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Abstract

The Fujian Tanka people are officially classified as a southern Han ethnic group while they have customs similar to Daic and Austronesian people. Whether they originated in Han or Daic people, there is no consensus. Three hypotheses have been proposed to explain the origin of this group: 1) the Han Chinese origin, 2) the ancient Daic origin, 3) and the admixture between Daic and Han. In this study, we address this issue by analyzing the paternal Y chromosome and maternal mtDNA variation of 62 Fujian Tanka and 25 neighboring Han in Fujian. We found that the southern East Asian predominant haplogroups, e.g. O1a1a-P203 and O1b1a1a-M95 of Y chromosome and F2a, M7c1, and F1a1 of mtDNA, reach relatively high frequencies in Tanka. The interpopulation comparison reveals that the Tanka have a closer affinity with Daic populations than with Han Chinese in paternal lineages while are closely clustered with southern Han populations such as Hakka and Chaoshanese in maternal lineages. Network and haplotype-sharing analyses also support the admixture hypothesis. The Fujian Tanka mainly originate from the ancient indigenous Daic people and have only limited gene flows from Han Chinese populations. Notably, the divergence time inferred by the Tanka-specific haplotypes indicates that the formation of Fujian Tanka was a least 1033.8-1050.6 years before present (the early Northern Song Dynasty), indicating that they are indigenous population, not late Daic migrants from southwestern China.

The genetic relationships between populations include three models: isolation, admixture, and replacement. Admixture is the most common event in human migrations and dispersals, appearing populations including African-Americans (Glass et al. 1953) and European-Americans (Reed 1969; Durand et al.2015). Isolated populations, those that by virtue of geography, history and/or culture experience, experienced little gene flows with surrounding populations. Such populations include the Andaman Islanders (Reich et al.2009; Thangaraj et al. 2005) and Sardinians (Pala et al. 2009; Francalacci et al. 2013; Sidore et al. 2015) who have their unique allele frequency and phenotypic characteristics due to the geographic barriers; the Roma (Gresham et al. 2001; Regueiro et al.2011; Mendizabal et al. 2012) and the Jews (Behar et al. 2006; Hammer et al. 2009; Behar et al. 2010) have maintained genetic coherence over vast geographical distances because of their distinctive history and culture. Population isolation is more likely to generate population-specific haplotypes or lineages, allowing geneticists to trace population history.

The Tanka people (Huang 2008) who live in southeastern China are officially classified as Southern Han, but have many distinct cultural traits. The Tanka people are widely distributed along southeast coast of China, spanning from Zhejiang to Guangxi provinces. Since 1949, the government built houses on land and enrolled them in compulsory primary and secondary education, leading to the gradual erosion of the Tanka people's original customs and lifeway. Now, the only remaining areas with many Tanka communities are in the Minjiang River estuary of Fujian province. In contrast to the ethnically Han farmers, the Tanka have remained lifestyle of fisher-traders since ancient time. In the past, the Tanka endured discrimination by neighboring populations and were barred from owning land.

Therefore, they were generally called “Gypsies in water” (Chen 1954). Their unique history makes them a potentially isolated genetic group.

Many researchers have discussed the origin of the Tanka using data from historical (Luo 1929; Lin 1936), ethnologic (Chen 1948) and folkloric (Zhong 1928) sources, leading to three testable hypotheses. First, according to folklore, the Tanka were originally Han Chinese refugees from war, famine, and political persecution in coastal areas. As a result of this hardship, they changed their life-style from farming the land to fishing in rivers. Second, some scholars (Luo 1929) hold the view that the Tanka are descendants of the ancient Daic people because they have similar customs to Daic and Austronesian populations, such as tattooing, the snake totems, and a long tradition of boating. Before Han Dynasty, there was an indigenous Daic kingdom of Minyue. In 110 BC, the kingdom was conquered and the Minyue people were migrated to the other place. However, there might still be some Minyue populations remained in Fujian, such as Tanka. Lastly, other researchers (Lin 1936) argued that the Tanka was the admixture of the Daic people and Han Chinese immigrants.

To test the aforementioned hypotheses and shed light on the origin and formation of Tanka, we analyzed the Y chromosome and mtDNA variation of 62 Fujian Tanka and 25 neighboring Han individuals in this study. Furthermore, in order to do some comparison among Tanka, indigenous people in southern East Asia and Han Chinese, the published genetic data in related articles were considered and reclassified as well.

Material and Methods

Population Samples

We collected blood samples of unrelated male individuals from four villages named Shuisheng (n=21), Huyu'ao (n=21), Beiqi (n=20) and Dongguan (n=25), located in Xiapu county, Fujian province of China (Figure 1). Notably, people in the first three villages are Tanka people, while Han are the majority in the latter village. This study has been approved by the Ethics Committee for Biological Research at Fudan University and all the samples were collected with informed consent.

Y Chromosome Markers

For each sample, we extracted DNA, typed relevant Y-chromosomal SNPs via a hierarchical strategy (Wang et al. 2014; Wen et al. 2017). These SNPs were included in the following seven panels:

Corset Panel: M130, P256, M1, M231, M168, M174, M45, M89, M272, M258, M242, M207, M9, M96, P125, M304, M201 and M306.

Haplogroup O panel: M175, M119, P203, M110, M268, P31, M95, M176, M122, M324, M121, P201, M7, M134, M117, 002611, P164, L127 (rs17269396), and KL1 (rs17276338).

Haplogroup C panel: P54, M105, M48, M208, M407, P33, M93, P39, P92, P53.1, M217, M38, M210, M356, P55, and M347.

Haplogroup D panel: P47, N1, P99, M15, M125, M55, M64.2, M116.1, M151, and 022457.

Haplogroup N panel: M214, M128, M46/Tat, P63, P119, P105, P43, and M178.

Haplogroup R panel: M306, M173, M124, M420, SRY10831.2, M17, M64.1, M198, M343, V88, M458, M73, P312, M269, and U106/M405.

Haplogroup Q panel: M3, M120, MEH2, M378, N14/M265, M25, M143, M346, L53, and M323.

17 YSTRs (DYS19, DYS389I/II, DYS390, DYS391, DYS392, DYS393, DYS437, DYS438, DYS439, DYS448, DYS456, DYS458, DYS635, Y-GATA H4, and DYS385a/b) were amplified using the Y-filer kit (Life Technologies, Carlsbad, CA, USA).

Mitochondrial DNA Markers

Sequencing of the mtDNA HSV-I and HSV-II region was performed for all 85 individuals (D07 and D08 were poorly amplified in this step). Primers for HSV sequencing are in Table S1. Purified PCR products were sequenced using the BigDye terminator cycle sequencing kit and an ABI 3100 genetic analyzer (Wen et al. 2004a, b, c). The HSV (hyper variable segment) region variations were determined refer to rCRS (GenBank: NC_012920) (Andrews et al. 1999). Haplogroups were assigned using HaploGrep2 (Kloss-Brandstätter et al. 2011) with PhyloTree mtDNA tree Build 17 (Oven et al. 2009). For ambiguous haplogroup assignment, sanger sequencing was performed in the coding regions to determine the assignment results (the primers were also in Table S1). In addition, one sample (H64) was completely sequenced using the method as described in our previous work (Qin et al. 2010). The mtDNA sequences have been deposited in Genbank with accession numbers (HSV-I: MN196578-MN196662; HSV-II: MN229382-MN229466).

Statistical Analyses

Principal component analysis (PCA) was performed using R 3.5.1 software. The pairwise

genetic distances of Rst between different populations were estimated and visualized in multidimensional scaling (MDS) plots using the AMOVA & MDS tool available at the YHRD website. 15-STR-haplotypes were analyzed (DYS385a and DYS385b were excluded; for DYS389, DYS389I and DYS389b [=DYS398II-DYS389I] were used). The search for shared haplotypes was conducted using the Haplomatch software (Chukhryaeva et al. 2016). Networks of Y chromosomal STR data and the mtDNA HVS-I motifs (1600-16569) were constructed by reduced median-joining method (Bandelt et al. 1999) using NETWORK v. 5.0.1.0 (Fluxus-engineering.com). Reference population data on the Y chromosomes (Wang et al. 2014; Wen et al. 2004a; Cai et al. 2011; Li et al. 2008b; Gan et al. 2008; Deng et al. 2013; Trejaut et al. 2014; Park et al. 2012) and mtDNA (Wen et al. 2004b; Ko et al. 2014; Summerer et al. 2014) were retrieved from the literature and 1000 Genomes Project. The time to the most recent common ancestor (TMRCA) for each clade was estimated using BATWING method based on 15 STRs (Wilson et al. 2003) under a model of exponential growth from an initially constant-sized population. The parameters used in estimation were following Xue et al (Xue et al. 2006). Four sets of Y-STR mutation rates were applied in time estimations as Wei et al did (Wei et al. 2013). These were a widely used evolutionary mutation rate (EMR) (Zhivotovsky et al. 2004), two observed genealogical mutation rates (OMRB and OMRS) (Burgarella et al. 2011; Shi et al. 2010), and a genealogical mutation rate adjusted for population variation using logistic model (lmMR) (Burgarella et al. 2011). A total of 10^4 samples of the program's output representing 10^6 MCMC cycles were taken after discarding the first 3×10^3 samples as burn-in. The Time to the Most Recent Common Ancestor (TMRCA) is calculated using the product of the estimated population size N and the

height of the tree T (in coalescent units) (Wilson et al. 2003). A generally accepted generation time of 25 years was used to produce a time estimate in years. The geographic distributions of mtDNA haplogroup F2a were presented by generation of contour maps using Surfer 8.0 Software (Golden Software).

Results

Y Chromosome and Mitochondrial DNA Haplogroup Profile

Y chromosome haplogroups of all 87 samples were determined according to ISOGG 2019 (Figure 2 and Table S2). Overall, there are three major haplogroups in Tanka: O1a1a-P203 (33.9%), O1b1a1a-M95 (30.6%), and O2a2b1a1-M117 (16.1%). The haplogroup O1a1a-P203 was quite common in Southern Asia populations (Li et al. 2008b; Trejaut et al. 2014; Karafet et al. 2010) like the Daic, Austronesian and southern Han, and Taiwan aboriginals (30-90%) (Trejaut et al. 2014). This haplogroup is most frequent in Tanka populations from village Beiqi (35%), ShuiSheng (33.33%), and Huyu'ao (33.33%). According to broadly accepted hypothesis, the O1b1a1a-M95 lineage originated in the southern East Asia (Zhang et al. 2015) and then dispersed southward to Southeast Asia before moving westward to the Indian subcontinent (Zhang et al. 2015; Chaubey et al. 2011; Arunkumar et al. 2015; Majumder et al. 2010). This haplogroup was shown to be prevalent in Austro-Asiatic speaking populations in Southeast Asia (74-87%) (Chaubey et al. 2011; Kumar et al. 2007) and Northeast India (85%) (Chaubey et al. 2011; Kumar et al. 2007), the Daic and Hmong-Mien speaking populations in China (45%) (Cai et al. 2011; Li et al. 2008a, b; Gan et al. 2008; Zhang et al. 2015), and the Austronesian speaking populations (28%) (Li et al. 2008b;

Karafet et al. 2010; Chaubey et al. 2011; Delfin et al. 2010). In Tanka populations, this haplogroup was detected in Shuisheng (38.1%) and Huyu'ao(52.38%), but not detected in Beiqi. O2a2b1a1-M117 was one of the major founder paternal lineages (Yan et al. 2014; Wen et al. 2016) in modern Han Chinese (Yan et al. 2014; Yan et al. 2011; Ning et al. 2016) about 15-16% and was also quite frequent in Tibeto-Burman populations (Xue et al. 2006; Shi et al. 2005; Gayden et al. 2007; Kang et al. 2012) like Nu (62%), Derung (32%), Lhoba (31%), Tibetan in Yunnan (22%) and Hani (17%). This haplogroup was prevalent in Han from Dongguan (36%) and its neighboring village Beiqi (35%), but was rare in other Tanka villages: ShuiSheng (9.52%) and Huyu'ao (4.76%). In summary, the two dominant lineages in the Tanka, O1a1a-P203 (33.9%) and O1b1a1a-M95 (30.6%), have a southern Asia origin and are prevalent in indigenous people like Daic, Hmong-Mien, Austro-Asiatic and Austronesia population, whereas O2a2b1a1-M117 mirrors the gene flows mainly from Han Chinese.

MtDNA haplogroups of 85 samples were determined by PhyloTree mtDNA tree Build 17. (Figure 3 and Table S3). Compared to the Y chromosome, the mtDNA gene pool is more heterogeneous. In Tanka, the most frequent haplogroups are F2a (25%), M7c1 (11.67%), M8a2 (8.33%), F1a1 (6.67%), B4b (5%) and A15 (5%). The dominant haplogroup F2a (average 25%) in Tanka reached the highest frequency in PhuLa (26.8%) (Thuy et al. 2018) and PaThen (19.44%) in northern Vietnam (Thuy et al. 2018) but was sporadic occurrence in East Asian populations, like Guangxi Mien (2.44%) (Wen et al. 2004a), Yunnan Yi (5-6.25%) (Wen et al. 2004c), Qinghai Han (8%) (Li et al. 2019), and southern Han (0.88%-2.04%) (Li et al. 2019) (Figure S3). The distribution pattern of the mtDNA haplogroup F2a indicates the

Fujian Tanka experienced a strong bottleneck effect caused by isolation. As for M7c1, this haplogroup was quite common in southern East Asia, especially in Daic populations like Phuan (28%) in Northern Thailand (Kutanan et al. 2017) and Dai (14.29-20%) in Yunnan (Li et al. 2016). Similarly, the haplogroup F1a1 was common in southern East Asia and had a southern East Asia origin (Kutanan et al. 2017). Then, the haplogroup M8a2 was low frequent in the whole East Asia, except for in Yuan in Southwestern Thailand (28%). In summary, the dominant mtDNA lineages like F2a, M7c1 and F1a1 are quite frequent in southern East Asian populations and have a southern Asia origin, whereas the low frequent haplogroups like A15, Y2, A5b and D5 reflect gene flows from northern China.

Population Comparisons

Based on the Y chromosome PCA plot (Figure 4), the Fujian Tanka (i.e. ShuiSheng and Huyu'ao) cluster with the minority populations, particularly the Daic people, while the neighboring Han from Dongguan village are closer to the Han Chinese. To further discern the relationship with surrounding populations, the multidimensional scaling (MDS) plot (in Figure S1) with Fujian Tanka and 26 populations from YHRD website was analyzed.

Similarly, in MDS plot, both Dongguan and Beiqi are closely related with Han Chinese like Fujian Han, Minnan Han and Zhejiang Han, while the Huyu'ao and ShuiSheng are near to Tai-Kadai populations. In the mtDNA plot, the Tanka population, except Huyu'ao, are close to the southern Han. However, the southern Han that cluster closely to Tanka are mixed populations including the Guangdong Hakka, Taiwan Hakka, Guangdong Chaoshanese, Dongguan Han and Hong Kong Han. According to previous studies, these populations were

mixed with mainly Han Chinese and part of indigenous people such as Daic, Austronesian, and Hmong-Mien populations. Substantial matrilineages of these southern Han are of southern origin (Wen et al. 2004a; Wang et al. 2010). This indicates that the Fujian Tanka are deeply affected by several southern aboriginal populations. In summary, the interpopulation comparison reveals that Fujian Tanka show close affinity with Daic population in the Y chromosome and with southern Han in their mtDNA.

Network Analyses

To discern the detailed relationship between the Tanka people and related populations including Han and other minority populations, we used reduced median-joining networks constructed based on 15 Y-STRs and mtDNA HSV-I motifs (16000-16569) of major haplogroups shown in Figures 5 and 6. The major Y haplogroups are O1a1a-P203, O1b1a1a-M95 and O2a2b1a1-M117 in the Fujian Tanka. Notably, reference samples belonging to haplogroup O1a1a-P203 and O1b1a1a-M95 were too many, so we selected haplotypes within 5 mutational steps from Tanka. There are two parts in the network of O1a1a-P203: the left part is dominant with Taiwan aborigines, while the right is Southern Han, especially Fujian Hakka and Taiwan Minnan individuals. In the left part of the network, the Tanka share the STR haplotypes with Siraya individuals from Taiwan aborigines and have tight ties (in general within three-step STR distance) with other Siraya and Amis individuals. In the right part of the network, the Tanka also share with Taiwan Minnan individuals and have tight ties with other Taiwan Minnan, Fujian Han and Fujian Hakka individuals. In the network of O1b1a1a-M95, the Tanka can be divided into two groups. The two groups are far from each

other, but individuals are close to each other within each group. In the network of O2a2b1a1-M117, the Tanka share haplotypes in common with southern Han samples. In addition to sharing, many Tanka samples link directly with Han samples from Beiqi, southern Han and northern Han. Moreover, these Han samples that link with the Tanka are closer to the center of the network, which indicates the Tanka individuals are derived from Han individuals since recent times.

The mtDNA HSV-I motifs and coding region sequencing information are given in Table S3. Based on the motifs, the networks of mtDNA haplogroups F2a, F1a1, M7c1, D4a and M8a2 were analyzed (Figure 6). The mtDNA networks are always star-like with a huge central haplotype and a great number of small haplotypes derive from the central one. Almost all of the populations share the central haplotype. Interactions among these ethnic groups can be frequently observed. In addition to the southern aboriginal populations, the Tanka also share the same motif with Han samples. This illustrates the recent gene flows between Tanka and Han Chinese widely. In overall, the Tanka still retain some southern origin maternal lineages.

Haplotype-Sharing Analysis and Time Estimation

To inspect the impact of recent events, we found the haplotypes less than 5 mutational steps from the Fujian Tanka. Considering 15 Y-STRs and mutation rate 0.0021 per locus per generation (Burgarella et al. 2011; Gusmão et al. 2005; Ge et al. 2009; Zhabagin et al. 2017), five mutations roughly occur within two thousand years, which might cover the time interval for our analysis. The search of shared haplotypes is performed in our in-house database

which contains 30548 Y-STR Asian haplotypes using the Haplomatch software (Chukhryaeva et al. 2016). The shared haplotypes are listed in Table S5. In haplogroup O1a1a-P203, the closely shared haplotypes were mostly from southeastern Han and Taiwan aborigines. In haplogroup O2a2b1a1-M117, the closely shared haplotypes were mostly from southern Han, northern Han and Tibetans. However, in haplogroup O1b1a1a-M95, we found 16 individuals had no shared haplotypes less than 4 steps away and they were tightly linked with each other, which may be a signal of an isolated population. Then we estimated the divergence time from these isolated individuals (IsoIndi) and other populations (Table 1, Table S6). First, we used time to the most recent common ancestor (TMRCA) of isolated individuals as the lower bound. Although pedigree STR mutation rate underestimates the TMRCA of older nodes (Wei et al. 2013), this method performs some precision for young nodes (<10 ka) (Hallast et al. 2015; Wang et al. 2015) when compared with full Y-chromosome sequence data. Then in our previous case studies (Wang et al. 2015) about evaluating the Y-STR dating in deep-rooting pedigrees, we found that the Y chromosomal genealogical mutation rates (OMRB and ImMR) from the BATWING method could give the best-fit estimation for historical lineage dating. Hence, the lower bound was about 1033.8-1050.6 years before present, in the early years of Northern Song Dynasty, which indicated the divergence time was a least 1033.8-1050.6 years before present. According to historical records (Han 1954), an event played important role in the formation of Tanka: the refugees eluding from wars in the Five Dynasties and Ten Kingdoms period (from 1040 to 1112 years before present). So our estimated time coincides with historical records, which suggests that the formation of Fujian Tanka may be related to this historical event.

Discussion

The ancient Daic people represented an ancient ethnic group residing along southern coast of China from around 2000-8000 years ago. According to archeological studies (Peng 2009), this group was characterized by rice farming, pottery with geometric patterns, stepped adze, shouldered stone axe, stilted houses (called Ganlan-style houses) and a custom of tooth ablation. Then, when the Han began to expand southward in 2000 years ago (Wen et al. 2004b), a large number of ancient Daic descendants were assimilated by Han Chinese. Others migrated and became the Daic people (Song 1991; Wang 1999; Xu 1988; Jiang 1988) and Taiwan aboriginal populations (Lin 1981; Lin 1955; Shi 1982). Since there are few direct genetic studies on the ancient Daic people, we had to represent them using their supposed present descendants like Daic populations including Zhuang, Dong, Sui, Thai, and Taiwan aborigines including Amis, Siraiya, and Atayal.

In this study, based on genetic evidence from Y chromosome and mtDNA, our results support the admixture origin hypothesis - the Tanka are mainly descendants of ancient Daic with limited gene flows from Han Chinese. The Tanka gene pools were mainly contributed by the lineages of southern East Asian origin. In population comparisons, the Fujian Tanka showed closer affinity with the Daic population than the Han Chinese in paternal Y chromosome lineages. However, in maternal mtDNA lineages, the Tanka people were closely clustered with some mixed southern Han populations such as Chaoshanese and Hakka. The network and haplotype-sharing analyses at individual level also supported the hypothesis. In haplogroup O1a1a-P203, the Fujian Tanka samples showed tight links to Taiwan aborigines

and southeastern Han. In haplogroup O2a2b1a1-M117, the samples reflected recent population expansion from Han Chinese. Notably, in haplogroup O1b1a1a-M95, the samples were isolated from other populations. The divergence time from these Tanka-specific haplotypes to others was at least in the early years of Northern Song Dynasty, which corresponded with an important historical event related to the formation of Tanka. Moreover, the highest frequency of mtDNA haplogroup F2a in Tanka also indicated the strong bottleneck in maternal lineages.

The Fujian Tanka population is an excellent sample for studying the population isolation in southern China in the context of demic diffusion of Han culture. The origin of Fujian Tanka is mainly from ancient Daic people. However, due to the discrimination and cultural differences, the Fujian Tanka have been relatively isolated from the Han populations on the land, and also from the Daic populations migrated to southwestern China. The divergence time inferred by Tanka-specific haplotypes indicated that the formation of Fujian Tanka was at least 1033.8-1050.6 years before present. Then limited diffusion from “land” population to Tanka has never been interrupted.

One of the interesting folklore about the origin of Han Chinese in Fujian is that they were admixture of Han male immigrants and indigenous Daic females. However, our data rejected this hypothesis. The Fujian Han people comprise maternal lineages mainly from Han origin. In the contrary, the indigenous Tanka people are mainly admixture of Daic males and Han females.

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Table 1. The TMRCA of Selected Individuals Using BATWING (time in years)

	EMR		lmMR		OMRB		OMRS	
	TMRCAs	95% CI	TMRCAs	95% CI	TMRCAs	95% CI	TMRCAs	95% CI
IsoIndi	4140.9	568-28479.8	1050.6	153-6477.6	1033.8	150.5-6380.7	813.8	115.8-5127.9

IsoIndi 16 isolated individuals; OMRB and OMRS Two observed genealogical mutation rates; lmMR Genealogical mutation rate adjusted for population variation using logistic model; EMR the evolutionary mutation rate.

Supplementary Table S1. The Primers of Mitochondrial Sequencing

Primer Name	Forward Primer	Reverse Primer	Length	Region (hg38)
HVS1	CTTTTCCAAGGACAAATCAGA	TTATGACCCTGAAGTAGGAACC	586bp	15939-16524
HVS2	TGTATCCGACATCTGGTTC	TGACTGTAAAAGTGCATACC	510bp	16489-432
10759-11209	AAGTCTGGCCTATGAGTGAC	GTGGGTGGTTGTGTTGATTC	492bp	10358-10849
14949-15408	TATTCCTAGCCATGCACTACTC	ATTGTGTAGTAAGGGTGAAGG	532bp	14892-15423
12616-13171	AGCTCTCCCTAAGCTTCAAAC	TGATAGCGCCTAAGCATAGTG	627bp	12560-13186
13157-13567	CAGGAATCTTCTTACTCATCC	GCGATGAGAGTAATAGATAGG	481bp	13100-13580
13485-13933	ACCATACCTCTCACTTCAACC	ATTGTGCGGTGTGTGATGC	518bp	13429-13946
13894-14349	TAGACCTCAACTACCTAACC	GTGGGTGAAAGAGTATGATG	522bp	13841-14362
14620-14979	ACACCGCTAACAATCAATAC	TGAAGGTAGCGGATGATTC	431bp	14564-14994
8111-8543	AAGACGTCTTGCACTCATG	GCAATGAATGAAGCGAACAG	504bp	8055-8558
12070-12634	ACTCACCCACCACATTAAC	TGAGAATTCTATGATGGACC	636bp	12013-12648
1297-1763	CTCTTGCTCAGCCTATAT	ATTGCGCCAGGTTTCAATTTC	533bp	1242-1774
9361-9864	AGCCATGTGATTTCACTTCC	TATTAGTTGGCGGATGAAGC	580bp	9299-9878

5035-5329	AGCAGTTCTACCGTACAACC	TTACTGAGGGCTTTGAAGGC	518bp	5042-5559
5914-6366	CAGTCCAATGCTTCACTCAGCC	CTAAGATAGAGGAGACACCTGC	520bp	5862-6381
10143-10553	AACACCCTCCTAGCCTTAC	AGGATATGAGGTGTGAGCG	469bp	10086-10554
2163-2602	AGGAACAGCTCTTTGGACAC	AGGAACAAGTGATTATGCTACC	508bp	2106-2613
4283-4718	TACCCATTACAATCTCCAGC	TTGGTTATGGTTCATTGTCC	507bp	4226-4732

Supplementary Table S2. 17 Y-STRs Data of 87 Individuals in This Study

Population	Sample ID	G_DYS19	B_DYS389I	B_DYS389b	B_DYS390	Y_DYS391	Y_DYS392	Y_DYS393	R_DYS437	R_DYS438	Y_DYS439	R_DYS448	B_DYS456	G_DYS458	Y_DYS635	R_Y_GATA_H4	G_DYS385a	G_DYS385b	Haplogroup
Beiqi	D01	16	12	17	25	10	13	12	15	10	12	19	15	16	21	13	11	16	O2a2b*-P164+,M134-
Beiqi	D02	15	13	16	23	11	11	15	14	10	12	21	15	17	22	12	11	18	C2-M217
Beiqi	D03	14	12	16	23	10	14	12	15	11	11	20	15	18	20	11	15	19	O2a2b1a1-M117
Beiqi	D04	15	12	17	24	11	14	13	14	10	13	18	17	15	19	12	13	13	O1a1a-P203
Beiqi	D05	15	12	16	22	10	14	13	14	10	12	18	14	16	20	12	13	14	O1a1a-P203
Beiqi	D06	17	13	17	24	10	13	12	14	10	13	20	15	18	23	11	12	20	O2a1b-002611
Beiqi	D07	14	12	16	23	10	14	12	15	11	11	20	15	19	20	12	15	18	O2a2b1a1-M117
Beiqi	D08	14	12	16	23	10	14	12	15	11	11	20	15	19	20	12	15	18	O2a2b1a1-M117
Beiqi	D09	15	12	16	22	11	14	13	14	10	12	18	14	15	20	12	13	14	O1a1a-P203
Beiqi	D10	14	12	16	23	10	14	12	15	11	12	20	15	19	21	12	15	18	O2a2b1a1-M117
Beiqi	D11	15	13	17	24	10	13	13	15	10	12	20	15	16	20	11	13	22	O2a2*-P201
Beiqi	D12	14	12	16	23	10	14	12	15	11	11	20	15	19	20	12	15	18	O2a2b1a1-M117
Beiqi	D13	15	12	16	23	10	14	13	14	10	11	18	14	17	20	12	13	13	O1a1a-P203
Beiqi	D14	15	13	16	24	10	13	12	15	10	13	19	15	18	21	12	11	16	O2a2b1*-M134+,M117-
Beiqi	D15	15	12	15	23	10	14	12	14	10	12	18	15	15	20	12	13	13	O1a1a-P203
Beiqi	D16	16	13	16	24	10	13	12	14	10	12	20	15	17	24	11	12	18	O2a1b-002611
Beiqi	D17	14	12	16	24	11	14	12	15	11	13	19	15	19	21	12	12	19	O2a2b1a1-M117
Beiqi	D18	14	12	16	24	10	14	12	15	11	13	20	15	17	18	12	13	19	O2a2b1a1-M117
Beiqi	D19	16	12	17	24	11	14	13	14	10	12	18	17	15	19	12	13	13	O1a1a-P203
Beiqi	D20	15	12	17	24	11	14	13	14	10	13	18	17	15	19	12	13	13	O1a1a-P203
Shuisheng	D21	15	12	16	24	10	13	12	16	11	11	20	15	16	21	12	12	18	O2a2b1a1-M117
Shuisheng	D22	14	12	16	25	10	13	12	14	10	11	19	14	16	20	12	12	19	O2a1b-002611

Shuisheng	D23	15	14	17	24	10	14	12	14	10	11	18	15	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D24	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D25	15	13	16	22	10	13	12	14	10	14	20	15	19	22	12	11	11	O2a1b-002611
Shuisheng	D26	15	14	17	24	10	14	12	14	10	11	18	15	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D27	15	12	17	24	11	14	13	14	10	11	18	17	15	19	12	13	13	O1a1a-P203
Shuisheng	D28	15	12	17	24	11	14	13	14	10	11	18	17	15	19	12	13	13	O1a1a-P203
Shuisheng	D29	15	13	18	23	10	13	12	14	10	11	19	14	18	21	12	13	18	O2a1a1a1a1-M121
Shuisheng	D30	15	14	18	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D31	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Shuisheng	D32	16	13	16	24	10	11	14	14	10	11	21	15	15	20	10	11	18	C2-M217
Shuisheng	D33	15	12	17	24	11	14	13	14	10	12	18	16	15	19	12	13	13	O1a1a-P203
Shuisheng	D34	15	12	17	24	11	14	13	14	10	12	18	16	15	19	12	13	13	O1a1a-P203
Shuisheng	D35	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D36	15	12	15	24	10	14	12	15	11	12	20	15	16	20	12	14	19	O2a2b1a1-M117
Shuisheng	D37	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Shuisheng	D38	15	14	18	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D39	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Shuisheng	D40	15	12	17	24	11	14	13	14	10	12	18	16	15	19	12	13	13	O1a1a-P203
Shuisheng	D41	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D42	15	14	19	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D43	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D44	15	14	19	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D45	15	14	16	24	11	13	14	14	10	12	18	14	20	21	10	13	17	O1b1a1a-M95
Huyu'ao	D46	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D47	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D48	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D49	15	14	17	24	10	14	12	14	10	11	18	16	17	22	10	13	19	O1b1a1a-M95
Huyu'ao	D50	15	13	17	24	10	13	13	15	10	12	20	15	16	20	11	13	22	O2a2*-P201
Huyu'ao	D51	15	14	19	24	10	14	12	14	10	11	18	16	19	22	10	13	19	O1b1a1a-M95
Huyu'ao	D52	16	13	16	23	11	14	14	14	10	10	18	14	18	21	12	11	11	N1a1a-M178
Huyu'ao	D53	15	14	16	24	11	13	14	14	10	12	18	14	20	21	10	13	17	O1b1a1a-M95

Huyu'ao	D54	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D55	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D56	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D57	15	12	15	24	10	14	12	15	11	12	20	15	16	20	12	14	19	O2a2b1a1-M117
Huyu'ao	D58	15	14	19	24	10	14	12	14	10	11	18	16	19	22	10	13	19	O1b1a1a-M95
Huyu'ao	D59	16	12	16	23	10	15	13	14	10	11	18	16	15	19	12	13	14	O1a1a-P203
Huyu'ao	D60	16	12	16	23	10	15	13	14	10	11	18	16	16	19	12	13	14	O1a1a-P203
Huyu'ao	D61	15	14	16	24	11	13	14	14	10	12	18	14	20	21	10	13	17	O1b1a1a-M95
Huyu'ao	D62	15	14	19	24	10	14	12	14	10	11	18	16	19	22	10	13	19	O1b1a1a-M95
Dongguan	DH63	14	12	18	23	10	11	12	15	11	13	20	15	16	19	12	15	16	D1a1-M15
Dongguan	DH64	15	12	16	24	11	13	12	15	11	12	20	15	19	20	12	14	18	O2a2b1a1-M117
Dongguan	DH65	15	13	17	23	10	11	13	14	10	12	22	15	16	21	11	11	18	C2-M217
Dongguan	DH66	14	12	18	23	10	11	12	15	11	13	20	15	15	19	12	15	16	D1a1-M15
Dongguan	DH67	15	12	16	23	10	14	13	14	10	11	17	15	16	20	12	13	13	O1a1a-P203
Dongguan	DH68	14	12	17	24	10	14	13	14	11	12	21	15	16	20	13	13	13	O2a2b1a1-M117
Dongguan	DH69	15	13	16	23	10	11	15	14	10	11	21	16	16	21	11	11	17	C2-M217
Dongguan	DH70	15	12	16	25	10	13	12	14	10	12	18	13	18	21	11	14	17	O2a1b-002611
Dongguan	DH71	15	12	16	23	11	14	13	15	7	12	18	15	15	19	12	13	13	O1a1a-P203
Dongguan	DH72	14	14	16	25	11	13	12	14	11	12	20	15	17	21	11	13	19	O2-M122
Dongguan	DH73	15	13	18	23	10	13	12	14	10	12	19	14	17	21	11	12	19	O2a1a1a1a1-M121
Dongguan	DH74	15	13	16	23	10	11	13	14	10	12	22	15	16	21	11	11	18	C2-M217
Dongguan	DH75	15	12	16	24	10	14	12	15	11	11	20	15	18	20	12	14	18	O2a2b1a1-M117
Dongguan	DH76	14	12	16	23	10	14	12	15	11	12	20	15	19	20	12	15	18	O2a2b1a1-M117
Dongguan	DH77	15	12	17	23	10	14	12	14	10	12	19	16	16	20	12	12	13	O1a*-M119
Dongguan	DH78	15	13	17	23	10	11	13	14	10	12	22	15	16	21	11	11	18	C2-M217
Dongguan	DH79	14	12	16	23	10	14	12	15	11	12	20	15	18	21	12	15	19	O2a2b1a1-M117
Dongguan	DH80	14	12	16	23	10	14	12	15	11	11	20	15	18	20	12	15	18	O2a2b1a1-M117
Dongguan	DH81	15	12	16	24	11	14	12	15	11	12	20	15	17	20	12	14	18	O2a2b1a1-M117
Dongguan	DH82	13	13	17	22	10	14	14	14	10	10	19	16	14	23	11	11	11	N*-M231
Dongguan	DH83	17	13	16	25	10	13	14	14	10	12	18	15	16	21	11	13	18	O1b1a1a-M95
Dongguan	DH84	15	12	16	24	10	14	12	15	11	12	20	15	19	20	12	14	18	O2a2b1a1-M117

Dongguan	DH85	14	12	16	23	10	15	12	15	11	12	20	15	18	20	12	16	19	O2a2b1a1-M117
Dongguan	DH86	15	14	17	24	10	13	13	14	10	13	18	14	19	23	10	13	13	O*-M175
Dongguan	DH87	15	13	16	23	10	14	13	14	10	11	19	15	15	20	12	12	14	O1a1a-P203

Supplementary Table S3. HVS Data of 85 Individuals in Present Study

Population	Sample ID	Haplogroup	Range	Polymorphisms
Beiqi	D01	F3a1	15954-16510 ; 16542-16569 ; 1-413 ;	73G 207A 249d 263G 309.1C 315.1C 16260T 16298C 16355T 16362C
Beiqi	D02	B4a3	15995-16474 ; 16544-16569 ; 1-387 ;	73G 195C 263G 309.1CC 315.1C 16092C 16182C 16183C 16189C 16217C 16261T 16325C 16399G
Beiqi	D03	B4b1a+207	15995-16474 ; 16544-16569 ; 1-387 ;	73G 150T 204C 207A 263G 309.1CC 315.1C 16136C 16179T 16182C 16183C 16189C 16217C
Beiqi	D04	F2a+@16291	16004-16508 ; 16544-16569 ; 1-414 ;	73G 182T 249d 263G 315.1C 16167T 16203G 16304C 16318G
Beiqi	D05	R9b1	16004-16508 ; 16544-16569 ; 1-410 ;	73G 152C 263G 309.1C 315.1C 16192T 16239T 16304C 16309G 16390A
Beiqi	D06	M7c1	15995-16511 ; 16555-16569 ; 1-378 ;	73G 146C 152C 199C 263G 309.1C 315.1C 16223T 16295T
Beiqi	D09	M8a2a1	16004-16509 ; 16544-16569 ; 1-387 ;	73G 146C 152C 263G 309d 315.1C 16184T 16185T 16189C 16223T 16298C 16311C 16319A 16468C 16470A 16471A 16473A
Beiqi	D10	F1a3b	16004-16509 ; 16544-16569 ; 1-387 ;	52C 53A 54C 70.1T 73G 74d 75d 249d 263G 309.1CC 315.1C 318C 16129A 16172C 16242T 16304C
Beiqi	D11	F1a1a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 150T 152C 199C 249d 263G 315.1C 16108T 16129A 16162G 16172C 16304C
Beiqi	D12	M7c1	16004-16511 ; 16544-16569 ; 1-387 ;	73G 146C 152C 199C 263G 309.1CC 315.1C 16223T 16295T
Beiqi	D13	A5b1b	16004-16509 ; 16544-16569 ; 1-387 ;	73G 235G 263G 309.1CC 315.1C 16126C 16223T 16234T 16235G 16290T 16319A
Beiqi	D14	A5b1b	16004-16509 ; 16544-16569 ; 1-387 ;	73G 235G 263G 309.1CC 315.1C 16126C 16223T 16234T 16235G 16290T 16319A
Beiqi	D15	F2a+@16291	16004-16509 ; 16544-16569 ; 1-387 ;	73G 150T 249d 263G 309.1C 315.1C 16203G 16304C
Beiqi	D16	B5b2	16004-16474 ; 16544-16569 ; 1-387 ;	73G 103A 131C 199C 204C 263G 309.1C 315.1C 16111T 16140C 16182C 16183C 16189C 16234T 16243C 16463G
Beiqi	D17	A15a	16004-16509 ; 16544-16569 ; 1-387 ; 10759-11209 ; 14949-15408 ;	73G 152C 207A 235G 309.1C 315.1C 329A 11084G 15326G 16223T 16290T 16319A 16362C
Beiqi	D18	F2a+@16291	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16086C 16203G 16304C

Beiqi	D19	F2a+@16291	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16086C 16203G 16304C
Beiqi	D20	B4c1b2c2	16004-16474 ; 16544-16569 ; 1-387 ;	73G 146C 150T 263G 309.1C 315.1C 16129A 16140C 16166G 16183C 16189C 16217C 16274A
Shuisheng	D21	A15	16004-16509 ; 16544-16569 ; 1-387 ;	73G 152C 207A 235G 309.1C 315.1C 329A 16223T 16290T 16319A 16362C
Shuisheng	D22	F2a	16004-16509 ; 16544-16569 ; 1-416 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Shuisheng	D23	M7c1	16004-16509 ; 16544-16569 ; 1-414 ;	73G 146C 152C 199C 263G 309.1C 315.1C 16223T 16295T
Shuisheng	D24	D4a3	16004-16509 ; 16544-16569 ; 1-414 ;	73G 152C 263G 309.1C 315.1C 16129A 16223T 16249C 16294T 16362C
Shuisheng	D25	F2a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Shuisheng	D26	D4a3	15995-16506 ; 16544-16569 ; 1-410 ;	73G 152C 263G 309.1C 315.1C 16129A 16223T 16249C 16294T 16362C
Shuisheng	D27	F1+16189	16004-16467 ; 16544-16569 ; 1-387 ;	73G 249d 263G 309.1C 315.1C 16182C 16183C 16189C 16304C
Shuisheng	D28	F2a	16004-16509 ; 16544-16569 ; 1-416 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Shuisheng	D29	M20	16004-16509 ; 16544-16569 ; 1-387 ; 12616-13171 ; 13157-13567 ; 13485- 13933 ; 13894-14349 ; 14620-14979 ;	73G 152C 225A 249d 263G 309.1C 315.1C 316A 12705T 14110C 14766T 14783C 14974T 16129A 16209C 16223T 16272G
Shuisheng	D30	M7c1	16004-16509 ; 16544-16569 ; 1-387 ;	73G 146C 152C 199C 263G 309.1C 315.1C 345d 16223T 16295T
Shuisheng	D31	M7b1a1	15995-16508 ; 16555-16569 ; 1-420 ;	73G 150T 199C 263G 315.1C 16129A 16223T 16297C
Shuisheng	D32	M7b1a1	16004-16509 ; 16544-16569 ; 1-387 ;	73G 150T 199C 263G 315.1C 16223T 16297C
Shuisheng	D33	D5	16004-16467 ; 16544-16569 ; 1-411 ;	73G 150T 263G 309.1C 315.1C 16183C 16189C 16223T 16362C
Shuisheng	D34	F2a+@16291	16004-16509 ; 16544-16569 ; 1-415 ;	73G 249d 263G 315.1C 16086C 16203G 16304C
Shuisheng	D35	B4b1	16004-16474 ; 16544-16569 ; 1-387 ;	73G 263G 309.1CC 315.1C 16136C 16183C 16189C 16217C 16260T
Shuisheng	D36	M8a2+152	16004-16509 ; 16544-16569 ; 1-387 ;	73G 152C 263G 309.1CC 315.1C 345d 16184T 16223T 16293C 16298C 16319A
Shuisheng	D37	B4b1	16004-16474 ; 16544-16569 ; 1-387 ;	73G 263G 309.1CC 315.1C 16136C 16183C 16189C 16217C 16260T
Shuisheng	D38	N9a4b	16004-16509 ; 16544-16569 ; 1-387 ;	73G 150T 263G 309.1C 315.1C 16092C 16145A 16172C 16223T 16245T 16257A 16261T

Shuisheng	D39	F1a1a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 143A 249d 263G 315.1C 16108T 16129A 16162G 16172C 16256T 16362C
Shuisheng	D40	F2a+@16291	16004-16509 ; 16544-16569 ; 1-411 ;	73G 249d 263G 315.1C 16086C 16203G 16304C
Shuisheng	D41	F4a2	16004-16509 ; 16544-16569 ; 1-414 ;	64T 73G 146C 152C 249d 263G 281G 315.1C 16207G 16304C 16399G
Huyu'ao	D42	B5	16004-16474 ; 16544-16569 ; 1-390 ; 8111-8543 ;	73G 210G 263G 309.1C 315.1C 8188G 8281d 8282d 8283d 8284d 8285d 8286d 8287d 8288d 8289d 16066G 16140C 16183C 16189C 16266G 16274A 16291T
Huyu'ao	D43	M8a2+152	15995-16509 ; 16544-16569 ; 1-387 ;	73G 152C 263G 309.1CC 315.1C 16184T 16223T 16293C 16298C 16319A
Huyu'ao	D44	A15	16004-16509 ; 16544-16569 ; 1-387 ;	73G 152C 207A 235G 309.1C 315.1C 329A 16223T 16290T 16319A 16362C
Huyu'ao	D45	F2a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 309.1C 315.1C 16203G 16262.1C 16291T 16304C
Huyu'ao	D46	M7c1b	15989-16510 ; 16547-16569 ; 1-387 ; 12070-12634 ;	73G 146C 152C 199C 263G 309.1C 315.1C 12091C 12561A 16223T 16295T 16550C 16552T
Huyu'ao	D47	R9b1a1a	16004-16474 ; 16544-16569 ; 1-387 ;	73G 143A 183G 263G 309.1C 315.1C 16093C 16189C 16288C 16304C 16390A
Huyu'ao	D48	M7c1	16004-16509 ; 16544-16569 ; 1-387 ;	73G 146C 152C 199C 263G 309.1CC 315.1C 16223T 16295T
Huyu'ao	D49	M8a2+152	16004-16509 ; 16544-16569 ; 1-411 ;	73G 152C 263G 309.1C 315.1C 16184T 16223T 16293C 16298C 16319A
Huyu'ao	D50	F2a	15995-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 309.1C 315.1C 16203G 16262.1C 16291T 16304C
Huyu'ao	D51	F2a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Huyu'ao	D52	F1a2	16004-16509 ; 16544-16569 ; 1-387 ;	73G 249d 263G 309.1C 315.1C 16172C 16304C
Huyu'ao	D53	N9a4b	16004-16509 ; 16544-16569 ; 1-387 ;	73G 150T 263G 309.1C 315.1C 16092C 16145A 16172C 16223T 16245T 16257A 16261T
Huyu'ao	D54	F1a1a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 143A 249d 263G 315.1C 16108T 16129A 16162G 16172C 16256T 16362C
Huyu'ao	D55	M7c1	15992-16509 ; 16544-16569 ; 1-365 ;	73G 146C 152C 199C 263G 309.1CC 315.1C 16223T 16295T
Huyu'ao	D56	Y2	15951-16509 ; 16498-16569 ; 1-414 ;	73G 150T 200G 263G 309.1C 315.1C 16126C 16231C 16311C
Huyu'ao	D57	F2a	16004-16509 ; 16544-16569 ; 1-415 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Huyu'ao	D58	F2a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C

Huyu'ao	D59	Y2	16004-16510 ; 16502-16569 ; 1-387 ;	73G 150T 200G 263G 309.1C 315.1C 16126C 16231C 16311C
Huyu'ao	D60	F1a1a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 143A 249d 263G 315.1C 16108T 16129A 16162G 16172C 16256T 16362C
Huyu'ao	D61	M8a2+152	16004-16509 ; 16544-16569 ; 1-411 ;	73G 152C 263G 309.1C 315.1C 16184T 16223T 16293C 16298C 16319A
Huyu'ao	D62	F2a	16004-16509 ; 16544-16569 ; 1-414 ;	73G 249d 263G 315.1C 16203G 16262.1C 16291T 16304C
Dongguan	H63	F1a	16004-16509 ; 16546-16569 ; 1-387 ;	73G 249d 263G 309.1C 315.1C 16129A 16172C 16304C
Dongguan	H64	H6a	16004-16509 ; 16546-16569 ; 1-384 ; 1297-1763 ; 9361-9864 ;	239C 263G 309.1CC 315.1C 1438G 9380A 16278T 16362C 16482G
Dongguan	H65	N10a	16004-16474 ; 16546-16569 ; 1-387 ;	73G 185A 189G 195C 234G 263G 309.1CC 315.1C 16111T 16172C 16183C 16189C 16209C 16223T 16362C
Dongguan	H66	B4+16261	16004-16467 ; 16546-16569 ; 1-387 ;	73G 263G 309.1CC 315.1C 345d 16182C 16183C 16189C 16217C 16261T
Dongguan	H67	M8a2+152	16004-16509 ; 16546-16569 ; 1-420 ;	73G 152C 263G 315.1C 16184T 16223T 16298C 16319A
Dongguan	H68	F1a1	16004-16509 ; 16546-16569 ; 1-387 ;	73G 249d 251A 263G 309.1C 315.1C 16129A 16162G 16172C 16304C 16335G
Dongguan	H69	F1ald	16004-16509 ; 16546-16569 ; 1-420 ;	73G 249d 263G 315.1C 16129A 16162G 16172C 16304C 16362C 16399G
Dongguan	H70	F2b1	16004-16509 ; 16546-16569 ; 1-420 ;	73G 249d 263G 315.1C 16092A 16291T 16304C 16311C
Dongguan	H71	F4a1b	15996-16509 ; 16546-16569 ; 1-387 ;	73G 146C 249d 263G 309.1CC 315.1C 317A 16126C 16140C 16207G 16304C 16311C 16362C 16399G
Dongguan	H72	F4a1a	16004-16509 ; 16546-16569 ; 1-420 ;	73G 146C 152C 207A 249d 263G 309.1C 315.1C 16207G 16304C 16362C 16399G 16497G
Dongguan	H73	M10a1+16129	16004-16509 ; 16546-16569 ; 1-420 ;	73G 263G 315.1C 16129A 16223T 16311C
Dongguan	H74	N10a	16004-16474 ; 16546-16569 ; 1-387 ;	73G 185A 189G 195C 234G 263G 309.1CC 315.1C 16111T 16172C 16183C 16189C 16209C 16223T 16362C
Dongguan	H75	M	15956-16509 ; 16544-16569 ; 1-417 ; 5035-5329 ; 5914-6366 ; 10143-10553 ; 2163-2602 ; 4283-4718 ;	73G 152C 263G 309.1C 315.1C 10398G 10400T 16223T 16362C
Dongguan	H76	D4a6	16004-16509 ; 16546-16569 ; 1-387 ;	73G 146C 217C 263G 309.1C 315.1C 345d 16223T 16234T 16362C

Dongguan	H77	D4a3a2	16004-16509 ; 16546-16569 ; 1-387 ;	73G 152C 263G 309.1C 315.1C 16093C 16129A 16223T 16249C 16362C
Dongguan	H78	N10a	16004-16474 ; 16546-16569 ; 1-387 ;	73G 185A 189G 195C 234G 263G 309.1CC 315.1C 16111T 16172C 16183C 16189C 16209C 16223T 16362C
Dongguan	H79	M7b1a1a3	16004-16474 ; 16546-16569 ; 1-378 ;	73G 150T 199C 204C 263G 309.1CC 315.1C 16129A 16189C 16193.1C 16223T 16265C 16297C 16368C
Dongguan	H80	A5b1b	16004-16509 ; 16546-16569 ; 1-387 ;	73G 235G 263G 309.1C 315.1C 16126C 16223T 16234T 16290T 16319A
Dongguan	H81	F2i	16004-16509 ; 16546-16569 ; 1-420 ;	73G 152C 195C 249d 263G 275A 315.1C 16221T 16304C
Dongguan	H82	B4+16261	16004-16467 ; 16546-16569 ; 1-387 ;	73G 263G 309.1C 315.1C 345d 16182C 16183C 16189C 16217C 16261T
Dongguan	H83	M7c1a3	16004-16509 ; 16546-16569 ; 1-420 ;	73G 146C 199C 263G 315.1C 16223T 16295T 16319A
Dongguan	H84	M7c1b2a	16004-16510 ; 16546-16569 ; 1-387 ;	73G 146C 199C 263G 309.1CC 315.1C 16172C 16173T 16223T 16295T 16362C
Dongguan	H85	F1c1a1	16004-16509 ; 16546-16569 ; 1-387 ;	73G 152C 249d 263G 309.1C 315.1C 16111T 16129A 16266T 16304C
Dongguan	H86	C	15956-16509 ; 16502-16569 ; 1-408 ;	73G 249d 263G 315.1C 16223T 16298C 16327T 16519C
Dongguan	H87	B4c1b2c1	16004-16474 ; 16546-16569 ; 1-420 ;	73G 150T 263G 315.1C 16136C 16140C 16183C 16189C 16217C 16249C 16274A 16280G 16291T 16294T 16335G

Supplementary Table S4. MtDNA Haplogroup Frequency Matrix of 173 Populations Analyzed in This Study

[Note: refer to supplemental Excel file. This has been updated to Supplementary Table S5 for the final version of this paper.]

Supplementary Table S5. Haplotype-Sharing Analysis of 87 Individuals in This Study

Population	ID	Haplogroup	Individuals of shared haplotypes					
			Step0	Step1	Step2	Step3	Step4	Step5
Beiqi	D04	O1a1a-P203	1	8	39	114	318	451
Beiqi	D19	O1a1a-P203	0	6	56	145	362	489
Beiqi	D20	O1a1a-P203	1	8	39	114	318	451
Shuisheng	D27	O1a1a-P203	7	62	227	382	423	323
Shuisheng	D28	O1a1a-P203	7	62	227	382	423	323
Shuisheng	D33	O1a1a-P203	1	13	94	218	433	535
Shuisheng	D34	O1a1a-P203	1	13	94	218	433	535
Shuisheng	D40	O1a1a-P203	1	13	94	218	433	535
Beiqi	D13	O1a1a-P203	1	7	27	53	124	254
Beiqi	D15	O1a1a-P203	1	2	15	55	165	321
Dongguan	DH67	O1a1a-P203	0	12	36	73	151	421
Dongguan	DH87	O1a1a-P203	0	2	17	71	200	548
Beiqi	D05	O1a1a-P203	0	3	19	67	111	249
Beiqi	D09	O1a1a-P203	0	2	13	42	109	259
Shuisheng	D31	O1a1a-P203	0	0	16	114	318	488
Shuisheng	D37	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D46	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D48	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D54	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D55	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D56	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D59	O1a1a-P203	0	0	16	114	318	488
Huyu'ao	D60	O1a1a-P203	0	1	5	46	195	427
Huyu'ao	D45	O1b1a1a-M95	0	4	24	43	38	49
Huyu'ao	D53	O1b1a1a-M95	0	4	24	43	38	49
Huyu'ao	D61	O1b1a1a-M95	0	4	24	43	38	49
Shuisheng	D23	O1b1a1a-M95	0	0	0	0	3	29

Shuisheng	D24	O1b1a1a-M95	0	0	0	0	1	8
Shuisheng	D26	O1b1a1a-M95	0	0	0	0	3	29
Shuisheng	D30	O1b1a1a-M95	0	0	0	0	0	2
Shuisheng	D35	O1b1a1a-M95	0	0	0	0	1	8
Shuisheng	D38	O1b1a1a-M95	0	0	0	0	0	2
Shuisheng	D39	O1b1a1a-M95	0	0	0	0	1	8
Shuisheng	D41	O1b1a1a-M95	0	0	0	0	1	8
Huyu'ao	D42	O1b1a1a-M95	0	0	0	0	0	0
Huyu'ao	D43	O1b1a1a-M95	0	0	0	0	1	8
Huyu'ao	D44	O1b1a1a-M95	0	0	0	0	0	0
Huyu'ao	D47	O1b1a1a-M95	0	0	0	0	1	8
Huyu'ao	D49	O1b1a1a-M95	0	0	0	0	1	8
Huyu'ao	D51	O1b1a1a-M95	0	0	0	0	0	0
Huyu'ao	D58	O1b1a1a-M95	0	0	0	0	0	0
Huyu'ao	D62	O1b1a1a-M95	0	0	0	0	0	0
Dongguan	DH83	O1b1a1a-M95	0	0	10	27	84	202
Beiqi	D03	O2a2b1a1-M117	0	29	151	456	717	904
Beiqi	D07	O2a2b1a1-M117	6	52	186	500	774	934
Beiqi	D08	O2a2b1a1-M117	6	52	186	500	774	934
Beiqi	D10	O2a2b1a1-M117	5	43	194	482	732	1008
Beiqi	D12	O2a2b1a1-M117	6	52	186	500	774	934
Shuisheng	D36	O2a2b1a1-M117	0	8	60	270	562	833
Huyu'ao	D57	O2a2b1a1-M117	0	8	60	270	562	833
Dongguan	DH75	O2a2b1a1-M117	8	42	178	455	893	1148
Dongguan	DH76	O2a2b1a1-M117	17	106	360	595	875	1000
Dongguan	DH79	O2a2b1a1-M117	12	70	284	611	996	1095
Dongguan	DH80	O2a2b1a1-M117	11	87	358	637	877	962
Dongguan	DH81	O2a2b1a1-M117	3	13	108	350	716	1116
Dongguan	DH84	O2a2b1a1-M117	8	54	233	535	861	970
Dongguan	DH85	O2a2b1a1-M117	5	39	231	473	823	1049
Shuisheng	D21	O2a2b1a1-M117	0	1	8	26	94	269

Beiqi	D17	O2a2b1a1-M117	0	4	19	78	204	491
Beiqi	D18	O2a2b1a1-M117	2	8	14	78	310	713
Dongguan	DH64	O2a2b1a1-M117	0	0	18	95	328	674
Dongguan	DH68	O2a2b1a1-M117	0	0	1	4	33	122
Beiqi	D06	O2a1b-002611	0	9	27	47	53	73
Beiqi	D16	O2a1b-002611	0	3	15	36	60	142
Dongguan	DH70	O2a1b-002611	0	1	10	32	94	207
Shuisheng	D22	O2a1b-002611	0	0	10	38	79	183
Shuisheng	D25	O2a1b-002611	0	0	0	0	1	5
Dongguan	DH69	C2-M217	0	20	105	216	359	403
Beiqi	D02	C2-M217	3	3	7	34	103	189
Shuisheng	D32	C2-M217	0	1	4	16	77	199
Dongguan	DH65	C2-M217	0	0	5	25	121	254
Dongguan	DH74	C2-M217	0	0	8	49	161	397
Dongguan	DH78	C2-M217	0	0	5	25	121	254
Beiqi	D11	O2a2*-P201	3	9	25	30	26	85
Huyu'ao	D50	O2a2*-P201	3	9	25	30	26	85
Shuisheng	D29	O2a1a1a1a1-M121	0	1	32	76	84	114
Dongguan	DH73	O2a1a1a1a1-M121	2	24	62	59	55	100
Dongguan	DH63	D1a1-M15	0	0	0	0	3	23
Dongguan	DH66	D1a1-M15	0	0	0	0	0	7
Beiqi	D14	O2a2b1*-M134+M117-	0	12	49	100	170	376
Dongguan	DH72	O2-M122	0	3	11	20	45	50
Dongguan	DH77	O1a*-M119	0	5	12	37	141	472
Beiqi	D01	O2a2b*-P164+M134-	0	0	0	9	56	180
Huyu'ao	D52	N1a1a-M178	0	0	0	1	6	16
Dongguan	DH82	N*-M231	0	0	4	5	7	3
Dongguan	DH86	O*-M175	0	0	0	1	11	42

Supplementary Table S6. The TMRCA of Selected Individuals Using BATWING (time in years)

	EMR		lmMR		OMRB		OMRS	
	TMRCA	95% CI	TMRCA	95% CI	TMRCA	95% CI	TMRCA	95% CI
IsoIndi	4140.9	568-28479.8	1050.6	153-6477.6	1033.8	150.5-6380.7	813.8	115.8-5127.9
IsoIndi+CH	8433.1	1253.4-52264	2157.9	364.4-11682	2229	374.4-12064	1797.4	297.2-9811

IsoIndi 16 isolated individuals; *IsoIndi+CH*:16 isolated individuals and one closest haplotypes; *OMRB and OMRS* Two observed genealogical mutation rates; *lmMR* Genealogical mutation rate adjusted for population variation using logistic model; *EMR* the evolutionary mutation rate.

Figure Captions

Figure 1. The distributions of East Asian populations in data analysis and detailed geographic location of Fujian Tanka.

Figure 2. The phylogenetic relationship of Y chromosome haplogroups surveyed in this study and their haplogroup-based frequencies in Tanka and Han. The marker names are shown along the branches, and haplogroup names are shown on the right side according to the ISOGG Y-DNA Haplogroup Tree 2019. Potentially paraphyletic undefined subgroups are distinguished from recognized haplogroups by the asterisk symbol. Haplogroups tested for but not seen in this study are enclosed in parentheses. Populations: BQ, Beiqi; SS, Shuisheng; HYA, Huyu'ao; DG, Dongguan.

Figure 3. The phylogenetic relationship of mtDNA haplogroups surveyed in this study and their haplogroup-based frequencies in Tanka and Han people. The marker names are shown along the branches, and haplogroup names are shown on the right side according to the PhyloTree mtDNA tree Build 17.

Figure 4. Principal component plot of Han Chinese and southern East Asian populations. A) Principal component plot of Y chromosome haplogroups; B) Principal component plot of mtDNA haplogroups.

Figure 5. Networks of the major Y chromosome haplogroups O1a1a-P203, O1b1a1a-M95

and O2a2b1a1-M117 of Fujian Tanka in comparison with Han Chinese and southern indigenous populations.

Figure 6. Networks of the major mtDNA haplogroups of Fujian Tanka in comparison with Han Chinese and southern indigenous populations.

Supplementary Figure S1. Multidimensional scaling plot based on 17 Y-STRs of Tanka and other populations.

Supplementary Figure S2. Network of 16 isolated individuals and shared haplotypes fewer than 5 mutational steps.

Supplementary Figure S3. Geographic distribution of mtDNA haplogroup F2a.

Figure 1.



Figure 2.

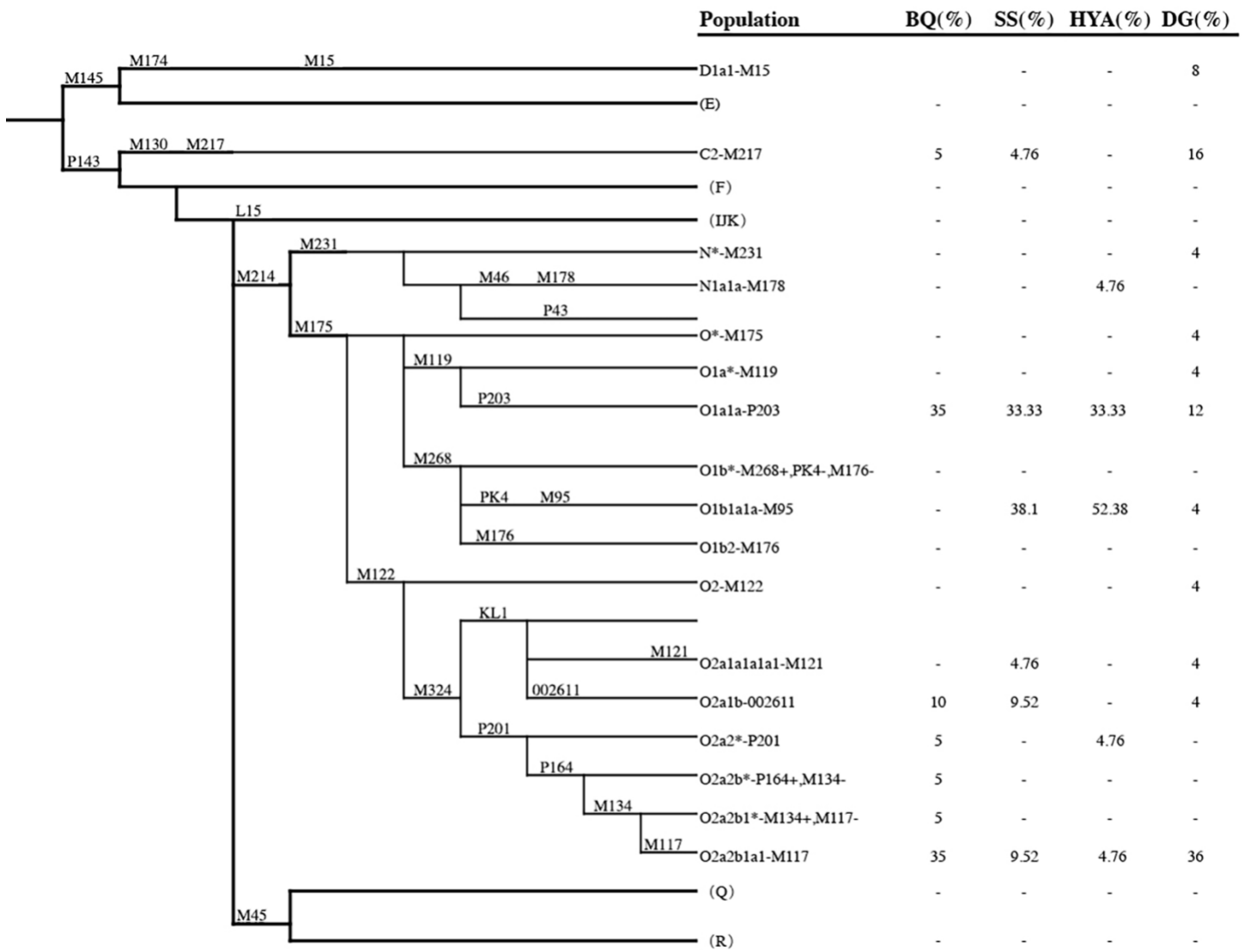


Figure 3.

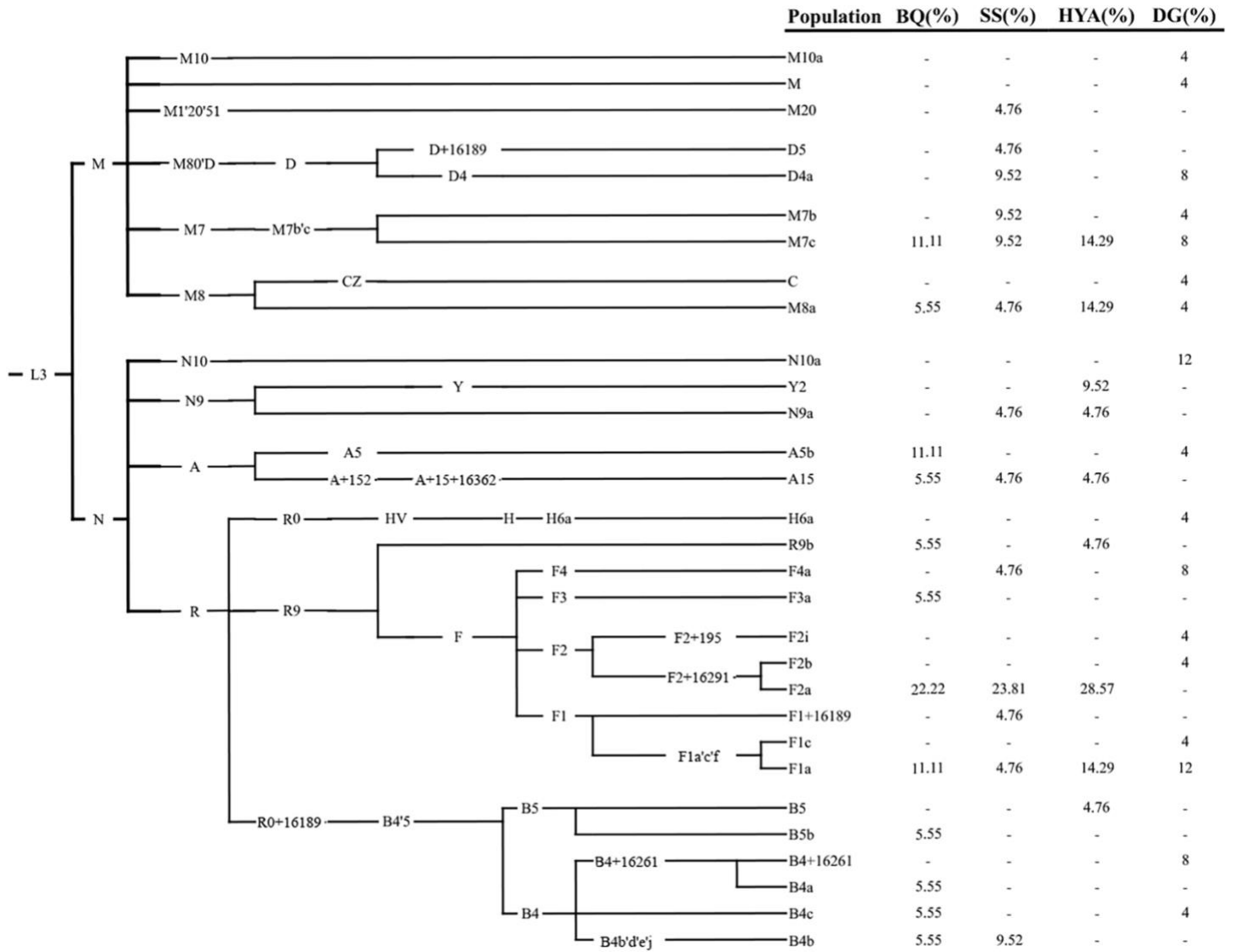


Figure 4.

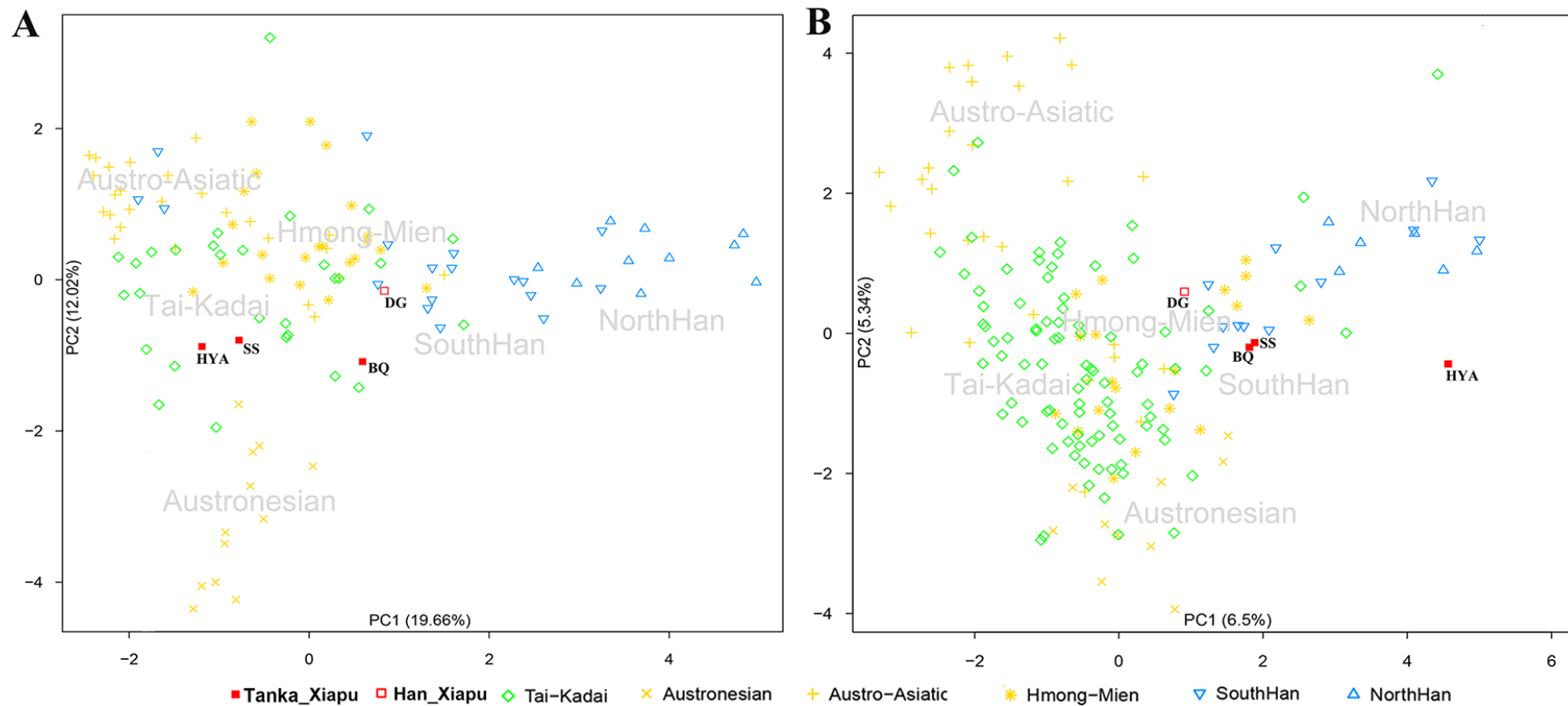


Figure 5.

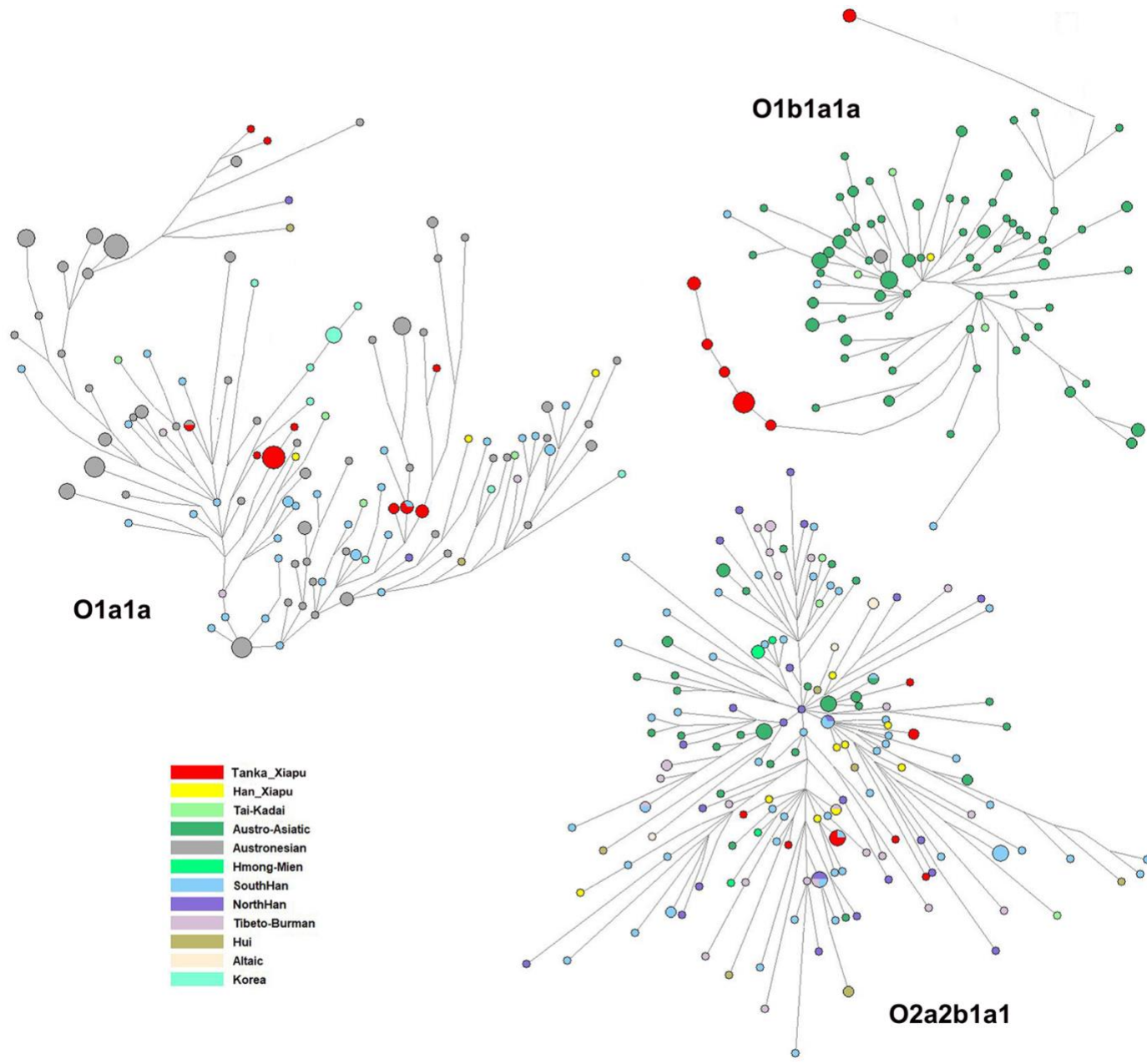
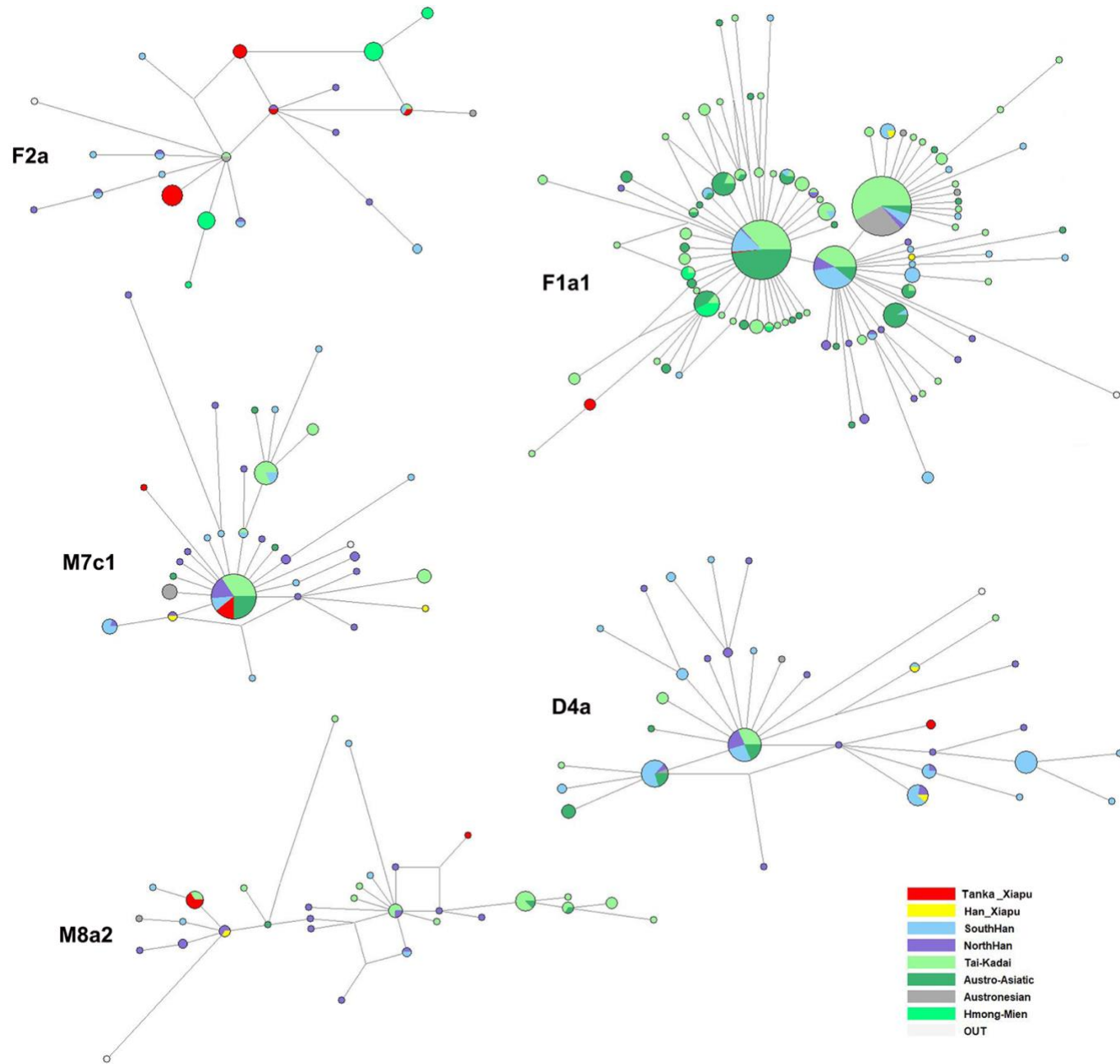
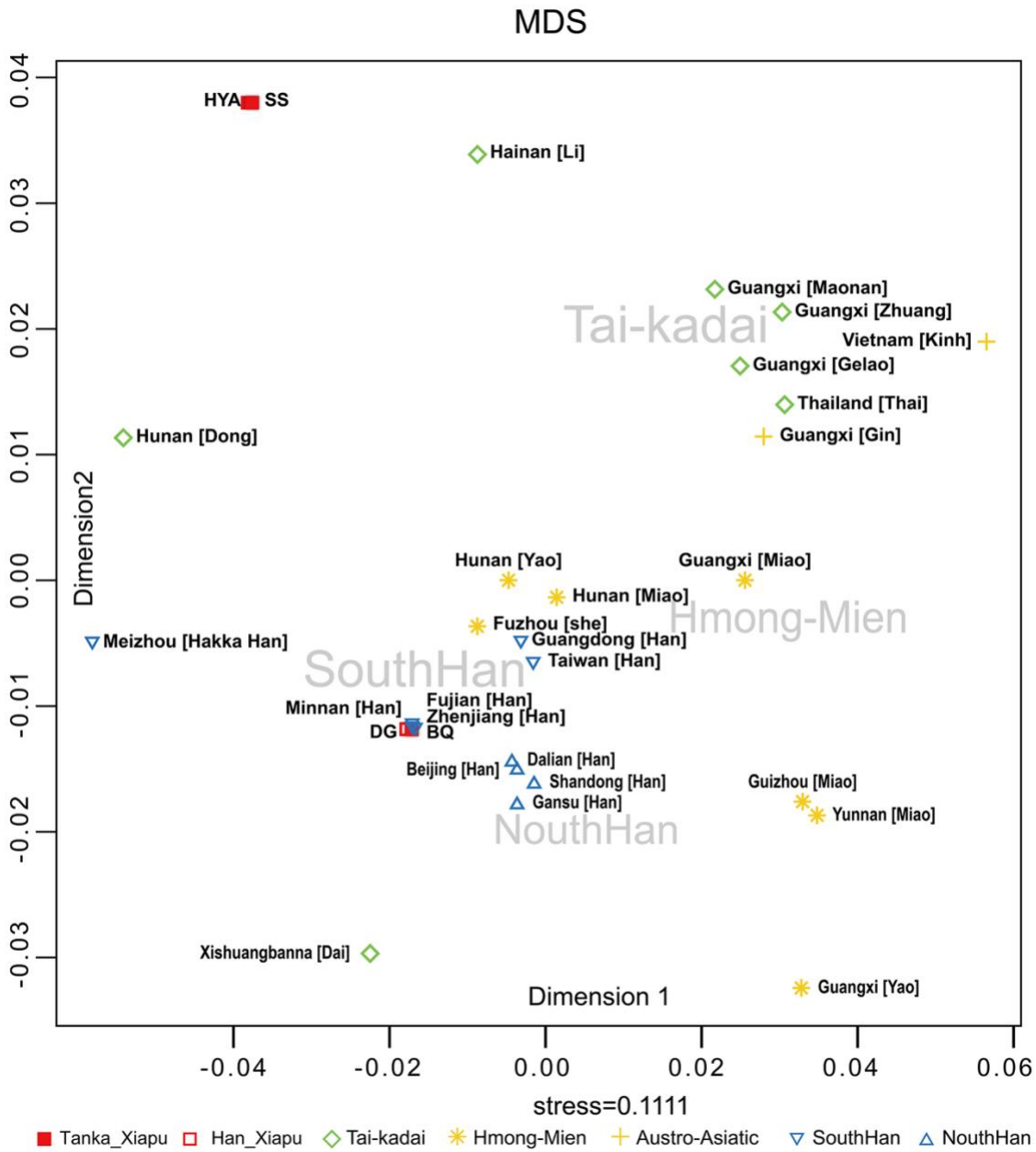


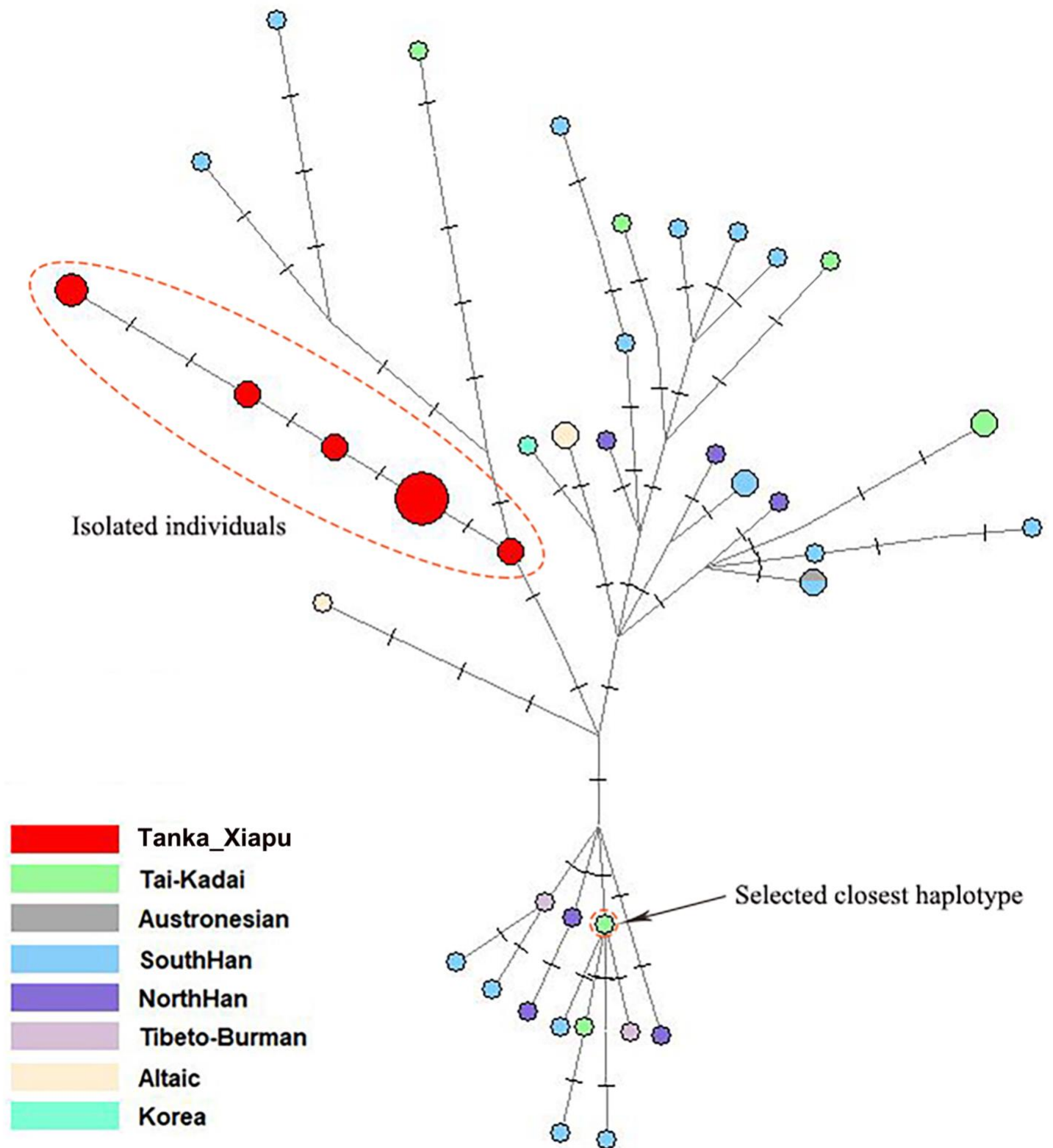
Figure 6.



Supplementary Figure S1.



Supplementary Figure S2.



Supplementary Figure S3.



Doc S1. One complete mtDNA haplotype compared to rCRS

Sample	Population	Variant rCRS	Haplogroup
		239C 263G 309.1CCT 310C 750G 1438G 3915A 4727G	
H64	DongGuan	4769G 8860G 9380A 10589A 12007A 15326G 15758G 16278T 16362C 16482G 16519C	B4a4

Doc S2. The divergence time estimation from Tanka-specific haplotypes

After haplotype-sharing analysis in haplogroup O1b1a1a-M95, we found 16 individuals had no shared haplotypes less than 4 steps away and they were tightly linked with each other, which may be a signal of an isolated population. Then we estimated the divergence time from these isolated individuals (IsoIndi) and other populations (Table S6). First, we used time to the most recent common ancestor (TMRCA) of isolated individuals as the lower bound. Next, we selected the closest haplotype (Figure S2) to estimate the TMRCA of them (i.e. 16 isolated individuals and the closest haplotypes, abbr. IsoIndi+CH) as an upper bound. In our previous case studies [86] about evaluating the Y-STR dating in deep-rooting pedigrees, we found that the Y chromosomal genealogical mutation rates (OMRB and ImMR) from the BATWING method could give the best-fit estimation for historical lineage dating. Hence, the upper bound of divergence time is about 2157.9-2229 years before present, at the beginning of the Western Han Dynasty. The lower bound is about 1033.8-1050.6 years before present, in the early years of Northern Song Dynasty. According to historical records [87], two events played important roles in the formation of Tanka: the survivors of kingdom of Minyue when this kingdom was conquered in 110 BC, the refugees eluding from wars in the Five Dynasties and Ten Kingdoms period (from 1040 to 1112 years before present). Our estimated divergence time suggests that the formation of Fujian Tanka may be related to at least one of these historical events.

86. Wang, CC, Li H. Evaluating the Y chromosomal STR dating in deep-rooting pedigrees. *Investig Genet.*2015; 6, 8.

87. Han ZH. The origin of Fujian Tanka. *Journal of Xiamen University.* 1954(5).