

Microbial species interactions determine community diversity in fluctuating environments

Shota Shibasaki¹, Mauro Mobilia², and Sara Mitri¹

¹: Dept. of Fundamental Microbiology, Univ. of Lausanne, Switzerland

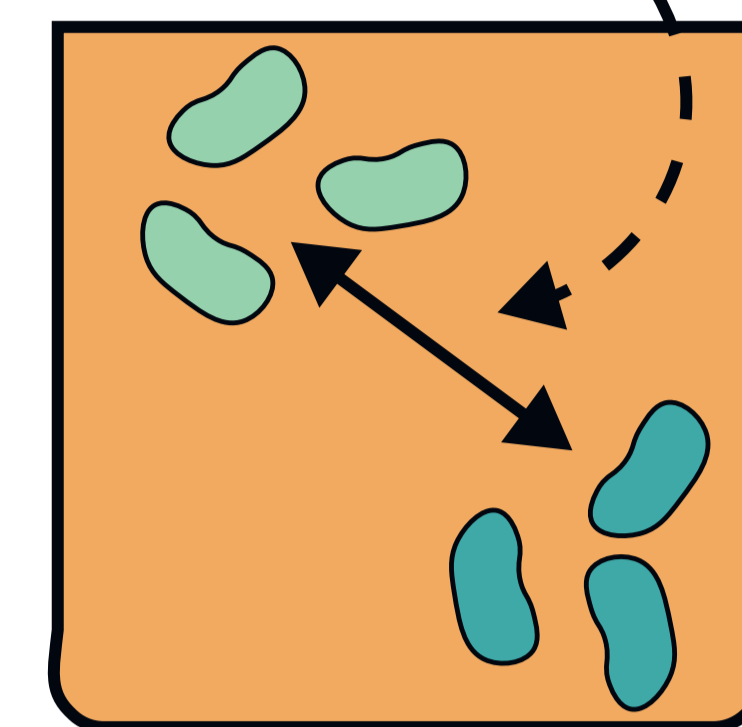
²: Dept. of Applied Mathematics, School of Mathematics, Univ. of Leeds, UK

contact to SS: shota.shibasaki@unil.ch

Introduction

Microbes often live in fluctuating environments
e.g., hosts' feeding rhythm for gut microbiota

Environmental fluctuations



+

Abiotic conditions (resources & toxin amounts) can affect species interactions

Hoek et al., (2016), Piccardi, Vessman, and Mitri (2019)



How does the rate of environmental fluctuation affect (i) species interactions and (ii) species diversity?

Summary

How the environmental switching rate affects the strength of competition and β diversity depends on properties of community members (toxin sensitivity)

BUT

Strength of competition between pair species is a good predictor for β diversity

Details are available in our preprint

<https://arxiv.org/abs/2007.12090>



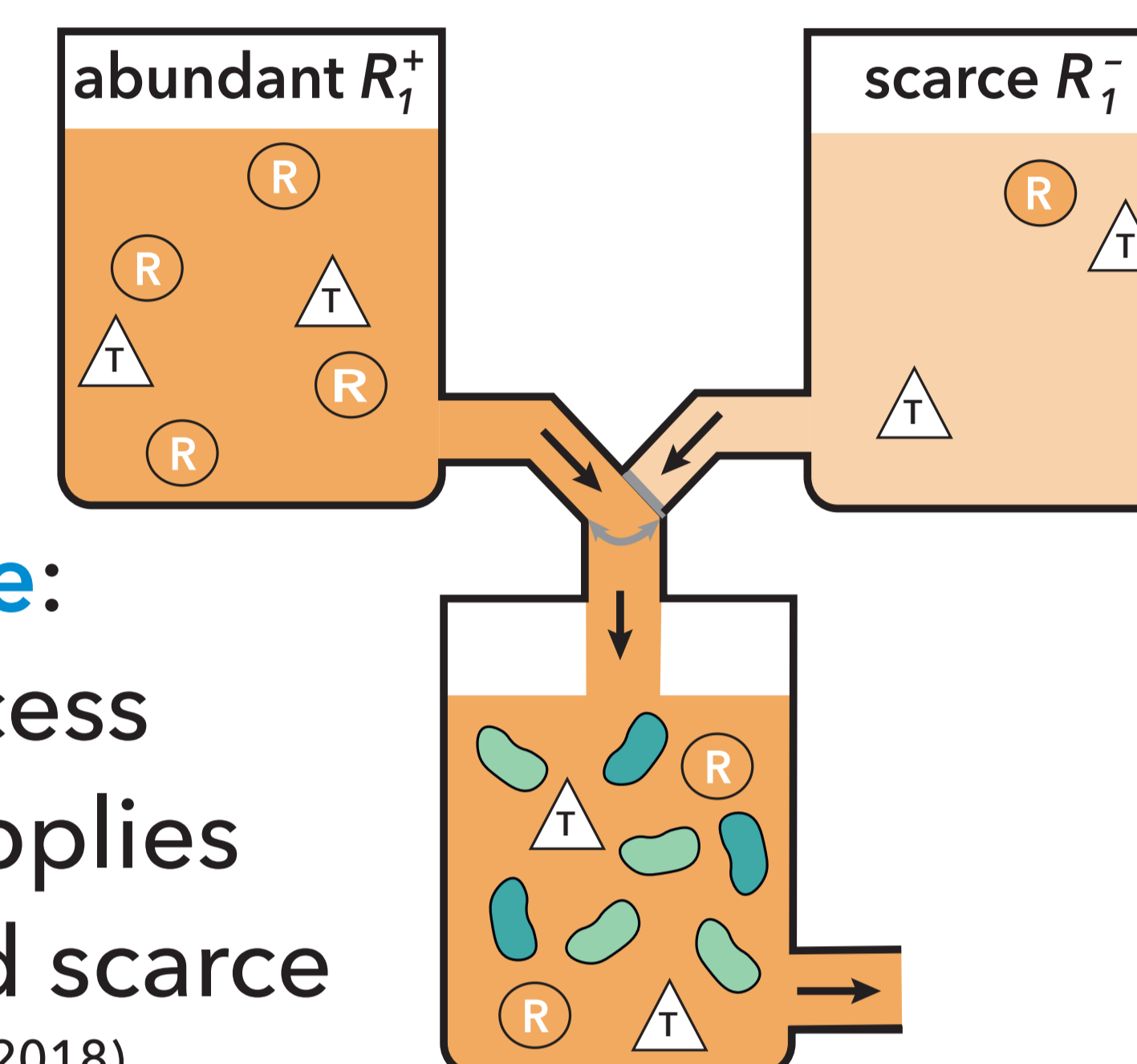
Model

Stochastic Dynamics in a chemostat

Amounts of N resources

Amounts of N toxin

Abundances of $2N$ species



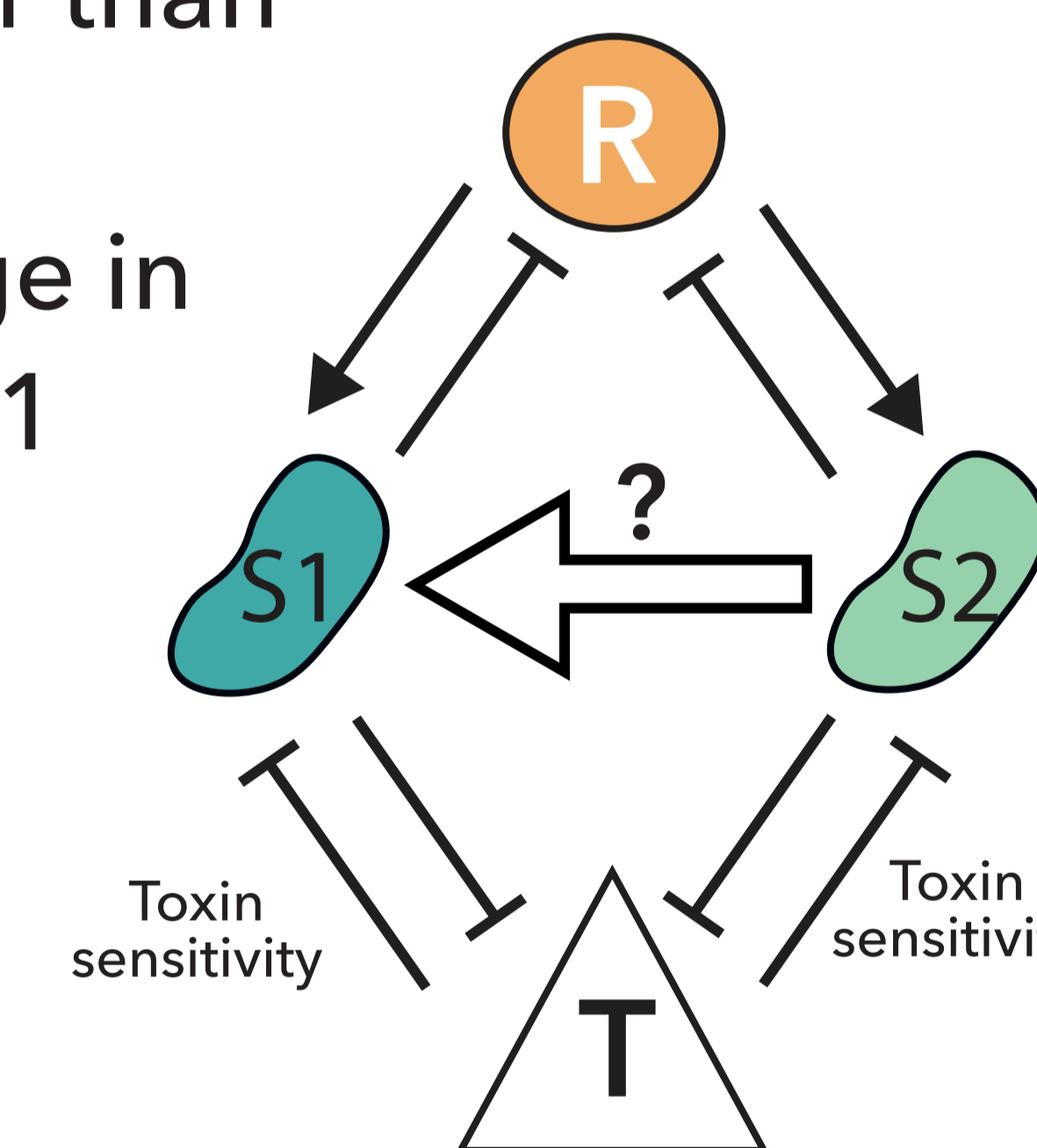
Coupling two types of noise:

1. "Birth-and-death" process
2. Switching resource supplies between abundant and scarce

see also Wienand, Frey, and Mobilia (2017, 2018)

In species interaction analysis ($N=1$)

1. Species 1 (S_1) grows faster than species 2 (S_2)
2. **Species interaction**: change in extinction probability of S_1 by the presence of S_2



In diversity analysis ($N=1$ or 5)

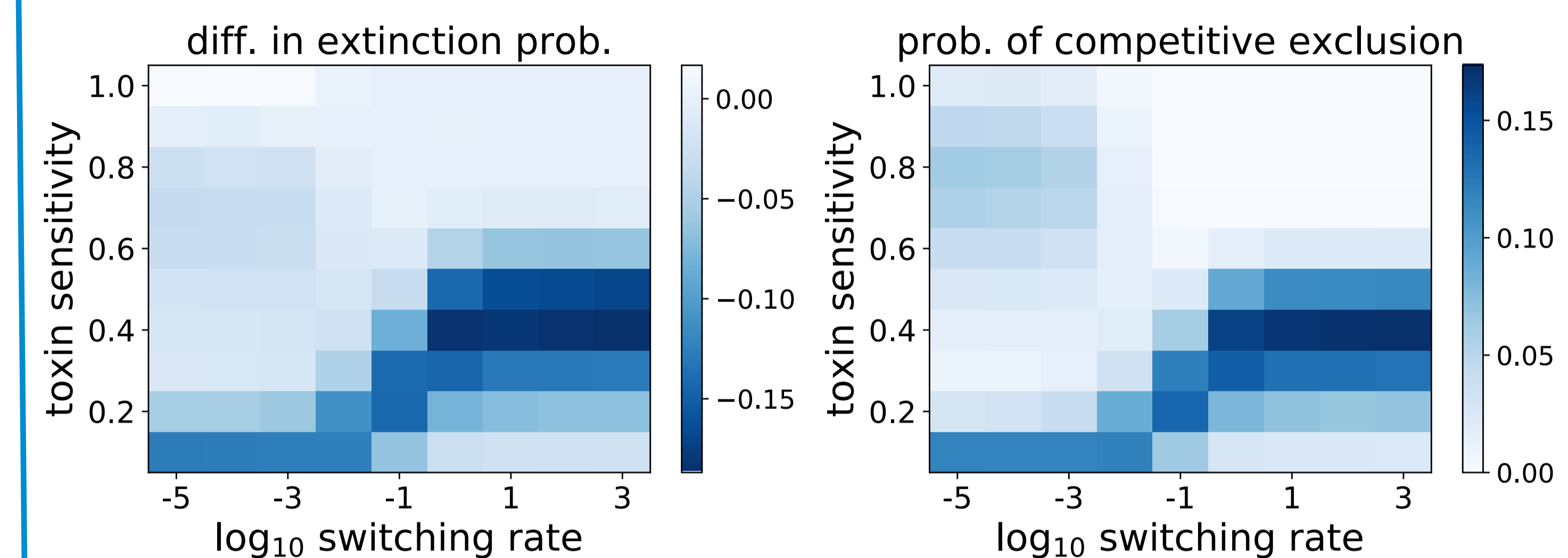
1. Generated 100 sets of community members with certain mean toxin sensitivity
2. Given a set of community members, ran 100 simulations with each switching rate
3. Calculated β diversity of each set of community members

Jost (2016)

Results

S_2 increases extinction probability of S_1 by **competitive exclusion**

Probability of competitive exclusion changes over the switching rate and toxin sensitivity



Changes in competitive exclusion are similar to β diversity

Mean toxin sensitivity affects at which switching rate β diversity is maximized or minimized

