Modelling the Neolithic transition in the Near East and Europe

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   2 slides

+ _______

23 slides
1. Neolithic databases

<table>
<thead>
<tr>
<th></th>
<th>sites total</th>
<th>Europe</th>
<th>Near East</th>
<th>Anatolia</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammerman 1971, 1984</td>
<td>53</td>
<td>53</td>
<td>0</td>
<td>0</td>
<td>(9)</td>
</tr>
<tr>
<td>Gkiaska et al 2003</td>
<td>510</td>
<td>510</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pinhasi 2005</td>
<td>735</td>
<td>606</td>
<td>92</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Vander Linden 2012</td>
<td>990</td>
<td>903</td>
<td>72</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Country</td>
<td>Sub-period</td>
<td>Site name</td>
<td>Site type</td>
<td>Lab Code</td>
<td>Cal BP</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>----------------</td>
<td>-----------</td>
<td>----------</td>
<td>--------</td>
</tr>
<tr>
<td>Andorra</td>
<td>Cardial</td>
<td>Balma Margineda</td>
<td>Cave</td>
<td>Ly-2839</td>
<td>7545</td>
</tr>
<tr>
<td>Austria</td>
<td>Lengyel</td>
<td>Unterpullendorf</td>
<td>Pit</td>
<td>VRI-42</td>
<td>7013</td>
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<tr>
<td>Austria</td>
<td>LBK</td>
<td>Neckenmarkt</td>
<td></td>
<td>OxA-1536</td>
<td>7105</td>
</tr>
<tr>
<td>Austria</td>
<td>LBK</td>
<td>Winden am See</td>
<td>Settlement</td>
<td>Bln-55</td>
<td>6776</td>
</tr>
</tbody>
</table>
Ammerman & Cavalli-Sforza (1971)

53 sites
speed = 1.0 km/yr
(0.8-1.2 km/yr)

$r = 0.89$ (Jericho, highest $r$)

No sites in the Near East
Pinhasi, Fort & Ammerman (2005)

735 sites
speed = 0.7-1.1 km/yr
r = 0.83
2. Homogeneous models

1) Classical model:
   Reproduction+dispersal
   Homogeneous model: no seas
   no mountains

2) Time-delayed model:
   Fort and Méndez (1999)
   Pinhasi, Fort & Ammerman (2005)
   Reproduction+dispersal+delay (generation time)
   Also homogeneous: no seas, no mountains
Homogeneous models

Archaeological data $\rightarrow$ 1 km/yr for the spread of farming across Europe

1) Classical model: 3 km/yr $\rightarrow$ too fast

2) Time-delayed model: 1 km/yr $\rightarrow$ it agrees with data at the global (continental) scale

How about local scales? Method: isochrones
Data: time origin at Jericho (11,863 cal yr BP) (other origins: lower r, similar maps) 1 gen=32 yr

Database by vander Linden

FAST

Neolithic wave
Generations

- < 1
- 1 - 30
- 31 - 60
- 61 - 90
- 91 - 120
- 121 - 150
- 151 - 180
- 181 - 210
- 211 - 240
- 241 - 270

903 European sites
87 Near-Eastern sites
Homogeneous models

0 < \( p_e \) < 1 persistency

a fraction \( p_e \) stays

\((1-p_e)/4\) move in each direction

\( p_e = 0.38, d = 50 \text{ km}, \) reproduction \( \text{Ro} = 2.2 \)

per generation (32 yr) (pre-industrial farmers)
Homogeneous model

Origin at Jericho

Neolithic wave
Generations
- 1 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100
- 101 - 120
- 121 - 140
- 141 - 160

homogeneous

50 gen

SLOW
Major inconsistency

Homogeneous model:
arrival to Greece in 50 generations

Data:
arrival to Greece in 120 generations

Let us introduce non-homogeneous models
3. Non-homogeneous models = grid

Elevation data from the SRTM30 database

Detail of the 50 km x 50 km grid on an Albers conic equal-area projection
Non-homogeneous models

x

y

mountains

sea

mountains

sea
Non-homogeneous models

Sea travels do not solve the inconsistency, because the front reaches Greece still sooner (in about 30 generations for the following example):
Mountain barriers have only local effects:

- Mountain barriers above 1000m (above 1750m† the effect is still smaller)

- No mountain barriers

† 1750m is used to avoid isolated sites
Recall the inconsistency:

**Models:** arrival to Greece in 30-50 generations.
**Data:** arrival to Greece in 120 generations.

**Possible solution:**
- Europe: a well-established set of farming practices spread.
- Near East: innovations appeared in different times and places → no front propagation!
- Near East: PPNB/C cultures correspond to the final, more homogeneous set of farming practices, from which the spread to Europe proceeded → use only PPNB/C sites.
Solving the inconsistency

Set PPNB/C sites (red squares in the map) full of farmers at 9000 cal yr BP (=average of their dates)
Solving the inconsistency

- Distances computed from Hemar for red+black circles: 87 Near Eastern sites
- PPNB/C sites (Jericho is not one of them)

- Blue circles: 87 Near Eastern sites
- Red circles: 16 PPNB/C sites (Jericho is not one of them)

Graph:
- Black dots: FEPRE + CONTEXT (PPNB-C) data
- Red dots: Simulation with PPNB-C CONTEXT sites at 9000 yr cal BP
- Blue dots: Simulation with origin at Jericho (site at 11863 yr cal BP)

Mountain barriers at 1750 m
150 km sea travel
Back to the homogeneous model

The inconsistency is solved (assuming the simulated front begins to spread at 9000 cal yr BP)

But the front arrives too late to the Adriatic and Iberian peninsulas

Let us consider non-homogeneous models
Mean error per site in the arrival time of the Neolithic front

<table>
<thead>
<tr>
<th>Dataset (in addition to the 903 European sites)</th>
<th>Initial Conditions used in the Simulations</th>
<th>Homogeneous Model</th>
<th>Mean Error, Model with Sea Travels &lt; 100 km and Mountains &gt; 1750 m</th>
<th>Mean Error, Model with Sea Travels &lt; 150 km and Mountains &gt; 1750 m</th>
<th>Mean Error, Model with Sea Travels &lt; 200 km and Mountains &gt; 1750 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>87 Near-Eastern sites</td>
<td>Single origin at Jericho</td>
<td>2088 yr</td>
<td>2024 yr</td>
<td>2508 yr</td>
<td>2899 yr</td>
</tr>
<tr>
<td>16 PPNB/C sites (1\textsuperscript{st} approach)</td>
<td>Single origin at Hemar\textsuperscript{†}</td>
<td>815 yr</td>
<td>759 yr</td>
<td>1152 yr</td>
<td>1553 yr</td>
</tr>
<tr>
<td>16 PPNB/C sites (2\textsuperscript{nd} approach)</td>
<td>PPNB/C sites full of farmers at 9,000 cal yr BP</td>
<td>685 yr</td>
<td>680 yr</td>
<td>\textbf{542 yr}</td>
<td>646 yr</td>
</tr>
</tbody>
</table>

\textsuperscript{†} Hemar is the oldest of the PPNB/C sites in the database

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Circles indicate better agreement than for the homogeneous model.

American Antiquity (2012)

Database by Marc vander Linden

Simulation programs by Toni Pujol
4. Conclusions

- Major inconsistency: according to models, the Neolithic front would have arrived to Greece in less than half the time implied by the data.
- It can be solved including only PPNB/C sites in the Near East.
- Best model: sea travel up to 150 km.
- Mountain barriers: negligible effect.
5. SimulPast transversal group

Case Study CS6, Neolithic front spread

- Europe: 4 published papers with acknowledgements to SimulPast (G8)

- Asia:
  profs. Madella, Rondelli... (G1, CSIC)
  prof. Ibáñez ... (G3, CSIC)
  prof. Stride ... (G4, UB)
SimulPast transversal group

Possible additional topics

- Bronze+iron transition-urnfield people, prof. Barceló (G7, UAB)
- Diffusion of pottery (prof. Ibáñez, G3)
- Diffusion of sickles (prof. Ibáñez, G3)
- ...