

Demic vs cultural Neolithic diffusion in mainland Europe and Scandinavia: archaeology and genetics

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Models of Neolithic transitions

- **Demic diffusion** = spread of farming populations
- **Cultural diffusion** = spread of ideas = interbreeding and/or acculturation.
- **Demic-cultural models**

Demic-cultural models

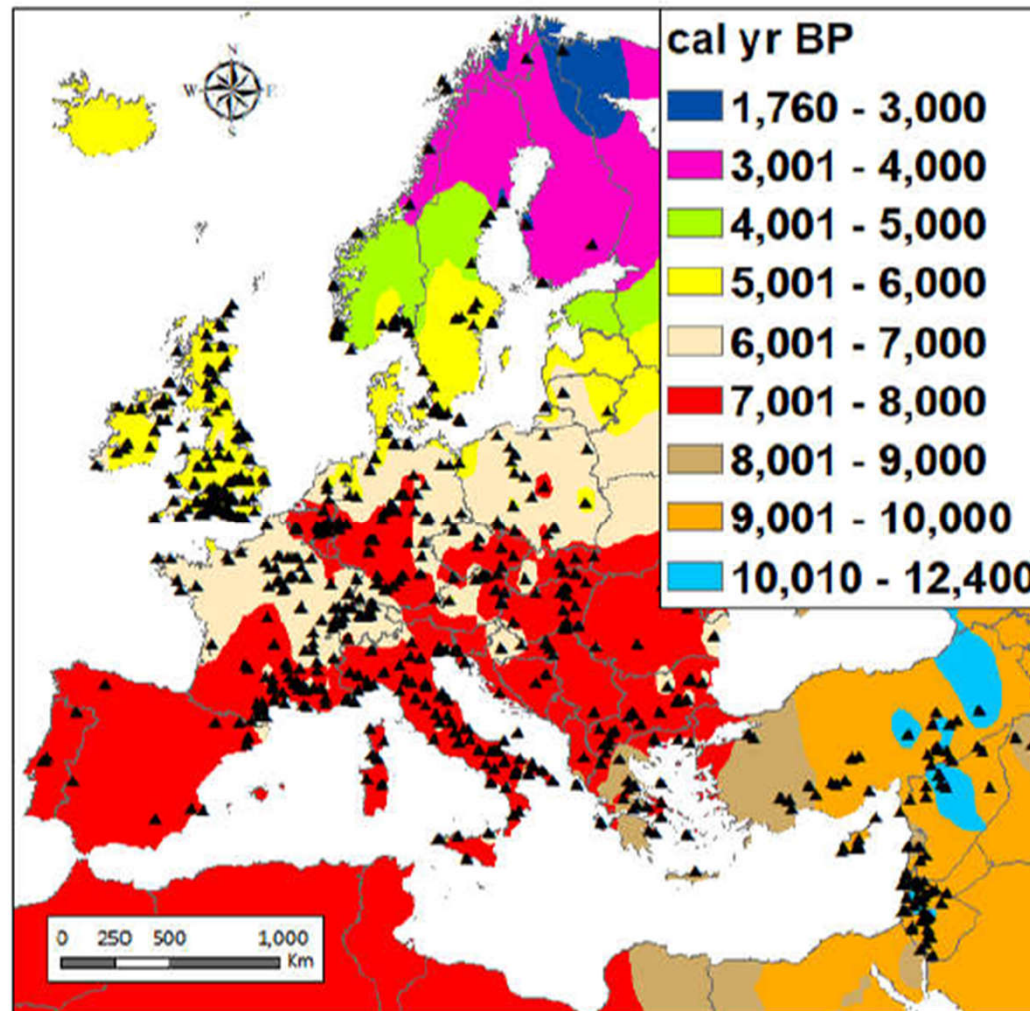
Recent case studies

- **Spread of the Neolithic in Scandinavia**
(Fort, Pareta & Sørensen, *J.Roy. Soc. Interface* 2018)
- **Bantu spread in Eastern Africa**
(Isern & Fort, *PLoS One* 2019)
- **Spread of rice in China & southeastern Asia**
(Cobo, Fort & Isern, *J. Arch. Sci.* 2019)

Europe

- **Mainland Europe: 1.0 km/yr ($R=0.82$)**
(Ammerman & Cavalli-Sforza 1971;
Gkiasta, Russell, Shennan & Steele 2003;
Pinhasi, Fort & Ammerman, *PLoS Biol.* 2005; etc.)
- **West Mediterranean: 8.7 km/yr ($R=0.83$)**
(Zilhao, *PNAS* 2001;
Isern, Zilhao, Fort & Ammerman, *PNAS* 2017)
- **Scandinavia: 0.55 km/yr ($R=0.77$)**
(Fort, Pareta & Sørensen, *J.Roy. Soc. Interface* 2018)
- **See also: S. Shennan, *The first farmers of Europe***
(Cambridge Univ. Press, 2018)

Scandinavia vs. mainland Europe



Databases:

Scandinavia:
Sørensen
(2018)

Rest of data:
Pinhasi
(2005)

- Mainland Europe: 1.0 km/yr
- Scandinavia: 0.55 km/yr

Why was the spread slower in Scandinavia?

One possible reason is a lower reproduction rate:

- values used in mainland Europe (from ethnography): 2.3%-3.3%

- values used in Scandinavia (from archaeology): 0.69%-1.9% (an example is given in the next slide)

One of 14 estimations of initial growth rates in Scandinavia

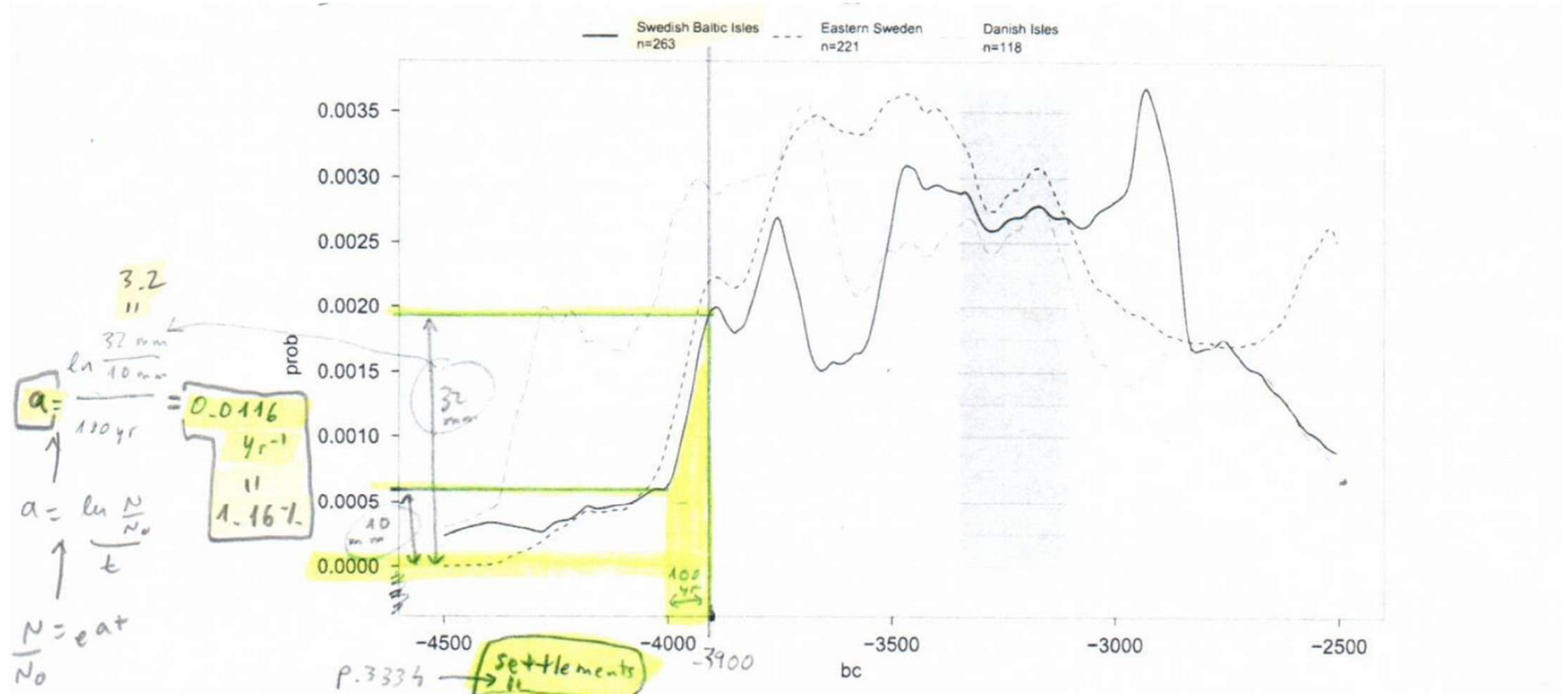
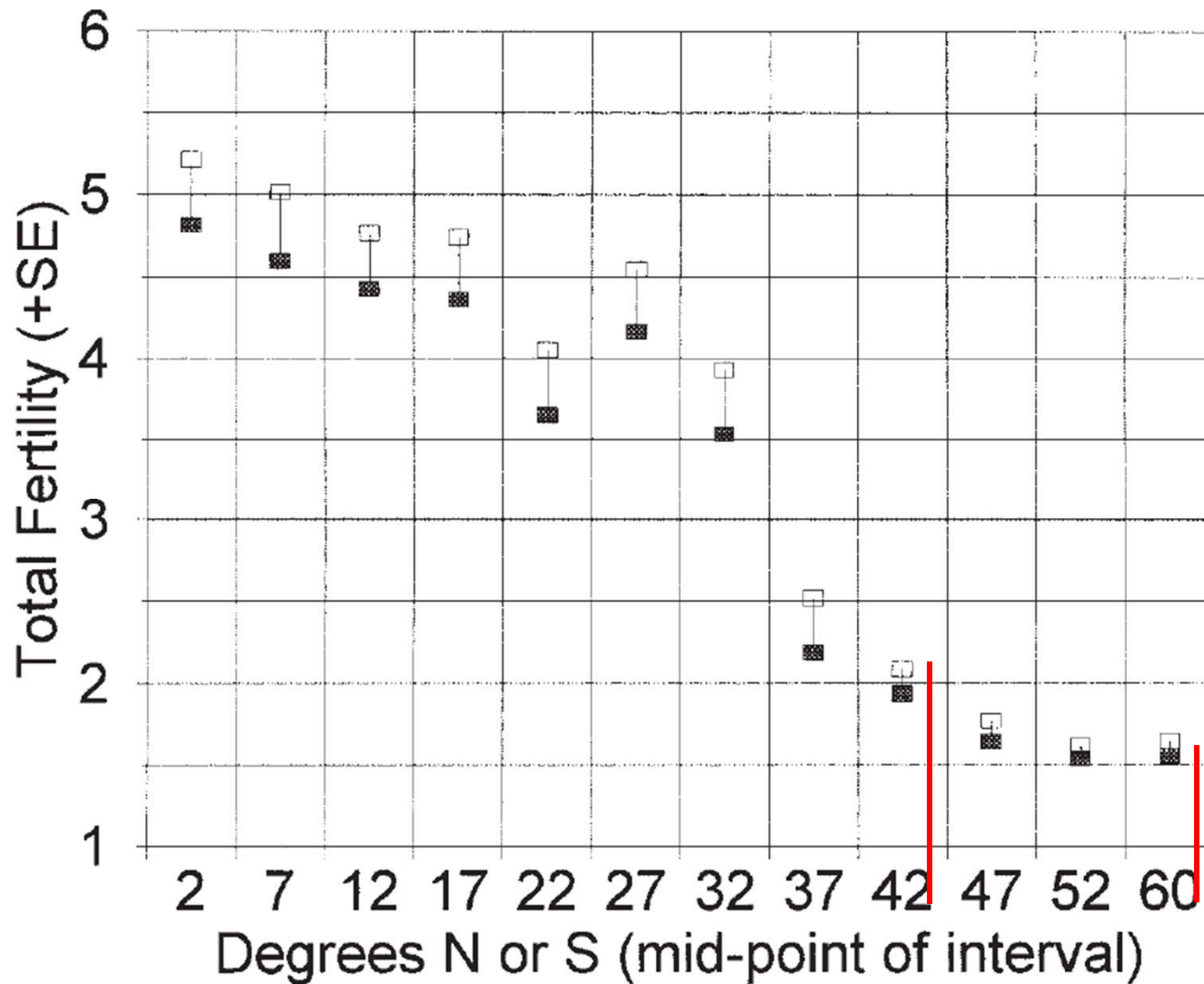


Fig. 4. Sum-calibrations for ^{14}C dates from domestic sites. Data indicates comparable patterns for the 6 regions from the Netherlands to Western Sweden (top) and the different development in the Northeast and on the Danish Isles (bottom).

M. Hinz et al., Demography ... of Funnel Beaker societies, *J. Arch. Sci.* (2012)



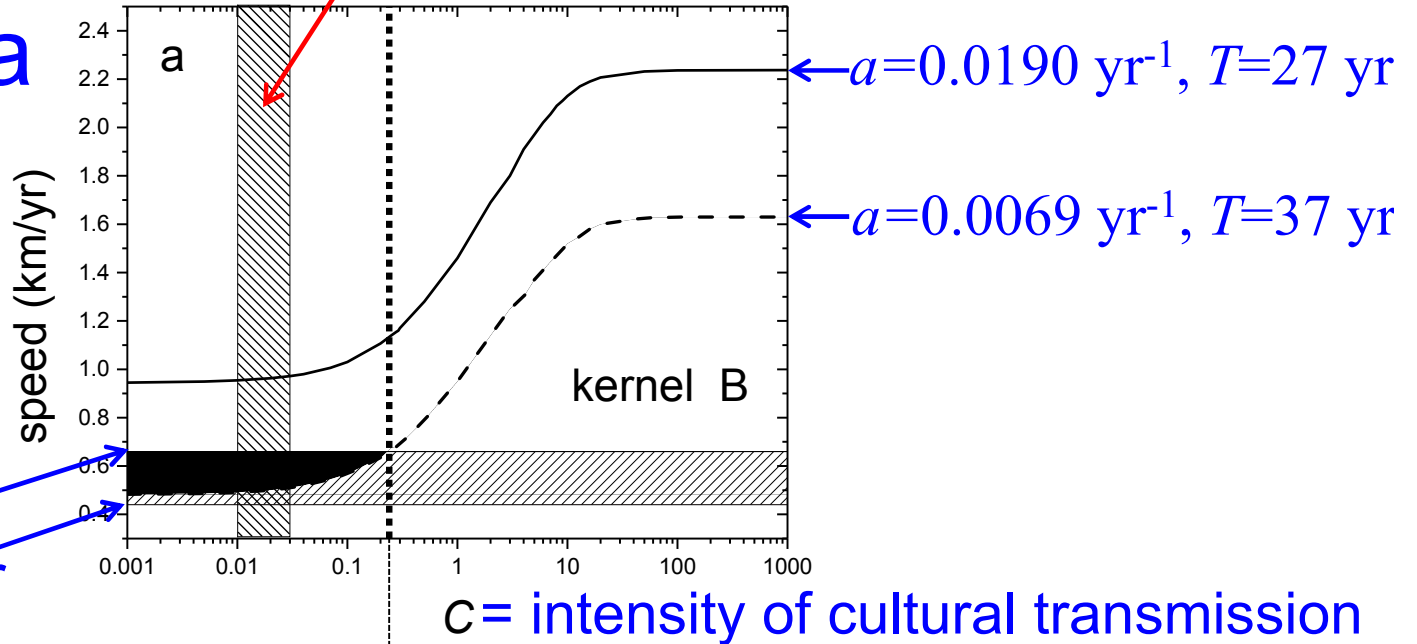
N. Barber,
*Cross-cultural
 Res. 36, 3*
 (2002): "the
 effect
 remained after
 controlling for
 urbanization,
 population size
 and density,
 female literacy
 rate and
 contraception"

Total fertility (number of children per woman) vs. latitude for 178 countries (88% of the world) in the mid and late 1990s.

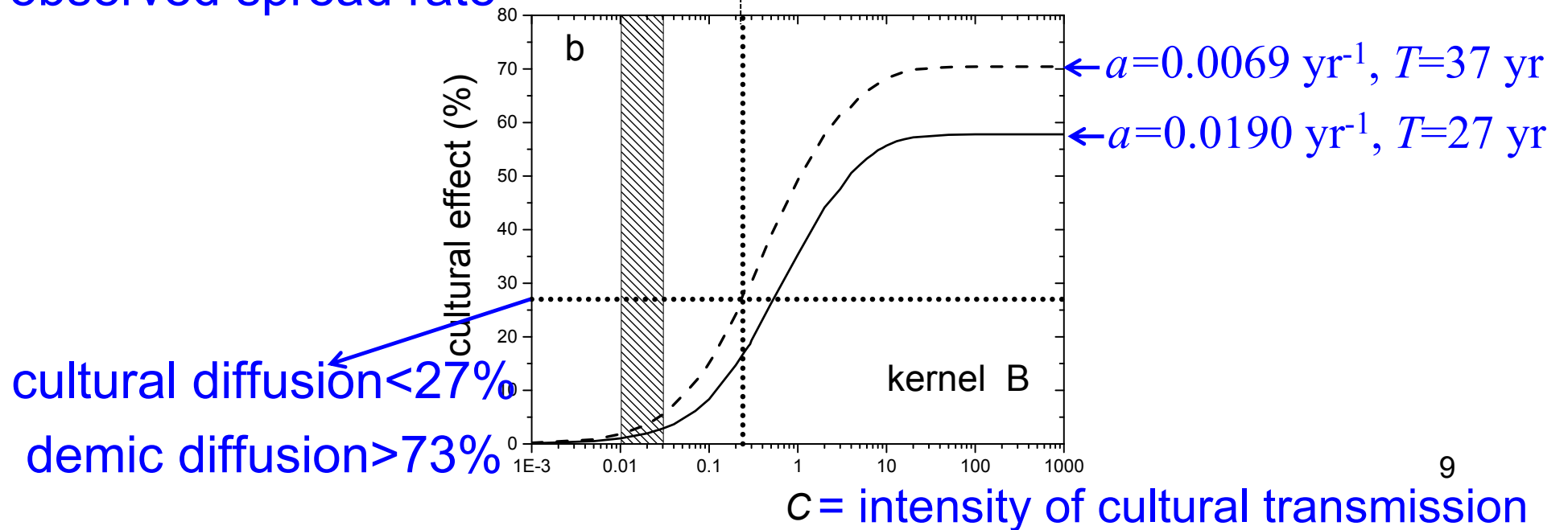
Same effect for other mammals (not only for humans) ⁸

Scandinavia

mainland Europe, from Genetics (for comparison)

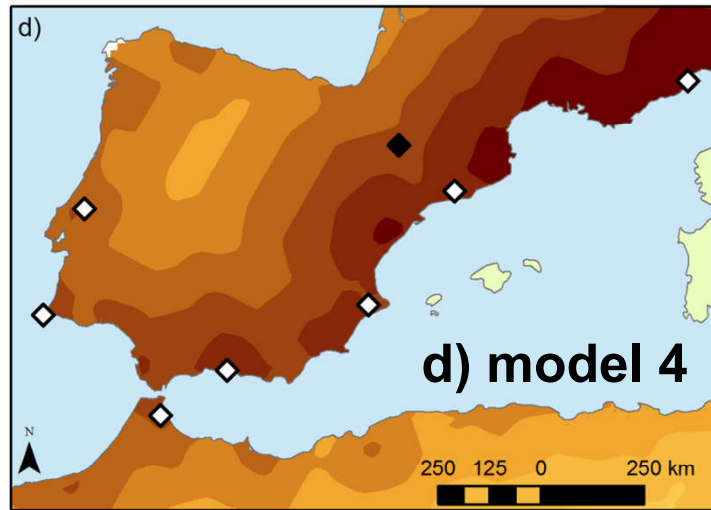
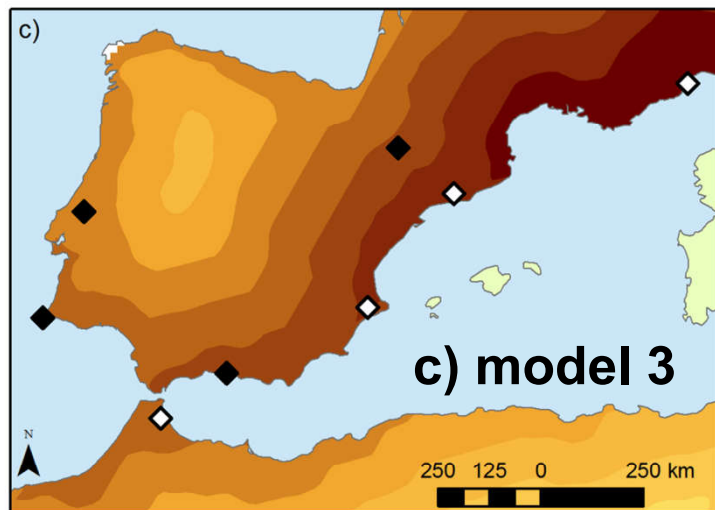
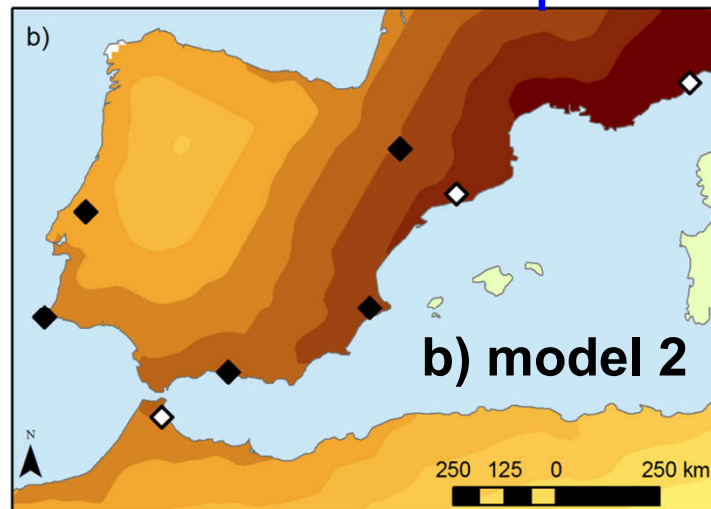
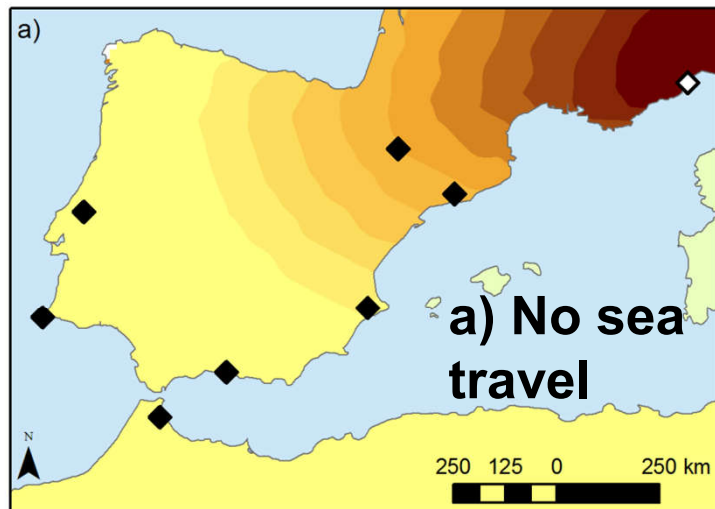


0.44-0.66 km/yr
observed spread rate



cultural diffusion < 27%
demic diffusion > 73%

WEST MEDITERRANEAN: oldest site per region



b)-d) Sea travel up to 350 km

b) preference for closer destinations

b) all distances within 350 km equally likely

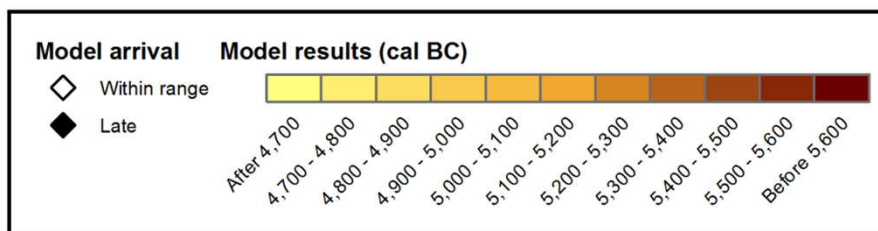
b) all jumps of 350 km

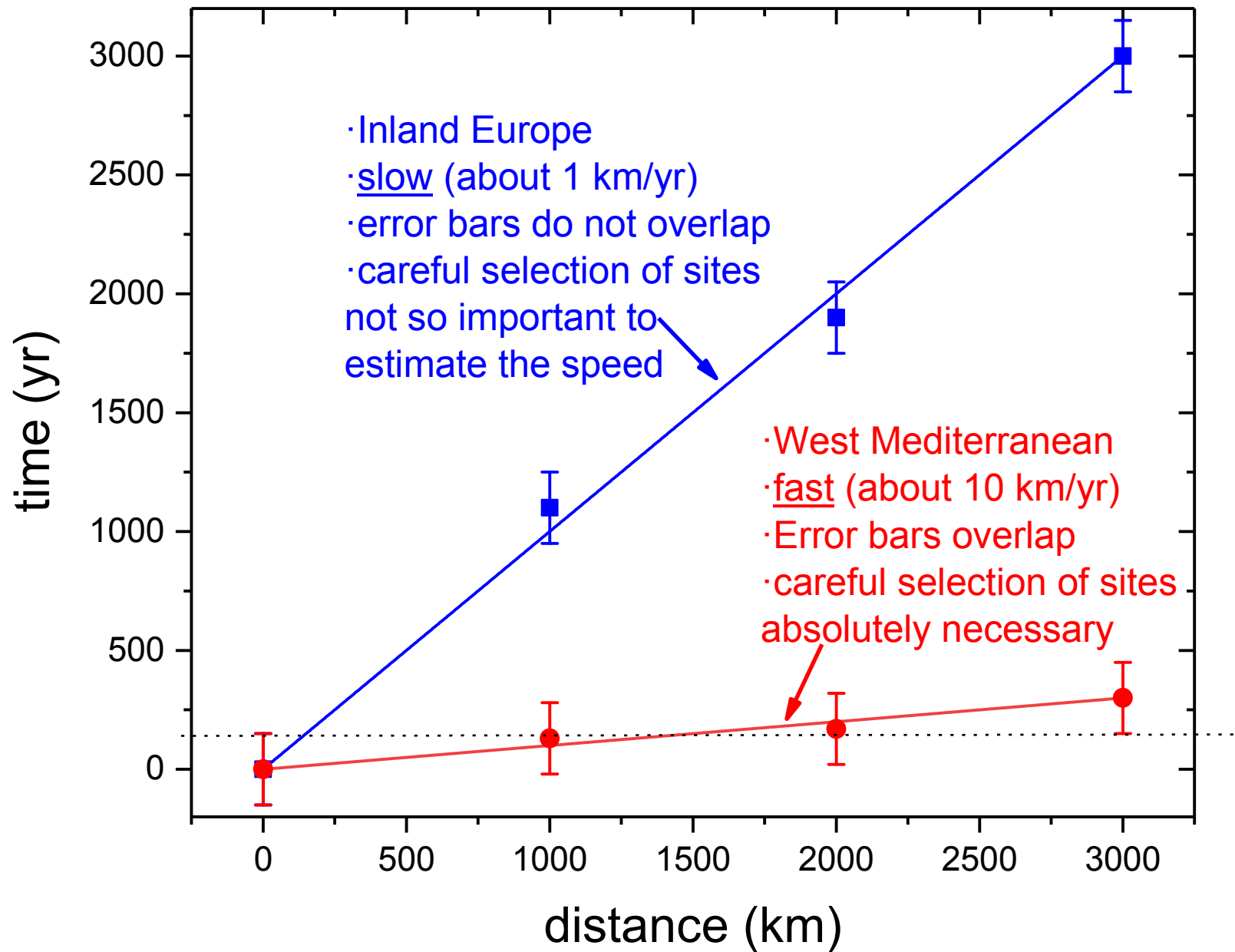
◇ within range

◆ too late

$$a = 2.8\%$$

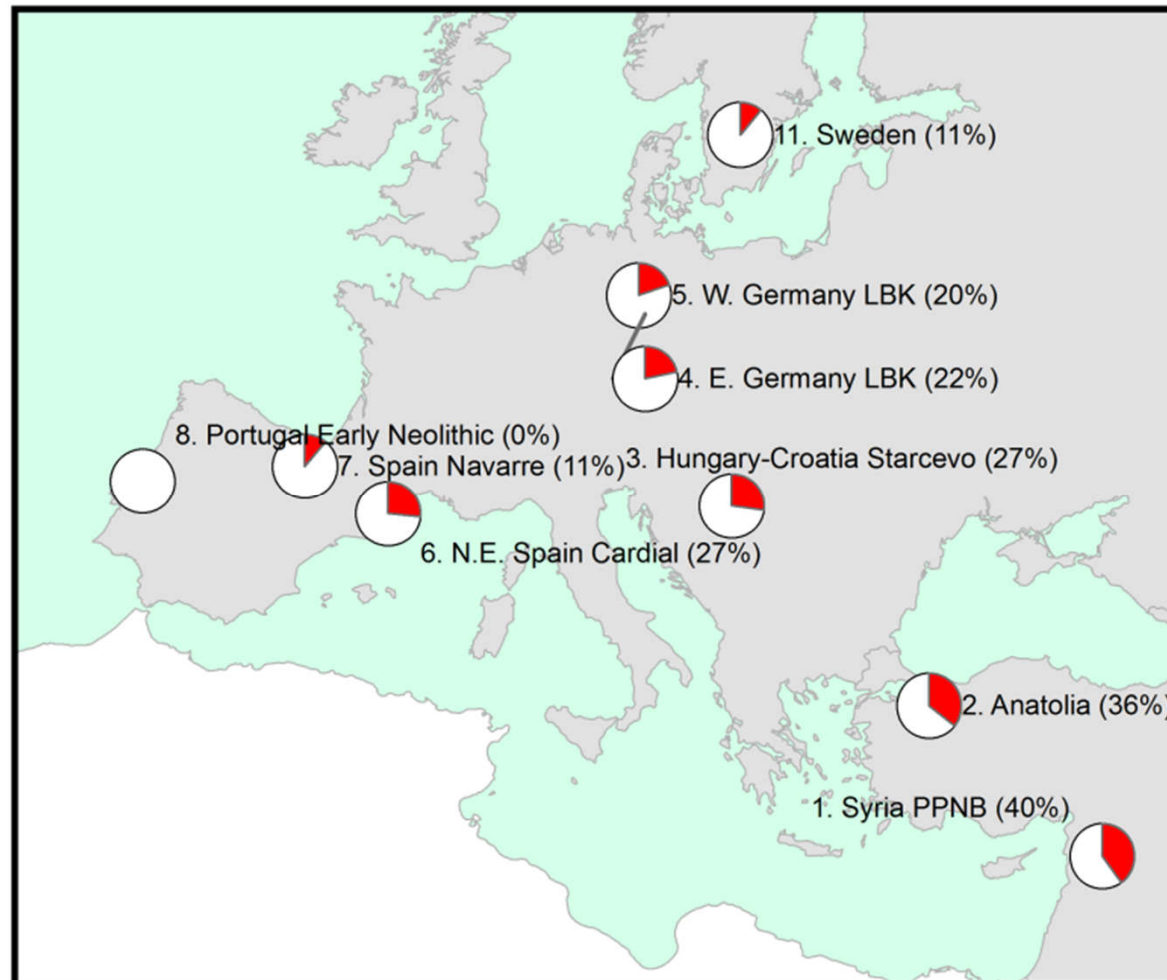
Isern, Zilhao, Fort & Ammerman, *PNAS* 2017



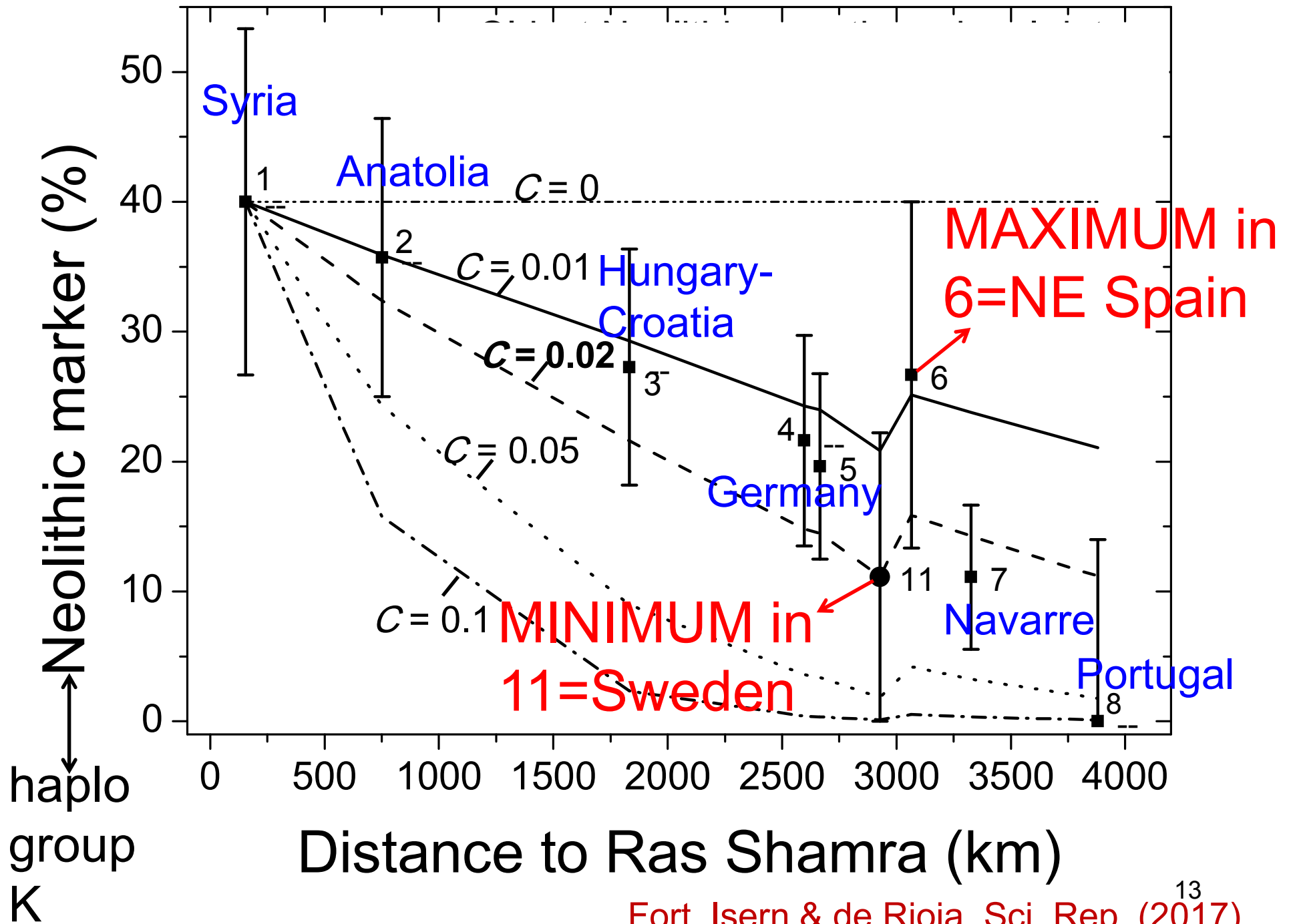


Ancient genetics

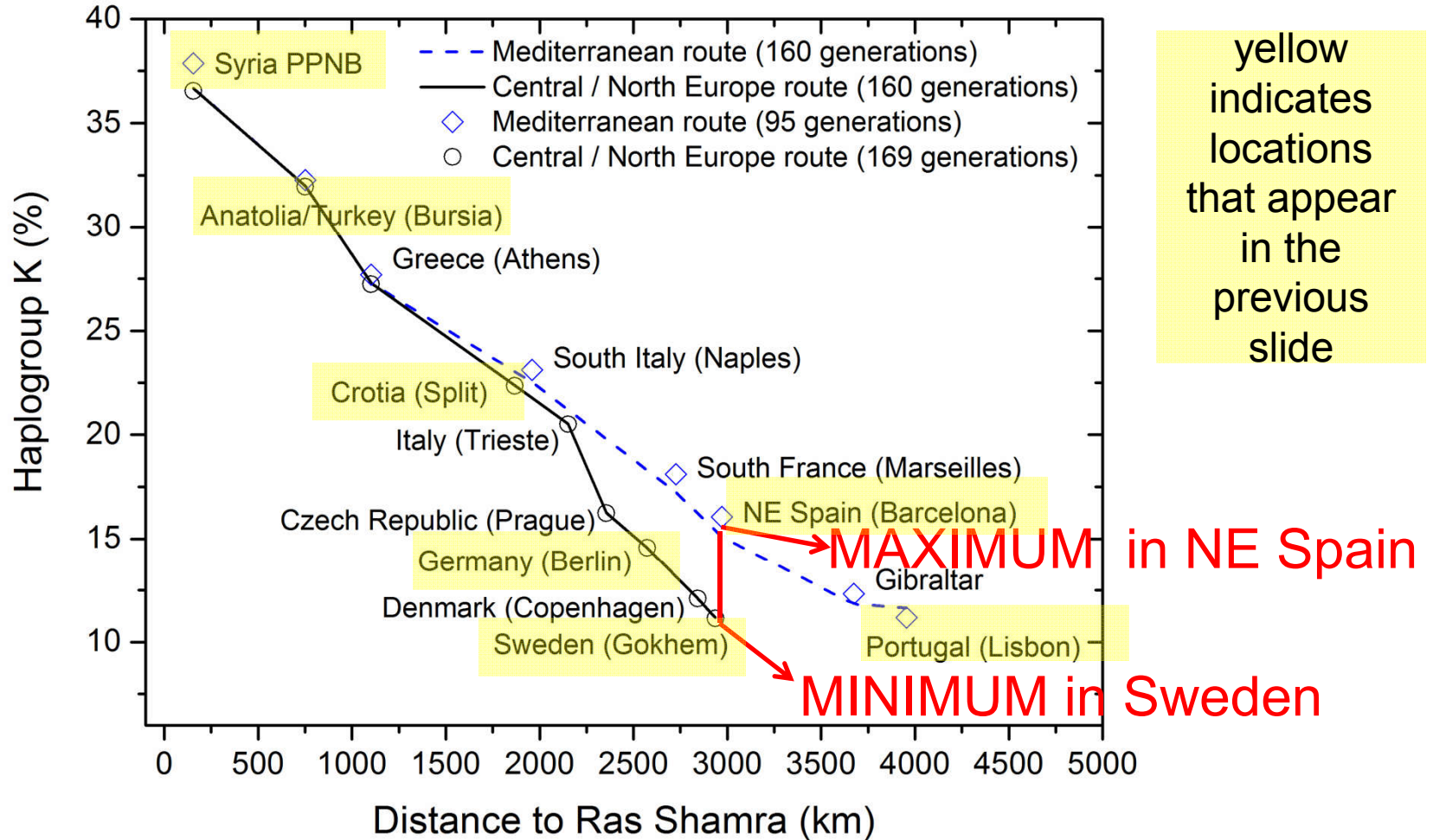
We have gathered a database of all Neolithic individuals (513) whose mtDNA has been determined



We analyze haplogroup K because its frequency **(red)** decreases Westwards and Northwards in farmers (and is absent in HGs). We expect that cultural transmission can cause this.¹²

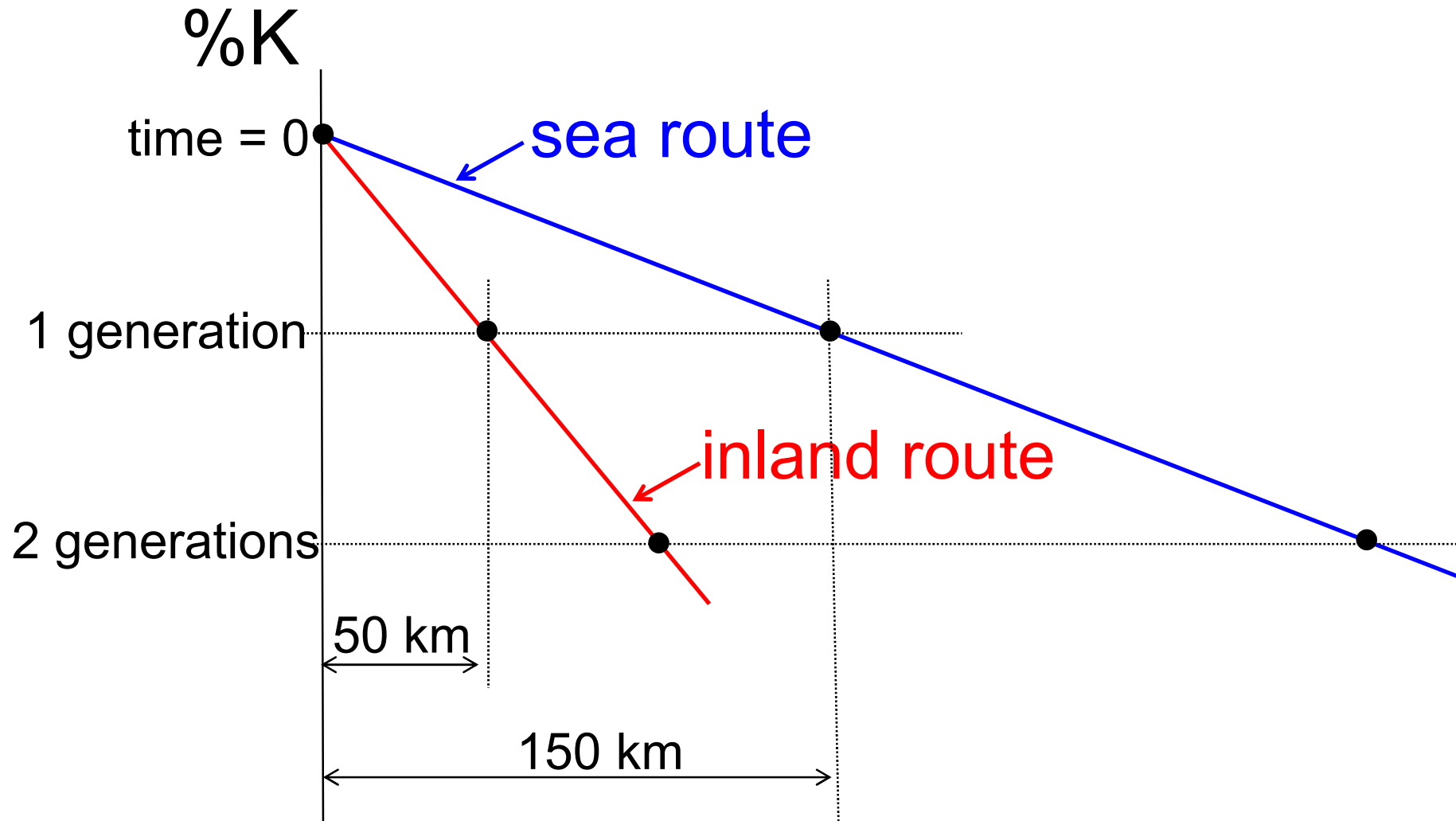


Why is there a minimum in Sweden? Why is there a maximum in NE Spain?



Why is the inland cline steeper than the Mediterranean cline?

Why is the inland cline steeper than the Mediterranean cline?



This explains the minimum and maximum.

It is also a genetic confirmation that sea jumps were longer.

Conclusions

1. Alternative models should also predict a minimum in Sweden and a maximum in NE Spain, as observed in the data.
2. The cline of haplogroup K suggests that only about 2% of early farmers were involved in cultural transmission (interbreeding or acculturation of HGs).
3. Then the model implies that cultural diffusion was responsible for only about 2% of the spread rate, and demic diffusion for 98%.
4. Genome-wide data cannot estimate the % of farmers involved in cultural transmission, because they include markers with completely different clines, due to processes different from cultural transmission (surfing, other drift effects, selection...)