Munich, 19.11.18

Replication in a thermal trap

Jongseo Kim, Simon Langnickel
Introduction

- Primordial soup hypothesis
- Panspermia – microscopic life came to earth by asteroids
- RNA world
- Clay hypothesis

There are still a lot of hypothesis!
Deep sea vent hypothesis:

Did we come from porous rock of hydrothermal vents?

Thermal trap modelling:
1. Convection driven PCR
2. Convection in a closed pore
3. Convection in an open pore
Convection driven PCR
Polymerase chain reaction (PCR):

\[ c(t) = c_0 \cdot 2^{t/\tau} \]

image: www.abmgood.com/marketing/knowledge_base/polymerase_chain_reaction_introduction.php
Convection driven PCR

- We do not have to heat up and cool down the whole sample ➔ 4 times faster than a standard PCR thermocycler
- Exponentially increase the amount of DNA

Similar reactions could occur in natural environment!

Jongseo Kim, Simon Langnickel
Convection in a closed pore

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015

Jongseo Kim, Simon Langnickel
Survival of Shortest

selection pressure for longer strands

Spiegelmann, 1967
Convection in an open pore

Closed Pore

Open Pore

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015
Short strands are subjected to the overall upwards course of the experiment (seven hours), the trapping volume was exchanged approximately 150 times with the template-free feeding and was run through the system at a speed of 6 µm s⁻¹. Continuously inside the open pore, a 2.5 mm short capillary was composition of a heterogeneous DNA population that replicates a dynamics model (see Methods). Error bars reflect the signal-to-noise ratio of the gel images (see Supplementary Fig. 11 for details).

We observed that only the long strands were able to replicate sufficiently to be replicated with labels, only replicated running reaction were taken from the outflow and analysed using gel electrophoresis. As the primers carried the labels, only replicated running reaction were taken from the outflow and the convection. Thermophoresis pushes the long strands into the downwards flow and the convection. Thermophoresis pushes the long strands into the downwards flow and leave the pore. The trapping is a function of the feeding velocity, which was easily with a simple model. The determinants of the growth kinetics for either the short or the long species, the twofold shorter strands became diluted and then extinct. This competitive replication and selection of two genetic poly-mers in favour of larger molecular lengths can be understood by a simple model. The determinants of the growth kinetics for either the short or the long species, the twofold shorter strands became diluted and then extinct. This competitive replication and selection of two genetic poly-mers in favour of larger molecular lengths can be understood.

Figure 3 | Convection in an open pore

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015
Selection for long strands:

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015
Short strands are subjected to the overall upwards generated by the superposition of the upwards exchanged approximately 150 times with the template-free feeding course of the experiment (seven hours), the trapping volume was nucleotides, polymerase and 7 nM continuous upwards distribution of 36 bp and 75 bp at a concentration of 1 nM each.

The twofold shorter strands became diluted and then extinct.

We observed that only the long strands were able to replicate sufficiently to withstand the diluting losses of genomic information.

Replication enables this arrangement to overcome Spiegelman above, we show how the joint thermally induced trapping and differential survival of replicating strands.

The velocity-dependent trapped fraction is described by a simple model. The determinants of the growth kinetics can be understood easily with a simple model. The determinants of the growth kinetics can be understood.
Competitive Replication and Selection

\[ \Delta k = (rep_L - rep_S) - (dil_L - dil_S) \]

- \( \Delta k \) Differential growth rate
- \( dil_i \) dilution rate
- \( rep_i \) replication rate

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015
Convection in an open pore

Competitive Replication and Selection

Survival of long strands!

Spiegelmann, 1967

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015
Conclusion

- cPCR

\[ \Delta T = 33 \text{ K} \]

- cPCR
- Accumulation

- cPCR
- Accumulation
- length selection

Jongseo Kim, Simon Langnickel
Conclusion

Thank you for your attention!

images: de.wikipedia.org/wiki/Raucher_(Hydrothermie)
Sources:


**Convection in an open pore**

**Dynamics:**
\[
\frac{dc_i}{dt} = (rep_i - dil_i) \cdot c_i
\]

\[
i = \{S, L\}
\]

**Ansatz:**
\[
c_i = c_i^0 e^{(rep_i - dil_i) \cdot t}
\]

\[
f_L = \frac{c_L}{c_L - c_S} = (1 + Ae^{-\Delta k t})^{-1}
\]

\[
A = \frac{c_S^0}{c_L^0}
\]

\[
\Delta k = (rep_L - rep_S) - (dil_L - dil_S)
\]

---

Kreysing, Keil, Lanzmich & Braun, Nature Chemistry 2015