MELISSA
MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

2022 MELISSA CONFERENCE
8-9-10 NOVEMBER 2022

CREATING A CIRCULAR FUTURE

Community shift of ammonia-oxidizing bacteria and washout of nitrite-oxidizing bacteria due to pH changes during urine nitrification

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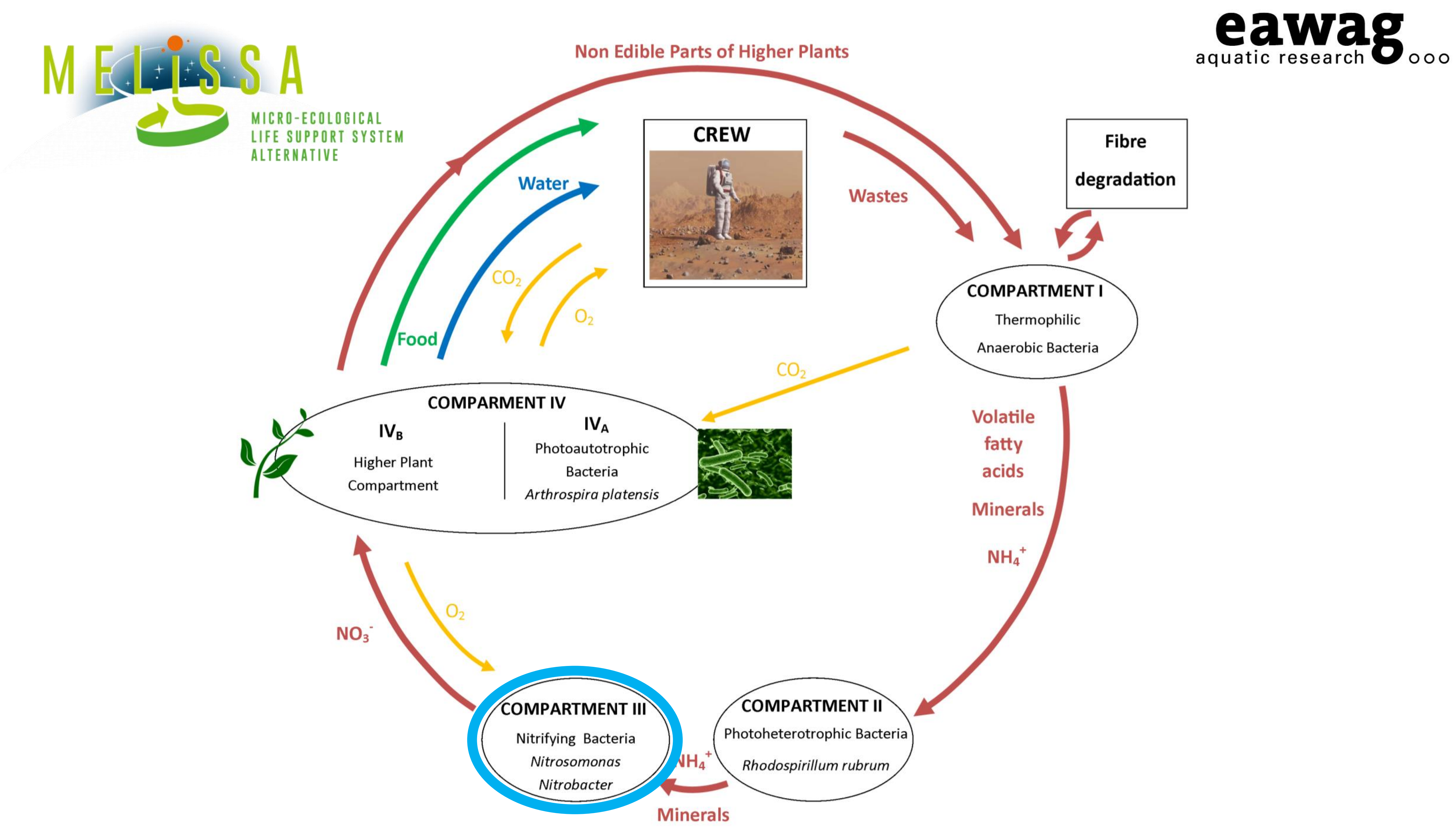
Ramon Ganigué (Ghent University), Kai M. Udert (Eawag)



MELiSSA
MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE
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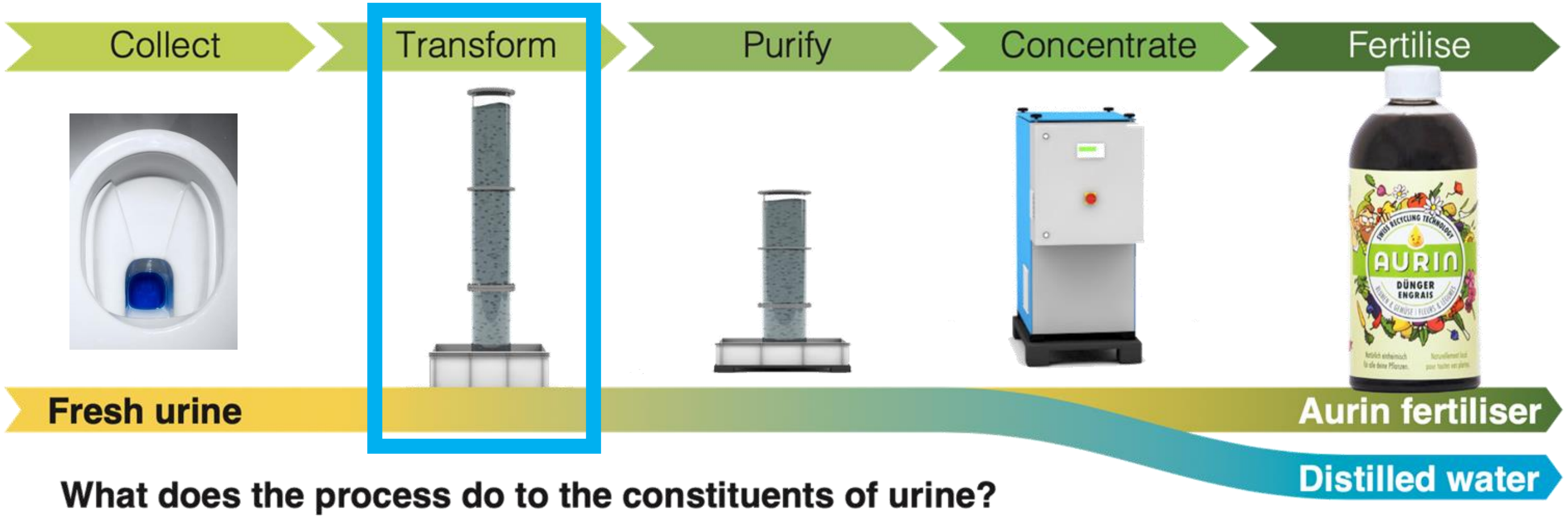
aquatic research
Non Edible Parts of Higher Plants
CREW
Wastes
Fibre degradation
Water
Food
CO_2
O_2
COMPARTMENT I
Thermophilic
Anaerobic Bacteria
CO_2
Volatile fatty acids
Minerals
NH_4^+
COMPARMENT IV
IV_B
Higher Plant Compartment
IV_A
Photoautotrophic Bacteria
Arthrospira platensis
NO_3^-
O_2
COMPARTMENT III
Nitrifying Bacteria
Nitrosomonas
Nitrobacter
NH_4^+
Minerals
COMPARTMENT II
Photoheterotrophic Bacteria
Rhodospirillum rubrum



What does the process do to the constituents of urine?

- ✗ Heavy metals – not present in urine
- Bad smell & volatile ammonia
- Pharmaceuticals & hormones
- Pathogens
- **Primary nutrients** (nitrogen, phosphorus, potassium etc.) ✓
- **Trace elements** (boron, iron, zinc etc.) ✓

Processed & preserved as essentials for your plants's growth

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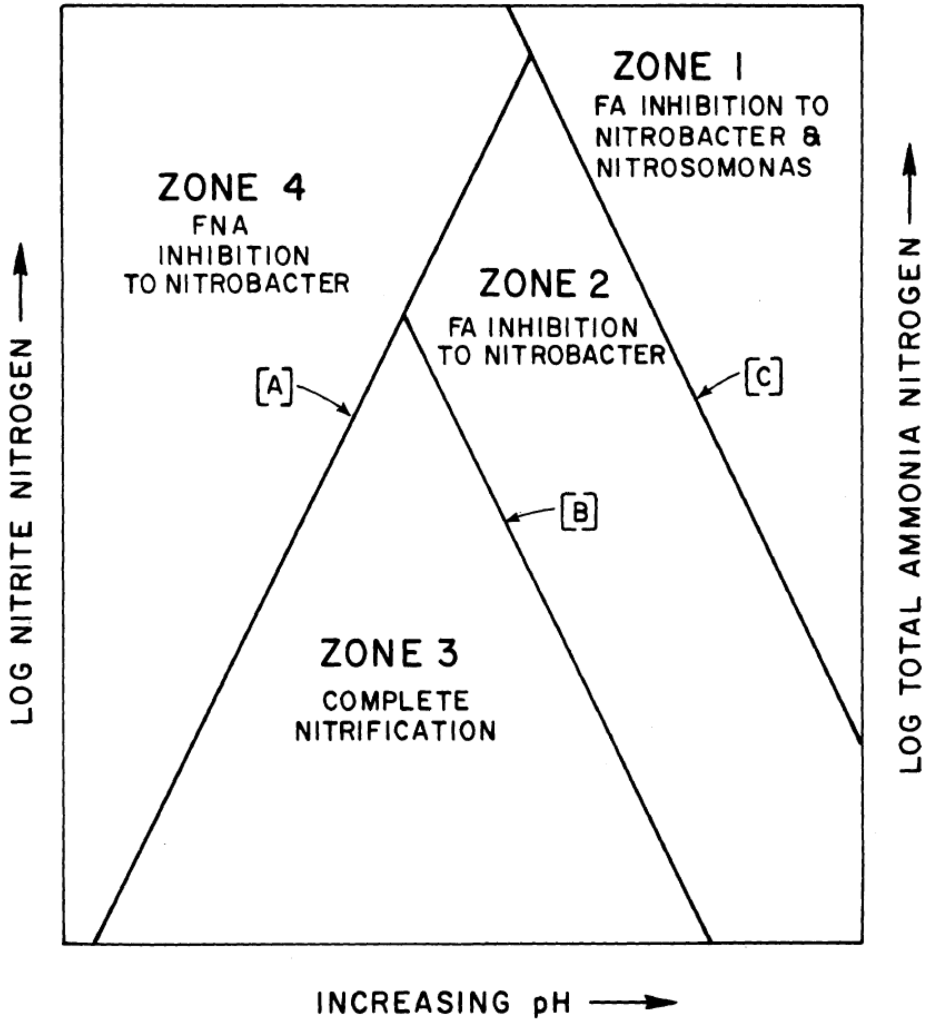
Substrate and product inhibition



Start of inhibition:

[A]	AOB and NOB by HNO_2	0.22 to 2.8 mgN/L
[B]	NOB by NH_3	0.1 to 10 mgN/L
[C]	AOB by NH_3	10 to 150 mgN/L

Anthonisen, A.C., Loehr, R.C., Prakasam, T.B.S. and Srinath, E.G. (1976) Inhibition of nitrification by ammonia and nitrous acid. *Journal of the Water Pollution Control Federation* **48(5),** 835-852.

Results of Batch Experiments

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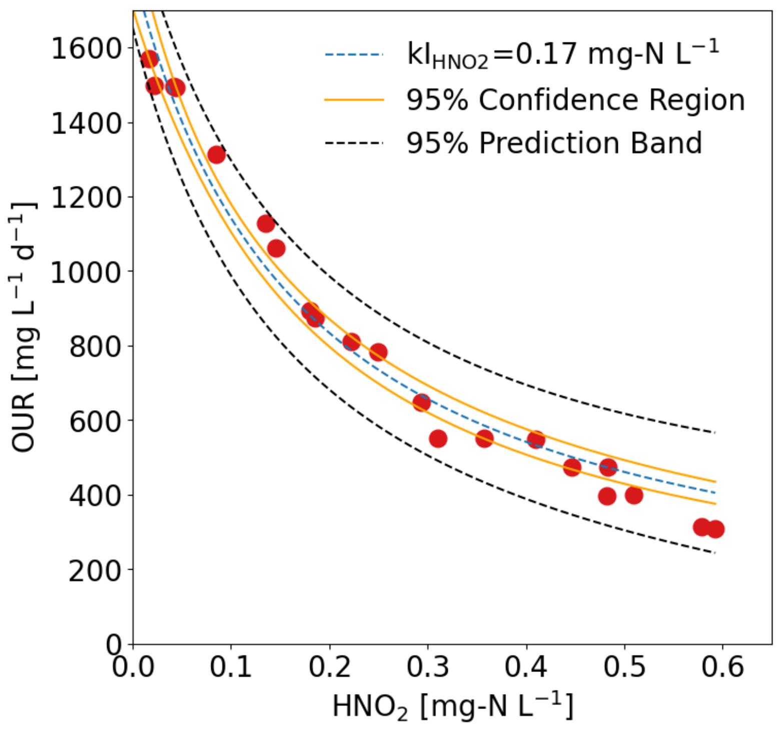
	$k_{S,NH3}$ [mgN/L]	$k_{S,NO2-}$ [mgN/L]	$k_{I,NH3}$ [mgN/L]	$k_{I,HNO2}$ [mgN/L]
AOB	1.6 ± 0.5	-	49 ± 17	0.34 ± 0.07
	0.28 to 1.06	-	70 to 3000	
NOB	-	1.5 ± 0.2	33 ± 6	0.17 ± 0.02
	-	0.05 to 9.6	0.8 to 252	0.13 to 2.8

Blue: own data
Black: literature values



HNO_2 inhibition constant for NOB

CSTR: pH increase from 6 to 7

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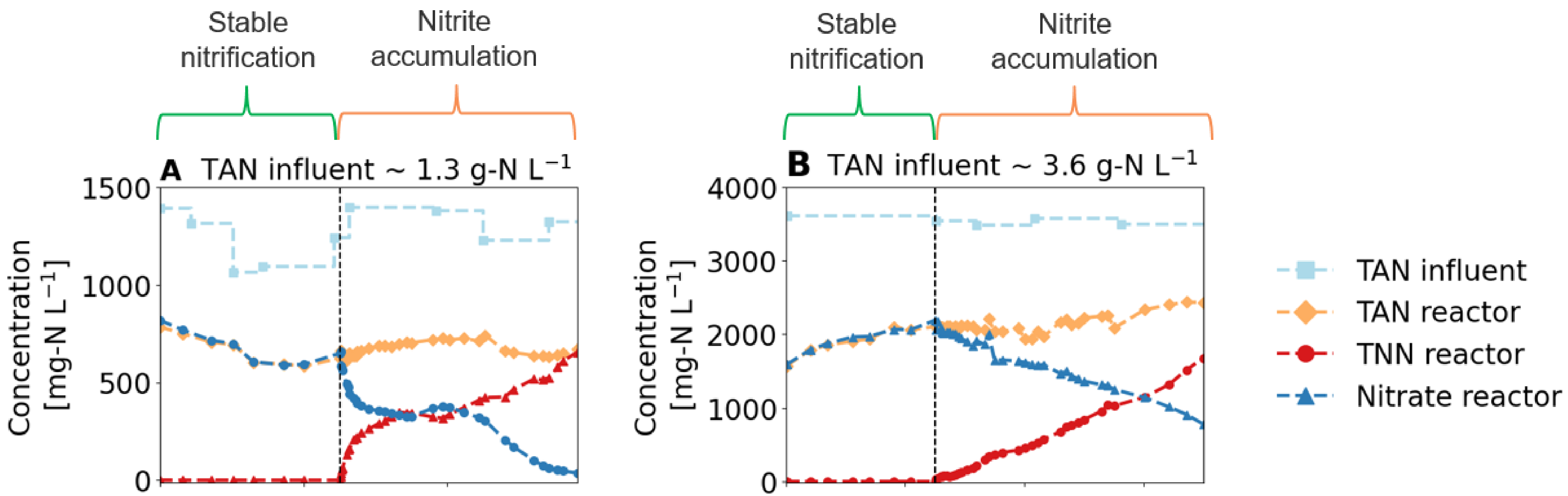
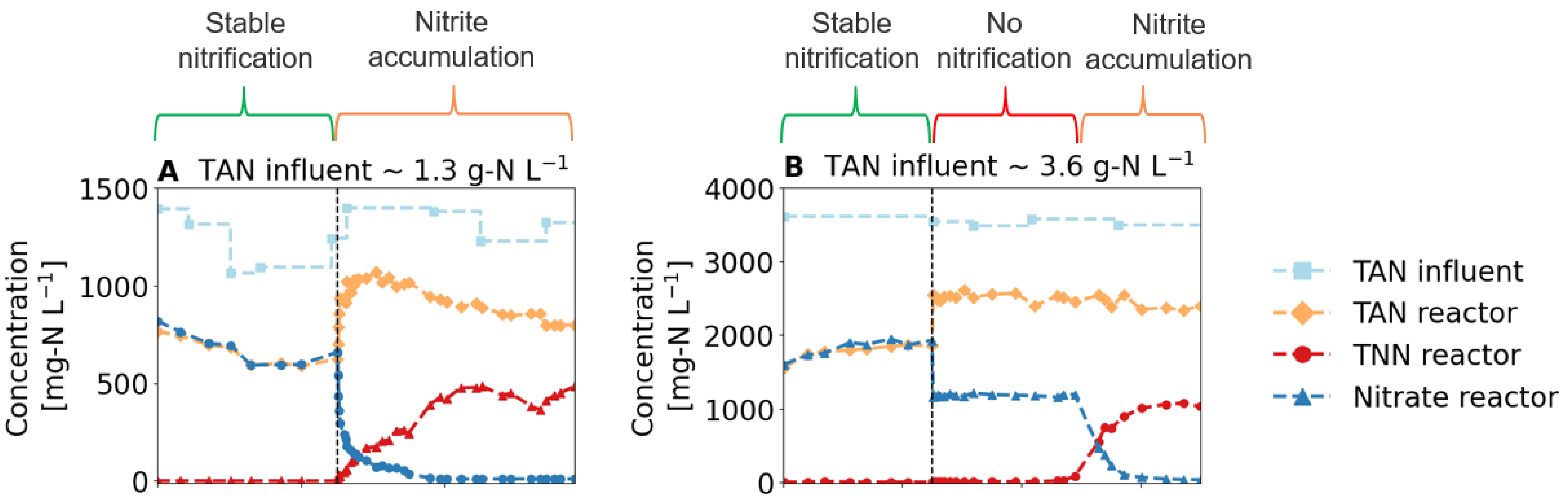


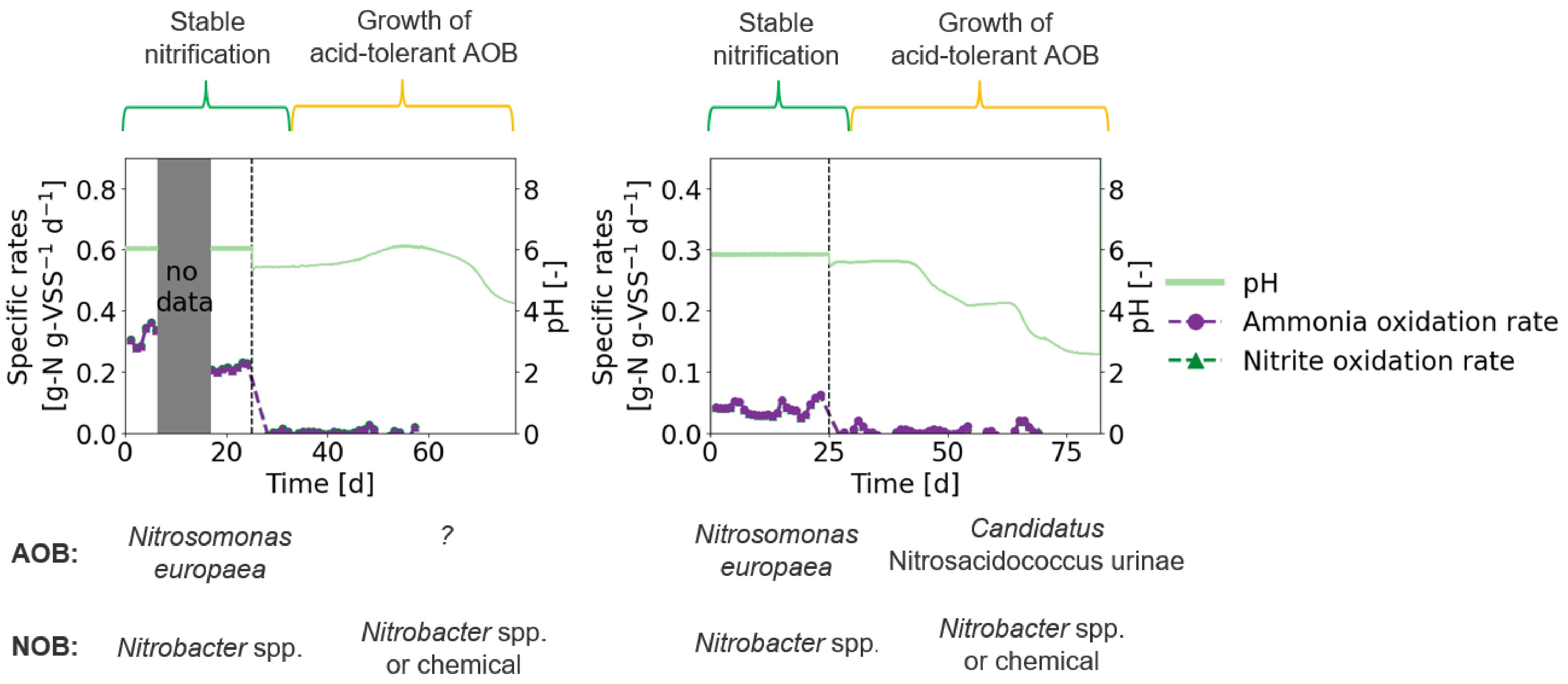
AOB:	*Nitrosomonas europaea*	*Nitrosomonas halophila*	*Nitrosomonas europaea*	*Nitrosomonas halophila*
NOB:	*Nitrobacter* spp.	-	*Nitrobacter* spp.	-

CSTR: pH increase from 6 to 8.5

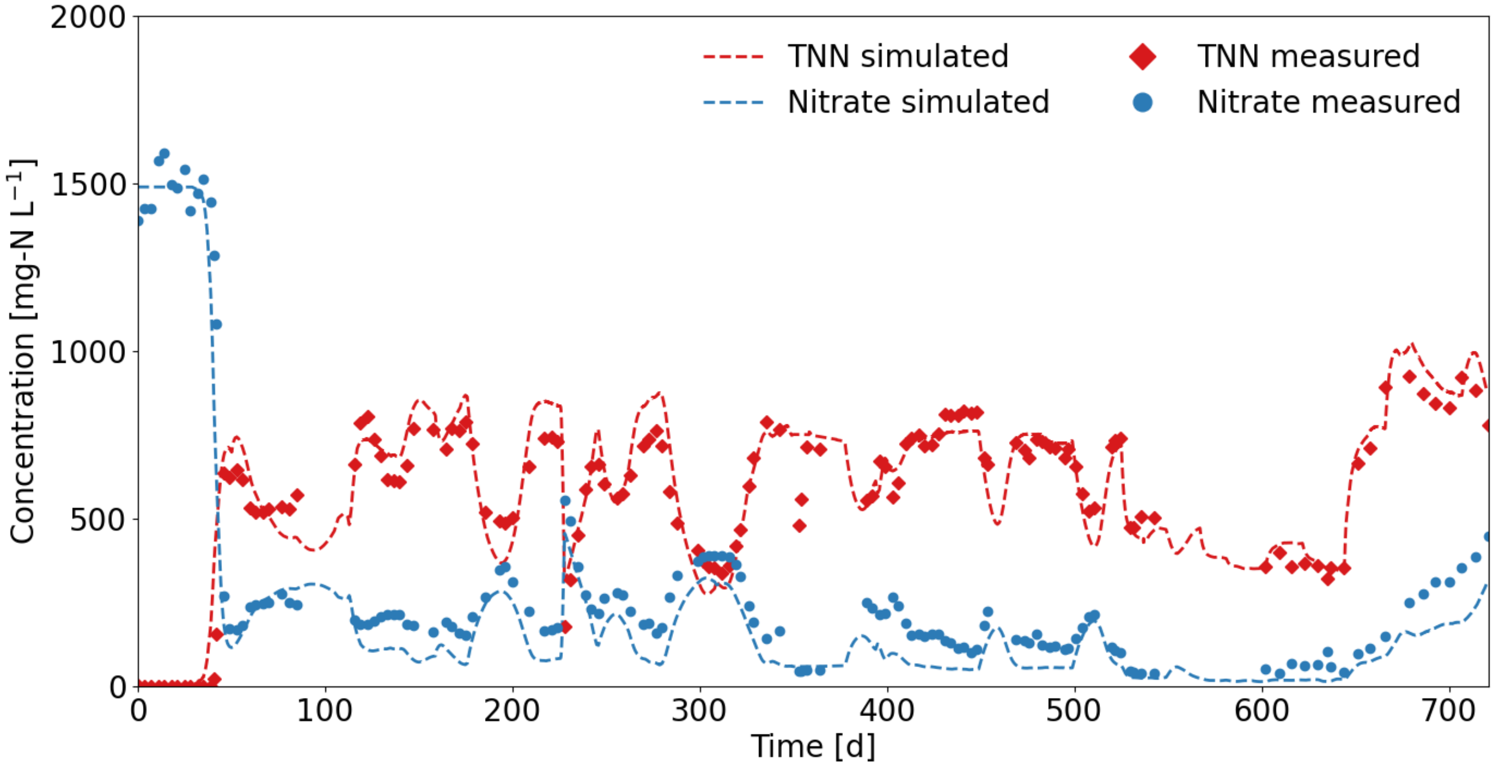


AOB:	*Nitrosomonas europaea*	*Nitrosomonas stercoris*	*Nitrosomonas europaea*	*Nitrosomonas stercoris*
NOB:	*Nitrobacter* spp.	-	*Nitrobacter* spp.	-

CSTR: no pH control



CSTR at pH 5

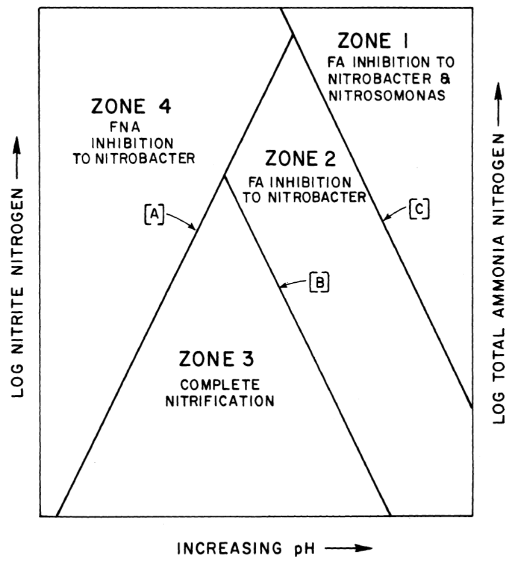


Chemical but no biological nitrite oxidation

Faust, V., van Alen, T.A., Op den Camp, H.J.M., Vlaeminck, S.E., Ganigué, R., Boon, N. and Udert, K.M. (2022) Ammonia oxidation by novel "Candidatus Nitrosacidococcus urinae" is sensitive to process disturbances at low pH and to iron limitation at neutral pH. *Water Research* X **17**, 100157.

Conclusions

For urine treatment, the model of Anthonisen et al. must be extended.



Biological nitrite oxidation only occurred between pH 5.8 and 6.7, but…

Biological ammonia oxidation was possible over a wide pH range (2.5 to 8.5), because specialized AOB were selected.

Chemical nitrite oxidation occurs at low pH values.

THANK YOU.

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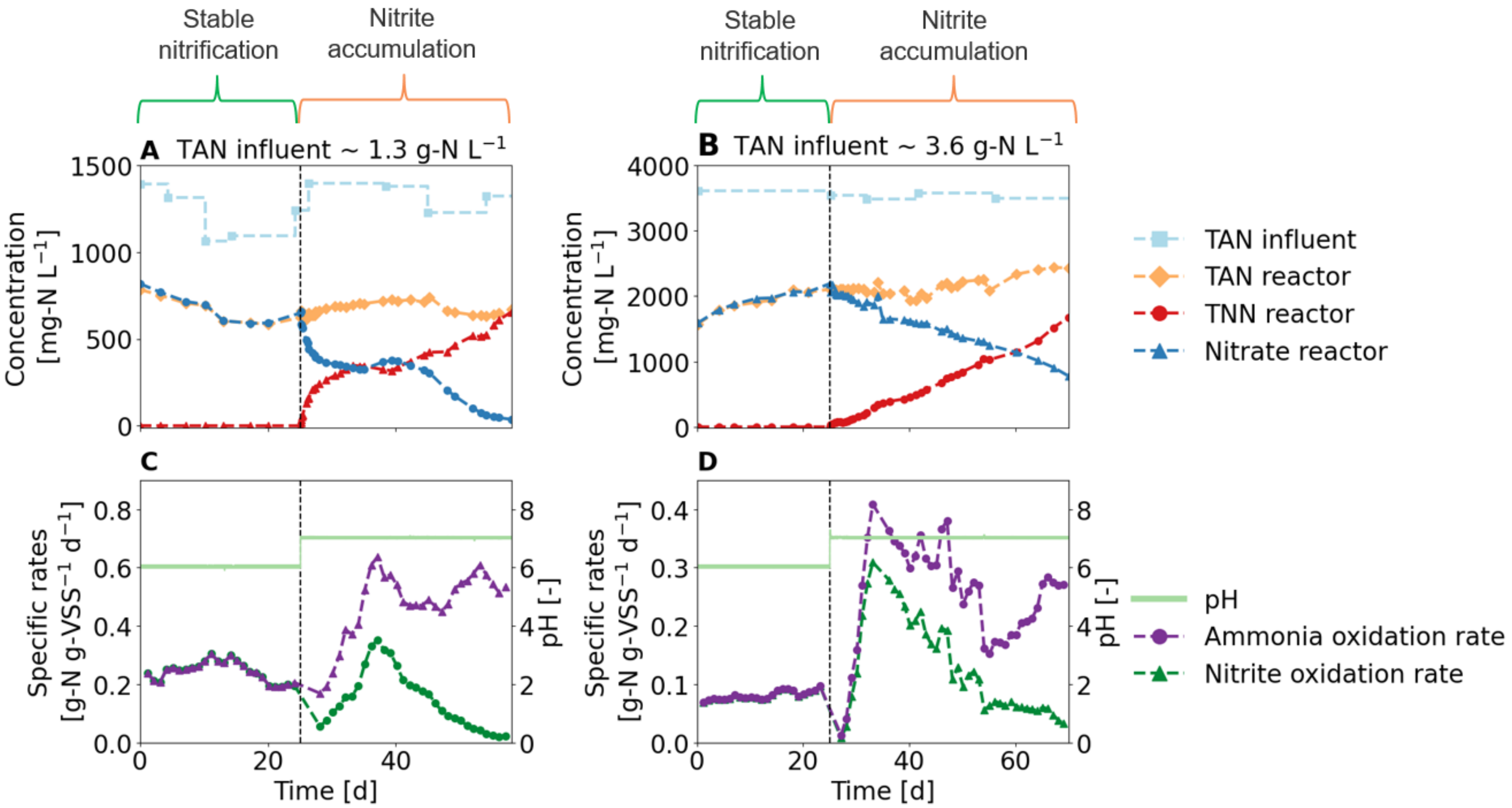
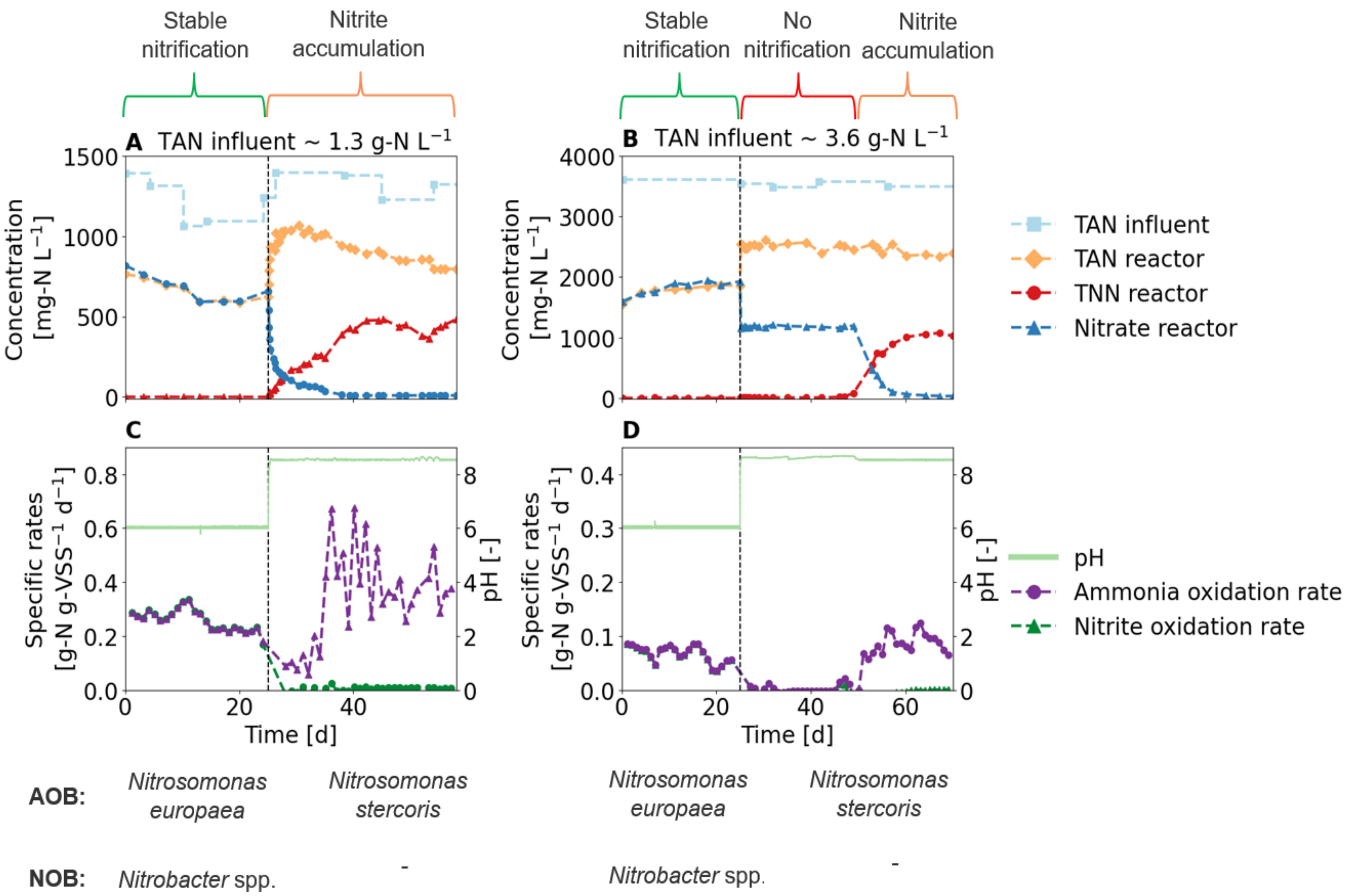
Further slides

CSTR: pH increase from 6 to 7

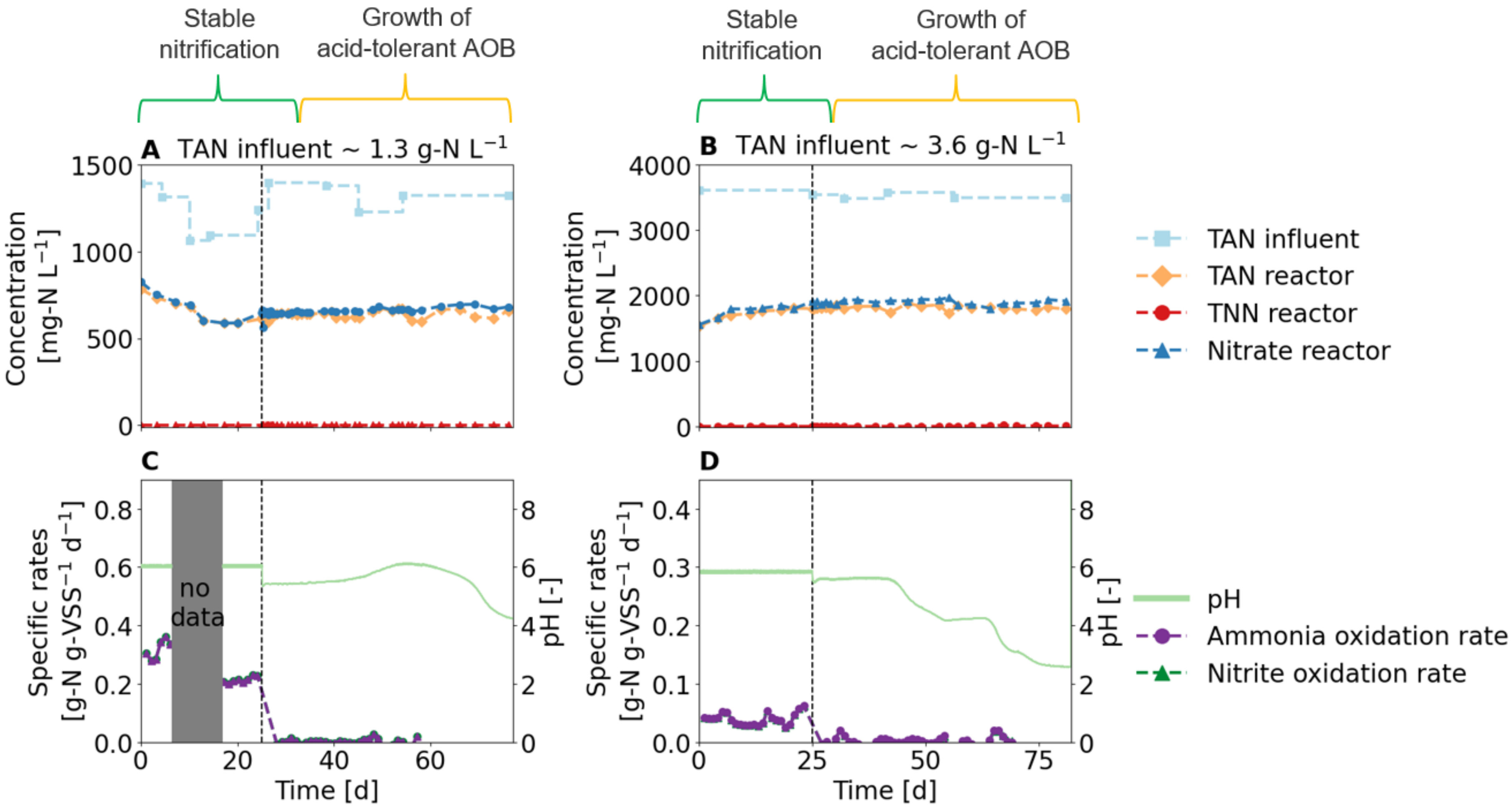


	Stable nitrification	Nitrite accumulation	Stable nitrification	Nitrite accumulation
AOB:	*Nitrosomonas europaea*	*Nitrosomonas halophila*	*Nitrosomonas europaea*	*Nitrosomonas halophila*
NOB:	*Nitrobacter* spp.	-	*Nitrobacter* spp.	-

CSTR: pH increase from 6 to 8.5



CSTR: no pH control



AOB:	*Nitrosomonas europaea*	?	*Nitrosomonas europaea*	*Candidatus* Nitrosacidococcus urinae
NOB:	*Nitrobacter* spp.	*Nitrobacter* spp. or chemical	*Nitrobacter* spp.	*Nitrobacter* spp. or chemical