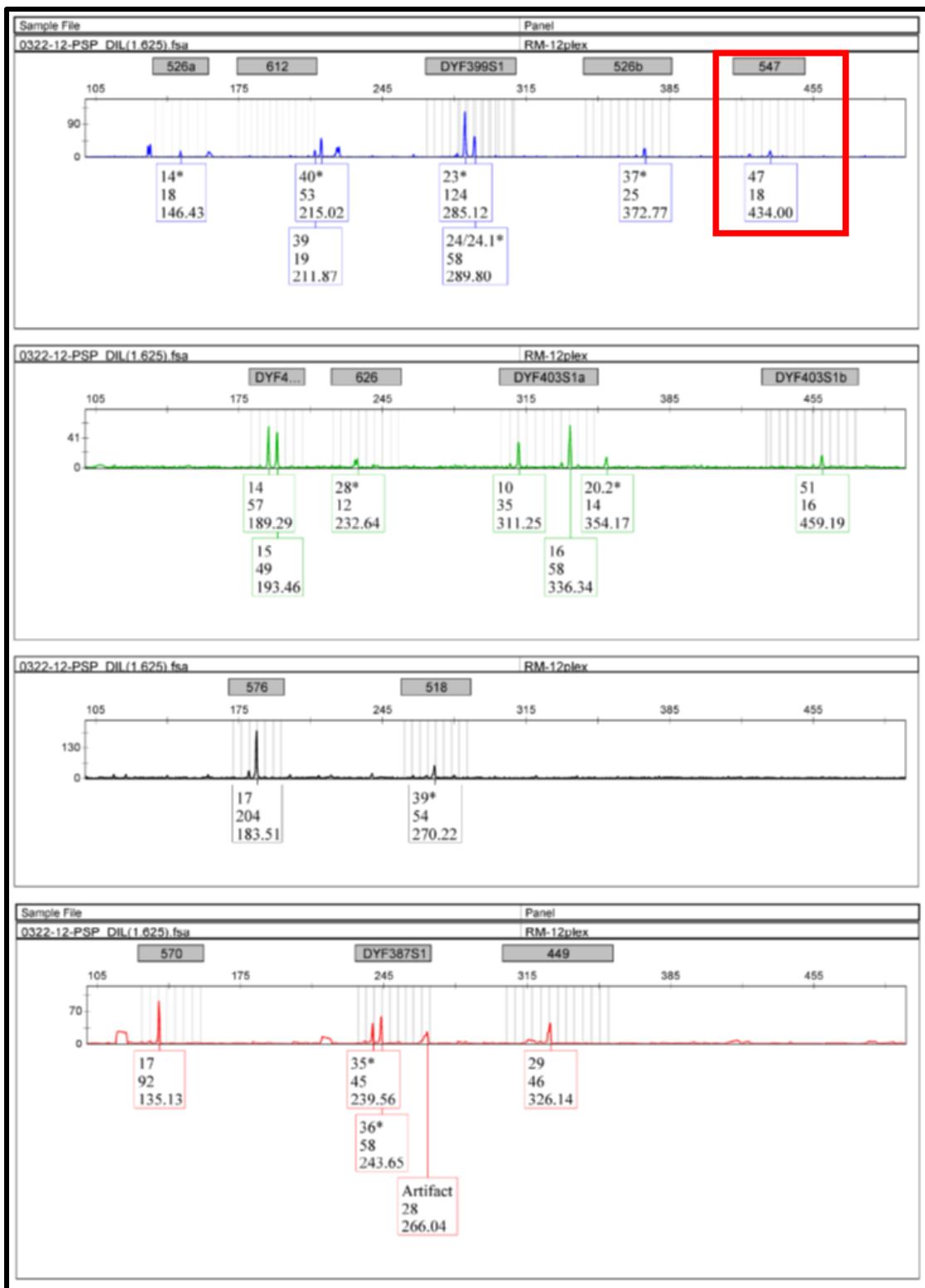
Figure 15: Grandfather 0322/12-PSP sample RM-12plex profile highlighting a 3-step mutation at DYS547.

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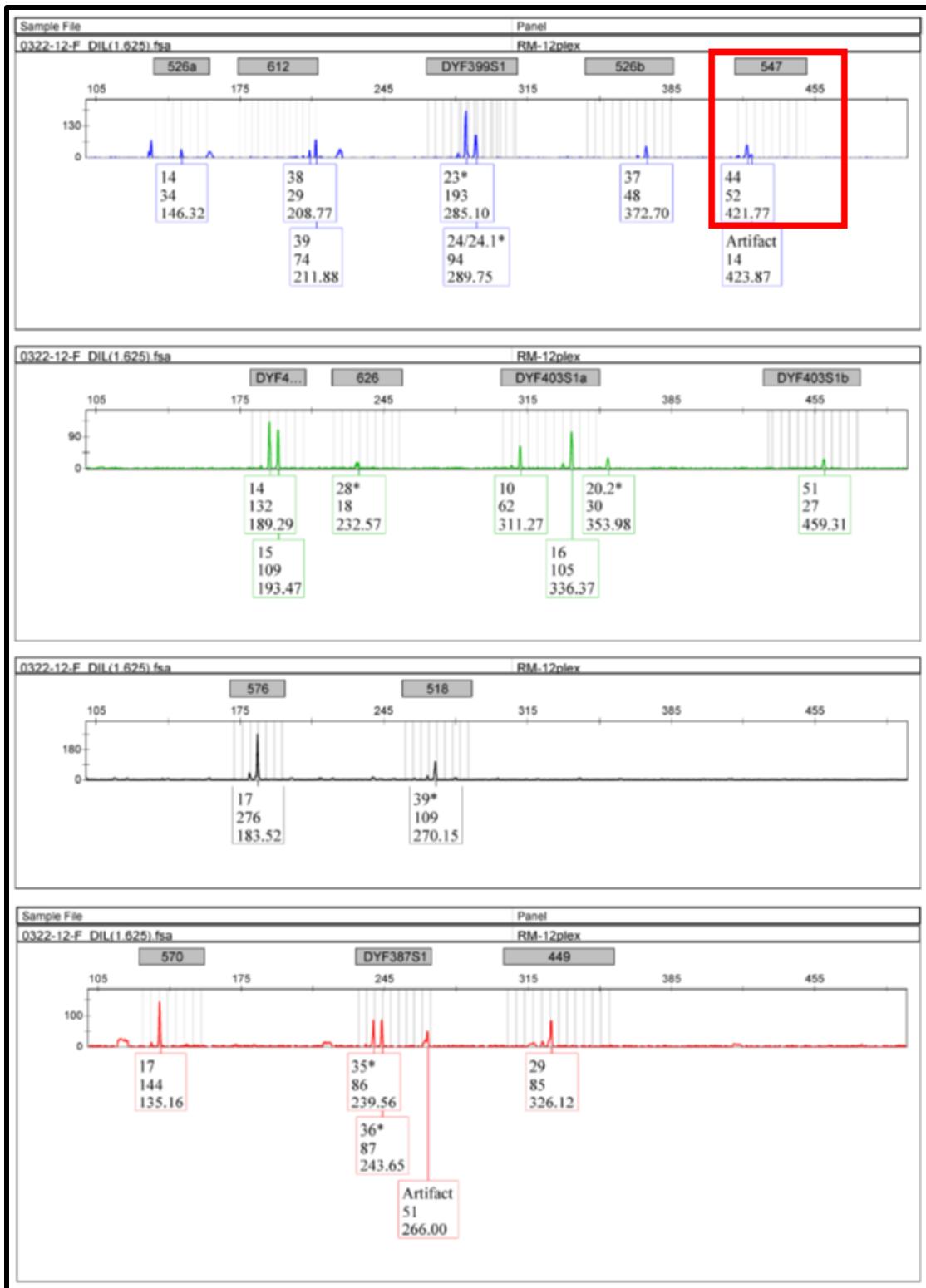
Figure 16: Grandson 0322/12-F sample RM-12plex profile highlighting a 3-step mutation at DYS547.
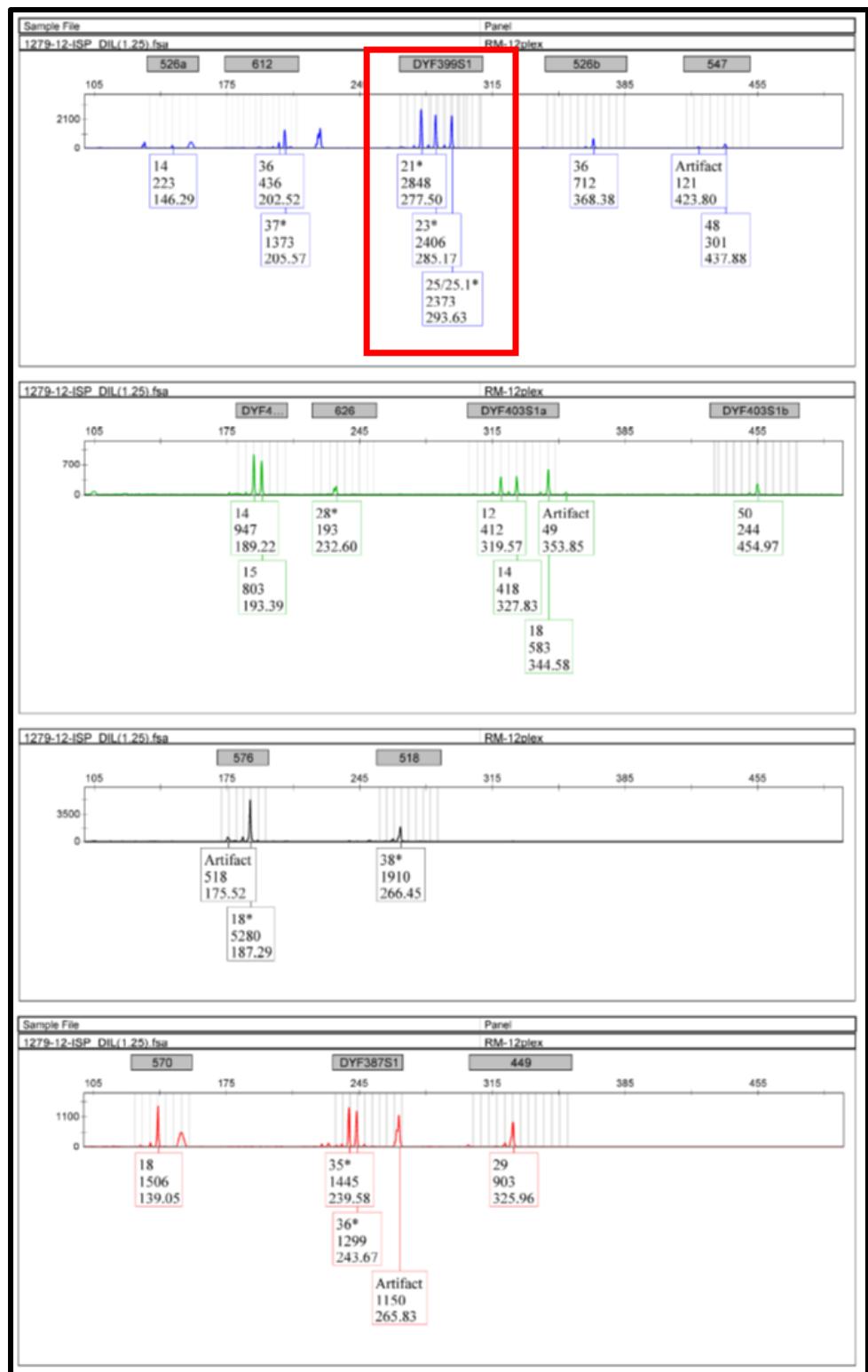
Figure 17: Uncle 1279/12-ISP sample RM-12plex profile highlighting a 3-step mutation at DYF399S1.
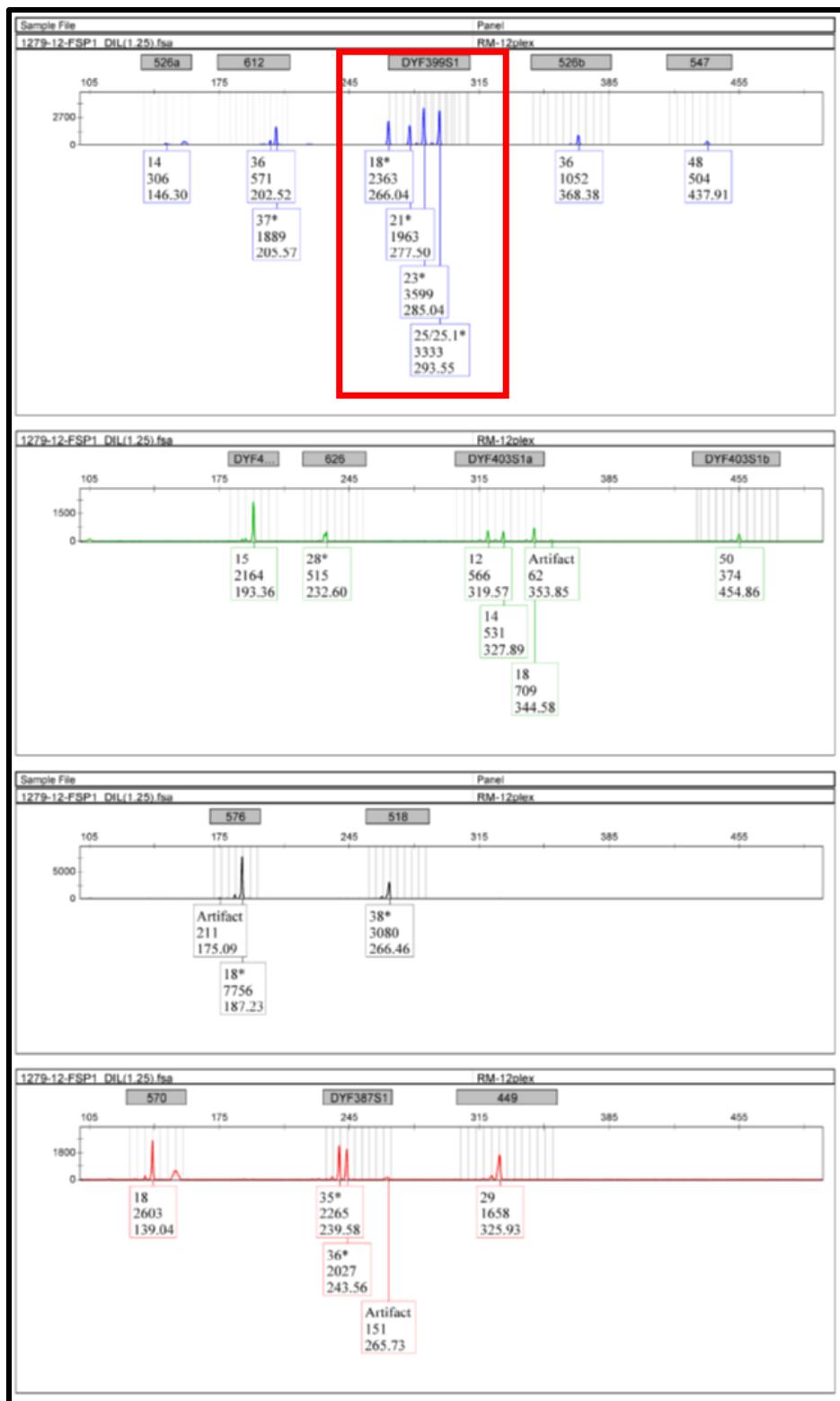
Figure 18: Nephew 1279/12-FSP1 sample RM-12plex profile highlighting a 3-step mutation at DYF399S1.
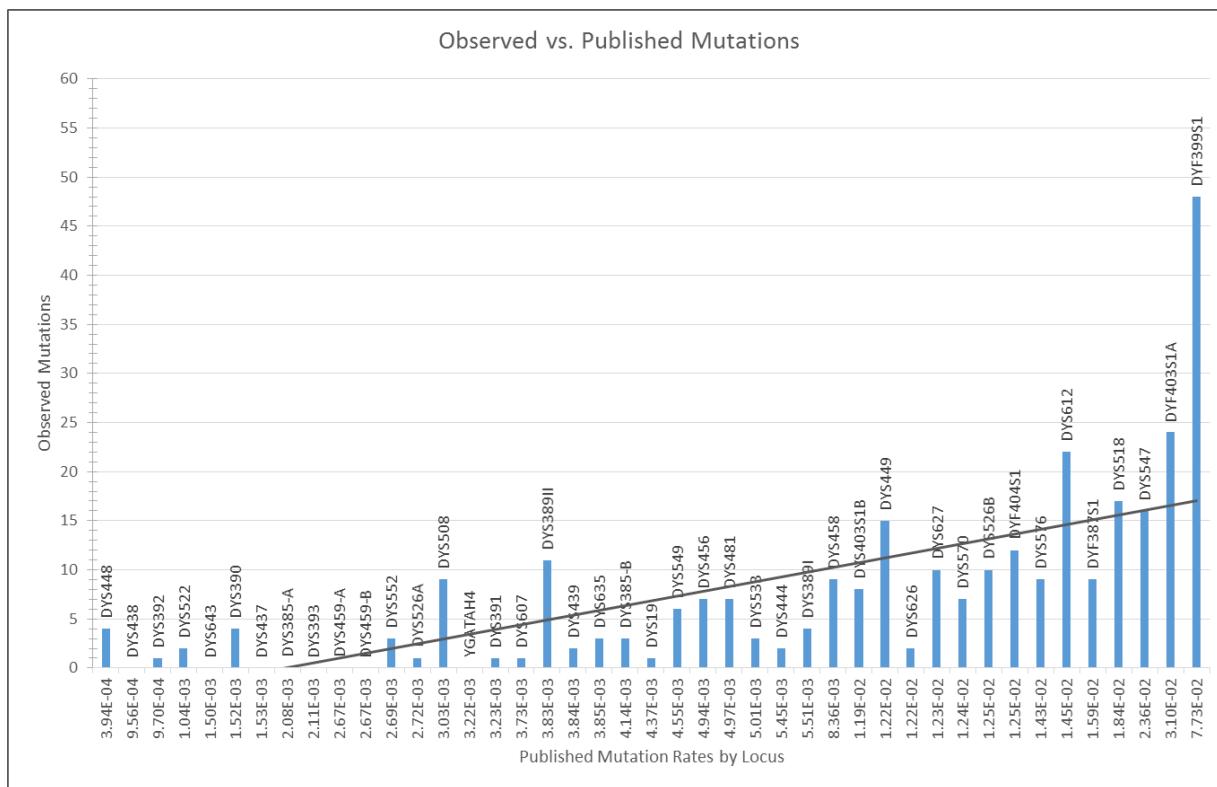
Figure 19: Observed Mutations versus Published Mutation Rates.
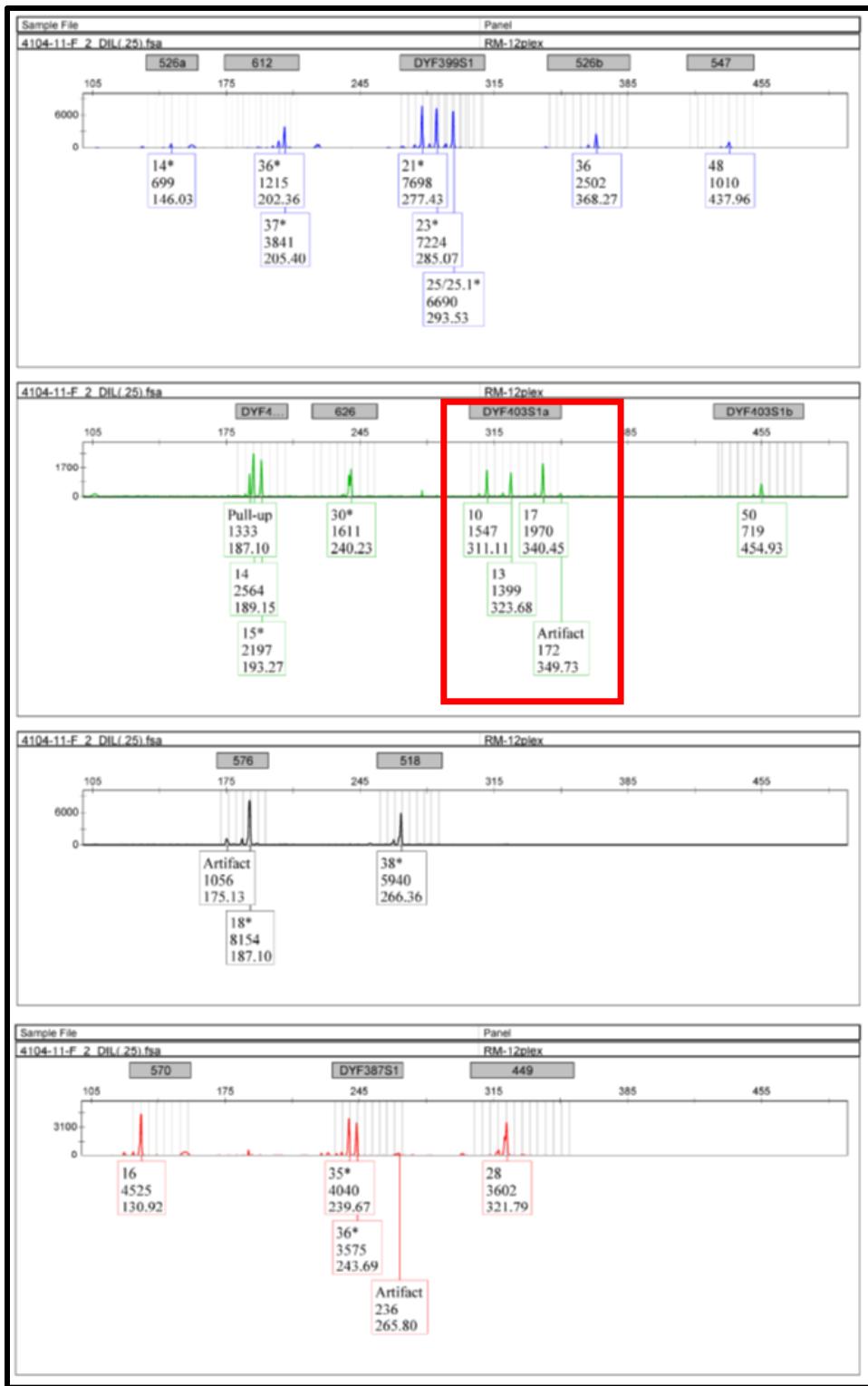
Figure 20: GF-GS 4104/11-F grandson sample (1:25 dilution) with reproducible (potential artifact) peak highlighted at locus DYF403S1a.

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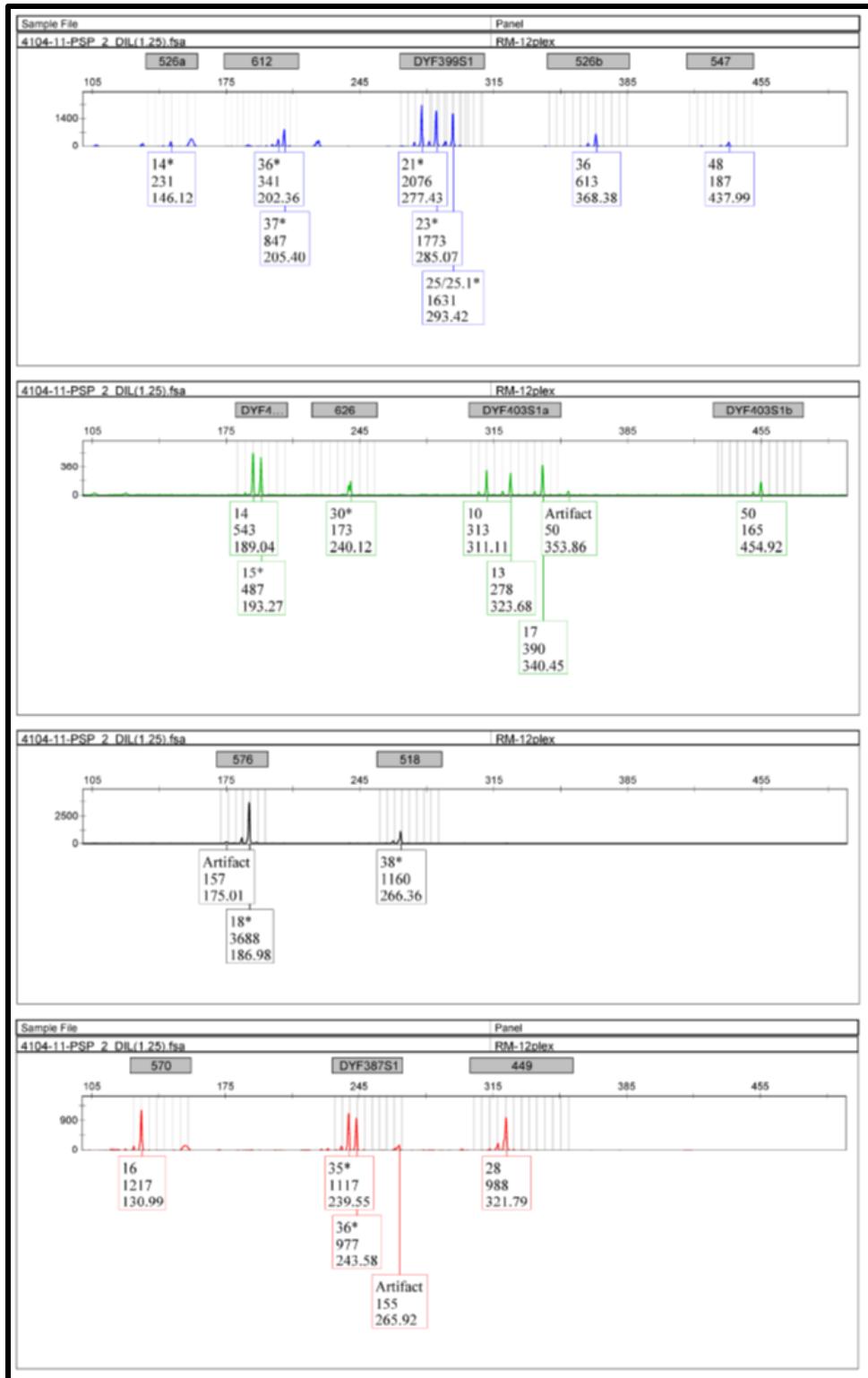
Figure 21: GF-GS 4104/11-PSP grandfather sample (1:25 dilution) with reproducible (potential artifact) peak highlighted at locus DYF403S1a.

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APPENDIX B: TABLES

Table 1. Loci by Multiplex

UHD	PPY23	RM	Masker Set (A)*	Masker Set (B)**
DYS481	**DYS576**	DYS526A/B	DYS481	DYS481
DYS576	DYS389I	DYS612	DYS576	DYS576
DYS570	DYS448	DYF399S1	DYS570	DYS570
DYS527A/B	DYS389II	DYS547	DYS527A/B	DYS527A/B
DYS459A/B	DYS19	DYS404S1	DYS459A/B	DYS459A/B
DYS549	DYS391	DYS626	DYS549	DYS549
DYS444	**DYS481**	DYS403S1A/B	DYS444	DYS444
DYS449	**DYS549**	**DYS576**	DYS449	DYS449
DYS508	DYS533	DYS518	DYS508	DYS508
DYS552	DYS438	**DYS570**	DYS552	DYS552
DYS522	DYS437	DYF387S1	DYS522	DYS522
DYS607	**DYS570**	**DYS449**	DYS607	DYS607
DYS627	DYS635	DYS627***	DYS627	DYS627
	DYS390		DYS389I	DYS389I
	DYS439		DYS448	DYS448
	DYS392		DYS389II	DYS389II
	DYS643		DYS19	DYS19
	DYS393		DYS391	DYS391
	DYS458		DYS533	DYS533
	DYS385A/B		DYS438	DYS438
	DYS456		DYS437	DYS437
	YGATAH4		DYS635	DYS635
			DYS390	DYS390
			DYS439	DYS439
			DYS392	DYS392
			DYS643	DYS643
			DYS393	DYS393
			DYS458	DYS458
			DYS385A/B	DYS385A/B
			DYS456	DYS456
			YGATAH4	YGATAH4
			DYS526A/B	DYS526A/B
			DYS612	DYS612
			DYF399S1	DYF399S1
			DYS547	DYS547
			DYS404S1	DYS404S1
			DYS626	DYS626
			DYS403S1A/B	DYS403S1A/B
			DYS518	DYS518
			DYF387S1	DYF387S1

Total Number of Unique Loci in Each Set			
UHD	**PPY23**	**RM**	**Masker Set**
13	**22**	**13**	**40**
Note: A/B Loci were not counted as two separate loci, while I and II were.			

Key:
*Masker Set (A) shows the 40-loci panel used in this study with blue shading for commercial loci and yellow shading for non-commercial loci.
**Masker Set (B) is a duplicate of the Masker loci, but has pink highlighting for RM loci, green for Highly Discriminating loci, and gray for "Standard" loci.
***Locus removed from RM multiplex (in UHD, so still in Masker Set.)
Loci with bold text: loci overlapping between multiplexes.

Table 2. Locus Characteristics for the "Masker Set" Loci

Multiplex	Marker	Repeat motif	Allele range
UHD	DYS481	CTT	18-31
	DYS576	$(AAAG)_n$	12-23
	DYS570	$(TTTC)_n$	13-22
	DYS527	$(GAAA)_1(AGAA)_1(GGAA)_3(ATGA)_1(AACA)_1(AGAA)_1(AGGA)_1(AAGA)_{14}(AAGG)_n(AAAG)$	28-38
	DYS459	$(ATTT)_n$	6-10
	DYS549	$(GATA)_n$	8-15
	DYS444	$(ATAG)_n$	10-15
	DYS449	$(TTTC)_n N_{50}(TTTC)_n$	25-37
	DYS508	$(TATC)_n$	9-15
	DYS552	$(TCTA)_3(TCTG)_1(TCTA)_n N_{40}(TCTA)_n$	21-27
	DYS522	$(GATA)_n$	8-14
	DYS446	$(TCTCT)_n$	10-23
	DYS607	$(GAAG)_n(GAAA)_1(GAAG)_1(GAAA)_1(GAAG)_1$	10-17
	DYS627	$(AAAG)_3(GAAA)_1(AAAG)_3(AGAG)_2(AGAA)_n(AAAG)_1(AGAA)_1$	49-61
PPY23	DYS19	TAGA	10-19
	DYS385a/b	GAAA	7-28
	DYS389I	(TCTG) (TCTA) (TCTG) (TCTA)	9-17
	DYS389II	(TCTG) (TCTA) (TCTG) (TCTA)	24-34
	DYS390	(TCTA) (TCTG)	17-28
	DYS391	TCTA	6-14
	DYS392	TAT	6-17
	DYS393	AGAT	9-17
	DYS437	TCTA	13-17
	DYS438	TTTTC	6-14
	DYS439	AGAT	9-14

Multiplex	Marker	Repeat motif	Allele range
PPY23	DYS448	AGAGAT	20-26
	DYS456	AGAT	13-18
	DYS458	GAAA	13-20
	DYS635	T**S**TA compound	17-27
	Y-GATA H4	TAGA	8-13 (25-30)
	DYS481	CTT	20-30
	DYS533	ATCT	9-14
	DYS549	GATA	10-14
	DYS570	TTTC	12-23
	DYS576	AAAG	13-21
	DYS643	CTTTT	7-15
RM	DYF387S1	$(AAAG)_3(GTAG)_1(GAAG)_4N_{16}(GAAG)_9(\textbf{AAAG})_{\textbf{13}}$	28–38
	DYS399S1	$(GAAA)_3N_{7–8}(\textbf{GAAA})_{10–23}$	10–23
	DYS403S1a+b	A: $(\textbf{TTCT})_{10–17}\textbf{N}_{2–3}(\textbf{TTCT})_{3–17}$ / B: $(TTCT)_{12}N_2(\textbf{TTCT})_8(\textbf{TTCC})_9(\textbf{TTCT})_{14}N_2(TTCT)_3$	A: 12–39 B: 40–59
	DYF404S1	$(\textbf{TTTC})_{10–20}N_{42}(TTTC)_3$	10–20
	DYS449	$(\textbf{TTCT})_{13–19}N_{22}(TTCT)_3N_{12}(\textbf{TTCT})_{13–19}$	24–37
	DYS518	$(AAAG)_3(GAAG)_1(\textbf{AAAG})_{14–22}(GGAG)_1(AAAG)_4N_6(\textbf{AAAG})_{11–19}N_{27}(AAGG)_4$	23–35
	DYS526a+b	$(CCCT)_3N_{20}(\textbf{CTTT})_{11–17}(\textbf{CCTT})_{6–10}N_{113}(\textbf{CCTT})_{10–17}$	A: 10–17 B: 29–42
	DYS547	$(\textbf{CCTT})_{9–13}T(\textbf{CTTC})_{4–5}N_{56}(\textbf{TTTC})_{10–22}N_{10}(CCTT)_4(TCTC)_1(\textbf{TTTC})_{9–16}N_{14}(TTTC)_3$	36–48
	DYS570	$(\textbf{TTTC})_{14–24}$	10–21
	DYS576	$(\textbf{AAAG})_{13–22}$	13–23
	DYS612	$(CCT)_5(CTT)_1(TCT)_4(CCT)_1(\textbf{TCT})_{19–31}$	14–31
	DYS626	$(\textbf{GAAA})_{14–23}N_{24}(GAAA)_3N_6(GAAA)_5(AAA)_1(\textbf{GAAA})_{2–3}(GAAG)_1(GAAA)_3$	11–23
	DYS627	$(AGAA)_3N_{16}(AGAG)_3(\textbf{AAAG})_{12–24}N_{81}(AAGG)_3$	10–24

Note: The bold letter S in the DYS635 repeat motif indicates a variable nucleotide which could be a C or a G. RM loci have bold font to highlight the variable motif.

Table 3. Sample Summary (on FTA™ paper)

Relationship Pair	# of Samples	# of Unique Pairs	# of Meiotic Events Per Pair	Total # of Meiotic Events
Grandfather-Grandson	186	99	2	198
Uncle-Nephew	160	103	3	309
Brothers	179	140	2	280
TOTAL	525	342	N/A	787

Table 4. UHD Primer Mix Components

Locus	Volume (µL) F/R primer (each)	Concentration (µM)
DYS481	0.15	20
DYS576	0.05	40
DYS570	0.065	40
DYS527	0.7	40
DYS459	0.35	20
DYS549	0.3	20
DYS444	0.65	40
DYS449	1.0	40
DYS508	0.25	20
DYS552	0.35	40
DYS522	1.0	40
DYS607	0.6	20
DYS627	0.7	40
Total primer mix (per sample)	12.33µL	

Table 5. UHD Loci Information and Primer Sequences

Locus	GDB Accession Number	Repeat Motif	Alleles	Size Range (bp)	Avg % Stutter	Primer Sequences With Labled Dyes
DYS481[43]	11503780	CTT	18–31	115–158	18.8	FF: AGGAATGTGGCTAACGCTGT
						R: ACAGCTCACCAGAAGGTTGC
DYS576[11]	11503970	$(AAAG)_n$	12–23	167–209	9.0	FF: TTGGGCTGAGGAGTTCAATC
						R: GGCAGTCTCATTTCCTGGAG
DYS570[11]	11503958	$(TTTC)_n$	13–22	244–280	9.2	FF: GAACTGTCTACAATGGCTCACG
						R: TCAGCATAGTCAAGAAACCAGACA
DYS527[10,11]	11503872	$(GAAA)_4(AGAA)_1$ $(GGAA)_3(ATGA)_1$ $(AACA)_1(AGAA)_1$ $(AGGA)_1(AAGA)_{14}$ $(AAGG)_n(AAAG)$	28–38	326–365	7.2	FF: TCGCAAACATAGCACTTCAG
						R: TTCTAGGAAGATTAGCCACAACA
DYS459[11]	11498133	$(ATTT)_n$	6–10	136–156	4.1	FV: CAGGTGAACTGGGGTAAATAAT
						R: TTGAGCAACAGAGCAAGACTTA
DYS549[11]	11503916	(GATA)n	8–15	220–250	5.8	FV: AACCAAATTCAGGGATGTACTGA R: GTCCCCTTTTCCATTTGTGA
DYS444[43]	10807128	$(ATAG)_n$	10–15	291–311	4.2	FV: TCTAAGGGATCCAAAGGCAGAA
						R: GTGTGAACCATTTGGCATGTTTA
DYS449[10,11]	10879367	$(TTTC)_nN_{50}(TTTC)_n$	25–37	344–392	10.0	FV: TGGAGTCTCTCAAGCCTGTTCTA
						R: CCTGGAAGTGGAGTTTGCTGT
DYS508[43]	11503834	$(TATC)_n$	9–15	170–195	5.2	FN: ACAATGGCAATCCCAAATTC
						R: GAACAAATAAGGTGGGATGGAT
DYS552[43]	11503922	$(TCTA)_3(TCTG)_1$ $(TCTA)_nN_{40}(TCTA)_n$	21–27	231–257	7.5	FN: CCATAGTCCGAGGTCAAGT
						R: AACACCTGATGCCTGGTTG
DYS522[10,11]	11503862	$(GATA)_n$	8–14	344–347	4.1	FN: CCTTTGAAATCATTCATAATGC
						R: TCATAAACAGAGGGTTCTGG
DYS446[11]	10873760	$(TCTCT)_n$	10–23	95–160	6.5	FP: TATTTTCAGTCTTGTCCTGTC
						R: GAGACTCTGTCTGAAGAGAG
DYS607[11]	11505463	$(GAAG)_n(GAAA)_1$ $(GAAG)_1(GAAA)_1$ $(GAAG)_1$	10–17	180–208	10.6	FP: AGCATACAGCGTAATCACAGC
						R: TCAGACAAAGCCCAGTTGAG
DYS627[43]	11510455	$(AAAG)_3(GAAA)_1$ $(AAAG)_3(AGAG)_2$ $(AGAA)_n(AAAG)_1$ $(AGAA)_1$	49–61	302–350	8.1	FP: CTAGGTGACAGCGCAGGATT
						R: GGATAATGAGCAAATGGCAAG

F = FAM; V = VIC; N = NED; P = PET.
doi:10.1371/journal.pone.0000688.t002

Table taken from: Hanson and Ballantyne [8].

Table 6. RM-12plex Primer Mix Components

Concentration (pmol/µL)	Marker	Primer	Volume added to primer mix (µL)
100	DYS526a/b	R,FF	3
100	DYS612	R, FF	2
100	DYF399S1	R,FF	1
100	DYS547	R,FF	4
100	DYF404S1	R, FV	1
100	DYS626	R, FV	1
100	DYF403S1a/b	R, FV	4
100	DYS576	R, FN	1
100	DYS518	R, FN	1
100	DYS570	R, FP	1
100	DYF387S1	R, FP	1
100	DYS449	R, FP	2
			44µL

Table 7. RM-12plex Primer Sequences

Locus	Primer sequence
DYF387S1	Forward: ATTO565- ACAGAGCTAGATTCCATTTTACCC
	Reverse: GCCACAGTGTGAGAAGTGTGA
DYF399S1	Forward: 6-FAM- GGGTTTTCACCAGTTTGCAT
	Reverse: CCATGTTTTGGGACATTCCT
DYF403S1a/b	Forward: YakimaYellow- CAAAATTCATGTGGATAATGAG
	Reverse: ACAGAGCAGGATTCCATCTA
DYF404S1	Forward: YakimaYellow- GGCTTAAGAAATTTCAACGCATA
	Reverse: CCATGATGGAACAATTGCAG
DYS449	Forward: ATTO565- TGGAGTCTCTCAAGCCTGTTC
	Reverse: CCATTGCACTCTAGGTTGGAC
DYS518	Forward: ATTO550- GGCAACACAAGTGAAACTGC
	Reverse: TCAGCTCTTACCATGGGTGAT
DYS526a/b	Forward: 6-FAM- TCTGGTGAACTGATCCAAACC
	Reverse: GGGTTACTTCGCCAGAAGGT
DYS547	Forward: 6-FAM- TCCATGTTACTGCAAAATACAC
	Reverse: TGACAGAGCATAAACGTGTC
DYS570	Forward: ATTO565- CTGGCTGTGTCCTCCAAGTT
	Reverse: GGCAACCTAAGCTGAAATGC
DYS576	Forward: ATTO550- GTTGGGCTGAGGAGTTCAATC
	Reverse: GGCAGTCTCATTTCCTGGAG
DYS612	Forward: 6-FAM- CCCCATGCCAGTAAGAATA
	Reverse: GTGAGGGAAGGCAAAAGAAAA
DYS626	Forward: YakimaYellow- GCAAGACCCCATAGCAAAAG
	Reverse: AAGAAGAATTTTGGGACATGTTT
DYS627	Forward: ATTO550- CTAGGTGACAGCGCAGGATT
	Reverse: GGATAATGAGCAAATGGCAAG

Table taken from: Alghafri et al. [10].

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Table 8. Example of UHD profiles for a brother pair with 2 mutations

(Electropherograms shown in Figure 6 and Figure 7.) The mutation at locus DYS576 is highlighted in a darker blue, and the one at DYS508 is highlighted in the brighter yellow.

Case	Sample	DYS 481	DYS 576	DYS 570	DYS 527-A	DYS 527-B	DYS 459-A	DYS 459-B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522	DYS 607	DYS 627
1878|12	F1	24	20	18	28	34	9	10	13	13	34	12	24	14	16	19
1878|12	F3	24	19	18	28	34	9	10	13	13	34	13	24	14	16	19

Table 9. Example of PPY23 profiles for an uncle-nephew pair with 2 mutations

(Electropherograms shown in Figure 8 and Figure 9) There is a mutation at the locus DYS389II, which is highlighted in a darker blue, and at DYS570, which is highlighted in the brighter yellow.

Case	Sample	Relation	DYS 576	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 481	DYS 549	DYS 533	DYS 438	DYS 437	DYS 570	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643	DYS 393	DYS 458	DYS 385-A	DYS 385-B	DYS 456	Y-GATA-H4
1142|12	FSP	Nephew	16	13	21	30	15	10	27	11	11	11	14	18	22	21	12	11	13	13	16	14	18	15	12
1142|12	ISP1	Uncle	16	13	21	31	15	10	27	11	11	11	14	19	22	21	12	11	13	13	16	14	18	15	12

Table 10. Example of RM-12plex profiles for a grandfather-grandson pair with 2 mutations

(Electropherograms shown in Figure 10 and Figure 11) There is a mutation at the locus DYS547, which is highlighted in a darker blue, and at DYF403S1A, which is highlighted in a darker green.

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1			DYS 526B	DYS 547	DYF 404S1		DYS 626	DYF 403S1A			DYS 403S1B	DYS 576	DYS 518	DYS 570	DYF 387S1		DYS 449
0262/12	F	Grandson 1	14	39	21	24/24.1		38	50	13	15	28	9	13	17	49	17	37?	17	35	36	29
0262/12	PSP	Grandfather	14	39	21	24/24.1		38	49	13	15	28	9	13	18	49	17	37?	17	35	36	29

Table 11. Adjusted Number of Meioses by Multiplex

Multiplex	Total # of Meioses	Adjusted # of Meioses
UHD		773
PPY23	787	787
RM-12plex		785

Table 12. Adjusted Number of Meioses by Relationship Group

Locus	Adjusted # of Meiotic Events		
	GF-GS	U-N	Brothers
DYS481	-	-	-
DYS576	-	-	-
DYS570	-	-	-
DYS527-A	192	303	278
DYS527-B	192	303	278
DYS459-A	192	303	278
DYS459-B	192	303	278
DYS549	-	-	-
DYS444	192	303	278
DYS449	196	-	-
DYS508	192	303	278
DYS552	192	303	278
DYS522	192	303	278
DYS607	192	303	278
DYS627	192	303	278
DYS389I	-	-	-
DYS448	-	-	-
DYS389II	-	-	-
DYS19	-	-	-
DYS391	-	-	-
DYS553	-	-	-
DYS438	-	-	-
DYS437	-	-	-
DYS635	-	-	-
DYS390	-	-	-
DYS439	-	-	-
DYS392	-	-	-
DYS643	-	-	-
DYS393	-	-	-
DYS458	-	-	-

Locus	Adjusted # of Meiotic Events		
	GF-GS	U-N	Brothers
DYS456	-	-	-
YGATAH4	-	-	-
DYS526A	196	-	-
DYS612	196	-	-
DYF399S1	196	-	-
DYS526B	196	-	-
DYS547	196	-	-
DYF404S1	196	-	-
DYS626	196	-	-
DYF403S1A	196	-	-
DYF403S1B	196	-	-
DYS518	196	-	-
DYF387S1	196	-	-
Total # of Meioses	198	309	280
Note: If total was not adjusted, a "-" symbol was used instead of a value.			

Table 13. Mutation Rates by Relationship Group

MUTATION RATES	Relationship Group		
	GF-GS	U-N	Brothers
1 STEP:	0.35	0.34	0.39
2 STEPS:	0.0051	0.020	0.039
3 STEPS:	0.0051	0.0032	0.0000
TOTAL:	0.36	0.36	0.43
95% Confidence Interval	0.29-0.43	0.31-0.41	0.37-0.49
# of meiosis/pair:	2	3	2
Average Multi-locus Mutation Rate (per Pair):	0.72	1.1	0.86

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Table 14. Mutation Rates by Multiplex

MUTATION RATES	Multiplex		
	UHD	PPY23	RM-12plex
1 STEP:	0.093	0.10	0.24
2 STEPS:	0.0078	0.0025	0.014
3 STEPS:	0.0000	0.0000	0.0025
TOTAL:	**0.10**	**0.10**	**0.25**
95% Confidence Interval	**0.080-0.12**	**0.082-0.12**	**0.22-0.29**

Table 15. Mutation Rates by Loci, Commercial Kit vs. Non-commercial Loci

MUTATION RATES	Loci	
	Commercial Kit	Non-commercial
1 STEP:	0.17	0.19
2 STEPS:	0.0025	0.020
3 STEPS:	0.0000	0.0025
TOTAL:	**0.17**	**0.21**
95% Confidence Interval	**0.14-0.20**	**0.19-0.24**

Table 16. Mutation Rates by Loci, RM vs. Non-RM loci

MUTATION RATES	RM-loci	Non-RM Loci	
		Highly Discriminating	Standard
1 STEP:	0.25	0.044	0.064
2 STEPS:	0.014	0.0090	0.0000
3 STEPS:	0.0025	0.0000	0.0000
TOTAL:	**0.27**	**0.053**	**0.064**
		95% C.I.: 0.037-0.069	95% C.I.: 0.046-0.081
		0.12	
95% C.I.	**0.24-0.30**	**0.094-0.14**	

Table 17. Mutation Rates by Loci

LOCI	MUTATION RATES			
	1 STEP:	**2 STEPS:**	**3 STEPS:**	**TOTAL:**
DYS481	0.0064	0.0025	0.0000	0.0089
DYS576	0.011	0.0000	0.0000	0.011
DYS570	0.0089	0.0000	0.0000	0.0089
DYS527-A	0.0026	0.0000	0.0000	0.0026
DYS527-B	0.0078	0.0000	0.0000	0.0078
DYS459-A	0.0000	0.0000	0.0000	0.0000
DYS459-B	0.0000	0.0000	0.0000	0.0000
DYS549	0.0076	0.0000	0.0000	0.0076
DYS444	0.0026	0.0000	0.0000	0.0026
DYS449	0.019	0.0000	0.0000	0.019
DYS508	0.0052	0.0065	0.0000	0.012
DYS552	0.0039	0.0000	0.0000	0.0039
DYS522	0.0026	0.0000	0.0000	0.0026
DYS607	0.0013	0.0000	0.0000	0.0013
DYS627	0.013	0.0000	0.0000	0.013
DYS389I	0.0051	0.0000	0.0000	0.0051
DYS448	0.0051	0.0000	0.0000	0.0051
DYS389II	0.014	0.0000	0.0000	0.014
DYS19	0.0013	0.0000	0.0000	0.0013
DYS391	0.0013	0.0000	0.0000	0.0013
DYS533	0.0038	0.0000	0.0000	0.0038
DYS438	0.0000	0.0000	0.0000	0.0000
DYS437	0.0000	0.0000	0.0000	0.0000
DYS635	0.0038	0.0000	0.0000	0.0038
DYS390	0.0051	0.0000	0.0000	0.0051
DYS439	0.0025	0.0000	0.0000	0.0025
DYS392	0.0013	0.0000	0.0000	0.0013
DYS643	0.0000	0.0000	0.0000	0.0000
DYS393	0.0000	0.0000	0.0000	0.0000
DYS458	0.011	0.0000	0.0000	0.011
DYS385-A	0.0000	0.0000	0.0000	0.0000
DYS385-B	0.0038	0.0000	0.0000	0.0038
DYS456	0.0089	0.0000	0.0000	0.0089
YGATAH4	0.0000	0.0000	0.0000	0.0000
DYS526A	0.0013	0.0000	0.0000	0.0013
DYS612	0.020	0.0076	0.0000	0.028
DYF399S1	0.059	0.0013	0.0013	0.061
DYS526B	0.013	0.0000	0.0000	0.013

LOCI	MUTATION RATES			
	1 STEP:	**2 STEPS:**	**3 STEPS:**	**TOTAL:**
DYS547	0.014	0.0051	0.0013	0.020
DYF404S1	0.015	0.0000	0.0000	0.015
DYS626	0.0025	0.0000	0.0000	0.0025
DYF403S1A	0.031	0.0000	0.0000	0.031
DYS403S1B	0.010	0.0000	0.0000	0.010
DYS518	0.022	0.0000	0.0000	0.022
DYF387S1	0.011	0.0000	0.0000	0.011
TOTAL	**0.36**	**0.023**	**0.0025**	**0.38**

Table 18. Total Multi-locus Mutation Rates, All Samples and All Loci

MUTATION RATES	All Loci	95% C.I.
1 STEP:	0.36	0.32-0.39
2 STEPS:	0.023	0.012-0.034
3 STEPS:	0.0025	0.0000-0.0060
TOTAL:	**0.38**	**0.35-0.42**

Table 19. Mutation Frequencies, Repeat Gain vs. Loss Mutations

RELATIONSHIP GROUP	MUTATIONS	MUTATION RATES	
		Gains	**Losses**
GF-GS	**1 STEP:**	0.23	0.12
	2 STEPS:	0.0000	0.0051
	3 STEPS:	0.0000	0.0051
	TOTAL:	**0.23**	**0.13**
	95% C.I.	**0.17-0.29**	**0.080-0.17**
U-N	**1 STEP:**	0.20	0.14
	2 STEPS:	0.0066	0.013
	3 STEPS:	0.0000	0.0032
	TOTAL:	**0.20**	**0.16**
	95% C.I.	**0.16-0.25**	**0.12-0.20**
TOTAL:		**0.43**	**0.28**
95% C.I.		**0.39-0.48**	**0.25-0.32**

Table 20. Observed Mutations versus Published Mutation Rates by Locus

Locus	# mutations observed	Published Mutation Rate
DYS448	4	3.94E-04
DYS438	0	9.56E-04
DYS392	1	9.70E-04
DYS522	2	1.04E-03
DYS643	0	1.50E-03
DYS390	4	1.52E-03
DYS437	0	1.53E-03
DYS385-A	0	2.08E-03
DYS393	0	2.11E-03
DYS459-A	0	2.67E-03
DYS459-B	0	2.67E-03
DYS552	3	2.69E-03
DYS526A	1	2.72E-03
DYS508	9	3.03E-03
YGATAH4	0	3.22E-03
DYS391	1	3.23E-03
DYS607	1	3.73E-03
DYS389II	11	3.83E-03
DYS439	2	3.84E-03
DYS635	3	3.85E-03
DYS385-B	3	4.14E-03
DYS19	1	4.37E-03
DYS549	6	4.55E-03
DYS456	7	4.94E-03
DYS481	7	4.97E-03
DYS533	3	5.01E-03
DYS444	2	5.45E-03
DYS389I	4	5.51E-03
DYS458	9	8.36E-03
DYS403S1B	8	1.19E-02
DYS449	15	1.22E-02
DYS626	2	1.22E-02
DYS627	10	1.23E-02
DYS570	7	1.24E-02
DYS526B	10	1.25E-02
DYF404S1	12	1.25E-02
DYS576	9	1.43E-02
DYS612	22	1.45E-02

Locus	# mutations observed	Published Mutation Rate
DYF387S1	9	1.59E-02
DYS518	17	1.84E-02
DYS547	16	2.36E-02
DYF403S1A	24	3.10E-02
DYF399S1	48	7.73E-02
DYS527-A	2	No data available
DYS527-B	6	No data available

Table 21. Discriminative Potential by Relationship Group

Relationship Group	# of pairs with at least 1 mutation	# of pairs	Discriminative Potential (DP)	DP 95% Confidence Interval (C.I.)
GF-GS	52	99	53%	43% - 62%
U-N	64	103	62%	53% - 72%
Brothers	76	140	54%	46% - 63%

Table 22. Loci by Discriminative Capability

Low Discrimination Ability		Somewhat Discriminative		Highly Discriminative	
0.0000-0.0049		0.0050-0.0099		0.010-0.061	
LOCI	Total Mutation Rate:	LOCI	Total Mutation Rate:	LOCI	Total Mutation Rate:
DYS459-A	0.0000	DYS389I	0.0051	DYS403S1B	0.010
DYS459-B	0.0000	DYS448	0.0051	DYS576	0.011
DYS438	0.0000	DYS390	0.0051	DYS458	0.011
DYS437	0.0000	DYS549	0.0076	DYF387S1	0.011
DYS643	0.0000	DYS527-B	0.0078	DYS508	0.012
DYS393	0.0000	DYS481	0.0089	DYS526B	0.013
DYS385-A	0.0000	DYS570	0.0089	DYS627	0.013
YGATAH4	0.0000	DYS456	0.0089	DYS389II	0.014
DYS19	0.0013			DYF404S1	0.015
DYS391	0.0013			DYS449	0.019
DYS392	0.0013			DYS547	0.020
DYS526A	0.0013			DYS518	0.023
DYS607	0.0013			DYS612	0.028
DYS439	0.0025			DYF403S1A	0.031
DYS626	0.0025			DYF399S1	0.061
DYS527-A	0.0026				
DYS444	0.0026				
DYS522	0.0026				
DYS533	0.0038				
DYS635	0.0038				
DYS385-B	0.0038				
DYS552	0.0039				

Table 23. Recommended Loci for a Paternal Relative Differentiation Multiplex

LOCI		
DYF387S1	DYF404S1	DYS526B
DYS389II	DYS449	DYS547
DYF399S1	DYS458	DYS576
DYF403S1A	DYS508	DYS612
DYS403S1B	DYS518	DYS627

Table 24. Samples with Potential, Unverified Mutations

Relationship Group	Sample		Allele Calls	Unknown Peak (base pairs)
GF-GS	2014/12	F	10, 16, 19	353.91
		PSP	10, 16, 19	N/A
	4104/11	F	10, 13, 17	349.73
		PSP	10, 13, 17	353.86
U-N	3497/11	F	11, 13, 17	353.81
		ISP2	11, 13, 17	357.82
		ISP3	11, 13, 17	353.82
	4171/11	FSP1	14, 16, 17	353.74
		ISP1	13, 16, 17	349.63

APPENDIX C: SUPPLEMENTARY MUTATION DATA SUMMARY TABLES

The following supplementary tables contain the raw mutation data by locus for the 40-locus "Masker Set". The labelling used for the samples is as follows: PSP for grandfathers, ISP for uncles, and F or FSP for the sons (see Figure 4). Due to size restrictions, the data was divided into four different sets of loci and is sorted by relationship group (grandfather-grandson, uncle-nephew, and brothers). Table S1 shows the loci in each set. The tables are shaded based on the mutations with different shading for a one-step mutation, two-step mutation, three-step mutation, and no mutation. The shading key is given in Table S2. At the end of each relationship group section, the total number of mutations for each locus is given (divided into the four sets), as well as the sum total for all 40 loci in the "Masker Set". These same total values for the combination of all of the samples are shown at the end of the appendix after the relationship group data.

Table S1. Locus Sets for Mutation Data Summary Charts

Locus Set			
1	**2**	**3**	**4**
DYS481	DYS607	DYS393	DYS526A
DYS576	DYS627	DYS458	DYS612
DYS570	DYS389I	DYS385A	DYF399S1
DYS527A	DYS448	DYS385B	DYS526B
DYS527B	DYS389II	DYS456	DYS547
DYS459A	DYS19	YGATAH4	DYF387S1
DYS459B	DYS391	DYF404S1	
DYS549	DYS553	DYS626	
DYS444	DYS438	DYF403S1A	
DYS449	DYS437	DYF403S1B	
DYS508	DYS635	DYS518	
DYS552	DYS390		
DYS522	DYS439		
	DYS392		
	DYS643		

Table S2. Sample Shading for Mutations

Shading Key:				
Locus Dye	None	1 Step	2 Step	3 Step
Blue				
Green				
Yellow				
Red				

Grandfather-Grandson Mutation Summary Data

Table S3. Grandfather-Grandson Loci Set 1

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0040/11	F	Grandson	22	15	17	34	35	9		12	12	28	11	27	11
0040/11	PSP	Grandfather	22	15	17	34	35	9		12	12	28	11	27	11
0115/12	F	Grandson	20	18	16	34	38	8	9	12	13	28	10	24	12
0115/12	PSP	Grandfather	20	18	16	34	38	8	9	12	13	28	10	24	12
A 0158/11	F	Grandson 1	21	18	18	33	35	9		14	12	30	11	24	10
B/A 0158/11	**PSP**	**Grandfather**	**21**	**18**	**18**	**33**	**35**	**9**		**14**	**12**	**30**	**11**	**24**	**10**
B 0158/11	FSP1	Grandson 2	21	18	18	33	35	9		14	12	30	11	24	10
B/A 0158/11	**PSP**	**Grandfather**	**21**	**18**	**18**	**33**	**35**	**9**		**14**	**12**	**30**	**11**	**24**	**10**
0160/11	F	Grandson	22	17	17	33	35	9	10	12	12	29	11	24	10
0160/11	PSP	Grandfather	22	17	17	33	35	9	10	12	12	29	11	24	10
0167/12	F	Grandson	22	17	17	31	33	9		13	11	33	12	27	12
0167/12	PSP	Grandfather	22	17	17	31	33	9		13	11	33	12	27	12
B 0262/12	F	Grandson 1	23	17	17	33	36	9	10	12	12	29	11	26	10
B 0262/12	**PSP**	**Grandfather**	**23**	**17**	**17**	**33**	**35**	**9**	**10**	**12**	**12**	**29**	**11**	**26**	**10**
C 0262/12	FSP	Grandson 2	23	17	17	33	35	9	10	12	12	29	11	26	10
B 0262/12	**PSP**	**Grandfather**	**23**	**17**	**17**	**33**	**35**	**9**	**10**	**12**	**12**	**29**	**11**	**26**	**10**
0322/12	F	Grandson	22	17	17	33	35	9	10	12	12	29	10	24	10
0322/12	PSP	Grandfather	22	17	17	33	35	9	10	12	12	29	10	24	10
0385/12	F	Grandson	22	18	19	33	36	9	10	12	12	28	11	24	10
0385/12	PSP	Grandfather	22	18	19	33	36	9	10	12	12	28	11	24	10
C 0440/12	F3	Grandson 1	25	20	18	28.2	33	9		12	11	29	15	24	12
B 0440/12	**PSP**	**Grandfather**	**25**	**21**	**18**	**28.2**	**33**	**9**		**12**	**11**	**29**	**15**	**24**	**12**

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
B 0440/12	F2	Grandson 2	25	20	18	28.2	33	9		12	11	29	15	24	12
B 0440/12	**PSP**	**Grandfather**	**25**	**21**	**18**	**28.2**	**33**	**9**		**12**	**11**	**29**	**15**	**24**	**12**
0505/11	F	Grandson	23	18	21	28	34	9		12	11	31	11	24	11
0505/11	PSP	Grandfather	23	18	21	28	34	9		12	11	31	11	24	11
0531/12	F	Grandson	22	17	19	33	35	9		13	13	30	11	25	11
0531/12	PSP	Grandfather	22	17	19	33	35	9		13	13	30	11	25	11
0662/11	F	Grandson	28	17	17	36		8	9	14	13	27	11	27	12
0662/11	PSP	Grandfather	28	17	17	36		8	9	14	13	27	11	27	12
0699/12	F	Grandson	22	16	17	33	34	9		13	12	29	12	24	10
0699/12	PSP	Grandfather	22	16	17	33	34	9		13	12	29	12	24	10
A 0713/12	F1	Grandson 1	22	17	18	33	35	9	10	12	12	29	11	24	10
A 0713/12	**PSP**	**Grandfather**	**22**	**17**	**18**	**33**	**35**	**9**	**10**	**12**	**12**	**29**	**11**	**24**	**10**
B 0713/12	F2	Grandson 2	22	17	18	33	35	9	10	12	12	29	11	24	10
A 0713/12	**PSP**	**Grandfather**	**22**	**17**	**18**	**33**	**35**	**9**	**10**	**12**	**12**	**29**	**11**	**24**	**10**
0768/10	F	Grandson	25	16	20	34	36	7	9	11	14	28	10	25	11
0768/10	PSP	Grandfather	25	16	20	34	36	7	9	11	14	28	10	25	11
0822/11	F	Grandson	32	15	18	33		10		13	13	27	11	26	12
0822/11	PSP	Grandfather	32	15	18	33		10		13	13	27	11	26	12
0897/12	F	Grandson	22	17	19	28	33	9		12	13	32	13	23	12
0897/12	PSP	Grandfather	22	17	19	28	33	9		12	13	32	13	23	12
0903/10	F	Grandson	22	16	18					14		28			
0903/10	PSP	Grandfather	22	16	18	34		9	10	14	11	28	11	25	10
0965/10	F	Grandson	23	18	16	32	35/36	9	10	13	12	29	11	24	11
0965/10	PSP	Grandfather	23	18	16	32	35/36	9	10	13	12	29	11	24	11
0982/10	F	Grandson	22	20	17	33	36	9		12	12	30	11	24	10
0982/10	PSP	Grandfather	22	20	17	33	36	9		12	12	30	11	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1038/12	F	Grandson	22	17	17	33	35	9	10	12	12	31	11	24	10
1038/12	PSP	Grandfather	22	17	17	33	35	9	10	12	12	31	11	24	10
1083/11	F	Grandson	29	17	18	33	34	7	9	12	14	28	10	25	11
1083/11	PSP	Grandfather	29	17	18	33	34	7	9	12	14	28	10	25	11
1095/12	F	Grandson	27	17	19	35	36	8	10	12	14	27	11	25	12
1095/12	PSP	Grandfather	27	17	19	35	36	8	10	12	14	27	11	25	12
1243/12	F	Grandson	22	18	17	34	36	9		12	12	27	11	24	10
1243/12	PSP	Grandfather	22	18	17	34	36	9		12	12	27	11	24	10
B 1276/12	FSP1	Grandson	27	18	25	30	32	9		11	12	32	11	25	12
B 1276/12	PSP	Grandfather	27	18	25	30	32	9		11	12	32	11	25	12
1316/11	F	Grandson	25	17	20	34	36	8	9	12	13	29	10	25	11
1316/11	PSP	Grandfather	25	17	20	34	36	8	9	12	13	29	10	25	11
1386/11	F	Grandson	23	17	17	33	37	9		13	11	30	11	24	10
1386/11	PSP	Grandfather	23	17	17	33	37	9		13	11	30	11	24	10
1391/12	F	Grandson	22	16	19	32	33	9		13	11	35	10	27	11
1391/12	PSP	Grandfather	22	16	19	32	33	9		13	11	35	10	27	11
1400/12	F	Grandson	23	16	17	34	35	8	9	13	13	29	13	24	11
1400/12	PSP	Grandfather	23	16	17	34	35	8	9	13	13	29	13	24	11
1419/12	F	Grandson	22	17	18	32		9		12	12	28	11	24	10
1419/12	PSP	Grandfather	22	17	18	32		9		13	12	28	11	24	10
1549/10	F	Grandson	22	17	19	33	34	9		11	13	30	11	27	11
1549/10	PSP	Grandfather	22	17	19	33	34	9		11	13	29	11	27	11
1750/10	F	Grandson	22	18	18	35		9	10	12	12	29	11	25	10
1750/10	PSP	Grandfather	22	18	18	35		9	10	12	12	29	11	25	10
1775/12	F	Grandson	22	18	18	33	35	9	10	14	12	29	11	24	11
1775/12	PSP	Grandfather	22	18	18	33	35	9	10	13	12	29	11	24	11

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1781/10	F	Grandson	22	20	16	33	34	9	10	12	14	30	12	25	10
1781/10	PSP	Grandfather	22	20	16	33	34	9	10	12	14	30	12	25	10
D 1878/12	F1	Grandson 1	24	20	18	28	34	9	10	13	13	33	12	24	14
D 1878/12	**PSP**	**Grandfather**	**24**	**19**	**18**	**28**	**34**	**9**	**10**	**13**	**13**	**33**	**12**	**24**	**14**
E 1878/12	F2	Grandson 2	24	19	18	28	34	9	10	13	13	32	12	24	14
D 1878/12	**PSP**	**Grandfather**	**24**	**19**	**18**	**28**	**34**	**9**	**10**	**13**	**13**	**33**	**12**	**24**	**14**
F 1878/12	F3	Grandson 3	24	19	18	28	34	9	10	13	13	33	13	24	14
D 1878/12	**PSP**	**Grandfather**	**24**	**19**	**18**	**28**	**34**	**9**	**10**	**13**	**13**	**33**	**12**	**24**	**14**
1886/10	F	Grandson	25	18	17	32	34/35	8	9	12	12	26	11	25	12
1886/10	PSP	Grandfather	25	18	17	32	34/35	8	9	12	12	26	11	25	12
1893/10	FSP1	Grandson	22	18	22	33	35	9	10	11	13	33	11	26	12
1893/10	PSP	Grandfather	22	18	22	33	35	9	10	11	13	33	11	26	12
A 1904/12	F	Grandson	25	17	18	33	34	8	10	11	14	29	12	26	11
A 1904/12	PSP	Grandfather	25	17	18	33	34	8	10	11	14	29	12	26	11
1912/10	F	Grandson	22	17	16	33		9		13	12	30	11	25	11
1912/10	PSP	Grandfather	22	17	16	33		9		13	12	29	11	25	11
1917/10	F	Grandson	25	20	18	28.2?	33	9		12	11	29	15	24	12
1917/10	PSP	Grandfather	25	20	18	28.2?	33	9		12	11	29	15	24	12
1952/10	F	Grandson	28	15	19	29		8	10	11	12	29	14	24	11
1952/10	PSP	Grandfather	28	15	19	29		8	10	11	12	29	14	24	11
1990/12	F	Grandson	21	15	19	34	37	9		10	12	32	10	25	12
1990/12	PSP	Grandfather	21	15	19	34	37	9		10	12	32	10	25	12
2014/12	F	Grandson	22	20	17	33	35	9		12	12	31	11	24	10
2014/12	PSP	Grandfather	22	20	17	33	35	9		12	12	31	11	24	10
2027/11	F1	Grandson	22	20	18	33		9	10	13	12	32	11	24	11
2027/11	PSP	Grandfather	22	20	18	33		9	10	13	12	32	11	24	11

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
2041/11	F	Grandson	28	16	23	31	32	9		11	12	32	10	26	12
2041/11	PSP	Grandfather	28	16	23	31	32	9		11	12	32	10	26	12
2100/10	F	Grandson	22	18	17	33	35	9	10	13	12	30	11	24	10
2100/10	PSP	Grandfather	22	18	17	33	35	9	10	13	12	30	11	24	10
2171/12	F	Grandson	22	19	16	33	35	9	10	13	12	31	11	24	10
2171/12	PSP	Grandfather	22	19	16	33	35	9	10	13	12	31	11	24	10
2239/12	F	Grandson	22	18	17	32	35	9	10	13	12	31	11	24	10
2239/12	PSP	Grandfather	22	18	17	33	35	9	10	13	12	31	11	24	10
2285/11	F	Grandson	20	17	19	28	34	9		13	12	33	12	25	11
2285/11	PSP	Grandfather	20	17	19	28	34	9		13	12	33	12	25	11
2322/11	FSP1	Grandson	26	18	20	30	33	9		11	12	32	10	26	11
2322/11	PSP	Grandfather	26	18	20	30	33	9		11	12	32	10	26	11
2336/11	F	Grandson	22	19	17	33	34	9	10	12	13	28	11	24	10
2336/11	PSP	Grandfather	22	19	17	33	34	9	10	12	13	28	11	24	10
2433/12	F	Grandson	24	17	17	33	35	9	10	12	11	32	12	24	10
2433/12	PSP	Grandfather	24	17	17	33	35	9	10	12	11	32	12	24	10
2611/12	F	Grandson	23	19	17	33	36/37	8	10	12	12	31	11	24	11
2611/12	PSP	Grandfather	23	19	17	33	36/37	8	10	12	12	31	11	24	11
2675/12	F	Grandson	23	18	20	33	36	9		13	12	30	11	25	10
2675/12	PSP	Grandfather	23	18	20	33	36	9		13	12	30	11	25	10
2727/11	F	Grandson	21	15	18	33	35	9		12	13	30	10	26	12
2727/11	PSP	Grandfather	21	15	18	33	35	9		12	13	31	10	26	12
2784/11	FSP (F)	Grandson	27	16	20					13					
2784/11	PSP	Grandfather	27	16	20	35		8	9	13	13	28	11	29	13
A 3144/11	F	Grandson	22	17	18	33	35	9		14	12	29	11	26	10
A 3144/11	PSP	Grandfather	22	17	18	33	35	9		14	12	29	11	26	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
3257/11	F	Grandson	27	15	19	29	33	8	10	11	13	28	14	24	11
3257/11	PSP	Grandfather	27	15	19	29	33	8	10	11	13	28	14	24	11
3431/11	F	Grandson	22	19	16	32	37	10		12	12	29	11	24	11
3431/11	PSP	Grandfather	22	19	16	32	37	10		12	12	29	11	24	11
3483/10	F	Grandson	24	18	18	33	35	9	11	13	14	30	11	24	10
3483/10	PSP	Grandfather	24	18	18	33	35	9	11	13	14	30	11	24	10
3518/11	F	Grandson	22	18	17	33	35	9	10	13	12	28	11	24	10
3518/11	PSP	Grandfather	22	18	17	33	35	9	10	13	12	28	11	24	10
3543/11	F	Grandson	26	18	19	35		8	10	13	13	27	13	26	12
3543/11	PSP	Grandfather	26	18	19	35		8	10	13	13	27	13	26	12
A 3593/11	F2	Grandson 1	25	17	18	36		9		11	12	29	11	25	11
A 3593/11	**PSP**	**Grandfather**	**25**	**17**	**18**	**36**		**9**		**11**	**12**	**29**	**11**	**25**	**11**
B 3593/11	F3	Grandson 2	25	17	18	36		9		11	12	29	11	25	11
A 3593/11	**PSP**	**Grandfather**	**25**	**17**	**18**	**36**		**9**		**11**	**12**	**29**	**11**	**25**	**11**
3615/11	F	Grandson	22	16	22	33	34	8	9	12	13	31	11	24	11
3615/11	PSP	Grandfather	22	16	22	33	34	8	9	12	13	31	11	24	11
3617/11	FSP	Grandson	23	18	19	33	35	9	10	12	14	33	10	26	10
3617/11	PSP	Grandfather	23	18	19	33	35	9	10	12	14	33	10	26	10
3662/10	F	Grandson	22	18	17	34	36	9	10	14	11	31	11	23	10
3662/10	PSP	Grandfather	22	18	17	33	36	9	10	14	11	31	11	23	10
3674/12	F	Grandson	31	18	19	34		8	10	11	10	32	10	23	11
3674/12	PSP	Grandfather	31	17	18	34		8	10	11	10	32	10	23	11
A 3769/10	F4	Grandson 1	24	19	17	29	33	8	9	11	12	32	12	25	11
A 3769/10	**PSP**	**Grandfather**	**24**	**19**	**17**	**29**	**33**	**8**	**9**	**11**	**12**	**32**	**12**	**25**	**11**
B 3769/10	F6	Grandson 2	24	19	17	29	33	8	9	11	12	32	12	25	11
A 3769/10	**PSP**	**Grandfather**	**24**	**19**	**17**	**29**	**33**	**8**	**9**	**11**	**12**	**32**	**12**	**25**	**11**

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
B 3780/12	F	Grandson	22	18	16	34		9	10	12	11	31	11	24	10
A 3780/12	PSP	Grandfather	22	18	16	34		9	10	12	11	31	11	24	10
3832/10	F	Grandson	24	17	14	37	38	9		13	12	29	12	24	11
3832/10	PSP	Grandfather	24	17	14	37	38	9		13	12	29	12	24	11
3864/12	F	Grandson	23	18	17	36	37	9		12	12	32	11	25	11
3864/12	PSP	Grandfather	23	18	17	36	37	9		12	12	31	11	25	11
3907/10	F	Grandson	20	19	18	33	36	9	10	14	12	29	11	24	10
3907/10	PSP	Grandfather	20	19	18	33	36	9	10	14	12	29	11	24	10
3911/10	F	Grandson	24	18	19	33	35	9	10	14	12	29	11	24	10
3911/10	PSP	Grandfather	24	18	19	33	35	9	10	14	12	29	11	24	10
B 4045/09	FSP2	Grandson 1	22	18	17	33	35	9		13	12	29	10	24	10
A 4045/09	**PSP**	**Grandfather**	**22**	**18**	**17**	**33**	**35**	**9**		**13**	**12**	**29**	**10**	**24**	**10**
A 4045/09	FSP1	Grandson 2	22	18	17	33	35	9		13	12	29	10	24	10
A 4045/09	**PSP**	**Grandfather**	**22**	**18**	**17**	**33**	**35**	**9**		**13**	**12**	**29**	**10**	**24**	**10**
C 4045/09	F	Grandson 3	22	18	17	33	35	9		13	12	29	10	24	10
A 4045/09	**PSP**	**Grandfather**	**22**	**18**	**17**	**33**	**35**	**9**		**13**	**12**	**29**	**10**	**24**	**10**
4104/11	F	Grandson	22	18	16	33	35	9	10	12	12	28	11	27	10
4104/11	PSP	Grandfather	22	18	16	33	35	9	10	12	12	28	11	27	10
4133/09	F	Grandson	23	17	18	33	35	9	10	12	14	32	11	24	10
4133/09	PSP	Grandfather	23	17	18	33	35	9	10	12	14	32	11	24	10
4137/09	F	Grandson	22	18	19	33	35	9		12	13	31	12	24	10
4137/09	PSP	Grandfather	22	18	19	33	35	9		12	13	31	12	24	10
4213/09	F	Grandson	22	19	15	33	35	9		12	12	30	12	24	10
4213/09	PSP	Grandfather	22	19	15	33	35	9		12	12	30	12	24	10
4222/10	F	Grandson	22	18	20	33	35	9	10	13	12	29	12	24	10
4222/10	PSP	Grandfather	22	18	20	33	35	9	10	13	12	29	11	24	10

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
4269/12	F	Grandson	23	16	17	33	34	8	10	11	13	29	11	26	12
4269/12	PSP	Grandfather	23	16	17	33	34	8	10	11	13	28	11	26	12
4337/11	F	Grandson	22	16	16	34	35	9	10	12	12	29	11	24	10
4337/11	PSP	Grandfather	22	16	16	34	35	9	10	12	12	29	11	24	10
4348/09	F	Grandson	28	18	22	30	32	9		12	12	32	10	26	12
4348/09	PSP	Grandfather	28	18	22	30	32	9		12	12	32	10	26	12
4361/12	F	Grandson	22	19	16	34		9		12	11	29	10	24	11
4361/12	PSP	Grandfather	22	19	16					12		29			
4431/09	F	Grandson	27	19	22	30	32	9		12	12	31	10	25	13
4431/09	PSP	Grandfather	27	19	22	30	32	9		12	12	31	10	25	13
4596/09	F	Grandson	22	19	17	33	36	9		13	12	29	11	24	11
4596/09	PSP	Grandfather	22	19	17	33	36	9		13	12	29	11	24	11
4794/09	F	Grandson	22	17	16	33	34	9		12	11	30	11	24	11
4794/09	PSP	Grandfather	22	17	16	33	34	9		12	11	30	11	24	11
A 4960/09	F1	Grandson 1	27	17	21	30	32	9		11	12	31	10	26	12
B 4960/09	**PSP**	**Grandfather**	**27**	**17**	**21**	**30**	**32**	**9**		**11**	**12**	**31**	**10**	**26**	**12**
B 4960/09	F2	Grandson 2	27	17	21	30	32	9		11	12	31	10	26	12
B 4960/09	**PSP**	**Grandfather**	**27**	**17**	**21**	**30**	**32**	**9**		**11**	**12**	**31**	**10**	**26**	**12**
C 4960/09	F3	Grandson 3	27	17	21	30	32	9		11	12	31	10	26	12
B 4960/09	**PSP**	**Grandfather**	**27**	**17**	**21**	**30**	**32**	**9**		**11**	**12**	**31**	**10**	**26**	**12**

Table S4. Grandfather-Grandson Loci Set 2

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0040/11	F	Grandson	18	22	12	23	29	15	10	10	10	16	22	21	12	11	12
0040/11	PSP	Grandfather	18	22	12	23	29	15	10	10	10	16	22	21	12	11	12
0115/12	F	Grandson	18	17	13	20	29	14	10	11	9	15	22	24	11	11	10
0115/12	PSP	Grandfather	18	17	13	20	29	14	10	11	9	15	22	24	11	11	10
A 0158/11	F	Grandson 1	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
B/A 0158/11	PSP	Grandfather	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
B 0158/11	FSP1	Grandson 2	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
B/A 0158/11	PSP	Grandfather	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
0160/11	F	Grandson	19	23	13	19	29	14	11	13	12	15	23	23	12	13	10
0160/11	PSP	Grandfather	19	23	13	19	29	14	11	13	12	15	23	23	12	13	10
0167/12	F	Grandson	18	20	14	19	31	15	10	11	9	14	21	23	11	13	10
0167/12	PSP	Grandfather	18	20	14	19	31	15	10	11	9	14	21	23	11	13	10
B 0262/12	F	Grandson 1	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
B 0262/12	PSP	Grandfather	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
C 0262/12	FSP	Grandson 2	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
B 0262/12	PSP	Grandfather	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
0322/12	F	Grandson	18	23	13	19	29	15	11	12	12	15	23	24	12	13	10
0322/12	PSP	Grandfather	18	23	13	19	29	15	11	12	12	15	23	24	12	13	10
0385/12	F	Grandson	21	22	13	19	29	15	11	12	12	15	23	24	13	13	10
0385/12	PSP	Grandfather	20	22	13	19	29	15	11	12	12	15	23	24	13	13	10
C 0440/12	F3	Grandson 1	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
B 0440/12	PSP	Grandfather	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
B 0440/12	F2	Grandson 2	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
B 0440/12	PSP	Grandfather	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0505/11	F	Grandson	16	21	12	20	29	14	10	12	10	14	21	24	10	11	12
0505/11	PSP	Grandfather	16	21	12	20	29	14	10	12	10	14	21	24	10	11	12
0531/12	F	Grandson	18	19	12	21	29	15	10	9	10	16	22	22	12	11	11
0531/12	PSP	Grandfather	18	19	12	21	29	15	10	9	10	16	22	22	12	11	11
0662/11	F	Grandson	19	21	12	20	29	15	10	12	10	14	21	23	11	12	12
0662/11	PSP	Grandfather	19	21	12	20	29	15	10	12	10	14	21	23	11	12	12
0699/12	F	Grandson	20	21	14	18	30	14	11	12	12	14	23	24	13	13	10
0699/12	PSP	Grandfather	20	21	14	18	30	14	11	12	12	14	23	24	13	13	10
A 0713/12	F1	Grandson 1	18	23	13	18	29	14	11	12	12	14	23	24	12	13	10
A 0713/12	**PSP**	**Grandfather**	**18**	**22**	**13**	**18**	**29**	**14**	**11**	**12**	**12**	**14**	**23**	**24**	**12**	**13**	**10**
B 0713/12	F2	Grandson 2	18	23	13	18	29	14	11	12	12	14	23	24	12	13	10
A 0713/12	**PSP**	**Grandfather**	**18**	**22**	**13**	**18**	**29**	**14**	**11**	**12**	**12**	**14**	**23**	**24**	**12**	**13**	**10**
0768/10	F	Grandson	18	20	12	20	27	14	10	11	10	16	22	23	11	11	12
0768/10	PSP	Grandfather	18	20	12	20	27	14	10	11	10	16	22	23	11	11	12
0822/11	F	Grandson	17	22	12	19	28	14	10	12	11	14	24	25	11	11	11
0822/11	PSP	Grandfather	17	22	12	19	28	14	10	12	11	14	24	25	11	11	11
0897/12	F	Grandson	16	22	13	20	30	13	10	12	10	14	22	25	11	11	13
0897/12	PSP	Grandfather	16	22	13	20	30	13	10	12	10	14	22	25	11	11	13
0903/10	F	Grandson			13	19	30	14	11	12	12	15	23	24	11	13	10
0903/10	PSP	Grandfather	19	22	13	19	30	14	11	12	12	15	23	24	11	13	10
0965/10	F	Grandson	20	21	13	19	29	14	10	13	12	14	23	24	11	13	10
0965/10	PSP	Grandfather	20	21	13	19	29	14	10	13	12	14	23	24	11	13	10
0982/10	F	Grandson	19	24	13	18	29	15	11	12	12	15	25	23	12	13	10
0982/10	PSP	Grandfather	19	24	13	18	29	15	11	12	12	15	25	23	12	13	10
1038/12	F	Grandson	19	22	14	18	31	14	10	12	12	14	23	24	12	13	10
1038/12	PSP	Grandfather	19	22	14	18	31	14	10	12	12	14	23	24	12	13	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1083/11	F	Grandson	18	19	12	20	28	14	10	11	10	16	23	23	12	11	12
1083/11	PSP	Grandfather	18	19	12	20	28	14	10	11	10	16	23	23	12	11	12
1095/12	F	Grandson	18	20	14	21	32	15	10	12	10	14	21	23	11	12	13
1095/12	PSP	Grandfather	18	20	14	21	32	15	10	12	10	14	21	23	11	12	13
1243/12	F	Grandson	19	23	13	20	30	14	11	12	12	15	23	25	12	13	10
1243/12	PSP	Grandfather	19	23	13	20	30	14	11	12	12	15	23	25	12	13	10
B 1276/12	FSP1	Grandson	16	18	14	20	30	13	9	11	10	14	21	24	10	11	12
B 1276/12	PSP	Grandfather	16	18	14	20	30	13	9	11	10	14	21	24	10	11	12
1316/11	F	Grandson	19	19	12	20	28	14	10	11	10	16	21	22	11	11	12
1316/11	PSP	Grandfather	19	19	12	20	28	14	10	11	10	16	21	22	11	11	12
1386/11	F	Grandson	20	23	13	20	30	13	11	12	12	15	23	24	12	13	10
1386/11	PSP	Grandfather	20	23	13	20	30	13	11	12	12	15	23	24	12	13	10
1391/12	F	Grandson	18	21	14	20	29	14	10	12	9	14	22	23	11	13	10
1391/12	PSP	Grandfather	18	21	14	20	29	14	10	12	9	14	22	23	11	13	10
1400/12	F	Grandson	19	18	12	19	28	15	10	12	9	16	21	24	11	11	9
1400/12	PSP	Grandfather	19	18	12	19	28	15	10	12	9	16	21	24	11	11	9
1419/12	F	Grandson	19	22	13	18	29	14	10	12	13	14	23	24	12	13	10
1419/12	PSP	Grandfather	19	22	13	18	29	14	10	12	13	14	23	24	12	13	10
1549/10	F	Grandson	18	18	12	21	30	15	11	9	10	16	21	22	13	11	11
1549/10	PSP	Grandfather	18	18	12	21	30	15	11	9	10	16	21	22	13	11	11
1750/10	F	Grandson	19	23	13	19	29	14	12	12	12	15	23	24	12	13	10
1750/10	PSP	Grandfather	19	23	13	19	29	14	12	12	12	15	23	24	12	13	10
1775/12	F	Grandson	19	20	14	19	30	14	11	12	12	15	23	24	13	13	10
1775/12	PSP	Grandfather	19	20	14	19	30	14	11	12	12	15	23	24	13	13	10
1781/10	F	Grandson	19	21	13	19	29	14	11	12	12	15	23	26	11	13	11
1781/10	PSP	Grandfather	19	21	13	19	29	14	11	12	12	15	23	26	11	13	11

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
D 1878/12	F1	Grandson 1	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
D 1878/12	**PSP**	**Grandfather**	**16**	**19**	**13**	**20**	**30**	**14**	**10**	**12**	**10**	**14**	**20**	**23**	**13**	**11**	**12**
E 1878/12	F2	Grandson 2	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
D 1878/12	**PSP**	**Grandfather**	**16**	**19**	**13**	**20**	**30**	**14**	**10**	**12**	**10**	**14**	**20**	**23**	**13**	**11**	**12**
F 1878/12	F3	Grandson 3	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
D 1878/12	**PSP**	**Grandfather**	**16**	**19**	**13**	**20**	**30**	**14**	**10**	**12**	**10**	**14**	**20**	**23**	**13**	**11**	**12**
1886/10	F	Grandson	18	21	13	20	29	14	10	12	10	14	21	23	11	11	9
1886/10	PSP	Grandfather	18	21	13	20	29	14	10	12	10	14	21	23	11	11	9
1893/10	FSP1	Grandson	20	17	13	19	30	15	11	12	11	14	24	26	10	11	10
1893/10	PSP	Grandfather	20	17	13	19	30	15	11	12	11	14	24	26	10	11	10
A 1904/12	F	Grandson	18	22	13	20	30	15	10	10	10	15	20	24	11	12	12
A 1904/12	PSP	Grandfather	18	22	13	20	30	15	10	10	10	15	20	24	11	12	12
1912/10	F	Grandson	20	21	13	19	29	14	10	13	12	15	23	24	13	13	10
1912/10	PSP	Grandfather	20	21	13	19	29	14	10	13	12	15	23	24	13	13	10
1917/10	F	Grandson	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
1917/10	PSP	Grandfather	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
1952/10	F	Grandson	18	19	13	21	31	15	11	11	11	14	21	21	12	11	14
1952/10	PSP	Grandfather	18	19	13	21	31	15	11	11	11	14	21	21	12	11	14
1990/12	F	Grandson	17	18	12	21	28	15	10	9	10	16	20	22	11	11	11
1990/12	PSP	Grandfather	17	18	12	21	28	15	10	9	10	16	20	22	11	11	11
2014/12	F	Grandson	19	23	13	18	29	14	10	12	12	15	23	24	12	13	10
2014/12	PSP	Grandfather	19	22	13	18	29	14	10	12	12	15	23	24	12	13	10
2027/11	F1	Grandson	18	23	13	19	29	14	11	12	12	15	23	23	13	13	10
2027/11	PSP	Grandfather	18	23	13	19	29	14	11	12	12	15	23	23	12	13	10
2041/11	F	Grandson	17	18	14	20	30	13	8	11	10	14	21	24	10	11	12
2041/11	PSP	Grandfather	17	18	14	20	30	13	8	11	10	14	21	24	10	11	12

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Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
2100/10	F	Grandson	19	22	13	19	29	14	11	12	12	15	23	24	12	13	11
2100/10	PSP	Grandfather	19	22	13	19	29	14	11	12	12	15	23	24	12	13	11
2171/12	F	Grandson	19	22	13	19	29	14	11	12	12	15	23	24	12	13	10
2171/12	PSP	Grandfather	19	22	13	19	29	14	11	12	12	15	23	24	12	13	10
2239/12	F	Grandson	19	22	13	19	29	15	10	12	12	15	23	24	11	13	10
2239/12	PSP	Grandfather	19	22	13	19	29	15	10	12	12	15	23	24	11	13	10
2285/11	F	Grandson	17	19	11	20	29	13	10	11	10	14	22	25	11	12	13
2285/11	PSP	Grandfather	17	19	11	20	29	13	10	11	10	14	22	25	11	12	13
2322/11	FSP1	Grandson	17	18	13	20	29	13	9	11	10	14	21	24	10	11	12
2322/11	PSP	Grandfather	17	18	13	20	29	13	9	11	10	14	21	24	10	11	12
2336/11	F	Grandson	19	26.3	14	19	31	14	11	12	12	15	23	23	12	13	10
2336/11	PSP	Grandfather	19	25.3	14	19	31	14	11	12	12	15	23	23	12	13	10
2433/12	F	Grandson	19	23	13	19	30	15	11	12	12	15	24	24	12	13	9
2433/12	PSP	Grandfather	19	23	13	19	30	15	11	12	12	15	24	24	12	13	9
2611/12	F	Grandson	20	22	12	20	29	13	10	11	11	14	23	24	12	15	9
2611/12	PSP	Grandfather	20	22	12	20	29	13	10	11	11	14	23	24	13	15	9
2675/12	F	Grandson	19	21	13	18	29	15	11	11	12	15	23	24	12	11	9
2675/12	PSP	Grandfather	19	21	13	18	29	15	11	11	12	15	23	24	12	11	9
2727/11	F	Grandson	17	19	12	21	29	15	10	9	10	16	21	22	11	11	11
2727/11	PSP	Grandfather	17	19	12	21	29	15	10	9	10	16	21	22	11	11	11
2784/11	FSP (F)	Grandson			14	20	31	15	11	11	10	14	21	23	11	12	12
2784/11	PSP	Grandfather	18	23	14	20	31	15	11	11	10	14	21	23	11	12	12
A 3144/11	F	Grandson	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
A 3144/11	PSP	Grandfather	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3257/11	F	Grandson	17	20	13	21	31	15	10	11	11	14	21	21	11	11	14
3257/11	PSP	Grandfather	17	20	13	21	31	15	10	11	11	14	21	21	11	11	14

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
3431/11	F	Grandson	19	20	13	20	29	14	10	12	12	16	23	23	13	13	10
3431/11	PSP	Grandfather	19	20	13	20	29	14	10	12	12	16	23	23	13	13	10
3483/10	F	Grandson	20	16	13	20	30	15	10	12	11	14	24	25	10	11	10
3483/10	PSP	Grandfather	20	16	13	20	30	15	10	12	11	14	24	25	10	11	10
3518/11	F	Grandson	20	21	12	20	28	14	10	12	13	15	24	24	11	13	10
3518/11	PSP	Grandfather	20	21	12	20	28	14	10	12	13	15	24	24	11	13	10
3543/11	F	Grandson	18	19	13	21	31	16	10	12	10	14	21	23	11	12	12
3543/11	PSP	Grandfather	18	19	13	21	32	16	10	12	10	14	21	23	11	12	12
A 3593/11	F2	Grandson 1	18	19	12	21	29	15	11	12	10	15	24	22	14	11	12
A 3593/11	**PSP**	**Grandfather**	**18**	**19**	**12**	**21**	**29**	**15**	**11**	**12**	**10**	**15**	**24**	**22**	**14**	**11**	**12**
B 3593/11	F3	Grandson 2	18	19	12	21	29	15	11	12	10	15	24	22	14	11	12
A 3593/11	**PSP**	**Grandfather**	**18**	**19**	**12**	**21**	**29**	**15**	**11**	**12**	**10**	**15**	**24**	**22**	**14**	**11**	**12**
3615/11	F	Grandson	18	22	13	21	29	15	9	12	9	14	24	23	11	11	10
3615/11	PSP	Grandfather	18	22	13	21	29	14	9	12	9	14	24	23	11	11	10
3617/11	FSP	Grandson	19	17	13	20	30	17	11	12	11	14	23	26	11	11	9
3617/11	PSP	Grandfather	19	17	13	20	30	17	11	12	11	14	23	26	11	11	9
3662/10	F	Grandson	20	22	12	19	27	14	10	12	12	15	23	24	12	12	11
3662/10	PSP	Grandfather	20	22	12	19	27	14	10	12	12	15	23	24	12	12	11
3674/12	F	Grandson	16	20	13	20	32	16	11	13	10	15	22	24	13	11	10
3674/12	PSP	Grandfather	16	20	13	20	32	16	11	13	10	15	22	24	13	11	10
A 3769/10	F4	Grandson 1	17	20	13	21	30	16	10	11	11	14	21	21	12	11	13
A 3769/10	**PSP**	**Grandfather**	**17**	**20**	**13**	**21**	**30**	**16**	**10**	**11**	**11**	**14**	**21**	**21**	**12**	**11**	**13**
B 3769/10	F6	Grandson 2	17	20	13	21	30	16	10	11	11	14	21	21	12	11	13
A 3769/10	**PSP**	**Grandfather**	**17**	**20**	**13**	**21**	**30**	**16**	**10**	**11**	**11**	**14**	**21**	**21**	**12**	**11**	**13**
B 3780/12	F	Grandson	19	25	13	18	29	14	11	12	12	14	23	24	13	13	9
A 3780/12	PSP	Grandfather	19	25	13	18	29	14	11	12	12	14	23	24	13	13	9

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
3832/10	F	Grandson	20	20	13	20	31	13	11	11	11	15	23	26	12	14	10
3832/10	PSP	Grandfather	20	20	13	20	31	13	11	11	11	15	23	26	12	14	10
3864/12	F	Grandson	19	21	13	19	29	14	11	12	12	15	23	24	13	13	11
3864/12	PSP	Grandfather	19	21	13	19	29	14	11	12	12	15	23	24	13	13	11
3907/10	F	Grandson	19	21	13	19	29	14	11	12	12	15	24	23	12	13	10
3907/10	PSP	Grandfather	19	21	13	19	29	14	11	12	12	15	24	23	12	13	10
3911/10	F	Grandson	19	23	13	18	29	14	10	12	12	14	23	24	11	13	11
3911/10	PSP	Grandfather	19	23	13	18	29	14	10	12	12	14	23	24	11	13	11
B 4045/09	FSP2	Grandson 1	18	21	13	19	29	15	11	12	12	15	23	24	13	13	10
A 4045/09	**PSP**	**Grandfather**	**18**	**21**	**13**	**19**	**29**	**15**	**11**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
A 4045/09	FSP1	Grandson 2	18	21	13	19	29	15	11	12	12	15	23	24	13	13	10
A 4045/09	**PSP**	**Grandfather**	**18**	**21**	**13**	**19**	**29**	**15**	**11**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
C 4045/09	F	Grandson 3	18	21	13	19	29	15	11	12	12	15	23	24	13	13	10
A 4045/09	**PSP**	**Grandfather**	**18**	**21**	**13**	**19**	**29**	**15**	**11**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
4104/11	F	Grandson	19	22	13	18	29	14	11	12	12	14	23	24	11	13	10
4104/11	PSP	Grandfather	19	23	13	18	29	14	11	12	12	14	23	24	11	13	10
4133/09	F	Grandson	20	17	13	20	30	16	11	12	11	14	23	24	10	11	10
4133/09	PSP	Grandfather	20	17	13	20	30	16	11	12	11	14	23	24	10	11	10
4137/09	F	Grandson	19	21	13	19	29	14	11	12	12	15	23	24	12	13	10
4137/09	PSP	Grandfather	19	21	13	19	29	14	11	12	12	15	23	24	12	13	10
4213/09	F	Grandson	19	23	13	19	30	14	11	12	12	16	26	23	13	13	10
4213/09	PSP	Grandfather	19	23	13	19	30	14	11	12	12	16	26	23	13	13	10
4222/10	F	Grandson	19	null	13	19	29	14	11	13	12	15	23	24	13	13	10
4222/10	PSP	Grandfather	19	null	13	19	29	14	11	13	12	15	23	24	13	13	10
4269/12	F	Grandson	17	23	12	21	29	17	11	11	10	15	21	25	10	11	13
4269/12	PSP	Grandfather	17	23	12	21	29	17	11	11	10	15	21	25	10	11	13

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
4337/11	F	Grandson	19	20	13	20	29	14	11	12	12	15	23	24	12	13	10
4337/11	PSP	Grandfather	19	20	13	20	29	14	11	12	12	15	23	24	12	13	10
4348/09	F	Grandson	17	18	14	20	30	13	10	11	10	14	21	24	10	11	13
4348/09	PSP	Grandfather	17	18	14	20	30	13	10	11	10	14	21	24	10	11	13
4361/12	F	Grandson	18	22	13	21	30	14	10	11	9	14	22	23	11	11	9
4361/12	PSP	Grandfather			13	21	30	14	10	11	9	14	22	23	11	11	9
4431/09	F	Grandson	17	18	13	21	29	13	9	12	10	14	21	24	10	11	12
4431/09	PSP	Grandfather	17	18	13	21	29	13	9	12	10	14	21	24	10	11	12
4596/09	F	Grandson	20	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4596/09	PSP	Grandfather	20	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4794/09	F	Grandson	19	19	13	19	30	14	11	12	12	15	23	23	11	13	10
4794/09	PSP	Grandfather	19	19	13	19	30	14	11	12	12	15	23	23	11	13	10
A 4960/09	F1	Grandson 1	17	18	13	21	29	13	9	11	10	14	21	24	10	11	12
B 4960/09	**PSP**	**Grandfather**	**17**	**18**	**13**	**21**	**29**	**13**	**9**	**11**	**10**	**14**	**21**	**24**	**10**	**11**	**12**
B 4960/09	F2	Grandson 2	17	18	13	21	29	13	9	11	10	14	21	24	10	11	12
B 4960/09	**PSP**	**Grandfather**	**17**	**18**	**13**	**21**	**29**	**13**	**9**	**11**	**10**	**14**	**21**	**24**	**10**	**11**	**12**
C 4960/09	F3	Grandson 3	17	18	13	21	29	13	9	11	10	14	21	24	10	11	12
B 4960/09	**PSP**	**Grandfather**	**17**	**18**	**13**	**21**	**29**	**13**	**9**	**11**	**10**	**14**	**21**	**24**	**10**	**11**	**12**

Table S5. Grandfather-Grandson Loci Set 3

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0040/11	F	Grandson	15	18	13	17	15	11	13		31	15	16		43	37
0040/11	PSP	Grandfather	15	18	13	17	15	11	13		31	15	16		43	37
0115/12	F	Grandson	12	17	13	19	16	11	14	16	28	9	12	13	51	40
0115/12	PSP	Grandfather	12	17	13	19	16	11	14	16	28	9	12	13	51	40
A 0158/11	F	Grandson 1	13	17	11	14	18	12	14	15	29	8	11	17	49	39
B/A 0158/11	PSP	Grandfather	13	16	11	14	18	12	14	15	29	8	11	17	49	39
B 0158/11	FSP1	Grandson 2	13	17	11	14	18	12	14	15	29	8	11	17	49	39
B/A 0158/11	PSP	Grandfather	13	16	11	14	18	12	14	15	29	8	11	17	49	39
0160/11	F	Grandson	13	18	10	15	16	12	14	15	31	12	13	17	50	38
0160/11	PSP	Grandfather	13	18	10	15	16	12	14	15	31	12	13	17	50	38
0167/12	F	Grandson	13	15	15	16	16	11	13	17	30	16	17		45	35
0167/12	PSP	Grandfather	13	15	15	16	16	11	13	17	30	16	17		45	35
B 0262/12	F	Grandson 1	13	15	11	14	16	12	13	15	28	9	13	17	49	37
B 0262/12	PSP	Grandfather	13	15	11	14	16	12	13	15	28	9	13	18	49	37
C 0262/12	FSP	Grandson 2	13	15	11	14	16	12	13	15	28	9	13	18	49	37
B 0262/12	PSP	Grandfather	13	15	11	14	16	12	13	15	28	9	13	18	49	37
0322/12	F	Grandson	13	16	11	14	16	12	14	15	28	10	16	20.2	51	39
0322/12	PSP	Grandfather	13	16	11	14	16	12	14	15	28	10	16	20.2	51	39
0385/12	F	Grandson	12	16	11	14	16	12	13	16	32	12	16		49	39
0385/12	PSP	Grandfather	12	16	11	14	16	12	13	16	32	12	16		49	39
C 0440/12	F3	Grandson 1	12	18	16		15	12	14		26	12	13	14	50	37
B 0440/12	PSP	Grandfather	12	18	16		15	12	14		26	12	13	14	50	37
B 0440/12	F2	Grandson 2	12	18	16		15	12	14		26	12	13	14	50	37
B 0440/12	PSP	Grandfather	12	18	16		15	12	14		26	12	13	14	50	37

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0505/11	F	Grandson	13	14	17	19	15	11	13	16	25	11	15		50	42
0505/11	PSP	Grandfather	13	14	17	19	15	11	13	16	25	11	15		50	42
0531/12	F	Grandson	14	16	12	15	16	13	13.2	14	33	13	14	16	47	38
0531/12	PSP	Grandfather	14	16	12	15	16	13	13.2	14	33	13	14	16	47	38
0662/11	F	Grandson	15	15	15		15	11	14	15	31	13	17	19	46	39
0662/11	PSP	Grandfather	15	15	15		15	11	14	15	31	13	17	19	46	39
0699/12	F	Grandson	13	17	10	13	17	11	14	15	30	11	13	16	51	38
0699/12	PSP	Grandfather	13	17	10	13	17	11	14	15	30	11	13	16	51	38
A 0713/12	F1	Grandson 1	13	16	11	14	15	12	14	15	30	12	18		52	39
A 0713/12	**PSP**	**Grandfather**	**13**	**16**	**11**	**14**	**15**	**12**	**14**	**15**	**30**	**12**	**18**		**52**	**38**
B 0713/12	F2	Grandson 2	13	16	11	14	15	12	14	15	30	12	18		52	39
A 0713/12	**PSP**	**Grandfather**	**13**	**16**	**11**	**14**	**15**	**12**	**14**	**15**	**30**	**12**	**18**		**52**	**38**
0768/10	F	Grandson	13	17	14	15	14	11	13	15	31	10	16	18	47	38
0768/10	PSP	Grandfather	13	17	14	15	14	11	13	15	31	10	16	18	47	38
0822/11	F	Grandson	13	18	14	19	16	10	14	16	28	12	13		50	43
0822/11	PSP	Grandfather	13	18	14	19	16	10	14	16	28	12	13		50	43
0897/12	F	Grandson	13	15	16	17	15	12	15		25	15	16	19	47	39
0897/12	PSP	Grandfather	13	15	16	17	15	12	15		25	15	16	19	47	39
0903/10	F	Grandson	13	18	11	14	17	12	15	16	31	12	13	17	48	37
0903/10	PSP	Grandfather	13	18	11	14	17	12	15		31	12	13	17	48	37
0965/10	F	Grandson	12	17	11	14	17	12	15	16	29	11	14	17	51	38
0965/10	PSP	Grandfather	12	17	11	14	17	12	15	16	29	11	14	17	51	38
0982/10	F	Grandson	13	17	12	13	16	12	15		29	11	13	19	49	37
0982/10	PSP	Grandfather	13	17	12	13	16	12	15		29	11	13	19	49	37
1038/12	F	Grandson	13	17	11	15	17	12	14	16	30	11	13	18	50	38
1038/12	PSP	Grandfather	13	17	11	15	17	12	14	16	30	11	13	18	50	38

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Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1083/11	F	Grandson	13	16	14		14	12	12	14	33	10	18	20	47	38
1083/11	PSP	Grandfather	13	16	14		14	12	12	14	33	10	18	20	47	39
1095/12	F	Grandson	14	15	15		15	11	14	15	30	14	17	18	46	40
1095/12	PSP	Grandfather	14	15	15		15	11	14	15	30	14	17	18	46	40
1243/12	F	Grandson	13	17	10	14	15	12	14	15	30	11	13	17	50	40
1243/12	PSP	Grandfather	13	17	10	14	15	12	14	15	30	11	13	17	50	40
B 1276/12	FSP1	Grandson	13	17	13	14	15	12	14	15	24	11	14	15	49	41
B 1276/12	PSP	Grandfather	13	17	13	14	15	12	14	15	24	11	14	15	49	41
1316/11	F	Grandson	13	14	13	14	14	11	11	15	33	10	15	19	47	39
1316/11	PSP	Grandfather	13	14	13	14	14	11	11	15	33	10	15	19	47	39
1386/11	F	Grandson	13	17	11	14	15	11	14	17	29	10	13	16	47	39
1386/11	PSP	Grandfather	13	17	11	14	15	11	14	17	29	10	13	16	47	39
1391/12	F	Grandson	13	17	14	17	15	10	13	15	30	11	15	19	45	35
1391/12	PSP	Grandfather	13	17	14	17	15	10	13	15	30	11	15	19	45	35
1400/12	F	Grandson	13	16	13	17	13	11	14	16	29	6	10	16	47	38
1400/12	PSP	Grandfather	13	16	13	17	13	11	14	16	29	6	10	16	47	38
1419/12	F	Grandson	13	16	10	14	15	11	14	15	30	10	13	14	51	36
1419/12	PSP	Grandfather	13	16	10	14	15	11	14	15	30	10	13	14	51	36
1549/10	F	Grandson	14	16	15		18	12	13.2	15	31	14	17		47	38
1549/10	PSP	Grandfather	14	16	15		18	12	13.2	15	31	14	17		47	38
1750/10	F	Grandson	13	18	11	14	15	12	13	15	29	9	13	17	50	36
1750/10	PSP	Grandfather	13	18	11	14	15	12	13	15	29	9	13	17	50	36
1775/12	F	Grandson	14	17	11	14	15	12	13	15	29	11	15	17	50	38
1775/12	PSP	Grandfather	14	17	11	14	15	12	13	15	29	11	15	17	50	38
1781/10	F	Grandson	12	16	11	14	15	12	14	17	28	10	13	16	49	39
1781/10	PSP	Grandfather	12	16	11	14	15	12	14	17	28	10	13	16	49	39

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
D 1878/12	F1	Grandson 1	13	16	18		15	13	15		25	13		16	51	37
D 1878/12	**PSP**	**Grandfather**	**13**	**16**	**18**		**15**	**13**	**15**		**25**	**13**		**16**	**51**	**37**
E 1878/12	F2	Grandson 2	13	16	18		15	13	15		25	13		16	51	37
D 1878/12	**PSP**	**Grandfather**	**13**	**16**	**18**		**15**	**13**	**15**		**25**	**13**		**16**	**51**	**37**
F 1878/12	F3	Grandson 3	13	16	18	19	15	13	15		25	13	15	16	51	37
D 1878/12	**PSP**	**Grandfather**	**13**	**16**	**18**		**15**	**13**	**15**		**25**	**13**		**16**	**51**	**37**
1886/10	F	Grandson	12	18.2	13	17	15	11	14	16	29	15	16	17	54	37
1886/10	PSP	Grandfather	12	18.2	13	17	15	11	14	16	29	15	16	17	54	37
1893/10	FSP1	Grandson	13	15	11	14	16	12	13	15	35	11	14	16	50	42
1893/10	PSP	Grandfather	13	15	11	14	16	12	13	15	34	11	14	16	50	42
A 1904/12	F	Grandson	15	16	14	15	14	11	15	17	28	12	17	18	50	41
A 1904/12	PSP	Grandfather	15	16	14	15	14	11	15	17	28	12	17	18	50	41
1912/10	F	Grandson	13	17	12	15	15	12	14		29	10	12	18	50	37
1912/10	PSP	Grandfather	13	17	12	15	15	12	14		29	10	12	18	50	37
1917/10	F	Grandson	12	18	16		15	12	14		26	12	13	14	51	37
1917/10	PSP	Grandfather	12	18	16		15	12	14		26	12	13	14	50	37
1952/10	F	Grandson	13	16	17		15	12	13	15	28	14	15		51	38
1952/10	PSP	Grandfather	13	16	17		15	12	13	15	28	14	15		51	38
1990/12	F	Grandson	13	17	14		16	11	15.2	16	31	14	16		47	37
1990/12	PSP	Grandfather	13	17	14		16	11	15.2	16	31	14	16		47	37
2014/12	F	Grandson	13	17	12	14	15	12	14	15	30	10	16	19	50	37
2014/12	PSP	Grandfather	13	17	12	14	15	12	14	15	30	10	16	19	50	37
2027/11	F1	Grandson	13	17	12	14	17	12	14	15	29	12	13	18	51	37
2027/11	PSP	Grandfather	13	17	12	14	17	12	14	15	29	12	13	18	51	37
2041/11	F	Grandson	13	18	13	14	15	12	14		24	11	15		49	43
2041/11	PSP	Grandfather	13	18	13	14	15	12	14		24	11	15		49	43

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
2100/10	F	Grandson	13	17	11	14	15	12	14	15		30	9	15		51	39
2100/10	PSP	Grandfather	13	17	11	14	15	12	14	15		30	9	15		51	39
2171/12	F	Grandson	14	17	11	13	16	12	14	15		29	12	15	18	50	38
2171/12	PSP	Grandfather	14	17	11	13	16	12	14	15		29	12	15	18	50	38
2239/12	F	Grandson	12	18	11	14	14	11	14	15		30	9	15	16	50	36
2239/12	PSP	Grandfather	12	18	11	14	14	11	14	15		30	9	15	16	50	36
2285/11	F	Grandson	13	17	15	19	15	11	14	15		25	11	13	15	53	40
2285/11	PSP	Grandfather	13	17	15	19	15	11	14	15		25	11	13	15	53	40
2322/11	FSP1	Grandson	13	18	12	14	16	12	14			24	13	15	16	50	41
2322/11	PSP	Grandfather	13	18	12	14	16	12	14			24	13	15	16	50	41
2336/11	F	Grandson	13	17	11	14	15	12	15			29	12	14	18	49	37
2336/11	PSP	Grandfather	13	17	11	14	15	12	15			29	11	14	18	49	37
2433/12	F	Grandson	13	16	11	14	15	12	14			30	10	14	15	51	39
2433/12	PSP	Grandfather	13	16	11	14	15	12	14			30	10		15	51	39
2611/12	F	Grandson	12	17	14		16	12	11	12	15	31	13	14		51	40
2611/12	PSP	Grandfather	12	17	14		16	12	11	12	15	31	13	14		51	40
2675/12	F	Grandson	13	17	11		16	11	14	15		30	9	13	18	50	40
2675/12	PSP	Grandfather	13	17	11		16	11	14	15		30	9	13	18	50	40
2727/11	F	Grandson	14	17	14		15	12	13.2	16		32	13	15	18	46	36
2727/11	PSP	Grandfather	14	17	14		15	12	13.2	16		32	13	15	18	46	36
2784/11	FSP (F)	Grandson	15	14	15		14	10									
2784/11	PSP	Grandfather	15	14	15		14	10	14	15		29	12	14	20	48	39
A 3144/11	F	Grandson	13	16	11	14	16	11	14	16		30	11	12	20	49	38
A 3144/11	PSP	Grandfather	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3257/11	F	Grandson	13	17	16	17	15	12	15	16		30	13	17		51	37
3257/11	PSP	Grandfather	13	17	16	17	15	12	15	16		30	13	17		51	37

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
3431/11	F	Grandson	13	18	11	13	17	12	14	15		29	11	13	18	54	40
3431/11	PSP	Grandfather	13	18	11	13	17	12	14	15		29	11	13	18	54	40
3483/10	F	Grandson	13	15	11	15	15	13	14	17		31	11	15	17	54	41
3483/10	PSP	Grandfather	13	15	11	15	15	13	14	17		31	11	15	17	54	41
3518/11	F	Grandson	13	16	11	14	15	12	14	15		29	12	13	16	51	37
3518/11	PSP	Grandfather	13	16	11	14	15	12	14	15		29	12	13	16	51	37
3543/11	F	Grandson	15	15	15		21	11	14	16		29	12	18	19	47	39
3543/11	PSP	Grandfather	15	15	15		21	11	14	16		29	12	18		47	39
A 3593/11	F2	Grandson 1	13	19	13	15	15	11	17			29	10	15	20	48	43
A 3593/11	**PSP**	**Grandfather**	**13**	**19**	**13**	**15**	**15**	**11**	**17**			**29**	**10**	**15**	**20**	**48**	**43**
B 3593/11	F3	Grandson 2	13	19	13	15	15	11	17			29	10	15	20	48	43
A 3593/11	**PSP**	**Grandfather**	**13**	**19**	**13**	**15**	**15**	**11**	**17**			**29**	**10**	**15**	**20**	**48**	**43**
3615/11	F	Grandson	12	14	13	16	16	12	13	15		32	13	14	15	49	40
3615/11	PSP	Grandfather	12	14	13	16	16	12	13	15		32	13	14	15	49	40
3617/11	FSP	Grandson	13	15	11	13	16	13	14	16		30	10	16	17	53	43
3617/11	PSP	Grandfather	13	15	11	13	16	13	14	16		30	10	16	17	53	43
3662/10	F	Grandson	14	17	10	15	17	12	15			29	11	13	17	50	38
3662/10	PSP	Grandfather	14	17	10	15	17	12	15			29	12	13	17	50	38
3674/12	F	Grandson	13	14	14	15	15	11	12	15		27	11	16		45	40
3674/12	PSP	Grandfather	13	14	14	15	15	11	12	15		27	11	16		45	40
A 3769/10	F4	Grandson 1	14	17	17	18	17	11	14	15		31	12	15	16	52	40
A 3769/10	**PSP**	**Grandfather**	**14**	**17**	**17**	**18**	**17**	**11**	**14**	**15**		**31**	**12**	**15**	**16**	**52**	**40**
B 3769/10	F6	Grandson 2	14	17	17	18	17	11	14	15		31	12	15	16	52	40
A 3769/10	**PSP**	**Grandfather**	**14**	**17**	**17**	**18**	**17**	**11**	**14**	**15**		**31**	**12**	**15**	**16**	**52**	**40**
B 3780/12	F	Grandson	13	16	11	14	17	11	13	16		30	12	13	16	50	38
A 3780/12	PSP	Grandfather	13	16	11	14	17	11	13	16		30	12	13	16	50	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
3832/10	F	Grandson	13	17	14	15	15	13	12		28	13	15	17	51	38
3832/10	PSP	Grandfather	13	17	14	15	15	13	12		28	13	15	17	51	38
3864/12	F	Grandson	13	20	12	14	16	11	14		29	13	15	16	49	37
3864/12	PSP	Grandfather	13	20	12	14	16	11	14		29	13	15	16	49	37
3907/10	F	Grandson	13	18	11	14	15	12	15	16	29	10	13	19	51	39
3907/10	PSP	Grandfather	13	18	11	14	15	12	15	16	29	10	13	19	51	39
3911/10	F	Grandson	13	17	11	14	17	12	13	15	31	11	12	17	47	37
3911/10	PSP	Grandfather	13	17	11	14	17	12	13	15	31	11	12	17	47	37
B 4045/09	FSP2	Grandson 1	13	16	11	14	17	12	14	15	28	10	15	17	49	39
A 4045/09	**PSP**	**Grandfather**	**13**	**16**	**11**	**14**	**17**	**12**	**14**	**15**	**28**	**10**	**15**	**17**	**49**	**39**
A 4045/09	FSP1	Grandson 2	13	16	11	14	17	12	14	15	28	10	15	17	49	39
A 4045/09	**PSP**	**Grandfather**	**13**	**16**	**11**	**14**	**17**	**12**	**14**	**15**	**28**	**10**	**15**	**17**	**49**	**39**
C 4045/09	F	Grandson 3	13	16	11	14	17	12	14	15	28	10	15	17	49	39
A 4045/09	**PSP**	**Grandfather**	**13**	**16**	**11**	**14**	**17**	**12**	**14**	**15**	**28**	**10**	**15**	**17**	**49**	**39**
4104/11	F	Grandson	13	17	11	15	16	11	14	15	30	10	13	17	50	38
4104/11	PSP	Grandfather	13	17	11	15	16	11	14	15	30	10	13	17	50	38
4133/09	F	Grandson	13	15	11	14	17	11	13	14	32	10	15	16	50	43
4133/09	PSP	Grandfather	13	15	11	14	17	11	13	14	32	10	15	16	50	43
4137/09	F	Grandson	13	17	14		16	12	13	14	29	13	16		47	39
4137/09	PSP	Grandfather	13	17	14		16	12	13	14	29	13	16		47	39
4213/09	F	Grandson	13	18	11	15	15	11	14	16	29	9	14	16	51	38
4213/09	PSP	Grandfather	13	18	11	15	15	11	14	16	29	9	14	16	51	38
4222/10	F	Grandson	13	17	11	14	15	12		16	29	12	14	17	51	37
4222/10	PSP	Grandfather	13	17	11	14	15	12	15	16	29	12	14	17	51	37
4269/12	F	Grandson	14	18	13	16	14	10	13	15	29	13	17	18	50	38
4269/12	PSP	Grandfather	14	18	13	16	14	10	13	15	29	13	17	18	50	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
4337/11	F	Grandson	13	17	11	14	15	12	14	15		29	12	14	17	50	39
4337/11	PSP	Grandfather	13	17	11	14	15	12	14	15		29	12	14	17	50	39
4348/09	F	Grandson	13	18	13	14	15	12	14			24	11	13	16	50	43
4348/09	PSP	Grandfather	13	18	13	14	15	12	14			24	11	13	16	50	43
4361/12	F	Grandson	12	17	13	18	15	11	15			29	13	14	16	49	40
4361/12	PSP	Grandfather	12	17	13	18	15	11	15			29	13	14	16	49	40
4431/09	F	Grandson	13	16	13	14	15	12	13			24	11	15	16	50	41
4431/09	PSP	Grandfather	13	16	13	14	15	12	13			24	11	15	16	50	41
4596/09	F	Grandson	13	17	11	14	17	12	14	15		26	10	13	19	50	39
4596/09	PSP	Grandfather	13	17	11	14	17	12	14	15		26	10	13	19	50	39
4794/09	F	Grandson	13	17	11	14	16	11	14	16		29	10	13	18	52	39
4794/09	PSP	Grandfather	13	17	11	14	16	11	14	16		29	10	13	18	52	39
A 4960/09	F1	Grandson 1	13	18	13	14	16	12	14			24	11	15		49	41
B 4960/09	**PSP**	**Grandfather**	**13**	**18**	**13**	**14**	**16**	**12**	**14**			**24**	**11**	**15**		**49**	**41**
B 4960/09	F2	Grandson 2	13	18	13	14	16	12	14			24	11	15		49	41
B 4960/09	**PSP**	**Grandfather**	**13**	**18**	**13**	**14**	**16**	**12**	**14**			**24**	**11**	**15**		**49**	**41**
C 4960/09	F3	Grandson 3	13	18	13	14	16	12	14			24	11	15		49	41
B 4960/09	**PSP**	**Grandfather**	**13**	**18**	**13**	**14**	**16**	**12**	**14**			**24**	**11**	**15**		**49**	**41**

Table S6. Grandfather-Grandson Loci Set 4

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547		DYF 387S1		
0040/11	F	Grandson	13	37	17.1	23	24				34		47		37	40	
0040/11	PSP	Grandfather	13	37	17.1	23	24				34		47		37	40	
0115/12	F	Grandson	14	37	19	25					37		46		38	41	
0115/12	PSP	Grandfather	14	37	19	25					37		46		38	41	
A 0158/11	F	Grandson 1	15	37	22	24	24.1				38		47		35	36	
B/A 0158/11	**PSP**	**Grandfather**	**15**	**37**	**22**	**24**	**24.1**				**38**		**47**		**35**	**36**	
B 0158/11	FSP1	Grandson 2	15	37	22	24	24.1				38		47		35	36	
B/A 0158/11	**PSP**	**Grandfather**	**15**	**37**	**22**	**24**	**24.1**				**38**		**47**		**35**	**36**	
0160/11	F	Grandson	14	38	22	25	26				39		49		35	36	
0160/11	PSP	Grandfather	14	38	22	24	26				39		49		35	36	
0167/12	F	Grandson	12	34	24	24.1	25/25.1				35		45		38		
0167/12	PSP	Grandfather	12	34	24	24.1					35		44		38		
B 0262/12	F	Grandson 1	14	39	21	24/24.1					38		50		35	36	
B 0262/12	**PSP**	**Grandfather**	**14**	**39**	**21**	**24/24.1**					**38**		**49**		**35**	**36**	
C 0262/12	FSP	Grandson 2	14	39	21	24/24.1					38		49		35	36	
B 0262/12	**PSP**	**Grandfather**	**14**	**39**	**21**	**24/24.1**					**38**		**49**		**35**	**36**	
0322/12	F	Grandson	14	39	23	24/24.1					37		44		35	36	
0322/12	PSP	Grandfather	14	40	23	24/24.1					37		47		35	36	
0385/12	F	Grandson	14	38	21	24/24.1					31		46		34	35	
0385/12	PSP	Grandfather	14	38	21	24/24.1					31		46		34	35	
C 0440/12	F3	Grandson 1	8	33	22	25/25.1	26				30		46		37		
B 0440/12	**PSP**	**Grandfather**	**8**	**33**	**22**	**25/25.1**	**26**				**30**		**46**		**37**		
B 0440/12	F2	Grandson 2	8	33	22	25/25.1	26				30		46		37		
B 0440/12	**PSP**	**Grandfather**	**8**	**33**	**22**	**25/25.1**	**26**				**30**		**46**		**37**		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
0505/11	F	Grandson	13	38	21	23/23.1	24			33		50	36	37	
0505/11	PSP	Grandfather	13	38	21	23/23.1	24			33		50	36	37	
0531/12	F	Grandson	13	37	17.2	23	23.1			35		48	36	39	
0531/12	PSP	Grandfather	13	37	17.2	23	23.1			35		48	36	39	
0662/11	F	Grandson	12	40	23	24				33		48	37		
0662/11	PSP	Grandfather	12	40	23	24				33		48	37		
0699/12	F	Grandson	16	37	21	24	25/25.1			38		48	35	36	
0699/12	PSP	Grandfather	16	37	21	24	25/25.1			38		48	35	36	
A 0713/12	F1	Grandson 1	14	33	21	22	28			35		48	36	37	
A 0713/12	**PSP**	**Grandfather**	**14**	**33**	**21**	**22**	**28**			**35**		**48**	**36**	**37**	
B 0713/12	F2	Grandson 2	14	33	21	22	28			35		48	36	37	
A 0713/12	**PSP**	**Grandfather**	**14**	**33**	**21**	**22**	**28**			**35**		**48**	**36**	**37**	
0768/10	F	Grandson	16	36	21	23				38		46	37	38	
0768/10	PSP	Grandfather	16	36	21	23				38		46	37	38	
0822/11	F	Grandson	13	26	22	24	26/26.1			31		47	38		
0822/11	PSP	Grandfather	13	26	22	24	26/26.1			31		47	38		
0897/12	F	Grandson	12	36	20	24	24.1			32		48	36	37	
0897/12	PSP	Grandfather	12	36	20	24	24.1			32		48	36	37	
0903/10	F	Grandson	15	35	20	23	25/25.1			36		51	35	36	
0903/10	PSP	Grandfather	15	35	20	23	25/25.1			36		51	35	36	
0965/10	F	Grandson	14	38	21	22	24	24.1		37		48	35	36	
0965/10	PSP	Grandfather	14	38	21	22	24	24.1		37		48	35	36	
0982/10	F	Grandson	14	39	22	24	25/25.1			37		46	35	36	
0982/10	PSP	Grandfather	14	39	22	24	25/25.1			37		47	35	36	
1038/12	F	Grandson	14	38	23	24	24.1			37		47	35	36	
1038/12	PSP	Grandfather	14	38	23	24	24.1			37		47	35	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
1083/11	F	Grandson	16	36	23	24				37		45	37	38	
1083/11	PSP	Grandfather	16	36	23	24				37		45	37	38	
1095/12	F	Grandson	12	36	23	25				32		47	36	37	
1095/12	PSP	Grandfather	12	36	23	25				32		47	36	37	
1243/12	F	Grandson	14	35	21	24	26/26.1			37		51	36	37	
1243/12	PSP	Grandfather	14	35	21	24	26/26.1			37		51	36	37	
B 1276/12	FSP1	Grandson	12	36	19	21	24/24.1			32		51	36	39	
B 1276/12	PSP	Grandfather	12	36	19	21	24/24.1			32		51	36	39	
1316/11	F	Grandson	16	36	22	24				39		46	37		
1316/11	PSP	Grandfather	16	36	23	24				39		46	37		
1386/11	F	Grandson	14	36	21	22	27.1			38		47	35	36	
1386/11	PSP	Grandfather	14	36	21	22	27.1			38		47	35	36	
1391/12	F	Grandson	12	38	23	23.1	25/25.1			34		44	37	40	
1391/12	PSP	Grandfather	12	37	23	23.1	25/25.1			34		44	37	39	
1400/12	F	Grandson	12	40	22	22.1	24			34		50	38		
1400/12	PSP	Grandfather	12	40	22	22.1	24			34		50	38		
1419/12	F	Grandson	14	38	21	22	25/25.1			38		48	35	36	
1419/12	PSP	Grandfather	14	38	21	22	25/25.1			38		48	35	36	
1549/10	F	Grandson	13	38	18.2		26	26.1		35		46	37	39	
1549/10	PSP	Grandfather	13	38	18.2	25/25.1	26			35		47	37	39	
1750/10	F	Grandson	14	36	22	24	25/25.1			38		45	35		
1750/10	PSP	Grandfather	14	36	23	24	25/25.1			38		45	35		
1775/12	F	Grandson	14	37	21	25	25.1			36		47	35		
1775/12	PSP	Grandfather	14	37	21	25	25.1			36		47	35		
1781/10	F	Grandson	15	37	23	25	25.1			39		48	36		
1781/10	PSP	Grandfather	15	37	23	25	25.1			39		48	36		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B	DYS 547	DYF 387S1		
D 1878/12	F1	Grandson 1	12	33	22	24	25/25.1			32	53	35	37	
D 1878/12	**PSP**	**Grandfather**	**12**	**33**	**22**	**24**	**25/25.1**			**32**	**53**	**35**	**37**	
E 1878/12	F2	Grandson 2	12	33	22	24	25/25.1			32	53	35	37	
D 1878/12	**PSP**	**Grandfather**	**12**	**33**	**22**	**24**	**25/25.1**			**32**	**53**	**35**	**37**	
F 1878/12	F3	Grandson 3	12	33	22	24	25/25.1			32	53	35	37	
D 1878/12	**PSP**	**Grandfather**	**12**	**33**	**22**	**24**	**25/25.1**			**32**	**53**	**35**	**37**	
1886/10	F	Grandson	16	37	19	20	22/22.1			38	51	36	37	
1886/10	PSP	Grandfather	16	37	19	20	22/22.1			38	51	36	37	
1893/10	FSP1	Grandson	15	37	21	24/24.1	25			39	50	37	39	
1893/10	PSP	Grandfather	15	37	21	23/23.1	25			39	50	37	39	
A 1904/12	F	Grandson	13	36	21	22				34	42	37	39	
A 1904/12	PSP	Grandfather	13	36	21	22				34	42	37	39	
1912/10	F	Grandson	14	37	23	24				37	50	36		
1912/10	PSP	Grandfather	14	37	23	24				37	50	36		
1917/10	F	Grandson	8	33	22	25/25.1	26			30	46	37		
1917/10	PSP	Grandfather	8	33	22	25/25.1	26			30	46	37		
1952/10	F	Grandson	12	35	19	24	26			33	51	35	39	
1952/10	PSP	Grandfather	12	35	19	24	26			33	51	35	39	
1990/12	F	Grandson	13	36	18	19	24			36	48	37	38	
1990/12	PSP	Grandfather	13	36	18	19	24			36	48	37	38	
2014/12	F	Grandson	14	36	20	21	25/25.1			37	50	35	36	
2014/12	PSP	Grandfather	14	36	20	21	25/25.1			37	50	35	36	
2027/11	F1	Grandson	14	40	22	24	25/25.1			37	49	35	36	
2027/11	PSP	Grandfather	14	40	22	24	25/25.1			37	49	35	36	
2041/11	F	Grandson	12	36	19	23	23.1			34	49	36	37	
2041/11	PSP	Grandfather	12	36	19	23	23.1			34	49	36	37	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
2100/10	F	Grandson	14	38	22	24	24.1				38		48	35	36	
2100/10	PSP	Grandfather	14	38	22	24	25.1				38		48	35	36	
2171/12	F	Grandson	15	38	20	24/24.1	25				37		47	36		
2171/12	PSP	Grandfather	15	38	20	24/24.1	25				37		49	36		
2239/12	F	Grandson	14	35	22	24	28				36		50	36		
2239/12	PSP	Grandfather	14	35	22	24	28				36		50	36		
2285/11	F	Grandson	12	33	21	24/24.1					34		49	35	36	
2285/11	PSP	Grandfather	12	33	21	24/24.1					34		49	35	36	
2322/11	FSP1	Grandson	12	36	19	23	23.1				32		49	36		
2322/11	PSP	Grandfather	12	36	19	23	23.1				32		49	36		
2336/11	F	Grandson	15	38	21	22/22.1	25				38		48	34	35	
2336/11	PSP	Grandfather	15	38	21	22/22.1	25				38		48	34	35	
2433/12	F	Grandson	14	38	21	23	25/25.1				37		49	35	37	
2433/12	PSP	Grandfather	14	38	21	23	25/25.1				37		49	35	37	
2611/12	F	Grandson	16	34	22	23	23.1				37		45	35	40	
2611/12	PSP	Grandfather	16	34	22	23	23.1				37		45	35	40	
2675/12	F	Grandson	15	37	21	23	25/25.1				37		48	35	36	
2675/12	PSP	Grandfather	14	37	21	23	25/25.1				36		48	35	36	
2727/11	F	Grandson	13	33	17.2	19	22				35		47	37	40	
2727/11	PSP	Grandfather	13	33	17.2	19	22				35		47	37	40	
2784/11	FSP (F)	Grandson														
2784/11	PSP	Grandfather	12	38	22	23					32		46	37		
A 3144/11	F	Grandson	14	35	21	23	26/26.1				36	37	49	35	36	
A 3144/11	PSP	Grandfather	14	35	21	23	26/26.1				36		49	35	36	
3257/11	F	Grandson	14	34	20	24	25				33		49	37	40	
3257/11	PSP	Grandfather	14	34	20	24	25				33		49	37	40	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B	DYS 547	DYF 387S1		
3431/11	F	Grandson	15	37	22	23	24/24.1				38	47	34	36	
3431/11	PSP	Grandfather	15	37	22	23	24/24.1				38	47	34	36	
3483/10	F	Grandson	15	38	21	23	25/25.1				39	47	37	38	
3483/10	PSP	Grandfather	15	38	21	23	25/25.1				39	47	37	38	
3518/11	F	Grandson	14	38	22	23/23.1	26				35	48	35	36	
3518/11	PSP	Grandfather	14	38	22	23/23.1	26				35	48	35	36	
3543/11	F	Grandson	12	37	16	23	25				32	47	36	37	
3543/11	PSP	Grandfather	12	37	16	23	25				32	47	36	37	
A 3593/11	F2	Grandson 1	13	32	20	21	24				33	47	38		
A 3593/11	**PSP**	**Grandfather**	**13**	**32**	**20**	**21**	**24**				**33**	**47**	**38**		
B 3593/11	F3	Grandson 2	13	32	20	21	24				33	47	38		
A 3593/11	**PSP**	**Grandfather**	**13**	**32**	**20**	**21**	**24**				**33**	**47**	**38**		
3615/11	F	Grandson	13	36	23	27					34	48	37	39	
3615/11	PSP	Grandfather	13	36	23	27					34	48	37	39	
3617/11	FSP	Grandson	15	38	21	23	25/25.1				40	49	38		
3617/11	PSP	Grandfather	15	37	21	23	25/25.1				40	49	38		
3662/10	F	Grandson	14	37	23	24	24.1				36	51	35	36	
3662/10	PSP	Grandfather	14	37	23	24	24.1				36	51	35	36	
3674/12	F	Grandson	14	35	21	24					36	48.2	38	39	
3674/12	PSP	Grandfather	14	35	21	24					36	48.2	38	39	
A 3769/10	F4	Grandson 1	14	34	23	24					35	49	39		
A 3769/10	**PSP**	**Grandfather**	**14**	**34**	**23**	**24**					**35**	**49**	**39**		
B 3769/10	F6	Grandson 2	14	34	23	24					35	49	39		
A 3769/10	**PSP**	**Grandfather**	**14**	**34**	**23**	**24**					**35**	**49**	**39**		
B 3780/12	F	Grandson	15	36	20	26/26.1					38	49	35	37	
A 3780/12	PSP	Grandfather	15	36	20	26/26.1					38	49	35	37	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
3832/10	F	Grandson	15	35	23	24	24.1			36		45	35	38	
3832/10	PSP	Grandfather	15	35	23	24	25.1			36		45	35	38	
3864/12	F	Grandson	14	35	20	24/24.1	25			36		49	35		
3864/12	PSP	Grandfather	14	35	20	24/24.1	25			36		49	35		
3907/10	F	Grandson	14	39	21	23	23.1			38		49	35	36	
3907/10	PSP	Grandfather	14	39	21	23	23.1			38		49	35	36	
3911/10	F	Grandson	14	35	22/22.1	23				36		50	35	36	
3911/10	PSP	Grandfather	14	35		23	23.1			36		50	35	36	
B 4045/09	FSP2	Grandson 1	14	37	23	25/25.1				37		48	35	37	
A 4045/09	**PSP**	**Grandfather**	**14**	**37**	**23**	**25/25.1**				**37**		**47**	**35**	**37**	
A 4045/09	FSP1	Grandson 2	14	37	23	25/25.1				37		48	35	37	
A 4045/09	**PSP**	**Grandfather**	**14**	**37**	**23**	**25/25.1**				**37**		**47**	**35**	**37**	
C 4045/09	F	Grandson 3	14	37	23	25/25.1				37		48	35	37	
A 4045/09	**PSP**	**Grandfather**	**14**	**37**	**23**	**25/25.1**				**37**		**47**	**35**	**37**	
4104/11	F	Grandson	14	37	21	23	25/25.1			36		48	35	36	
4104/11	PSP	Grandfather	14	37	21	23	25/25.1			36		48	35	36	
4133/09	F	Grandson	15	37	23	25	25.1			40		48	38	39	
4133/09	PSP	Grandfather	15	37	23	25	25.1			40		48	38	39	
4137/09	F	Grandson	14	34	21	27/27.1				36		47	35	37	
4137/09	PSP	Grandfather	14	34	21	27/27.1				36		47	35	37	
4213/09	F	Grandson	14	36	21	24/24.1	27			36		47	36	37	
4213/09	PSP	Grandfather	14	36	21	24/24.1	27			36		47	36	37	
4222/10	F	Grandson	15	35	21	25	26/26.1			36		47	36	37	
4222/10	PSP	Grandfather	15	35	21	24	26/26.1			36		47	36	37	
4269/12	F	Grandson	14	36	19	22				34		44	36	38	
4269/12	PSP	Grandfather	14	36	19	22				34		44	36	38	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1			DYS 526B	DYS 547	DYF 387S1	
4337/11	F	Grandson	15	38	22	23	24/24.1	37	50	34	36
4337/11	PSP	Grandfather	15	38	22	23	24/24.1	37	50	34	36
4348/09	F	Grandson	12	36	18	23	24/24.1	33	50	36	38
4348/09	PSP	Grandfather	12	36	18	22	24/24.1	33	50	36	38
4361/12	F	Grandson	13	36	21	24/24.1		35	50	39	
4361/12	PSP	Grandfather	13	36	21	24/24.1		35	50	39	
4431/09	F	Grandson	12	38	20	23	24/24.1	33	50	36	
4431/09	PSP	Grandfather	12	38	20	23	24/24.1	33	50	36	
4596/09	F	Grandson	14	36	22	23	26/26.1	38	45	36	
4596/09	PSP	Grandfather	14	36	22	23	26/26.1	38	45	36	
4794/09	F	Grandson	14	36	21	24	26/26.1	36	46	35	36
4794/09	PSP	Grandfather	14	36	21	24	27/27.1	36	46	35	36
A 4960/09	F1	Grandson 1	12	37	19	23	24/24.1	32	48	36	37
B 4960/09	**PSP**	**Grandfather**	**12**	**37**	**19**	**23**	**24/24.1**	**32**	**48**	**36**	**37**
B 4960/09	F2	Grandson 2	12	37	19	23	24/24.1	32	48	36	37
B 4960/09	**PSP**	**Grandfather**	**12**	**37**	**19**	**23**	**24/24.1**	**32**	**48**	**36**	**37**
C 4960/09	F3	Grandson 3	12	37	19	23	24/24.1	32	48	36	37
B 4960/09	**PSP**	**Grandfather**	**12**	**37**	**19**	**23**	**24/24.1**	**32**	**48**	**36**	**37**

Total Mutations by Locus: Grandfather-Grandson

Table S7. Grandfather-Grandson Mutation Totals Loci Set 1

MUTATIONS	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1 STEP:	0	4	1	2	1	0	0	2	0	6	1	0	0
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	4	1	2	1	0	0	2	0	6	1	0	0

Table S8. Grandfather-Grandson Mutation Totals Loci Set 2

MUTATIONS	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1 STEP:	1	5	0	0	1	0	0	0	0	0	0	0	2	0	0
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	1	5	0	0	1	0	0	0	0	0	0	0	2	0	0

Table S9. Grandfather-Grandson Mutation Totals Loci Set 3

MUTATIONS	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1	DYS 626	DYF 403S1A	DYF 403S1B	DYS 518
1 STEP:	0	2	0	1	0	0	2	1	6	1	3
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	2	0	1	0	0	2	1	6	1	3

Table S10. Grandfather-Grandson Mutation Totals Loci Set 4

MUTATIONS	DYS 526A	DYS 612	DYF 399S1	DYS 526B	DYS 547	DYF 387S1
1 STEP:	1	3	12	2	7	1
2 STEPS:	0	0	0	0	1	0
3 STEPS:	0	0	0	0	1	0
TOTAL:	1	3	12	2	9	1

Table S11. Grandfather-Grandson Mutation Totals All Loci

MUTATIONS	TOTAL
1 STEP:	68
2 STEPS:	1
3 STEPS:	1
TOTAL:	70

Uncle-Nephew Mutation Summary Data

Table S12. Uncle-Nephew Loci Set 1

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0043|11	**F**	**Nephew**	**22**	**19**	**21**	**28**	**33**	**9**	**9**	**13**	**12**	**33**	**13**	**23**	**12**
0043|11	ISP1	Uncle	22	19	21	28	32	9	9	13	12	33	13	23	12
0043|11	**F**	**Nephew**	**22**	**19**	**21**	**28**	**33**	**9**	**9**	**13**	**12**	**33**	**13**	**23**	**12**
0043|11	ISP2	Uncle	22	19	21	28	32	9	9	13	12	33	13	23	12
0140|11	F	Nephew	25	18	19	33	35	9	10	12	15	31	11	25	10
0140|11	ISP2	Uncle	25	18	19	33	35	9	10	12	15	31	11	25	10
0158|11	F	Nephew	21	18	18	33	35	9	9	14	12	30	11	24	10
0158|11	**ISP2**	**Uncle**	**21**	**18**	**18**	**33**	**35**	**9**	**9**	**14**	**12**	**30**	**11**	**24**	**10**
0158|11	FSP1	Nephew	21	18	18	33	35	9	9	14	12	30	11	24	10
0158|11	**ISP2**	**Uncle**	**21**	**18**	**18**	**33**	**35**	**9**	**9**	**14**	**12**	**30**	**11**	**24**	**10**
0342|12	F	Nephew	22	19	17	33	35	9	9	12	12	30	11	25	10
0342|12	ISP3	Uncle	22	19	17	33	35	9	9	12	12	30	11	25	10
0412|11	F	Nephew	21	16	18	34	35	9	9	12	13	31	10	26	12
0412|11	ISP3	Uncle	21	16	18	34	35	9	9	12	13	31	10	26	12
0457|11	F	Nephew	28	19	20	34	35	8	9	13	13	31	12	24	12
0457|11	ISP4	Uncle	28	19	20	34	35	8	9	13	13	31	12	24	12
0480|11	**FSP1**	**Nephew**	**22**	**18**	**19**	**33**	**33**	**9**	**9**	**13**	**12**	**33**	**12**	**23**	**12**
0480|11	ISP1	Uncle	22	18	19	33	33	9	9	13	12	33	12	23	13
0480|11	**FSP1**	**Nephew**	**22**	**18**	**19**	**33**	**33**	**9**	**9**	**13**	**12**	**33**	**12**	**23**	**12**
0480|11	ISP2	Uncle	22	18	19	33	33	9	9	13	12	33	12	23	13
0530|12	**F**	**Nephew**	**22**	**17**	**17**	**33**	**35**	**9**	**9**	**11**	**12**	**31**	**12**	**24**	**10**
0530|12	ISP1	Uncle	22	17	17	33	35	9	9	11	12	31	12	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0530|12	**F**	**Nephew**	**22**	**17**	**17**	**33**	**35**	**9**	**9**	**11**	**12**	**31**	**12**	**24**	**10**
0530|12	ISP2	Uncle	22	17	17	33	35	9	9	11	12	31	12	24	10
0613|11	**F**	**Nephew**	**27**	**18**	**19**	**33**	**36**	**8**	**9**	**13**	**13**	**27**	**11**	**25**	**10**
0613|11	ISP2	Uncle	27	18	19	33	36	8	9	13	13	27	11	25	10
0613|11	**F**	**Nephew**	**27**	**18**	**19**	**33**	**36**	**8**	**9**	**13**	**13**	**27**	**11**	**25**	**10**
0613|11	ISP3	Uncle	27	18	19	33	36	8	9	13	13	27	11	25	10
0634|12	FSP2	Nephew	22	18	18	33 - 35	37	9	10	12	11	27	11	26	11
0634|12	ISP	Uncle	22	18	18	33 - 35	37	9	10	12	11	27	11	26	11
0636|12	FSP2	Nephew	22	16	16	34	34	9	9	11	12	29	12	24	11
0636|12	ISP	Uncle	22	16	16	34	35	9	9	11	12	29	12	24	11
0901|12	**F**	**Nephew**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
0901|12	**ISP3**	**Uncle**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**25**	**10**
0901|12	**FSP2**	**Nephew**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
0901|12	**ISP3**	**Uncle**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**25**	**10**
0901|12	**F**	**Nephew**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
0901|12	**ISP4**	**Uncle**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
0901|12	**FSP2**	**Nephew**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
0901|12	**ISP4**	**Uncle**	**22**	**18**	**18**	**33**	**35**	**9**	**9**	**13**	**11**	**28**	**10**	**24**	**10**
1074|12	F	Nephew	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	**ISP**	**Uncle**	**22**	**17**	**17**	**33**	**34**	**9**	**10**	**13**	**12**	**30**	**11**	**25**	**10**
1074|12	FSP2	Nephew	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	**ISP**	**Uncle**	**22**	**17**	**17**	**33**	**34**	**9**	**10**	**13**	**12**	**30**	**11**	**25**	**10**
1074|12	FSP3	Nephew	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	**ISP**	**Uncle**	**22**	**17**	**17**	**33**	**34**	**9**	**10**	**13**	**12**	**30**	**11**	**25**	**10**
1092|11	F	Nephew	22	15	18	33	34	9	10	14	12	31	11	24	10
1092|11	ISP	Uncle	22	15	18	33	34	9	10	14	12	31	11	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1142|12	FSP	Nephew	27	16	18	29	33	8	10	11	12	31	12	24	11
1142|12	ISP1	Uncle	27	16	19	29	33	8	10	11	12	31	12	24	11
1276|12	FSP1	Nephew	27	18	25	30	32	9	9	11	12	32	11	25	12
1276|12	ISP	Uncle	27	18	25	30	32	9	9	11	12	32	11	25	12
1278|11	F	Nephew	22	17	16					13		28			
1278|11	**ISP1**	**Uncle**	**22**	**17**	**16**					**13**		**28**			
1278|11	FSP	Nephew	22	17	16					13		28			
1278|11	**ISP1**	**Uncle**	**22**	**17**	**16**					**13**		**28**			
1279|12	FSP1	Nephew	22	18	18	33	35	9	9	13	12	29	11	24	10
1279|12	ISP	Uncle	22	18	18	33	35	9	9	13	12	29	11	24	10
1317|11	F	Nephew	22	18	17	35	35	9	10	14	12	28	11	24	10
1317|11	ISP	Uncle	22	18	17	35	35	9	10	14	12	28	11	24	10
1354|11	FSP1	Nephew	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	**ISP2**	**Uncle**	**23**	**18**	**18**	**33**	**38**	**8**	**9**	**10**	**11**	**29**	**12**	**25**	**11**
1354|11	FSP2	Nephew	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	**ISP2**	**Uncle**	**23**	**18**	**18**	**33**	**38**	**8**	**9**	**10**	**11**	**29**	**12**	**25**	**11**
1354|11	FSP3	Nephew	23	19	18	33	38	8	9	10	11	29	12	25	11
1354|11	**ISP2**	**Uncle**	**23**	**18**	**18**	**33**	**38**	**8**	**9**	**10**	**11**	**29**	**12**	**25**	**11**
1419|11	FSP	Nephew	24	18	21	33	36	8	9	12	13	30	10	25	11
1419|11	ISP2	Uncle	24	18	21	33	36	8	9	12	13	30	10	25	11
1495|11A	FSP2	Nephew	21	15	18	35	35	9	9	13	13	31	10	26	13
1495|11A	ISP3	Uncle	21	15	18	35	35	9	9	13	13	31	10	26	13
1514|12	F	Nephew	22	15	17	34	37	9	10	12	12	33	10	26	12
1514|12	ISP1	Uncle	22	15	17	34	37	9	10	12	12	33	10	26	12
1549|12	**F**	**Nephew**	**21**	**19**	**19**	**33**	**35**	**9**	**10**	**12**	**13**	**31**	**12**	**24**	**10**
1549|12	ISP1	Uncle	21	19	19	33	35	9	10	12	13	31	12	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1549|12	**F**	**Nephew**	**21**	**19**	**19**	**33**	**35**	**9**	**10**	**12**	**13**	**31**	**12**	**24**	**10**
1549|12	ISP2	Uncle	21	19	19	33	35	9	10	12	13	31	12	24	10
1549|12	**F**	**Nephew**	**21**	**19**	**19**	**33**	**35**	**9**	**10**	**12**	**13**	**31**	**12**	**24**	**10**
1549|12	ISP4	Uncle	21	19	19	33	35	9	10	12	13	31	12	24	10
1577|11	F	Nephew	25	18	21	34	36	8	9	12	14	30	10	25	11
1577|11	ISP	Uncle	25	18	21	34	36	8	9	12	14	30	10	25	11
1588|12	**F**	**Nephew**	**24**	**19**	**17**	**31**	**34**	**8**	**9**	**12**	**11**	**25**	**11**	**25**	**12**
1588|12	ISP1	Uncle	24	19	17	31	34	8	9	12	11	25	9	25	12
1588|12	**F**	**Nephew**	**24**	**19**	**17**	**31**	**34**	**8**	**9**	**12**	**11**	**25**	**11**	**25**	**12**
1588|12	ISP2	Uncle	24	19	17	31	34	8	9	12	11	25	11	25	12
1737|11	**FSP**	**Nephew**	**22**	**16**	**16**	**33**	**36**	**9**	**10**	**12**	**12**	**30**	**11**	**24**	**10**
1737|11	ISP2	Uncle	22	16	16	33	36	9	10	12	12	30	11	24	10
1737|11	**FSP**	**Nephew**	**22**	**16**	**16**	**33**	**36**	**9**	**10**	**12**	**12**	**30**	**11**	**24**	**10**
1737|11	ISP3	Uncle	22	16	16	33	36	9	10	12	12	30	11	24	10
1772|11	**F**	**Nephew**	**22**	**16**	**21**	**28**	**33**	**9**	**9**	**12**	**12**	**31**	**12**	**23**	**12**
1772|11	ISP1	Uncle	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	**F**	**Nephew**	**22**	**16**	**21**	**28**	**33**	**9**	**9**	**12**	**12**	**31**	**12**	**23**	**12**
1772|11	ISP2	Uncle	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	**F**	**Nephew**	**22**	**16**	**21**	**28**	**33**	**9**	**9**	**12**	**12**	**31**	**12**	**23**	**12**
1772|11	ISP3	Uncle	22	16	21	28	33	9	9	12	12	31	12	23	12
1774|11	F	Nephew	22	18	17	34	35	8	9	13	12	31	11	24	11
1774|11	ISP	Uncle	22	18	17	34	35	8	9	13	12	31	11	24	11
1779|11	F	Nephew	22	17	19	33	35	9	9	13	12	33	10	24	11
1779|11	ISP1	Uncle	22	17	19	33	35	9	9	13	12	33	10	24	11
1834|12	**F**	**Nephew**	**22**	**16**	**20**	**28**	**34**	**9**	**9**	**12**	**12**	**33**	**12**	**23**	**12**
1834|12	ISP1	Uncle	22	16	20	28	34	9	9	12	12	33	12	23	12

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1834|12	**F**	**Nephew**	**22**	**16**	**20**	**28**	**34**	**9**	**9**	**12**	**12**	**33**	**12**	**23**	**12**
1834|12	ISP2	Uncle	22	16	20	28	34	9	9	12	12	33	12	23	12
1869|12	F	Nephew	25	20	19	37	39	8	9	12	14	29	11	25	13
1869|12	ISP2	Uncle	25	20	19	37	39	8	9	12	14	29	11	25	13
1904|12	F	Nephew	25	17	18	33	34	8	10	11	14	29	12	26	11
1904|12	ISP3	Uncle	25	17	18	33	34	8	10	11	14	29	12	26	11
1951|11	F	Nephew	21	14	17	33	34	9	9	12	13	30	10	26	12
1951|11	ISP	Uncle	21	14	17	33	34	9	9	12	13	30	10	26	12
2237|12	**FSP1**	**Nephew**	**24**	**15**	**19**	**28**	**34**	**9**	**9**	**12**	**12**	**36**	**12**	**25**	**11**
2237|12	ISP1	Uncle	24	15	19	28	34	9	9	12	12	36	12	25	11
2237|12	**FSP1**	**Nephew**	**24**	**15**	**19**	**28**	**34**	**9**	**9**	**12**	**12**	**36**	**12**	**25**	**11**
2237|12	ISP2	Uncle	24	15	19	28	34	9	9	12	12	36	12	25	11
2282|12	F	Nephew	22	18	17	33	35	9	10	12	13	30	11	24	11
2282|12	**ISP2**	**Uncle**	**22**	**18**	**17**	**33**	**35**	**9**	**10**	**12**	**13**	**30**	**11**	**24**	**11**
2282|12	FSP	Nephew	22	18	17	33	35	9	10	12	13	30	11	24	11
2282|12	**ISP2**	**Uncle**	**22**	**18**	**17**	**33**	**35**	**9**	**10**	**12**	**13**	**30**	**11**	**24**	**11**
2368|12	FSP1	Nephew	23	20	18	34	38	8	9	10	12	29	13	25	11
2368|12	ISP2	Uncle	23	20	18	34	38	8	9	10	12	29	12	25	11
2528|12	F	Nephew	22	17	19	28	32	9	9	12	13	30	11	24	12
2528|12	ISP1	Uncle	22	17	19	28	32	9	9	12	13	30	11	24	12
2607|12	F	Nephew	22	18	17	34	35	9	10	13	12	30	11	25	10
2607|12	ISP	Uncle	22	18	17	34	35	9	10	13	12	30	11	25	10
3144|11	**F**	**Nephew**	**22**	**17**	**18**	**33**	**35**	**9**	**9**	**14**	**12**	**29**	**11**	**26**	**10**
3144|11	ISP1	Uncle	22	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	**F**	**Nephew**	**22**	**17**	**18**	**33**	**35**	**9**	**9**	**14**	**12**	**29**	**11**	**26**	**10**
3144|11	ISP2	Uncle	23	17	18	33	35	9	9	14	12	29	11	26	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
3144|11	**F**	**Nephew**	22	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP3	Uncle	22	17	18	33	35	9	9	14	12	29	11	26	10
3338|11	F	Nephew	22	17	17	33	33	9	10	14	12	32	11	24	11
3338|11	ISP2	Uncle	22	17	17	33	33	9	10	14	12	32	11	24	11
3421|11	F	Nephew	22	18	17	33	36	8	10	13	12	29	12	24	10
3421|11	ISP2	Uncle	22	18	17	33	36	8	10	13	12	29	12	24	10
3428|11	**F**	**Nephew**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**ISP1**	**Uncle**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**FSP**	**Nephew**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**ISP1**	**Uncle**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**F**	**Nephew**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**ISP3**	**Uncle**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**FSP**	**Nephew**	21	18	18	31	34	9	9	13	13	27	11	26	12
3428|11	**ISP3**	**Uncle**	21	18	18	31	34	9	9	13	13	27	11	26	12
3497|11	**F**	**Nephew**	22	19	17	33	34	9	10	13	13	32	11	25	10
3497|11	ISP2	Uncle	22	19	17	33	34	9	10	14	13	32	11	25	10
3497|11	**F**	**Nephew**	22	19	17	33	34	9	10	13	13	32	11	25	10
3497|11	ISP3	Uncle	22	19	17	33	34	9	10	14	13	32	11	25	10
3780|12	F	Nephew	22	18	16	34	34	9	10	12	11	31	11	24	10
3780|12	ISP2	Uncle	22	18	16	34	34	9	10	12	11	31	11	24	10
3841|12	F	Nephew	23	19	17	29	33	8	10	11	12	31	12	24	11
3841|12	ISP2	Uncle	23	19	17	29	33	8	10	11	12	31	12	24	11
3867|12	F1	Nephew	25	18	18	29	33	8	10	13	12	32	13	24	11
3867|12	ISP2	Uncle	25	18	18	29	33	8	10	13	12	32	13	24	11
3906|12	FSP	Nephew	25	17	19	32	35	9	10	12	14	32	11	24	10
3906|12	ISP	Uncle	25	17	19	32	35	9	10	12	14	32	11	24	10

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
3943|10	F1	Nephew	22	19	19	33	33	9	9	13	12	26	11	25	10
3943|10	ISP2	Uncle	22	19	19	33	33	9	9	13	12	26	11	25	10
4090|12	**F1**	**Nephew**	**21**	**18**	**17**	**37**	**39**	**9**	**9**	**12**	**11**	**30**	**10**	**25**	**11**
4090|12	ISP1	Uncle	21	18	17	37	39	9	9	12	11	30	10	25	11
4090|12	**F1**	**Nephew**	**21**	**18**	**17**	**37**	**39**	**9**	**9**	**12**	**11**	**30**	**10**	**25**	**11**
4090|12	ISP2	Uncle	21	18	17	37	39	9	9	12	11	30	10	25	11
4139|12	**F**	**Nephew**	**23**	**18**	**17**	**34**	**36**	**9**	**10**	**13**	**12**	**28**	**12**	**24**	**11**
4139|12	ISP1	Uncle	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	**F**	**Nephew**	**23**	**18**	**17**	**34**	**36**	**9**	**10**	**13**	**12**	**28**	**12**	**24**	**11**
4139|12	ISP2	Uncle	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	**F**	**Nephew**	**23**	**18**	**17**	**34**	**36**	**9**	**10**	**13**	**12**	**28**	**12**	**24**	**11**
4139|12	ISP3	Uncle	23	18	17	34	36	9	10	13	12	28	12	24	11
4155|11	**F**	**Nephew**	**23**	**18**	**19**	**34**	**38**	**8**	**10**	**10**	**13**	**29**	**14**	**25**	**12**
4155|11	ISP1	Uncle	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	**F**	**Nephew**	**23**	**18**	**19**	**34**	**38**	**8**	**10**	**10**	**13**	**29**	**14**	**25**	**12**
4155|11	ISP2	Uncle	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	**F**	**Nephew**	**23**	**18**	**19**	**34**	**38**	**8**	**10**	**10**	**13**	**29**	**14**	**25**	**12**
4155|11	ISP3	Uncle	23	18	19	34	38	8	10	10	13	29	14	25	12
4171|11	FSP1	Nephew	22	18	17	33 -34	35	9	10	13	12	29	11	24	10
4171|11	ISP1	Uncle	22	18	17	33 -34	35	9	10	13	12	29	11	24	10
4222|11	F	Nephew	23	17	18	33	35	9	10	13	12	28	11	24	10
4222|11	ISP1	Uncle	23	17	18	33	35	9	10	13	12	28	11	24	10
4234|12	**F**	**Nephew**	**24**	**19**	**17**	**31**	**34**	**8**	**9**	**12**	**11**	**25**	**11**	**25**	**12**
4234|12	ISP1	Uncle	24	19	17	31	34	8	9	12	11	25	9	25	12
4234|12	**F**	**Nephew**	**24**	**19**	**17**	**31**	**34**	**8**	**9**	**12**	**11**	**25**	**11**	**25**	**12**
4234|12	ISP2	Uncle	24	19	17	31	34	8	9	12	11	25	11	25	12

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
4234|12	**F**	**Nephew**	24	19	17	31	34	8	9	12	11	25	11	25	12
4234|12	ISP3	Uncle	24	19	17	31	34	8	9	12	11	25	11	25	12
4244|11	F	Nephew	22	18	16	32	35	9	10	12	12	30	11	24	10
4244|11	ISP	Uncle	22	18	16	32	35	9	10	12	12	30	11	24	10
4333|11	FSP1	Nephew	27	21	22	30	32	9	9	11	12	31	10	26	12
4333|11	**ISP1**	**Uncle**	26	21	22	30	32	9	9	11	12	31	10	26	12
4333|11	FSP2	Nephew	27	21	22	30	32	9	9	11	12	31	10	26	12
4333|11	**ISP1**	**Uncle**	26	21	22	30	32	9	9	11	12	31	10	26	12
4357|10	F	Nephew	22	17	17	34	35	9	10	13	12	28	11	24	10
4357|10	ISP	Uncle	22	17	17	34	35	9	10	13	12	28	11	24	10
4425|12	**F**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP2**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**FSP2**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP2**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**F**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP3**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**FSP2**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP3**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**F**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP4**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**FSP2**	**Nephew**	24	19	17	32	35	9	10	12	12	31	10	24	12
4425|12	**ISP4**	**Uncle**	24	19	17	32	35	9	10	12	12	31	10	24	12
4442|12	F	Nephew	24	18	15	35	37	9	9	13	13	27	10	25	12
4442|12	ISP	Uncle	24	18	15	35	37	9	9	13	13	27	10	25	12
4523|10	**F**	**Nephew**	22	19	17	31	34	9	10	13	12	28	10	25	10
4523|10	ISP1	Uncle	22	19	17	31	34	9	10	13	12	28	10	25	10
4523|10	**F**	**Nephew**	22	19	17	31	34	9	10	13	12	28	10	25	10
4523|10	ISP2	Uncle	22	19	17	31	34	9	10	12	12	28	10	25	10

Table S13. Uncle-Nephew Loci Set 2

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0043|11	**F**	**Nephew**	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0043|11	ISP1	Uncle	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0043|11	**F**	**Nephew**	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0043|11	ISP2	Uncle	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0140|11	F	Nephew	20	17	13	20	30	18	10	12	12	14	23	25	11	11	10
0140|11	ISP2	Uncle	20	17	13	20	30	17	10	12	12	14	23	25	11	11	10
0158|11	F	Nephew	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
0158|11	**ISP2**	**Uncle**	**19**	**23**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
0158|11	FSP1	Nephew	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
0158|11	**ISP2**	**Uncle**	**19**	**23**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
0342|12	F	Nephew	19	23	13	19	29	14	11	11	12	15	23	24	12	13	10
0342|12	ISP3	Uncle	19	23	13	19	29	14	11	11	12	15	23	24	12	13	10
0412|11	F	Nephew	17	18	13	21	31	15	11	9	10	16	22	22	11	11	11
0412|11	ISP3	Uncle	17	18	13	21	31	15	11	9	10	16	22	22	11	11	11
0457|11	F	Nephew	17	20	13	20	31	15	10	11	10	15	22	25	12	12	14
0457|11	ISP4	Uncle	17	20	13	20	31	15	10	11	10	15	21	25	12	12	14
0480|11	**FSP1**	**Nephew**	16	20	13	20	31	13	11	12	10	14	22	24	11	11	12
0480|11	ISP1	Uncle	16	20	13	20	30	13	11	12	10	14	22	24	11	11	12
0480|11	**FSP1**	**Nephew**	16	20	13	20	31	13	11	12	10	14	22	24	11	11	12
0480|11	ISP2	Uncle	16	20	13	20	30	13	11	12	10	14	22	24	11	11	12
0530|12	**F**	**Nephew**	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10
0530|12	ISP1	Uncle	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10
0530|12	**F**	**Nephew**	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10
0530|12	ISP2	Uncle	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0613|11	**F**	**Nephew**	19	19	12	20	28	14	10	11	10	16	24	22	11	11	12
0613|11	ISP2	Uncle	19	19	13	20	29	14	10	11	10	16	24	22	11	11	12
0613|11	**F**	**Nephew**	19	19	12	20	28	14	10	11	10	16	24	22	11	11	12
0613|11	ISP3	Uncle	19	19	12	20	28	14	10	11	10	16	24	22	11	11	12
0634|12	FSP2	Nephew	17	19	12	19	27	16	10	9	10	16	21	22	11	11	12
0634|12	ISP	Uncle	17	19	12	19	27	16	10	9	10	16	21	22	11	11	12
0636|12	FSP2	Nephew	19	25	13	19	29	14	10	13	12	15	23	24	11	13	11
0636|12	ISP	Uncle	19	25	13	19	29	14	10	13	12	15	23	24	11	13	11
0901|12	**F**	**Nephew**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**ISP3**	**Uncle**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**FSP2**	**Nephew**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**ISP3**	**Uncle**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**F**	**Nephew**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**ISP4**	**Uncle**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**FSP2**	**Nephew**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901|12	**ISP4**	**Uncle**	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
1074|12	F	Nephew	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	**ISP**	**Uncle**	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP2	Nephew	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	**ISP**	**Uncle**	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP3	Nephew	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	**ISP**	**Uncle**	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1092|11	F	Nephew	19	23	13	19	30	14	11	12	12	14	24	23	13	13	10
1092|11	ISP	Uncle	19	23	13	19	30	14	11	12	12	14	24	23	13	13	10
1142|12	FSP	Nephew	18	19	13	21	30	15	10	11	11	14	22	21	12	11	13
1142|12	ISP1	Uncle	18	19	13	21	31	15	10	11	11	14	22	21	12	11	13

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1276|12	FSP1	Nephew	16	18	14	20	30	13	9	11	10	14	21	24	10	11	12
1276|12	ISP	Uncle	16	18	14	20	30	13	9	11	10	14	21	24	10	11	12
1278|11	F	Nephew			13	18	29	14	11	12	13	15	23	25	12	12	10
1278|11	**ISP1**	**Uncle**			**13**	**18**	**29**	**14**	**11**	**12**	**13**	**15**	**23**	**25**	**12**	**12**	**10**
1278|11	FSP	Nephew			13	18	29	14	11	12	13	15	23	25	12	12	10
1278|11	**ISP1**	**Uncle**			**13**	**18**	**29**	**14**	**11**	**12**	**13**	**15**	**23**	**25**	**12**	**12**	**10**
1279|12	FSP1	Nephew	19	23	13	18	29	14	11	12	13	14	23	24	12	13	10
1279|12	ISP	Uncle	19	23	13	18	29	14	11	12	13	14	23	24	12	13	10
1317|11	F	Nephew	19	22	13	19	28	14	10	12	12	15	23	24	12	13	10
1317|11	ISP	Uncle	19	22	13	19	28	14	10	12	12	15	23	24	12	14	10
1354|11	FSP1	Nephew	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	**ISP2**	**Uncle**	**16**	**23**	**13**	**21**	**28**	**16**	**10**	**12**	**10**	**15**	**22**	**23**	**13**	**11**	**13**
1354|11	FSP2	Nephew	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	**ISP2**	**Uncle**	**16**	**23**	**13**	**21**	**28**	**16**	**10**	**12**	**10**	**15**	**22**	**23**	**13**	**11**	**13**
1354|11	FSP3	Nephew	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	**ISP2**	**Uncle**	**16**	**23**	**13**	**21**	**28**	**16**	**10**	**12**	**10**	**15**	**22**	**23**	**13**	**11**	**13**
1419|11	FSP	Nephew	18	21	12	20	30	14	10	11	10	16	22	23	12	11	12
1419|11	ISP2	Uncle	18	21	12	20	30	14	10	11	10	16	22	23	12	11	12
1495|11A	FSP2	Nephew	16	20	12	21	29	15	10	9	10	14	20	22	11	11	11
1495|11A	ISP3	Uncle	16	20	12	21	29	15	10	9	10	14	20	22	11	11	11
1514|12	F	Nephew	17	20	12	21	30	15	10	9	10	16	20	22	11	11	11
1514|12	ISP1	Uncle	17	20	12	21	30	15	10	9	10	16	20	22	11	11	11
1549|12	**F**	**Nephew**	**20**	**20**	**14**	**19**	**31**	**14**	**11**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
1549|12	ISP1	Uncle	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1549|12	**F**	**Nephew**	**20**	**20**	**14**	**19**	**31**	**14**	**11**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
1549|12	ISP2	Uncle	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1549|12	**F**	**Nephew**	**20**	**20**	**14**	**19**	**31**	**14**	**11**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
1549|12	ISP4	Uncle	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1577|11	F	Nephew	18	19	12	20	28	14	10	11	10	16	21	23	11	11	12
1577|11	ISP	Uncle	18	19	12	20	28	14	10	12	10	16	21	23	11	11	12
1588|12	**F**	**Nephew**	**18**	**21**	**14**	**20**	**31**	**14**	**10**	**11**	**10**	**14**	**20**	**23**	**11**	**11**	**9**
1588|12	ISP1	Uncle	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
1588|12	**F**	**Nephew**	**18**	**21**	**14**	**20**	**31**	**14**	**10**	**11**	**10**	**14**	**20**	**23**	**11**	**11**	**9**
1588|12	ISP2	Uncle	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
1737|11	**FSP**	**Nephew**	**19**	**21**	**13**	**19**	**29**	**14**	**11**	**14**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
1737|11	ISP2	Uncle	19	21	13	19	29	14	11	14	12	15	23	24	12	13	10
1737|11	**FSP**	**Nephew**	**19**	**21**	**13**	**19**	**29**	**14**	**11**	**14**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
1737|11	ISP3	Uncle	19	21	13	19	29	14	11	14	12	15	23	24	12	13	10
1772|11	**F**	**Nephew**	**17**	**22**	**13**	**20**	**30**	**13**	**10**	**12**	**10**	**14**	**22**	**24**	**11**	**11**	**12**
1772|11	ISP1	Uncle	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	**F**	**Nephew**	**17**	**22**	**13**	**20**	**30**	**13**	**10**	**12**	**10**	**14**	**22**	**24**	**11**	**11**	**12**
1772|11	ISP2	Uncle	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	**F**	**Nephew**	**17**	**22**	**13**	**20**	**30**	**13**	**10**	**12**	**10**	**14**	**22**	**24**	**11**	**11**	**12**
1772|11	ISP3	Uncle	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1774|11	F	Nephew	19	20	13	19	29	14	11	12	12	15	23	24	12	13	10
1774|11	ISP	Uncle	19	20	13	19	29	14	11	12	12	15	23	24	12	13	10
1779|11	F	Nephew	19	23	13	20	29	14	10	11	9	15	22	24	12	11	10
1779|11	ISP1	Uncle	19	23	13	20	29	14	10	11	9	15	22	24	12	11	10
1834|12	**F**	**Nephew**	**16**	**22**	**13**	**20**	**30**	**13**	**10**	**13**	**10**	**14**	**24**	**24**	**12**	**11**	**12**
1834|12	ISP1	Uncle	16	22	13	20	30	13	10	13	10	14	24	24	12	11	12
1834|12	**F**	**Nephew**	**16**	**22**	**13**	**20**	**30**	**13**	**10**	**13**	**10**	**14**	**24**	**24**	**12**	**11**	**12**
1834|12	ISP2	Uncle	16	22	13	20	30	13	10	12	10	14	24	24	12	11	12

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1869|12	F	Nephew	20	19	13	20	29	16	11	14	10	15	20	24	11	12	13
1869|12	ISP2	Uncle	20	19	13	20	29	16	11	14	10	15	20	24	11	12	13
1904|12	F	Nephew	18	22	13	20	30	15	10	10	10	15	20	24	11	12	12
1904|12	ISP3	Uncle	18	22	13	20	30	15	10	10	10	15	20	24	11	12	12
1951|11	F	Nephew	17	18	12	22	29	15	10	9	10	16	22	22	11	11	11
1951|11	ISP	Uncle	17	18	12	22	29	15	10	9	10	16	22	22	11	11	11
2237|12	**FSP1**	**Nephew**	**16**	**20**	**13**	**20**	**30**	**13**	**10**	**12**	**10**	**14**	**22**	**23**	**12**	**11**	**13**
2237|12	ISP1	Uncle	16	20	13	20	30	13	10	12	10	14	22	23	12	11	13
2237|12	**FSP1**	**Nephew**	**16**	**20**	**13**	**20**	**30**	**13**	**10**	**12**	**10**	**14**	**22**	**23**	**12**	**11**	**13**
2237|12	ISP2	Uncle	16	20	13	20	30	13	10	12	10	14	22	23	12	11	13
2282|12	F	Nephew	19	22	14	19	30	13	11	12	12	15	23	25	12	13	10
2282|12	**ISP2**	**Uncle**	**19**	**22**	**14**	**19**	**30**	**13**	**11**	**12**	**12**	**15**	**23**	**25**	**12**	**13**	**10**
2282|12	FSP	Nephew	19	22	14	19	30	13	11	12	12	15	23	25	12	13	10
2282|12	**ISP2**	**Uncle**	**19**	**22**	**14**	**19**	**30**	**13**	**11**	**12**	**12**	**15**	**23**	**25**	**12**	**13**	**10**
2368|12	FSP1	Nephew	16	21	13	21	28	16	11	12	10	14	22	23	11	11	13
2368|12	ISP2	Uncle	16	21	13	21	28	16	11	12	10	14	22	23	11	11	13
2528|12	F	Nephew	17	20	14	19	31	13	10	12	10	14	20	26	12	11	12
2528|12	ISP1	Uncle	17	20	14	19	31	13	10	12	10	14	20	26	12	11	12
2607|12	F	Nephew	19	22	13	19	29	15	10	12	12	15	23	23	13	13	10
2607|12	ISP	Uncle	19	22	13	19	29	15	10	12	12	15	23	23	13	13	10
3144|11	**F**	**Nephew**	**18**	**21**	**13**	**18**	**29**	**15**	**10**	**12**	**12**	**14**	**23**	**24**	**13**	**13**	**10**
3144|11	ISP1	Uncle	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	**F**	**Nephew**	**18**	**21**	**13**	**18**	**29**	**15**	**10**	**12**	**12**	**14**	**23**	**24**	**13**	**13**	**10**
3144|11	ISP2	Uncle	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	**F**	**Nephew**	**18**	**21**	**13**	**18**	**29**	**15**	**10**	**12**	**12**	**14**	**23**	**24**	**13**	**13**	**10**
3144|11	ISP3	Uncle	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
3338|11	F	Nephew	18	24	14	19	30	14	10	12	12	15	23	23	12	13	11
3338|11	ISP2	Uncle	18	24	14	19	30	14	10	12	12	15	23	23	12	13	11
3421|11	F	Nephew	19	21	13	19	29	14	11	12	12	15	23	20	13	13	10
3421|11	ISP2	Uncle	19	21	13	19	29	14	11	12	12	15	23	20	13	13	10
3428|11	**F**	**Nephew**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**ISP1**	**Uncle**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**FSP**	**Nephew**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**ISP1**	**Uncle**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**F**	**Nephew**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**ISP3**	**Uncle**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**FSP**	**Nephew**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3428|11	**ISP3**	**Uncle**	**17**	**19**	**12**	**21**	**28**	**16**	**10**	**10**	**10**	**15**	**21**	**23**	**12**	**12**	**11**
3497|11	**F**	**Nephew**	**18**	**23**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**24**	**24**	**11**	**13**	**9**
3497|11	ISP2	Uncle	18	24	13	19	29	14	10	12	12	15	24	24	11	13	9
3497|11	**F**	**Nephew**	**18**	**23**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**24**	**24**	**11**	**13**	**9**
3497|11	ISP3	Uncle	18	23	13	19	29	14	10	12	12	15	24	24	11	13	9
3780|12	F	Nephew	19	25	13	18	29	14	11	12	12	14	23	24	13	13	9
3780|12	ISP2	Uncle	19	25	13	18	29	14	11	12	12	14	23	24	13	13	9
3841|12	F	Nephew	17	21	13	21	30	16	10	11	11	14	21	21	12	11	13
3841|12	ISP2	Uncle	17	21	13	21	30	16	10	11	11	14	21	21	12	11	13
3867|12	F1	Nephew	17	20	13	21	30	16	10	11	11	14	21	21	11	11	14
3867|12	ISP2	Uncle	17	20	13	21	30	16	10	11	11	14	21	21	11	11	14
3906|12	FSP	Nephew	20	16	13	20	29	16	10	12	11	14	23	24	10	11	10
3906|12	ISP	Uncle	20	16	13	20	29	16	10	12	11	14	23	24	10	11	10
3943|10	F1	Nephew	19	21	13	17	28	15	11	13	12	15	23	23	11	13	10
3943|10	ISP2	Uncle	19	21	13	17	28	15	11	13	12	15	23	23	11	13	10

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Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
4090|12	F1	Nephew	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4090|12	ISP1	Uncle	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4090|12	F1	Nephew	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4090|12	ISP2	Uncle	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4139|12	F	Nephew	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP1	Uncle	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	F	Nephew	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP2	Uncle	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	F	Nephew	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP3	Uncle	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4155|11	F	Nephew	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP1	Uncle	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	F	Nephew	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP2	Uncle	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	F	Nephew	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP3	Uncle	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4171|11	FSP1	Nephew	19	23	13	19	29	14	11	12	12	15	23	24	12	13	10
4171|11	ISP1	Uncle	19	22	13	19	29	14	11	12	12	15	23	24	12	13	10
4222|11	F	Nephew	19	23	13	19	30	14	11	13	12	15	23	25	11	13	9
4222|11	ISP1	Uncle	19	23	13	19	30	14	11	13	12	15	23	25	11	13	9
4234|12	F	Nephew	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP1	Uncle	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	F	Nephew	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP2	Uncle	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	F	Nephew	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP3	Uncle	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
4244|11	F	Nephew	19	21	13	19	29	14	11	11	12	15	23	24	12	13	10
4244|11	ISP	Uncle	19	21	13	19	29	14	11	11	12	15	23	24	12	13	10
4333|11	FSP1	Nephew	17	19	14	20	30	13	9	11	10	14	21	24	10	11	12
4333|11	**ISP1**	**Uncle**	**17**	**19**	**14**	**20**	**30**	**13**	**9**	**11**	**10**	**14**	**21**	**24**	**10**	**11**	**12**
4333|11	FSP2	Nephew	17	19	14	20	30	13	9	11	10	14	21	24	10	11	12
4333|11	**ISP1**	**Uncle**	**17**	**19**	**14**	**20**	**30**	**13**	**9**	**11**	**10**	**14**	**21**	**24**	**10**	**11**	**12**
4357|10	F	Nephew	18	22	13	19	29	14	11	12	12	15	24	24	12	13	11
4357|10	ISP	Uncle	18	22	13	19	29	14	11	12	12	15	24	24	12	13	11
4425|12	**F**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP2**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**FSP2**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP2**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**F**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP3**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**FSP2**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP3**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**F**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP4**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**FSP2**	**Nephew**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4425|12	**ISP4**	**Uncle**	**19**	**22**	**13**	**19**	**29**	**14**	**10**	**12**	**12**	**15**	**23**	**24**	**12**	**13**	**10**
4442|12	F	Nephew	18	20	13	19	29	14	11	11	9	15	22	24	11	11	9
4442|12	ISP	Uncle	18	20	13	19	29	14	11	11	9	15	22	24	11	11	9
4523|10	**F**	**Nephew**	**20**	**22**	**14**	**19**	**29**	**15**	**11**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
4523|10	ISP1	Uncle	20	22	14	19	29	15	11	12	12	15	23	24	13	13	10
4523|10	**F**	**Nephew**	**20**	**22**	**14**	**19**	**29**	**15**	**11**	**12**	**12**	**15**	**23**	**24**	**13**	**13**	**10**
4523|10	ISP2	Uncle	20	22	14	19	29	15	11	12	12	15	23	24	13	13	10

Table S14. Uncle-Nephew Loci Set 3

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0043|11	**F**	**Nephew**	13	15	15	18	17	12	14	15		25	14	16	18	51	40
0043|11	ISP1	Uncle	13	15	15	18	17	12	14			25	14	16	18	51	40
0043|11	**F**	**Nephew**	13	15	15	18	17	12	14	15		25	14	16	18	51	40
0043|11	ISP2	Uncle	13	15	15	18	17	12	14	15		25	14	16	18	51	40
0140|11	F	Nephew	13	16	10	14	17	13	14	16		32	10	15	19	53	43
0140|11	ISP2	Uncle	13	16	10	14	17	13	14	16		32	10	15	19	53	43
0158|11	F	Nephew	13	17	11	14	18	12	14	15		29	8	11	17	49	39
0158|11	**ISP2**	**Uncle**	13	16	11	14	18	12	14	15		29	8	11	17	49	39
0158|11	FSP1	Nephew	13	17	11	14	18	12	14	15		29	8	11	17	49	39
0158|11	**ISP2**	**Uncle**	13	16	11	14	18	12	14	15		29	8	11	17	49	39
0342|12	F	Nephew	13	18	11	14	16	12	14	15		28	11	13	16	51	38
0342|12	ISP3	Uncle	13	18	11	14	16	12	14	15		28	11	13	16	51	38
0412|11	F	Nephew	14	18	14	15	15	13	13.2	16		32	13	17		46	36
0412|11	ISP3	Uncle	14	18	14	15	15	13	13.2	16		32	13	17		46	36
0457|11	F	Nephew	14	19	12	15	15	11	13	15		29	12	17	18	45	38
0457|11	ISP4	Uncle	14	19	12	15	15	11	13	16		29	13	17		45	38
0480|11	**FSP1**	**Nephew**	13	15	17	19	18	11	15			24	13	15	18	49	39
0480|11	ISP1	Uncle	13	15	17	19	18	11	15			24	13	15	18	49	39
0480|11	**FSP1**	**Nephew**	13	15	17	19	18	11	15			24	13	15	18	49	39
0480|11	ISP2	Uncle	13	15	17	19	18	11	15			24	13	15	18	49	39
0530|12	**F**	**Nephew**	13	16	11	14	15	11	13	14		27	11	13	18	50	42
0530|12	ISP1	Uncle	13	16	11	14	15	11	13	14		27	11	13	18	50	42
0530|12	**F**	**Nephew**	13	16	11	14	15	11	13	14		27	11	13	18	50	42
0530|12	ISP2	Uncle	13	16	11	14	15	11	13	14		27	11	13	18	50	42

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0613|11	**F**	**Nephew**	13	15	13	14	15	11	12	15	31	10	16	19	47	39
0613|11	ISP2	Uncle	13	15	13	14	15	11	12	15	31	10	16	19	47	39
0613|11	**F**	**Nephew**	13	15	13	14	15	11	12	15	31	10	16	19	47	39
0613|11	ISP3	Uncle	13	15	13	14	15	11	12	15	31	10	16	19	47	39
0634|12	FSP2	Nephew	13	19	12	14	15	11	14		32	14	17	19	45	36
0634|12	ISP	Uncle	13	19	12	14	15	11	14		32	14	17	19	45	36
0636|12	FSP2	Nephew	13	19	10	15	16	12	14		29	12	18	22.2?	50	37
0636|12	ISP	Uncle	13	19	10	15	16	12	14		29	12	18	22.2?	50	37
0901|12	**F**	**Nephew**	13	16	11	14	15	12	14	16	29	10	13	16	50	39
0901|12	**ISP3**	**Uncle**	13	15	11	14	16	12	14	16	29	10	13	16	50	38
0901|12	**FSP2**	**Nephew**	13	16	11	14	16	12	14	16	29	10	13	16	50	39
0901|12	**ISP3**	**Uncle**	13	15	11	14	16	12	14	16	29	10	13	16	50	38
0901|12	**F**	**Nephew**	13	16	11	14	15	12	14	16	29	10	13	16	50	39
0901|12	**ISP4**	**Uncle**	13	16	11	14	16	12	14	16	29	10	13	16	50	38
0901|12	**FSP2**	**Nephew**	13	16	11	14	16	12	14	16	29	10	13	16	50	39
0901|12	**ISP4**	**Uncle**	13	16	11	14	16	12	14	16	29	10	13	16	50	38
1074|12	F	Nephew	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	**ISP**	**Uncle**	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP2	Nephew	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	**ISP**	**Uncle**	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP3	Nephew	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	**ISP**	**Uncle**	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1092|11	F	Nephew	13	15	12	14	15	12	14	15	30	11	13	17	49	39
1092|11	ISP	Uncle	13	15	12	14	15	12	14	15	30	11	13	17	49	39
1142|12	FSP	Nephew	13	16	14	18	15	12	13		30	13	14	17	49	38
1142|12	ISP1	Uncle	13	16	14	18	15	12	13		30	13	14	17	49	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1276|12	FSP1	Nephew	13	17	13	14	15	12	14	15		24	11	14	15	49	41
1276|12	ISP	Uncle	13	17	13	14	15	12	14	15		24	11	14	15	49	41
1278|11	F	Nephew	13	16	12	15	15	12	14	15		29	12	13	17	51	37
1278|11	**ISP1**	**Uncle**	**13**	**16**	**12**	**15**	**15**	**12**	**14**	**15**		**29**	**12**	**13**	**17**	**51**	**37**
1278|11	FSP	Nephew	13	16	12	15	15	12	14	15		29	12	13	17	51	37
1278|11	**ISP1**	**Uncle**	**13**	**16**	**12**	**15**	**15**	**12**	**14**	**15**		**29**	**12**	**13**	**17**	**51**	**37**
1279|12	FSP1	Nephew	13	17	11	15	16	11		15		28	12	14	18	50	38
1279|12	ISP	Uncle	13	17	11	15	16	11	14	15		28	12	14	18	50	38
1317|11	F	Nephew	13	17	11	14	15	12	14	15		29	10	12	18	50	38
1317|11	ISP	Uncle	13	17	11	14	15	12	14	15		29	10	12	17	50	38
1354|11	FSP1	Nephew	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	**ISP2**	**Uncle**	**13**	**18**	**12**		**14**	**11**	**15**			**30**	**10**	**14**	**17**	**48**	**36**
1354|11	FSP2	Nephew	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	**ISP2**	**Uncle**	**13**	**18**	**12**		**14**	**11**	**15**			**30**	**10**	**14**	**17**	**48**	**36**
1354|11	FSP3	Nephew	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	**ISP2**	**Uncle**	**13**	**18**	**12**		**14**	**11**	**15**			**30**	**10**	**14**	**17**	**48**	**36**
1419|11	FSP	Nephew	13	15	14		14	11	11	14		33	10	17		46	42
1419|11	ISP2	Uncle	13	15	14		14	11	11	15		33	10	17		46	42
1495|11A	FSP2	Nephew	14	17	14	15	15	11	13.2	16		31	14	15	16	47	36
1495|11A	ISP3	Uncle	14	17	14	15	15	11	13.2	16		32	14		16	47	36
1514|12	F	Nephew	13	16	14		15	12	13.2	16		31	14	15	17	47	38
1514|12	ISP1	Uncle	13	17	14		15	12	13.2	16		31	14	15	17	47	38
1549|12	**F**	**Nephew**	**12**	**15**	**12**	**14**	**15**	**13**	**14**	**15**		**30**	**11**	**12**	**15**	**49**	**40**
1549|12	ISP1	Uncle	12	15	12	14	15	13	14	15		30	11	12	15	49	40
1549|12	**F**	**Nephew**	**12**	**15**	**12**	**14**	**15**	**13**	**14**	**15**		**30**	**11**	**12**	**15**	**49**	**40**
1549|12	ISP2	Uncle	12	15	12	14	15	13	14	15		30	11	12	15	49	40

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1549|12	**F**	**Nephew**	12	15	12	14	15	13	14	15		30	11	12	15	49	40
1549|12	ISP4	Uncle	12	15	12	14	15	13	14	15		30	11	12	15	49	40
1577|11	F	Nephew	13	16	14		14	11	12	15		31	10	16	18	47	38
1577|11	ISP	Uncle	13	16	14		14	11	12	15		31	10	16	18	47	38
1588|12	**F**	**Nephew**	12	18.2	13	16	15	11	14	15		33	15	16		54	39
1588|12	ISP1	Uncle	12	18.2	13	16	15	11	14	15		33	15	17		54	39
1588|12	**F**	**Nephew**	12	18.2	13	16	15	11	14	15		33	15	16		54	39
1588|12	ISP2	Uncle	12	18.2	13	16	15	11	14	15		33	15	17		54	39
1737|11	**FSP**	**Nephew**	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1737|11	ISP2	Uncle	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1737|11	**FSP**	**Nephew**	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1737|11	ISP3	Uncle	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1772|11	**F**	**Nephew**	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP1	Uncle	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	**F**	**Nephew**	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP2	Uncle	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	**F**	**Nephew**	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP3	Uncle	13	16	16	17	16	13	15	17		(25)	12	16	17	48	42
1774|11	F	Nephew	13	18	11	14	16	12	13	15		30	10	16	17	51	37
1774|11	ISP	Uncle	13	18	11	14	16	12	13	15		30	10	16	17	51	37
1779|11	F	Nephew	12	17	14	15	17	12	13	15		(31)	11	12	15	48	39
1779|11	ISP1	Uncle	12	17	14	15	17	12	13	15		31	11	12	15	48	39
1834|12	**F**	**Nephew**	13	15	16	18	17	11	14	17		25	15		18	51	41
1834|12	ISP1	Uncle	13	15	16	18	17	11	14	17		25	15	17	18	51	41
1834|12	**F**	**Nephew**	13	15	16	18	17	11	14	17		25	15		18	51	41
1834|12	ISP2	Uncle	13	15	16	18	17	11	14	17		25	15	17	18	51	41

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1869|12	F	Nephew	15	15	15		17	11	14	15		30	12	17		48	42
1869|12	ISP2	Uncle	15	15	15		17	11	14	15		30	12	17		48	42
1904|12	F	Nephew	15	16	14	15	14	11	15	17		28	12	17	18	50	41
1904|12	ISP3	Uncle	15	16	14	15	14	11	15	17		28	12	17	18	50	41
1951|11	F	Nephew	14	16	14		15	12	14.2	18		30	13	15	19	45	36
1951|11	ISP	Uncle	14	17	14		15	12	14.2	17		30	13	15	19	45	36
2237|12	**FSP1**	**Nephew**	**13**	**16**	**16**		**15**	**11**	**13**	**15**		**25**	**11**	**15**	**17**	**52**	**39**
2237|12	ISP1	Uncle	13	16	16		16	11	13	15		25	11	15	17	52	39
2237|12	**FSP1**	**Nephew**	**13**	**16**	**16**		**15**	**11**	**13**	**15**		**25**	**11**	**15**	**17**	**52**	**39**
2237|12	ISP2	Uncle	13	16	16		16	11	13	15		25	11	15	17	52	39
2282|12	F	Nephew	13	17	11	14	15	12	14	16		29	11	14	16	49	39
2282|12	**ISP2**	**Uncle**	**13**	**17**	**11**	**14**	**15**	**12**	**14**	**16**		**29**	**11**	**14**	**16**	**49**	**38**
2282|12	FSP	Nephew	13	17	11	14	15	12	14	16		29	11	14	16	50	38
2282|12	**ISP2**	**Uncle**	**13**	**17**	**11**	**14**	**15**	**12**	**14**	**16**		**29**	**11**	**14**	**16**	**49**	**38**
2368|12	FSP1	Nephew	13	18	12		14	12	15	16		30		16	18	48	34
2368|12	ISP2	Uncle	13	18	12		14	12	15	16		30	15	16	18	48	33
2528|12	F	Nephew	13	15	16	18	18	12	16			26	14	16		52	43
2528|12	ISP1	Uncle	13	15	16	18	18	12	16			26	14	16		52	43
2607|12	F	Nephew	13	18	12	14	17	12	14	15		28	11	15	17	53	38
2607|12	ISP	Uncle	13	18	12	14	17	12	14	15		28	11	15	17	53	38
3144|11	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**11**	**14**	**16**		**30**	**11**	**12**	**20**	**49**	**38**
3144|11	ISP1	Uncle	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**11**	**14**	**16**		**30**	**11**	**12**	**20**	**49**	**38**
3144|11	ISP2	Uncle	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**11**	**14**	**16**		**30**	**11**	**12**	**20**	**49**	**38**
3144|11	ISP3	Uncle	13	16	11	14	16	11	14	16		30	11	12	20	49	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
3338|11	F	Nephew	13	17	11	14	16	12	14	15		29	12	14	18	51	37
3338|11	ISP2	Uncle	13	17	11	14	16	12	14	15		29	12	14	18	51	37
3421|11	F	Nephew	13	17	11	14	15	11	14	16		29	11	13	17	50	39
3421|11	ISP2	Uncle	13	17	11	14	15	11	14	16		29	11	13	17	50	39
3428|11	**F**	**Nephew**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**ISP1**	**Uncle**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**FSP**	**Nephew**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**ISP1**	**Uncle**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**F**	**Nephew**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**ISP3**	**Uncle**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**FSP**	**Nephew**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3428|11	**ISP3**	**Uncle**	**14**	**16**	**13**	**15**	**15**	**13**	**12.2**	**14**		**29**	**16**	**18**		**46**	**36**
3497|11	**F**	**Nephew**	**14**	**18**	**12**	**14**	**16**	**12**	**14**	**16**		**31**	**11**	**13**	**17**	**50**	**37**
3497|11	ISP2	Uncle	14	18	12	14	16	12	14	16		31	11	13	17	50	37
3497|11	**F**	**Nephew**	**14**	**18**	**12**	**14**	**16**	**12**	**14**	**16**		**31**	**11**	**13**	**17**	**50**	**37**
3497|11	ISP3	Uncle	14	18	12	14	16	12	14	16		31	11	13	17	50	37
3780|12	F	Nephew	13	16	11	14	17	11	13	16		30	12	13	16	50	38
3780|12	ISP2	Uncle	13	16	11	14	17	11	13	16		30	12	13	16	50	38
3841|12	F	Nephew	14	16	17		15	11	13	14		31	12	13	16	52	42
3841|12	ISP2	Uncle	14	16	17		15	11	13	14		31	12	13	16	52	42
3867|12	F1	Nephew	15	17	17	19	16	11	14			32	11	15	16	51	41
3867|12	ISP2	Uncle	15	17	17	19	16	11	14			32	11	15	16	51	41
3906|12	FSP	Nephew	13	16	11	14	15	12	14	15		33	10	16	17	53	42
3906|12	ISP	Uncle	13	16	11	14	15	12	14	15		33	10	16	17	53	42
3943|10	F1	Nephew	13	17	11	14	15	12	14			29	11	13	16	50	38
3943|10	ISP2	Uncle	13	17	11	14	15	12	14			29	11	13	16	50	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
4090|12	**F1**	**Nephew**	12	18	13	17	14	11	13	16	31	11	13	16	46	40
4090|12	ISP1	Uncle	12	18	13	17	14	11	13	16	31	11	13	16	46	40
4090|12	**F1**	**Nephew**	12	18	13	17	14	11	13	16	31	11	13	16	46	40
4090|12	ISP2	Uncle	12	18	13	17	14	11	13	16	31	11	13	16	46	40
4139|12	**F**	**Nephew**	13	18	11	14	16	12	15	16	29	11	14	16	50	39
4139|12	ISP1	Uncle	13	18	11	14	16	12	15	16	29	11	14	16	50	39
4139|12	**F**	**Nephew**	13	18	11	14	16	12	15	16	29	11	14	16	50	39
4139|12	ISP2	Uncle	13	18	11	14	16	12	15	17	29	11	14	16	50	39
4139|12	**F**	**Nephew**	13	18	11	14	16	12	15	16	29	11	14	16	50	39
4139|12	ISP3	Uncle	13	18	11	14	16	12	15	16	29	11	14	16	50	39
4155|11	**F**	**Nephew**	13	16	12		14	12	14		31	12	15	17	50	37
4155|11	ISP1	Uncle	13	16	12		14	12	14		31	12	15	17	49	37
4155|11	**F**	**Nephew**	13	16	12		14	12	14		31	12	15	17	50	37
4155|11	ISP2	Uncle	13	16	12		14	12	14		31	12	15	17	49	37
4155|11	**F**	**Nephew**	13	16	12		14	12	14		31	12	15	17	50	37
4155|11	ISP3	Uncle	13	16	12		14	12	14		31	12	15	17	49	37
4171|11	FSP1	Nephew	14	17	11	13	15	12	14	15	29	14	16	17	51	38
4171|11	ISP1	Uncle	14	17	11	13	15	12	14	15	29	13	16	17	51	38
4222|11	F	Nephew	13	16	11	14	15	12	14	15	31	11	12	15	51	37
4222|11	ISP1	Uncle	13	16	11	14	15	12	14	15	31	11	12	15	51	37
4234|12	**F**	**Nephew**	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP1	Uncle	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	**F**	**Nephew**	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP2	Uncle	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	**F**	**Nephew**	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP3	Uncle	12	18.2	13	16	15	11	14	15	33	15	17		54	39

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
4244|11	F	Nephew	13	16	11	15	16	12	14	15	29	13	14	17	51	38
4244|11	ISP	Uncle	13	16	11	15	16	12	14	15	29	13	14	17	51	38
4333|11	FSP1	Nephew	13	17	13	14	16	12	15	17	24	10	15	16	51	42
4333|11	**ISP1**	**Uncle**	**13**	**17**	**13**	**14**	**16**	**12**	**15**	**17**	**24**	**10**	**15**	**16**	**51**	**42**
4333|11	FSP2	Nephew	13	17	13	14	16	12	15	17	24	10	15	16	51	42
4333|11	**ISP1**	**Uncle**	**13**	**17**	**13**	**14**	**16**	**12**	**15**	**17**	**24**	**10**	**15**	**16**	**51**	**42**
4357|10	F	Nephew	14	16	11	14	16	12	14	16	29	9	13	17	49	38
4357|10	ISP	Uncle	14	16	11	14	16	12	14	16	29	9	13	17	49	38
4425|12	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP2**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**FSP2**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP2**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP3**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**FSP2**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP3**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**F**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP4**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**FSP2**	**Nephew**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4425|12	**ISP4**	**Uncle**	**13**	**16**	**11**	**14**	**16**	**12**	**14**		**30**	**12**	**13**	**18**	**49**	**39**
4442|12	F	Nephew	12	17	13	15	14	11	15		29	12	14	16	49	36
4442|12	ISP	Uncle	12	17	13	15	14	11	15		29	12	14	16	49	36
4523|10	**F**	**Nephew**	**13**	**18**	**11**	**15**	**15**	**12**	**15**	**16**	**28**	**11**	**14**	**17**	**48**	**40**
4523|10	ISP1	Uncle	13	18	11	15	15	12	15	16	28	11	14	17	48	40
4523|10	**F**	**Nephew**	**13**	**18**	**11**	**15**	**15**	**12**	**15**	**16**	**28**	**11**	**14**	**17**	**48**	**40**
4523|10	ISP2	Uncle	13	18	11	15	15	12	**15**	**16**	**28**	**11**	**14**	**17**	**48**	**40**

Table S15. Uncle-Nephew Loci Set 4

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1				DYS 526B	DYS 547	DYF 387S1	
0043|11	**F**	**Nephew**	**12**	**40**	**19**	**25**	**25.1**		**32**	**50**	**35**	**37**
0043|11	ISP1	Uncle	12	40	19	25	25.1		32	50	35	37
0043|11	**F**	**Nephew**	**12**	**40**	**19**	**25**	**25.1**		**32**	**50**	**35**	**37**
0043|11	ISP2	Uncle	12	40	19	25	25.1		32	50	35	37
0140|11	F	Nephew	15	34	22	24.1	26	28	37	49	36	38
0140|11	ISP2	Uncle	15	34	22	24.1		28	37	49	36	38
0158|11	F	Nephew	15	37	22	24	24.1		38	47	35	36
0158|11	**ISP2**	**Uncle**	**15**	**37**	**22**	**24**	**24.1**		**38**	**47**	**35**	**36**
0158|11	FSP1	Nephew	15	37	22	24	24.1		38	47	35	36
0158|11	**ISP2**	**Uncle**	**15**	**37**	**22**	**24**	**24.1**		**38**	**47**	**35**	**36**
0342|12	F	Nephew	14	38	21	25	27.1		38	47	35	36
0342|12	ISP3	Uncle	14	38	21	25	27.1		38	47	35	36
0412|11	F	Nephew	13	31	17.1	17.2	24		34	49	38	
0412|11	ISP3	Uncle	13	31	17.1	17.2	23		34	49	38	
0457|11	F	Nephew	13	34	19	22	23		35	49	36	41
0457|11	ISP4	Uncle	13	34	19	22	23		35	49	36	41
0480|11	**FSP1**	**Nephew**	**12**	**36**	**24.1**				**33**	**48**	**34**	
0480|11	ISP1	Uncle	12	36	24.1				33	48	34	
0480|11	**FSP1**	**Nephew**	**12**	**36**	**24.1**				**33**	**48**	**34**	
0480|11	ISP2	Uncle	12	36	24.1				33	48	34	
0530|12	**F**	**Nephew**	**14**	**39**	**21**	**23**	**26.1**		**36**	**49**	**36**	
0530|12	ISP1	Uncle	14	39	21	23	26.1		36	49	36	
0530|12	**F**	**Nephew**	**14**	**39**	**21**	**23**	**26.1**		**36**	**49**	**36**	
0530|12	ISP2	Uncle	14	39	21	23	26.1		36	49	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
0613|11	**F**	**Nephew**	16	36	22						37		44	37	38	
0613|11	ISP2	Uncle	16	36	22						37		44	37	38	
0613|11	**F**	**Nephew**	16	36	22						37		44	37	38	
0613|11	ISP3	Uncle	16	36	22						37		44	37	38	
0634|12	FSP2	Nephew	13	36	18.2	20.1	22	23			34		47	37	38	
0634|12	ISP	Uncle	13	36	18.2	20.1	22	23			34		47	37	38	
0636|12	FSP2	Nephew	14	37	23	24	25.1				37		47	35	37	
0636|12	ISP	Uncle	14	37	23	24	25.1				37		47	35	37	
0901|12	**F**	**Nephew**	14	39	22	24	26.1				37		47	35	36	
0901|12	**ISP3**	**Uncle**	14	39	22	23	27.1				37		47	35	36	
0901|12	**FSP2**	**Nephew**	14	39	22	23	26.1				37		47	35	36	
0901|12	**ISP3**	**Uncle**	14	39	22	23	27.1				37		47	35	36	
0901|12	**F**	**Nephew**	14	39	22	24	26.1				37		47	35	36	
0901|12	**ISP4**	**Uncle**	14	38	22	23	27.1				37		47	35	36	
0901|12	**FSP2**	**Nephew**	14	39	22	23	26.1				37		47	35	36	
0901|12	**ISP4**	**Uncle**	14	38	22	23	27.1				37		47	35	36	
1074|12	F	Nephew	14	38	21	23	24.1				37		46	35	36	
1074|12	**ISP**	**Uncle**	14	40	21	23	24.1				37		46	35	36	
1074|12	FSP2	Nephew	14	38	21	23	24.1				37		46	35	36	
1074|12	**ISP**	**Uncle**	14	40	21	23	24.1				37		46	35	36	
1074|12	FSP3	Nephew	14	38	21	23	24.1				37		46	35	36	
1074|12	**ISP**	**Uncle**	14	40	21	23	24.1				37		46	35	36	
1092|11	F	Nephew	14	38	21	24	25.1				38		48	36	37	
1092|11	ISP	Uncle	14	38	21	24	25.1				38		48	36	37	
1142|12	FSP	Nephew	14	33	20	22	24				35		51	36	38	
1142|12	ISP1	Uncle	14	33	20	22	24				35		51	36	38	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
1276|12	FSP1	Nephew	12	36	19	21	24.1			32		51	36	39	
1276|12	ISP	Uncle	12	36	19	21	24.1			32		51	36	39	
1278|11	F	Nephew	14	40	21	24	26.1			38		49	36		
1278|11	**ISP1**	**Uncle**	**14**	**40**	**21**	**24**	**26.1**			**38**		**49**	**36**		
1278|11	FSP	Nephew	14	40	21	24	26.1			38		49	36		
1278|11	**ISP1**	**Uncle**	**14**	**40**	**21**	**24**	**26.1**			**38**		**49**	**36**		
1279|12	FSP1	Nephew	14	37	18	21	23	25/25.1		36		48	35	36	
1279|12	ISP	Uncle	14	37		21	23	25/25.1		36		48	35	36	
1317|11	F	Nephew	14	37	20	24	27.1			39		48	36	37	
1317|11	ISP	Uncle	14	37	20	24	27.1			38		47	36	37	
1354|11	FSP1	Nephew	14	39	22	23	25			35		47	35		
1354|11	**ISP2**	**Uncle**	**14**	**39**	**22**	**23**	**25**			**35**		**47**	**35**		
1354|11	FSP2	Nephew	14	39	22	23	25			35		47	35		
1354|11	**ISP2**	**Uncle**	**14**	**39**	**22**	**23**	**25**			**35**		**47**	**35**		
1354|11	FSP3	Nephew	14	39	22	23	25			35		47	35		
1354|11	**ISP2**	**Uncle**	**14**	**39**	**22**	**23**	**25**			**35**		**47**	**35**		
1419|11	FSP	Nephew	15	35	21	23	24			36		46	37		
1419|11	ISP2	Uncle	15	35	21	23	24			36		46	37		
1495|11A	FSP2	Nephew	13	34	18.1	18.2	24			33		46	37	40	
1495|11A	ISP3	Uncle	13	34	18.1	18.2	24			33		46	37	40	
1514|12	F	Nephew	13	34	17.2	19.1	24			34		49	38	40	42
1514|12	ISP1	Uncle	13	34	17.2	19.1	24			34		49	38	40	41
1549|12	**F**	**Nephew**	**15**	**35**	**21**	**23**	**24.1**			**39**		**48**	**35**	**36**	
1549|12	ISP1	Uncle	15	35	21	23	24.1			39		48	35	36	
1549|12	**F**	**Nephew**	**15**	**35**	**21**	**23**	**24.1**			**39**		**48**	**35**	**36**	
1549|12	ISP2	Uncle	15	35	21	24	24.1			39		48	35	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
1549|12	**F**	**Nephew**	**15**	**35**	**21**	**23**	**24.1**				**39**		**48**	**35**	**36**	
1549|12	ISP4	Uncle	15	35	21	23	24.1				39		48	35	36	
1577|11	F	Nephew	16	34	21	22					37		48	36	37	
1577|11	ISP	Uncle	16	34	21	22					37		48	36	37	
1588|12	**F**	**Nephew**	**16**	**36**	**19**	**21**	**24/24.1**				**38**		**53**	**36**	**38**	
1588|12	ISP1	Uncle	16	36	19	21	24/24.1				38		53	36	38	
1588|12	**F**	**Nephew**	**16**	**36**	**19**	**21**	**24/24.1**				**38**		**53**	**36**	**38**	
1588|12	ISP2	Uncle	16	36	19	21	24/24.1				38		53	36	38	
1737|11	**FSP**	**Nephew**	**15**	**36**	**22**	**24**	**27.1**				**38**		**51**	**36**		
1737|11	ISP2	Uncle	15	36	22	24	27.1				38		51	36		
1737|11	**FSP**	**Nephew**	**15**	**36**	**22**	**24**	**27.1**				**38**		**51**	**36**		
1737|11	ISP3	Uncle	15	36	22	24	27.1				38		51	36		
1772|11	**F**	**Nephew**	**12**	**38**	**19**	**23**	**26.1**				**32**		**52**	**35**	**38**	
1772|11	ISP1	Uncle	12	38	19	23	26.1				32		52	35	38	
1772|11	**F**	**Nephew**	**12**	**38**	**19**	**23**	**26.1**				**32**		**52**	**35**	**38**	
1772|11	ISP2	Uncle	12	38	19	23	26.1				32		52	35	38	
1772|11	**F**	**Nephew**	**12**	**38**	**19**	**23**	**26.1**				**32**		**52**	**35**	**38**	
1772|11	ISP3	Uncle	12	38	19	23	26.1				32		52	35	38	
1774|11	F	Nephew	14	38	20	24	24.1				35		47	35	36	
1774|11	ISP	Uncle	14	38	20	24	24.1				35		47	35	36	
1779|11	F	Nephew	13	34	21	23	23.1				35		47	36	39	
1779|11	ISP1	Uncle	13	34	21	23	23.1				35		47	36	39	
1834|12	**F**	**Nephew**	**12**	**38**	**22**	**24**	**28.1**				**33**		**48**	**35**	**38**	
1834|12	ISP1	Uncle	12	38	22	24	28.1				33		48	35	38	
1834|12	**F**	**Nephew**	**12**	**38**	**22**	**24**	**28.1**				**33**		**48**	**35**	**38**	
1834|12	ISP2	Uncle	12	38	22	24	28.1				33		48	35	38	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
1869|12	F	Nephew	13	37	22	23					36		46	36	38	
1869|12	ISP2	Uncle	13	37	22	23					36		46	36	38	
1904|12	F	Nephew	13	36	21	22					34		42	37	39	
1904|12	ISP3	Uncle	13	36	21	22					34		42	37	39	
1951|11	F	Nephew	13	33	17.2	20.1	24				34		47	38	39	
1951|11	ISP	Uncle	13	33	17.2	20.1	24				34		47	38	39	
2237|12	**FSP1**	**Nephew**	**12**	**38**	**20**	**23**	**24/24.1**				**32**		**49**	**35**	**37**	
2237|12	ISP1	Uncle	12	38	20	23	24/24.1				32		49	35	37	
2237|12	**FSP1**	**Nephew**	**12**	**38**	**20**	**23**	**24/24.1**				**32**		**49**	**35**	**37**	
2237|12	ISP2	Uncle	12	38	20	23	24/24.1				32		49	35	37	
2282|12	F	Nephew	15	37	22	25.1	26				39		49	36		
2282|12	**ISP2**	**Uncle**	**15**	**37**	**22**	**25.1**	**27**				**39**		**49**	**36**		
2282|12	FSP	Nephew	15	37	22	25.1	26				39		49	36		
2282|12	**ISP2**	**Uncle**	**15**	**37**	**22**	**25.1**	**27**				**39**		**49**	**36**		
2368|12	FSP1	Nephew	14	36	21	23					35		48	35	37	
2368|12	ISP2	Uncle	14	36	21	23					35		48	35	37	
2528|12	F	Nephew	12	38	20	22	28.1				32		47	35	38	
2528|12	ISP1	Uncle	12	38	20	22	28.1				32		47	35	38	
2607|12	F	Nephew	14	36	21	23	27.1				36		48	35	36	
2607|12	ISP	Uncle	14	36	21	24	28.1				36		48	35	36	
3144|11	**F**	**Nephew**	**14**	**35**	**21**	**23**	**26.1**				**36**	**37**	**49**	**35**	**36**	
3144|11	ISP1	Uncle	14	35	21	23	26.1				36		49	35	36	
3144|11	**F**	**Nephew**	**14**	**35**	**21**	**23**	**26.1**				**36**	**37**	**49**	**35**	**36**	
3144|11	ISP2	Uncle	14	35	21	23	26.1				36		49	35	36	
3144|11	**F**	**Nephew**	**14**	**35**	**21**	**23**	**26.1**				**36**	**37**	**49**	**35**	**36**	
3144|11	ISP3	Uncle	14	35	21	23	26.1				36		49	35	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
3338|11	F	Nephew	14	39	23	24	27.1			37		49	34	35	
3338|11	ISP2	Uncle	14	39	23	24	27.1			37		49	34	35	
3421|11	F	Nephew	14	35	21	24	26.1			38		47	35	36	
3421|11	ISP2	Uncle	14	36	21	23	26.1			38		47	35	36	
3428|11	**F**	**Nephew**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**ISP1**	**Uncle**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**FSP**	**Nephew**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**ISP1**	**Uncle**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**F**	**Nephew**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**ISP3**	**Uncle**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**FSP**	**Nephew**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3428|11	**ISP3**	**Uncle**	**13**	**37**	**21.1**	**21.2**	**23**			**34**		**50**	**37**	**40**	
3497|11	**F**	**Nephew**	**14**	**38**	**21.1**	**22**	**24**			**36**		**48**	**34**	**36**	
3497|11	ISP2	Uncle	14	38	21.1	22	24			36		48	34	36	
3497|11	**F**	**Nephew**	**14**	**38**	**21.1**	**22**	**24**			**36**		**48**	**34**	**36**	
3497|11	ISP3	Uncle	14	38	21.1	22	24			36		48	34	36	
3780|12	F	Nephew	15	36	20	26.1				38		49	35	37	
3780|12	ISP2	Uncle	15	36	20	26.1				38		49	35	37	
3841|12	F	Nephew	14	34	20	23	25			33		48	39	40	
3841|12	ISP2	Uncle	14	34	20	23	25			33		48	39	40	
3867|12	F1	Nephew	14	35	22	24				32		49	38	39	
3867|12	ISP2	Uncle	14	35	22	24				32		49	38	39	
3906|12	FSP	Nephew	15	37	22	24	25.1			39		47	37	38	
3906|12	ISP	Uncle	15	37	22	24	25.1			39		47	37	38	
3943|10	F1	Nephew	14	38	22	24				37		50	37	38	
3943|10	ISP2	Uncle	14	38	22	24				37		50	37		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1	
4090|12	**F1**	**Nephew**	14	37	20	21	24.1				35		49	35	38
4090|12	ISP1	Uncle	14	37	20	21	24.1				35		49	35	38
4090|12	**F1**	**Nephew**	14	37	20	21	24.1				35		49	35	38
4090|12	ISP2	Uncle	14	37	20	21	24.1				35		49	35	38
4139|12	**F**	**Nephew**	13	37	21	24	24.1				37		47	36	
4139|12	ISP1	Uncle	13	37	21	24.1	25				36		47	36	
4139|12	**F**	**Nephew**	13	37	21	24	24.1				37		47	36	
4139|12	ISP2	Uncle	13	37	21	24.1	25				36		47	36	
4139|12	**F**	**Nephew**	13	37	21	24	24.1				37		47	36	
4139|12	ISP3	Uncle	13	37	21	24.1	25				36		47	36	
4155|11	**F**	**Nephew**	14	35	21	24					36		46	35	38
4155|11	ISP1	Uncle	14	35	21	24					36		46	35	38
4155|11	**F**	**Nephew**	14	35	21	24					36		46	35	38
4155|11	ISP2	Uncle	14	35	21	24					36		46	35	38
4155|11	**F**	**Nephew**	14	35	21	24					36		46	35	38
4155|11	ISP3	Uncle	14	35	21	24					36		46	35	38
4171|11	FSP1	Nephew	15	38	20	21	22	24.1	25	25.1	38		47	36	
4171|11	ISP1	Uncle	15	38	20	21	22	24.1	25	25.1	38		47	36	
4222|11	F	Nephew	14	37	22	25	25.1				36		48	35	36
4222|11	ISP1	Uncle	14	37	22	24	25.1				36		48	35	36
4234|12	**F**	**Nephew**	16	36	19	21	25/25.1				38		53	36	38
4234|12	ISP1	Uncle	16	36	19	21	24/24.1				38		53	36	38
4234|12	**F**	**Nephew**	16	36	19	21	25/25.1				38		53	36	38
4234|12	ISP2	Uncle	16	36	19	21	24/24.1				38		53	36	38
4234|12	**F**	**Nephew**	16	36	19	21	25/25.1				38		53	36	38
4234|12	ISP3	Uncle	16	36	19	21	24/24.1				38		53	36	38

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
4244|11	F	Nephew	14	40	23	24	26.1				38		47	36		
4244|11	ISP	Uncle	14	40	23	24	26.1				38		47	36		
4333|11	FSP1	Nephew	12	38	19	23	25.1				32		50	36	38	
4333|11	**ISP1**	**Uncle**	**12**	**38**	**19**	**23**	**25.1**				**32**		**50**	**36**	**38**	
4333|11	FSP2	Nephew	12	37	19	23	25.1				32		50	36	38	
4333|11	**ISP1**	**Uncle**	**12**	**38**	**19**	**23**	**25.1**				**32**		**50**	**36**	**38**	
4357|10	F	Nephew	14	37	20	21	23.1				37		48	35	37	
4357|10	ISP	Uncle	14	37	20	21	23.1				37		48	35	37	
4425|12	**F**	**Nephew**	**14**	**38**	**20**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP2**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**FSP2**	**Nephew**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP2**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**F**	**Nephew**	**14**	**38**	**20**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP3**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**FSP2**	**Nephew**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP3**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**F**	**Nephew**	**14**	**38**	**20**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP4**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**FSP2**	**Nephew**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4425|12	**ISP4**	**Uncle**	**14**	**38**	**21**	**24**	**25.1**				**37**		**50**	**35**	**37**	
4442|12	F	Nephew	15	36	21	24.1					36		49	38	39	
4442|12	ISP	Uncle	15	36	21	24.1					36		49	38		
4523|10	**F**	**Nephew**	**14**	**39**	**22**	**24**	**24.1**				**38**		**49**	**36**		
4523|10	ISP1	Uncle	14	39	22	24	24.1				38		49	36		
4523|10	**F**	**Nephew**	**14**	**39**	**22**	**24**	**24.1**				**38**		**49**	**36**		
4523|10	ISP2	Uncle	**14**	**39**	**22**	**24**	**24.1**				**38**		**49**	**36**		

Total Mutations by Locus: Uncle-Nephew

Table S16. Uncle-Nephew Mutation Totals Loci Set 1

MUTATIONS	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1 STEP:	3	1	1	0	3	0	0	3	0	0	1	2	2
2 STEPS:	0	0	0	0	0	0	0	0	0	0	2	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	3	1	1	0	3	0	0	3	0	0	3	2	2

Table S17. Uncle-Nephew Mutation Totals Loci Set 2

MUTATIONS	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1 STEP:	0	2	1	0	4	1	0	2	0	0	1	0	0	1	0
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	2	1	0	4	1	0	2	0	0	1	0	0	1	0

Table S18. Uncle-Nephew Mutation Totals Loci Set 3

MUTATIONS	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1	DYS 626	DYF 403S1A	DYF 403S1B	DYS 518
1 STEP:	0	6	0	0	4	0	6	1	10	4	7
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	6	0	0	4	0	6	1	10	4	7

Table S19. Uncle-Nephew Mutation Totals Loci Set 4

MUTATIONS	DYS526A	DYS612	DYF399S1	DYS526B	DYS547	DYF387S1
1 STEP:	0	4	23	7	1	3
2 STEPS:	0	3	1	0	0	0
3 STEPS:	0	0	1	0	0	0
TOTAL:	0	7	25	7	1	3

Table S20. Uncle-Nephew Mutation Totals All Loci

MUTATIONS	TOTAL
1 STEP:	104
2 STEPS:	6
3 STEPS:	1
TOTAL:	111

Brothers Mutation Summary Data

Table S21. Brothers Loci Set 1

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0152|12	F	Brother	22	18	19	33	33	9	10	13	13	33	11	24	10
0152|12	FSP1	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	F	Brother	22	18	19	33	33	9	10	13	13	33	11	24	10
0152|12	FSP3	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	F	Brother	22	18	19	33	33	9	10	13	13	33	11	24	10
0152|12	FSP4	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP1	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP3	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP1	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP4	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP3	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0152|12	FSP4	Brother	22	18	19	33	33	9	10	13	13	32	11	24	10
0181|12	ISP1	Brother	28	19	24	30	33	9	9	11	12	32	10	26	12
0181|12	ISP2	Brother	28	19	24	30	33	9	9	11	12	32	10	26	12
0219|12	ISP4	Brother	23	16	17	33	35	8	10	13	12	29	11	24	10
0219|12	ISP5	Brother	23	16	17	33	35	8	10	13	12	29	11	24	10
0262|12	F	Brother	23	17	17	33	36	9	10	12	12	29	11	26	10
0262|12	FSP	Brother	23	17	17	33	36	9	10	12	12	29	11	26	10
0263|12	F	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10
0263|12	FSP1	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10
0263|12	F	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10
0263|12	FSP2	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0263|12	FSP1	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10
0263|12	FSP2	Brother	25	17	17	29	34	8	9	11	12	31	12	24	10
0266|12	F	Brother	25	16	18	30	34	8	10	11	13	29	12	24	11
0266|12	FSP	Brother	25	16	17	30	34	8	10	11	13	29	12	24	11
0348|12	F	Brother	24	18	17	36	37	7	9	12	12	28	12	24	11
0348|12	FSP3	Brother	24	18	17	36	37	7	9	12	12	28	12	24	11
0356|12	FSP2	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP3	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP2	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP5	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP2	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP6	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP3	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP5	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP3	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP6	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP5	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0356|12	FSP6	Brother	21	17	17	33	35	9	10	13	12	30	11	24	10
0357|12	FSP1	Brother	24	15	20	32	35	8	9	12	12	31	10	25	10
0357|12	FSP4	Brother	24	15	19	32	35	8	9	12	12	31	10	25	10
0357|12	FSP1	Brother	24	15	20	32	35	8	9	12	12	31	10	25	10
0357|12	FSP5	Brother	24	15	19	32	35	8	9	12	12	31	10	25	10
0357|12	FSP4	Brother	24	15	19	32	35	8	9	12	12	31	10	25	10
0357|12	FSP5	Brother	24	15	19	32	35	8	9	12	12	31	10	25	10
0440|12	F2	Brother	25	20	18	28.?	33	9	9	12	11	29	15	24	12
0440|12	F3	Brother	25	20	18	28.?	33	9	9	12	11	29	15	24	12

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0517|12	FSP1	Brother	23	17	17	33	35	9	10	13	12	30	11	24	10
0517|12	FSP2	Brother	23	17	17	33	35	9	10	13	12	30	11	24	10
0530|12	ISP1	Brother	22	17	17	33	35	9	9	11	12	31	12	24	10
0530|12	ISP2	Brother	22	17	17	33	35	9	9	11	12	31	12	24	10
0538|12	FSP1	Brother	21	17	19	28	34	9	9	12	12	34	12	23	13
0538|12	FSP2	Brother	21	17	19	28	34	9	9	12	12	34	12	23	13
0635|12	FSP2	Brother	21	16	17	35	35	8	9	12	12	27	12	24	11
0635|12	FSP3	Brother	21	16	17	35	35	8	9	12	12	27	12	24	11
0676|12	F	Brother	27	17	21	30	32	9	9	11	12	31	10	26	12
0676|12	FSP2	Brother	27	17	21	30	32	9	9	11	12	31	10	26	12
0703|12	F	Brother	22	19	17	33	34	9	9	13	12	30	11	24	10
0703|12	FSP	Brother	22	20	17	33	34	9	9	13	12	30	11	24	10
0713|12	F1	Brother	22	17	18	33	35	9	10	12	12	29	11	24	10
0713|12	F2	Brother	22	17	18	33	35	9	10	12	12	29	11	24	10
0715|12	FSP1	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0715|12	FSP2	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0715|12	FSP1	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0715|12	FSP3	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0715|12	FSP2	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0715|12	FSP3	Brother	22	19	20	28	33	9	9	13	13	33	12	23	12
0762|12	FSP1	Brother	26	18	18	35	36	10	10	13	12	29	12	25	11
0762|12	FSP2	Brother	26	18	18	35	36	10	10	13	12	29	12	25	11
0891|12	F	Brother	22	19	16	33	35	9	10	13	12	29	11	25	10
0891|12	FSP3	Brother	22	19	16	33	35	9	10	13	12	29	11	25	10
0901a|12	F	Brother	22	18	18	33	35	9	9	13	11	28	10	24	10
0901a|12	FSP2	Brother	22	18	18	33	35	9	9	13	11	28	10	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
0901b|12	ISP3	Brother	22	18	18	33	35	9	9	13	11	28	10	25	10
0901b|12	ISP4	Brother	22	18	18	33	35	9	9	13	11	28	10	24	10
0941|12	FSP1	Brother	21	15	17	34	35	9	9	12	13	31	10	28	12
0941|12	FSP2	Brother	21	15	17	34	35	9	9	12	13	31	10	28	12
0941|12	FSP1	Brother	21	15	17	34	35	9	9	12	13	31	10	28	12
0941|12	FSP3	Brother	21	15	17	34	35	9	9	12	13	32	10	28	12
0941|12	FSP2	Brother	21	15	17	34	35	9	9	12	13	31	10	28	12
0941|12	FSP3	Brother	21	15	17	34	35	9	9	12	13	32	10	28	12
1074|12	F	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	FSP2	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	F	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	FSP3	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	FSP2	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1074|12	FSP3	Brother	22	17	17	33	34	9	10	13	12	30	11	25	10
1268|12	F	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1268|12	FSP2	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1268|12	F	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1268|12	FSP3	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1268|12	FSP2	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1268|12	FSP3	Brother	23	18	15	33	35	9	9	13	12	31	10	24	10
1278|10	F	Brother	28	16	20	29	34	8	10	11	13	27	14	24	11
1278|10	FSP4	Brother	28	16	20	29	34	8	10	11	13	27	14	24	11
1278|11	F	Brother	22	17	16					13		28			
1278|11	FSP	Brother	22	17	16					13		28			
1288|12	FSP1	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11
1288|12	FSP4	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1288|12	FSP1	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11
1288|12	FSP6	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11
1288|12	FSP4	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11
1288|12	FSP6	Brother	24	17	21	28	34	9	9	12	11	32	11	24	11
1342|12	ISP1	Brother	22	18	16	33	36	9	9	13	12	29	11	24	10
1342|12	ISP4	Brother	22	18	16	33	36	9	9	13	12	29	11	24	10
1360|12	FSP1	Brother	21	21	16	32	33	9	9	13	12	29	12	24	10
1360|12	FSP2	Brother	21	21	16	32	33	9	9	13	12	29	12	24	10
1402|12	ISP1	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1402|12	ISP2	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1402|12	ISP1	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1402|12	ISP3	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1402|12	ISP2	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1402|12	ISP3	Brother	24	16	18	33	34	8	10	12	12	28	11	27	13
1453|12	FSP2	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1453|12	FSP3	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1453|12	FSP2	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1453|12	FSP4	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1453|12	FSP3	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1453|12	FSP4	Brother	21	18	18	33	35	9	9	13	13	31	12	24	10
1499|12	ISP3	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12
1499|12	ISP5	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12
1539|12	F	Brother	23	17	18	34	36	9	10	15	12	27	11	24	10
1539|12	FSP1	Brother	23	18	18	34	36	9	10	15	12	27	11	24	10
1549|12	ISP1	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10
1549|12	ISP2	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1549|12	ISP1	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10
1549|12	ISP4	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10
1549|12	ISP2	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10
1549|12	ISP4	Brother	21	19	19	33	35	9	10	12	13	31	12	24	10
1588|12	ISP1	Brother	24	19	17	31	34	8	9	12	11	25	9	25	12
1588|12	ISP2	Brother	24	19	17	31	34	8	9	12	11	25	11	25	12
1602|12	FSP1	Brother	22	16	18	32	33	9	9	13	11	35	10	27	11
1602|12	FSP4	Brother	22	16	18	32	33	9	9	13	11	35	10	27	11
1628|12	ISP1	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1628|12	ISP3	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1628|12	ISP1	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1628|12	ISP4	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1628|12	ISP3	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1628|12	ISP4	Brother	22	17	17	35	35	9	10	14	12	29	11	24	10
1834|12	ISP1	Brother	22	16	20	28	34	9	9	12	12	33	12	23	12
1834|12	ISP2	Brother	22	16	20	28	34	9	9	12	12	33	12	23	12
1878|12	F1	Brother	24	20	18	28	34	9	10	13	13	33	12	24	14
1878|12	F2	Brother	24	19	18	28	34	9	10	13	13	32	12	24	14
1878|12	F1	Brother	24	20	18	28	34	9	10	13	13	33	12	24	14
1878|12	F3	Brother	24	19	18	28	34	9	10	13	13	33	13	24	14
1878|12	F2	Brother	24	19	18	28	34	9	10	13	13	32	12	24	14
1878|12	F3	Brother	24	19	18	28	34	9	10	13	13	33	13	24	14
2156|12	F	Brother	24	16	18	32	33	9	9	13	10	32	10	27	12
2156|12	FSP2	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12
2156|12	F	Brother	24	16	18	32	33	9	9	13	10	32	10	27	12
2156|12	FSP3	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
2156|12	FSP2	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12
2156|12	FSP3	Brother	22	16	18	32	33	9	9	13	10	32	10	27	12
2206|12	FSP1	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2206|12	FSP2	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2206|12	FSP1	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2206|12	FSP3	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2206|12	FSP2	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2206|12	FSP3	Brother	21	20	16	33	35	9	10	12	13	31	11	25	10
2215|12	F	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2215|12	FSP1	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2215|12	F	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2215|12	FSP2	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2215|12	FSP1	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2215|12	FSP2	Brother	22	15	18	34	35	9	9	12	13	33	10	26	12
2237|12	ISP1	Brother	24	15	19	28	34	9	9	12	12	36	12	25	11
2237|12	ISP2	Brother	24	15	19	28	34	9	9	12	12	36	12	25	11
2282|12	F	Brother	22	18	17	33	35	9	10	12	13	30	11	24	11
2282|12	FSP	Brother	22	18	17	33	35	9	10	12	13	30	11	24	11
2288|12	F	Brother	24	17	17	32	35	9	10	13	12	30	11	24	10
2288|12	FSP	Brother	24	17	17	32	35	9	10	13	12	30	11	24	10
2330|12	ISP1	Brother	27	18	22	30	32	9	9	12	12	32	10	25	12
2330|12	ISP3	Brother	27	18	22	30	33	9	9	12	12	32	10	25	12
2330|12	ISP1	Brother	27	18	22	30	32	9	9	12	12	32	10	25	12
2330|12	ISP4	Brother	27	18	22	30	33	9	9	12	12	32	10	25	12
2330|12	ISP3	Brother	27	18	22	30	33	9	9	12	12	32	10	25	12
2330|12	ISP4	Brother	27	18	22	30	33	9	9	12	12	32	10	25	12

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
2337|12	F	Brother	23	17	17	33	36	9	10	13	13	31	12	24	10
2337|12	FSP3	Brother	23	17	17	33	36	9	10	13	13	31	12	24	10
2380|12	F	Brother	26	16	20	34	36	8	9	12	13	29	10	25	11
2380|12	FSP2	Brother	26	16	20	34	36	8	9	12	13	28	10	25	11
2380|12	F	Brother	26	16	20	34	36	8	9	12	13	29	10	25	11
2380|12	FSP3	Brother	26	16	20	34	36	8	9	12	14	28	10	25	11
2380|12	FSP2	Brother	26	16	20	34	36	8	9	12	13	28	10	25	11
2380|12	FSP3	Brother	26	16	20	34	36	8	9	12	14	28	10	25	11
2442|12	F	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2442|12	FSP1	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2442|12	F	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2442|12	FSP2	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2442|12	FSP1	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2442|12	FSP2	Brother	25	18	19	32	34	8	8	12	11	24	11	25	12
2742|12	F	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
2742|12	FSP1	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
2742|12	F	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
2742|12	FSP2	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
2742|12	FSP1	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
2742|12	FSP2	Brother	23	16	17	35	35	8	9	13	13	28	11	25	12
3825|11	FSP2	Brother	23	17	19	34	36	8	9	12	12	28	10	25	11
3825|11	FSP4	Brother	23	17	19	34	36	8	9	12	12	28	10	25	11
4396|11	F	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP1	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	F	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP2	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
4396|11	F	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP3	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP1	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP2	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP1	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP3	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP2	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4396|11	FSP3	Brother	24	19	15	35	36	8	9	12	12	31	9	24	11
4400|11	F	Brother	27	18	22	29	31	9	9	11	12	32	11	26	12
4400|11	FSP2	Brother	27	18	22	29	31	9	9	11	12	32	11	26	12
0043|11	ISP1	Brother	22	19	21	28	32	9	9	13	12	33	13	23	12
0043|11	ISP2	Brother	22	19	21	28	32	9	9	13	12	33	13	23	12
0158|12	F	Brother	21	18	18	33	35	9	9	14	12	30	11	24	10
0158|12	FSP1	Brother	21	18	18	33	35	9	9	14	12	30	11	24	10
0480|11	ISP1	Brother	22	18	19	33	33	9	9	13	12	33	12	23	13
0480|11	ISP2	Brother	22	18	19	33	33	9	9	13	12	33	12	23	13
0613|11	ISP2	Brother	27	18	19	33	36	8	9	13	13	27	11	25	10
0613|11	ISP3	Brother	27	18	19	33	36	8	9	13	13	27	11	25	10
1354|11	FSP1	Brother	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	FSP2	Brother	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	FSP1	Brother	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	FSP3	Brother	23	18	19	33	38	8	9	10	11	29	12	25	11
1354|11	FSP2	Brother	23	18	18	33	38	8	9	10	11	29	12	25	11
1354|11	FSP3	Brother	23	18	19	33	38	8	9	10	11	29	12	25	11
1737|11	ISP2	Brother	22	16	16	33	36	9	10	12	12	30	11	24	10
1737|11	ISP3	Brother	22	16	16	33	36	9	10	12	12	30	11	24	10

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Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1772|11	ISP1	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	ISP2	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	ISP1	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	ISP3	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	ISP2	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
1772|11	ISP3	Brother	22	16	21	28	33	9	9	12	12	31	12	23	12
3144|11	ISP1	Brother	22	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP2	Brother	23	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP1	Brother	22	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP3	Brother	22	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP2	Brother	23	17	18	33	35	9	9	14	12	29	11	26	10
3144|11	ISP3	Brother	22	17	18	33	35	9	9	14	12	29	11	26	10
3428a|11	F	Brother	21	18	18	31	34	9	9	13	13	27	11	26	12
3428a|11	FSP	Brother	21	18	18	31	34	9	9	13	13	27	11	26	12
3428b|11	ISP1	Brother	21	18	18	31	34	9	9	13	13	27	11	26	12
3428b|11	ISP3	Brother	21	18	18	31	34	9	9	13	13	27	11	26	12
3497|11	ISP2	Brother	22	19	17	33	34	9	10	14	13	32	11	25	10
3497|11	ISP3	Brother	22	19	17	33	34	9	10	14	13	32	11	25	10
4090|12	ISP1	Brother	21	18	17	37	39	9	9	12	11	30	10	25	11
4090|12	ISP2	Brother	21	18	17	37	39	9	9	12	11	30	10	25	11
4139|12	ISP1	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	ISP2	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	ISP1	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	ISP3	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	ISP2	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11
4139|12	ISP3	Brother	23	18	17	34	36	9	10	13	12	28	12	24	11

Case	Sample	Relation	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
4155|11	ISP1	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	ISP2	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	ISP1	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	ISP3	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	ISP2	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4155|11	ISP3	Brother	23	18	19	34	38	8	10	10	13	29	14	25	12
4234|12	ISP1	Brother	24	19	17	31	34	8	9	12	11	25	9	25	12
4234|12	ISP2	Brother	24	19	17	31	34	8	9	12	11	25	11	25	12
4234|12	ISP1	Brother	24	19	17	31	34	8	9	12	11	25	9	25	12
4234|12	ISP3	Brother	24	19	17	31	34	8	9	12	11	25	11	25	12
4234|12	ISP2	Brother	24	19	17	31	34	8	9	12	11	25	11	25	12
4234|12	ISP3	Brother	24	19	17	31	34	8	9	12	11	25	11	25	12
4333|11	FSP1	Brother	27	21	22	30	32	9	9	11	12	31	10	26	12
4333|11	FSP2	Brother	27	21	22	30	32	9	9	11	12	31	10	26	12
4425a|12	F	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425a|12	FSP2	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP2	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP3	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP2	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP4	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP3	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4425b|12	ISP4	Brother	24	19	17	32	35	9	10	12	12	31	10	24	12
4523|10	ISP1	Brother	22	19	17	31	34	9	10	13	12	28	10	25	10
4523|10	ISP2	Brother	22	19	17	31	34	9	10	12	12	29	10	25	10

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Table S22. Brothers Loci Set 2

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0152|12	F	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP1	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	F	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP3	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	F	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP4	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP1	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP3	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP1	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP4	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP3	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0152|12	FSP4	Brother	19	21	15	19	31	14	10	12	12	14	24	24	12	13	10
0181|12	ISP1	Brother	17	18	13	20	30	13	9	11	10	14	21	24	10	11	12
0181|12	ISP2	Brother	17	18	13	20	30	13	9	11	10	14	21	24	10	11	12
0219|12	ISP4	Brother	19	21	13	19	29	14	10	14	12	15	23	24	11	13	10
0219|12	ISP5	Brother	19	21	13	19	29	14	10	14	12	15	23	24	11	13	10
0262|12	F	Brother	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
0262|12	FSP	Brother	19	21	13	18	29	12	10	12	12	15	23	23	11	13	10
0263|12	F	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11
0263|12	FSP1	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11
0263|12	F	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11
0263|12	FSP2	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11
0263|12	FSP1	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11
0263|12	FSP2	Brother	17	19	14	21	31	17	10	12	11	14	21	21	12	11	11

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0266|12	F	Brother	17	19	13	20	30	16	10	11	11	14	24	21	10	11	14
0266|12	FSP	Brother	17	19	13	20	30	16	10	11	11	14	24	21	10	11	14
0348|12	F	Brother	18	21	13	20	31	13	10	11	11	14	22	23	12	14	11
0348|12	FSP3	Brother	18	21	13	20	30	13	10	11	11	14	22	23	12	14	11
0356|12	FSP2	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP3	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP2	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP5	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP2	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP6	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP3	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP5	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP3	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP6	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP5	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0356|12	FSP6	Brother	19	22	13	19	29	15	11	13	12	15	23	22	11	13	10
0357|12	FSP1	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0357|12	FSP4	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0357|12	FSP1	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0357|12	FSP5	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0357|12	FSP4	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0357|12	FSP5	Brother	18	19	14	19	30	14	10	11	9	15	22	23	12	11	10
0440|12	F2	Brother	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
0440|12	F3	Brother	18	19	13	20	31	13	10	11	10	14	23	24	12	11	12
0517|12	FSP1	Brother	18	23	13	19	29	14	11	12	12	15	23	24	12	13	11
0517|12	FSP2	Brother	18	23	13	19	29	14	11	12	12	15	23	24	12	13	11

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0530|12	ISP1	Brother	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10
0530|12	ISP2	Brother	18	22	13	19	28	14	10	12	12	15	23	24	12	13	10
0538|12	FSP1	Brother	16	21	14	null	31	13	11	12	10	14	22	24	13	11	12
0538|12	FSP2	Brother	16	21	14	null	31	13	11	12	10	14	22	24	13	11	12
0635|12	FSP2	Brother	17	19	13	18	29	15	10	12	9	16	21	25	11	11	9
0635|12	FSP3	Brother	17	19	13	18	29	15	10	12	9	16	21	25	11	11	9
0676|12	F	Brother	17	18	13	21	29	13	9	11	10	14	21	23	10	11	12
0676|12	FSP2	Brother	17	18	13	21	29	13	9	11	10	14	21	23	10	11	12
0703|12	F	Brother	19	22	13	19	29	14	11	12	12	15	23	24	13	13	9
0703|12	FSP	Brother	19	22	13	19	29	14	11	12	12	15	23	24	13	13	9
0713|12	F1	Brother	18	23	13	18	29	14	11	12	12	14	23	24	12	13	10
0713|12	F2	Brother	18	23	13	18	29	14	11	12	12	14	23	24	12	13	10
0715|12	FSP1	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0715|12	FSP2	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0715|12	FSP1	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0715|12	FSP3	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0715|12	FSP2	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0715|12	FSP3	Brother	16	20	13	20	33	14	10	12	10	14	21	25	12	11	12
0762|12	FSP1	Brother	17	19.2	12	20	28	16	10	12	11	15	23	24	11	11	12
0762|12	FSP2	Brother	17	19.2	12	20	28	16	10	12	11	15	23	24	11	11	12
0891|12	F	Brother	19	21	13	19	29	14	11	12	12	15	23	24	12	13	10
0891|12	FSP3	Brother	19	21	13	19	29	14	11	12	12	15	23	24	12	13	10
0901a|12	F	Brother	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901a|12	FSP2	Brother	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901b|12	ISP3	Brother	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10
0901b|12	ISP4	Brother	19	21	13	19	29	14	10	13	12	14	25	24	12	13	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
0941|12	FSP1	Brother	17	19	12	21	29	15	10	9	10	16	22	22	11	11	11
0941|12	FSP2	Brother	17	19	12	21	29	15	10	9	10	16	22	22	11	11	11
0941|12	FSP1	Brother	17	19	12	21	29	15	10	9	10	16	22	22	11	11	11
0941|12	FSP3	Brother	17	19	12	21	29	15	10	9	10	16	21	22	11	11	11
0941|12	FSP2	Brother	17	19	12	21	29	15	10	9	10	16	22	22	11	11	11
0941|12	FSP3	Brother	17	19	12	21	29	15	10	9	10	16	21	22	11	11	11
1074|12	F	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP2	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	F	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP3	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP2	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1074|12	FSP3	Brother	19	21	13	18	28	15	11	12	12	15	23	23	12	13	10
1268|12	F	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1268|12	FSP2	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1268|12	F	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1268|12	FSP3	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1268|12	FSP2	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1268|12	FSP3	Brother	18	21	13	20	30	15	11	12	9	14	22	23	11	11	10
1278|10	F	Brother	17	21	13	21	31	15	11	11	11	14	21	21	11	11	14
1278|10	FSP4	Brother	17	21	13	21	31	15	11	11	11	14	21	21	11	11	14
1278|11	F	Brother			13	18	29	14	11	12	13	15	23	25	12	12	10
1278|11	FSP	Brother			13	18	29	14	11	12	13	15	23	25	12	12	10
1288|12	FSP1	Brother	17	21	12	20	29	14	10	12	10	14	21	24	10	11	12
1288|12	FSP4	Brother	17	21	12	20	29	14	10	12	10	14	21	24	10	11	12
1288|12	FSP1	Brother	17	21	12	20	29	14	10	12	10	14	21	24	10	11	12
1288|12	FSP6	Brother	17	21	12	21	29	14	10	12	10	14	21	24	10	11	12

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1288|12	FSP4	Brother	17	21	12	20	29	14	10	12	10	14	21	24	10	11	12
1288|12	FSP6	Brother	17	21	12	21	29	14	10	12	10	14	21	24	10	11	12
1342|12	ISP1	Brother	18	22	13	19	29	14	10	13	12	15	24	24	12	13	11
1342|12	ISP4	Brother	18	22	13	19	29	14	11	13	12	15	24	24	12	13	11
1360|12	FSP1	Brother	19	23	13	19	30	15	11	12	12	15	23	24	12	13	10
1360|12	FSP2	Brother	19	23	13	19	30	15	11	12	12	15	23	24	12	13	10
1402|12	ISP1	Brother	17	22	12	21	29	17	10	12	10	16	21	24	11	11	13
1402|12	ISP2	Brother	17	21	12	21	29	17	10	12	10	16	21	24	11	11	13
1402|12	ISP1	Brother	17	22	12	21	29	17	10	12	10	16	21	24	11	11	13
1402|12	ISP3	Brother	17	21	12	21	29	17	10	12	10	16	21	24	11	11	13
1402|12	ISP2	Brother	17	21	12	21	29	17	10	12	10	16	21	24	11	11	13
1402|12	ISP3	Brother	17	21	12	21	29	17	10	12	10	16	21	24	11	11	13
1453|12	FSP2	Brother	18	24	13	19	29	14	11	11	12	15	23	24	12	13	10
1453|12	FSP3	Brother	18	24	13	19	29	14	11	11	12	15	23	25	12	13	10
1453|12	FSP2	Brother	18	24	13	19	29	14	11	11	12	15	23	24	12	13	10
1453|12	FSP4	Brother	18	24	13	19	29	14	11	11	12	15	23	24	12	13	10
1453|12	FSP3	Brother	18	24	13	19	29	14	11	11	12	15	23	25	12	13	10
1453|12	FSP4	Brother	18	24	13	19	29	14	11	11	12	15	23	24	12	13	10
1499|12	ISP3	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
1499|12	ISP5	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
1539|12	F	Brother	18	19	14	19	30	14	11	12	12	15	23	24	13	13	10
1539|12	FSP1	Brother	18	19	14	19	30	14	11	12	12	15	23	24	13	13	10
1549|12	ISP1	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1549|12	ISP2	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1549|12	ISP1	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1549|12	ISP4	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10

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Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1549|12	ISP2	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1549|12	ISP4	Brother	20	20	14	19	31	14	11	12	12	15	23	24	12	13	10
1588|12	ISP1	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
1588|12	ISP2	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
1602|12	FSP1	Brother	18	21	14	20	29	14	10	12	9	14	22	23	11	13	10
1602|12	FSP4	Brother	18	21	14	20	29	14	10	12	9	14	22	23	11	13	10
1628|12	ISP1	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1628|12	ISP3	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1628|12	ISP1	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1628|12	ISP4	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1628|12	ISP3	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1628|12	ISP4	Brother	19	24	14	19	30	14	10	12	12	15	23	24	12	13	10
1834|12	ISP1	Brother	16	22	13	20	30	13	10	13	10	14	24	24	12	11	12
1834|12	ISP2	Brother	16	22	13	20	30	13	10	12	10	14	24	24	12	11	12
1878|12	F1	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
1878|12	F2	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
1878|12	F1	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
1878|12	F3	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
1878|12	F2	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
1878|12	F3	Brother	16	19	13	20	30	14	10	12	10	14	20	23	13	11	12
2156|12	F	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
2156|12	FSP2	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
2156|12	F	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
2156|12	FSP3	Brother	18	21	14	18	31	15	10	12	9	14	21	23	12	13	10
2156|12	FSP2	Brother	18	21	14	19	31	15	10	12	9	14	21	23	12	13	10
2156|12	FSP3	Brother	18	21	14	18	31	15	10	12	9	14	21	23	12	13	10

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Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
2206|12	FSP1	Brother	20	17	13	20	30	16	10	12	11	14	23	25	10	11	10
2206|12	FSP2	Brother	20	17	13	20	30	16	10	12	11	14	23	25	10	11	10
2206|12	FSP1	Brother	20	17	13	20	30	16	10	12	11	14	23	25	10	11	10
2206|12	FSP3	Brother	20	17	13	20	29	16	10	12	11	14	23	25	10	11	10
2206|12	FSP2	Brother	20	17	13	20	30	16	10	12	11	14	23	25	10	11	10
2206|12	FSP3	Brother	20	17	13	20	29	16	10	12	11	14	23	25	10	11	10
2215|12	F	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2215|12	FSP1	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2215|12	F	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2215|12	FSP2	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2215|12	FSP1	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2215|12	FSP2	Brother	17	19	12	21	30	15	10	9	10	16	20	22	12	11	11
2237|12	ISP1	Brother	16	20	13	20	30	13	10	12	10	14	22	23	12	11	13
2237|12	ISP2	Brother	16	20	13	20	30	13	10	12	10	14	22	23	12	11	13
2282|12	F	Brother	19	22	14	19	30	13	11	12	12	15	23	25	12	13	10
2282|12	FSP	Brother	19	22	14	19	30	13	11	12	12	15	23	25	12	13	10
2288|12	F	Brother	19	22	13	19	29	14	11	12	12	15	24	23	11	13	10
2288|12	FSP	Brother	19	22	13	19	29	14	11	12	12	15	24	23	11	13	10
2330|12	ISP1	Brother	17	19	14	20	30	13	9	12	10	14	20	24	10	11	12
2330|12	ISP3	Brother	17	19	14	20	30	13	9	12	10	14	20	23	10	11	12
2330|12	ISP1	Brother	17	19	14	20	30	13	9	12	10	14	20	24	10	11	12
2330|12	ISP4	Brother	17	19	13	20	29	13	9	12	10	14	20	24	10	11	12
2330|12	ISP3	Brother	17	19	14	20	30	13	9	12	10	14	20	23	10	11	12
2330|12	ISP4	Brother	17	19	13	20	29	13	9	12	10	14	20	24	10	11	12
2337|12	F	Brother	19	16	13	20	29	16	10	12	11	14	23	25	10	11	10
2337|12	FSP3	Brother	19	16	13	20	29	16	10	12	11	14	23	25	10	11	10

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
2380|12	F	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2380|12	FSP2	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2380|12	F	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2380|12	FSP3	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2380|12	FSP2	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2380|12	FSP3	Brother	18	19	12	20	28	14	10	11	10	16	21	22	11	11	11
2442|12	F	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2442|12	FSP1	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2442|12	F	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2442|12	FSP2	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2442|12	FSP1	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2442|12	FSP2	Brother	18	20	13	20	32	14	10	11	9	14	20	23	9	11	9
2742|12	F	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
2742|12	FSP1	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
2742|12	F	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
2742|12	FSP2	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
2742|12	FSP1	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
2742|12	FSP2	Brother	18	21	12	19	28	16	11	13	9	16	21	24	12	11	9
3825|11	FSP2	Brother	18	18	12	20	29	14	11	11	10	16	23	22	11	11	12
3825|11	FSP4	Brother	18	18	12	20	29	14	11	11	10	16	23	22	11	11	12
4396|11	F	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP1	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	F	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP2	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	F	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP3	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
4396|11	FSP1	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP2	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP1	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP3	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP2	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4396|11	FSP3	Brother	18	20	13	21	29	14	10	12	9	15	22	25	11	11	11
4400|11	F	Brother	17	18	14	20	30	13	9	11	10	14	21	23	10	11	12
4400|11	FSP2	Brother	17	18	14	20	30	13	9	11	10	14	21	23	10	11	12
0043|11	ISP1	Brother	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0043|11	ISP2	Brother	16	22	13	20	30	13	11	12	10	14	21	23	12	11	12
0158|12	F	Brother	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
0158|12	FSP1	Brother	19	23	13	19	29	14	10	12	12	15	23	24	13	13	10
0480|11	ISP1	Brother	16	20	13	20	30	13	11	12	10	14	22	24	11	11	12
0480|11	ISP2	Brother	16	20	13	20	30	13	11	12	10	14	22	24	11	11	12
0613|11	ISP2	Brother	19	19	13	20	29	14	10	11	10	16	24	22	11	11	12
0613|11	ISP3	Brother	19	19	12	20	28	14	10	11	10	16	24	22	11	11	12
1354|11	FSP1	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	FSP2	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	FSP1	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	FSP3	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	FSP2	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1354|11	FSP3	Brother	16	23	13	21	28	16	10	12	10	15	22	23	13	11	13
1737|11	ISP2	Brother	19	21	13	19	29	14	11	14	12	15	23	24	12	13	10
1737|11	ISP3	Brother	19	21	13	19	29	14	11	14	12	15	23	24	12	13	10
1772|11	ISP1	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	ISP2	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1772|11	ISP1	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	ISP3	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	ISP2	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
1772|11	ISP3	Brother	17	22	13	20	30	13	10	12	10	14	22	24	11	11	12
3144|11	ISP1	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	ISP2	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	ISP1	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	ISP3	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	ISP2	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3144|11	ISP3	Brother	18	21	13	18	29	15	10	12	12	14	23	24	13	13	10
3428a|11	F	Brother	17	19	12	21	28	16	10	10	10	15	21	23	12	12	11
3428a|11	FSP	Brother	17	19	12	21	28	16	10	10	10	15	21	23	12	12	11
3428b|11	ISP1	Brother	17	19	12	21	28	16	10	10	10	15	21	23	12	12	11
3428b|11	ISP3	Brother	17	19	12	21	28	16	10	10	10	15	21	23	12	12	11
3497|11	ISP2	Brother	18	24	13	19	29	14	10	12	12	15	24	24	11	13	9
3497|11	ISP3	Brother	18	23	13	19	29	14	10	12	12	15	24	24	11	13	9
4090|12	ISP1	Brother	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4090|12	ISP2	Brother	17	21	13	20	30	14	10	12	9	15	25	23	11	11	10
4139|12	ISP1	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP2	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP1	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP3	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP2	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4139|12	ISP3	Brother	18	24	14	19	31	14	11	14	12	15	23	25	11	13	10
4155|11	ISP1	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP2	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12

Case	Sample	Relation	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 553	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
4155|11	ISP1	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP3	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP2	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4155|11	ISP3	Brother	16	21	13	21	28	16	10	12	10	15	22	23	11	11	12
4234|12	ISP1	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP2	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP1	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP3	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP2	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4234|12	ISP3	Brother	18	21	14	20	31	14	10	11	10	14	20	23	11	11	9
4333|11	FSP1	Brother	17	19	14	20	30	13	9	11	10	14	21	24	10	11	12
4333|11	FSP2	Brother	17	19	14	20	30	13	9	11	10	14	21	24	10	11	12
4425a|12	F	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425a|12	FSP2	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP2	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP3	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP2	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP4	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP3	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4425b|12	ISP4	Brother	19	22	13	19	29	14	10	12	12	15	23	24	12	13	10
4523|10	ISP1	Brother	20	22	14	19	29	15	11	12	12	15	23	24	13	13	10
4523|10	ISP2	Brother	20	22	14	19	29	15	11	12	12	15	23	24	13	13	10

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Table S23. Brothers Loci Set 3

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0152|12	F	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP1	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	F	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP3	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	F	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP4	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP1	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP3	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP1	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP4	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP3	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0152|12	FSP4	Brother	13	17	11	15	14	12	14		29	11	14	18	50	38
0181|12	ISP1	Brother	13	18	13	14	16	12	14		24	11	16		49	43
0181|12	ISP2	Brother	13	18	13	14	16	12	14		24	11	16		49	43
0219|12	ISP4	Brother	13	17	11	14	17	12	13	15	31	10	12	17	49	41
0219|12	ISP5	Brother	13	17	11	14	17	12	13	15	31	10	12	17	49	40
0262|12	F	Brother	13	15	11	14	16	12	13	15	28	9	13	17	49	37
0262|12	FSP	Brother	13	15	11	14	16	12	13	15	28	9	13	18	49	37
0263|12	F	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39
0263|12	FSP1	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39
0263|12	F	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39
0263|12	FSP2	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39
0263|12	FSP1	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39
0263|12	FSP2	Brother	15	16	17	20	17	11	14		34	12	14	15	49	39

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Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0266|12	F	Brother	14	16	17		17	11	14		31	14	16		53	41
0266|12	FSP	Brother	14	16	17		17	11	14		31	14	16		53	41
0348|12	F	Brother	13	16	14	16	16	11	10	16	33	11	14	17	51	36
0348|12	FSP3	Brother	13	16	14	16	16	11	10	16	33	11	14	17	51	37
0356|12	FSP2	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP3	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP2	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP5	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP2	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP6	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP3	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP5	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP3	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP6	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP5	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0356|12	FSP6	Brother	12	19	11	14	16	12	13	15	30	11	15	16	52	37
0357|12	FSP1	Brother	12	16	13	17	15	13	14	15	32	12	14	17	48	38
0357|12	FSP4	Brother	12	16	13	17	15	13	14	15	32	12	13	17	48	38
0357|12	FSP1	Brother	12	16	13	17	15	13	14	15	32	12	14	17	48	38
0357|12	FSP5	Brother	12	16	13	17	15	13	14	15	32	12	14	17	48	38
0357|12	FSP4	Brother	12	16	13	17	15	13	14	15	32	12	13	17	48	38
0357|12	FSP5	Brother	12	16	13	17	15	13	14	15	32	12	14	17	48	38
0440|12	F2	Brother	12	18	16		15	12	14		26	12	13	14	50	37
0440|12	F3	Brother	12	18	16		15	12	14		26	12	13	14	50	37
0517|12	FSP1	Brother	13	17	12		15	11	14	16	30	13	16		50	40
0517|12	FSP2	Brother	13	17	12		15	11	14	16	30	13	16		50	40

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0530|12	ISP1	Brother	13	16	11	14	15	11	13	14	27	11	13	18	50	42
0530|12	ISP2	Brother	13	16	11	14	15	11	13	14	27	11	13	18	50	42
0538|12	FSP1	Brother	14	16	15	18	17	12	14	17	null	15	16		48	39
0538|12	FSP2	Brother	14	16	15	18	17	12	14	17	null	15	16		48	39
0635|12	FSP2	Brother	12	17	15	17	13	11	15		29	9	11	20	46	40
0635|12	FSP3	Brother	12	17	15	17	13	11	15		29	9	11	20	46	40
0676|12	F	Brother	13	17	13	14	16	12	14		24	11	15		49	41
0676|12	FSP2	Brother	13	17	13	14	16	12	14		24	11	15		49	41
0703|12	F	Brother	13	18	11	14	16	12	14	16	30	9	13	16	50	38
0703|12	FSP	Brother	13	18	11	14	16	12	14	16	30	9	13	16	50	38
0713|12	F1	Brother	13	16	11	14	15	12	14	15	30	12	18		52	39
0713|12	F2	Brother	13	16	11	14	15	12	14	15	30	12	18		52	39
0715|12	FSP1	Brother	13	15	16		16	12	14	15	26	15	16		49	43
0715|12	FSP2	Brother	13	15	16		16	12	14	15	26	15	16		49	43
0715|12	FSP1	Brother	13	15	16		16	12	14	15	26	15	16		49	43
0715|12	FSP3	Brother	13	15	16		16	12	14	15	26	15	17		49	43
0715|12	FSP2	Brother	13	15	16		16	12	14	15	26	15	16		49	43
0715|12	FSP3	Brother	13	15	16		16	12	14	15	26	15	17		49	43
0762|12	FSP1	Brother	13	16	12	14	15	11	13		27	10	15	17	47	40
0762|12	FSP2	Brother	13	16	12	14	15	11	13		27	10	16	17	47	40
0891|12	F	Brother	13	17	11	13	15	12	15	17	29	11	13	18	50	37
0891|12	FSP3	Brother	13	17	11	13	15	12	15	16	29	11	13	18	50	37
0901a|12	F	Brother	13	16	11	14	15	12	14	16	29	10	13	16	50	39
0901a|12	FSP2	Brother	13	16	11	14	16	12	14	16	29	10	13	16	50	39
0901b|12	ISP3	Brother	13	15	11	14	16	12	14	16	29	10	13	16	50	38
0901b|12	ISP4	Brother	13	16	11	14	16	12	14	16	29	10	13	16	50	38

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Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
0941|12	FSP1	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
0941|12	FSP2	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
0941|12	FSP1	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
0941|12	FSP3	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
0941|12	FSP2	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
0941|12	FSP3	Brother	14	15	14	15	15	12	13.2	15	33	13	16		46	36
1074|12	F	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP2	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	F	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP3	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP2	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1074|12	FSP3	Brother	13	19	11	14	17	13	14	17	28	11	14	17	50	38
1268|12	F	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1268|12	FSP2	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1268|12	F	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1268|12	FSP3	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1268|12	FSP2	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1268|12	FSP3	Brother	12	17	13	15	17	12	15		30	10	12	17	47	39
1278|10	F	Brother	13	16	17		15	12	15	16	29	13	16		51	38
1278|10	FSP4	Brother	13	16	17		15	12	15	16	29	13	16		51	38
1278|11	F	Brother	13	16	12	15	15	12	14	15	29	12	13	17	51	37
1278|11	FSP	Brother	13	16	12	15	15	12	14	15	29	12	13	17	51	37
1288|12	FSP1	Brother	13	14	17		15	11	13	16	25	11	14		49	40
1288|12	FSP4	Brother	13	14	17		15	11	13	16	25	11	14		49	40
1288|12	FSP1	Brother	13	14	17		15	11	13	16	25	11	14		49	40
1288|12	FSP6	Brother	13	14	17		15	11	13	16	25	11	14		48	40

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1288|12	FSP4	Brother	13	14	17		15	11	13	16	25	11	14		49	40
1288|12	FSP6	Brother	13	14	17		15	11	13	16	25	11	14		48	40
1342|12	ISP1	Brother	13	17	11	13	16	12	14	15	28	10	12	16	49	38
1342|12	ISP4	Brother	13	17	11	13	16	12	14	15	28	10	12	16	49	38
1360|12	FSP1	Brother	14	18	11	15	16	12	14	15	29	10	15	16	49	38
1360|12	FSP2	Brother	14	18	11	15	16	12	14	15	29	10	15	16	49	38
1402|12	ISP1	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1402|12	ISP2	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1402|12	ISP1	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1402|12	ISP3	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1402|12	ISP2	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1402|12	ISP3	Brother	13	16	13	17	14	10	13	14	28	12	16	17	50	39
1453|12	FSP2	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1453|12	FSP3	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1453|12	FSP2	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1453|12	FSP4	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1453|12	FSP3	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1453|12	FSP4	Brother	13	15	12	14	15	11	14	16	28	10	13	17	51	37
1499|12	ISP3	Brother	12	17	14		15	11	14	15	29	10	18	21	44	34
1499|12	ISP5	Brother	12	17	14		15	11	14	15	29	10	18	21	44	34
1539|12	F	Brother	12	16	12	14	16	14	15		30	12	14	16	49	35
1539|12	FSP1	Brother	12	16	12	14	16	14	15		30	12	14	16	49	35
1549|12	ISP1	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40
1549|12	ISP2	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40
1549|12	ISP1	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40
1549|12	ISP4	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1549|12	ISP2	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40
1549|12	ISP4	Brother	12	15	12	14	15	13	14	15	30	11	12	15	49	40
1588|12	ISP1	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
1588|12	ISP2	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
1602|12	FSP1	Brother	13	17	14	17	15	10	13	15	30	11	14	18	45	35
1602|12	FSP4	Brother	13	17	14	17	15	10	13	15	30	11	14	18	45	35
1628|12	ISP1	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1628|12	ISP3	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1628|12	ISP1	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1628|12	ISP4	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1628|12	ISP3	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1628|12	ISP4	Brother	13	16	11	14	16	12	14	15	29	9	12	17	52	39
1834|12	ISP1	Brother	13	15	16	18	17	11	14	17	25	15	17	18	51	41
1834|12	ISP2	Brother	13	15	16	18	17	11	14	17	25	15	17	18	51	41
1878|12	F1	Brother	13	16	18	18	15	13	15		25	13		16	51	37
1878|12	F2	Brother	13	16	18	18	15	13	15		25	13		16	51	37
1878|12	F1	Brother	13	16	18	18	15	13	15		25	13		16	51	37
1878|12	F3	Brother	13	16	18	19	15	13	15		25	13	15	16	51	37
1878|12	F2	Brother	13	16	18	18	15	13	15		25	13		16	51	37
1878|12	F3	Brother	13	16	18	19	15	13	15		25	13	15	16	51	37
2156|12	F	Brother	12	17	14		15	11	14	15	28	10	17	21	45	34
2156|12	FSP2	Brother	12	17	14		15	11	14	15	28	10	17	21	45	35
2156|12	F	Brother	12	17	14		15	11	14	15	28	10	17	21	45	34
2156|12	FSP3	Brother	12	17	14		15	11	14	15	28	10	17	21	45	34
2156|12	FSP2	Brother	12	17	14		15	11	14	15	28	10	17	21	45	35
2156|12	FSP3	Brother	12	17	14		15	11	14	15	28	10	17	21	45	34

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
2206|12	FSP1	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2206|12	FSP2	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2206|12	FSP1	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2206|12	FSP3	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2206|12	FSP2	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2206|12	FSP3	Brother	13	15	11	14	17	12	14	15	33	10	14	17	51	43
2215|12	F	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2215|12	FSP1	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2215|12	F	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2215|12	FSP2	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2215|12	FSP1	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2215|12	FSP2	Brother	14	18	14	15	15	12	13.2	17	34	14	17		47	38
2237|12	ISP1	Brother	13	16	16		16	11	13	15	25	11	15	17	52	39
2237|12	ISP2	Brother	13	16	16		16	11	13	15	25	11	15	17	52	39
2282|12	F	Brother	13	17	11	14	15	12	14	16	29	11	14	16	49	39
2282|12	FSP	Brother	13	17	11	14	15	12	14	16	29	11	14	16	50	38
2288|12	F	Brother	13	18	11	14	15	12	15	16	29	12	13	14	48	37
2288|12	FSP	Brother	13	18	11	14	15	12	15	16	29	12	13	14	48	37
2330|12	ISP1	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2330|12	ISP3	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2330|12	ISP1	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2330|12	ISP4	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2330|12	ISP3	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2330|12	ISP4	Brother	13	18	13		17	12	14		24	11	15	16	49	41
2337|12	F	Brother	13	15	11	15	16	13	14	15	34	10	14	17	53	41
2337|12	FSP3	Brother	13	15	11	15	16	13	14	15	34	10	14	17	53	41

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
2380|12	F	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2380|12	FSP2	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2380|12	F	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2380|12	FSP3	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2380|12	FSP2	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2380|12	FSP3	Brother	13	15	13	14	15	12	12	14		32	11	16		47	38
2442|12	F	Brother	12	16.2	13	17	15	11	12	13		30	13	15	18	55	39
2442|12	FSP1	Brother	12	16.2	13	17	16	11	12	13		30	13	15	18	55	39
2442|12	F	Brother	12	16.2	13	17	15	11	12	13		30	13	15	18	55	39
2442|12	FSP2	Brother	12	16.2	13	17	15	11	12	13		30	13	15	18	55	39
2442|12	FSP1	Brother	12	16.2	13	17	16	11	12	13		30	13	15	18	55	39
2442|12	FSP2	Brother	12	16.2	13	17	15	11	12	13		30	13	15	18	55	39
2742|12	F	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
2742|12	FSP1	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
2742|12	F	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
2742|12	FSP2	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
2742|12	FSP1	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
2742|12	FSP2	Brother	12	17	14	18	13	11	15			29	10	13	16	45	38
3825|11	FSP2	Brother	13	16	13	14	13	11	12	14		30	10	16	20	47	36
3825|11	FSP4	Brother	13	16	13	14	13	11	12	14		30	10	16	20	47	36
4396|11	F	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP1	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	F	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP2	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	F	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP3	Brother	12	21	13		15	11	15			33	9	13	16	48	38

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
4396|11	FSP1	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP2	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP1	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP3	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP2	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4396|11	FSP3	Brother	12	21	13		15	11	15			33	9	13	16	48	38
4400|11	F	Brother	13	17	13	14	16	12	14			24	15			50	42
4400|11	FSP2	Brother	13	17	13	14	16	12	14			24	15			50	42
0043|11	ISP1	Brother	13	15	15	18	17	12	14			25	14	16	18	51	40
0043|11	ISP2	Brother	13	15	15	18	17	12	14	15		25	14	16	18	51	40
0158|12	F	Brother	13	17	11	14	18	12	14	16		29	12	13	18	51	39
0158|12	FSP1	Brother	13	17	11	14	18	12	14	16		29	12	13	18	51	39
0480|11	ISP1	Brother	13	15	17	19	18	11	15			24	13	15	18	49	39
0480|11	ISP2	Brother	13	15	17	19	18	11	15			24	13	15	18	49	39
0613|11	ISP2	Brother	13	15	13	14	15	11	12	15		31	10	16	19	47	39
0613|11	ISP3	Brother	13	15	13	14	15	11	12	15		31	10	16	19	47	39
1354|11	FSP1	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	FSP2	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	FSP1	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	FSP3	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	FSP2	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1354|11	FSP3	Brother	13	18	12		14	11	15			30	10	14	17	48	36
1737|11	ISP2	Brother	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1737|11	ISP3	Brother	13	19	11	14	16	12	14	15		30	11	14	16	48	37
1772|11	ISP1	Brother	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP2	Brother	13	16	16	17	16	13	15	17		25	12	16	17	48	41

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1			DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
1772|11	ISP1	Brother	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP3	Brother	13	16	16	17	16	13	15	17		(25)	12	16	17	48	42
1772|11	ISP2	Brother	13	16	16	17	16	13	15	17		25	12	16	17	48	41
1772|11	ISP3	Brother	13	16	16	17	16	13	15	17		(25)	12	16	17	48	42
3144|11	ISP1	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	ISP2	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	ISP1	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	ISP3	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	ISP2	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3144|11	ISP3	Brother	13	16	11	14	16	11	14	16		30	11	12	20	49	38
3428a|11	F	Brother	14	16	13	15	15	13	12.2	14		29	16	18		46	36
3428a|11	FSP	Brother	14	16	13	15	15	13	12.2	14		29	16	18		46	36
3428b|11	ISP1	Brother	14	16	13	15	15	13	12.2	14		29	16	18		46	36
3428b|11	ISP3	Brother	14	16	13	15	15	13	12.2	14		29	16	18		46	36
3497|11	ISP2	Brother	14	18	12	14	16	12	14	16		31	11	13	17	50	37
3497|11	ISP3	Brother	14	18	12	14	16	12	14	16		31	11	13	17	50	37
4090|12	ISP1	Brother	12	18	13	17	14	11	13	16		31	11	13	16	46	40
4090|12	ISP2	Brother	12	18	13	17	14	11	13	16		31	11	13	16	46	40
4139|12	ISP1	Brother	13	18	11	14	16	12	15	16		29	11	14	16	50	39
4139|12	ISP2	Brother	13	18	11	14	16	12	15	17		29	11	14	16	50	39
4139|12	ISP1	Brother	13	18	11	14	16	12	15	16		29	11	14	16	50	39
4139|12	ISP3	Brother	13	18	11	14	16	12	15	16		29	11	14	16	50	39
4139|12	ISP2	Brother	13	18	11	14	16	12	15	17		29	11	14	16	50	39
4139|12	ISP3	Brother	13	18	11	14	16	12	15	16		29	11	14	16	50	39
4155|11	ISP1	Brother	13	16	12		14	12	14			31	12	15	17	49	37
4155|11	ISP2	Brother	13	16	12		14	12	14			31	12	15	17	49	37

Case	Sample	Relation	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1		DYS 626	DYF 403S1A			DYF 403S1B	DYS 518
4155|11	ISP1	Brother	13	16	12		14	12	14		31	12	15	17	49	37
4155|11	ISP3	Brother	13	16	12		14	12	14		31	12	15	17	49	37
4155|11	ISP2	Brother	13	16	12		14	12	14		31	12	15	17	49	37
4155|11	ISP3	Brother	13	16	12		14	12	14		31	12	15	17	49	37
4234|12	ISP1	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP2	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP1	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP3	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP2	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4234|12	ISP3	Brother	12	18.2	13	16	15	11	14	15	33	15	17		54	39
4333|11	FSP1	Brother	13	17	13	14	16	12	15	17	24	10	15	16	51	42
4333|11	FSP2	Brother	13	17	13	14	16	12	15	17	24	10	15	16	51	42
4425a|12	F	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425a|12	FSP2	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP2	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP3	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP2	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP4	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP3	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4425b|12	ISP4	Brother	13	16	11	14	16	12	14		30	12	13	18	49	39
4523|10	ISP1	Brother	13	18	11	15	15	12	15	16	28	11	14	17	48	40
4523|10	ISP2	Brother	13	18	11	15	15	12	15	16	28	11	14	17	48	40

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Table S24. Brothers Loci Set 4

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
0152|12	F	Brother	14	38	20	24/24.1	25			38		48	35	36	
0152|12	FSP1	Brother	14	38	20	25	25.1			38		48	35	36	
0152|12	F	Brother	14	38	20	24/24.1	25			38		48	35	36	
0152|12	FSP3	Brother	14	38	20	25	25.1			38		46	35	36	
0152|12	F	Brother	14	38	20	24/24.1	25			38		48	35	36	
0152|12	FSP4	Brother	14	38	20	25	25.1			38		48	35	36	
0152|12	FSP1	Brother	14	38	20	25	25.1			38		48	35	36	
0152|12	FSP3	Brother	14	38	20	25	25.1			38		46	35	36	
0152|12	FSP1	Brother	14	38	20	25	25.1			38		48	35	36	
0152|12	FSP4	Brother	14	38	20	25	25.1			38		48	35	36	
0152|12	FSP3	Brother	14	38	20	25	25.1			38		46	35	36	
0152|12	FSP4	Brother	14	38	20	25	25.1			38		48	35	36	
0181|12	ISP1	Brother	12	36	18	22	24/24.1			32		49	36	37	
0181|12	ISP2	Brother	12	36	18	22	24/24.1			32		49	36	37	
0219|12	ISP4	Brother	14	39	22	24	24.1			38		48	35	36	
0219|12	ISP5	Brother	14	40	22	24	25/25.1			38		48	35	36	
0262|12	F	Brother	14	39	21	24/24.1				38		50	35	36	
0262|12	FSP	Brother	14	39	21	24/24.1				38		49	35	36	
0263|12	F	Brother	13	37	21	24				32		50	39		
0263|12	FSP1	Brother	13	37	21	24				32		50	39		
0263|12	F	Brother	13	37	21	24				32		50	39		
0263|12	FSP2	Brother	13	37	21	24				32		50	39		
0263|12	FSP1	Brother	13	37	21	24				32		50	39		
0263|12	FSP2	Brother	13	37	21	24				32		50	39		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B	DYS 547	DYF 387S1		
0266|12	F	Brother	14	39	22	25					33	48	37	38	
0266|12	FSP	Brother	14	39	22	25					33	48	37	38	
0348|12	F	Brother	15	34	21	22	27/27.1				36	43	35	38	
0348|12	FSP3	Brother	15	34	21	22	27/27.1				36	43	35	38	
0356|12	FSP2	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP3	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP2	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP5	Brother	14	36	23	24	25/25.1				37	48	35	36	
0356|12	FSP2	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP6	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP3	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP5	Brother	14	36	23	24	25/25.1				37	48	35	36	
0356|12	FSP3	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP6	Brother	14	37	23	24	25/25.1				37	48	35	36	
0356|12	FSP5	Brother	14	36	23	24	25/25.1				37	48	35	36	
0356|12	FSP6	Brother	14	37	23	24	25/25.1				37	48	35	36	
0357|12	FSP1	Brother	13	33	20	22	27				34	47	39	40	
0357|12	FSP4	Brother	13	35	20	22	27				34	47	39	40	
0357|12	FSP1	Brother	13	33	20	22	27				34	47	39	40	
0357|12	FSP5	Brother	13	35	20	22	27				34	47	39	40	
0357|12	FSP4	Brother	13	35	20	22	27				34	47	39	40	
0357|12	FSP5	Brother	13	35	20	22	27				34	47	39	40	
0440|12	F2	Brother	8	33	22	25/25.1	26				30	46	37		
0440|12	F3	Brother	8	33	22	25/25.1	26				30	46	37		
0517|12	FSP1	Brother	14	37	22	24	24.1				36	47	36	37	
0517|12	FSP2	Brother	14	37	22	24	24.1				36	47	36	37	

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Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B	DYS 547	DYF 387S1		
0530|12	ISP1	Brother	14	39	21	23	26/26.1				36	49	36		
0530|12	ISP2	Brother	14	39	21	23	26/26.1				36	49	36		
0538|12	FSP1	Brother	12	36	19	26					32	50	34	37	
0538|12	FSP2	Brother	12	36	19	26					32	50	34	37	
0635|12	FSP2	Brother	12	39	21.1?	22	23				35	49	37	38	
0635|12	FSP3	Brother	12	39	21.1?	22	23				35	49	37	38	
0676|12	F	Brother	12	37	19	23	25/25.1				32	49	36	37	
0676|12	FSP2	Brother	12	38	19	23	24/24.1				32	49	36	37	
0703|12	F	Brother	14	37	22	24	26/26.1				36	47	35	36	
0703|12	FSP	Brother	14	37	22	24	26/26.1				36	47	35	36	
0713|12	F1	Brother	14	33	21	22	28/28.1?				35	48	36	37	
0713|12	F2	Brother	14	33	21	22	28/28.1?				35	48	36	37	
0715|12	FSP1	Brother	12	39	21	22	24/24.1				34	49	36	38	
0715|12	FSP2	Brother	12	39	21	22	24/24.1				34	49	36	38	
0715|12	FSP1	Brother	12	39	21	22	24/24.1				34	49	36	38	
0715|12	FSP3	Brother	12	39	21	22	24/24.1				34	49	36	38	
0715|12	FSP2	Brother	12	39	21	22	24/24.1				34	49	36	38	
0715|12	FSP3	Brother	12	39	21	22	24/24.1				34	49	36	38	
0762|12	FSP1	Brother	12	39	22						32	47	37		
0762|12	FSP2	Brother	12	39	22						32	47	37		
0891|12	F	Brother	14	37	22	23	25/25.1				36	49	36		
0891|12	FSP3	Brother	14	39	22	23	25/25.1				36	48	36		
0901a|12	F	Brother	14	39	22	24	26/26.1				37	47	35	36	
0901a|12	FSP2	Brother	14	39	22	23	26/26.1				37	47	35	36	
0901b|12	ISP3	Brother	14	39	22	23	27.1				37	47	35	36	
0901b|12	ISP4	Brother	14	38	22	23	27.1				37	47	35	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
0941|12	FSP1	Brother	13	33	17.2	19.1	23				34		48	36	40	
0941|12	FSP2	Brother	13	33	17.2	20.1	23				34		48	36	40	
0941|12	FSP1	Brother	13	33	17.2	19.1	23				34		48	36	40	
0941|12	FSP3	Brother	13	33	17.2	19.1	23				34		48	36	39	
0941|12	FSP2	Brother	13	33	17.2	20.1	23				34		48	36	40	
0941|12	FSP3	Brother	13	33	17.2	19.1	23				34		48	36	39	
1074|12	F	Brother	14	38	21	23	24.1				37		46	35	36	
1074|12	FSP2	Brother	14	38	21	23	24.1				37		46	35	36	
1074|12	F	Brother	14	38	21	23	24.1				37		46	35	36	
1074|12	FSP3	Brother	14	38	21	23	24.1				37		46	35	36	
1074|12	FSP2	Brother	14	38	21	23	24.1				37		46	35	36	
1074|12	FSP3	Brother	14	38	21	23	24.1				37		46	35	36	
1268|12	F	Brother	14	37	19	23	24/24.1				34		49	40		
1268|12	FSP2	Brother	14	37	19	23	24/24.1				34		49	40		
1268|12	F	Brother	14	37	19	23	24/24.1				34		49	40		
1268|12	FSP3	Brother	14	37	19	23	24/24.1				34		49	40		
1268|12	FSP2	Brother	14	37	19	23	24/24.1				34		49	40		
1268|12	FSP3	Brother	14	37	19	23	24/24.1				34		49	40		
1278|10	F	Brother	14	35	20	22	24				34		49	38	39	
1278|10	FSP4	Brother	14	35	20	22	24				34		49	38	39	
1278|11	F	Brother	14	40	21	24	26.1				38		49	36		
1278|11	FSP	Brother	14	40	21	24	26.1				38		49	36		
1288|12	FSP1	Brother	14	35	21	21.1	23				35		50	36	37	
1288|12	FSP4	Brother	14	35	21	21.1	23				35		50	36	37	
1288|12	FSP1	Brother	14	35	21	21.1	23				35		50	36	37	
1288|12	FSP6	Brother	14	35	21	21.1	23				35		50	36	37	

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Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
1288|12	FSP4	Brother	14	35	21	21.1	23			35		50	36	37	
1288|12	FSP6	Brother	14	35	21	21.1	23			35		50	36	37	
1342|12	ISP1	Brother	14	36	19	24	27.1			37		47	35	37	
1342|12	ISP4	Brother	14	36	19	24	27.1			37		47	35	37	
1360|12	FSP1	Brother	15	36	19	24	25/25.1			39		48	36		
1360|12	FSP2	Brother	15	36	19	24	25/25.1			39		48	36		
1402|12	ISP1	Brother	15	37	21	22				36		45	33	38	
1402|12	ISP2	Brother	15	37	21	22				36		45	33	38	
1402|12	ISP1	Brother	15	37	21	22				36		45	33	38	
1402|12	ISP3	Brother	15	37	21	22				36		45	33	38	
1402|12	ISP2	Brother	15	37	21	22				36		45	33	38	
1402|12	ISP3	Brother	15	37	21	22				36		45	33	38	
1453|12	FSP2	Brother	14	38	22	24	25/25.1			37		48	36		
1453|12	FSP3	Brother	14	38	22	24	25/25.1			37		48	36		
1453|12	FSP2	Brother	14	38	22	24	25/25.1			37		48	36		
1453|12	FSP4	Brother	14	38	22	24	25/25.1			37		48	36		
1453|12	FSP3	Brother	14	38	22	24	25/25.1			37		48	36		
1453|12	FSP4	Brother	14	38	22	24	25/25.1			37		48	36		
1499|12	ISP3	Brother	12	37	23	23.1	25.1			34		44	38		
1499|12	ISP5	Brother	12	37	23	23.1	25.1			34		45	38		
1539|12	F	Brother	14	36	21	22				37		48	35	36	
1539|12	FSP1	Brother	14	36	21	22				37		48	35	36	
1549|12	ISP1	Brother	15	35	21	23	24.1			39		48	35	36	
1549|12	ISP2	Brother	15	35	21	24	24.1			39		48	35	36	
1549|12	ISP1	Brother	15	35	21	23	24.1			39		48	35	36	
1549|12	ISP4	Brother	15	35	21	23	24.1			39		48	35	36	

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Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1					DYS 526B		DYS 547	DYF 387S1		
1549|12	ISP2	Brother	15	35	21	24	24.1			39		48	35	36	
1549|12	ISP4	Brother	15	35	21	23	24.1			39		48	35	36	
1588|12	ISP1	Brother	16	36	19	21	24.1			38		53	36	38	
1588|12	ISP2	Brother	16	36	19	21	24.1			38		53	36	38	
1602|12	FSP1	Brother	12	37	23	23.1	25.1			35		44	37	39	
1602|12	FSP4	Brother	12	37	23	23.1	25.1			35		44	37	39	
1628|12	ISP1	Brother	15	37	21	26	27.1			39		46	37		
1628|12	ISP3	Brother	15	37	21	26	27.1			39		46	37		
1628|12	ISP1	Brother	15	37	21	26	27.1			39		46	37		
1628|12	ISP4	Brother	15	37	21	26	27.1			39		46	37		
1628|12	ISP3	Brother	15	37	21	26	27.1			39		46	37		
1628|12	ISP4	Brother	15	37	21	26	27.1			39		46	37		
1834|12	ISP1	Brother	12	38	22	24	28/28.1			33		48	35	38	
1834|12	ISP2	Brother	12	38	22	24	28/28.1			33		48	35	38	
1878|12	F1	Brother	12	33	22	24	25/25.1			32		53	35	37	
1878|12	F2	Brother	12	33	22	24	25/25.1			32		53	35	37	
1878|12	F1	Brother	12	33	22	24	25/25.1			32		53	35	37	
1878|12	F3	Brother	12	33	22	24	25.1			32		53	35	37	
1878|12	F2	Brother	12	33	22	24	25/25.1			32		53	35	37	
1878|12	F3	Brother	12	33	22	24	25.1			32		53	35	37	
2156|12	F	Brother	12	36	23.1	24	25/25.1			34		44	38		
2156|12	FSP2	Brother	12	37	23.1	24	25.1			34		44	38		
2156|12	F	Brother	12	36	23.1	24	25/25.1			34		44	38		
2156|12	FSP3	Brother	12	37	23.1	24	25/25.1			34		44	38		
2156|12	FSP2	Brother	12	37	23.1	24	25.1			34		44	38		
2156|12	FSP3	Brother	12	37	23.1	24	25/25.1			34		44	38		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B	DYS 547	DYF 387S1		
2206|12	FSP1	Brother	15	37	19	21	24.1				40	48	37	38	
2206|12	FSP2	Brother	15	37	19	21	24.1				40	48	37	38	
2206|12	FSP1	Brother	15	37	19	21	24.1				40	48	37	38	
2206|12	FSP3	Brother	15	37	19	21	24.1				40	48	37	38	
2206|12	FSP2	Brother	15	37	19	21	24.1				40	48	37	38	
2206|12	FSP3	Brother	15	37	19	21	24.1				40	48	37	38	
2215|12	F	Brother	13	32	16.2	19.1	21				35	49	39	40	
2215|12	FSP1	Brother	13	32	16.2	19.1	21				35	49	39	41	
2215|12	F	Brother	13	32	16.2	19.1	21				35	49	39	40	
2215|12	FSP2	Brother	13	32	16.2	19.1	21				35	49	39	40	
2215|12	FSP1	Brother	13	32	16.2	19.1	21				35	49	39	41	
2215|12	FSP2	Brother	13	32	16.2	19.1	21				35	49	39	40	
2237|12	ISP1	Brother	12	38	20	23	24.1				32	49	35	37	
2237|12	ISP2	Brother	12	38	20	23	24.1				32	49	35	37	
2282|12	F	Brother	15	37	22	25.1	26				39	49	36		
2282|12	FSP	Brother	15	37	22	25.1	26				39	49	36		
2288|12	F	Brother	12	35	22	24	25/25.1				35	50	35	36	
2288|12	FSP	Brother	12	35	22	24	25/25.1				35	50	35	36	
2330|12	ISP1	Brother	12	37	19	22	24/24.1				34	49	36	37	
2330|12	ISP3	Brother	12	37	19	22	24/24.1				34	49	36	37	
2330|12	ISP1	Brother	12	37	19	22	24/24.1				34	49	36	37	
2330|12	ISP4	Brother	12	37	19	22	24/24.1				34	49	36	37	
2330|12	ISP3	Brother	12	37	19	22	24/24.1				34	49	36	37	
2330|12	ISP4	Brother	12	37	19	22	24/24.1				34	49	36	37	
2337|12	F	Brother	16	35	22	23	23.1				40	47	36	37	
2337|12	FSP3	Brother	16	35	22	23	23.1				40	47	36		

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
2380|12	F	Brother	16	35	20	22					37		45	37	38	
2380|12	FSP2	Brother	16	35	20	22					37		45	37	38	
2380|12	F	Brother	16	35	20	22					37		45	37	38	
2380|12	FSP3	Brother	16	35	20	22					37		45	37	38	
2380|12	FSP2	Brother	16	35	20	22					37		45	37	38	
2380|12	FSP3	Brother	16	35	20	22					37		45	37	38	
2442|12	F	Brother	16	35	20	21	23.1				38		49	37	38	
2442|12	FSP1	Brother	16	35	20	21	23.1				38		49	37	38	
2442|12	F	Brother	16	35	20	21	23.1				38		49	37	38	
2442|12	FSP2	Brother	16	35	20	21	23.1				38		49	37	38	
2442|12	FSP1	Brother	16	35	20	21	23.1				38		49	37	38	
2442|12	FSP2	Brother	16	35	20	21	23.1				38		49	37	38	
2742|12	F	Brother	12	40	23	23.1	24				36		50	38		
2742|12	FSP1	Brother	12	40	23	23.1	24				36		50	38		
2742|12	F	Brother	12	40	23	23.1	24				36		50	38		
2742|12	FSP2	Brother	12	40	23	23.1	24				36		50	38		
2742|12	FSP1	Brother	12	40	23	23.1	24				36		50	38		
2742|12	FSP2	Brother	12	40	23	23.1	24				36		50	38		
3825|11	FSP2	Brother	16	36	21	23	25				37		47	37	38	
3825|11	FSP4	Brother	16	36	21	23	25				37		47	37	38	
4396|11	F	Brother	14	35	21	21.1					37		48	35	36	
4396|11	FSP1	Brother	14	35	21	21.1					37		48	35	36	
4396|11	F	Brother	14	35	21	21.1					37		48	35	36	
4396|11	FSP2	Brother	14	35	21	21.1					37		48	35	36	
4396|11	F	Brother	14	35	21	21.1					37		48	35	36	
4396|11	FSP3	Brother	14	35	21	21.1					37		48	35	36	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B	DYS 547	DYF 387S1	
4396|11	FSP1	Brother	14	35	21	21.1					37	48	35	36
4396|11	FSP2	Brother	14	35	21	21.1					37	48	35	36
4396|11	FSP1	Brother	14	35	21	21.1					37	48	35	36
4396|11	FSP3	Brother	14	35	21	21.1					37	48	35	36
4396|11	FSP2	Brother	14	35	21	21.1					37	48	35	36
4396|11	FSP3	Brother	14	35	21	21.1					37	48	35	36
4400|11	F	Brother	12	36	21	22	24/24.1				31	49	36	38
4400|11	FSP2	Brother	12	36	21	22	24/24.1				32	49	36	38
0043|11	ISP1	Brother	12	40	19	25	25.1				32	50	35	37
0043|11	ISP2	Brother	12	40	19	25	25.1				32	50	35	37
0158|12	F	Brother	15	38	21	22	25.1				39	47	35	36
0158|12	FSP1	Brother	15	38	21	22	25.1				39	47	35	36
0480|11	ISP1	Brother	12	36	24.1						33	48	34	
0480|11	ISP2	Brother	12	36	24.1						33	48	34	
0613|11	ISP2	Brother	16	36	22						37	44	37	38
0613|11	ISP3	Brother	16	36	22						37	44	37	38
1354|11	FSP1	Brother	14	39	22	23	25				35	47	35	
1354|11	FSP2	Brother	14	39	22	23	25				35	47	35	
1354|11	FSP1	Brother	14	39	22	23	25				35	47	35	
1354|11	FSP3	Brother	14	39	22	23	25				35	47	35	
1354|11	FSP2	Brother	14	39	22	23	25				35	47	35	
1354|11	FSP3	Brother	14	39	22	23	25				35	47	35	
1737|11	ISP2	Brother	15	36	22	24	27.1				38	51	36	
1737|11	ISP3	Brother	15	36	22	24	27.1				38	51	36	
1772|11	ISP1	Brother	12	38	19	23	26.1				32	52	35	38
1772|11	ISP2	Brother	12	38	19	23	26.1				32	52	35	38

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
1772|11	ISP1	Brother	12	38	19	23	26.1				32		52	35	38	
1772|11	ISP3	Brother	12	38	19	23	26.1				32		52	35	38	
1772|11	ISP2	Brother	12	38	19	23	26.1				32		52	35	38	
1772|11	ISP3	Brother	12	38	19	23	26.1				32		52	35	38	
3144|11	ISP1	Brother	14	35	21	23	26.1				36		49	35	36	
3144|11	ISP2	Brother	14	35	21	23	26.1				36		49	35	36	
3144|11	ISP1	Brother	14	35	21	23	26.1				36		49	35	36	
3144|11	ISP3	Brother	14	35	21	23	26.1				36		49	35	36	
3144|11	ISP2	Brother	14	35	21	23	26.1				36		49	35	36	
3144|11	ISP3	Brother	14	35	21	23	26.1				36		49	35	36	
3428a|11	F	Brother	13	37	21.1	21.2	23				34		50	37	40	
3428a|11	FSP	Brother	13	37	21.1	21.2	23				34		50	37	40	
3428b|11	ISP1	Brother	13	37	21.1	21.2	23				34		50	37	40	
3428b|11	ISP3	Brother	13	37	21.1	21.2	23				34		50	37	40	
3497|11	ISP2	Brother	14	38	21.1	22	24				36		48	34	36	
3497|11	ISP3	Brother	14	38	21.1	22	24				36		48	34	36	
4090|12	ISP1	Brother	14	37	20	21	24.1				35		49	35	38	
4090|12	ISP2	Brother	14	37	20	21	24.1				35		49	35	38	
4139|12	ISP1	Brother	13	37	21	24.1	25				36		47	36		
4139|12	ISP2	Brother	13	37	21	24.1	25				36		47	36		
4139|12	ISP1	Brother	13	37	21	24.1	25				36		47	36		
4139|12	ISP3	Brother	13	37	21	24.1	25				36		47	36		
4139|12	ISP2	Brother	13	37	21	24.1	25				36		47	36		
4139|12	ISP3	Brother	13	37	21	24.1	25				36		47	36		
4155|11	ISP1	Brother	14	35	21	24					36		46	35	38	
4155|11	ISP2	Brother	14	35	21	24					36		46	35	38	

Case	Sample	Relation	DYS 526A	DYS 612	DYF 399S1						DYS 526B		DYS 547	DYF 387S1		
4155|11	ISP1	Brother	14	35	21	24					36		46	35	38	
4155|11	ISP3	Brother	14	35	21	24					36		46	35	38	
4155|11	ISP2	Brother	14	35	21	24					36		46	35	38	
4155|11	ISP3	Brother	14	35	21	24					36		46	35	38	
4234|12	ISP1	Brother	16	36	19	21	24/24.1				38		53	36	38	
4234|12	ISP2	Brother	16	36	19	21	24/24.1				38		53	36	38	
4234|12	ISP1	Brother	16	36	19	21	24/24.1				38		53	36	38	
4234|12	ISP3	Brother	16	36	19	21	24/24.1				38		53	36	38	
4234|12	ISP2	Brother	16	36	19	21	24/24.1				38		53	36	38	
4234|12	ISP3	Brother	16	36	19	21	24/24.1				38		53	36	38	
4333|11	FSP1	Brother	12	38	19	23	25.1				32		50	36	38	
4333|11	FSP2	Brother	12	37	19	23	25.1				32		50	36	38	
4425a|12	F	Brother	14	38	20	24	25.1				37		50	35	37	
4425a|12	FSP2	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP2	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP3	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP2	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP4	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP3	Brother	14	38	21	24	25.1				37		50	35	37	
4425b|12	ISP4	Brother	14	38	21	24	25.1				37		50	35	37	
4523|10	ISP1	Brother	14	39	22	24	24.1				38		49	36		
4523|10	ISP2	Brother	14	39	22	24	24.1				38		49	36		

Total Mutations by Locus: Brothers

Table S25. Brothers Mutation Totals Loci Set 1

MUTATIONS	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1 STEP:	2	4	5	0	2	0	0	1	2	9	2	1	0
2 STEPS:	2	0	0	0	0	0	0	0	0	0	3	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	4	4	5	0	2	0	0	1	2	9	5	1	0

Table S26. Brothers Mutation Totals Loci Set 2

MUTATIONS	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 533	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1 STEP:	0	3	3	4	6	0	1	1	0	0	2	4	0	0	0
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	3	3	4	6	0	1	1	0	0	2	4	0	0	0

Table S27. Brothers Mutation Totals Loci Set 3

MUTATIONS	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1	DYS 626	DYF 403S1A	DYF 403S1B	DYS 518
1 STEP:	0	1	0	2	3	0	4	0	8	3	7
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	1	0	2	3	0	4	0	8	3	7

Table S28. Brothers Mutation Totals Loci Set 4

MUTATIONS	DYS 526A	DYS 612	DYF 399S1	DYS 526B	DYS 547	DYF 387S1
1 STEP:	0	9	11	1	3	5
2 STEPS:	0	3	0	0	3	0
3 STEPS:	0	0	0	0	0	0
TOTAL:	0	12	11	1	6	5

Table S29. Brothers Mutation Totals All Loci

MUTATIONS	TOTAL
1 STEP:	109
2 STEPS:	11
3 STEPS:	0
TOTAL:	120

Total Mutations by Locus – All Samples

Table S30. Mutation Totals Loci Set 1 – All Samples

MUTATIONS	DYS 481	DYS 576	DYS 570	DYS 527A	DYS 527B	DYS 459A	DYS 459B	DYS 549	DYS 444	DYS 449	DYS 508	DYS 552	DYS 522
1 STEP:	5	9	7	2	6	0	0	6	2	15	4	3	2
2 STEPS:	2	0	0	0	0	0	0	0	0	0	5	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	7	9	7	2	6	0	0	6	2	15	9	3	2

Table S31. Mutation Totals Loci Set 2 – All Samples

MUTATIONS	DYS 607	DYS 627	DYS 389I	DYS 448	DYS 389II	DYS 19	DYS 391	DYS 533	DYS 438	DYS 437	DYS 635	DYS 390	DYS 439	DYS 392	DYS 643
1 STEP:	1	10	4	4	11	1	1	3	0	0	3	4	2	1	0
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	1	10	4	4	11	1	1	3	0	0	3	4	2	1	0

Table S32. Mutation Totals Loci Set 3 – All Samples

MUTATIONS	DYS 393	DYS 458	DYS 385A	DYS 385B	DYS 456	YGATA H4	DYF 404S1	DYS 626	DYF 403S1A	DYF 403S1B	DYS 518
1 STEP:	0	9	0	3	7	0	12	2	24	8	17
2 STEPS:	0	0	0	0	0	0	0	0	0	0	0
3 STEPS:	0	0	0	0	0	0	0	0	0	0	0
TOTAL:	0	9	0	3	7	0	12	2	24	8	17

Table S33. Mutation Totals Loci Set 4 – All Samples

MUTATIONS	DYS 526A	DYS 612	DYF 399S1	DYS 526B	DYS 547	DYF 387S1
1 STEP:	1	16	46	10	11	9
2 STEPS:	0	6	1	0	4	0
3 STEPS:	0	0	1	0	1	0
TOTAL:	1	22	48	10	16	9

Table S34. Mutation Totals All Loci – All Samples

MUTATIONS	TOTAL
1 STEP:	251
2 STEPS:	14
3 STEPS:	1
TOTAL:	266

APPENDIX D: PRESENTATIONS

Presentations

2016 **"THE ESTIMATION OF GERM LINE MUTATION RATES OF EXTENDED SETS OF Y-STR HAPLOTYPES TO AID IN THE DIFFERENTIATION OF MALE BIOLOGICAL RELATIVES IN CRIMINAL INVESTIGATIONS."** Masker, N.; Hanson, E.K.; Ballantyne, J. Presented at the Thirteenth Annual Showcase of Diverse Student Research. 2016 University of Central Florida Graduate Research Forum. Orlando, FL. April 5, 2016.

APPENDIX E: FUNDING

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