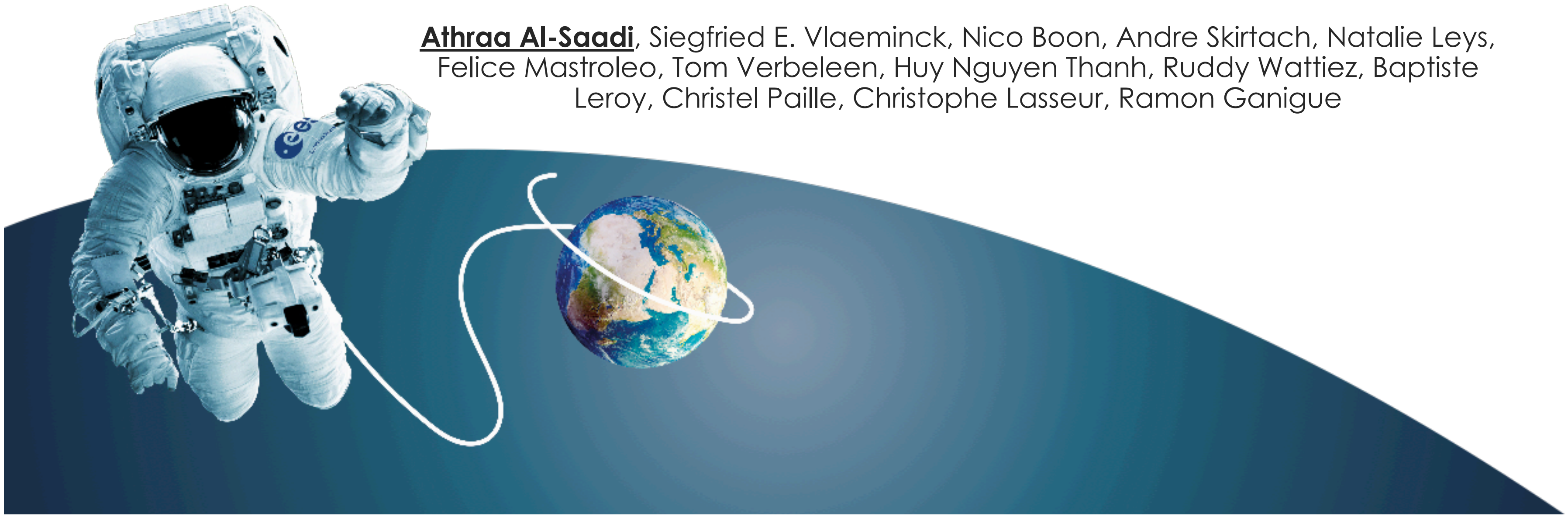
Urine nitrification in space: effect of storage conditions on *Nitosomonas europaea*

Athraa Al-Saadi, Siegfried E. Vlaeminck, Nico Boon, Andre Skirtach, Natalie Leys, Felice Mastroleo, Tom Verbeleen, Huy Nguyen Thanh, Ruddy Wattiez, Baptiste Leroy, Christel Paille, Christophe Lasseur, Ramon Ganigue



MELiSSA

Challenges for deep-space exploration

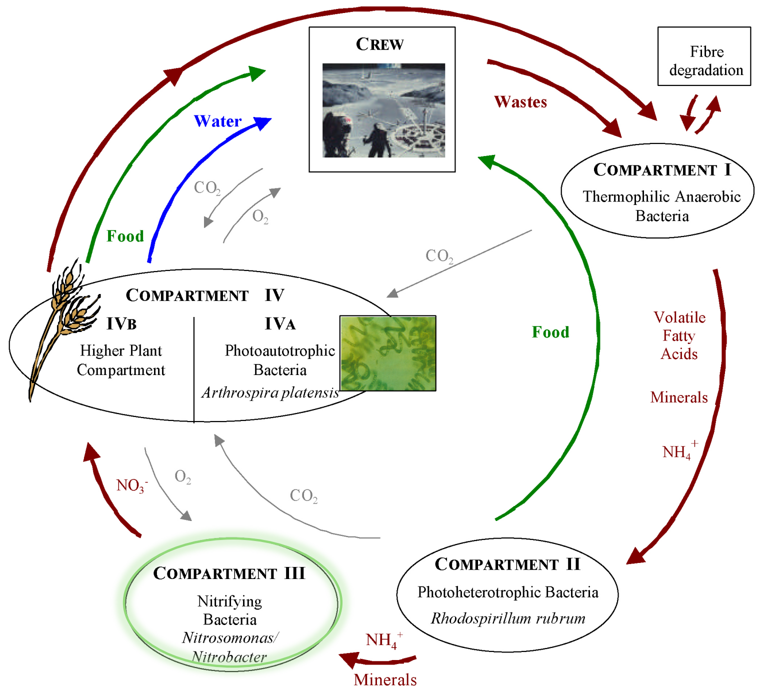
- Financial difficulties

➢ The launch price advertised by SpaceX service is $12600 per kilo .

➢ The mass requirement per a crew member is 340–470 kg per year

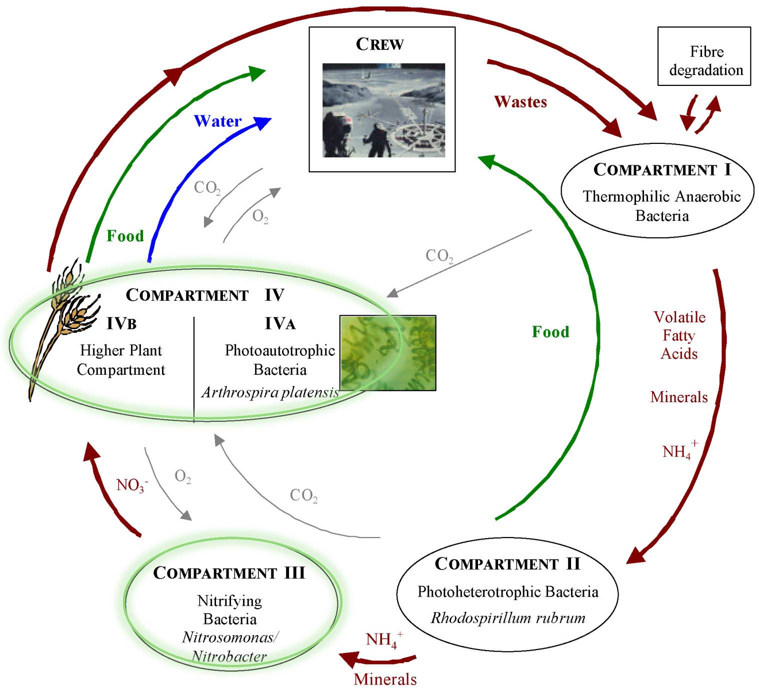
- Logistical Obstacles

Regenerative Life Support System



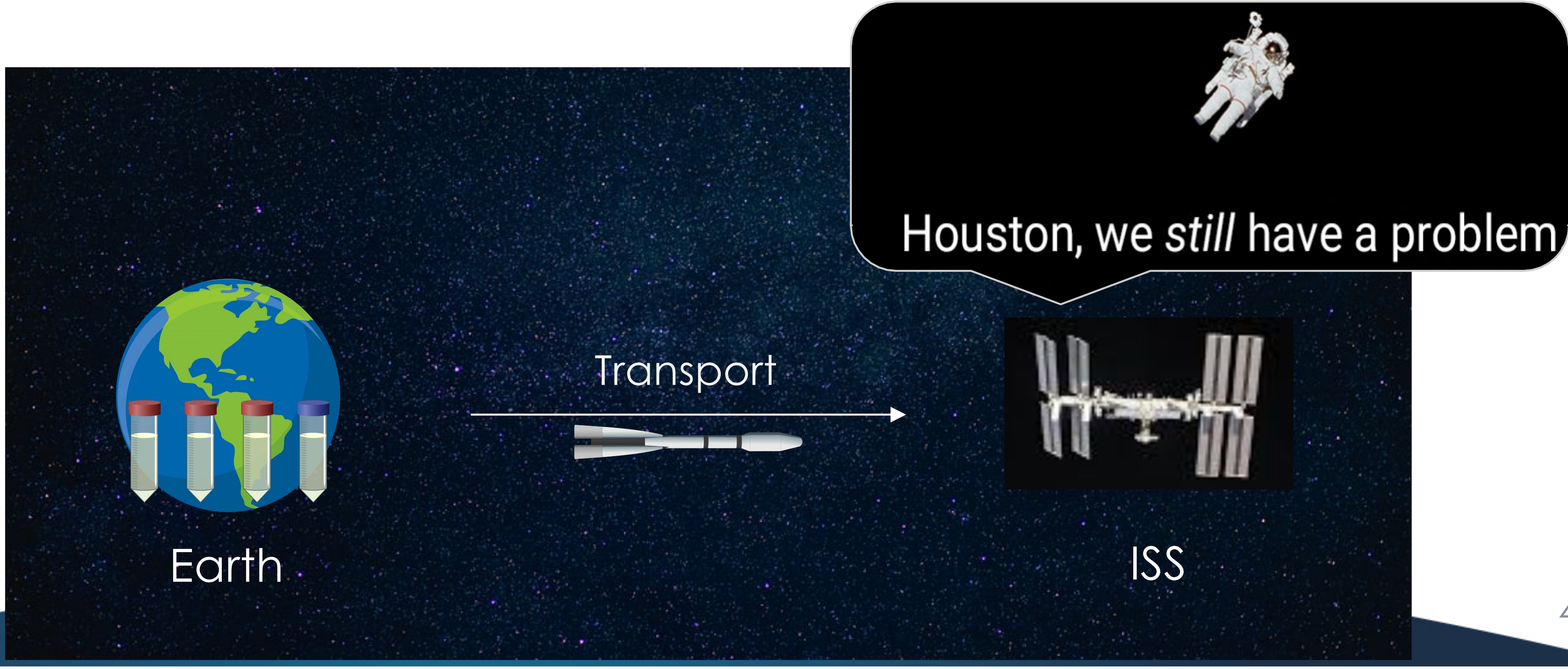
Urine nitrification in space

- Astronauts' urine posses 64% of the nitrogen can be used for food production.
- Proof of concept that **nitrification is possible** in space.
- Investigate **active nitrification** by axenic- synthetic community under space conditions.
- Synthetic community
  (Comamonas testosteroni ,Nitrosomonas euroapae, ,Nitrobacter winogradskyi)



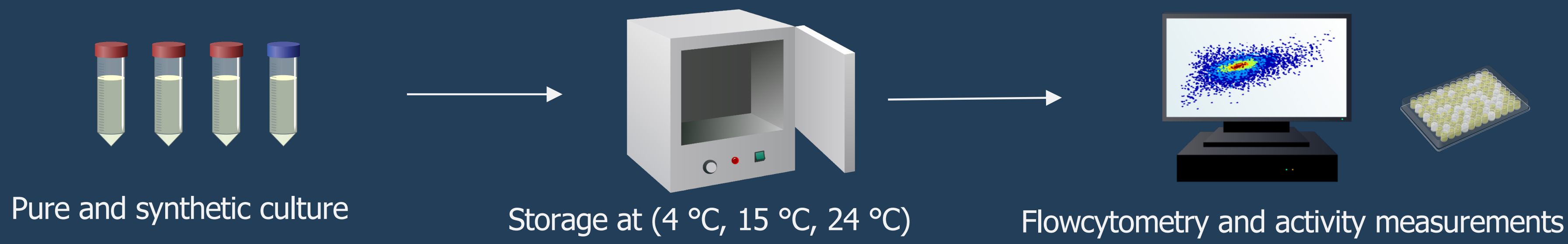
Active nitrification by axenic- synthetic nitrifying community

Define the optimal storage protocol and timeline



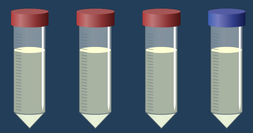
Optimization of long-term storage conditions

Experimental set up

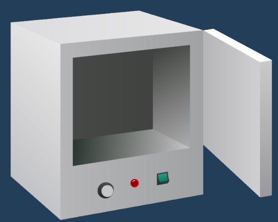


Optimization of long-term storage conditions

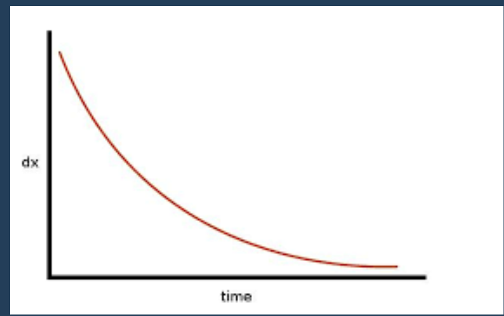
Hypothesis



Pure and synthetic culture



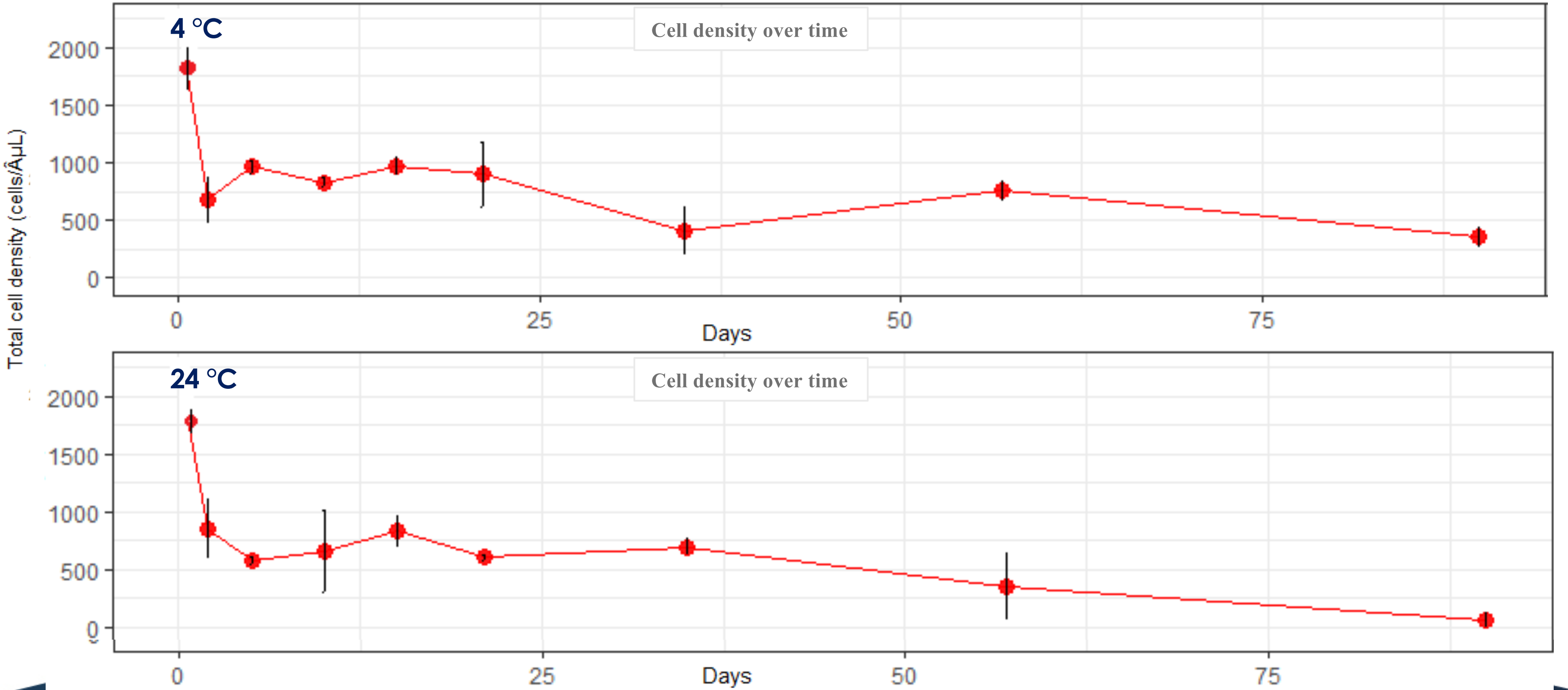
Storage at (4 °C, 15 °C, 24 °C)



Exponential decline in biomass and activity overtime

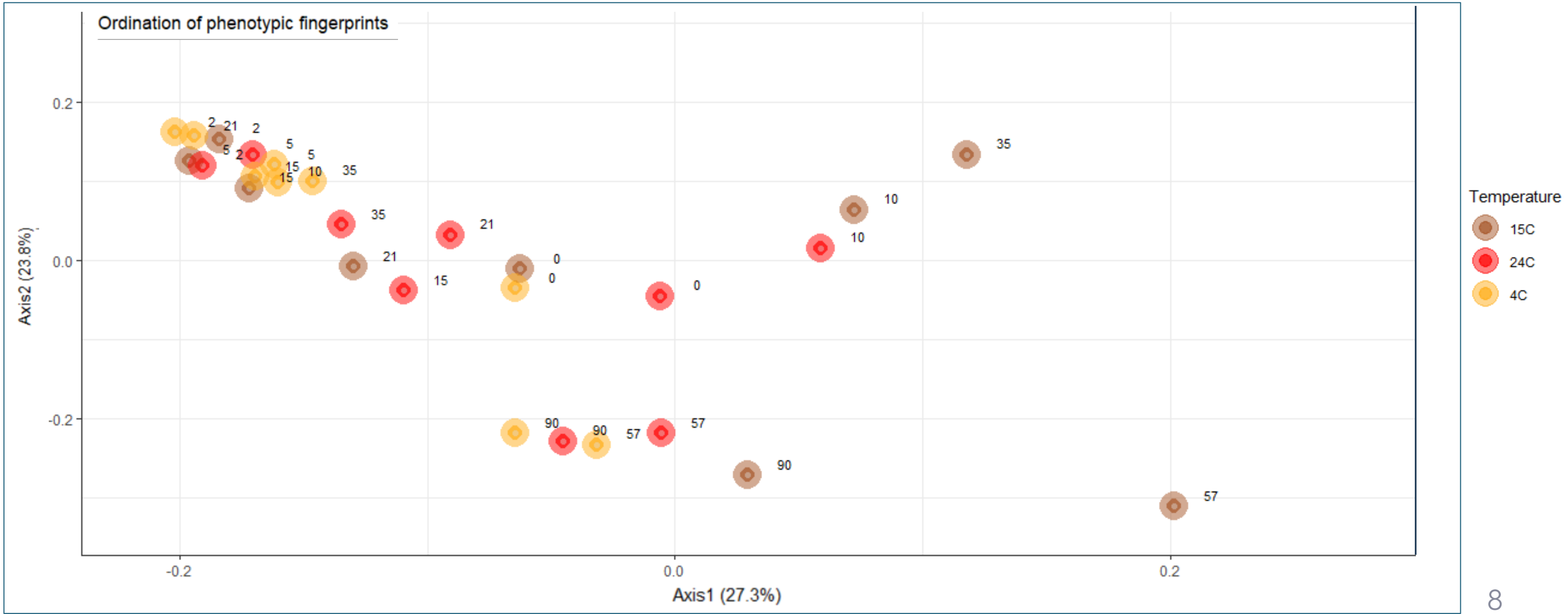
Results

A) decrease in cells density of *N.europaea* over time



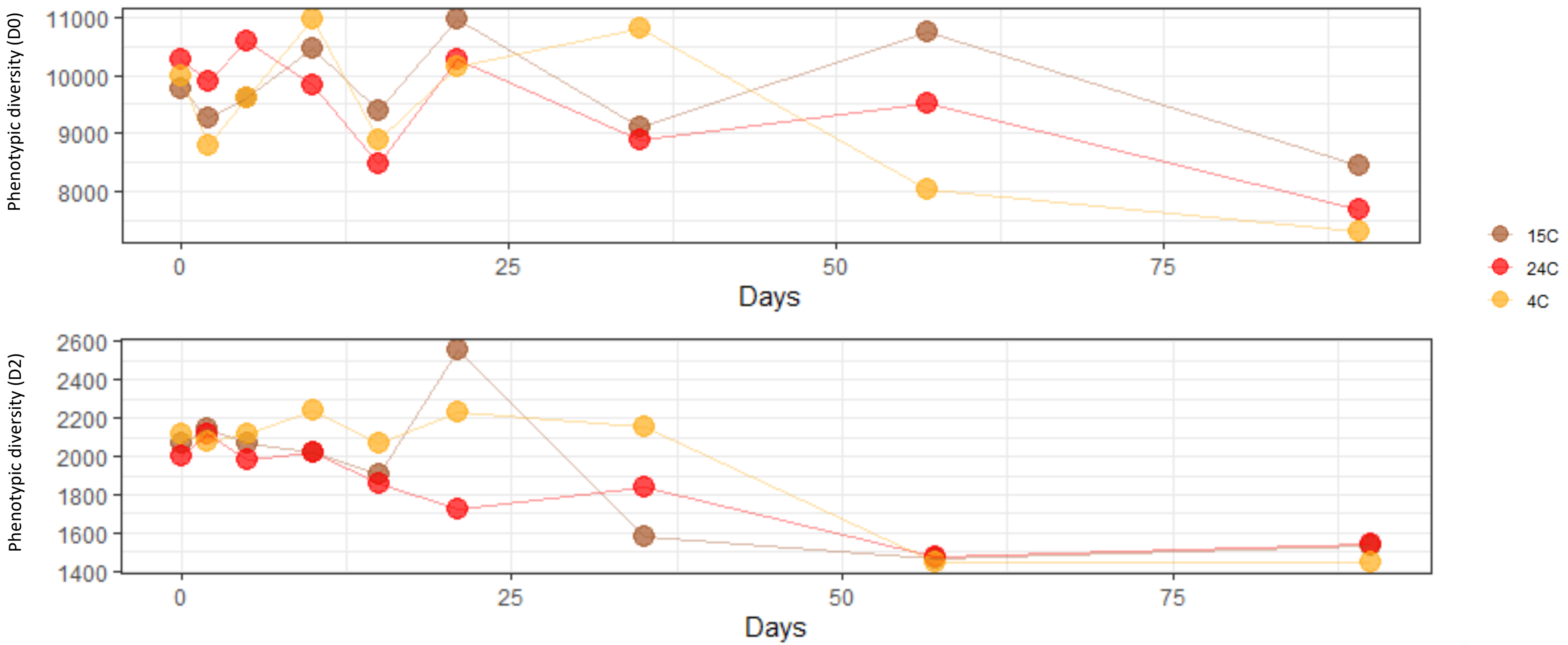
Results

B) The phenotypic structure and communities tended to evolve towards the same structure as the storage period lasts.



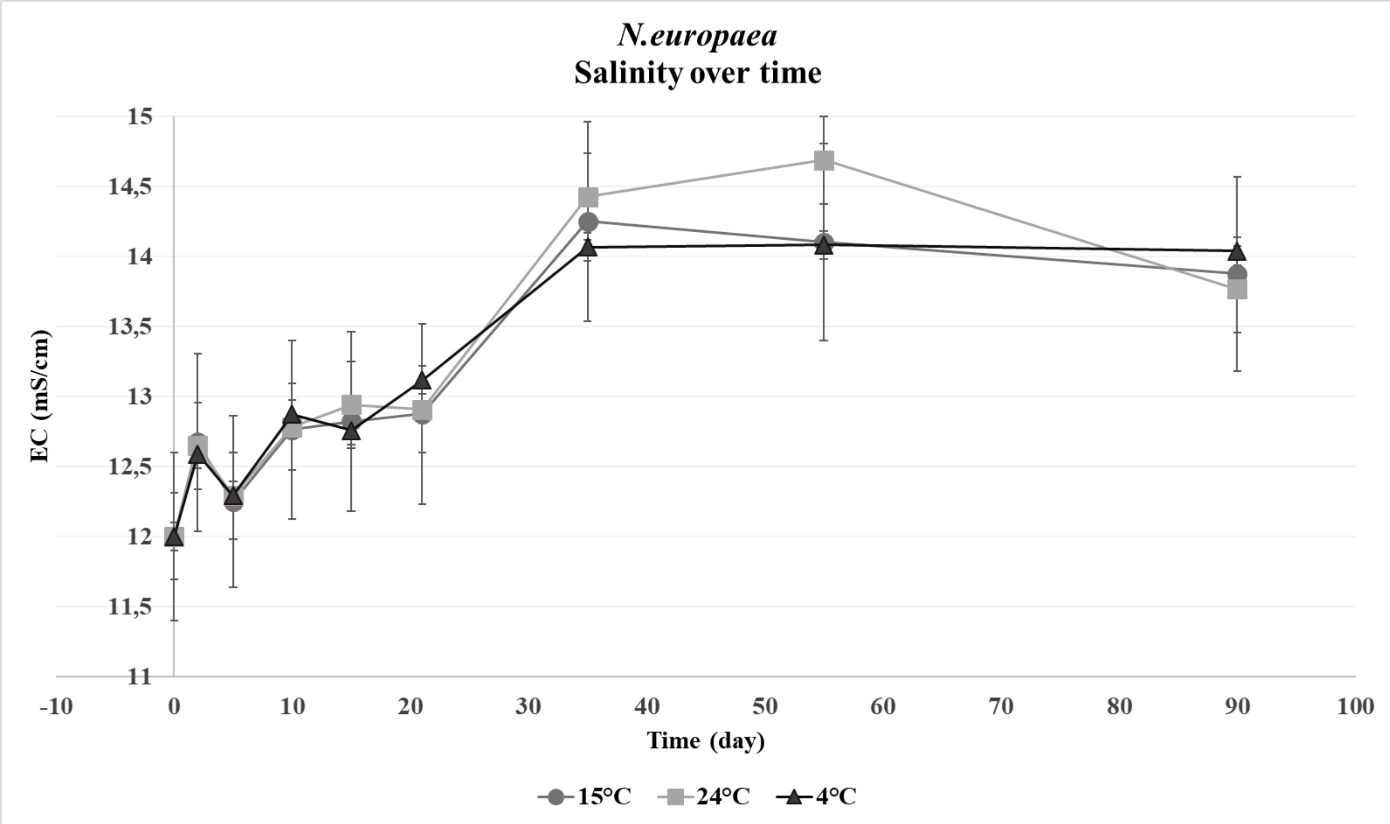
Results

C. The phenotypic heterogeneity within the samples exhibited reduction in both richness and phenotypic diversity for all temperatures



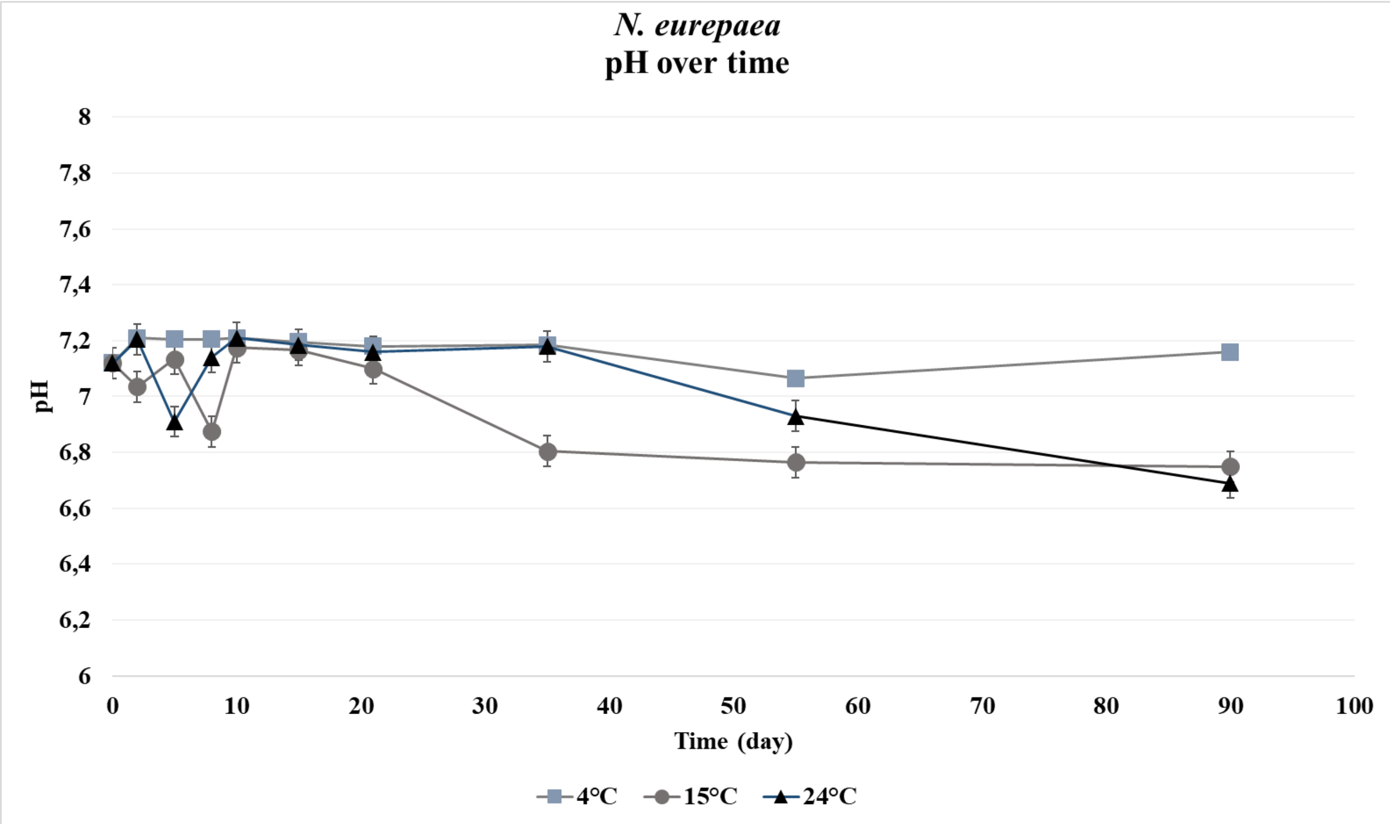
Results

D. Change in salinity and pH as the starvation continuous



Results

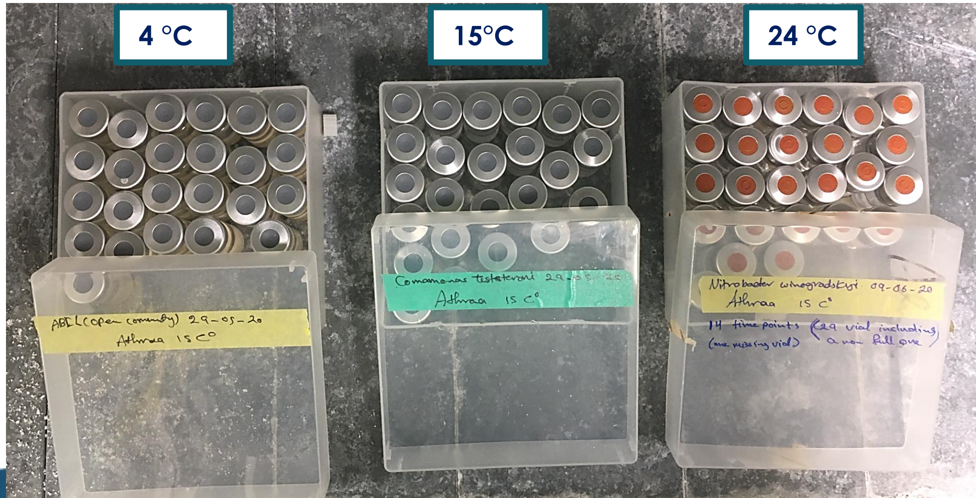
D. Change in salinity and pH as the starvation continuous



Results

Activity test after 90 days of storage:

- Samples from 4 °C stocks were successfully activated after 24 hours with NH_4 consumption rate of 8.36 mg L^{-1} d^{-1}
- No activity was observed by the samples retrieved from 15 °C and 24 °C stock



Summary

Starvation due to substrate depletion can lead to decrease in phenotypic heterogeneity ⟶ decrease in nitrification activity

- The optimal temperature for long term storage of *Nitrosomonas Europaea* is 4°C
- Phenotypic heterogeneity of *N. europaea* is affected by time
- The low activity by bacteria is correlated with low phenotypic diversity

- Compare the richness and evenness of *N, europaea* in the synthetic culture (*Comamonas testosteroni* and *Nitrobacter winogradskyi)*
- Study the effect of time and temperature on the growth kinetics (growth and decay rates, mass balance, nitrification efficiencies)

MELiSSA

MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

THANK YOU.

Athraa AL-SAADI

UGent- UAntwerpen

Athraa.alsaadi@ugent.be

GHENT UNIVERSITY | CMET | Universiteit Antwerpen | UMONS Université de Mons | sck cen | esa European Space Agency

belspo

www.melissafoundation.org

Follow us

PARTNERS

IN COOPERATION WITH

esa
European Space Agency

MELiSSA FOUNDATION

ENGIN SOFT

GHENT UNIVERSITY

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

SEMiLLA
IPSTAR Circular Systems™

SHERPA ENGINEERING

University of Antwerp

UAB
Universitat Autònoma de Barcelona

UCA
UNIVERSITÉ Clermont Auvergne

UNIVERSITY of GUELPH

UMONS
Université de Mons

Unil
UNIL | Université de Lausanne

vito