

Experimental evolution of self-replicating RNAs with spontaneously-appeared parasites

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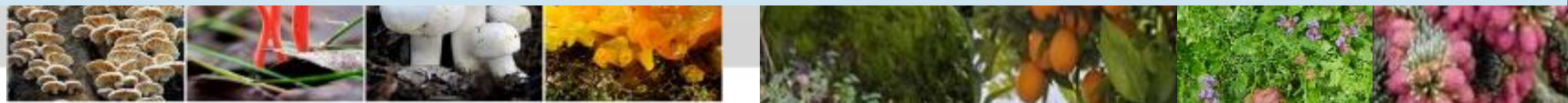
EVOLUTION Genetic Novelty/Genomic Variations by
RNA Networks and Viruses
2018/7/4-8, Salzburg, Austria, 30 min

Diverse and Complex organisms



Question:

Can we reproduce this evolutionary process in a laboratory?



■ **We cannot**

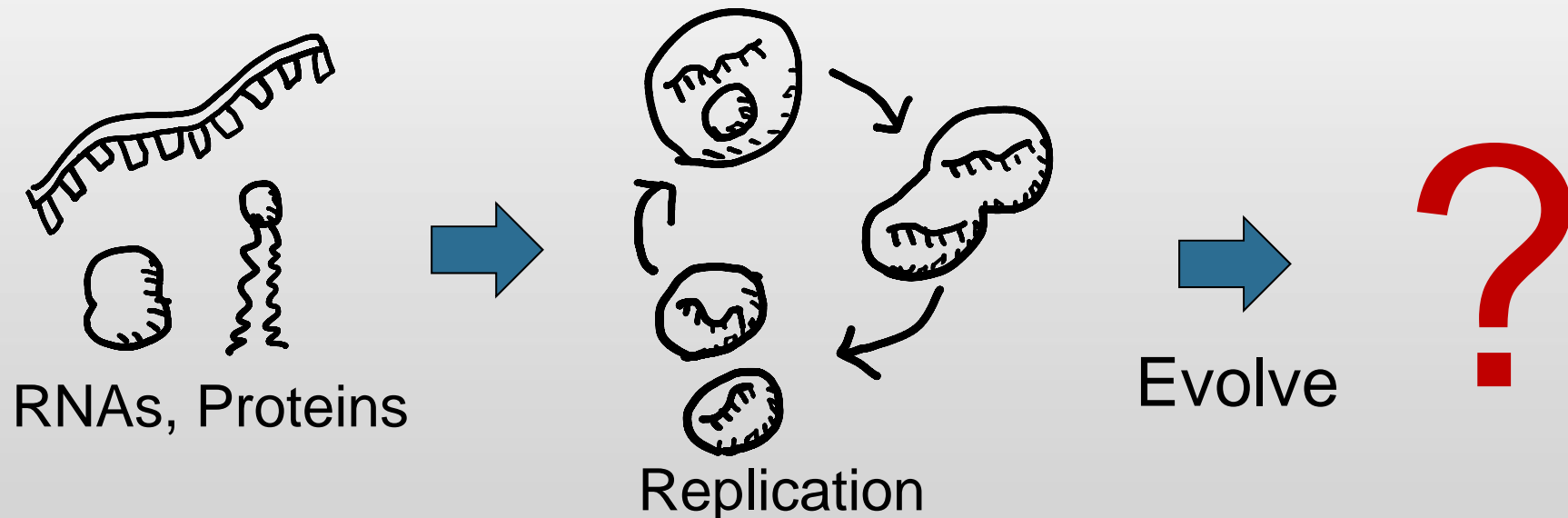
- Reproduce ancient life forms as they were.

■ **We can**

- Make a biochemical system that functionally mimic ancient life.
- Make experimental model!

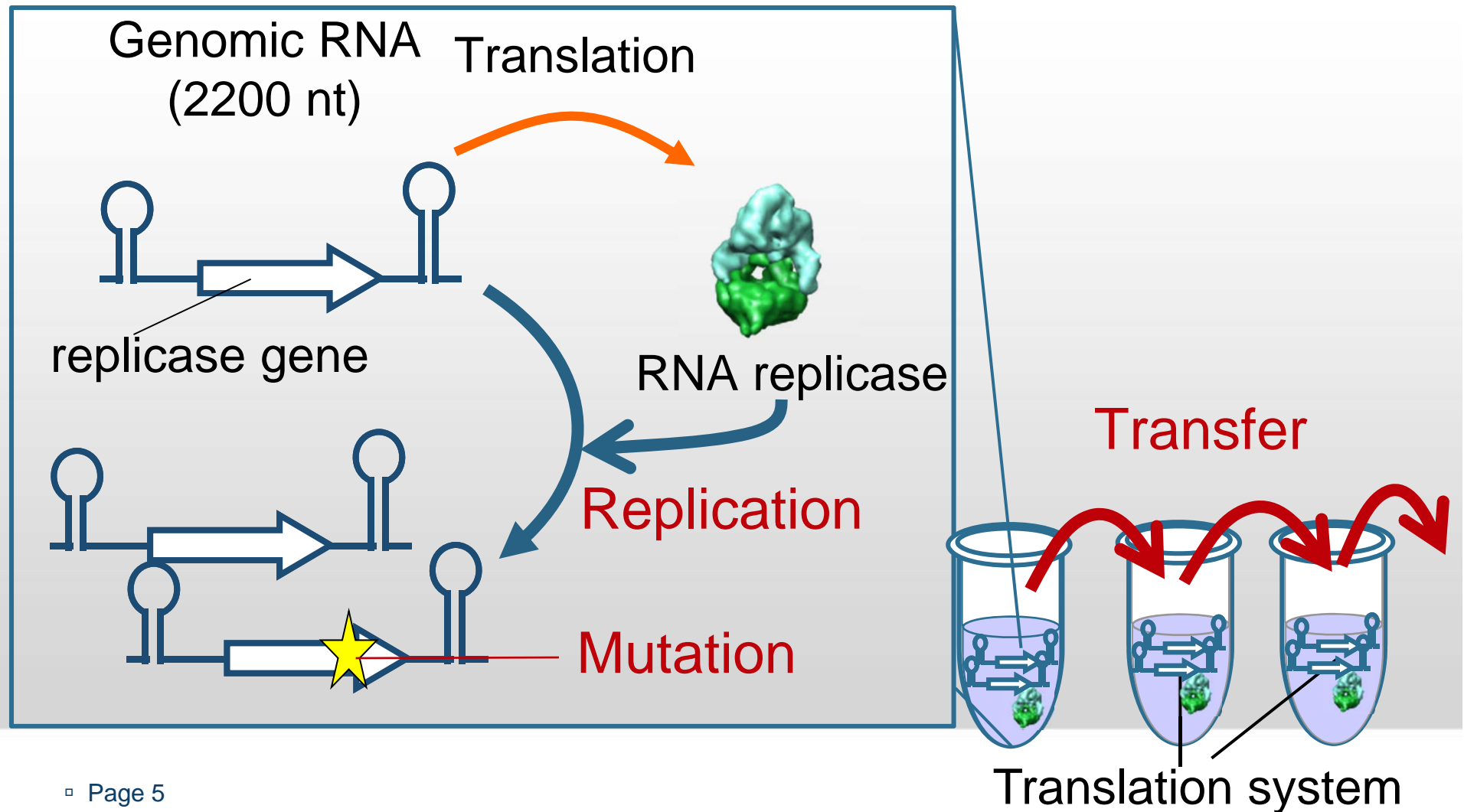
Strategy

1. Construct a evolvable replication system
2. Does it evolve like living organisms?
(Endlessly, produce diversity and complexity?)

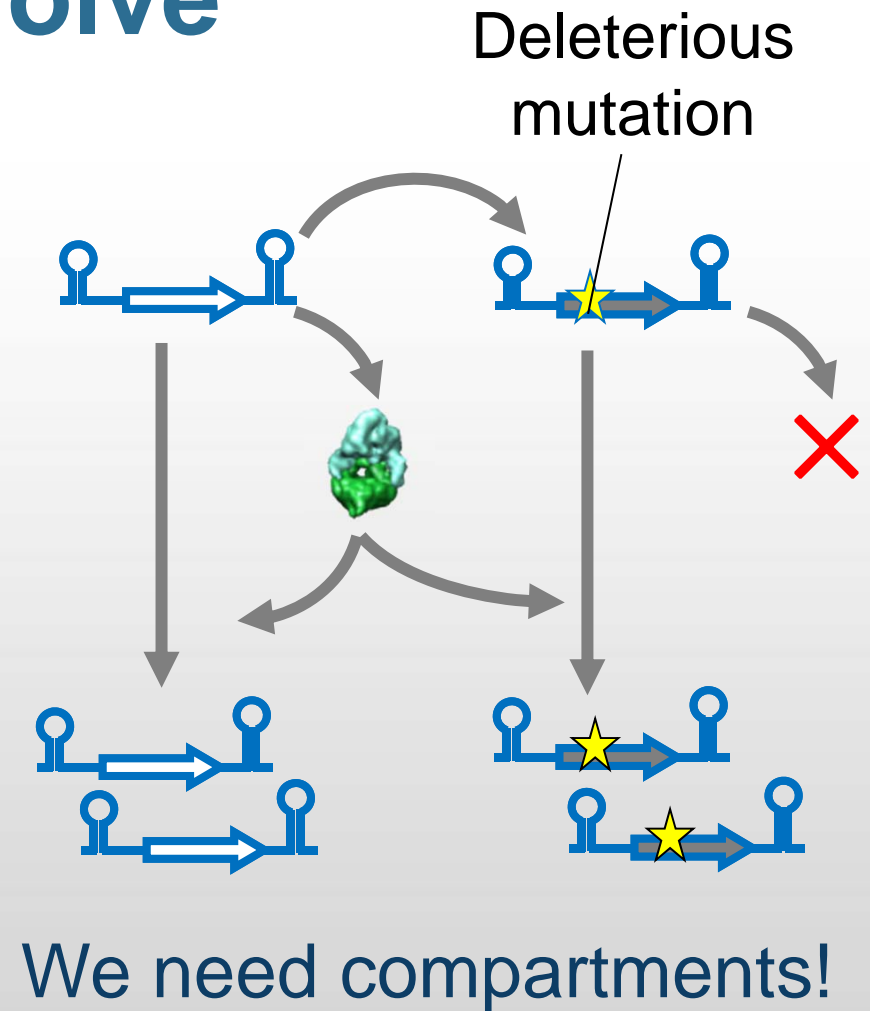
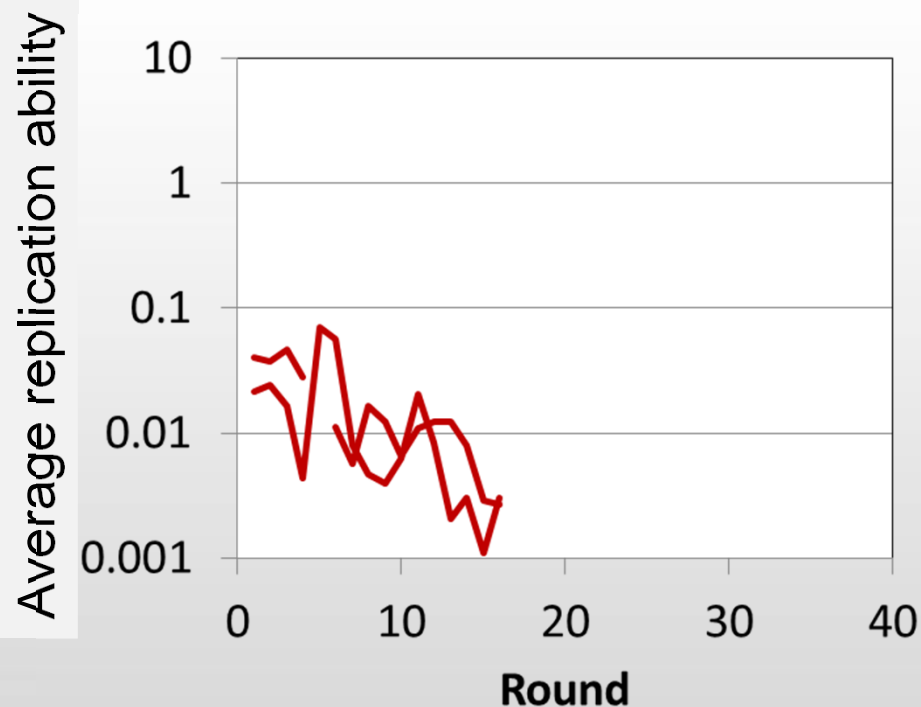


Translation-coupled RNA replication

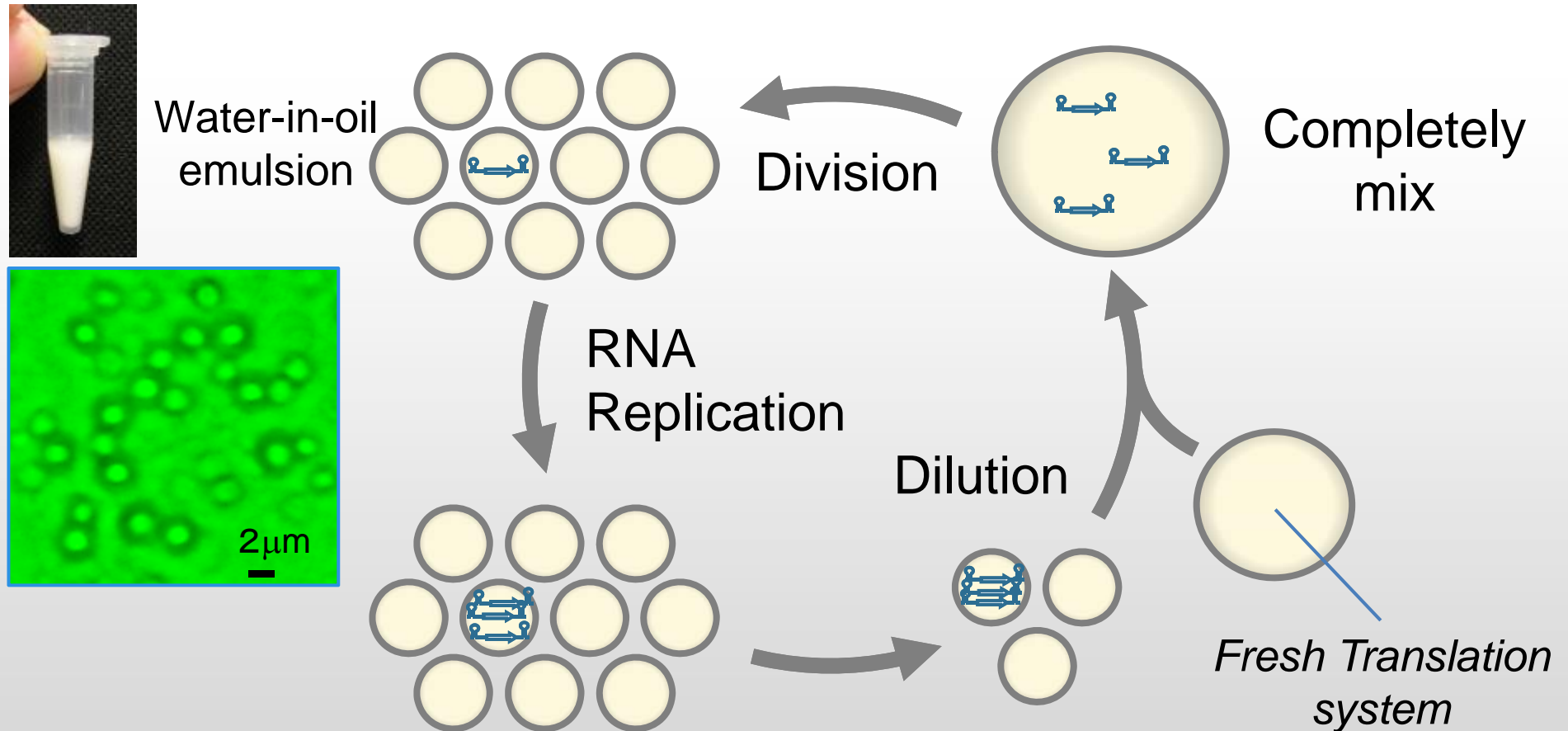
Based on Spiegelman's system (Mills 1967)



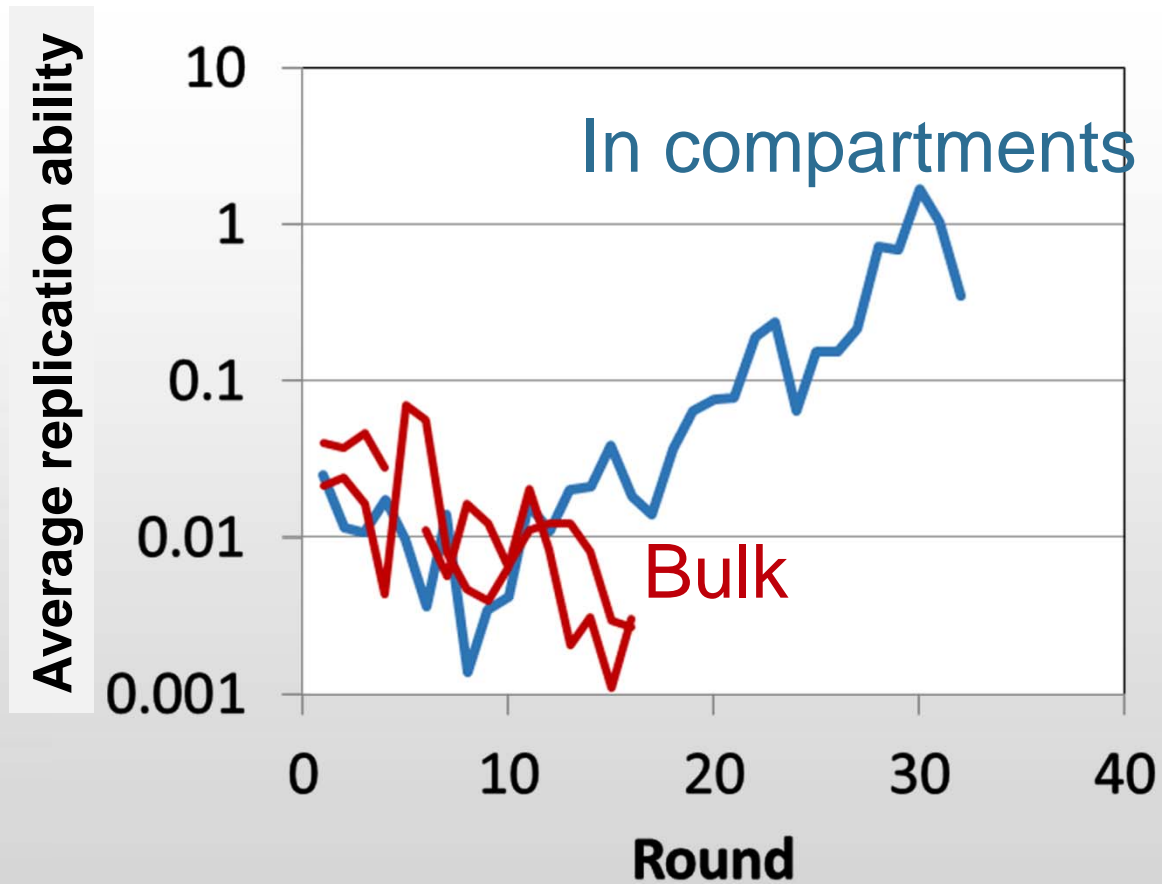
The RNA did not evolve



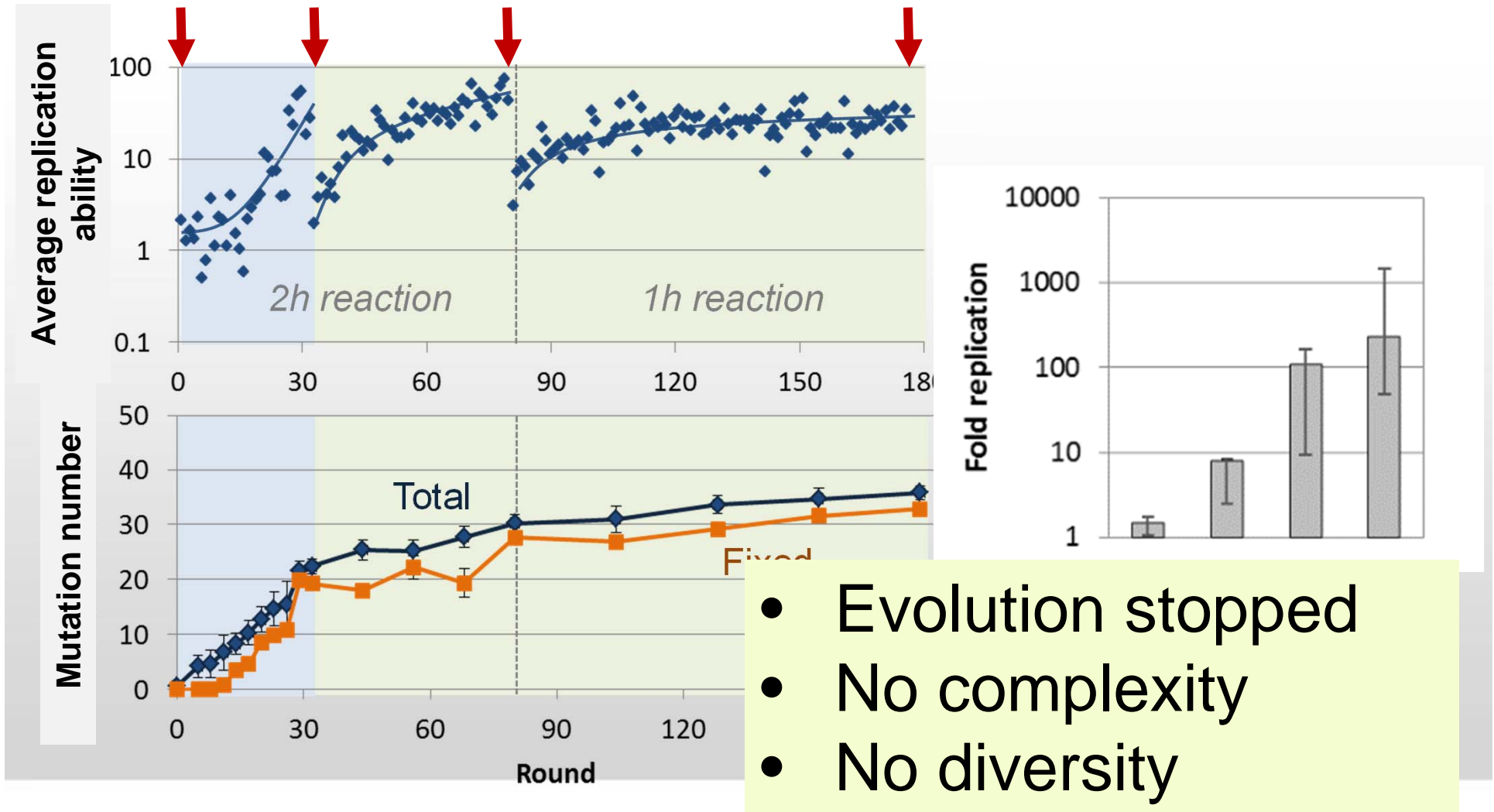
Transfer cycle in droplets



RNA evolved in droplets



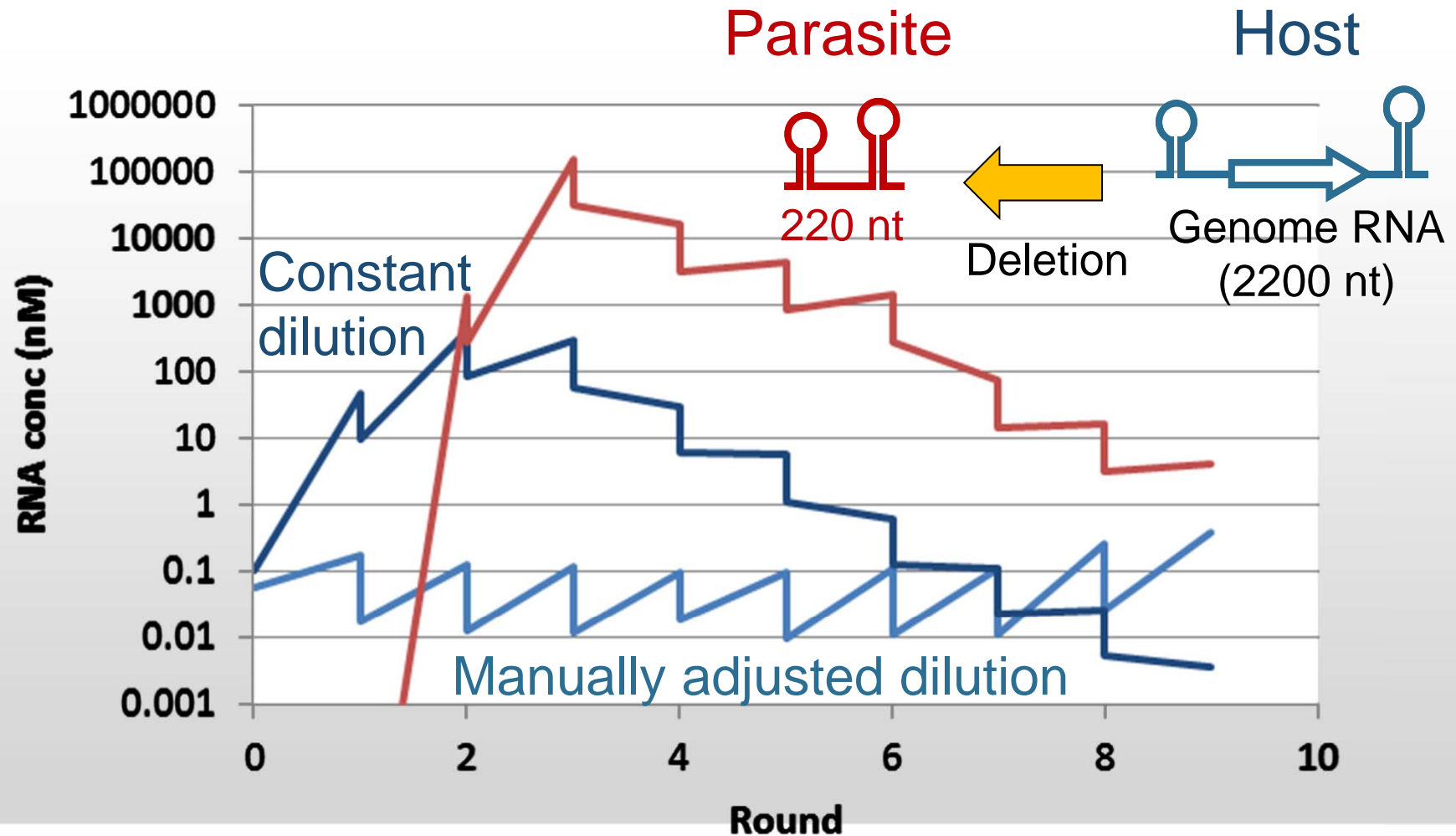
Long-term replication experiment



What is lacking?

- Parasites?
- Parasite drives host evolution and produce diversity.

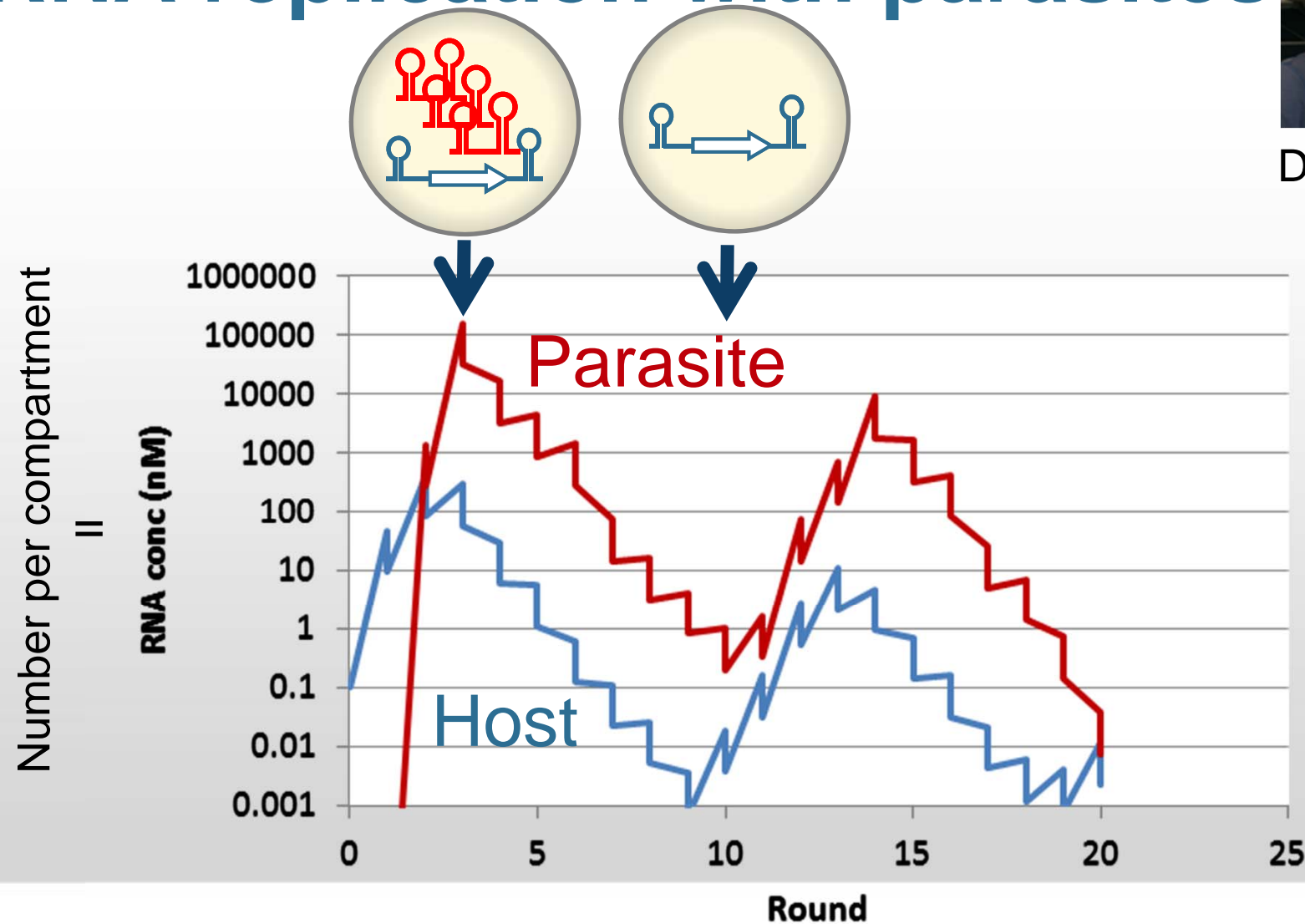
Parasite spontaneously appeared



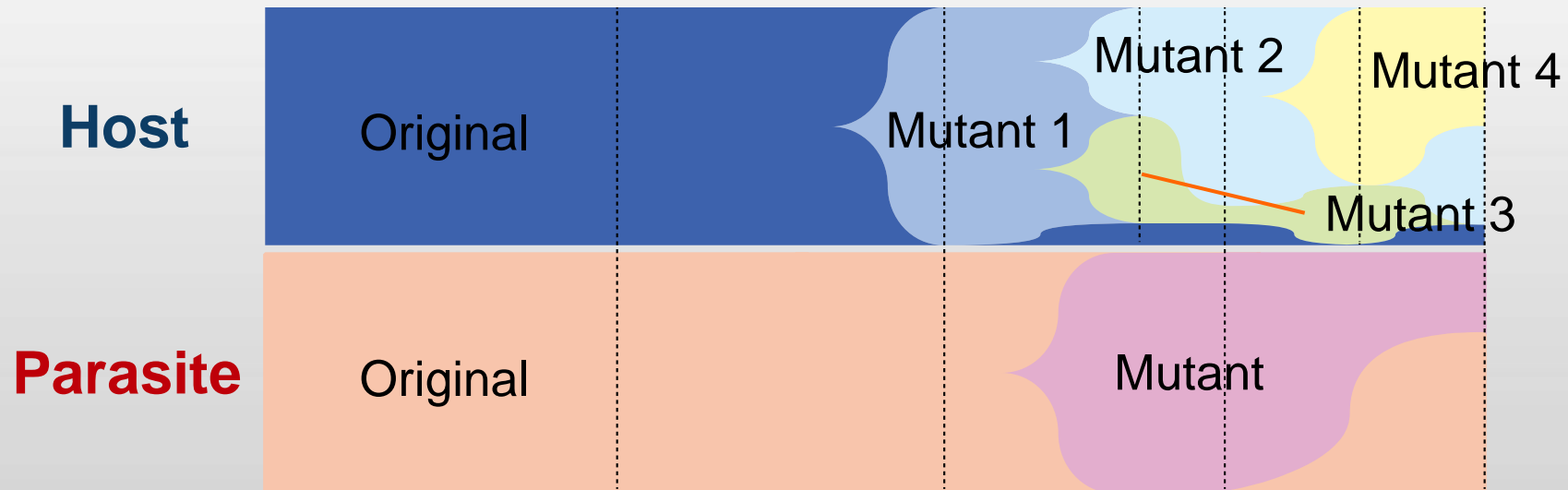
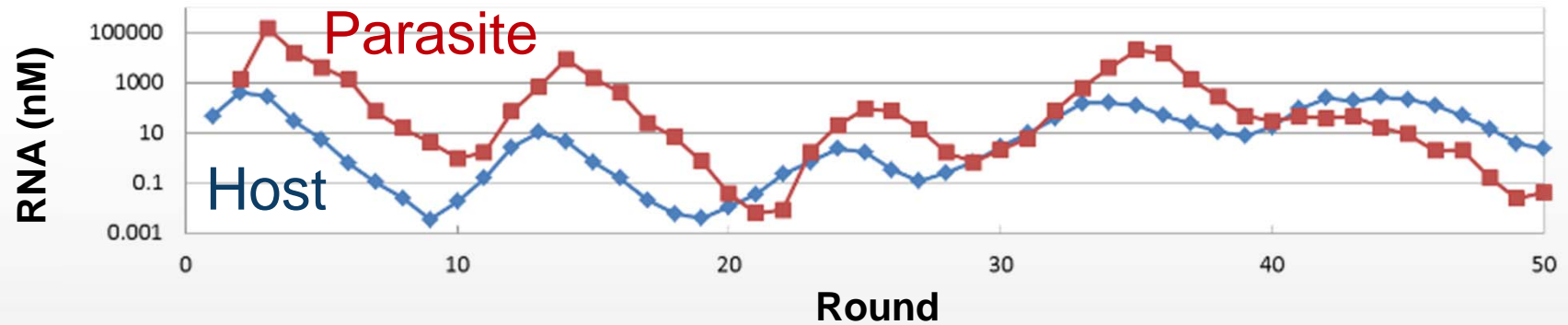
RNA replication with parasites



Dr. Yohsuke
Bansho



Evolution produces diversity



Bansho et al, PNAS 2016
Ichihashi, ALIFE 2018

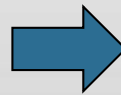
What happen if continued?

Large problem: **LABORIOUS!**

Initial 80 rounds
(1 year work)



Dr. Yohsuke
Bansho

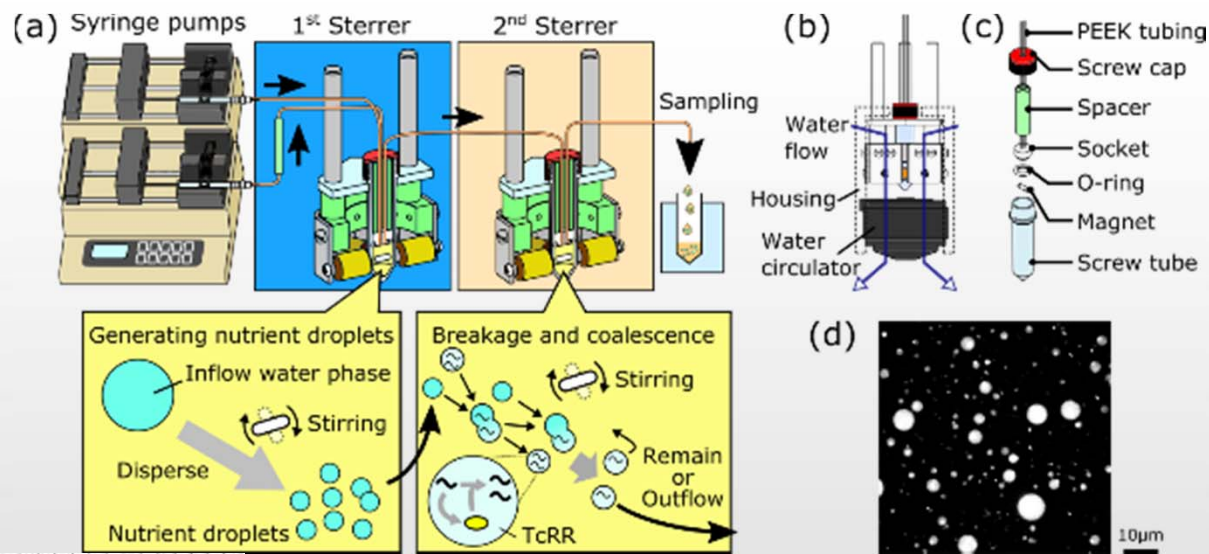


+ 80 rounds
(1 year work)



Dr. Taro
Furubayashi

Automated droplet reactor



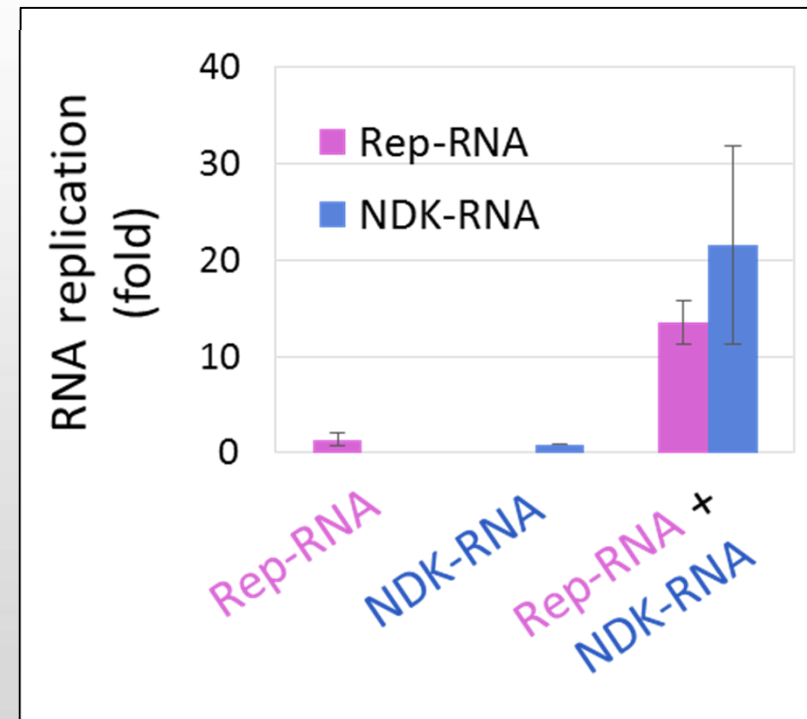
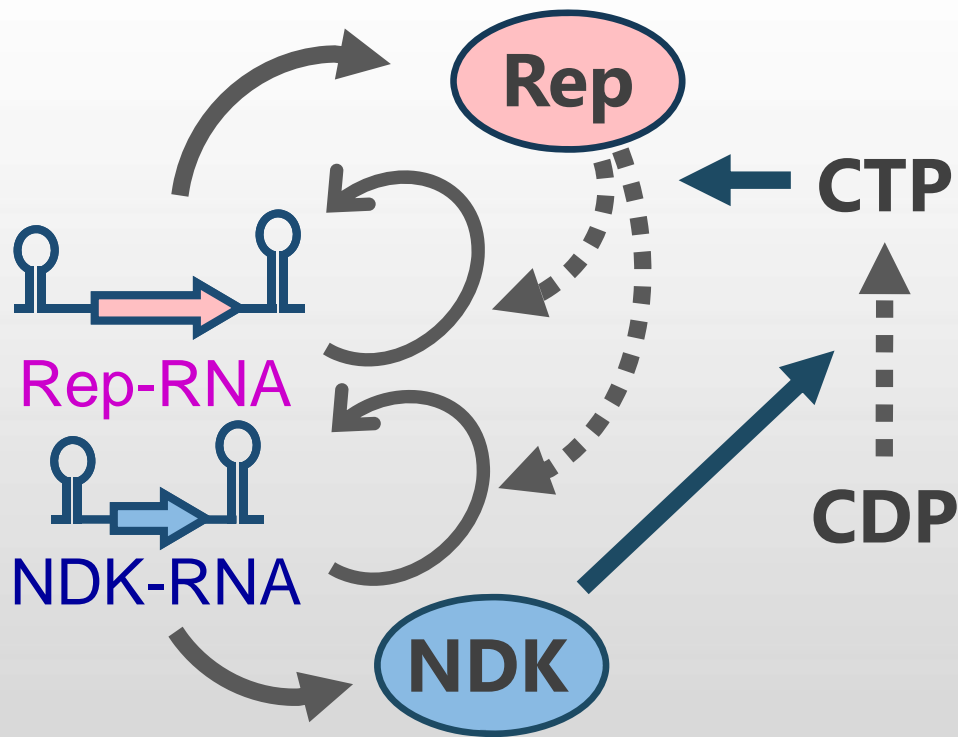
Tomoaki Yoshiyama

10 years → 1 year!

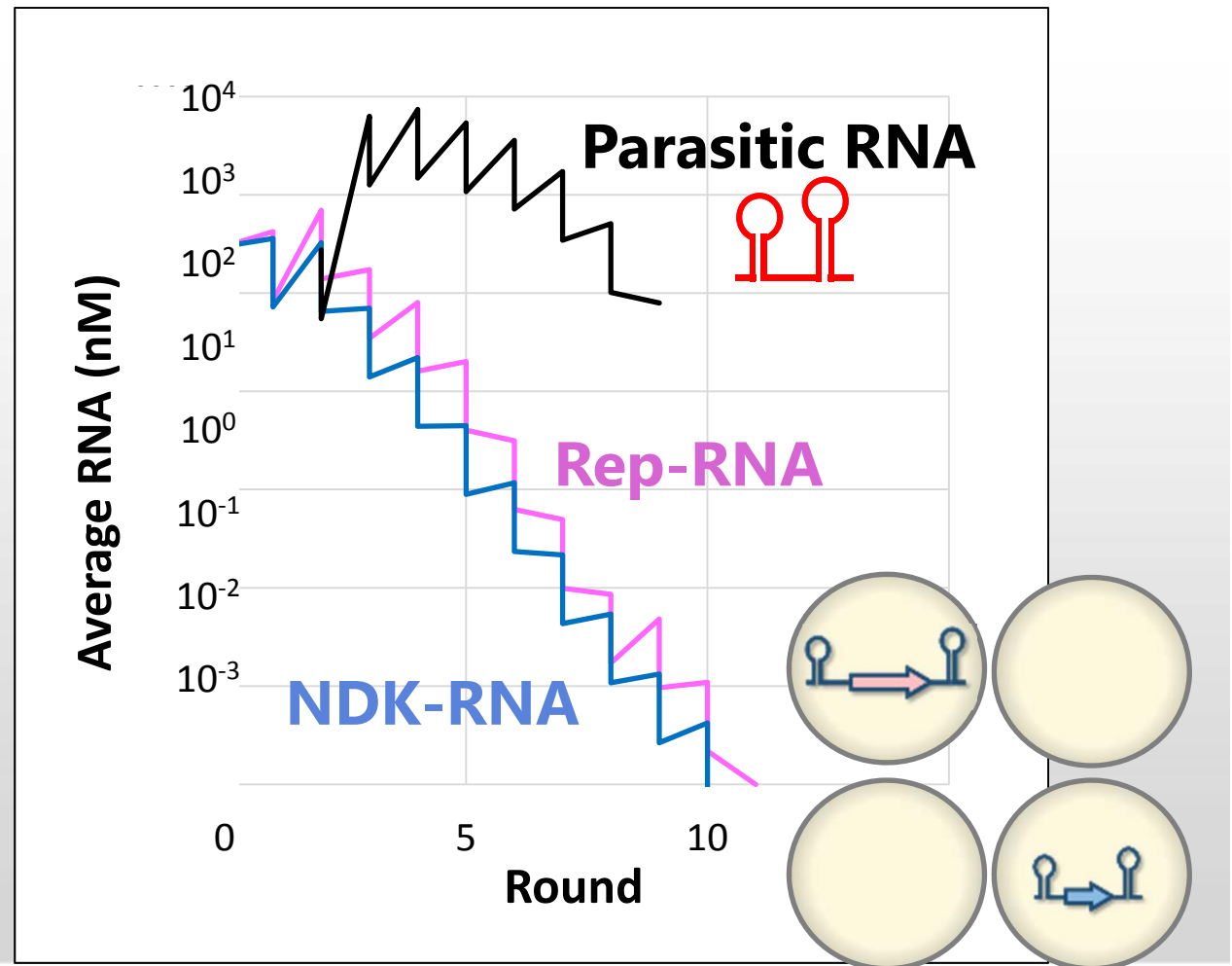
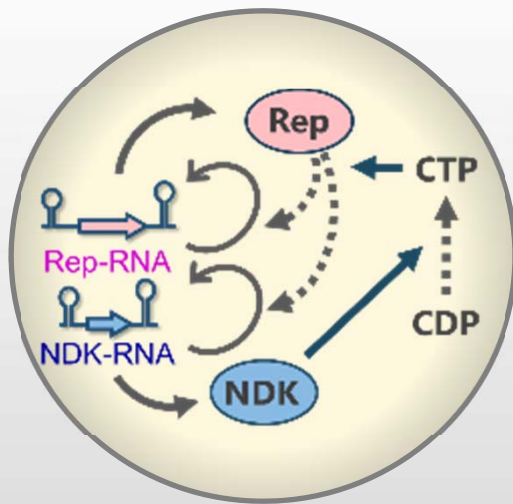
How about complexity?

- Presently, no complexity developed.
- Why?
- Complex system may be unstable in our system?

More complex replication



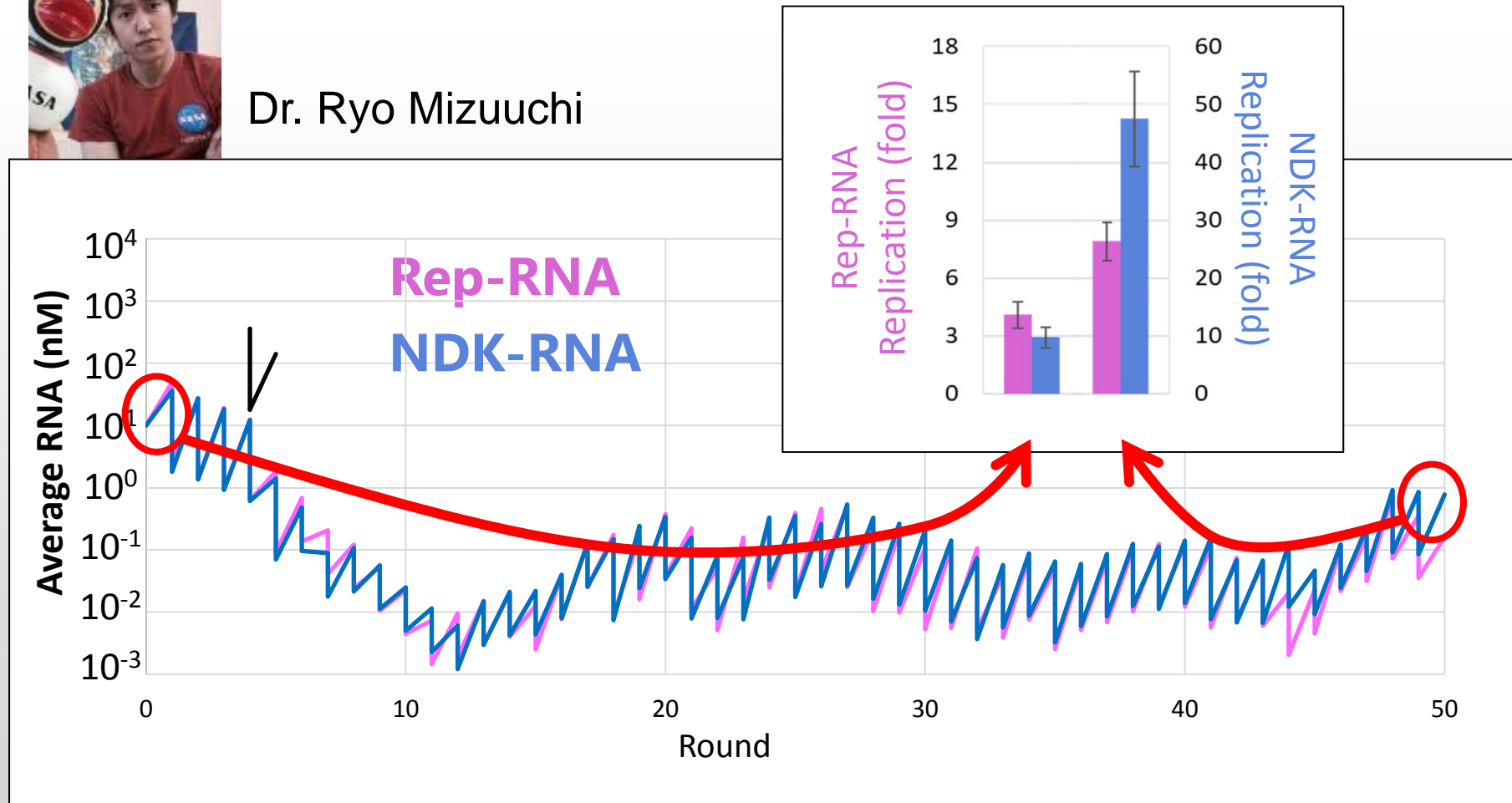
Cooperative replication easy to collapse



We found sustainable condition



Dr. Ryo Mizuuchi



Summary

- Parasites are important for continuous evolution and produce diversity.
- Complex (cooperative) system was unstable but can evolve under a certain condition.
- RNA replication system can be a good experimental model to understand possible evolutionary processes of life.

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