

Fra Big Bang til moderne menneske

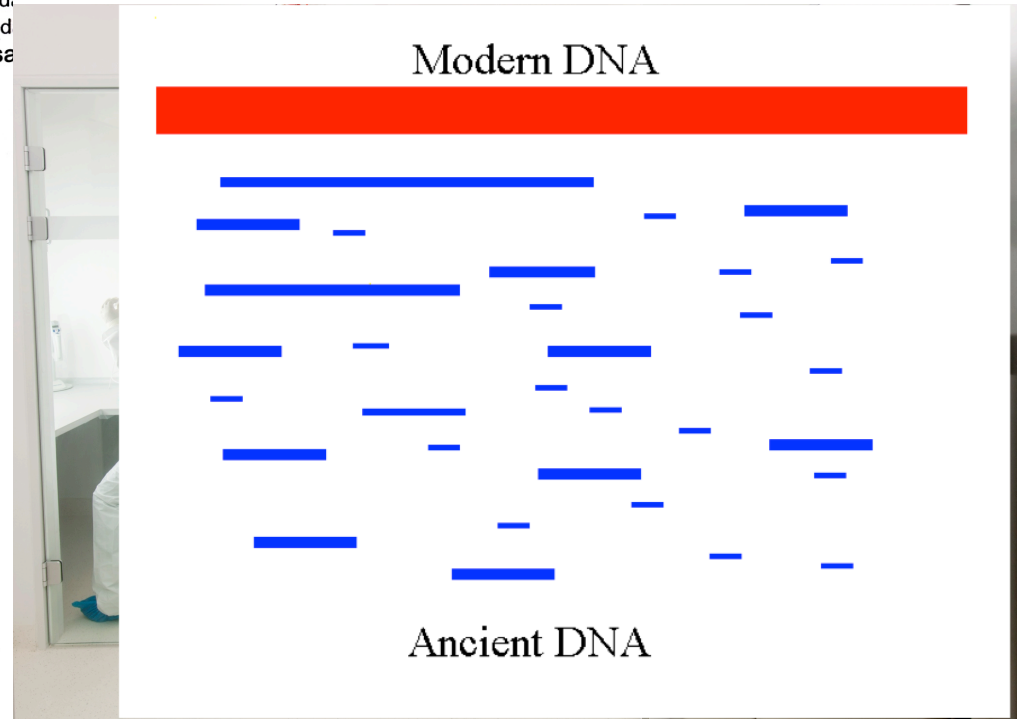
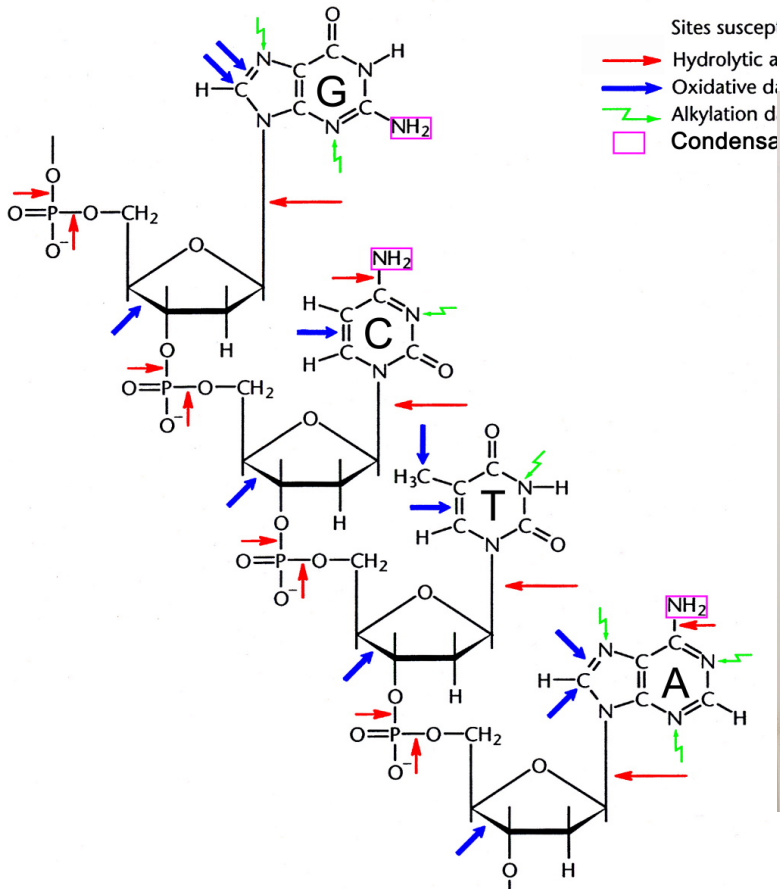
Fossilt DNA – et vindue til fortiden

Morten Allentoft



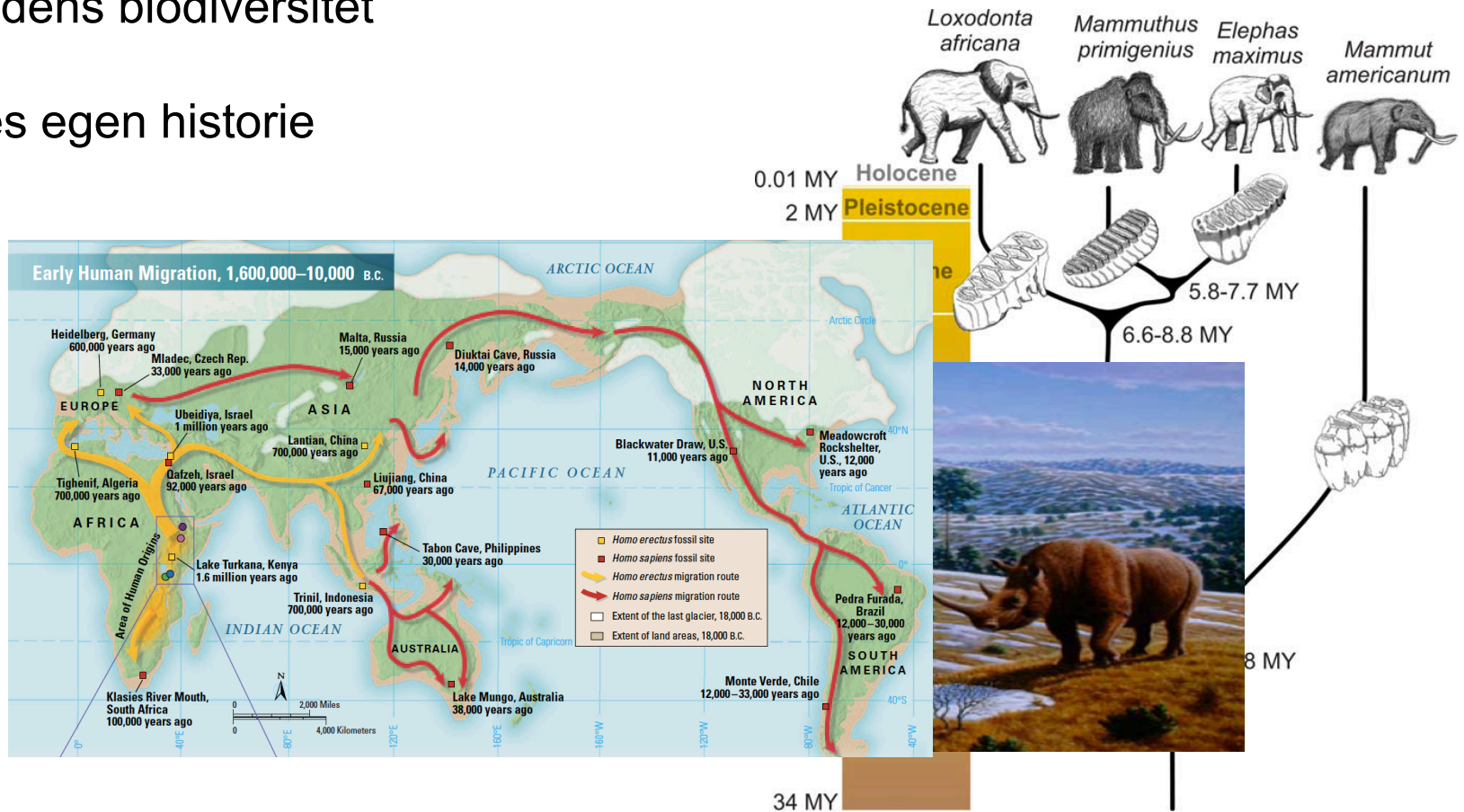
Hvad er fossilt DNA?

- meget ødelagt
- Høj forureningsrisiko



Hvorfor gider vi bøvle med det?

- Studier på uddøde arter
- Fortidens biodiversitet
- Vores egen historie



Arbejdsgang

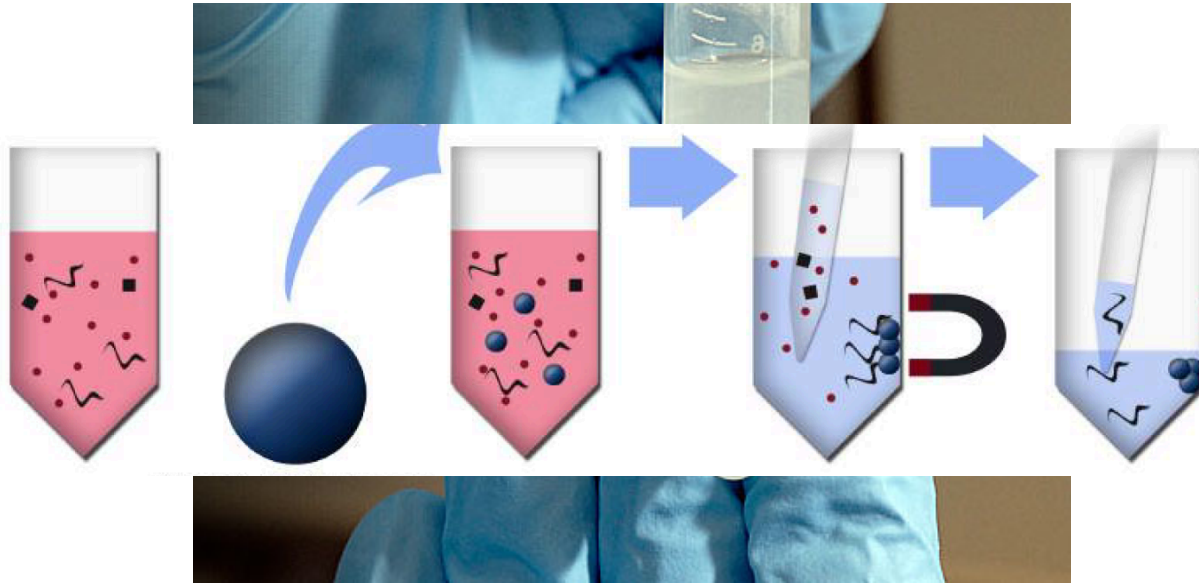
1) Indsamling



Arbejdsgang

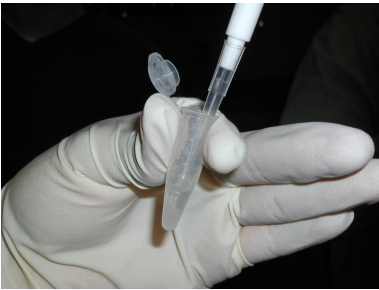
1) Indsamling

2) Ekstraktion



Next Generation DNA sekventering

DNA ekstrakt



Et par dage senere:
milliarder af DNA sekvenser

Fossilt DNA og Europas forhistorie

Det første genom fra jægerstenalderen

Nature 507 (2014)

Derived immune and ancestral pigmentation alleles in a 7,000-year-old Mesolithic European

Iñigo Olalde^{1*}, Morten E. Allentoft^{2*}, Federico Sánchez-Quinto¹, Gabriel Santpere¹, Charleston W. K. Chiang³, Michael DeGiorgio^{4,5}, Javier Prado-Martinez¹, Juan Antonio Rodríguez¹, Simon Rasmussen⁶, Javier Quilez¹, Oscar Ramírez¹, Urko M. Marigorta¹, Marcos Fernández-Callejo¹, María Encina Prada⁷, Julio Manuel Vidal Encinas⁸, Rasmus Nielsen⁹, Mihai G. Netea¹⁰, John Novembre¹¹, Richard A. Sturm¹², Pardis Sabeti^{13,14}, Tomàs Marquès-Bonet^{1,15}, Arcadi Navarro^{1,15,16,17}, Eske Willerslev² & Carles Lalueza-Fox¹



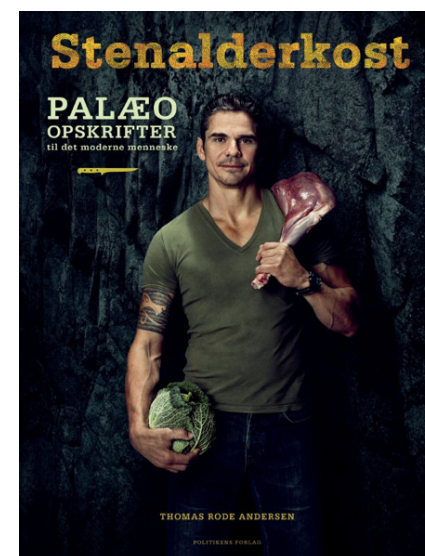
Data fra La Brana manden:

- Fantastisk DNA bevaring: 50% humant DNA
- 2.158.245.715 humane DNA sekvenser
- Et komplet genom med 3.4X dækning

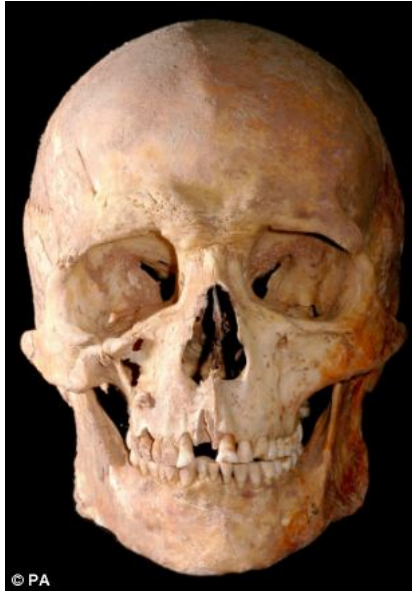


Et par observationer:

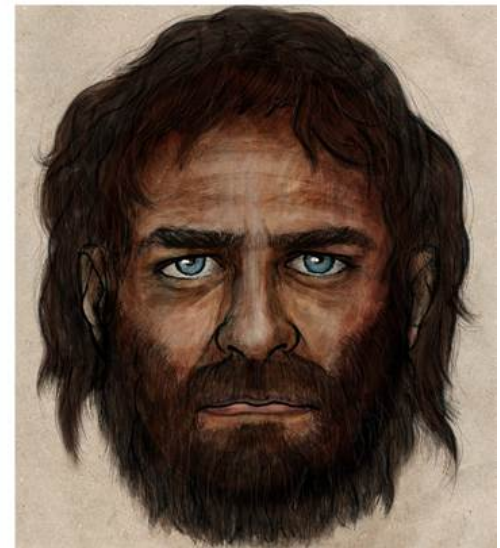
- C variant på position -13910 i *MCM6* genet
- Kun 5 kopier af *AMY1* genet

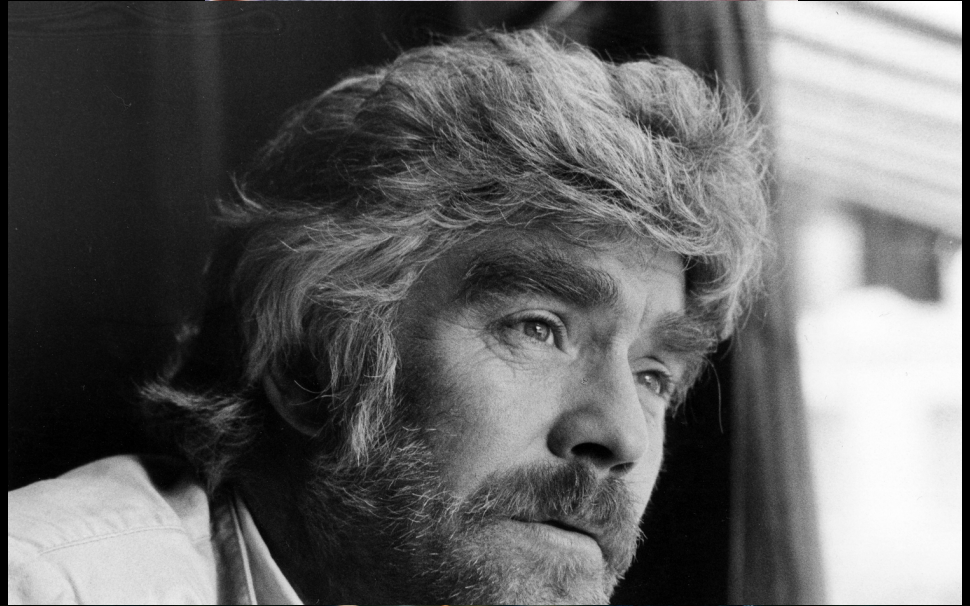


The cave man look



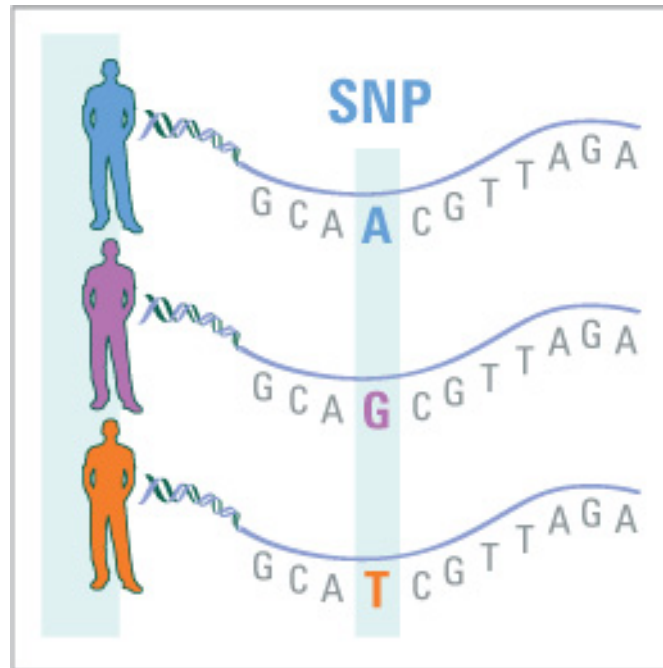
- Brunt hår
- meget mørk hud
- ikke-brune øjne



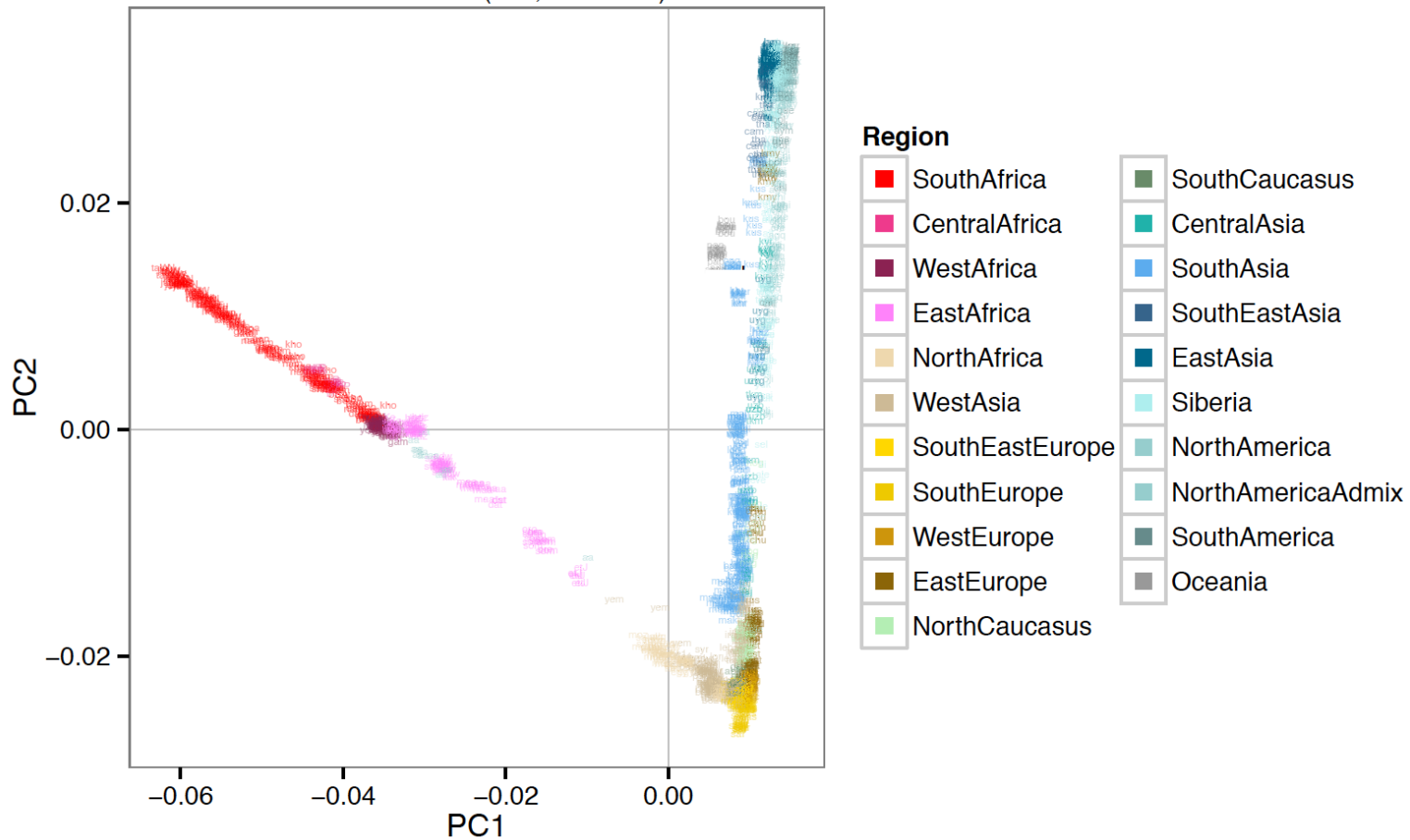


Lidt populationsgenetik

Reference data: 600,000 SNP's fra modern befolkningsgrupper

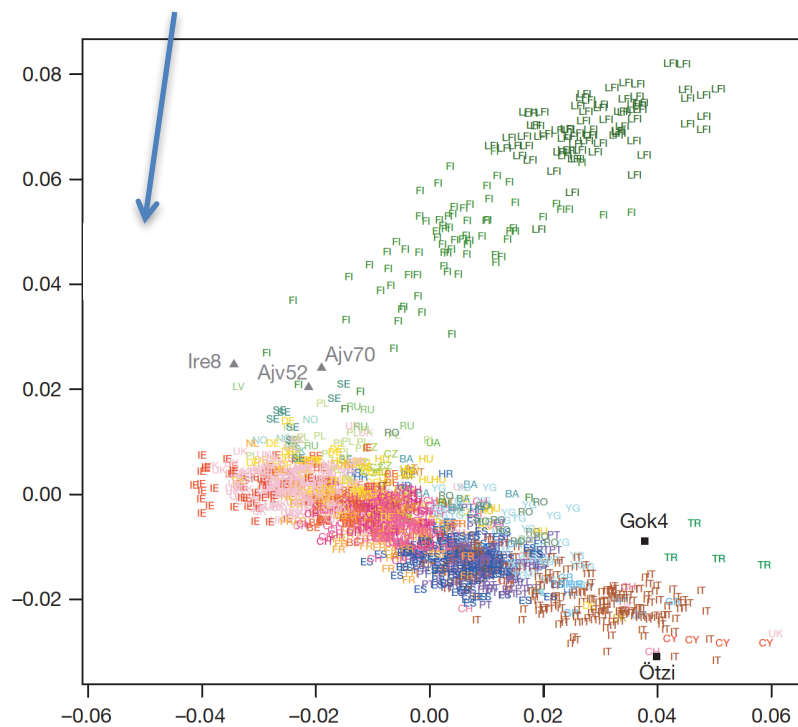


PCA af nuværende befolkninger





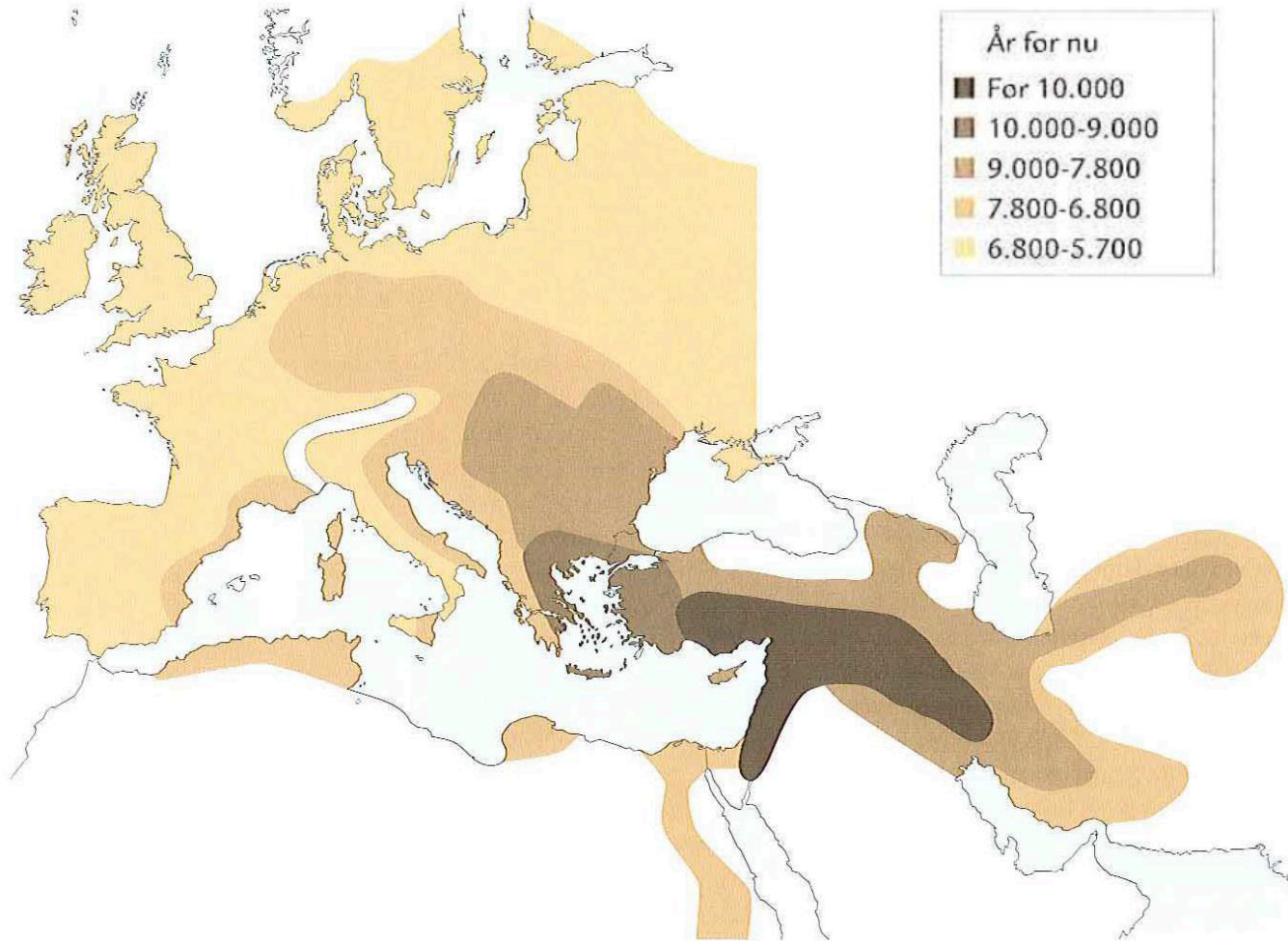
PCA af Europa



Han er ikke vores direkte stamfader!

Et par tusinde år senere...

Landbrug begynder at sprede sig henover Europa





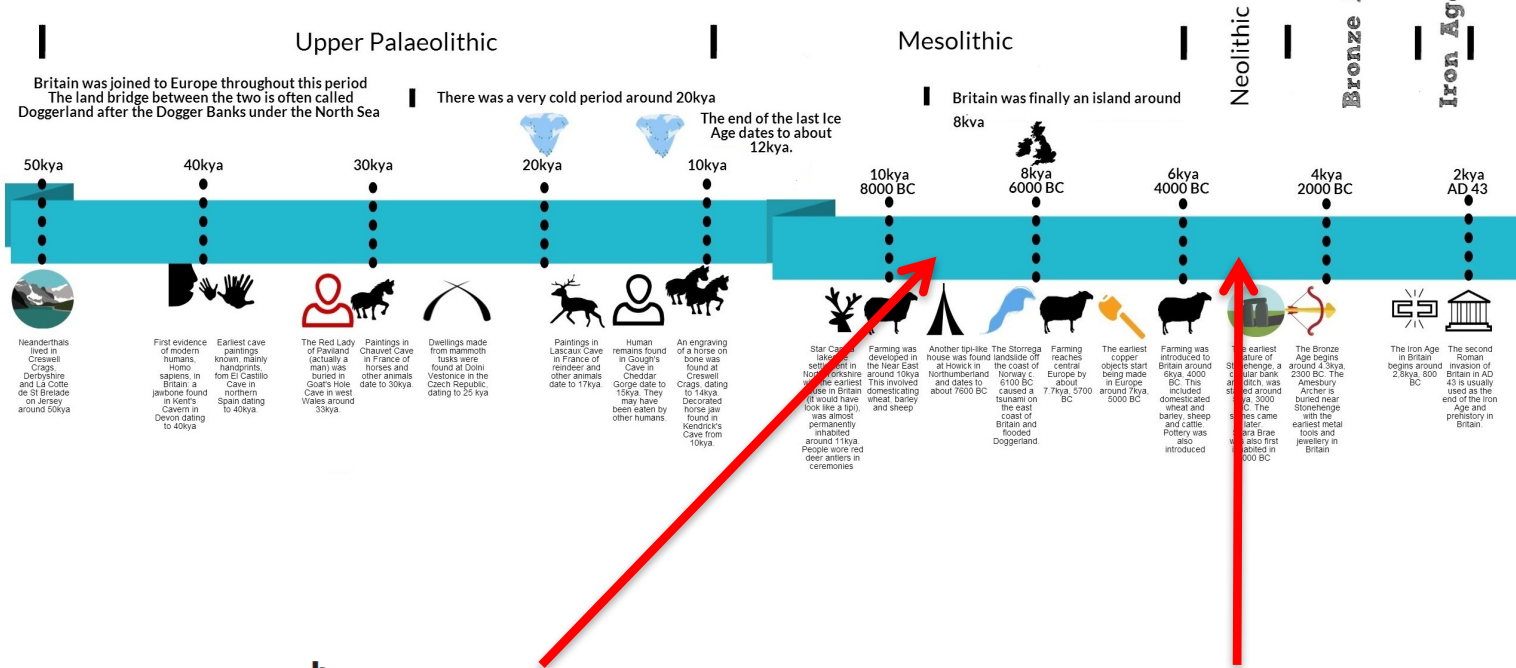
Hvad forårsager disse ændringer?

Hypotese 1: De tidlige bønder vandrer ind i Europa og erstatter jæger-samlerne

Hypotese 2: Ingen folkevandring – kun kulturen spredes



STONE AGE



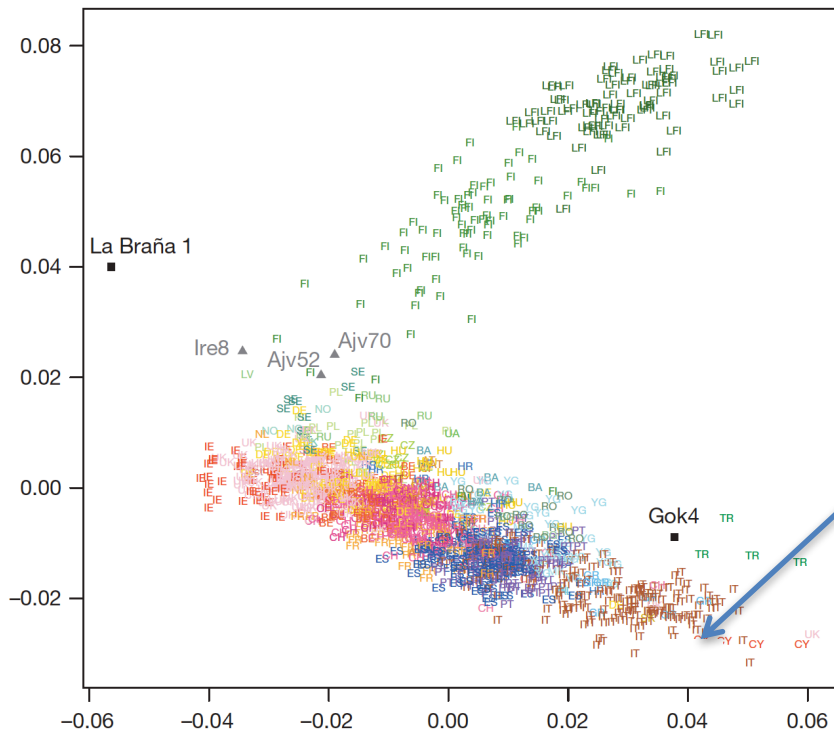
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New insights into the Tyrolean Iceman's origin and phenotype as inferred by whole-genome sequencing

Andreas Keller^{1,2,*}, Angela Graefen^{3,*}, Markus Ball^{4,*}, Mark Matzas⁵, Valesca Boisguerin⁵, Frank Maixner³, Petra Leidinger¹, Christina Backes¹, Rabab Khairat⁴, Michael Forster⁶, Björn Stade⁶, Andre Franke⁵, Jens Mayer¹, Jessica Spangler⁷, Stephen McLaughlin⁷, Minita Shah⁷, Clarence Lee⁷, Timothy T. Harkins⁷, Alexander Sartori⁷, Andres Moreno-Estrada⁸, Brenna Henn⁸, Martin Sikora⁸, Ornella Semino⁹, Jacques Chahon¹⁰, Siiri Roots¹¹, Natalie M. Myres¹², Vicente M. Cabrera¹³, Peter A. Underhill⁸, Carlos D. Bustamante⁸, Eduard Egarter Vigil¹⁴, Marco Samadelli³, Giovanna Cipollini³, Jan Haas¹⁵, Hugo Katus¹⁵, Brian D. O'Connor^{16,17}, Marc R.J. Carlson¹⁸, Benjamin Meder¹⁵, Nikolaus Blin^{4,19}, Eckart Meese¹, Carsten M. Pusch⁴ & Albert Zink³



- Enormt skift i genpuljen = indvandring
- Otzi er (heller ikke) vores direkte forfader!

Det store spørgsmål:

Hvad skete der efter Bondestenalderen?

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doi:10.1038/nature14507

Population genomics of Bronze Age Eurasia

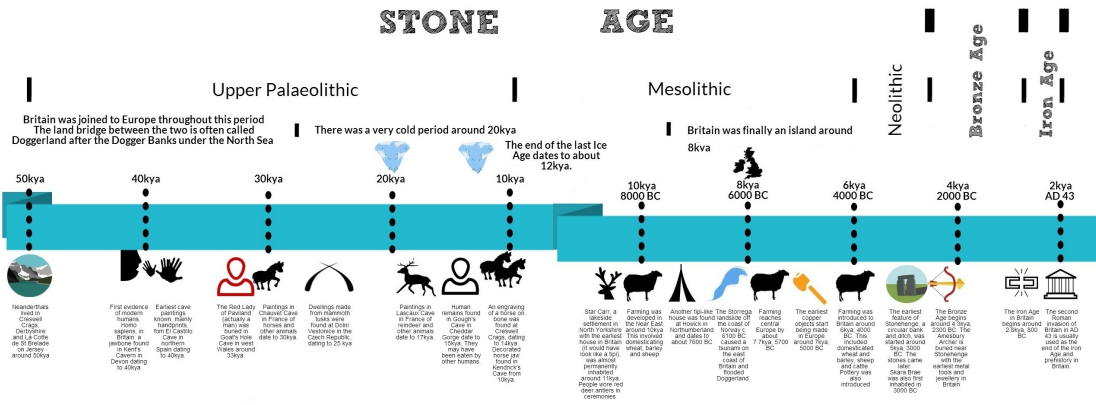
Morten E. Allentoft^{1*}, Martin Sikora^{1*}, Karl-Göran Sjögren², Simon Rasmussen³, Morten Rasmussen¹, Jesper Stenderup¹, Peter B. Damgaard¹, Hannes Schroeder^{1,4}, Torbjörn Ahlström⁵, Lasse Vinner¹, Anna-Sapfo Malaspinas¹, Ashot Margaryan¹, Tom Higham⁶, David Chivall⁶, Niels Lynnerup⁷, Lise Harvig⁷, Justyna Baron⁸, Philippe Della Casa⁹, Paweł Dąbrowski¹⁰, Paul R. Duffy¹¹, Alexander V. Ebel¹², Andrey Epimakhov¹³, Karin Frei¹⁴, Mirosław Furmanek⁸, Tomasz Gralak⁸, Andrey Gromov¹⁵, Stanisław Gronkiewicz¹⁶, Gisela Grupe¹⁷, Tamás Hajdu^{18,19}, Radosław Jarysz²⁰, Valeri Khartanovich¹⁵, Alexandr Khokhlov²¹, Viktória Kiss²², Jan Kolář^{23,24}, Aivar Kriiska²⁵, Irena Lasak⁸, Cristina Longhi²⁶, George McGlynn¹⁷, Algimantas Merkevičius²⁷, Inga Merkyte²⁸, Mait Metspalu²⁹, Ruzan Mkrtchyan³⁰, Vyacheslav Moiseyev¹⁵, László Paja^{31,32}, György Pálfi³², Dalia Pokutta², Łukasz Pospieszny³³, T. Douglas Price³⁴, Lehti Saag²⁹, Mikhail Sablin³⁵, Natalia Shishlina³⁶, Václav Smrčka³⁷, Vasili I. Soenov³⁸, Vajk Szeverényi²², Gusztáv Tóth³⁹, Synaru V. Trifanova³⁸, Liivi Varul²⁵, Magdolna Vicze⁴⁰, Levon Yepiskoposyan⁴¹, Vladislav Zhitenev⁴², Ludovic Orlando¹, Thomas Sicheritz-Pontén³, Søren Brunak^{3,43}, Rasmus Nielsen⁴⁴, Kristian Kristiansen² & Eske Willerslev¹



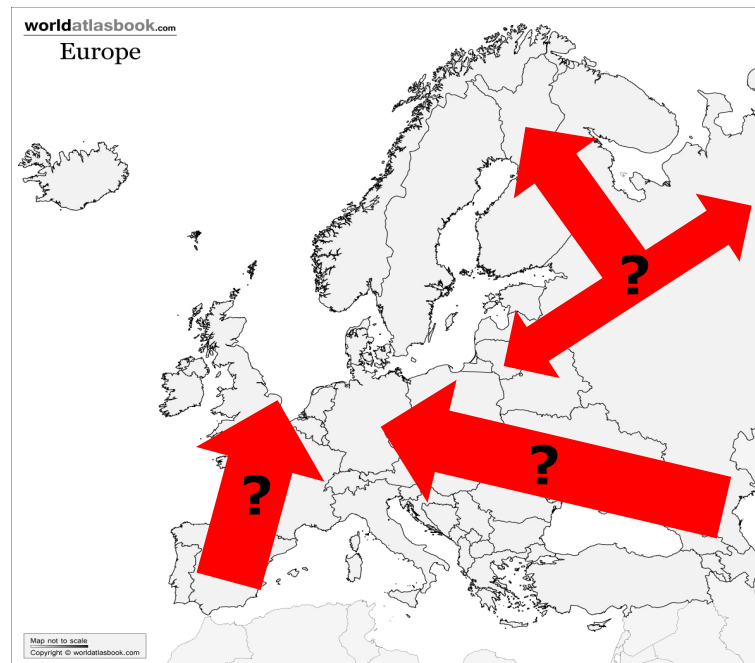
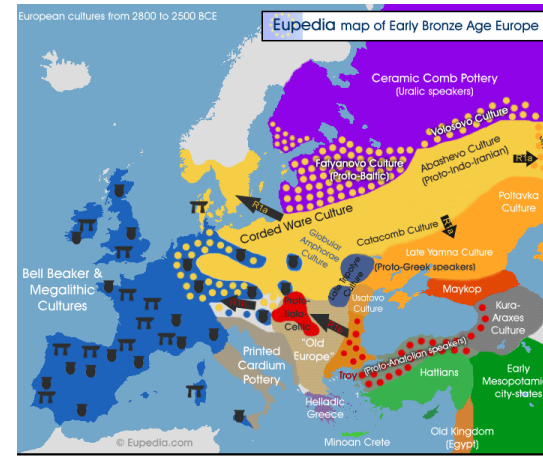
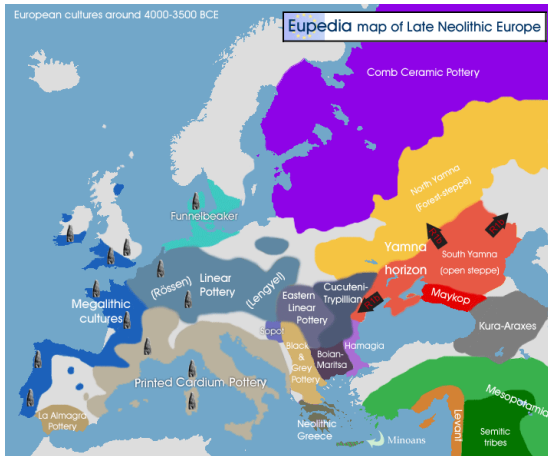
UNIVERSITY OF GOTHENBURG
DEPT OF HISTORICAL STUDIES

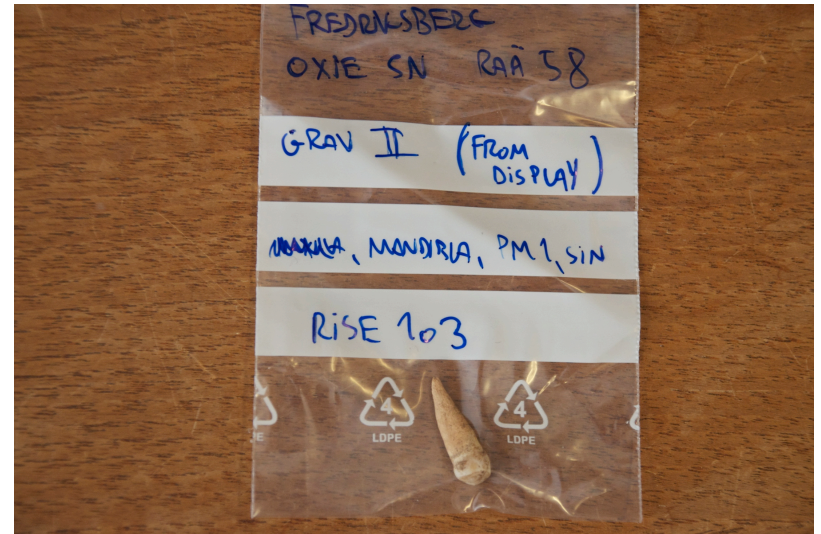
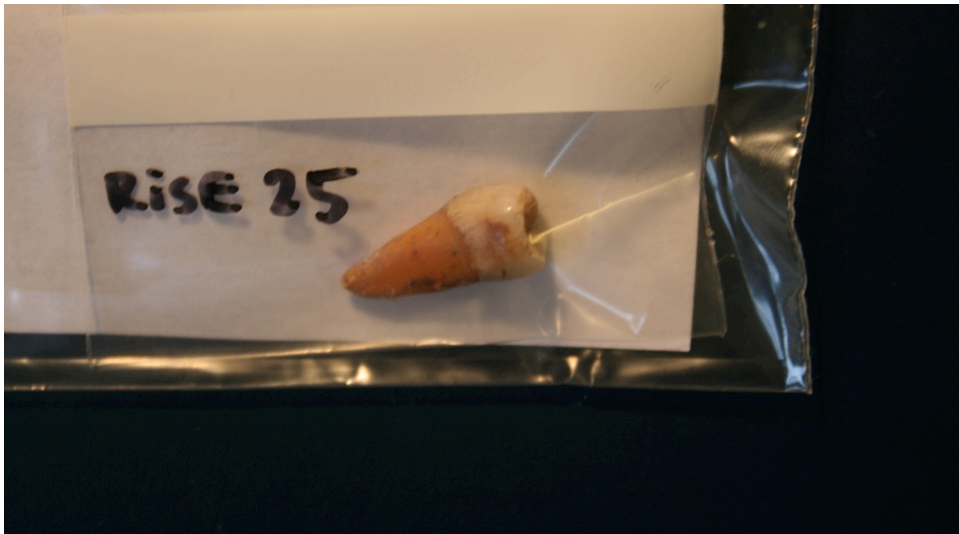
Centre for **Geo**
Genetics

Fossil DNA fra Bronzealderen...hvorfors?



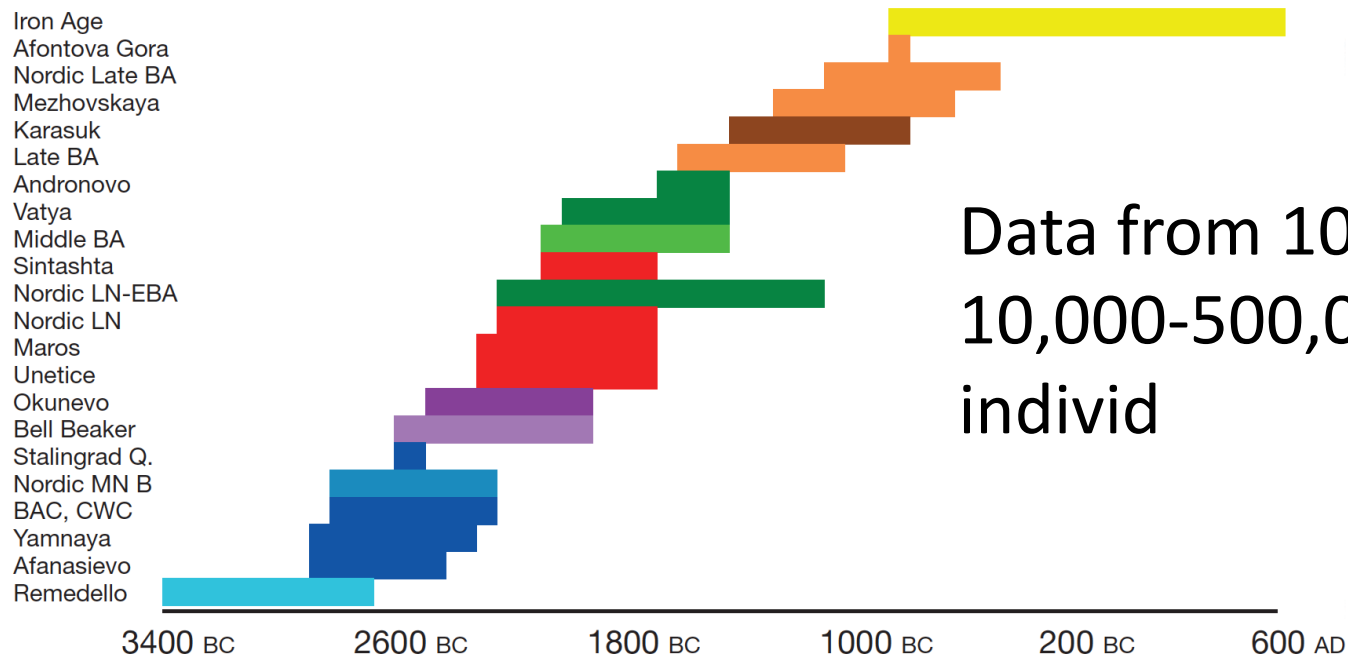
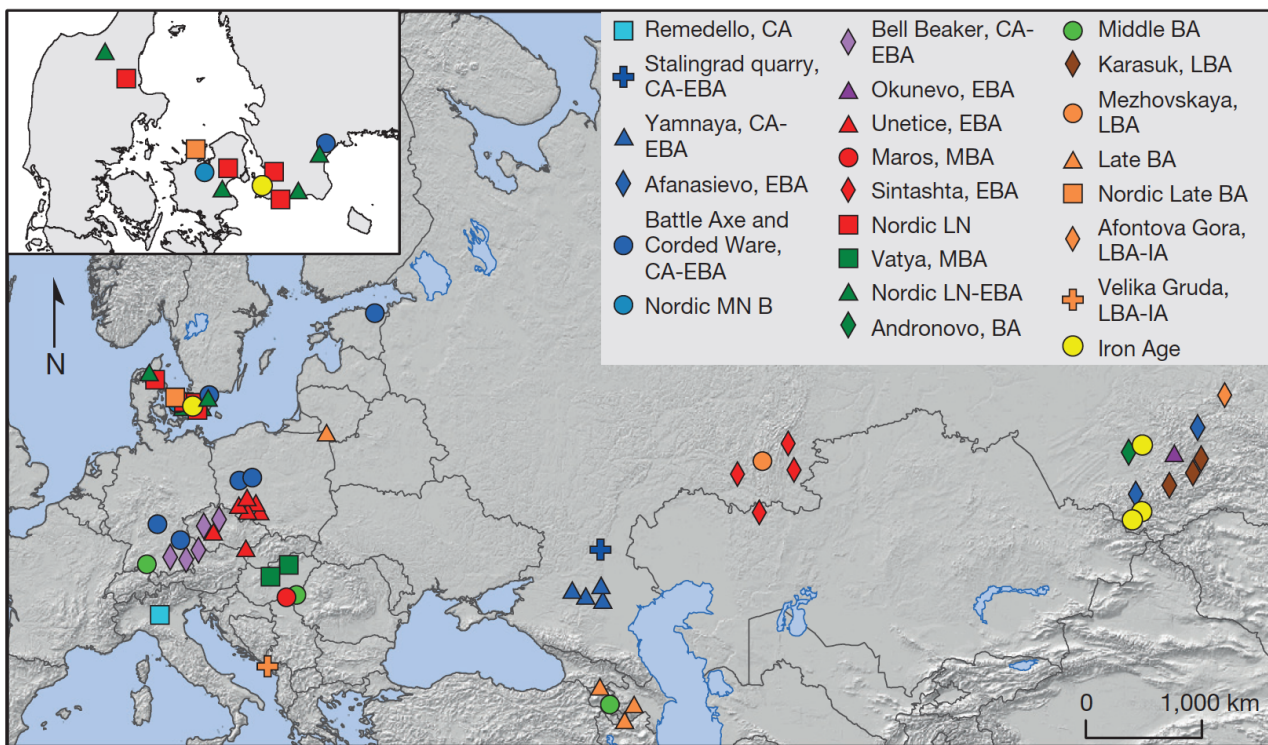
Mange forskellige kulturer opstår





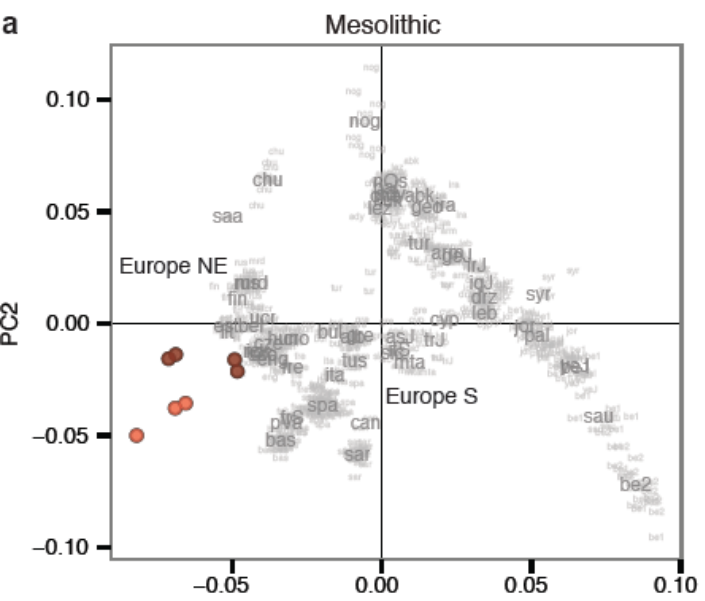
Tænder fra 600 skeletter





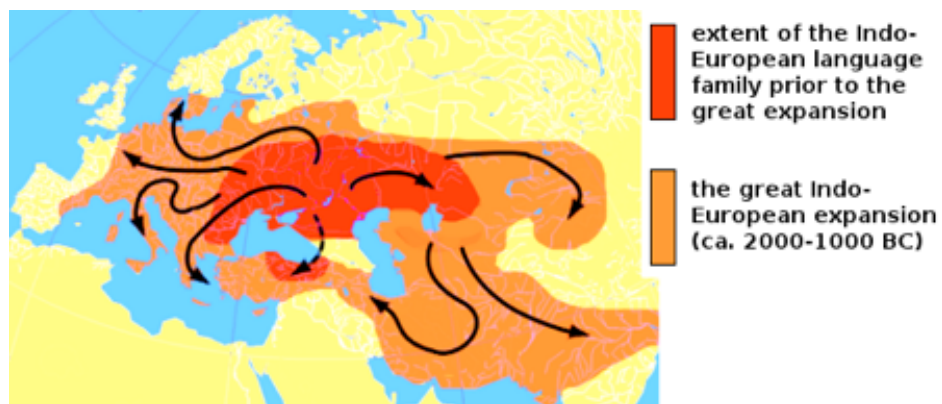
Data from 101 menesker:
10,000-500,000 SNP's per
individ

Europa gennem tid





Spredning af de indo-europæiske sprog





Yamnaya: hyrdefolk fra stepperne

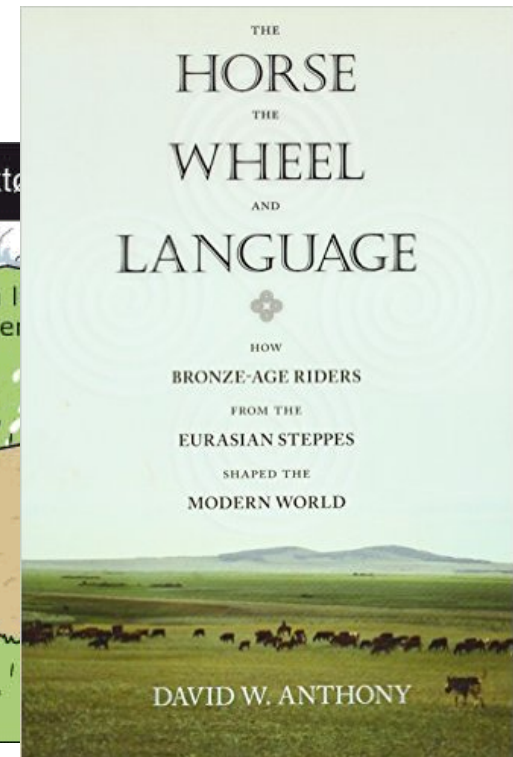


Take home message:

- Den europæiske befolkning blev dannet genetisk ved mindst tre folkevandringer, og disse tre genetiske komponenter udgør det meste af den DNA-variation, der findes i Europa i dag.

- Vi er alle immigranter

- Yamnaya-migrationen etablerer Europa genetisk
- 30-50% Yamnaya DNA i os alle
- Men hvorfor denne vandringslyst?

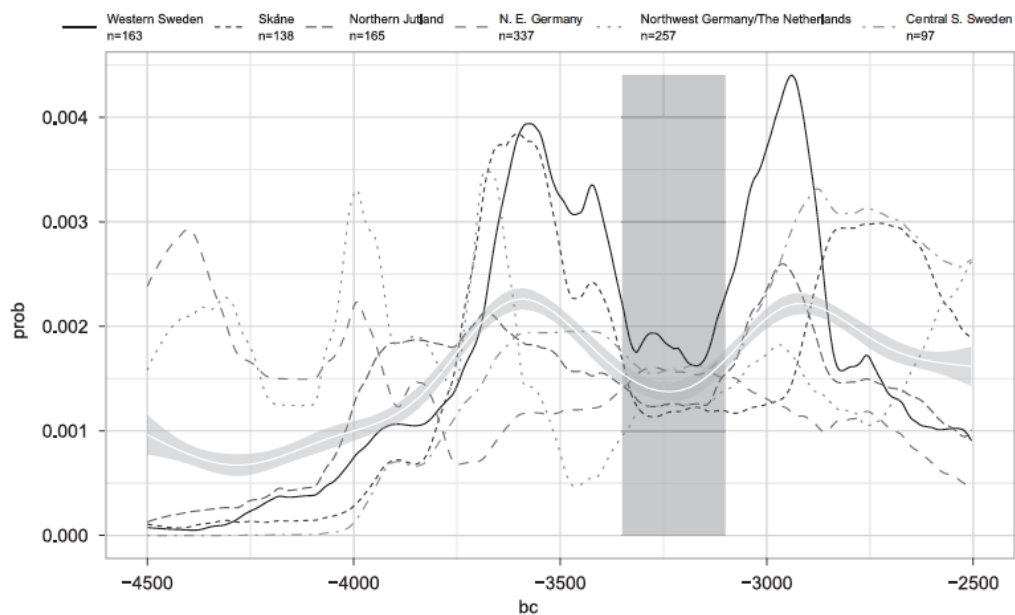




Demography and the intensity of cultural activities: an evaluation of Funnel Beaker Societies (4200–2800 cal BC)

Martin Hinz^{a,*}, Ingo Feeser^a, Karl-Göran Sjögren^b, Johannes Müller^a

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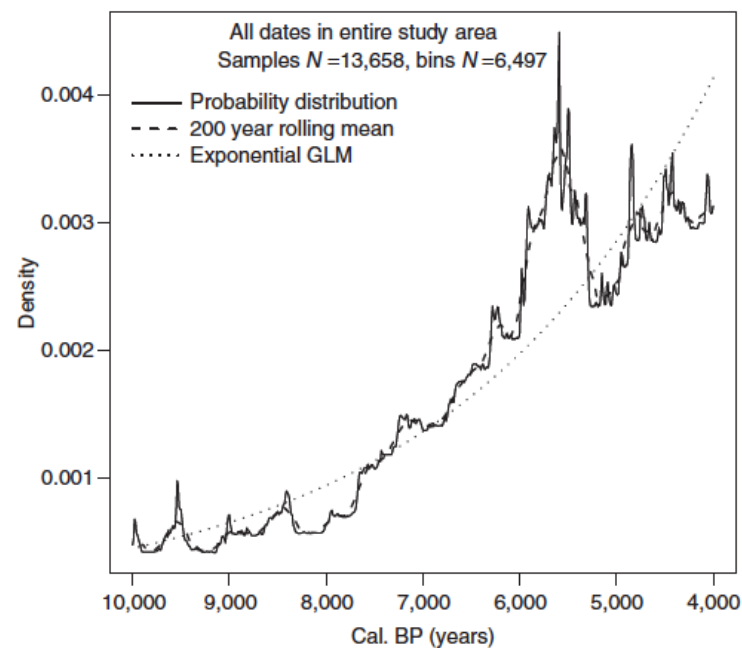
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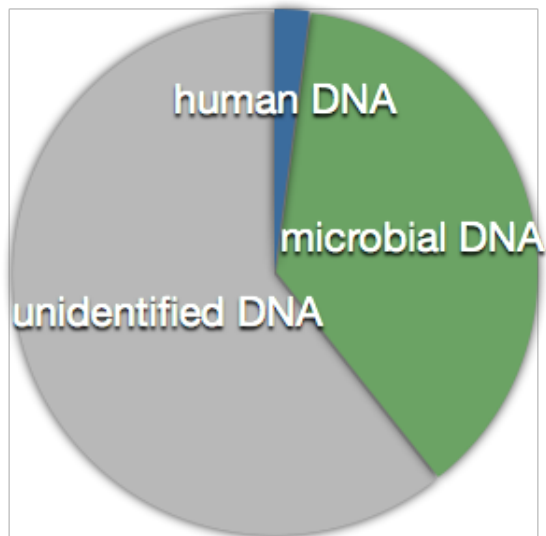
OPEN

Regional population collapse followed initial agriculture booms in mid-Holocene Europe

Stephen Shennan¹, Sean S. Downey^{1,2}, Adrian Timpson^{1,3}, Kevan Edinborough¹, Sue Colledge¹, Tim Kerig¹, Katie Manning¹ & Mark G. Thomas³

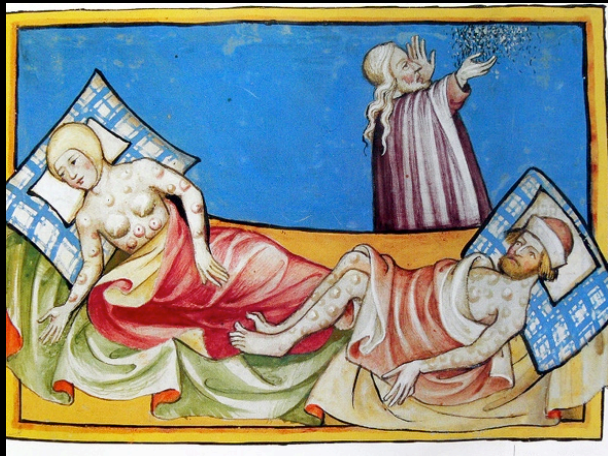


ancient DNA



Yersenia pestis





Early Divergent Strains of *Yersinia pestis* in Eurasia 5,000 Years Ago

Simon Rasmussen,^{1,18} Morten Erik Allentoft,^{2,18} Kasper Nielsen,¹ Ludovic Orlando,² Martin Sikora,² Karl-Göran Sjögren,³ Anders Gorm Pedersen,¹ Mikkel Schubert,² Alex Van Dam,¹ Christian Møllin Outzen Kapel,⁴ Henrik Bjørn Nielsen,¹ Søren Brunak,^{1,5} Pavel Avetisyan,⁶ Andrey Epimakhov,⁷ Mikhail Viktorovich Khalyapin,⁸ Artak Gnuni,⁹ Aivar Kriiska,¹⁰ Irena Lasak,¹¹ Mait Metspalu,¹² Vyacheslav Moiseyev,¹³ Andrei Gromov,¹³ Dalia Pokutta,³ Lehti Saag,¹² Liivi Varul,¹⁰ Levon Yepiskoposyan,¹⁴ Thomas Sicheritz-Pontén,¹ Robert A. Foley,¹⁵ Marta Mirazón Lahr,¹⁵ Rasmus Nielsen,¹⁶ Kristian Kristiansen,³ and Eske Willerslev^{2,17,*}

