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SHORT COMMUNICATION

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The polymorphisms of various short tandem repeats on the Y chromosome in Japanese and German populations

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Abstract In the present study we have analyzed the genotypes at the DYS389-I, DYS389-II, DYS390, DYS391, DYS393 and DYS19 loci on the Y chromosome in Japanese and German populations. The genotypes were determined in the white blood cell DNA of 200 Japanese and 111 German males. The 8-locus haplotype combination of these six loci with our previous data on DYS388 and DYS392 revealed much lower maximum matching probability (0.0053 in Japanese and 0.0092 in Germans), much higher minimum diversity (dw_{min}) (0.9947 in Japanese and 0.9908 in Germans) and more haplotypes (194 in Japanese and 110 in Germans). These very high abilities for discrimination could provide ideal tools for forensic analysis and population studies.

Key words Short tandem repeat · Y chromosome · Population study

Introduction

The human Y chromosome is unusual in that it is inherited in the hemizygous state solely by males and can be useful for sex determination as well as for individual identification, especially in cases of sexual assault and paternity testing when the alleged father is deceased and other relatives have to be tested. The Y chromosome could also preserve a unique record of the mutational events that occurred in ancestral generations [3, 11]. However the Y chromosome has also been shown to have a low level of polymorphism [11]. We previously provided data about DYS388 (G00–365–729) and DYS392 (G00–456–509) [10]. Because the Y-STRs are located on the non-recombining part of the Y chromosome, they are genetically linked to each other. Previous reports have however provided only separate data for each STR [4, 5, 9].

In the present study, we examined the allele distributions of the six polymorphic tetranucleotide loci, DYS389-I (G00–366–108), DYS389-II, DYS390 (G00–366–115), DYS391 (G00–366–118), DYS393 (G00–456–649) and DYS19 (G00–121–409) in 200 Japanese and 111 German males. We also combined these findings with our previous data of DYS388 and DYS392 analyzed on the same samples.

Materials and methods

Blood samples were obtained from 200 randomly selected Japanese males from Asahikawa city in Hokkaido. The German samples were obtained from 111 German males in the city of Munich. These samples were the same as these used in our previous report [1]. DNA was amplified by the polymerase chain reaction (PCR) using system-specific primers [4, 9, 10]. For separation, a 1 µl aliquot of PCR product was mixed with 0.5 µl of GeneScan size standard (GENESCAN-500 ROX) and 12 µl of deionized formamide. STR analysis was conducted with an ABI PRISM 311 Genetic Analyzer with Performance Optimized Polymer 4 (POP-4) and Genetic Analyzer capillaries. Each allele was confirmed by direct sequencing [9, 10]. The allele frequencies of these loci were compared to those in the other populations using the χ^2-test. The dw_{min} (minimum diversity within the population), mw_{min} (minimum matching probability within the population), mw_{max} (maximum matching probability within the population), and mb_{min} (minimum matching probability between two populations) were calculated as in previous reports [1, 2, 6, 7]. The ratio mw_{max}/mb_{min} gives an upper estimate of how many more times it is probable to find a match within a population than between two populations, and the ratio mw_{min}/mb_{min} gives a lower estimate.

Results

At the DYS389 I, DYS389 II, DYS390, DYS391 DYS393 and DYS19 loci, five, six, seven, five, five and six alleles were observed in Japanese males respectively and four, seven, six, four, five and five alleles were observed in German males at these loci.

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Table 1 The frequencies of DYS19, DYS388, DYS389 I, DYS389 II, DYS390, DYS391, DYS392, DYS393 haplotypes in Japanese and German populations

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
13	12	10	25	23	10	13	13	0.000	0.009
13	12	10	27	22	10	12	12	0.005	0.000
13	13	9	28	25	11	13	13	0.005	0.000
14	12	9	24	25	10	11	13	0.000	0.009
14	12	9	26	22	10	11	13	0.000	0.009
14	12	9	26	22	11	11	12	0.000	0.009
14	12	9	26	23	11	11	15	0.000	0.009
14	12	9	26	24	10	11	11	0.000	0.009
14	12	9	27	24	10	11	13	0.005	0.000
14	12	9	27	25	12	12	13	0.000	0.009
14	12	9	28	25	10	10	12	0.000	0.009
14	12	9	29	24	10	11	13	0.000	0.009
14	12	10	25	22	11	13	13	0.000	0.009
14	12	10	25	25	10	13	14	0.000	0.009
14	12	10	26	22	10	11	12	0.000	0.009
14	12	10	26	22	11	13	13	0.000	0.009
14	12	10	26	23	11	11	13	0.000	0.009
14	12	10	26	24	10	13	12	0.000	0.009
14	12	10	26	24	10	11	13	0.000	0.018
14	12	10	26	25	11	11	12	0.000	0.009
14	12	10	27	22	10	11	13	0.000	0.009
14	12	10	27	22	11	11	14	0.000	0.009
14	12	10	27	23	10	13	13	0.000	0.009
14	12	10	27	23	11	14	12	0.000	0.009
14	12	10	27	24	10	7	14	0.000	0.009
14	12	10	27	25	10	13	13	0.000	0.009
14	12	10	28	24	10	11	13	0.000	0.000
14	12	10	28	25	10	13	13	0.000	0.009
14	12	10	29	24	10	11	15	0.000	0.009
14	12	11	24	22	10	13	13	0.000	0.009
14	12	11	25	24	11	12	14	0.000	0.009
14	12	11	25	24	11	13	13	0.000	0.009
14	12	11	26	23	10	11	13	0.000	0.009
14	12	11	26	23	12	11	13	0.000	0.009
14	12	11	26	24	10	13	13	0.000	0.009
14	12	11	26	24	11	15	13	0.000	0.009
14	12	11	27	24	10	11	12	0.000	0.009
14	12	11	27	24	10	13	13	0.000	0.009
14	12	11	29	24	10	13	14	0.000	0.009
14	12	12	27	24	11	11	13	0.000	0.009
14	13	9	25	22	10	11	11	0.000	0.009
14	13	10	26	22	11	14	13	0.000	0.009
14	13	10	26	24	11	11	12	0.000	0.009
14	13	10	29	23	10	13	11	0.000	0.009
14	13	11	26	23	11	12	14	0.000	0.009
14	13	11	27	24	11	11	13	0.000	0.009
14	14	9	25	23	11	11	12	0.000	0.009
14	14	9	27	23	10	13	14	0.000	0.009
14	14	10	25	21	11	11	13	0.000	0.009
14	15	10	28	24	11	11	13	0.000	0.009
15	11	9	25	26	10	11	13	0.000	0.009
15	11	9	26	25	11	13	14	0.005	0.000
15	11	10	25	24	10	11	12	0.005	0.000
15	11	10	25	25	10	13	14	0.005	0.000
15	11	10	25	26	11	11	12	0.005	0.000

Table 1 (continued)

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
15	11	10	26	24	10	11	12	0.005	0.000
15	11	10	27	25	10	11	14	0.005	0.000
15	11	10	27	25	10	12	13	0.005	0.000
15	11	10	28	22	10	11	14	0.01	0.000
15	11	10	28	24	10	11	12	0.005	0.000
15	11	10	28	25	11	13	13	0.000	0.009
15	11	11	25	21	11	11	13	0.005	0.000
15	11	11	25	23	10	13	12	0.005	0.000
15	11	11	27	23	10	11	13	0.000	0.009
15	11	11	27	23	11	10	13	0.005	0.000
15	11	11	28	25	10	12	13	0.005	0.000
15	12	8	26	24	10	11	13	0.005	0.000
15	12	8	28	24	10	12	14	0.005	0.000
15	12	9	25	23	9	11	14	0.005	0.000
15	12	9	25	23	10	13	13	0.000	0.009
15	12	9	25	24	10	11	11	0.005	0.000
15	12	9	25	24	10	11	13	0.000	0.009
15	12	9	26	23	10	8	13	0.000	0.009
15	12	9	26	23	13	13	14	0.005	0.000
15	12	9	26	24	10	12	12	0.005	0.000
15	12	9	26	24	12	10	12	0.005	0.000
15	12	9	26	25	10	11	12	0.005	0.000
15	12	9	26	25	10	13	13	0.005	0.009
15	12	9	27	22	9	13	13	0.005	0.000
15	12	9	27	23	12	12	14	0.005	0.000
15	12	9	27	25	10	10	13	0.005	0.000
15	12	9	27	25	10	11	13	0.005	0.000
15	12	9	27	25	12	12	13	0.005	0.000
15	12	9	28	22	10	11	13	0.000	0.009
15	12	9	28	25	10	10	13	0.005	0.000
15	12	9	28	25	12	13	14	0.005	0.000
15	12	9	28	26	12	11	13	0.005	0.000
15	12	10	23	23	10	11	13	0.000	0.009
15	12	10	25	22	10	11	13	0.000	0.009
15	12	10	25	23	10	10	13	0.005	0.000
15	12	10	25	23	10	11	13	0.000	0.009
15	12	10	25	23	10	12	11	0.005	0.000
15	12	10	25	23	13	11	13	0.005	0.000
15	12	10	25	24	10	13	12	0.005	0.000
15	12	10	25	25	9	11	12	0.005	0.000
15	12	10	25	25	10	11	12	0.005	0.000
15	12	10	25	25	10	13	13	0.005	0.000
15	12	10	25	25	11	11	12	0.005	0.000
15	12	10	25	25	11	12	13	0.005	0.000
15	12	10	25	25	11	12	14	0.000	0.009
15	12	10	25	25	12	11	12	0.005	0.000
15	12	10	25	26	10	11	13	0.005	0.000
15	12	10	25	27	10	11	13	0.005	0.000
15	12	10	26	22	10	11	13	0.000	0.009
15	12	10	26	23	9	13	13	0.005	0.000
15	12	10	26	23	10	11	13	0.000	0.009
15	12	10	26	24	11	11	15	0.005	0.000
15	12	10	26	24	11	12	13	0.000	0.009
15	12	10	26	24	12	13	14	0.000	0.009
15	12	10	26	25	9	14	14	0.005	0.000
15	12	10	26	25	10	11	12	0.005	0.000

Table 1 (continued)

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
15	12	10	26	25	10	12	14	0.005	0.000
15	12	10	26	25	10	13	13	0.005	0.000
15	12	10	26	25	11	11	14	0.005	0.000
15	12	10	26	26	11	12	14	0.000	0.009
15	12	10	27	22	10	11	13	0.005	0.000
15	12	10	27	22	11	11	15	0.005	0.000
15	12	10	27	22	12	13	13	0.005	0.000
15	12	10	27	23	11	12	14	0.005	0.000
15	12	10	27	24	10	12	13	0.000	0.009
15	12	10	27	24	12	11	14	0.005	0.000
15	12	10	27	25	10	11	12	0.005	0.000
15	12	10	27	25	10	11	13	0.005	0.000
15	12	10	27	25	10	13	13	0.005	0.000
15	12	10	27	25	11	10	14	0.005	0.000
15	12	10	27	25	11	11	13	0.005	0.000
15	12	10	28	22	10	11	14	0.000	0.009
15	12	10	28	23	10	11	14	0.005	0.000
15	12	10	28	23	10	13	14	0.005	0.000
15	12	10	28	23	12	12	13	0.005	0.000
15	12	10	28	24	9	10	13	0.000	0.009
15	12	10	28	24	10	11	13	0.005	0.000
15	12	10	28	24	10	12	13	0.000	0.009
15	12	10	28	25	10	10	13	0.005	0.000
15	12	10	28	25	11	11	13	0.005	0.000
15	12	10	28	26	10	11	12	0.005	0.000
15	12	11	25	23	10	11	12	0.005	0.009
15	12	11	25	23	10	11	15	0.005	0.000
15	12	11	25	24	9	10	12	0.005	0.000
15	12	11	25	24	12	11	13	0.005	0.000
15	12	11	25	25	11	11	13	0.005	0.000
15	12	11	26	22	10	13	12	0.005	0.000
15	12	11	26	22	13	16	13	0.005	0.000
15	12	11	26	23	11	11	12	0.005	0.000
15	12	11	26	24	10	11	13	0.005	0.000
15	12	11	26	24	10	11	14	0.005	0.000
15	12	11	26	25	10	10	13	0.005	0.000
15	12	11	26	25	11	11	12	0.005	0.000
15	12	11	27	22	10	11	12	0.005	0.000
15	12	11	27	22	10	13	14	0.005	0.000
15	12	11	27	23	9	13	13	0.000	0.009
15	12	11	27	23	12	11	13	0.005	0.000
15	12	11	27	24	10	10	13	0.005	0.000
15	12	11	27	24	10	11	13	0.000	0.009
15	12	11	27	24	12	11	13	0.000	0.009
15	12	11	27	25	10	13	14	0.005	0.000
15	12	11	27	25	11	13	13	0.000	0.009
15	12	11	27	25	13	11	14	0.005	0.000
15	12	11	28	21	10	11	13	0.005	0.000
15	12	11	28	22	12	11	13	0.005	0.000
15	12	11	28	24	10	11	12	0.005	0.000
15	12	11	28	24	10	11	13	0.005	0.000
15	12	11	28	24	11	12	15	0.000	0.009
15	12	11	28	25	10	13	13	0.01	0.000
15	12	11	28	26	10	11	13	0.005	0.000
15	12	11	29	23	11	15	12	0.000	0.009
15	12	12	25	24	10	13	13	0.000	0.009

Table 1 (continued)

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
15	12	12	27	25	10	11	13	0.005	0.000
15	13	9	26	23	10	13	14	0.005	0.000
15	13	10	26	23	10	13	13	0.005	0.000
15	13	10	26	24	10	11	13	0.005	0.000
15	13	10	27	24	10	13	13	0.000	0.009
15	13	11	26	24	10	11	12	0.005	0.000
15	14	11	27	24	11	11	12	0.005	0.000
15	15	10	27	23	10	11	13	0.000	0.009
15	16	10	27	24	12	11	13	0.000	0.009
16	9	9	28	26	10	11	12	0.005	0.000
16	10	9	27	26	11	10	13	0.005	0.000
16	11	9	25	26	9	11	12	0.005	0.000
16	11	9	28	22	10	11	12	0.005	0.000
16	11	10	24	24	10	11	12	0.005	0.000
16	11	10	27	22	10	10	15	0.005	0.000
16	11	10	28	25	10	12	13	0.005	0.000
16	12	9	25	25	10	11	15	0.000	0.009
16	12	9	27	22	12	11	14	0.005	0.000
16	12	9	27	24	10	11	13	0.000	0.009
16	12	9	28	22	12	11	11	0.000	0.009
16	12	9	28	23	10	13	13	0.005	0.000
16	12	9	28	23	12	13	12	0.000	0.009
16	12	9	28	26	10	13	14	0.005	0.000
16	12	10	25	22	9	14	12	0.005	0.000
16	12	10	25	22	10	11	13	0.000	0.009
16	12	10	25	22	10	12	13	0.005	0.000
16	12	10	25	24	10	11	14	0.005	0.000
16	12	10	25	24	11	12	13	0.005	0.000
16	12	10	25	24	11	16	13	0.000	0.009
16	12	10	25	25	9	11	13	0.000	0.009
16	12	10	26	24	9	10	14	0.005	0.000
16	12	10	26	25	9	12	13	0.005	0.000
16	12	10	26	25	10	11	13	0.01	0.000
16	12	10	26	25	10	11	14	0.01	0.000
16	12	10	26	25	11	13	13	0.005	0.000
16	12	10	27	22	10	13	13	0.005	0.000
16	12	10	27	23	10	11	13	0.005	0.000
16	12	10	27	23	10	12	13	0.005	0.000
16	12	10	27	23	11	13	13	0.000	0.009
16	12	10	27	24	10	13	13	0.000	0.009
16	12	10	27	24	11	11	13	0.005	0.009
16	12	10	27	25	10	11	12	0.005	0.000
16	12	10	27	26	10	11	13	0.005	0.000
16	12	10	27	27	10	13	13	0.005	0.000
16	12	10	28	21	10	13	13	0.000	0.009
16	12	10	28	22	10	11	13	0.005	0.000
16	12	10	28	23	11	13	13	0.005	0.000
16	12	10	28	24	10	12	13	0.005	0.000
16	12	10	28	25	9	7	13	0.005	0.000
16	12	10	28	25	9	13	13	0.005	0.000
16	12	10	28	25	10	10	12	0.005	0.000
16	12	10	28	25	10	12	12	0.005	0.000
16	12	10	28	25	11	11	12	0.005	0.000
16	12	10	28	25	11	11	13	0.000	0.009
16	12	10	28	26	9	11	13	0.005	0.000
16	12	10	29	23	10	12	13	0.005	0.000

Table 1 (continued)

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
16	12	11	25	22	10	11	13	0.005	0.000
16	12	11	25	24	10	11	12	0.000	0.009
16	12	11	25	24	10	13	14	0.000	0.009
16	12	11	25	25	10	13	14	0.000	0.009
16	12	11	26	21	10	11	13	0.000	0.009
16	12	11	26	23	10	13	13	0.000	0.009
16	12	11	26	24	10	12	13	0.000	0.009
16	12	11	26	25	10	11	13	0.000	0.009
16	12	11	27	23	9	11	13	0.005	0.000
16	12	11	28	22	10	8	13	0.005	0.000
16	12	11	28	23	12	13	13	0.005	0.000
16	13	9	27	23	10	12	13	0.005	0.000
16	13	10	27	25	13	11	13	0.005	0.000
16	13	10	28	22	12	11	12	0.005	0.000
16	13	10	28	25	10	14	13	0.005	0.000
16	13	11	25	23	11	11	13	0.000	0.009
16	13	11	28	23	10	10	13	0.005	0.000
17	10	10	28	24	10	13	14	0.005	0.000
17	11	9	27	22	10	11	13	0.005	0.000
17	11	9	28	23	11	14	12	0.005	0.000
17	11	9	28	25	10	11	13	0.005	0.000
17	11	10	26	24	9	12	13	0.005	0.000
17	11	10	27	22	10	12	13	0.000	0.009
17	11	10	27	25	10	11	11	0.005	0.000
17	11	10	28	22	10	13	14	0.005	0.000
17	11	10	28	25	9	11	12	0.005	0.000
17	12	9	25	25	11	13	14	0.005	0.000
17	12	9	26	22	10	12	13	0.005	0.000
17	12	9	26	23	10	11	12	0.005	0.000
17	12	9	26	25	10	12	15	0.005	0.000
17	12	9	26	25	10	13	12	0.005	0.000
17	12	9	26	26	10	11	13	0.005	0.000
17	12	9	26	26	10	13	14	0.005	0.000
17	12	9	27	23	10	13	13	0.000	0.009
17	12	9	27	24	13	11	13	0.005	0.000
17	12	9	27	26	10	11	13	0.005	0.000
17	12	9	28	22	11	12	12	0.005	0.000
17	12	9	28	24	10	11	13	0.005	0.000
17	12	9	28	25	12	11	14	0.005	0.000
17	12	10	25	22	10	11	12	0.005	0.000
17	12	10	25	24	10	12	14	0.000	0.009
17	12	10	25	24	12	11	13	0.005	0.000
17	12	10	25	25	10	11	12	0.005	0.000
17	12	10	25	25	10	12	12	0.005	0.000
17	12	10	26	23	9	12	12	0.005	0.000
17	12	10	26	23	10	11	12	0.005	0.009
17	12	10	26	23	10	11	13	0.000	0.009
17	12	10	26	23	10	12	12	0.005	0.000
17	12	10	26	24	9	11	13	0.000	0.009
17	12	10	26	24	10	13	13	0.005	0.000
17	12	10	26	24	10	12	14	0.005	0.000
17	12	10	26	24	11	10	14	0.005	0.000
17	12	10	26	25	10	11	12	0.01	0.000
17	12	10	26	25	12	11	13	0.01	0.000
17	12	10	27	24	9	11	13	0.005	0.000
17	12	10	27	24	10	10	12	0.005	0.000

Table 1 (continued)

DYS19	DYS388	DYS389 I	DYS389 II	DYS390	DYS391	DYS392	DYS393	Japanese	Germans
Repeat number									
17	12	10	27	24	10	11	13	0.005	0.000
17	12	10	27	24	10	13	13	0.005	0.000
17	12	10	27	24	11	11	13	0.000	0.009
17	12	10	27	26	10	11	13	0.000	0.009
17	12	10	28	21	10	12	12	0.005	0.000
17	12	10	28	22	10	13	12	0.005	0.000
17	12	10	28	22	11	11	14	0.005	0.000
17	12	10	28	22	11	13	13	0.005	0.000
17	12	10	28	24	10	10	15	0.005	0.000
17	12	10	28	24	10	11	13	0.005	0.000
17	12	10	28	25	11	11	12	0.005	0.000
17	12	10	29	22	10	11	13	0.005	0.000
17	12	11	25	25	10	11	13	0.005	0.000
17	12	11	25	25	10	14	13	0.000	0.009
17	13	10	25	22	11	11	13	0.005	0.000
17	12	11	27	23	11	11	13	0.000	0.009
17	12	11	27	23	11	11	14	0.005	0.000
17	12	11	28	25	10	11	12	0.005	0.000
17	13	9	26	24	10	11	13	0.000	0.009
18	12	9	25	25	10	11	13	0.005	0.000
18	12	10	26	23	9	11	15	0.005	0.000

Table 2 The properties of combined STRs on Y chromosome in Japanese and German populations

	No. of different haplotypes		dw_{min}		mw_{max}		mw_{min}	
	Japanese	German	Japanese	German	Japanese	German	Japanese	German
8loci	194	110	0.9947	0.9908	0.0053	0.0092	3/19900	1/6105
Yh1	194	110	0.9947	0.9908	0.0053	0.0092	3/19900	1/6105
Yh5	110	88	0.9839	0.9860	0.0161	0.0140	109/ 5950	31/6105

	Japanese/German		German/Japanese	
	mw_{max}/mb_{min}	mw_{min}/mb_{min}	mw_{max}/mb_{min}	mw_{min}/mb_{min}
8loci	29.4	1.4	51.1	0.9
Yh1	29.4	1.4	51.1	0.9
Yh5	3.7	2.2	3.2	1.2

These alleles resulted from the (CTG/AT)n, (CTG/AT)n, (CTAT)n, (CTAT)n, (GATA)n and (CTAT/C)n repeats in these loci.

The distributions of these loci were significantly different among the two populations (DYS389 I $0.001 < P < 0.01$; DYS390 $P < 0.001$; DYS391 $0.001 < P < 0.01$; DYS393 $0.001 < P < 0.01$ and DYS19 $P < 0.001$), except DYS389 II ($0.2 < P$).

Using the same samples, we previously provided data about the DYS388 and DYS392 loci [9]. The 8-locus haplotypes consisting of the six loci and DYS388 and DYS392 are shown as Table 1. The maximum frequencies of a haplotype were 0.010 (2/200) in the Japanese population and 0.018 (2/111) in the German population. The number of different haplotypes was 194 in the Japanese population and 110 in the German population (Table 1). Kayser et al. [4] and de Knijff et al.[5] described Yh formats as Y-STR haplotyping. The haplotypes of Yh1 (DYS19+DYS389-I+DYS389II+DYS390+DYS391+DYS392+DYS393) and Yh5 (DYS19+DYS389-I+DYS389-II+DYS390) in the two populations are shown in Table 2. The values for dw_{min}, mw_{min}, mw_{max}, mb_{min}, mw_{max} / mb_{min} and mw_{min} / mb_{min} are shown in Table 2.

Discussion

The human Y chromosome is inherited solely by males in the hemizygous state with the exception of the pseudoautosomal region [11]. By examining genetic changes in this chromosome, we were able to explain an ancient genetic migration [11]. A similar argument has been used for mitochondrial DNA, which is inherited in a similar manner only in females [3, 12]. Thus, Y-chromosomal and mitochondrial DNA could be used to clarify the evolutionary relationship of human populations [12].

The genetic changes in the Y chromosome can also be used in forensic analysis, such as in cases of sexual assault and paternity testing [8, 9]. In cases of sexual assault, analysis of the Y chromosome provides genetic information about the male assailant as well as proof of the presence of male DNA in forensic stains. In paternity testing and especially in deficiency cases, the Y chromosome analysis provides a much higher exclusion power than autosomal STRs.

However, very few Y-specific polymorphisms have been previously reported [11], possibly because the recombination mechanism is mutagenic and the Y chromosome, being protected from recombination, is also protected from mutation.

In the present study, we examined the allele distributions of the six polymorphic STRs (DYS389-I, DYS389-II, DYS390, DYS391, DYS393 and DYS19) in Japanese and German populations. Kayser et al. [4] and de Knijff et al. [5] carried out a multicenter study of these loci with world-wide populations, however, their study lacked information on DYS391 and DYS393 in the Japanese population. In the present study, we found significant differences in the distributions of these loci in Japanese and German populations. Also, we found no inconsistency in the allele distributions of these loci in the German population compared to those reported by Kayser et al. [4] and de Knijff et al. [5].

Because the Y-STRs are located on the non-recombining part of the Y chromosome, they are genetically linked, however, the previous reports also lacked information of the combined haplotypes of these loci [4, 5, 9]. Therefore, we provided information about the haplotypes combined with several loci in this paper.

The 8-locus-haplotype combination of DYS19, DYS388, DYS389-I, DYS389-II, DYS390, DYS391, DYS392 and DYS393 had a much lower maximum matching probability (mw_{max}) (0.0053 in Japanese and 0.0092 in German), a much higher minimum diversity (dw_{min}) (0.9947 in Japanese and 0.9908 in German) and more haplotypes (194 in Japanese and 110 in German), while the Yh5 system (DYS389-I, DYS389-II, DYS390 and DYS19) had a relatively low ability for discrimination. The maximum frequencies of haplotypes by the 8-locus-haplotype system were very low (0.010 in Japanese and 0.018 in the German). Only 2/200 in the Japanese and 2/111 in the German populations showed the same combined haplotypes in this system. These very high abilities for discrimination could provide an ideal tool for forensic analysis and population studies when such combined haplotype systems allow us to assign one haplotype to one male in the future.

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