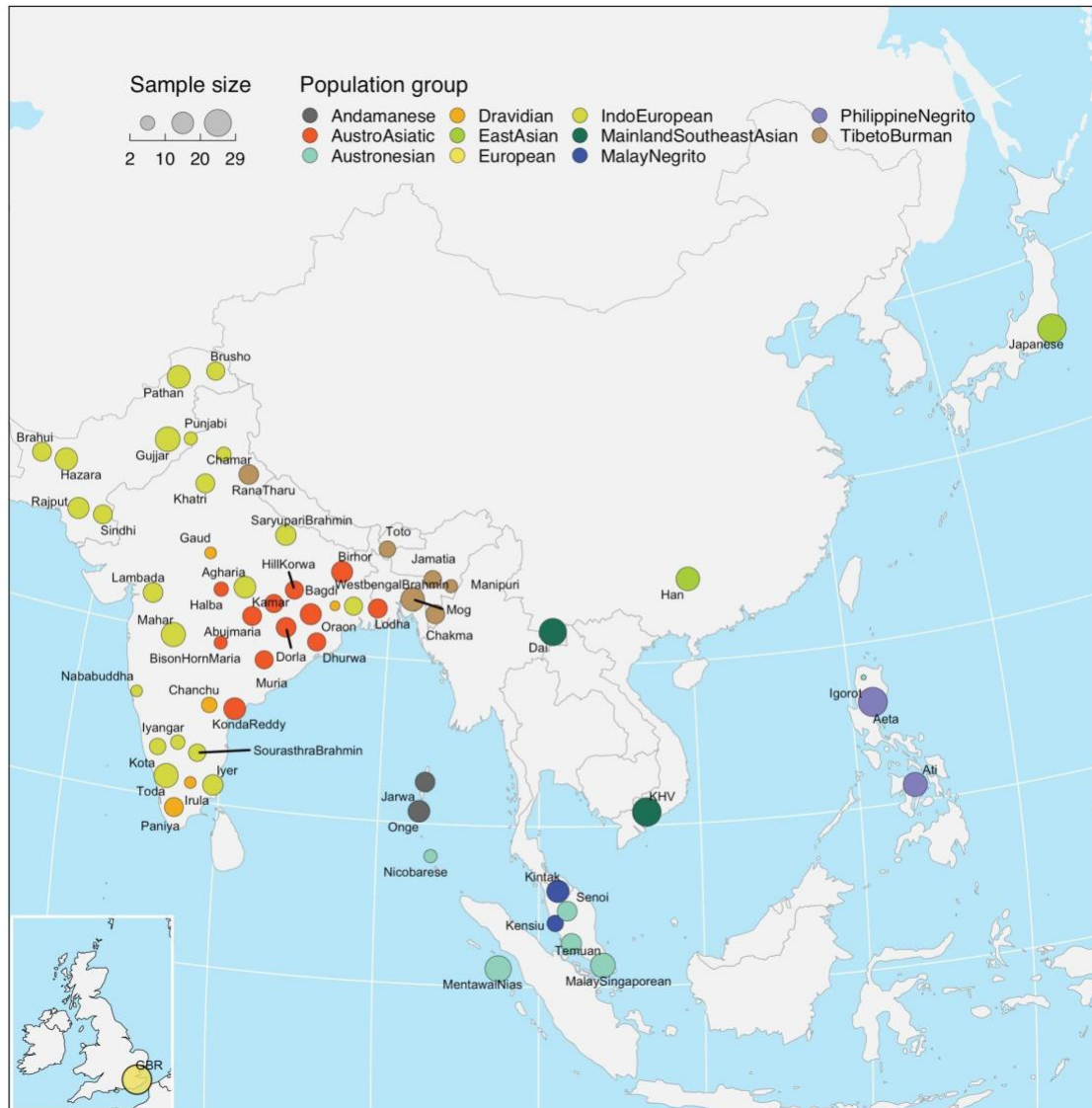**Supplementary Information for**

Prehistoric human migration between Sundaland and South Asia was driven by sea-level rise

Hie Lim Kim, Tanghua Li, Namrata Kalsi, Hung Tran The Nguyen, Timothy A. Shaw, Khai C. Ang, Keith C. Cheng, Aakrosh Ratan, W. Richard Peltier, Dhrubajyoti Samanta, Mahesh Pratapneni, Stephan C. Schuster, Benjamin P. Horton
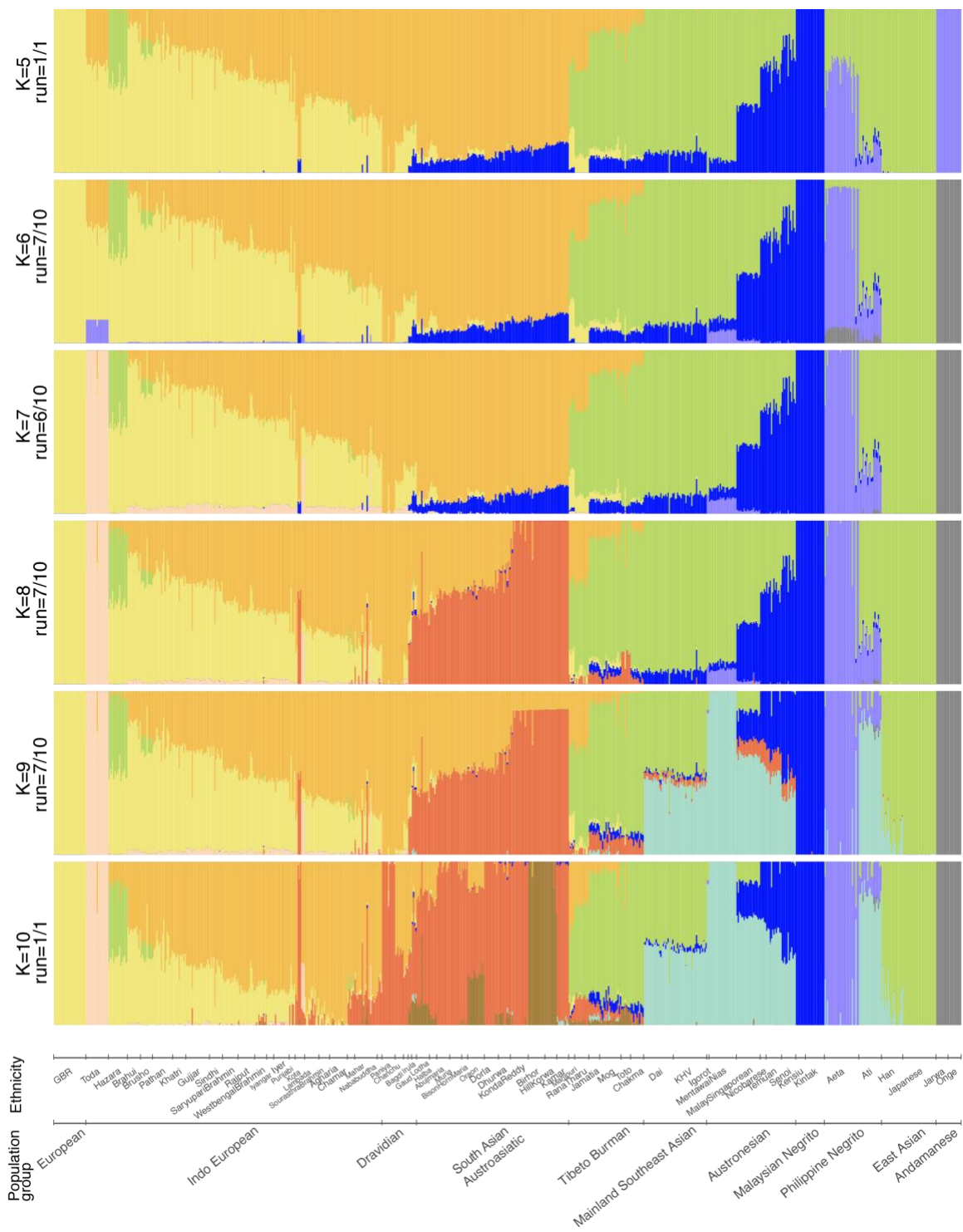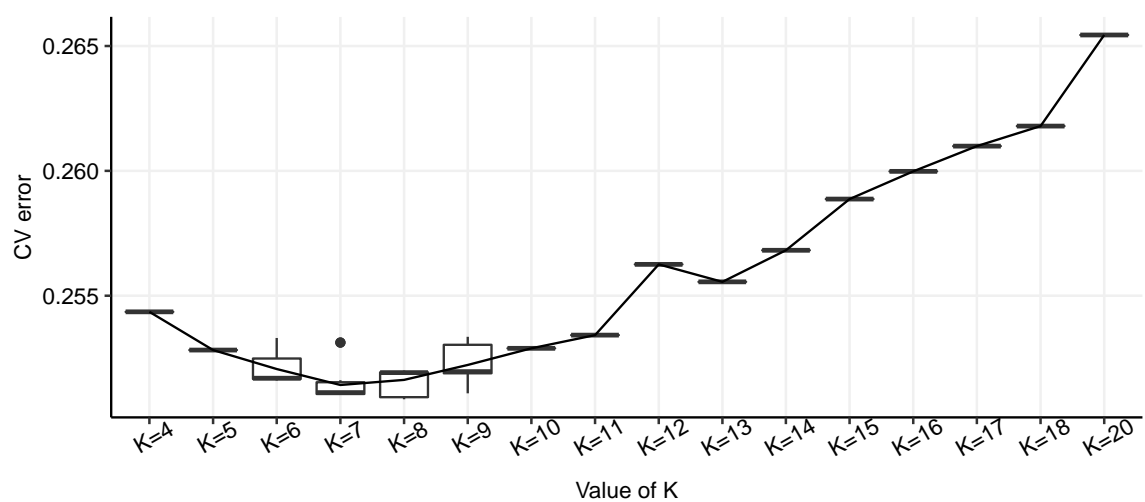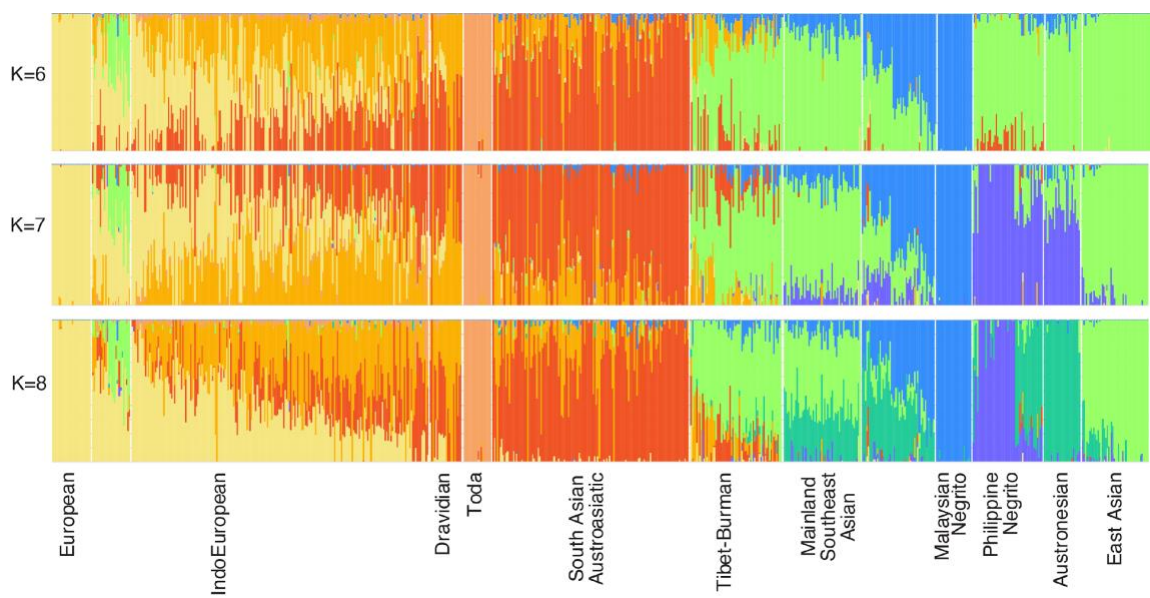
**Supplementary Figure 1. Sample distribution map**. The figure below shows the location of the populations in the geological map except for the GBR. The sample distribution in the map is the same figure in Figure 2A in the main text. This figure includes the population label.

**Supplementary Figure 2.** PCA plots with ethnicity label. **A** the same plot is shown in Figure 2C in the main text. **B** and **C** PCA plots calculated for the same dataset plotted by PC1 vs. PC3 and PC2 vs. PC3, respectively. Plot **A** and **B** are very similar to each other because it is largely determined
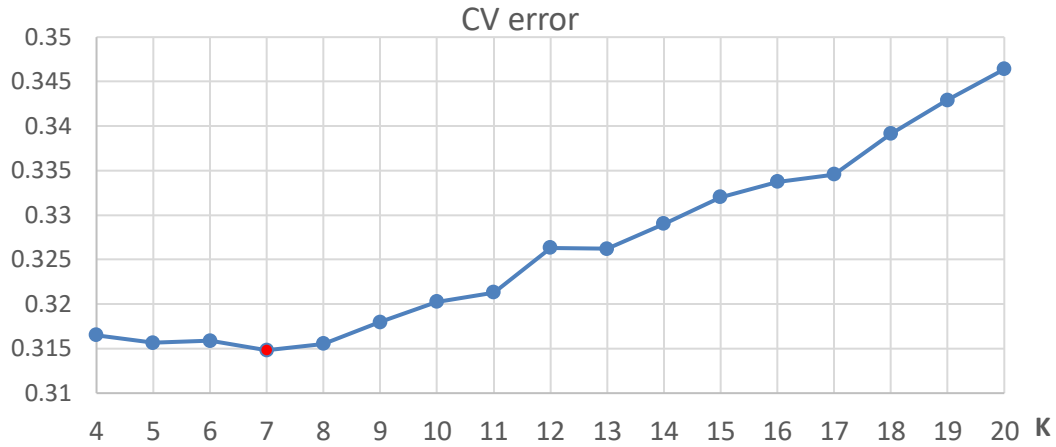
by PC1 (22.8%) which represent the difference between South and Southeast Asians. Plot **C** is different because either PC1 and PC2 represents each of South and Southeast Asians.
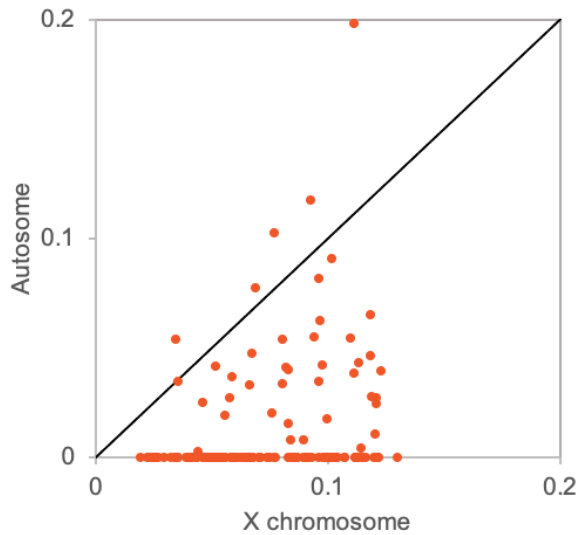
**A**



Rows labels: K=5 run=1/1, K=6 run=7/10, K=7 run=6/10, K=8 run=7/10, K=9 run=7/10, K=10 run=1/1

Ethnicity: GBR, Toda, Hazara, Brahui, Brusho, Pathan, Khatri, Gujjar, Sindhi, Saryupari Brahmin, Westbengal Brahmin, Rajput, Iyengar, Iyer, Punjabi, Kshatriya, Kurmi, Agharia, Chamar, Nabaita, Mahar, Kurumba, Caravan, Bagdi India, Gaud India, Abujmaria, Irula, Basor Mir, Chenchu, Oraon, Dhurwa, Dhurwa, Konda Reddy, Birhor, Hill Korwa, Kharia, Rana Tharu, Jamatia, Mog, Toto, Chakma, Dai, KHV, Igorot, Mentawai, Nias, Malay Singaporean, Nicobarese, Temian, Semai, Jehai, Kintak, Aeta, Ati, Han, Japanese, Jarwa, Onge

Population group: European, Indo European, Dravidian, South Asian Austroasiatic, Tibeto Burman, Mainland Southeast Asian, Austronesian, Malaysian Negrito, Philippine Negrito, East Asian, Andamanese

**B**



**C**

**D**



**E**



**Supplementary Figure 3. Ancestral population structures in Southeast and South Asians are examined.**

**A** Admixture plot for the 763 genome dataset. The proportions of ancestries of the 763 individuals are estimated for K=4-20 using ADMIXTURE1 and are shown in the plot for K=5-10. The main Figure 2c is the same plot of K=6-9 of this figure. In this figure, each population is labelled on the X axis.

**B** Cross-validation (CV) errors (Y axis) of K=4-20 (X axis) analyses are plotted. The optimal K is 7 based on the error rates, and the rates keep increasing with the higher Ks.

**C** Admixture plots of X chromosomes for the same dataset except for Andamanese. While the Malaysian Negrito ancestry (purple) in Indian Austroasiatic groups is present significantly in the

autosome data, the ancestry in the X chromosome is not significantly present. It suggests that Malaysian Negrito women had a little or minimum role to play in the admixture with Indian Austroasiatic populations. For the admixture with Mainland Southeast Asian groups, the Malaysian Negrito ancestry component appears clearly. Thus, the admixture events in India and Southeast Asia occurred in a different context.

**D** Cross-validation (CV) errors (Y axis) of K=4-20 (X axis) analyses for the plot **A**. The optimal K is 7 (red) based on the error rates, and the rates keep increasing with the higher Ks.
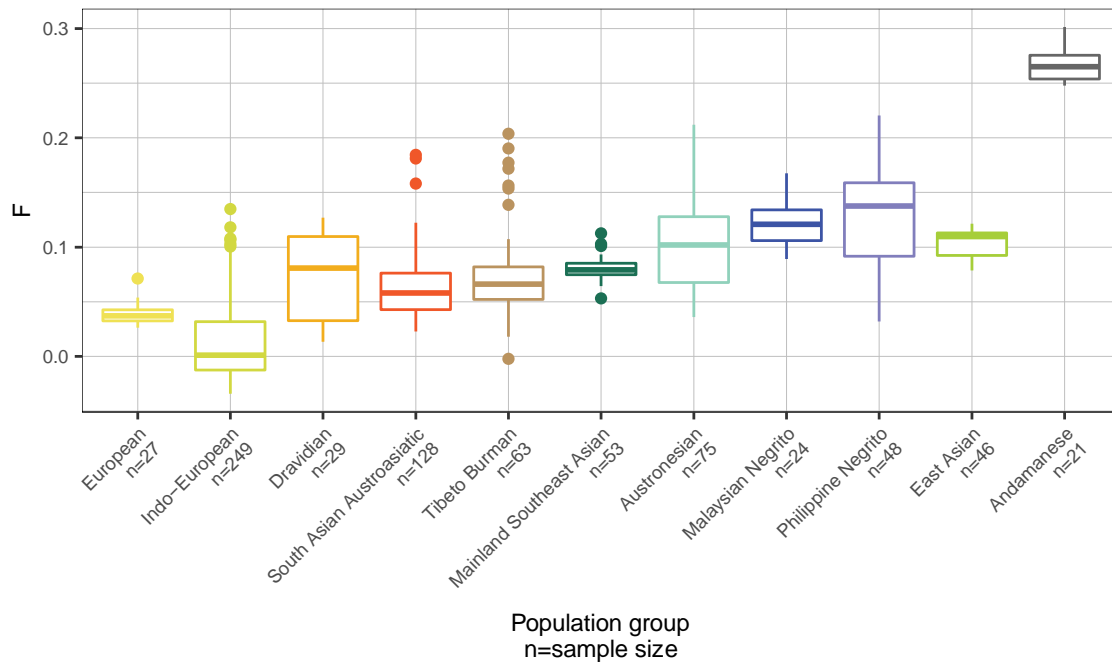
**E** Proportion of the Malaysian Negrito ancestry in South Asian Austroasiatic populations between autosomes (Supplementary Figure 3A) and X chromosome at K=7. The less contribution of X chromosome of Malaysian Negritos in South Asian Austroasiatic suggests male-driven migration.

**A. Runs of Homozygosity (ROH)**
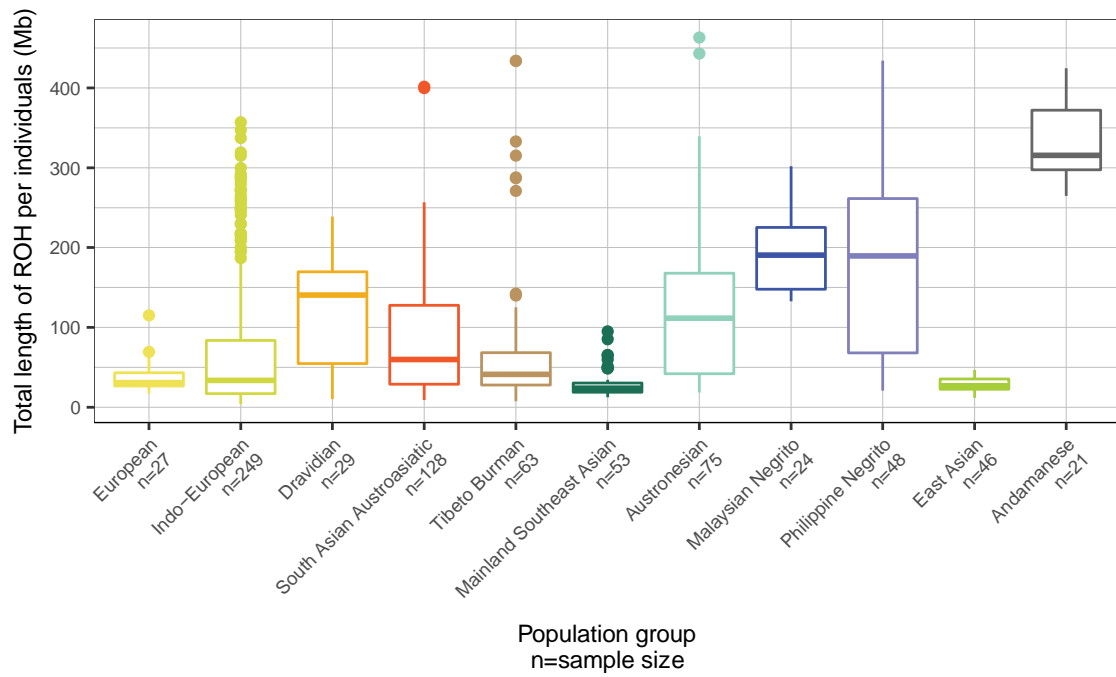


**B. Inbreeding coefficient (F)**

**Supplementary Figure 4. Distribution of homogeneity of population groups**

**A** Total length of Runs of Homozygosity (ROH) and **B** Inbreeding coefficient (F) for every individual were calculated with the 1,141,813 SNPs filtered as same as the admixture analysis using PLINK 1.92. A box plot for each parameter is shown for each of 11 population groups. ROH calculation was performed with the default parameters of PLINK: contain at least 100 SNPs, length of at least 1000kb; density of at least 1 SNP / 50kb on average; gap between 2 consecutive SNP less than 1000kb; scanning window contains 50 SNP and can tolerate 1 heterozygous call and 5 missing calls; SNPs must have hit rate of at least 0.05 on all scanning windows including it to be counted in the ROH.

F is calculated with the plink option –het. It estimates the excess of homozygotes compared to heterozygotes. Based on this value, we selected outliers for Treemix and qpGraph analyses since it provides a more conservative estimate of population group outliers and requires less assumptions of parameters compared to ROH.
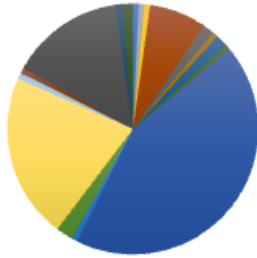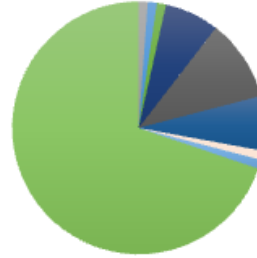
## A. Mitochondria

## B. Y chromosome
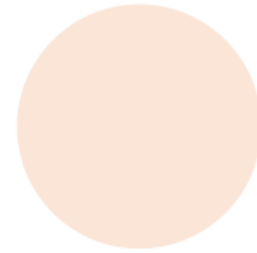


**Supplementary Figure 5. Mitochondrial DNA and Y chromosomal haplogroup frequency.** The haplogroup identification for mitochondrial DNA and Y chromosomes is retrieved from the previous study[3]. Frequencies of **A** mitochondrial and **B** Y chromosome haplogroups in Indo-European and South Asian Austroasiatic groups, and the Malaysian Negritos are shown in the pie chart. The South Asian Austroasiatic populations show a high frequency of the Y haplogroup "O", which is found predominantly in Southeast Asians. No such signal is in the mitochondrial haplogroups.

## A. Southeast and East Asia

### Kensiu

### Aeta

### Dai

### Igorot

### Han

### KHV
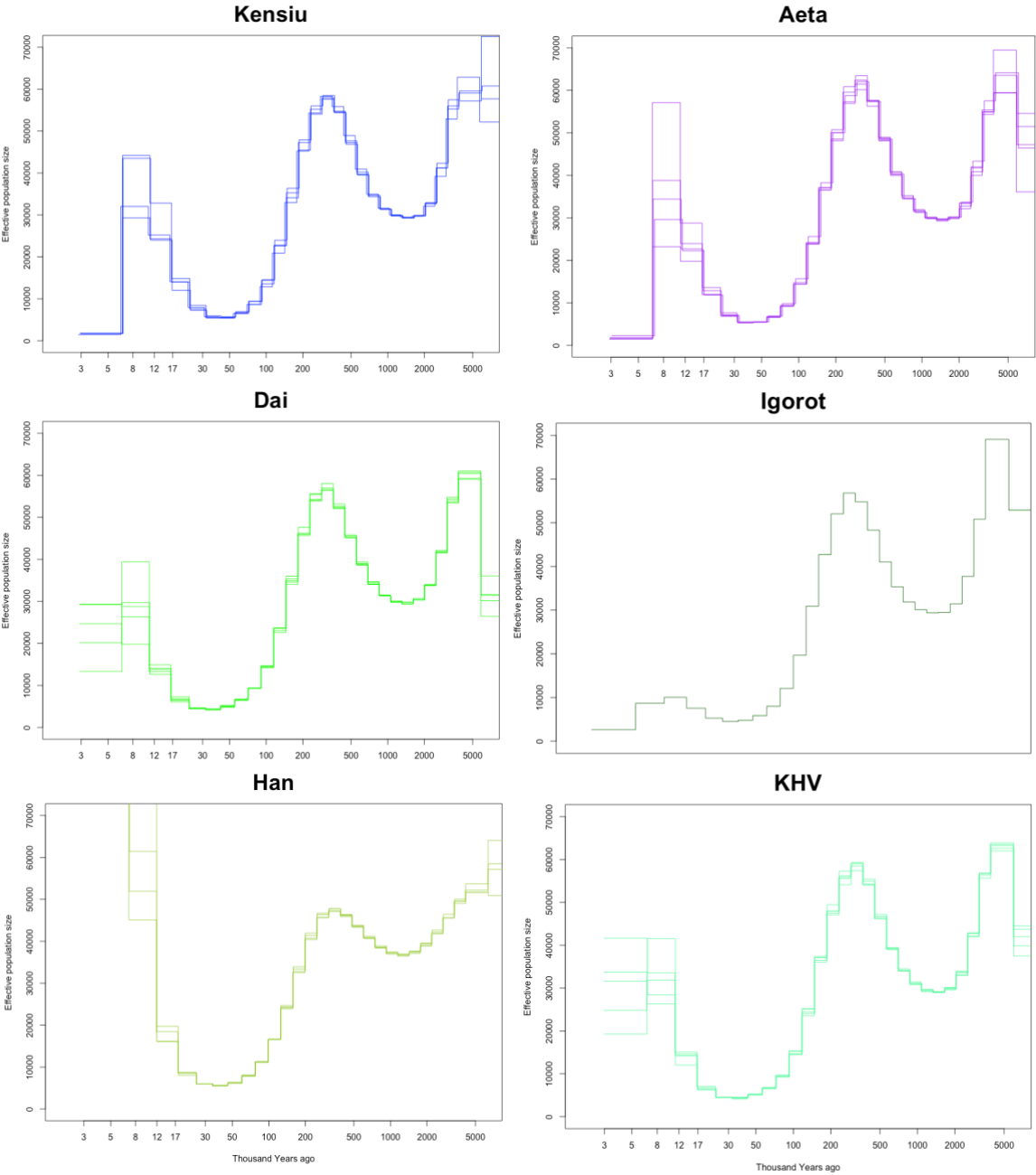
**B. South Asia and European**
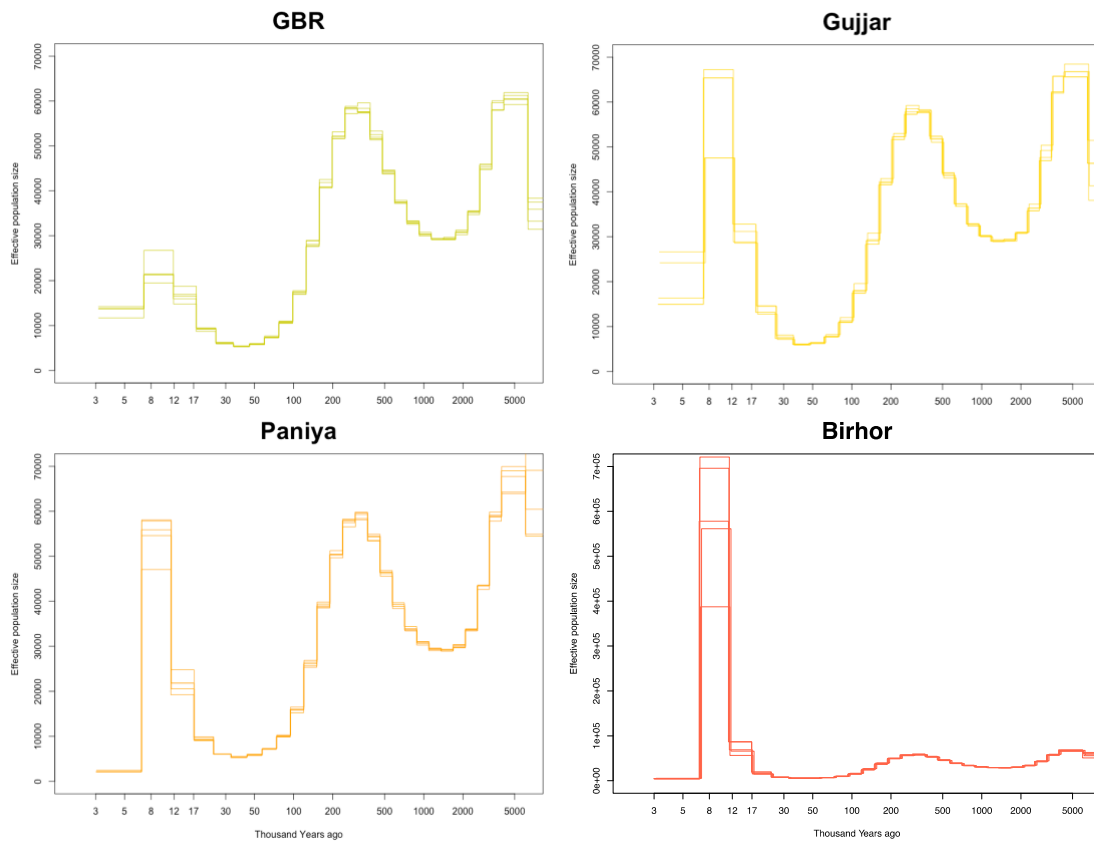


**C. South Asian Austroasiatic groups**

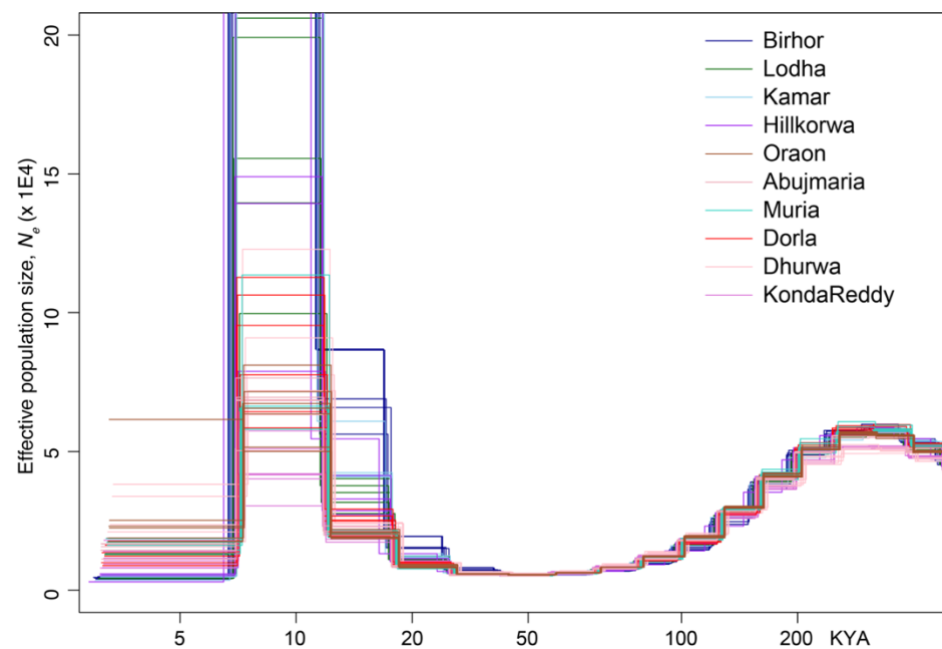**Supplementary Figure 6. Effective population size changes over time estimated by MSMC2**[4,5]. One line indicates population size estimates from two individual genomes (four haplotypes), and every line shows estimates from different sets of individuals. For each population, we run two to five different sets of individuals and each result is plotted. The Y axis is the effective population size, and the X axis is log scaled time with a unit of thousand years ago (KYA). **A** shows MSMC estimates for the six Southeast and East Asian populations and **B** shows one European (GBR) and three South Asian populations. Only Birhor has a different scale for the Y axis because its population size is extremely high. **C** shows MSMC estimates for the 10 different ethnic groups of South Asian Austroasiatic populations. Many of the populations' effective population sizes are out the range of the Y axis and not shown in the plot.

## A Southeast and East Asia

### Kensiu-Han



### Kensiu-Han



### Kensiu-Aeta



### Kensiu-Aeta



### Kensiu-Dai



### Kensiu-Dai



### Kensiu-KHV



### Kensiu-KHV



15
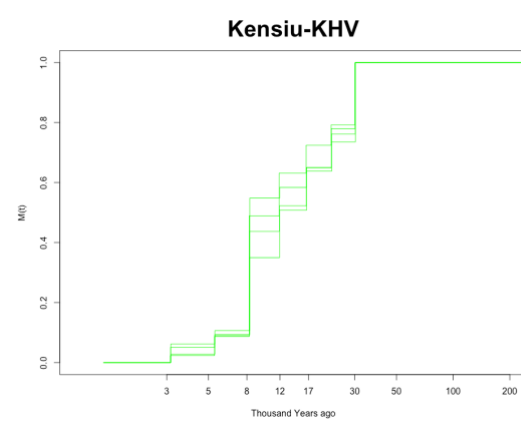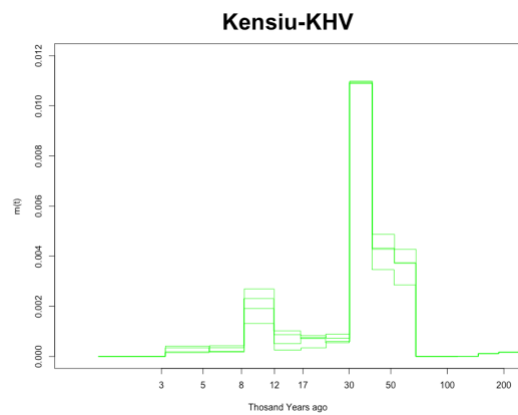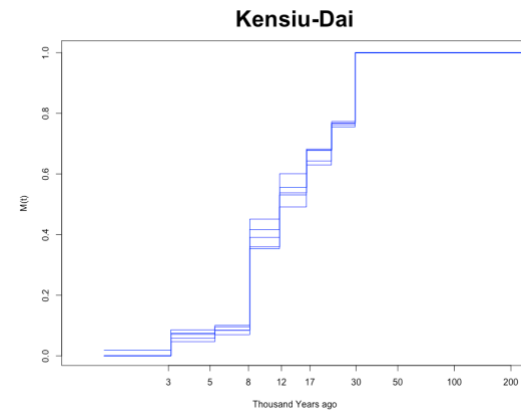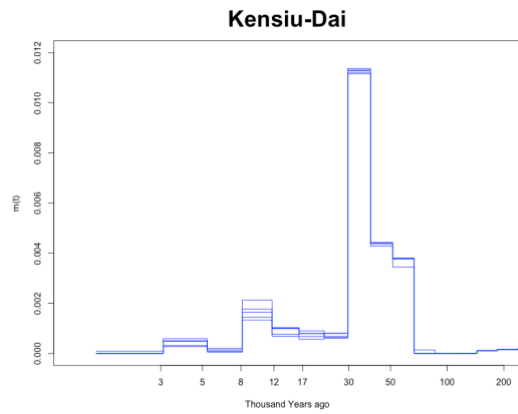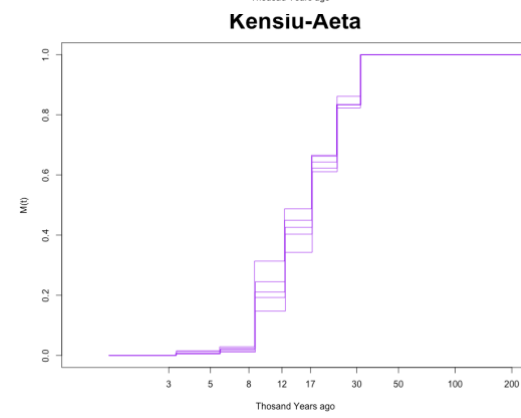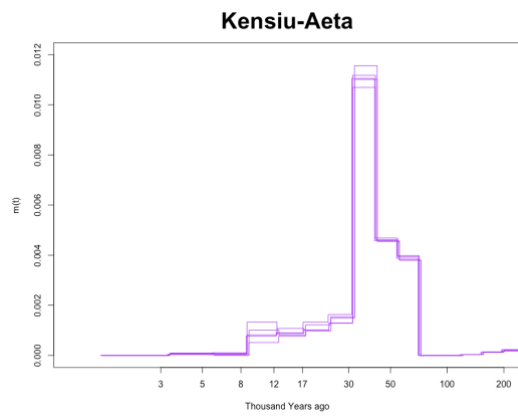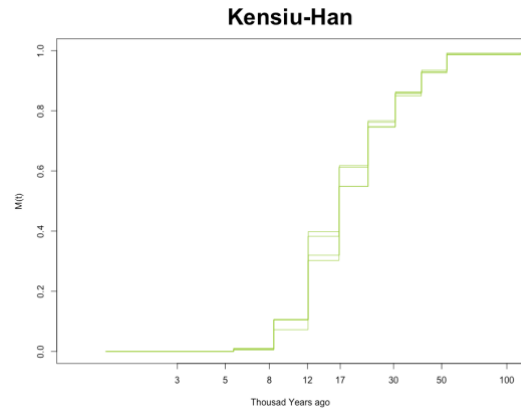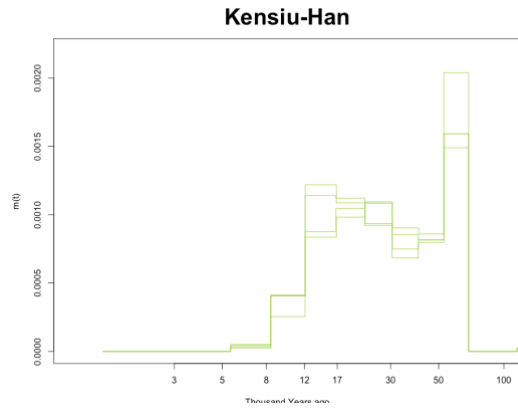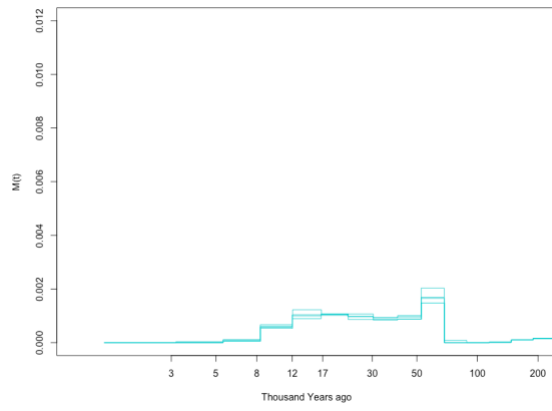
## Kensiu-Igorot



## Kensiu-Igorot
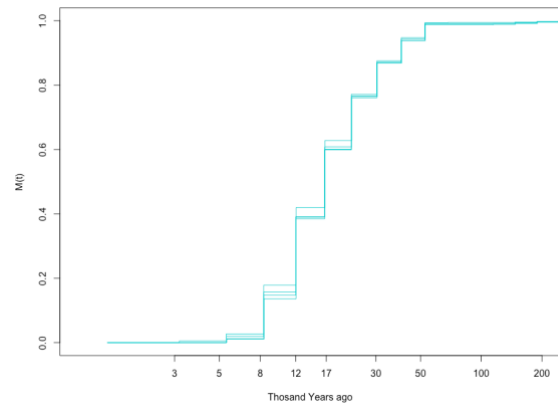


## Dai-Igorot



## Dai-Igorot

## B South Asia

### Birhor-Paniya



### Birhor-Paniya



### Birhor-Gujjar



### Birhor-Gujjar



### Paniya-Gujjar



### Paniya-Gujjar

## C Between Birhor and Southeast Asia



**Birhor-Kensiu**

**Birhor-Kensiu**

**Birhor-Aeta**

**Birhor-Aeta**

**Birhor-Igorot**

**Birhor-Igorot**

Birhor-Dai

Birhor-Dai

Birhor-KHV

Birhor-KHV
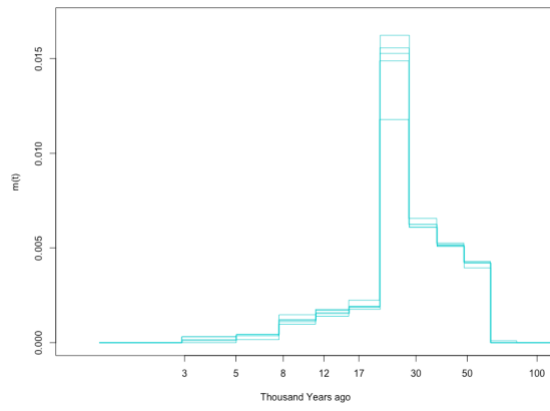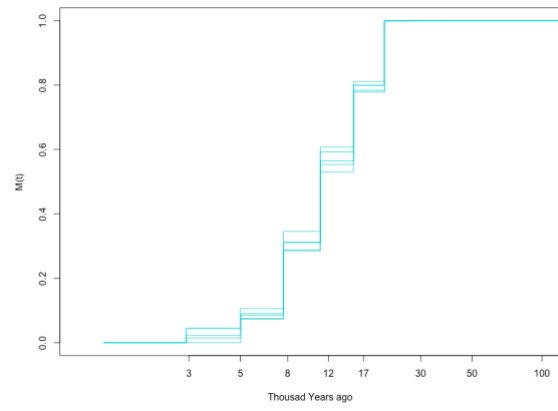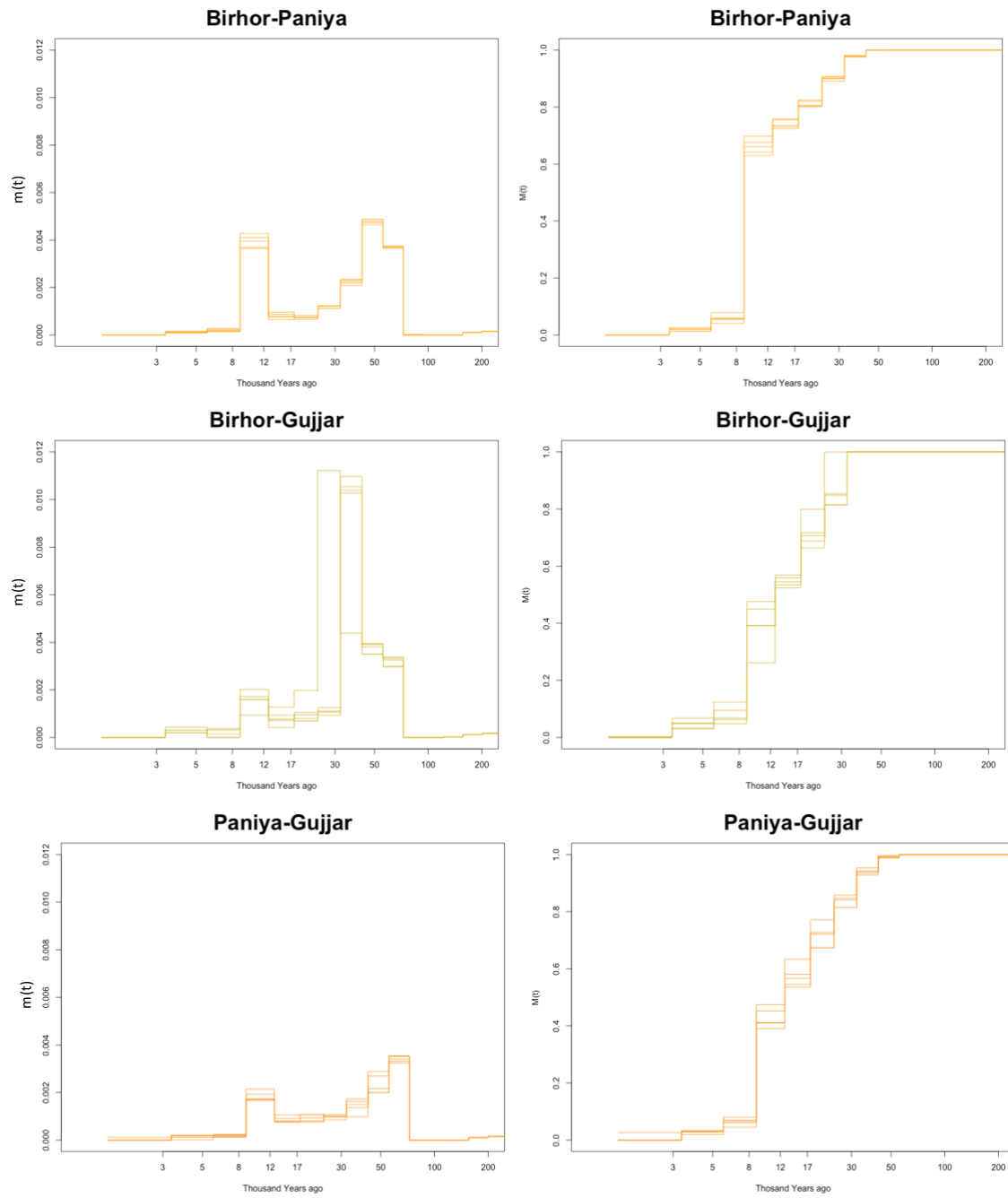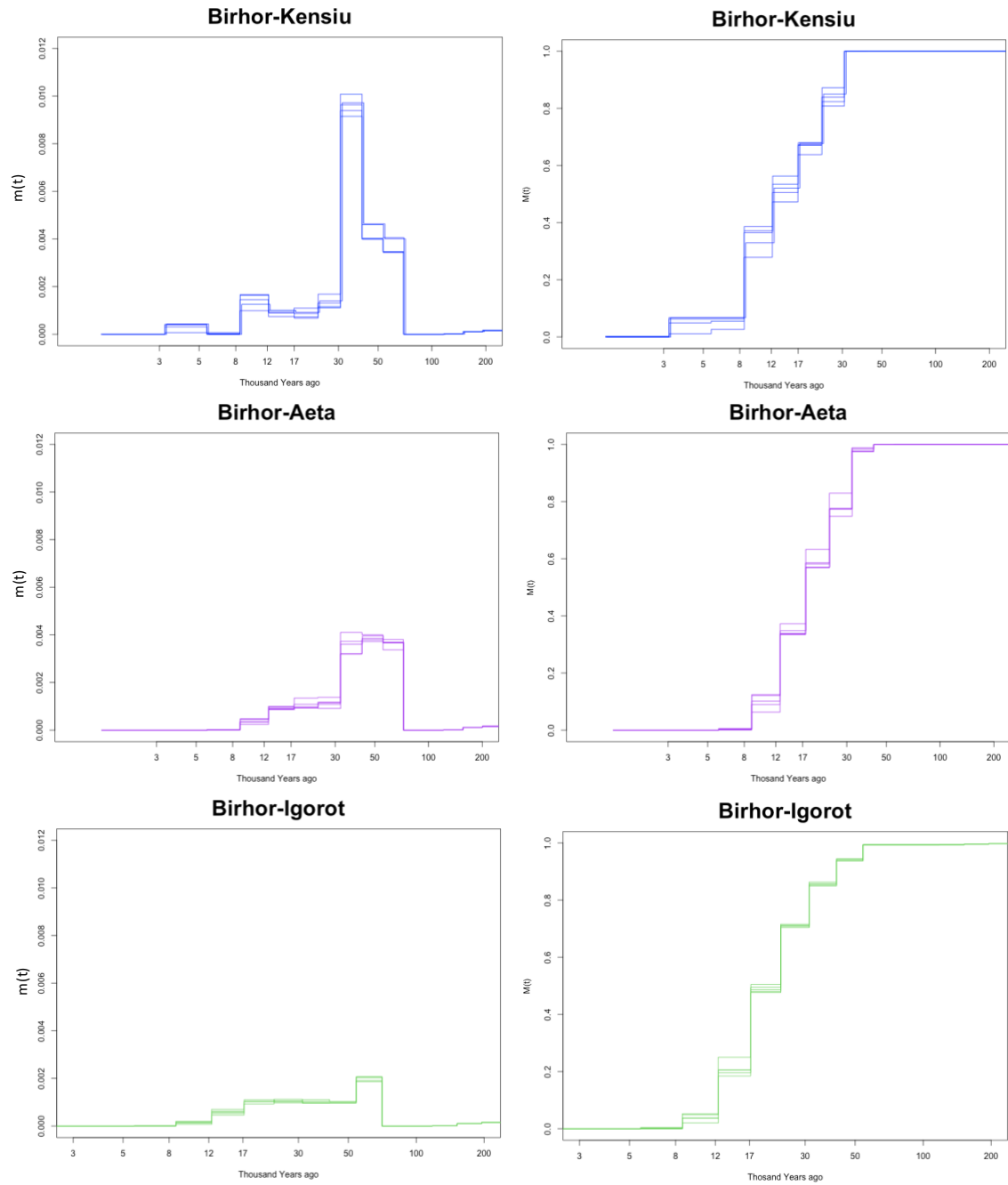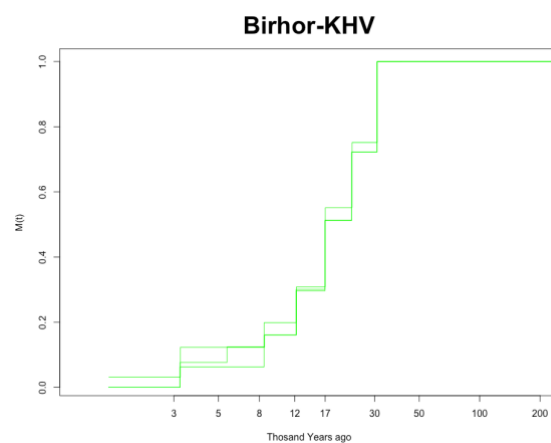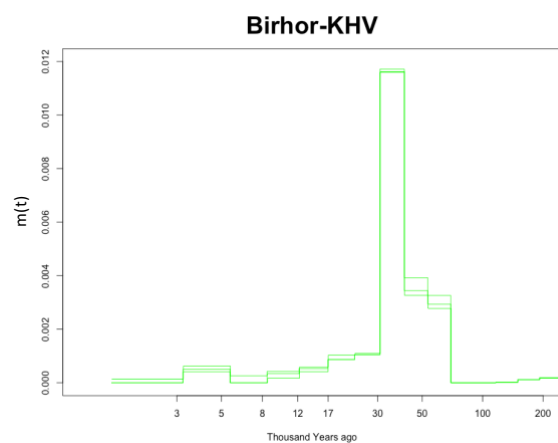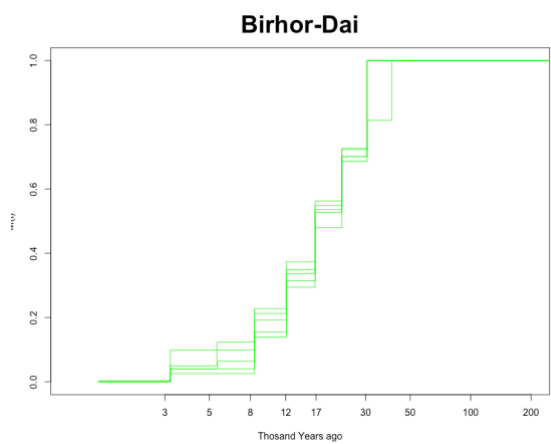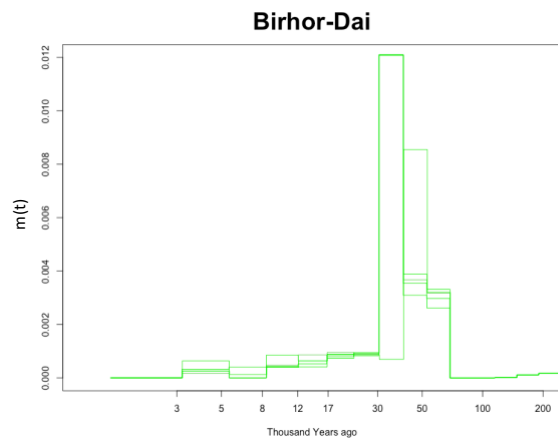
## D Between Tibeto-Burman and Others

### Jamatia-Gujjar



### Jamatia-Gujjar



### Jamatia-Paniya



### Jamatia-Paniya



### Jamatia-Birhor



### Jamatia-Birhor



### Jamatia-Aeta



### Jamatia-Aeta



20

Jamatia-Kensiu

Jamatia-Kensiu

Jamatia-Igorot

Jamatia-Igorot

Jamatia-Dai

Jamatia-Dai

Jamatia-Han

Jamatia-Han
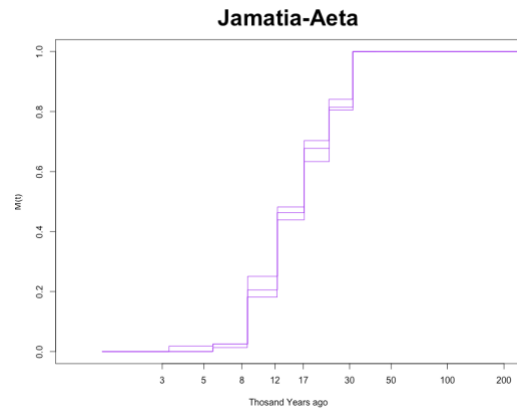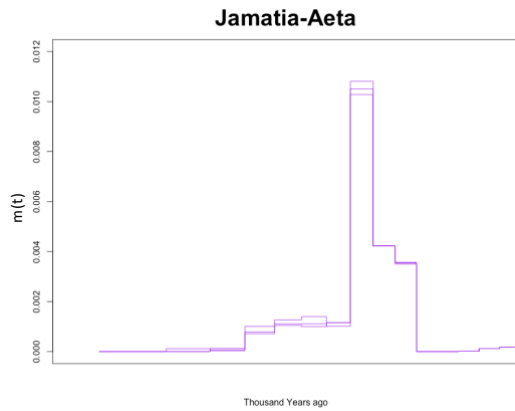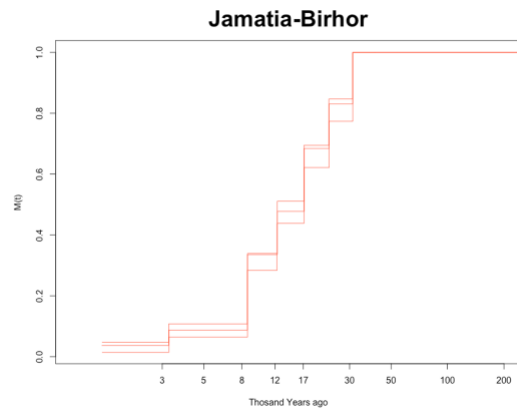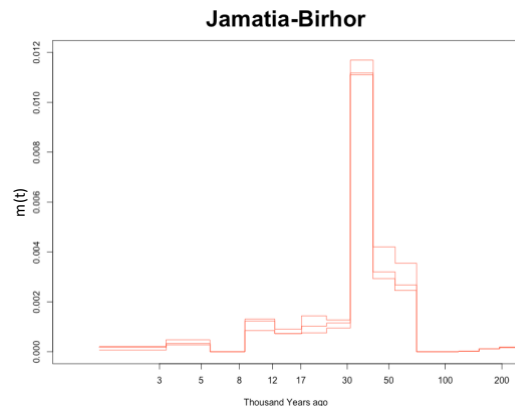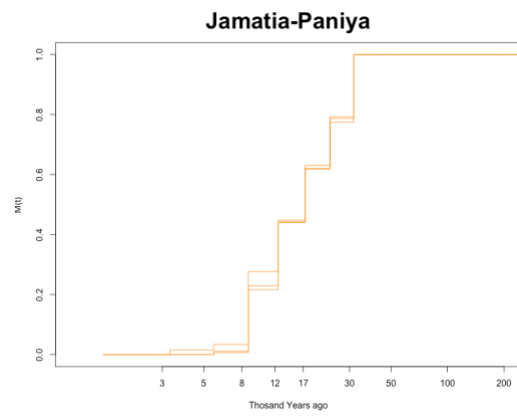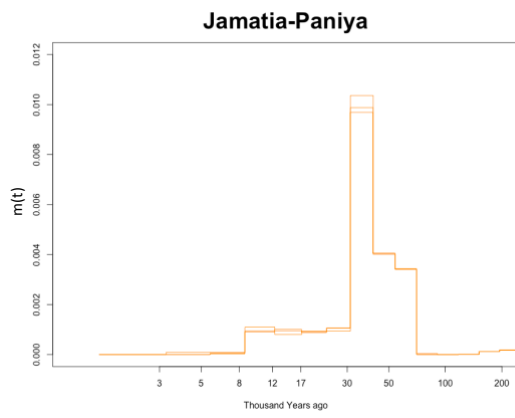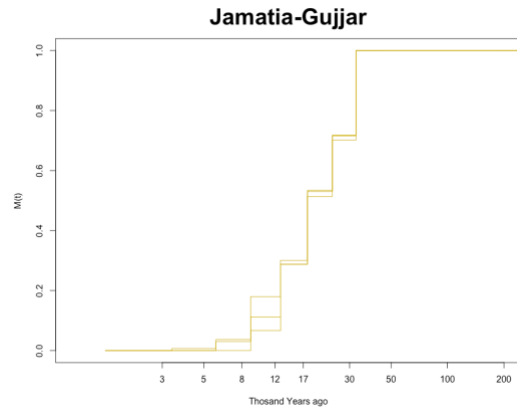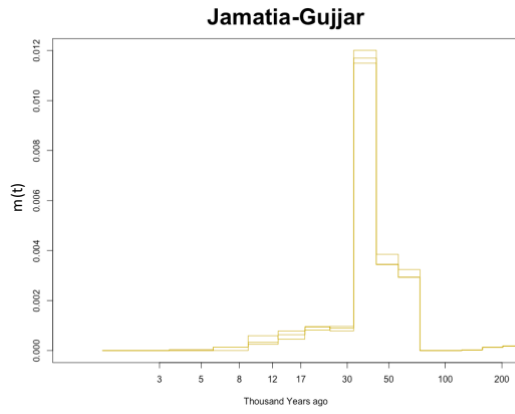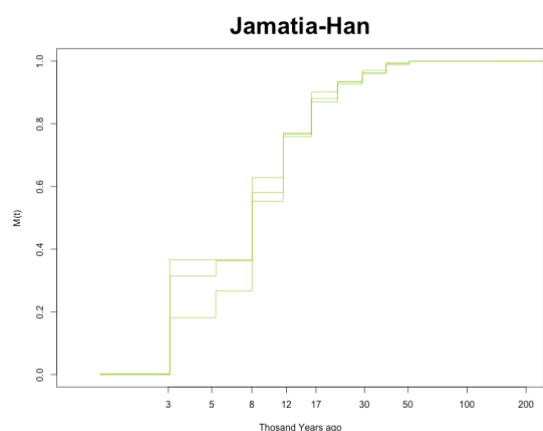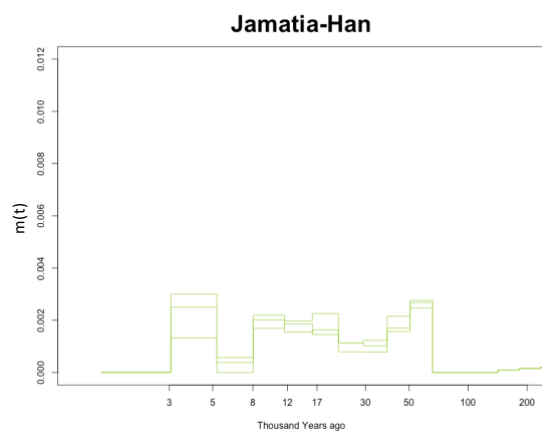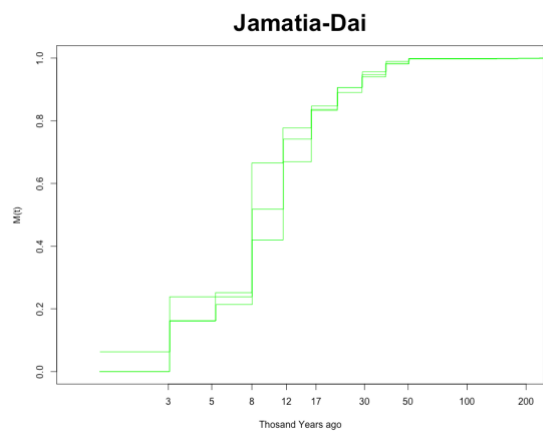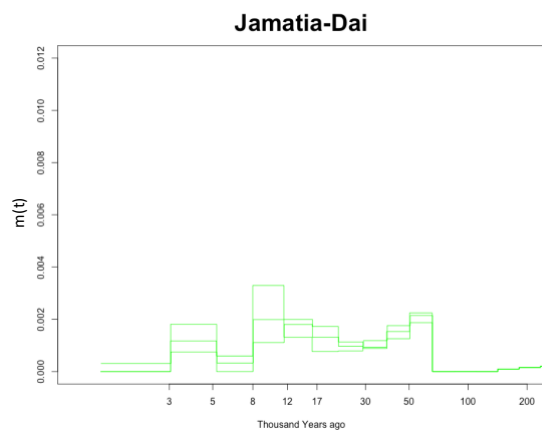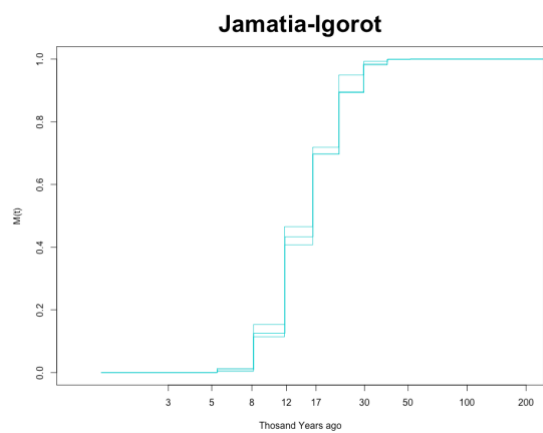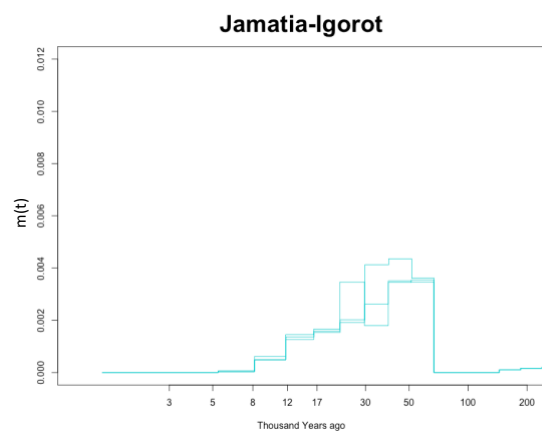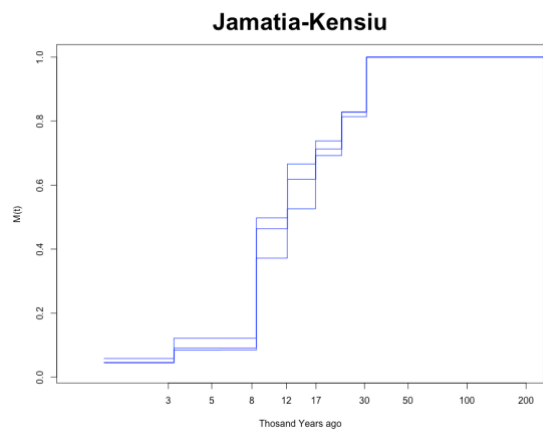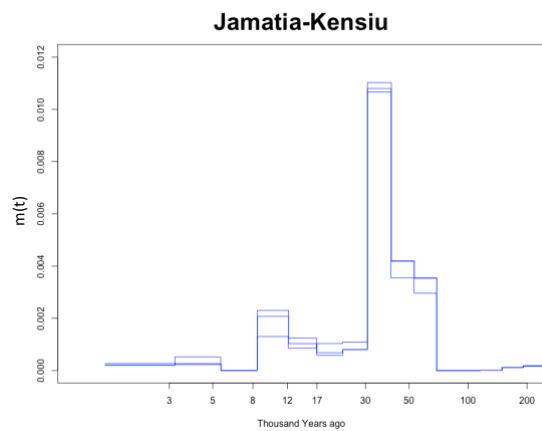
**Supplementary Figure 7. Migration rate between populations over time estimated by MSMC-IM[6].**

Population split times (years ago) for a pair of populations are estimated using MSMC-IM. The plots of left column show the migration rate between the two populations, m(t) on the Y axis over time *t* on the X axis, thousand years ago. On the plots of right column, the Y axis, *M(t),* is the cumulative migration probability that denotes the probability for lineages to have merged by the time *t*. The X axis is the time *t*, thousand years ago. One line indicates an estimate based on four individuals, two genomes from two different populations. For each plot there are three to five estimates from different combinations of individuals.

**A** pairs of Southeast and East Asian populations. The pairs Kensiu-Dai and Kensiu-KHV show very similar results, indicating the close relationships between Dai and KHV as mainland Southeast Asians. And only two pairs show the increase in the migration rate after population split about the same time, 8~12 thousand years ago. **B** pairs of South Asian populations. **C** pairs between Birhor and Southeast Asians. Only Kensiu shows the increase in the migration rate after split with Birhor. **D** pairs between Jamatia and other Asians. Jamatia (Tibeto-Burman) has split with East Asian (Han) most recently with continuous migration until ~3,000 years ago, as well as with Dai. Jamatia has the migration rate rise after split with Kensiu as same as Birhor-Dai.

**A Within Southeast Asia**
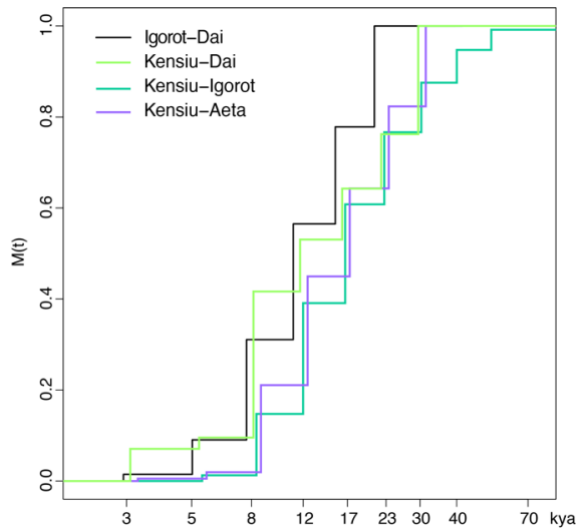


**B Between Birhor and Southeast Asia**
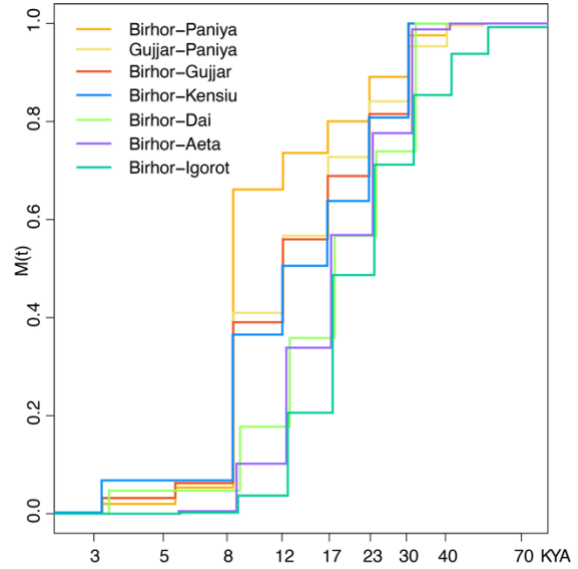


**C Between Konda Reddy and Southeast Asia**
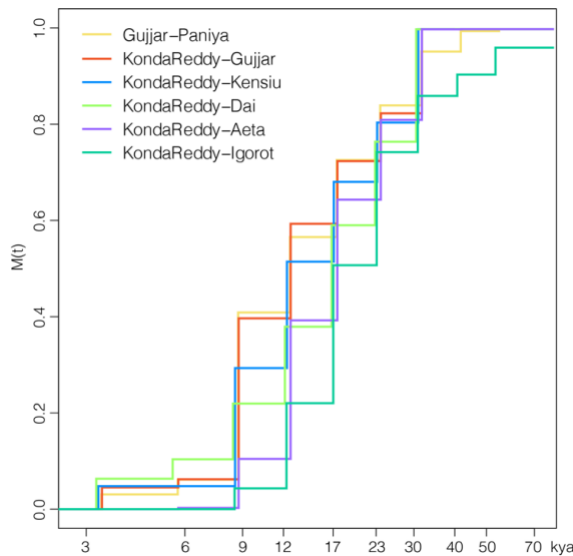


**Supplementary Figure 8. Comparison of Population splits across different pairs of populations.** Population split times (years ago) for a pair of populations are estimated using MSMC-IM[6]. The Y axis, *M(t),* is the cumulative migration probability that denotes the probability for lineages to have merged by the time *t*. The X axis is the time *t*, thousand years ago (KYA). The detailed results are shown in Supplementary Table 3.

**A.** Within Southeast Asian populations, the population splits of Kensiu-Aeta (blue) and Kensiu-Igorot (cyan) are overlapped, suggesting the population split across Malaysian Negritos, Philippine Negritos, and the common ancestor of Austronesians (Igorot) and mainland Southeast Asia (Dai) occurred in the close time frame period. The split between Igorot and Dai (black)

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occurred more recently. The split between Kensiu and Dai (light green) is shifted to recent since about M*(t)*=0.5 compared to the splits of Kensiu-Aeta and Kensiu-Igorot, probably due to the admixture between Malaysian Negritos (Kensiu) and Mainland Southeast Asians (Dai) occurred around the time as we described in the main text.

**B and C.** The population splits between Birhor and Southeast Asian populations (B) and between Konda Reddy and Southeast Asian populations (C) are estimated and plotted. The results are similar between the two results, (B) and (C), suggesting the robustness of the estimates. The splits of Birhor with Dai (light green), Aeta (green), and Igorot (cyan) are the oldest and occurred in a similar period. The splits within South Asians (red, yellow, and orange), are younger than the splits between South Asians and Southeast Asians. Only the split of Birhor-Kensiu (blue) is more recent than the splits with other Southeast Asians. This is again likely a result of admixture between Malaysian Negritos (Kensiu) and South Asian Austroasiatic groups (Birhor and Konda Reddy).

**A. The consensus tree from 100 iterations of Treemix runs (block size=1000 SNPs)**
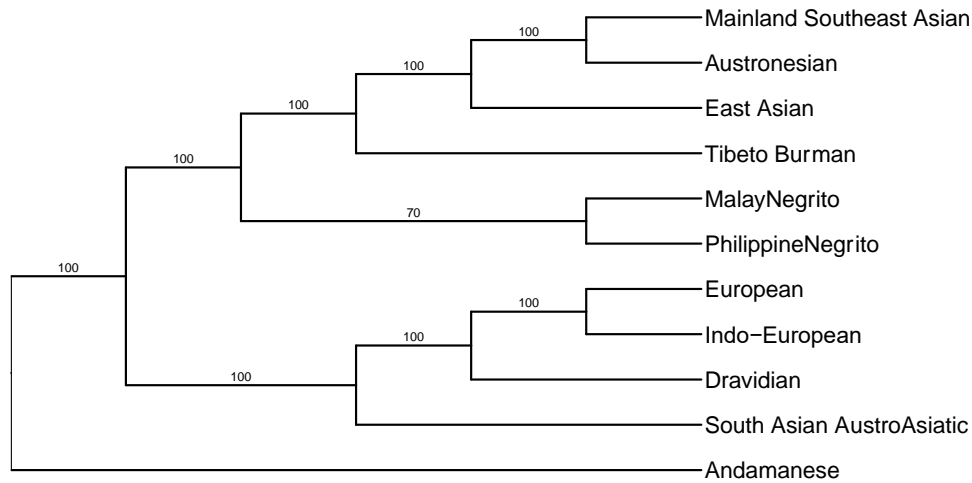


**B. The consensus tree from 100 iterations of Treemix runs (block size=2000 SNPs)**
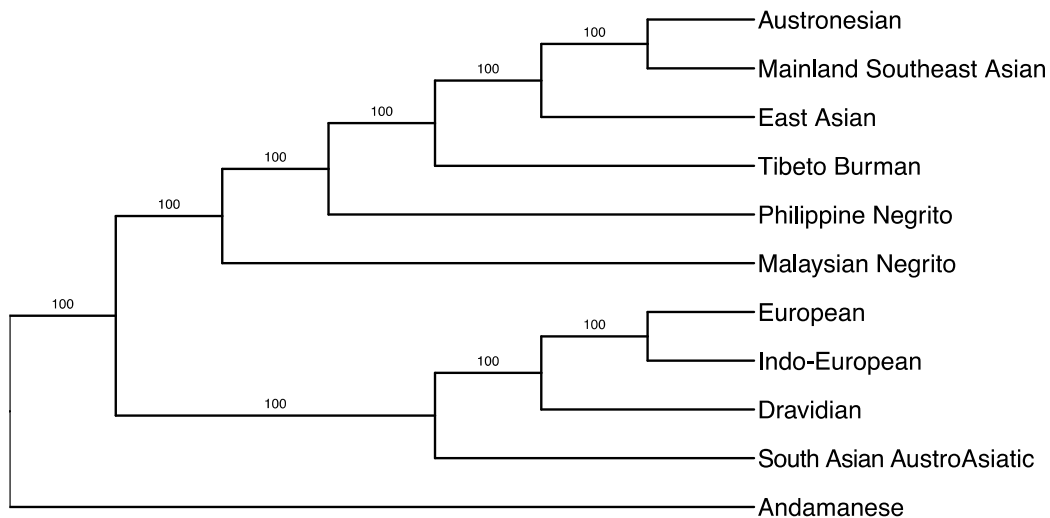


**Supplementary Figure 9. Treemix analysis**
To reconstruct population tree, we selected 630 individuals from 11 population groups after removing outliers based on degree of admixture and excess of homozygotes. In total 919,892 SNPs were used for performing Treemix[7] and Phylip-consense[8] analyses. Treemix was run with various size of a block (10 to 10,000 SNPs) and 100 iterations for bootstrapping the dataset. The root is determined with the given outgroup, Andamanese. Phylip-consense identifies a consensus tree among the iterations. The tree topology is same with the block size between 10 to 1000 SNPs (**A**), and the topology is same between 2000 and 10000 SNP (**B**).

**A** The consensus tree with bootstrap with the block size 1000 SNPs is plotted. The bootstrap value is the number on each node of the tree and is the number of replicates that support the clade among the 100 iterations.

**B** The consensus tree with the window size of 2,000 SNPs with the bootstrap values. The only difference between the two phylogenies is the position of Malaysian Negritos. In the tree A, Malaysian Negritos is clustered together with Philippine Negritos. In the tree B, Malaysian Negritos is outside of Philippine Negritos with the higher bootstrap value (100) than the value in the tree A (70). Thus we chose the tree **B** for qpGraph modelling. The qpGraph results are similar enough between using the two different two topologies.

**A** score=19024.09277823
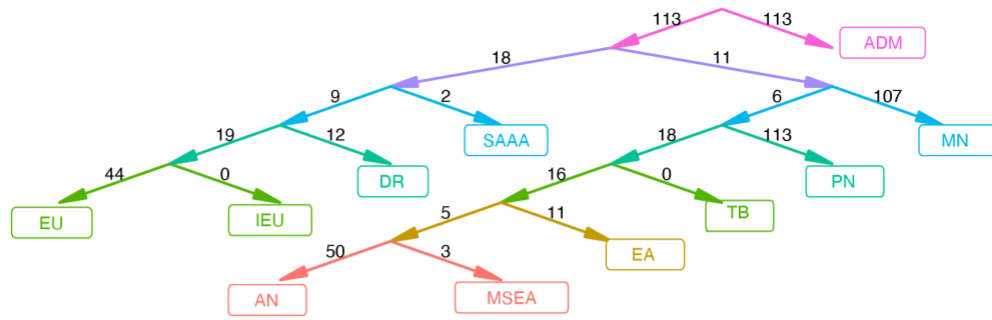
**B** score=18770.0273098567
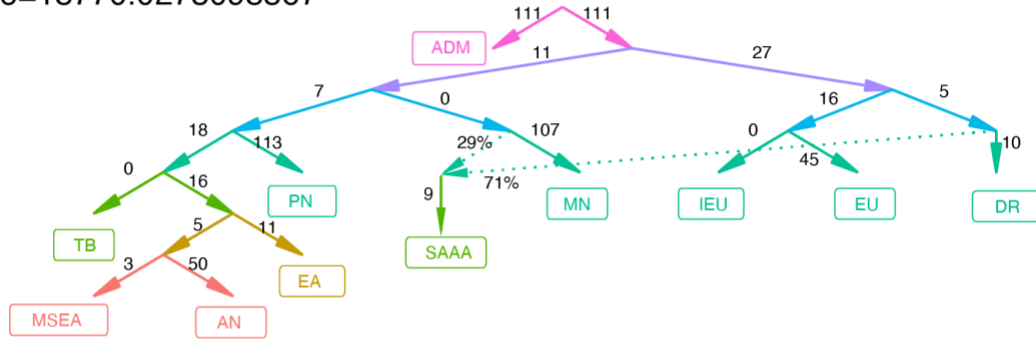
**C** score=18480.1804714219
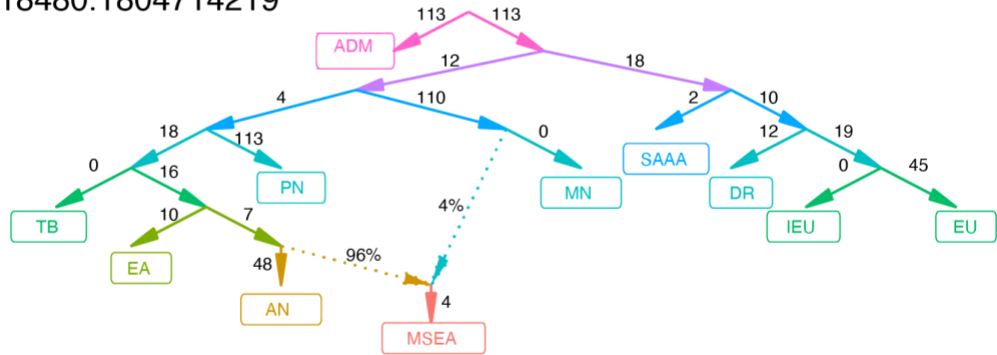
**D** score=12403.1982139655
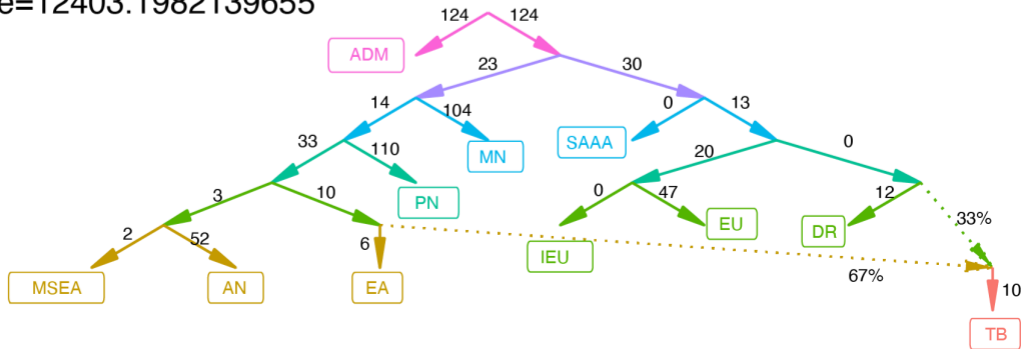
**E** score=18720.31
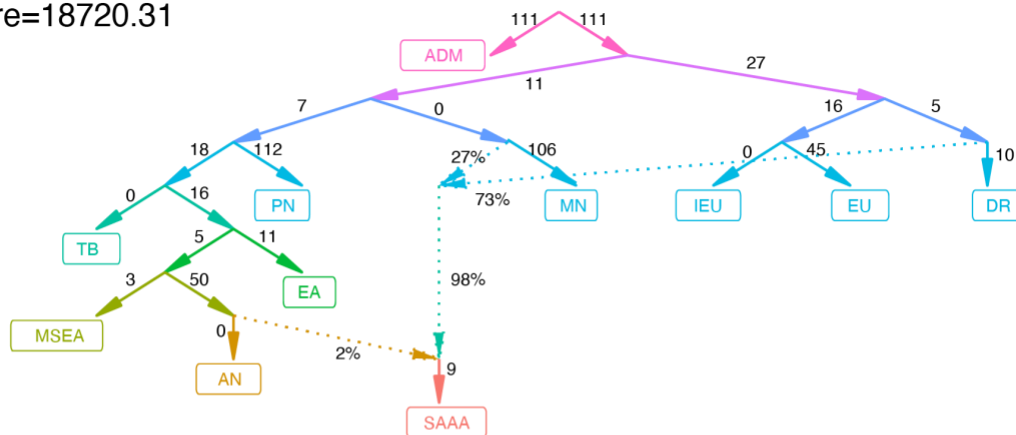
**F** score=18244.37
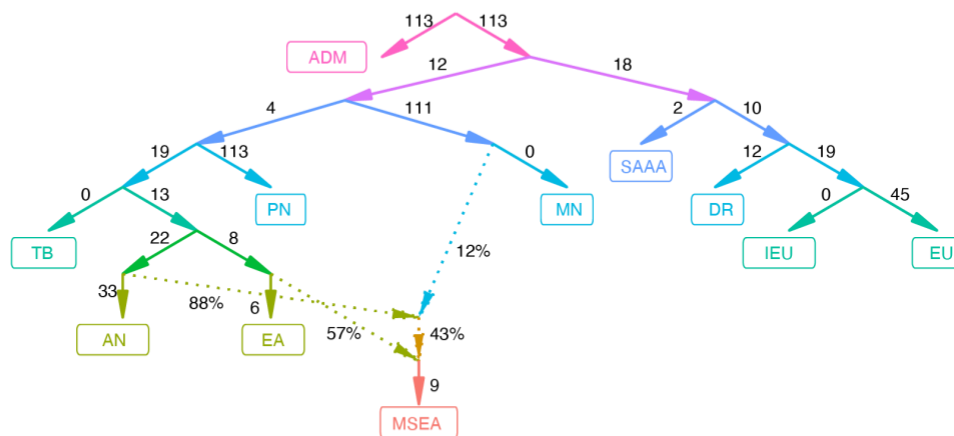
**G** score=12267.1
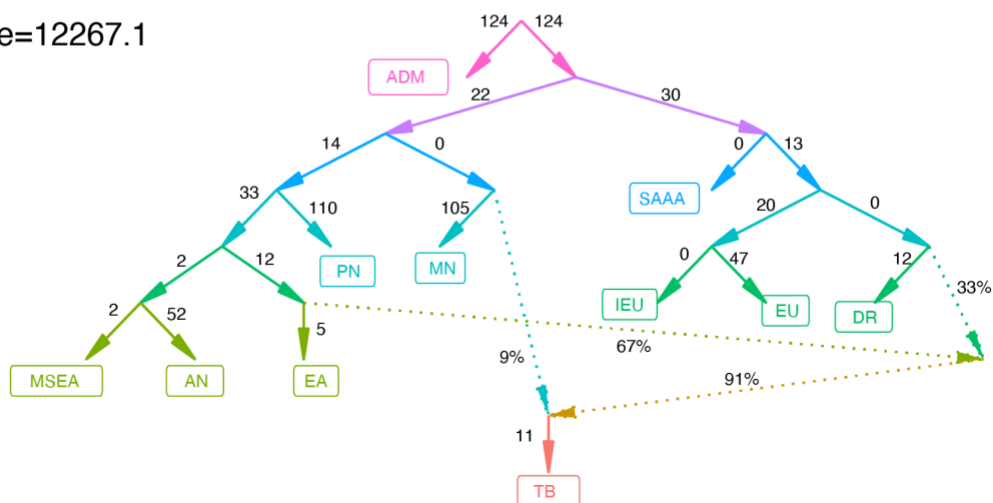
**Supplementary Figure 10. Population genetic relationship modelling using qpGraph.**
QpGraph modeling was performed using Admixtools 2[9]. We used the same set of data with Treemix, 630 individuals from 11 population groups and 919,892 SNPs. The base tree for running qpGraph was imported from the consensus tree of 100 iterations of Treemix with Andamanese as the outgroup (Supplementary Figure 9B). The name of the population groups in the graph are abbreviated as Andamanese (ADM), European (EU), Indo-European (IEU), Dravidian (DR), South Asian Austroasiatic (SAAA), Malaysian Negrito (MN), Philippine Negrito (PN), Austronesian (AN), Mainland Southeast Asian (MSEA), East Asian (EA), and Tibeto Burman (TB).

**A** The best-fit model without admixture event is plotted. Andamanese is the given outgroup for the consensus tree estimated by Treemix with no migration (Supplementary Figure 9B). The number on the branch is the drift lengths estimated by qpGraph.

To examine the admixture on **B** South Asian Austroasiatic, **C** Mainland Southeast Asian, and **D** Tibeto Burman population groups, we tested the 2-way admixture events for the three population groups as the target populations. We calculated the likelihood score of all pairs among 10 population groups for each of the three target population groups. There are 108 combinations of events that we tested, and the results are shown in Supplementary Table 4. The best-fit model to explain the South Asian Austroasiatic group (**B**) is admixture between Malaysian Negritos (71%) and Dravidian (29%) populations as shown in dotted lines. For Mainland Southeast Asians (**C**), the admixed edge coming from Malaysian Negritos and Austronesians have the lowest likelihood score with the admixture weight of 4% and 96%, respectively. For Tibeto Burman (**D**), the best-fit model is the admixture between Dravidians and East Asians with the admixture weight of 33% and 67%, respectively. We also performed the analysis with the other consensus tree (Supplementary Figure 9A) and found that the best-fit models for the target populations are same, as shown in Supplementary Table 5.

The best-fit model with 3-way admixture was calculated for the three target population groups, the South Asian Austroasiatic group **(E),** Mainland Southeast Asian (**F**), and Tibeto Burman **(G).** For the 3-way admixture, we added one more population group to the best-fitted 2-way admixture model and tested all combinations as shown in Supplementary Table 6.
**E** For the South Asian Austroasiatic group, the third best-fitted population group is Austronesian with 2% contribution to the admixture of Malaysian Negritos and Dravidian.
**F** Mainland Southeast Asians shows the best-fit with East Asian (57%) as third population groups to contribute in addition to Malaysian Negritos and Austronesians.
**G** Tibeto Burmans is best fitted with 9% of Malaysian Negrito contributions in addition to East Asians and Dravidians.

## A. Admixture
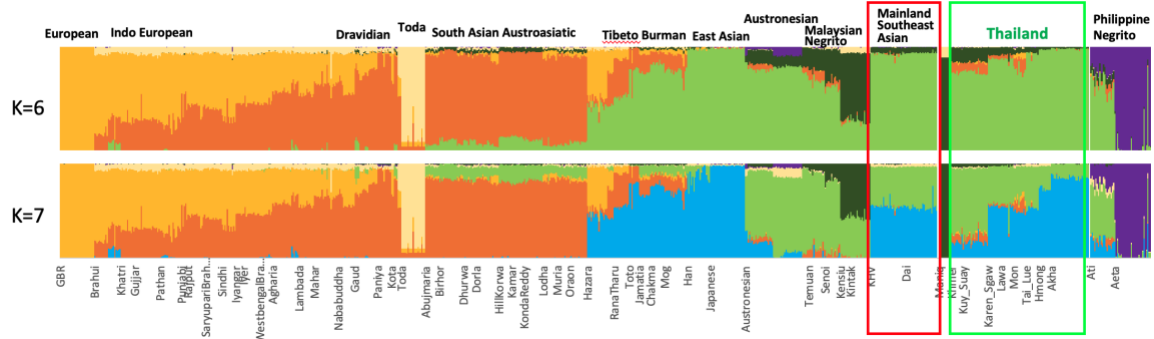


## B. PCA
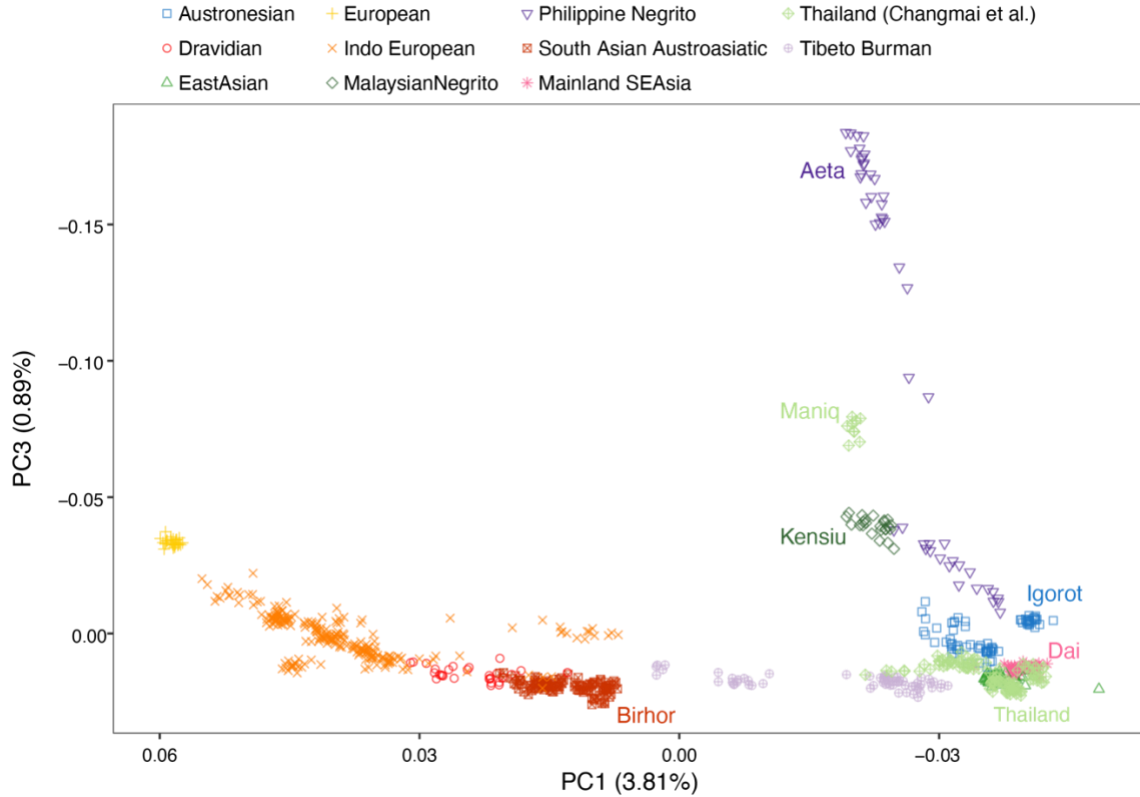


**Supplementary Figure 11. Population structure analysis for Mainland Southeast Asian populations.**

To fill the gap of Mainland Southeast Asian populations in our dataset, we retrieved the genotyping datasets of 120 individuals and 597,573 SNPs of mainly Thailand populations from the previous study[10]. We merge our datasets with the Thailand datasets based on the overlapping SNP positions. The merged datasets have 576,746 SNPs with 862 samples. The dataset was then filtered with PLINK1.9[2] with the following parameters: we included autosomes, individuals with missing genotype rate <0.1, SNPs with missing genotype <0.02, SNPs with MAF >0.01, and we pruned out SNPs with linkage $r^2$ >0.2 in a window size of 50kb with overlap 5 SNPs. The filtered datasets have 114,625 SNPs of 862 samples. Using this dataset we performed ADMIXTURE[1] (**A**) and PCA using PLINK (**B**).

Based on the results, we found that the KHV and Dai populations in our dataset (red line rectangular in **A**) show same major ancestral components with the diverse Thailand populations (green line rectangular). Only difference is some Northern Thailand populations have additional ancestry, South Asian component, which is a result of recent admixture[10]. The KHV and Dai have the minimum signal of the South Asian admixture. The PCA result also supports that our Mainland Southeast Asian populations, Dai and KHV, shown as pink stars in the plot (**B**), clustered together with most Thailand populations (light green diamond in the plot) except for the Negrito population, Maniq. Thus, we conclude that our Dai can be representative for Mainland Southeast Asians.

**Supplementary Table 1.** Global mean sea level (GMSL), its rate, and land size change history from 26 thousand years ago (KYA) till present.

| **A** Global mean sea level (GMSL) | | **B** GMSL rate | |
|---|---|---|---|
| KYA | GMSL (m) | KYA | GMSL rate (mm/yr) |
| 25 | -130.59 | 25.5 | 4.12 |
| 24 | -126.56 | 24.5 | 4.03 |
| 23 | -124.13 | 23.5 | 2.43 |
| 22 | -121.81 | 22.5 | 2.32 |
| 21 | -120.17 | 21.5 | 1.64 |
| 20.5 | -119.26 | 20.75 | 1.82 |
| 20 | -118.34 | 20.25 | 1.84 |
| 19.5 | -117.36 | 19.75 | 1.96 |
| 19 | -116.40 | 19.25 | 1.92 |
| 18.5 | -115.32 | 18.75 | 2.16 |
| 18 | -113.52 | 18.25 | 3.60 |
| 17.5 | -111.78 | 17.75 | 3.49 |
| 17 | -109.95 | 17.25 | 3.66 |
| 16.5 | -108.10 | 16.75 | 3.70 |
| 16 | -105.73 | 16.25 | 4.73 |
| 15.5 | -101.60 | 15.75 | 8.27 |
| 15 | -97.80 | 15.25 | 7.61 |
| 14.5 | -93.81 | 14.75 | 7.96 |
| 14 | -70.90 | 14.25 | 45.83 |
| 13.5 | -64.14 | 13.75 | 13.52 |
| 13 | -59.47 | 13.25 | 9.35 |
| 12.5 | -53.25 | 12.75 | 12.42 |
| 12 | -48.89 | 12.25 | 8.73 |
| 11.5 | -43.60 | 11.75 | 10.59 |
| 11 | -32.68 | 11.25 | 21.83 |
| 10.5 | -27.57 | 10.75 | 10.22 |
| 10 | -22.36 | 10.25 | 10.44 |
| 9.5 | -17.42 | 9.75 | 9.87 |
| 9 | -13.56 | 9.25 | 7.73 |
| 8.5 | -9.50 | 8.75 | 8.12 |
| 8 | -6.47 | 8.25 | 6.04 |
| 7.5 | -3.74 | 7.75 | 5.46 |
| 7 | -2.35 | 7.25 | 2.80 |
| 6.5 | -1.36 | 6.75 | 1.97 |
| 6 | -0.97 | 6.25 | 0.79 |
| 5.5 | -0.81 | 5.75 | 0.32 |
| 5 | -0.62 | 5.25 | 0.37 |
| 4.5 | -0.47 | 4.75 | 0.30 |
| 4 | -0.25 | 4.25 | 0.44 |
| 3.5 | -0.20 | 3.75 | 0.11 |
| 3 | -0.16 | 3.25 | 0.07 |
| 2.5 | -0.11 | 2.75 | 0.11 |
| 2 | 0 | 2.25 | 0.22 |
| 1.5 | 0 | 1.75 | 0 |
| 1 | 0 | 1.25 | 0 |
| 0.5 | 0 | 0.75 | 0 |
| 0 | 0 | 0.25 | 0 |

**C** Land size (Fig. 1C inset)

| KYA | Land Size (x30.9136 km$^2$) |
|---|---|
| 26 | 141,356 |
| 25 | 140,581 |
| 24 | 139,789 |
| 23 | 139,343 |
| 22 | 138,902 |
| 21 | 138,574 |
| 20 | 138,185 |
| 19 | 137,728 |
| 18 | 137,052 |
| 17 | 136,005 |
| 16 | 134,802 |
| 15 | 131,598 |
| 14 | 111,934 |
| 13 | 102,267 |
| 12 | 95,053 |
| 11 | 84,435 |
| 10 | 78,144 |
| 9 | 71,386 |
| 8 | 67,044 |
| 7 | 64,986 |
| 6 | 65,078 |
| 5 | 65,844 |
| 4 | 66,399 |
| 3 | 67,051 |
| 2 | 67,300 |
| 1 | 67,582 |
| 0 | 67,727 |

**D** Regional land size, effective population size, and population density. The effective population size (msmcN) was estimated by MSMC2[4,5] as shown in Supplementary Figure 6.

| Kya | Island Southeast Asia (Fig. 4b blue inset) | | | Mainland Southeast Asia (Fig. 4b green inset) | | |
|---|---|---|---|---|---|---|
| | Land Size (x30.9136 km²) | msmcN | msmcN / Land size | Land Size (x30.9136 km²) | msmcN | msmcN / Land size |
| 26 | 109,184 | 7975 | 0.073 | 81,238 | 4437 | 0.055 |
| 25 | 108,560 | 7975 | 0.073 | 81,007 | 4437 | 0.055 |
| 24 | 107,866 | 7975 | 0.074 | 80,791 | 4437 | 0.055 |
| 23 | 107,493 | 7975 | 0.074 | 80,672 | 4437 | 0.055 |
| 22 | 107,114 | 14080 | 0.131 | 80,538 | 6068 | 0.075 |
| 21 | 106,833 | 14080 | 0.132 | 80,418 | 6068 | 0.075 |
| 20.5 | 106,662 | 14080 | 0.132 | 80,358 | 6068 | 0.076 |
| 20 | 106,491 | 14080 | 0.132 | 80,285 | 6068 | 0.076 |
| 19.5 | 106,276 | 14080 | 0.132 | 80,215 | 6068 | 0.076 |
| 19 | 106,105 | 14080 | 0.133 | 80,155 | 6068 | 0.076 |
| 18.5 | 105,884 | 14080 | 0.133 | 80,074 | 6068 | 0.076 |
| 18 | 105,502 | 14080 | 0.133 | 79,934 | 6068 | 0.076 |
| 17.5 | 105,116 | 14080 | 0.134 | 79,693 | 6068 | 0.076 |
| 17 | 105,047 | 14080 | 0.134 | 79,578 | 6068 | 0.076 |
| 16.5 | 104,862 | 14080 | 0.134 | 79,443 | 6068 | 0.076 |
| 16 | 104,502 | 14080 | 0.135 | 79,266 | 12635 | 0.159 |
| 15.5 | 103,480 | 25205 | 0.244 | 78,778 | 12635 | 0.160 |
| 15 | 101,823 | 25205 | 0.248 | 78,105 | 12635 | 0.162 |
| 14.5 | 100,611 | 25205 | 0.251 | 77,543 | 12635 | 0.163 |
| 14 | 87,064 | 25205 | 0.289 | 72,585 | 12635 | 0.174 |
| 13.5 | 82,240 | 25205 | 0.306 | 71,313 | 12635 | 0.177 |
| 13 | 78,774 | 25205 | 0.320 | 70,293 | 12635 | 0.180 |
| 12.5 | 74,431 | 25205 | 0.339 | 68,870 | 12635 | 0.183 |
| 12 | 72,084 | 25205 | 0.350 | 67,824 | 12635 | 0.186 |
| 11.5 | 69,433 | 25205 | 0.363 | 66,248 | 12635 | 0.191 |
| 11 | 63,490 | 25205 | 0.397 | 63,316 | 12635 | 0.200 |
| 10.5 | 61,255 | 25205 | 0.411 | 61,763 | 29724 | 0.481 |
| 10 | 58,955 | 32028 | 0.543 | 60,202 | 29724 | 0.494 |
| 9.5 | 56,718 | 32028 | 0.565 | 58,669 | 29724 | 0.507 |
| 9 | 54,894 | 32028 | 0.583 | 57,259 | 29724 | 0.519 |
| 8.5 | 52,693 | 32028 | 0.608 | 55,411 | 29724 | 0.536 |
| 8 | 51,831 | 32028 | 0.618 | 54,708 | 29724 | 0.543 |
| 7.5 | 51,096 | 32028 | 0.627 | 53,492 | 29724 | 0.556 |
| 7 | 50,838 | 32028 | 0.630 | 53,099 | 29724 | 0.560 |
| 6.5 | 50,665 | 32028 | 0.632 | 52,966 | 29724 | 0.561 |
| 6 | 50,796 | 1466 | 0.029 | 53,149 | 29350 | 0.552 |
| 5.5 | 50,993 | 1466 | 0.029 | 53,433 | 29350 | 0.549 |
| 5 | 51,139 | 1466 | 0.029 | 53,670 | 29350 | 0.547 |
| 4.5 | 51,251 | 1466 | 0.029 | 53,883 | 29350 | 0.545 |
| 4 | 51,346 | 1466 | 0.029 | 54,087 | 29350 | 0.543 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3.5 | 51,442 | 1466 | 0.028 | 54,273 | 29350 | 0.541 |
| 3 | 51,553 | 1466 | 0.028 | 54,401 | 29350 | 0.540 |
| 2.5 | 51,639 | 1466 | 0.028 | 54,450 | 29350 | 0.539 |
| 2 | 51,701 | 1466 | 0.028 | 54,487 | 29350 | 0.539 |
| 1.5 | 51,767 | 1466 | 0.028 | 54,550 | 29350 | 0.538 |
| 1 | 51,805 | 1466 | 0.028 | 54,604 | 29350 | 0.537 |
| 0.5 | 51,902 | 1466 | 0.028 | 54,671 | 29350 | 0.537 |
| 0 | 51,902 | 1466 | 0.028 | 54,671 | 29350 | 0.537 |

**Supplementary Table 2.** The 763 whole genome datasets are a portion of the GenomeAsia 100K pilot dataset[3]. The table shows the number of samples for each population used in this study.

| Group | Population | No. of Samples |
|---|---|---|
| European | GBR (British in England and Scotland) | 27 |
| Indo European | Brahui | 11 |
| | Pathan | 17 |
| | Brusho | 10 |
| | Hazara | 16 |
| | Sindhi | 11 |
| | Gujjar | 20 |
| | Khatri | 11 |
| | Punjabi | 5 |
| | Rajput | 14 |
| | Saryupari Brahmin | 13 |
| | West Bengal Brahmin | 10 |
| | Iyangar | 6 |
| | Iyer | 13 |
| | Saurashtra Brahmin | 9 |
| | Agharia | 15 |
| | Lambada | 12 |
| | Chamar | 6 |
| | Nababuddha | 4 |
| | Mahar | 19 |
| | Kota | 8 |
| | Toda | 19 |
| Dravidian | Irula | 4 |
| | Chanchu | 7 |
| | Paniya | 11 |
| | Bagdi | 3 |
| | Gaud | 4 |
| South Asian Austroasiatic | Halba | 6 |
| | Lodha | 11 |
| | Abujmaria | 11 |
| | Bison Horn Maria | 5 |
| | Muria | 10 |
| | Oraon | 14 |
| | Dorla | 12 |
| | Dhurwa | 10 |
| | Konda Reddy | 15 |
| | Kamar | 10 |
| | Hill Korwa | 10 |
| | Birhor | 14 |
| Tibeto Burman | Manipuri | 5 |
| | Rana Tharu | 12 |
| | Toto | 8 |
| | Jamatia | 9 |
| | Mog | 18 |
| | Chakma | 11 |
| Malaysian Negrito | Kensiu | 8 |
| | Kintak | 16 |
| Austronesian | Senoi | 12 |
| | Temuan | 13 |
| | Malay Singaporean | 20 |
| | Mentawai/Nias | 23 |

|  | Igorot | 2 |
|---|---|---|
|  | Nicobarese | 5 |
| Philippine Negrito | Ati | 19 |
|  | Aeta | 29 |
| Mainland Southeast Asian | Dai | 25 |
|  | KHV (Kinh in Ho Chi Minh) | 28 |
| East Asian | Han Chinese | 18 |
|  | Japanese | 28 |
| Andamanese | Jarwa | 10 |
|  | Onge | 11 |
| **TOTAL** | **61** | **763** |

**Supplementary Table 3.** Population split time (years ago) estimated based on *M(t),* that is the cumulative migration probability that denotes the probability for lineages to have merged by the time *t,* at quantile for a pair of populations, estimated using MSMC-IM[6]. For each pair, we performed four to five pairs of different combinations of individual genomes to see the robustness of estimates. *M(t)* is the cumulative migration probability that denotes the probability for lineages to have merged by the time *t*. Supplementary Figure 3 shows the plots from these tables and includes one estimate for each pair of populations.

**A** The time *t* between **a pair of populations within Southeast Asians** for each MSMC run is shown in the table for three *M(t)* quantile = 0.25, 0.5, and 0.75. The time between Kensiu and Dai supposes to be similar to the time of two other pairs, Kensiu-Aeta and Kensiu-Igorot, as shown at *M(t)* = 0.75, but is younger at *M(t)* = 0.5 and 0.25. Kensiu-Dai results are similar with Kensiu-KHV (purple shaded).

| M(t) quantile | 0.25 | 0.5 | 0.75 |
|---|---|---|---|
| **Kensiu-Han** | 10,223 | 14,292 | 22,171 |
| | 10,290 | 14,472 | 22,314 |
| | 11,214 | 15,850 | 23,098 |
| | 10,886 | 15,836 | 23,048 |
| **Kensiu-Aeta** | 10,673 | 15,361 | 21,291 |
| | 8,763 | 14,319 | 21,127 |
| | 9,687 | 14,290 | 20,084 |
| | 9,240 | 13,693 | 20,969 |
| | 7,909 | 12,712 | 20,288 |
| **Kensiu-Igorot** | 9,590 | 14,501 | 22,300 |
| | 9,778 | 14,460 | 21,919 |
| | 9,863 | 14,352 | 22,052 |
| | 9,830 | 13,860 | 22,136 |
| **Kensiu-Dai** | 6,970 | 12,013 | 21,888 |
| | 7,009 | 10,974 | 20,748 |
| | 6,657 | 10,746 | 21,545 |
| | 6,843 | 10,534 | 21,045 |
| | 6,639 | 9,299 | 20,973 |
| **Kensiu-KHV** | 6,711 | 10,944 | 21,155 |
| | 7,158 | 11,758 | 21,938 |
| | 6,536 | 8,514 | 18,764 |
| | 6,344 | 7,974 | 23,026 |
| **Igorot-Dai** | 7,093 | 10,615 | 14,565 |
| | 7,234 | 10,394 | 14,765 |
| | 6,956 | 10,228 | 14,865 |
| | 6,926 | 9,922 | 14,328 |
| | 6,734 | 9,682 | 14,113 |

**B** M(t) estimates between **a pair of populations within South Asians** populations

| M(t) quantile | 0.25 | 0.5 | 0.75 |
|---|---|---|---|
| **Birhor-Gujjar** | 7,316 | 12,894 | 19,208 |
| | 7,491 | 11,791 | 19,619 |
| | 7,520 | 11,366 | 20,810 |

|  | | | |
|---|---|---|---|
|  | 6,956 | 10,480 | 19,346 |
|  | 7,008 | 10,186 | 21,341 |
| **Paniya-Gujjar** | 7,561 | 11,738 | 21,120 |
|  | 7,341 | 11,360 | 21,073 |
|  | 7,381 | 11,010 | 18,878 |
|  | 7,143 | 10,253 | 19,113 |
|  | 7,111 | 9,405 | 16,861 |
| **Birhor-Paniya** | 6,632 | 7,892 | 13,566 |
|  | 6,543 | 7,816 | 13,817 |
|  | 6,514 | 7,729 | 13,333 |
|  | 6,485 | 7,680 | 11,932 |
|  | 6,378 | 7,573 | 11,955 |

**C** The *t* between a pair of populations **between Birhor and Southeast Asian** populations for each MSMC run is shown in the table for three *M(t)* quantile = 0.25, 0.5, and 0.75. The time between Birhor and Kensiu supposes to be older as similar as the pairs between Birhor-Igorot, Birhor-Aeta, and Birhor-Dai. However, the time is younger (purple shaded) as similar to the split within South Asian populations such as Birhor-Gujjar.

| M(t) quantile | 0.25 | 0.5 | 0.75 |
|---|---|---|---|
|  | 13,4 49 | 17,813 | 25,317 |
|  | 13,305 | 17,773 | 25,891 |
| **Birhor-Igorot** | 13,143 | 17,591 | 25,521 |
|  | 12,349 | 17,345 | 25,621 |
|  | 13,110 | 17,159 | 25,590 |
|  | 11,246 | 16,199 | 23,219 |
|  | 11,067 | 16,176 | 23,377 |
| **Birhor-Aeta** | 11,340 | 15,956 | 23,173 |
|  | 10,794 | 15,755 | 24,107 |
|  | 11,473 | 15,455 | 21,461 |
|  | 10,460 | 17,399 | 24,402 |
|  | 10,613 | 16,250 | 26,235 |
| **Birhor-Dai** | 9,450 | 15,893 | 24,006 |
|  | 8,919 | 15,455 | 23,547 |
|  | 10,333 | 15,417 | 23,493 |
|  | 10,749 | 16,007 | 23,086 |
| **Birhor-KHV** | 7,536 | 14,268 | 24,154 |
|  | 10,333 | 16,671 | 23,838 |
|  | 8,222 | 13,112 | 20,227 |
|  | 7,450 | 12,267 | 21,363 |
| **Birhor-Kensiu** | 7,699 | 11,991 | 19,881 |
|  | 7,538 | 11,581 | 19,495 |
|  | 7,400 | 11,093 | 20,519 |

**D** M(t) estimates between **Jamatia (Tibeto Burman) and other Asians.** Migration after split between Jamatia and Dai/Han has been prolonged after their splits and the time at M(t)=0.25 is younger compared to the Jamatia-Igorot pair.

| M(t) quantile | 0.25 | 0.5 | 0.75 |
|---|---|---|---|
| | 11,188 | 17,529 | 25,182 |
| Jamatia-Gujjar | 12,173 | 17,174 | 25,635 |
| | 12,023 | 17,263 | 25,289 |
| | 9,225 | 14,089 | 22,251 |
| Jamatia-Paniya | 9,047 | 14,120 | 22,660 |
| | 8,323 | 13,868 | 21,961 |
| | 7,960 | 13,471 | 19,357 |
| Jamatia-Birhor | 7,625 | 13,099 | 22,393 |
| | 7,502 | 12,105 | 19,938 |
| | 9,464 | 13,073 | 19,233 |
| Jamatia-Aeta | 9,296 | 13,887 | 21,415 |
| | 8,566 | 12,815 | 20,492 |
| | 6,988 | 11,507 | 19,454 |
| Jamatia-Kensiu | 6,788 | 9,314 | 19,174 |
| | 6,643 | 8,479 | 17,679 |
| | 9,813 | 13,217 | 17,566 |
| Jamatia-Igorot | 9,649 | 12,976 | 18,027 |
| | 9,264 | 12,378 | 17,390 |
| | 5,179 | 6,884 | 10,662 |
| Jamatia-Dai | 5,581 | 7,876 | 11,957 |
| | 5,406 | 9,154 | 13,785 |
| | 4,816 | 7,506 | 11,413 |
| Jamatia-Han | 2,711 | 6,690 | 11,075 |
| | 2,510 | 6,975 | 11,264 |

**Supplementary Table 4.** QpGraph 2-way admixture likelihood scores with the consensus tree of Supplementary Figure 9B. The name of the population groups in the graph are abbreviated: South Asian Austroasiatic (SAAA) and Mainland Southeast Asian (MSEA). The best fitted model, having the lowest likelihood score (score), is shaded by purple, for each admixed population, is plotted in Supplementary Figure 10.

| pop1 | pop2 | Admixed pop | score | weight.pop1 | weight.pop2 |
|------|------|-------------|-------|-------------|-------------|
| Dravidian | Malaysian Negrito | SAAA | 18770.0 | 0.7082 | 0.2918 |
| Dravidian | Philippine Negrito | SAAA | 18821.6 | 0.7486 | 0.2514 |
| Dravidian | TibetoBurman | SAAA | 18992.3 | 0.8334 | 0.1666 |
| Dravidian | EastAsian | SAAA | 19509.7 | 0.8840 | 0.1160 |
| Dravidian | Austronesian | SAAA | 19527.8 | 0.8927 | 0.1073 |
| Dravidian | MSEA | SAAA | 19527.9 | 0.8925 | 0.1075 |
| Dravidian | European | SAAA | 20326.1 | 1.0000 | 0.0000 |
| Dravidian | IndoEuropean | SAAA | 20326.1 | 1.0000 | 0.0000 |
| European | Malaysian Negrito | SAAA | 22139.8 | 0.3244 | 0.6756 |
| IndoEuropean | Malaysian Negrito | SAAA | 22139.8 | 0.3244 | 0.6756 |
| Austronesian | Malaysian Negrito | SAAA | 22641.5 | 0.0129 | 0.9871 |
| MSEA | Malaysian Negrito | SAAA | 22667.4 | 0.0046 | 0.9954 |
| Philippine Negrito | Malaysian Negrito | SAAA | 22668.6 | 0.0000 | 1.0000 |
| EastAsian | Malaysian Negrito | SAAA | 22668.7 | 0.0000 | 1.0000 |
| TibetoBurman | Malaysian Negrito | SAAA | 22668.7 | 0.0000 | 1.0000 |
| European | Philippine Negrito | SAAA | 22839.4 | 0.4825 | 0.5175 |
| IndoEuropean | Philippine Negrito | SAAA | 22839.4 | 0.4825 | 0.5175 |
| European | TibetoBurman | SAAA | 24240.8 | 0.7288 | 0.2712 |
| IndoEuropean | TibetoBurman | SAAA | 24240.8 | 0.7288 | 0.2712 |
| Austronesian | Philippine Negrito | SAAA | 24768.3 | 0.0117 | 0.9883 |
| MSEA | Philippine Negrito | SAAA | 24789.4 | 0.0025 | 0.9975 |
| EastAsian | Philippine Negrito | SAAA | 24789.7 | 0.0000 | 1.0000 |
| TibetoBurman | Philippine Negrito | SAAA | 24789.8 | 0.0000 | 1.0000 |
| IndoEuropean | EastAsian | SAAA | 25262.2 | 0.8361 | 0.1639 |
| European | EastAsian | SAAA | 25262.2 | 0.8361 | 0.1639 |
| IndoEuropean | Austronesian | SAAA | 25360.3 | 0.8488 | 0.1512 |
| European | Austronesian | SAAA | 25360.3 | 0.8488 | 0.1512 |
| IndoEuropean | MSEA | SAAA | 25360.3 | 0.8488 | 0.1512 |
| European | MSEA | SAAA | 25360.3 | 0.8488 | 0.1512 |
| IndoEuropean | European | SAAA | 26988.6 | 0.6544 | 0.3456 |
| TibetoBurman | Austronesian | SAAA | 31339.4 | 1.0000 | 0.0000 |
| TibetoBurman | EastAsian | SAAA | 31339.5 | 1.0000 | 0.0000 |
| TibetoBurman | MSEA | SAAA | 31339.5 | 1.0000 | 0.0000 |
| Austronesian | EastAsian | SAAA | 32779.0 | 0.0091 | 0.9909 |
| MSEA | EastAsian | SAAA | 32779.7 | 0.0189 | 0.9811 |
| MSEA | Austronesian | SAAA | 33603.4 | 0.4460 | 0.5540 |
| | | | | | |
| Austronesian | Malaysian Negrito | MSEA | 18480.2 | 0.9560 | 0.0440 |
| Austronesian | EastAsian | MSEA | 18826.9 | 0.3837 | 0.6163 |
| Austronesian | Philippine Negrito | MSEA | 18842.4 | 0.9800 | 0.0200 |
| European | Austronesian | MSEA | 18934.1 | 0.0000 | 1.0000 |
| Dravidian | Austronesian | MSEA | 18934.1 | 0.0000 | 1.0000 |
| TibetoBurman | Austronesian | MSEA | 18934.1 | 0.0000 | 1.0000 |

| | | | | | |
|---|---|---|---|---|---|
| SAAA | Austronesian | MSEA | 18934.1 | 0.0000 | 1.0000 |
| IndoEuropean | Austronesian | MSEA | 18934.1 | 0.0000 | 1.0000 |
| EastAsian | Malaysian Negrito | MSEA | 19065.7 | 0.9672 | 0.0328 |
| EastAsian | Philippine Negrito | MSEA | 19316.2 | 0.9915 | 0.0085 |
| European | EastAsian | MSEA | 19329.8 | 0.0000 | 1.0000 |
| Dravidian | EastAsian | MSEA | 19329.8 | 0.0000 | 1.0000 |
| TibetoBurman | EastAsian | MSEA | 19329.9 | 0.0000 | 1.0000 |
| SAAA | EastAsian | MSEA | 19329.9 | 0.0000 | 1.0000 |
| IndoEuropean | EastAsian | MSEA | 19329.9 | 0.0000 | 1.0000 |
| TibetoBurman | Malaysian Negrito | MSEA | 23964.1 | 0.9781 | 0.0219 |
| TibetoBurman | Philippine Negrito | MSEA | 24065.5 | 1.0000 | 0.0000 |
| European | TibetoBurman | MSEA | 24065.6 | 0.0000 | 1.0000 |
| Dravidian | TibetoBurman | MSEA | 24065.6 | 0.0000 | 1.0000 |
| SAAA | TibetoBurman | MSEA | 24065.6 | 0.0000 | 1.0000 |
| IndoEuropean | TibetoBurman | MSEA | 24065.6 | 0.0000 | 1.0000 |
| Philippine Negrito | Malaysian Negrito | MSEA | 25701.2 | 0.9782 | 0.0218 |
| European | Philippine Negrito | MSEA | 25791.7 | 0.0000 | 1.0000 |
| Dravidian | Philippine Negrito | MSEA | 25791.8 | 0.0000 | 1.0000 |
| SAAA | Philippine Negrito | MSEA | 25791.8 | 0.0000 | 1.0000 |
| IndoEuropean | Philippine Negrito | MSEA | 25791.8 | 0.0000 | 1.0000 |
| European | Malaysian Negrito | MSEA | 26705.6 | 0.0000 | 1.0000 |
| Dravidian | Malaysian Negrito | MSEA | 26705.6 | 0.0000 | 1.0000 |
| SAAA | Malaysian Negrito | MSEA | 26705.7 | 0.0000 | 1.0000 |
| IndoEuropean | Malaysian Negrito | MSEA | 26705.7 | 0.0000 | 1.0000 |
| SAAA | European | MSEA | 33690.4 | 1.0000 | 0.0000 |
| SAAA | Dravidian | MSEA | 33690.4 | 1.0000 | 0.0000 |
| SAAA | IndoEuropean | MSEA | 33690.5 | 1.0000 | 0.0000 |
| Dravidian | European | MSEA | 34119.5 | 1.0000 | 0.0000 |
| Dravidian | IndoEuropean | MSEA | 34119.6 | 1.0000 | 0.0000 |
| IndoEuropean | European | MSEA | 39020.5 | 0.3427 | 0.6573 |
| | | | | | |
| Dravidian | EastAsian | TibetoBurman | 12403.2 | 0.3324 | 0.6676 |
| SAAA | EastAsian | TibetoBurman | 12824.9 | 0.3524 | 0.6476 |
| European | EastAsian | TibetoBurman | 13092.3 | 0.2919 | 0.7081 |
| IndoEuropean | EastAsian | TibetoBurman | 13101.1 | 0.2922 | 0.7078 |
| Dravidian | Austronesian | TibetoBurman | 13932.3 | 0.3155 | 0.6845 |
| Dravidian | MSEA | TibetoBurman | 13932.4 | 0.3155 | 0.6845 |
| SAAA | Austronesian | TibetoBurman | 14312.3 | 0.3330 | 0.6670 |
| SAAA | MSEA | TibetoBurman | 14312.4 | 0.3330 | 0.6670 |
| European | Austronesian | TibetoBurman | 14583.7 | 0.2787 | 0.7213 |
| European | MSEA | TibetoBurman | 14583.7 | 0.2787 | 0.7213 |
| IndoEuropean | Austronesian | TibetoBurman | 14591.4 | 0.2790 | 0.7210 |
| IndoEuropean | MSEA | TibetoBurman | 14591.4 | 0.2790 | 0.7210 |
| EastAsian | Malaysian Negrito | TibetoBurman | 15611.6 | 0.4967 | 0.5033 |
| Dravidian | Philippine Negrito | TibetoBurman | 16237.0 | 0.2620 | 0.7380 |
| European | Philippine Negrito | TibetoBurman | 16249.1 | 0.2209 | 0.7791 |
| IndoEuropean | Philippine Negrito | TibetoBurman | 16258.2 | 0.2211 | 0.7789 |
| SAAA | Philippine Negrito | TibetoBurman | 16820.0 | 0.2796 | 0.7204 |
| Austronesian | Malaysian Negrito | TibetoBurman | 17071.9 | 0.5331 | 0.4669 |
| MSEA | Malaysian Negrito | TibetoBurman | 17071.9 | 0.5331 | 0.4669 |

| | | | | | |
|---|---|---|---|---|---|
| EastAsian | Philippine Negrito | TibetoBurman | 17669.1 | 0.4596 | 0.5404 |
| European | Malaysian Negrito | TibetoBurman | 18520.1 | 0.1802 | 0.8198 |
| IndoEuropean | Malaysian Negrito | TibetoBurman | 18523.3 | 0.1801 | 0.8199 |
| Dravidian | Malaysian Negrito | TibetoBurman | 18691.5 | 0.2198 | 0.7802 |
| Philippine Negrito | Malaysian Negrito | TibetoBurman | 18885.1 | 0.5632 | 0.4368 |
| Austronesian | Philippine Negrito | TibetoBurman | 18941.1 | 0.5051 | 0.4949 |
| MSEA | Philippine Negrito | TibetoBurman | 18941.1 | 0.5051 | 0.4949 |
| SAAA | Malaysian Negrito | TibetoBurman | 19228.1 | 0.2284 | 0.7716 |
| Austronesian | EastAsian | TibetoBurman | 22901.6 | 0.0000 | 1.0000 |
| MSEA | EastAsian | TibetoBurman | 22901.7 | 0.0000 | 1.0000 |
| MSEA | Austronesian | TibetoBurman | 24065.6 | 0.5518 | 0.4482 |
| SAAA | European | TibetoBurman | 30138.1 | 0.9586 | 0.0414 |
| SAAA | IndoEuropean | TibetoBurman | 30138.1 | 0.9586 | 0.0414 |
| SAAA | Dravidian | TibetoBurman | 30175.8 | 1.0000 | 0.0000 |
| Dravidian | European | TibetoBurman | 30740.1 | 0.9687 | 0.0313 |
| Dravidian | IndoEuropean | TibetoBurman | 30740.2 | 0.9687 | 0.0313 |
| IndoEuropean | European | TibetoBurman | 36039.4 | 0.4375 | 0.5625 |

**Supplementary Table 5.** QpGraph 2-way likelihood scores with the consensus tree of Supplementary Figure 9A. The name of the population groups in the graph are abbreviated: South Asian Austroasiatic (SAAA) and Mainland Southeast Asian (MSEA). The best fitted model, having the lowest likelihood score (score), is shaded by purple.

| pop1 | pop2 | Admixed pop | score | weight.pop1 | weight.pop2 |
|---|---|---|---|---|---|
| Dravidian | MalaysianNegrito | SAAA | 18947.1 | 0.7351 | 0.2649 |
| Dravidian | PhilippineNegrito | SAAA | 18948.7 | 0.7334 | 0.2666 |
| Dravidian | TibetoBurman | SAAA | 19139.2 | 0.8313 | 0.1687 |
| Dravidian | EastAsian | SAAA | 19669.7 | 0.8834 | 0.1166 |
| Dravidian | Austronesian | SAAA | 19689.8 | 0.8921 | 0.1079 |
| Dravidian | MSEA | SAAA | 19689.8 | 0.8920 | 0.1080 |
| Dravidian | European | SAAA | 20478.2 | 1.0000 | 0.0000 |
| Dravidian | IndoEuropean | SAAA | 20478.2 | 1.0000 | 0.0000 |
| European | MalaysianNegrito | SAAA | 22839.7 | 0.4811 | 0.5189 |
| European | PhilippineNegrito | SAAA | 22839.7 | 0.4811 | 0.5189 |
| IndoEuropean | MalaysianNegrito | SAAA | 22839.7 | 0.4811 | 0.5189 |
| IndoEuropean | PhilippineNegrito | SAAA | 22839.7 | 0.4811 | 0.5189 |
| European | TibetoBurman | SAAA | 24343.9 | 0.7141 | 0.2859 |
| IndoEuropean | TibetoBurman | SAAA | 24343.9 | 0.7141 | 0.2859 |
| Austronesian | MalaysianNegrito | SAAA | 24768.3 | 0.0117 | 0.9883 |
| Austronesian | PhilippineNegrito | SAAA | 24768.3 | 0.0117 | 0.9883 |
| MSEA | MalaysianNegrito | SAAA | 24789.4 | 0.0025 | 0.9975 |
| MSEA | PhilippineNegrito | SAAA | 24789.4 | 0.0025 | 0.9975 |
| PhilippineNegrito | MalaysianNegrito | SAAA | 24789.7 | 0.4958 | 0.5042 |
| EastAsian | MalaysianNegrito | SAAA | 24789.8 | 0.0000 | 1.0000 |
| EastAsian | PhilippineNegrito | SAAA | 24789.8 | 0.0000 | 1.0000 |
| TibetoBurman | MalaysianNegrito | SAAA | 24789.8 | 0.0000 | 1.0000 |
| TibetoBurman | PhilippineNegrito | SAAA | 24789.8 | 0.0000 | 1.0000 |
| European | EastAsian | SAAA | 25452.6 | 0.8286 | 0.1714 |
| IndoEuropean | EastAsian | SAAA | 25452.6 | 0.8286 | 0.1714 |

| | | | | | |
|---|---|---|---|---|---|
| IndoEuropean | Austronesian | SAAA | 25558.8 | 0.8459 | 0.1541 |
| European | Austronesian | SAAA | 25558.8 | 0.8459 | 0.1541 |
| IndoEuropean | MSEA | SAAA | 25558.8 | 0.8459 | 0.1541 |
| European | MSEA | SAAA | 25558.8 | 0.8459 | 0.1541 |
| European | IndoEuropean | SAAA | 27193.2 | 0.3456 | 0.6544 |
| Austronesian | TibetoBurman | SAAA | 31326.9 | 0.0000 | 1.0000 |
| EastAsian | TibetoBurman | SAAA | 31326.9 | 0.0000 | 1.0000 |
| MSEA | TibetoBurman | SAAA | 31326.9 | 0.0000 | 1.0000 |
| Austronesian | EastAsian | SAAA | 32730.2 | 0.0089 | 0.9911 |
| MSEA | EastAsian | SAAA | 32730.7 | 0.0192 | 0.9808 |
| Austronesian | MSEA | SAAA | 33534.3 | 0.5540 | 0.4460 |

| | | | | | |
|---|---|---|---|---|---|
| Austronesian | MalaysianNegrito | MSEA | 18560.2 | 0.9532 | 0.0468 |
| Austronesian | EastAsian | MSEA | 18961.9 | 0.3848 | 0.6152 |
| Austronesian | PhilippineNegrito | MSEA | 18976.5 | 0.9799 | 0.0201 |
| European | Austronesian | MSEA | 19073.0 | 0.0000 | 1.0000 |
| Dravidian | Austronesian | MSEA | 19073.0 | 0.0000 | 1.0000 |
| Austronesian | TibetoBurman | MSEA | 19073.1 | 1.0000 | 0.0000 |
| SAAA | Austronesian | MSEA | 19073.1 | 0.0000 | 1.0000 |
| IndoEuropean | Austronesian | MSEA | 19073.1 | 0.0000 | 1.0000 |
| EastAsian | MalaysianNegrito | MSEA | 19146.1 | 0.9645 | 0.0355 |
| EastAsian | PhilippineNegrito | MSEA | 19437.3 | 0.9914 | 0.0086 |
| European | EastAsian | MSEA | 19455.0 | 0.0000 | 1.0000 |
| Dravidian | EastAsian | MSEA | 19455.0 | 0.0000 | 1.0000 |
| EastAsian | TibetoBurman | MSEA | 19455.0 | 1.0000 | 0.0000 |
| SAAA | EastAsian | MSEA | 19455.0 | 0.0000 | 1.0000 |
| IndoEuropean | EastAsian | MSEA | 19455.1 | 0.0000 | 1.0000 |
| TibetoBurman | MalaysianNegrito | MSEA | 23997.7 | 0.9764 | 0.0236 |
| TibetoBurman | PhilippineNegrito | MSEA | 24115.6 | 1.0000 | 0.0000 |
| European | TibetoBurman | MSEA | 24115.6 | 0.0000 | 1.0000 |
| Dravidian | TibetoBurman | MSEA | 24115.7 | 0.0000 | 1.0000 |
| SAAA | TibetoBurman | MSEA | 24115.7 | 0.0000 | 1.0000 |
| IndoEuropean | TibetoBurman | MSEA | 24115.7 | 0.0000 | 1.0000 |
| PhilippineNegrito | MalaysianNegrito | MSEA | 26705.5 | 0.0000 | 1.0000 |
| European | MalaysianNegrito | MSEA | 26705.5 | 0.0000 | 1.0000 |
| Dravidian | MalaysianNegrito | MSEA | 26705.6 | 0.0000 | 1.0000 |
| SAAA | MalaysianNegrito | MSEA | 26705.6 | 0.0000 | 1.0000 |
| IndoEuropean | MalaysianNegrito | MSEA | 26705.6 | 0.0000 | 1.0000 |
| European | PhilippineNegrito | MSEA | 26866.9 | 0.0000 | 1.0000 |
| Dravidian | PhilippineNegrito | MSEA | 26867.0 | 0.0000 | 1.0000 |
| SAAA | PhilippineNegrito | MSEA | 26867.0 | 0.0000 | 1.0000 |
| IndoEuropean | PhilippineNegrito | MSEA | 26867.0 | 0.0000 | 1.0000 |
| SAAA | European | MSEA | 33641.3 | 1.0000 | 0.0000 |
| SAAA | Dravidian | MSEA | 33641.3 | 1.0000 | 0.0000 |
| SAAA | IndoEuropean | MSEA | 33641.4 | 1.0000 | 0.0000 |
| Dravidian | European | MSEA | 34073.1 | 1.0000 | 0.0000 |
| Dravidian | IndoEuropean | MSEA | 34073.2 | 1.0000 | 0.0000 |
| European | IndoEuropean | MSEA | 38973.5 | 0.6569 | 0.3431 |

| | | | | | |
|---|---|---|---|---|---|
| Dravidian | EastAsian | TibetoBurman | 12941.9 | 0.3293 | 0.6707 |

| | | | | | |
|---|---|---|---|---|---|
| SAAA | EastAsian | TibetoBurman | 13374.7 | 0.3496 | 0.6504 |
| European | EastAsian | TibetoBurman | 13592.0 | 0.2879 | 0.7121 |
| IndoEuropean | EastAsian | TibetoBurman | 13600.3 | 0.2882 | 0.7118 |
| Dravidian | Austronesian | TibetoBurman | 14451.1 | 0.3118 | 0.6882 |
| Dravidian | MSEA | TibetoBurman | 14451.2 | 0.3118 | 0.6882 |
| SAAA | Austronesian | TibetoBurman | 14844.3 | 0.3294 | 0.6706 |
| SAAA | MSEA | TibetoBurman | 14844.3 | 0.3294 | 0.6706 |
| European | Austronesian | TibetoBurman | 15059.7 | 0.2743 | 0.7257 |
| European | MSEA | TibetoBurman | 15059.7 | 0.2743 | 0.7257 |
| IndoEuropean | Austronesian | TibetoBurman | 15066.8 | 0.2746 | 0.7254 |
| IndoEuropean | MSEA | TibetoBurman | 15066.9 | 0.2746 | 0.7254 |
| EastAsian | MalaysianNegrito | TibetoBurman | 17845.5 | 0.5006 | 0.4994 |
| EastAsian | PhilippineNegrito | TibetoBurman | 17845.5 | 0.5006 | 0.4994 |
| European | MalaysianNegrito | TibetoBurman | 18811.8 | 0.2065 | 0.7935 |
| European | PhilippineNegrito | TibetoBurman | 18811.8 | 0.2065 | 0.7935 |
| IndoEuropean | MalaysianNegrito | TibetoBurman | 18819.1 | 0.2066 | 0.7934 |
| IndoEuropean | PhilippineNegrito | TibetoBurman | 18819.1 | 0.2066 | 0.7934 |
| Dravidian | MalaysianNegrito | TibetoBurman | 18874.1 | 0.2462 | 0.7538 |
| Dravidian | PhilippineNegrito | TibetoBurman | 18874.1 | 0.2462 | 0.7538 |
| Austronesian | MalaysianNegrito | TibetoBurman | 19108.4 | 0.5424 | 0.4576 |
| Austronesian | PhilippineNegrito | TibetoBurman | 19108.4 | 0.5424 | 0.4576 |
| MSEA | MalaysianNegrito | TibetoBurman | 19108.4 | 0.5424 | 0.4576 |
| MSEA | PhilippineNegrito | TibetoBurman | 19108.4 | 0.5424 | 0.4576 |
| SAAA | MalaysianNegrito | TibetoBurman | 19433.0 | 0.2622 | 0.7378 |
| SAAA | PhilippineNegrito | TibetoBurman | 19433.0 | 0.2622 | 0.7378 |
| PhilippineNegrito | MalaysianNegrito | TibetoBurman | 22516.3 | 0.4889 | 0.5111 |
| Austronesian | EastAsian | TibetoBurman | 22968.0 | 0.0000 | 1.0000 |
| MSEA | EastAsian | TibetoBurman | 22968.0 | 0.0000 | 1.0000 |
| Austronesian | MSEA | TibetoBurman | 24115.6 | 0.4482 | 0.5518 |
| SAAA | European | TibetoBurman | 30212.4 | 0.9562 | 0.0438 |
| SAAA | IndoEuropean | TibetoBurman | 30212.5 | 0.9562 | 0.0438 |
| SAAA | Dravidian | TibetoBurman | 30254.9 | 1.0000 | 0.0000 |
| Dravidian | European | TibetoBurman | 30809.8 | 0.9659 | 0.0341 |
| Dravidian | IndoEuropean | TibetoBurman | 30809.9 | 0.9659 | 0.0341 |
| European | IndoEuropean | TibetoBurman | 36086.9 | 0.5625 | 0.4375 |

**Supplementary Table 6.** QpGraph 3-way admixture likelihood scores with the consensus tree (Supplementary Figure 9B). The name of the population groups in the graph are abbreviated: South Asian Austroasiatic (SAAA) and Mainland Southeast Asian (MSEA). The best fitted model, having the lowest likelihood score (score), is shaded by purple, for each admixed population, is plotted in Supplementary Figure 10.

| pop1 | pop2 | pop3 | Admixed pop | score | Weight pop1 | Weight pop2 | weight.2 pop3 | weight.2 (pop1.pop2) |
|---|---|---|---|---|---|---|---|---|
| Dravidian | Malaysian Negrito | Austronesian | SAAA | 18720.31 | 0.7265 | 0.2735 | 0.0180 | 0.9820 |
| Dravidian | Malaysian Negrito | Tibeto Burman | SAAA | 18740.83 | 0.7768 | 0.2232 | 0.0559 | 0.9441 |
| Dravidian | Malaysian Negrito | MSEA | SAAA | 18748.39 | 0.7305 | 0.2695 | 0.0212 | 0.9788 |
| Dravidian | Malaysian Negrito | East Asian | SAAA | 18765.56 | 0.7204 | 0.2796 | 0.0116 | 0.9884 |
| Dravidian | Malaysian Negrito | Philippine Negrito | SAAA | 18769.98 | 0.7082 | 0.2918 | 0.0000 | 1.0000 |
| Dravidian | Malaysian Negrito | European | SAAA | 18770.01 | 0.7082 | 0.2918 | 0.0000 | 1.0000 |

| Dravidian | Malaysian Negrito | Indo-European | SAAA | 18770.08 | 0.7082 | 0.2918 | 0.0000 | 1.0000 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Austronesian | Malaysian Negrito | East Asian | MSEA | 18244.37 | 0.8815 | 0.1185 | 0.5695 | 0.4305 |
| Austronesian | Malaysian Negrito | Philippine Negrito | MSEA | 18429.41 | 0.9572 | 0.0428 | 0.0149 | 0.9851 |
| Austronesian | Malaysian Negrito | European | MSEA | 18480.16 | 0.9560 | 0.0440 | 0.0000 | 1.0000 |
| Austronesian | Malaysian Negrito | Dravidian | MSEA | 18480.18 | 0.9560 | 0.0440 | 0.0000 | 1.0000 |
| Austronesian | Malaysian Negrito | Tibeto Burman | MSEA | 18480.21 | 0.9560 | 0.0440 | 0.0000 | 1.0000 |
| Austronesian | Malaysian Negrito | SAAA | MSEA | 18480.22 | 0.9560 | 0.0440 | 0.0000 | 1.0000 |
| Austronesian | Malaysian Negrito | Indo-European | MSEA | 18480.24 | 0.9560 | 0.0440 | 0.0000 | 1.0000 |
| | | | | | | | | |
| Dravidian | East Asian | Malaysian Negrito | Tibeto Burman | 12267.10 | 0.3263 | 0.6737 | 0.0947 | 0.9053 |
| Dravidian | East Asian | European | Tibeto Burman | 12267.30 | 0.2622 | 0.7378 | 0.0868 | 0.9132 |
| Dravidian | East Asian | Indo-European | Tibeto Burman | 12267.38 | 0.2623 | 0.7377 | 0.0867 | 0.9133 |
| Dravidian | East Asian | Philippine Negrito | Tibeto Burman | 12311.86 | 0.3391 | 0.6609 | 0.0866 | 0.9134 |
| Dravidian | East Asian | SAAA | Tibeto Burman | 12314.14 | 0.2632 | 0.7368 | 0.1054 | 0.8946 |
| Dravidian | East Asian | MSEA | Tibeto Burman | 12401.87 | 0.4245 | 0.5755 | 0.2004 | 0.7996 |
| Dravidian | East Asian | Austronesian | Tibeto Burman | 12403.17 | 0.3324 | 0.6676 | 0.0000 | 1.0000 |

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