

# Substructured population growth in the Ashkenazi Jews inferred with Approximate Bayesian Computation

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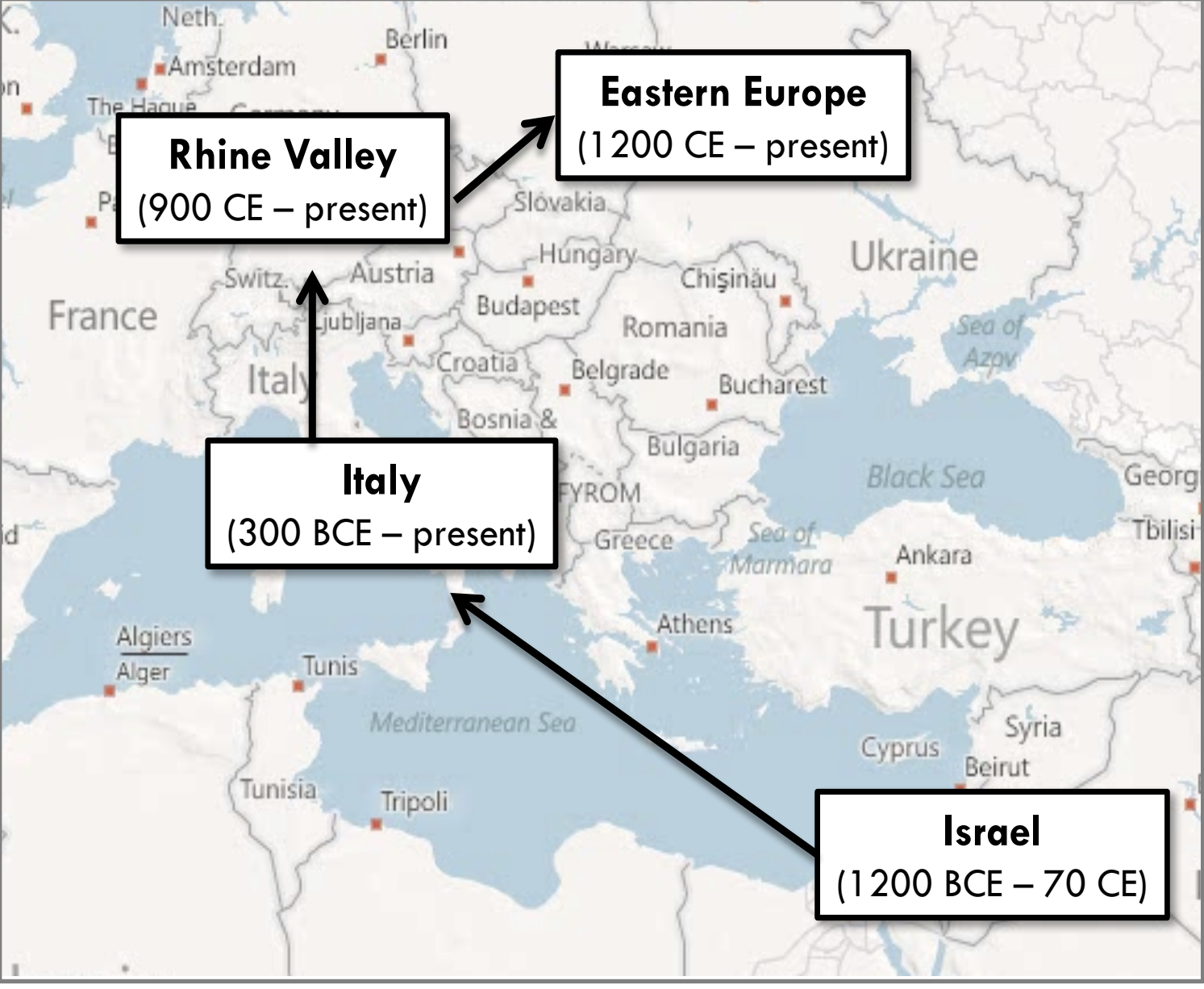
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## Introduction

### Who are the Ashkenazi Jews (AJ)?

AJ culturally, religiously, and linguistically identify as Jews whose ancestors came from the Rhine Valley.

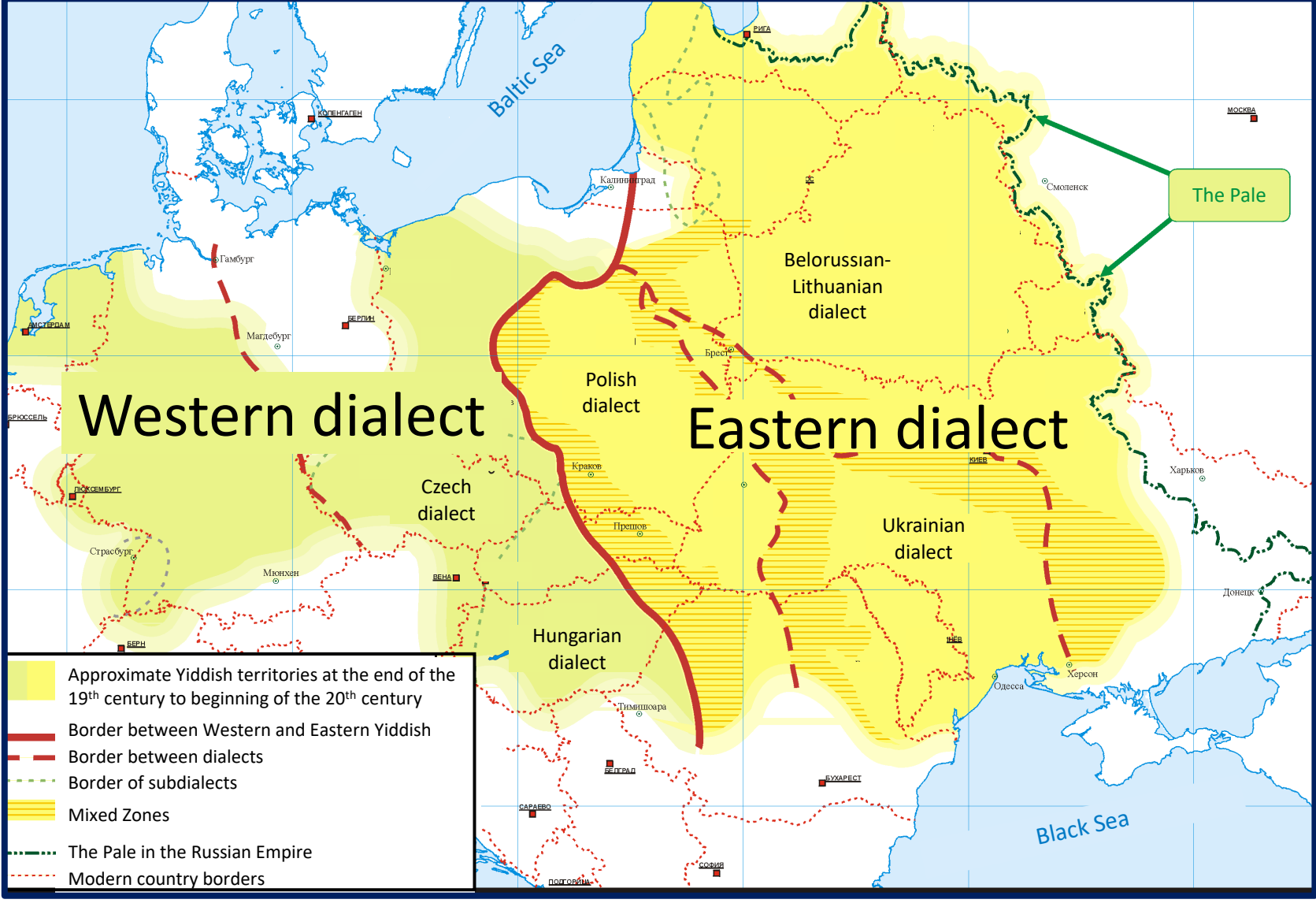
### Hypothesis of AJ origins



### Western vs. Eastern AJ

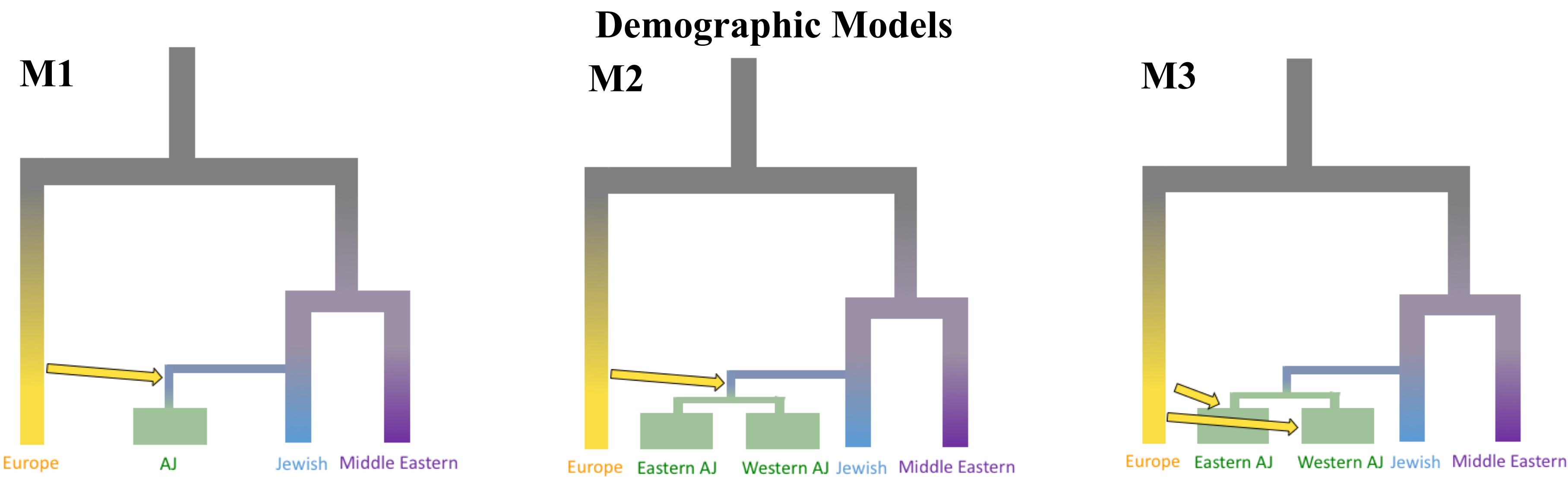
- 11<sup>th</sup> – 16<sup>th</sup> centuries AJ expelled from Central Europe and invited to Poland by nobility.
- From 16<sup>th</sup> century culturally distinct communities developed.

### Yiddish Dialects

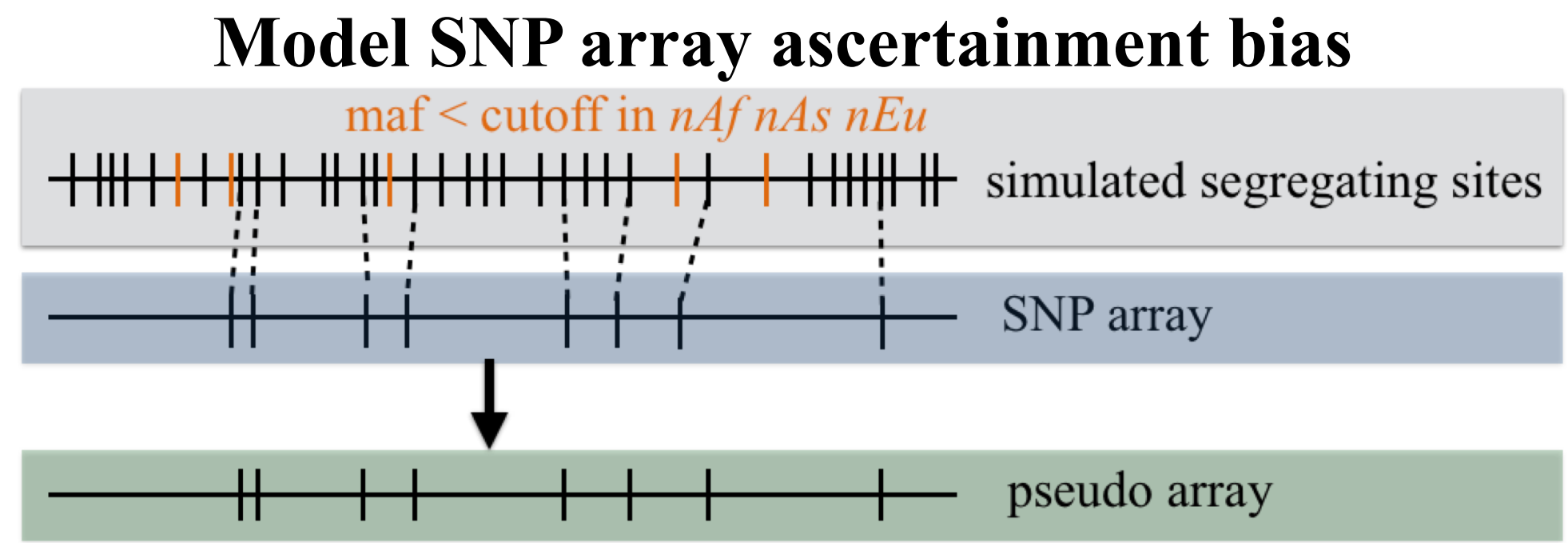
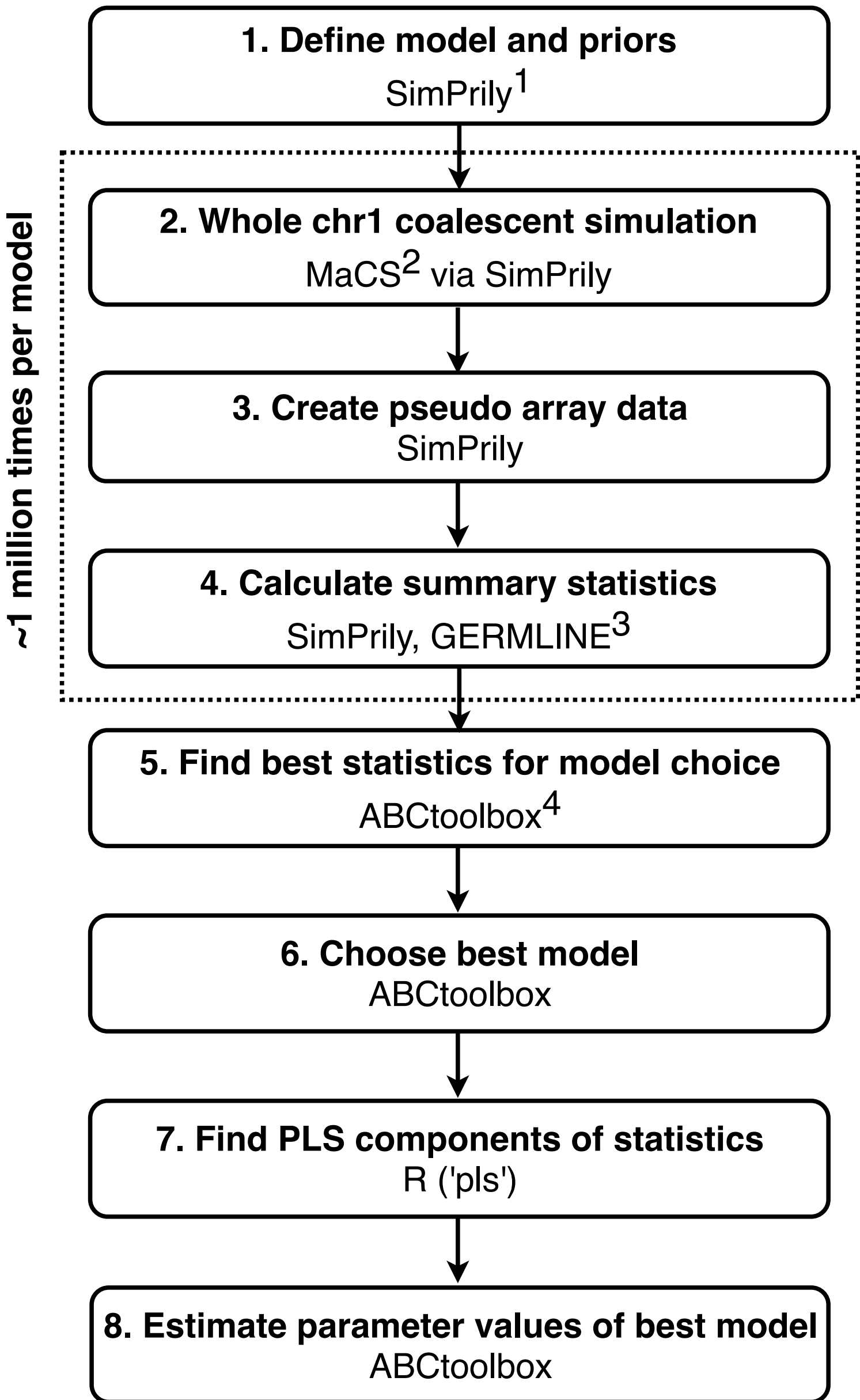


### Questions:

- 1) Is there substructure within AJ?
- 2) If so, is this substructure purely due to genetic isolation, or does differential migration from European populations play a role?

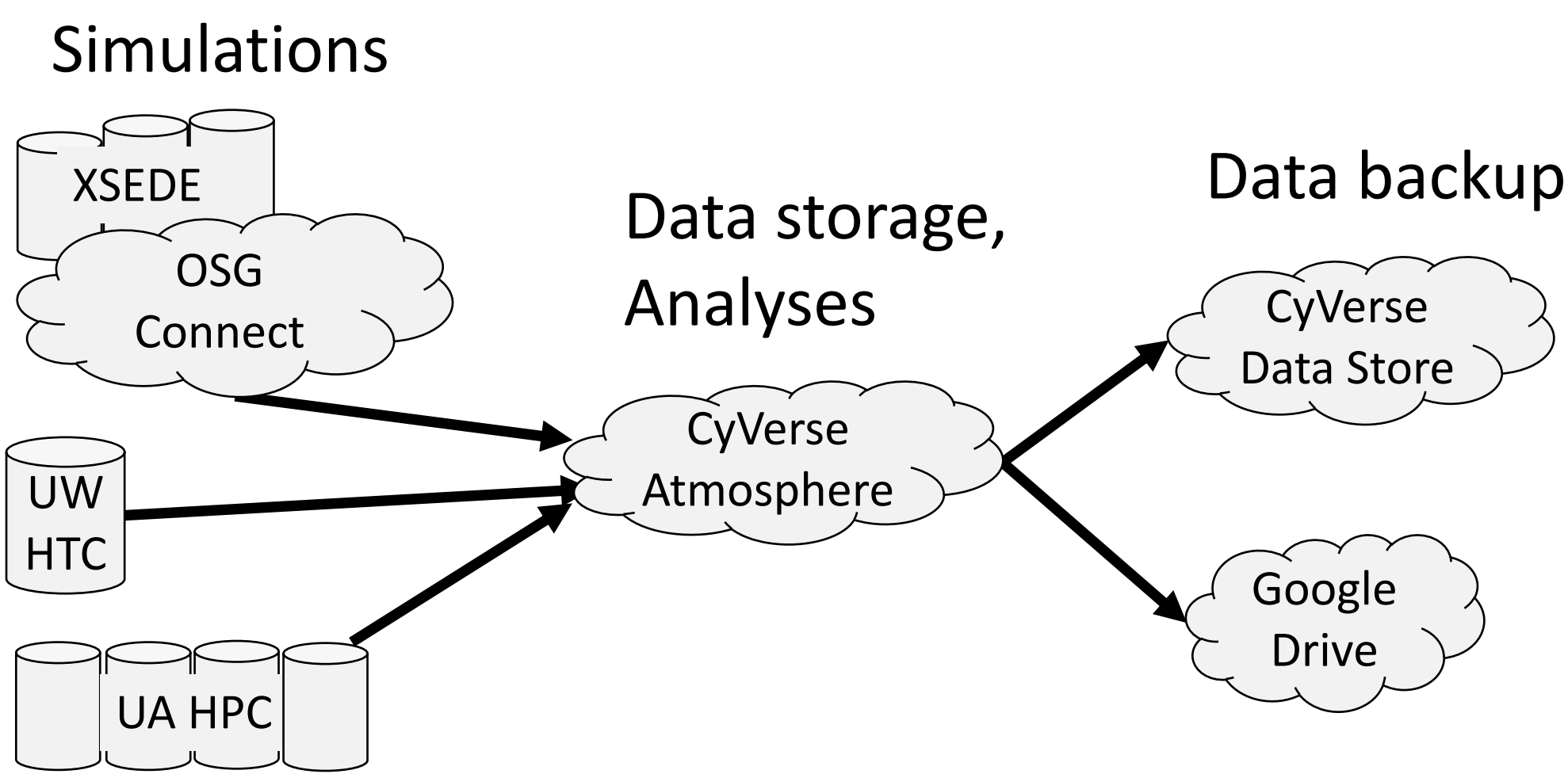


## Methods



- 181 summary statistics
- Site frequency spectrum-based stats for older history
  - Identity by descent-based stats for recent history

### Simulations on HTC clusters, analyses on cloud



## Results

- Eastern and Western AJ are separated on PCA.
- ABC chosen model is M2 (see Model Choice table below).
- Eastern and Western growth rate calculated from estimated Ne's are on the order of census growth rates.

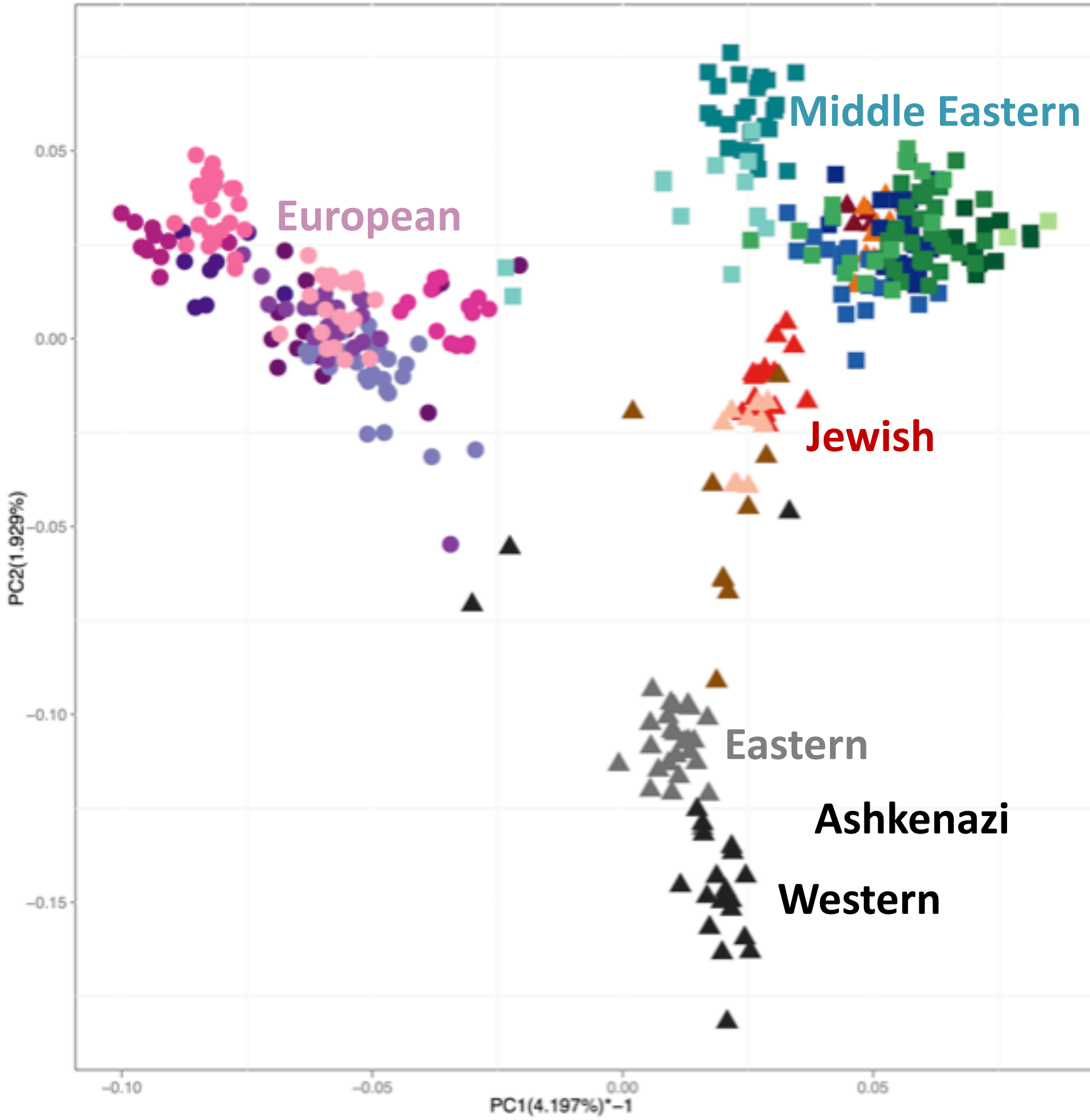
### Model Choice

	M1	M2	M3
Bayes Factor	0.0005	2.01	0.50
P(false negative   M2)	0.08		0.14

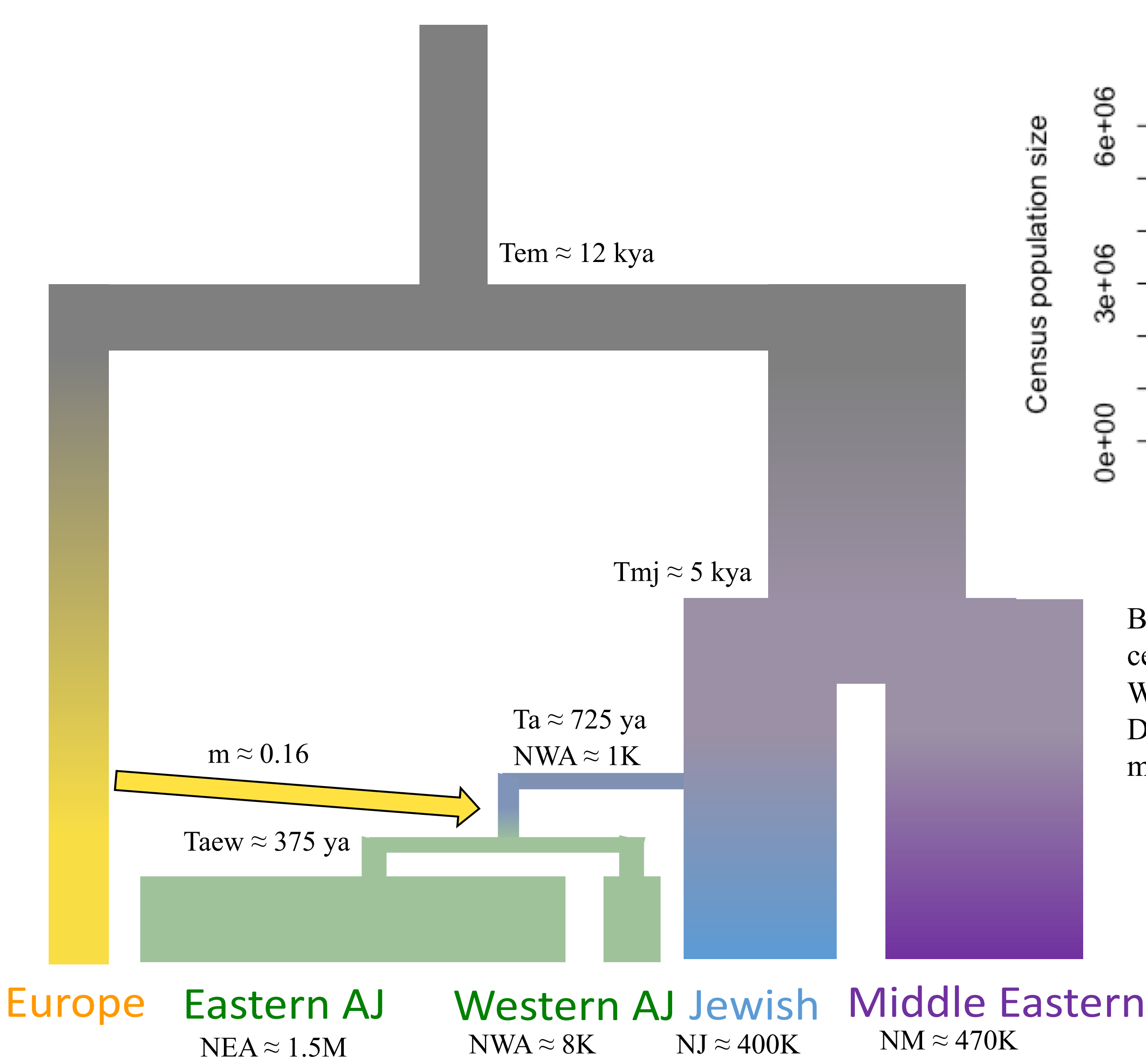
### Exponential Growth Rate (per generation)

	Eastern AJ	Western AJ
ABC	0.25	0.069
Census	0.18 +- 0.017	0.081 +- 0.026

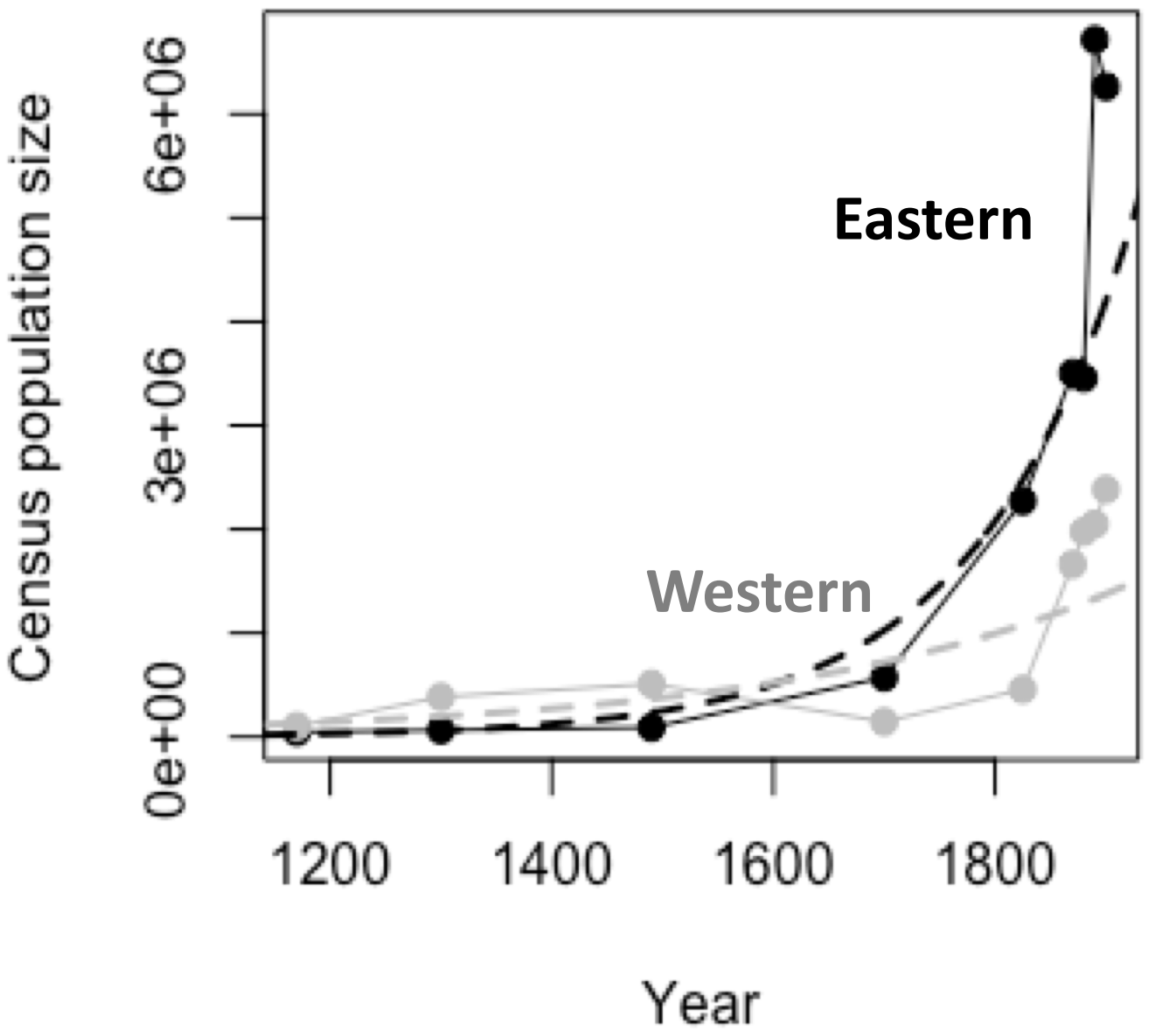
### PCA of AJ, Europeans, and Middle Easterners



### Best Model



### Census<sup>5</sup> Growth



Black lines are estimated Eastern Jewish census sizes and grey lines are estimated Western/Southern Jewish census sizes. Dashed lines are exponential growth models fitted to the census data.

### Conclusions:

- 1) There is substructure within AJ
- 2) Differentiation between Eastern and Western AJ is best explained by isolation followed by differences in population growth rates (higher in Eastern AJ).

### Historical differences that may have contributed to greater growth in Eastern AJ

	Eastern Europe	Central Europe
Restricted movement and living area.		✓
Limitation on number of families.		✓
Integration into gentile society.		✓
Religious and traditional norms encouraged early marriage and high fertility.	✓	

### References

1) Gladstein et al., 2018; 2) Chen et al. 2009; 3) Gusev et al. 2009; 4) Wegmann et al. 2009; 5) DellaPergola 2001

### Acknowledgments

We would like to thank Mats Rynge for his help setting up the Pegasus workflow and running it on the Open Science Grid. We would also like to thank Research Bazaar Arizona for programming help.

### Compute Resources

University of Arizona Research Computing HPC; Open Science Grid; CyVerse; Extreme Science and Discovery Environment (Comet, Jetstream, Bridges); University of Wisconsin Center for HTC



THE UNIVERSITY OF ARIZONA



Open Science Grid



Extreme Science and Engineering Discovery Environment

