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Is violence necessary to explain the post-Neolithic Y chromosome bottleneck?

- Genetic impact of segmentary patrilineal systems •

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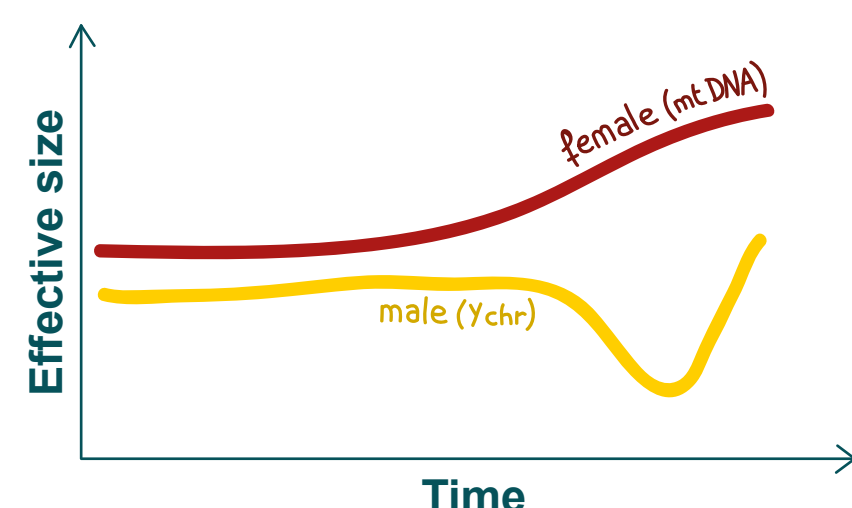


MUSÉE DE L'HOMME



Introduction

The **male effective size** of human populations from all over the world underwent a **severe bottleneck around 3,000-5,000 years ago** [1, 4, 8]. However, this bottleneck was **not observed for the female effective size**.



What caused the male effective size bottleneck?



→ the **first socio-cultural model** proposed to account for this bottleneck involved **violent competition between patrilineal kin groups** leading to group extinction [10].

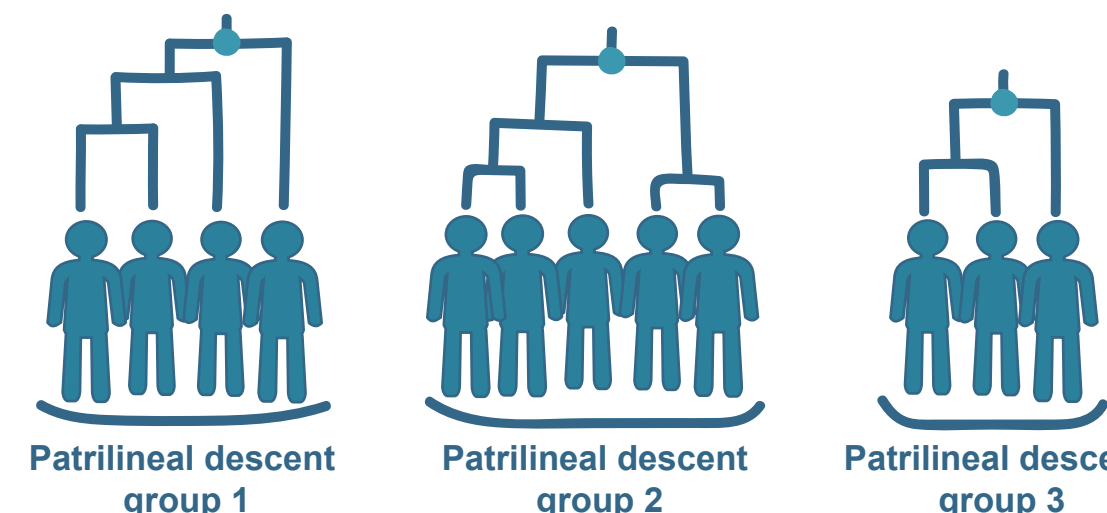
But is violence necessary to explain the male effective size bottleneck?

Hypothesis: a **transition to non violent patrilineal organisations** may have triggered an important loss of Y chromosome diversity.

Approach: simulation of scenarios involving a transition to patrilocal residence and patrilineal descent rules in human populations, using parameters based on anthropological literature.

Patrilineal descent

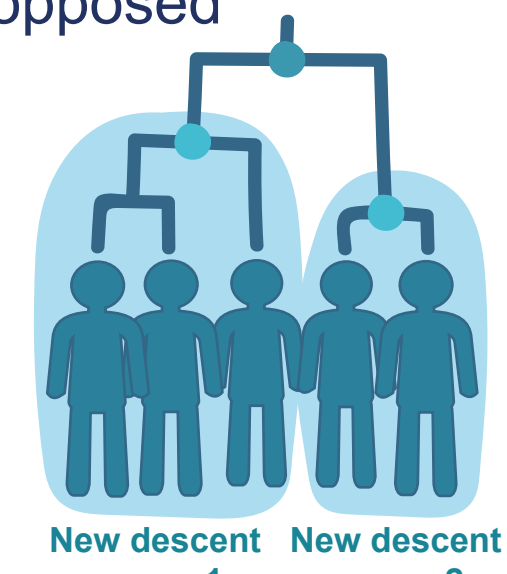
→ rule according to which individuals are **affiliated to the descent group of their father**.



- males are **closely related in the paternal line**
- **variance in reproductive success and transmission** to splitting groups
- **lineal fission**, as opposed to random fission

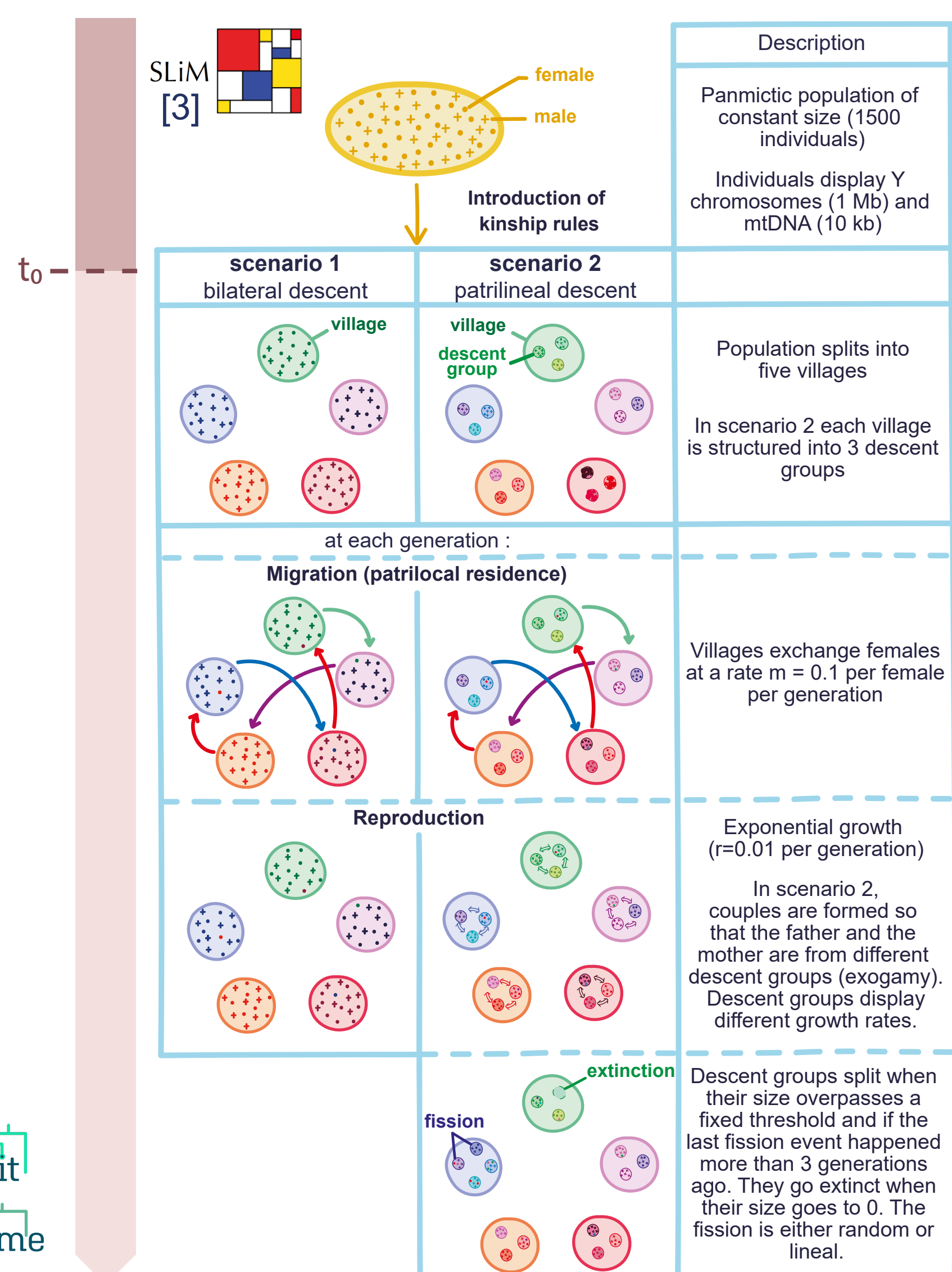
• often associated with **patrilocality** (women migrate to their husband's place of birth after marriage)

• **decreases Y chromosome diversity with respect to mtDNA** [2, 6, 7]



Methods

Simulations with SLiM



Testing **different variants** of scenario 2 (villages with patrilineal descent):

- with or without **variance in reproductive success** between descent groups
- descent groups undergoing **random fissions** or **lineal fissions**
- with or without **violent intergroup competition**

Ne(π) and Bayesian Skyline Plots (BSPs)

Computation of male and female effective sizes using:

- average number of pairwise nucleotide differences (π)
- Bayesian Skyline Plots (BSPs) generated with BEAST [9]

Results

Impact of different parameters on the reduction of male Ne(π)

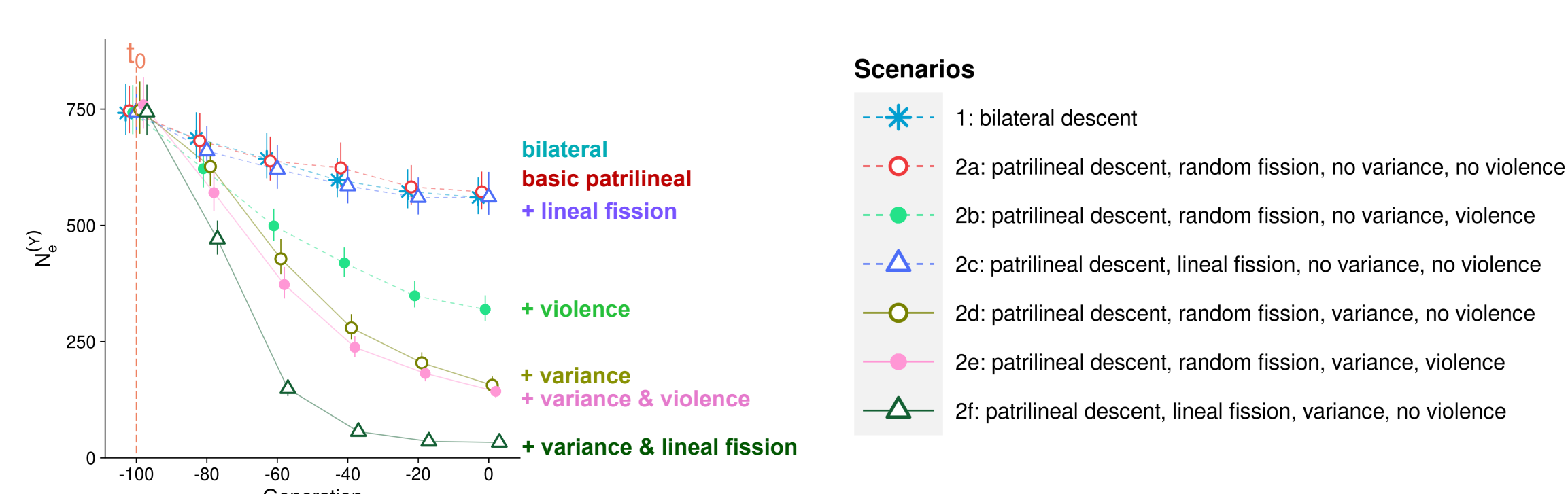


Fig 1 . Evolution of male effective size within villages through time computed from mean number of pairwise nucleotide differences (π)

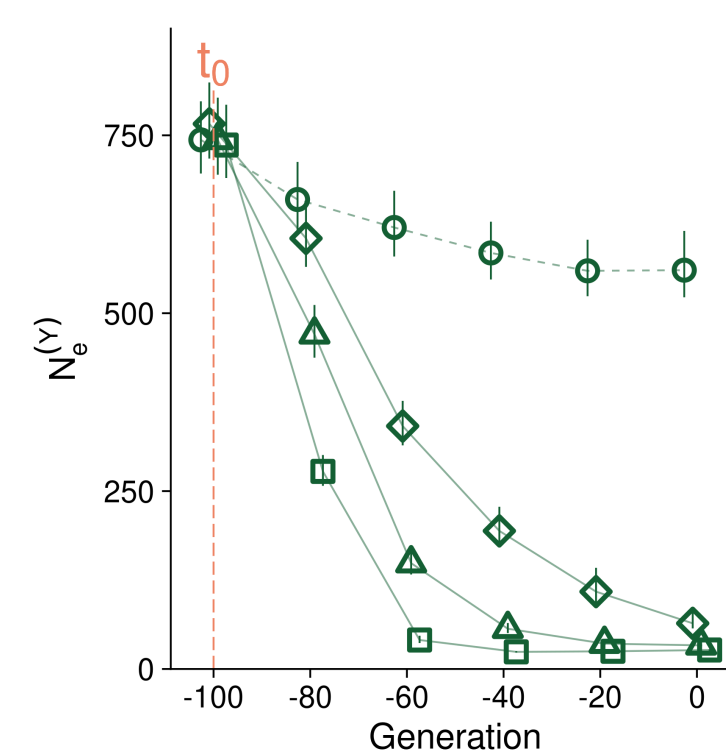


Fig 2 . Effect of variance in reproductive success of descent groups on the evolution of male effective size within villages

Estimation of male and female Ne using BEAST under scenario 2f (patrilineal descent, lineal fission, variance, no violence)

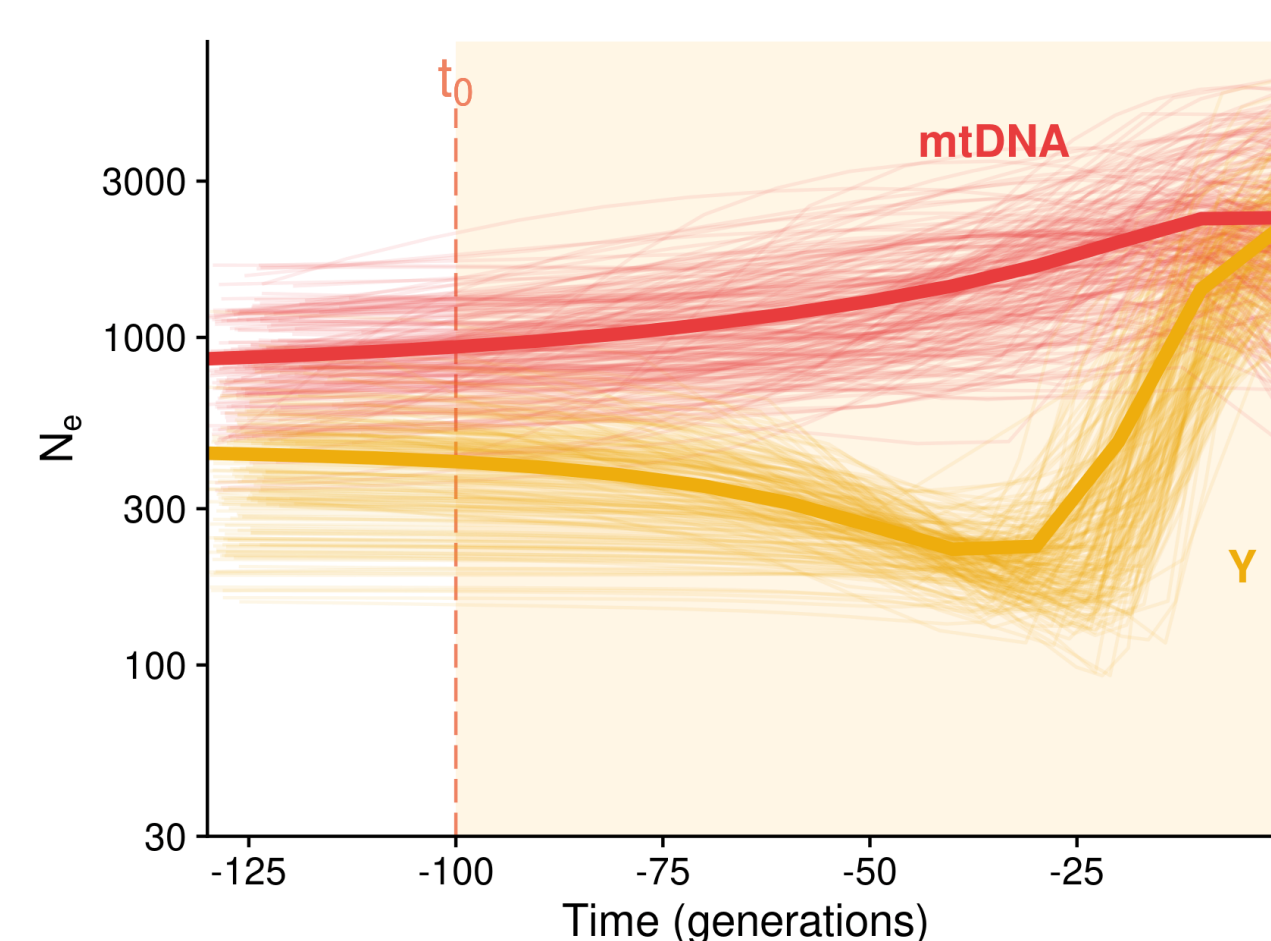


Fig 3 . Bayesian Skyline Plots of Y chromosome and mtDNA under scenario 2f (patrilineal descent with variance in reproductive success between groups, lineal fission without violent competition)

Discussion

Male effective size decreases when:

- 1) **Variance in reproductive success** between descent groups increases
- 2) Descent groups undergo **lineal fissions** rather than random fission
- 3) There is **violent intergroup competition**

→ variance and transmission of reproductive success and lineal fission are more efficient to decrease the male effective size than violent intergroup competition.

→ **violent intergroup competition is not necessary** to account for the post-Neolithic Y chromosome bottleneck.

References

1. Batini, C. *et al.* Large-scale recent expansion of European patrilineages shown by population resequencing. *Nat Commun* 6, 7152 (2015).
2. Chaix, R. *et al.* From Social to Genetic Structures in Central Asia. *Current Biology* 17, 43–48 (2007).
3. Haller, B. C. & Messer, P. W. SLiM 3: Forward Genetic Simulations Beyond the Wright–Fisher Model. *Molecular Biology and Evolution* 36, 632–637 (2019).
4. Karmin, M. *et al.* A recent bottleneck of Y chromosome diversity coincides with a global change in culture. *Genome Res.* 25, 459–466 (2015).
5. Kelleher, J., Etheridge, A. M. & McVean, G. Efficient Coalescent Simulation and Genealogical Analysis for Large Sample Sizes. *PLOS Computational Biology* 12 (2016).
6. Ly, G. *et al.* Residence rule flexibility and descent groups dynamics shape uniparental genetic diversities in South East Asia. *American Journal of Physical Anthropology* 165, 480–491 (2018).
7. Marchi, N. *et al.* Sex-specific genetic diversity is shaped by cultural factors in Inner Asian human populations. *American Journal of Physical Anthropology* 162, 627–640 (2017).
8. Poznik, G. D. *et al.* Punctuated bursts in human male demography inferred from 1,244 worldwide Y-chromosome sequences. *Nat Genet* 48, 593–599 (2016).
9. Suchard, M. A. *et al.* Bayesian phylogenetic and phylodynamic data integration using BEAST 1.10. *Virus Evolution* 4, vey016 (2018).
10. Zeng, T. C., Aw, A. J. & Feldman, M. W. Cultural hitchhiking and competition between patrilineal kin groups explain the post-Neolithic Y-chromosome bottleneck. *Nat Commun* 9, 2077 (2018).