

Predicting pathogen invasion in synthetic communities in function of evenness

Wai Kit Tsang

Promotors: Prof. dr. ir. Nico Boon
Prof. dr. Willem Waegeman

Tutor: Ir. Michiel Stock
Dr. Ramiro Vilchez Vargas

Ghent University

waitkit.tsang@ugent.be

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Background

Motivation

Gathering my own data and machine learning to predict pathogen invasion.

Microbial aspect

- Initial community evenness favours functionality under selective stress.
(Wittebolle et al., 2009)
- Evenness describes the relative abundance of species in a community.
- How does the initial community evenness influence pathogen invasion in a community?

Definition Pielou's Evenness

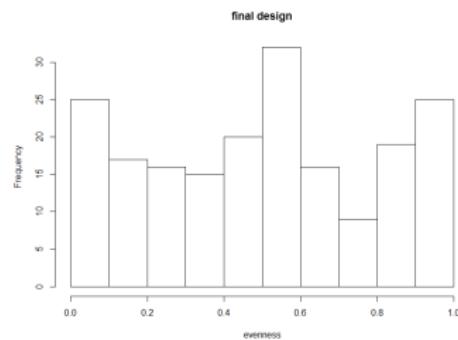
$$J' = \frac{-\sum_{i=1}^N p_i \ln p_i}{\ln(N)}$$

Aim

To reject Null hypothesis

$$H_0 : \mathcal{P}(\text{Invasion} \cap \text{evenness} = \text{High}) = \mathcal{P}(\text{Invasion} \cap \text{evenness} = \text{Low})$$

Ideally a 2-factor design tests for this hypothesis.



Synthetic community

- 10 bacteria in each community, in different quantities (Ehsani, E.)
- Introduce one pathogen
- 194 communities in entire design

Plan of the experiments

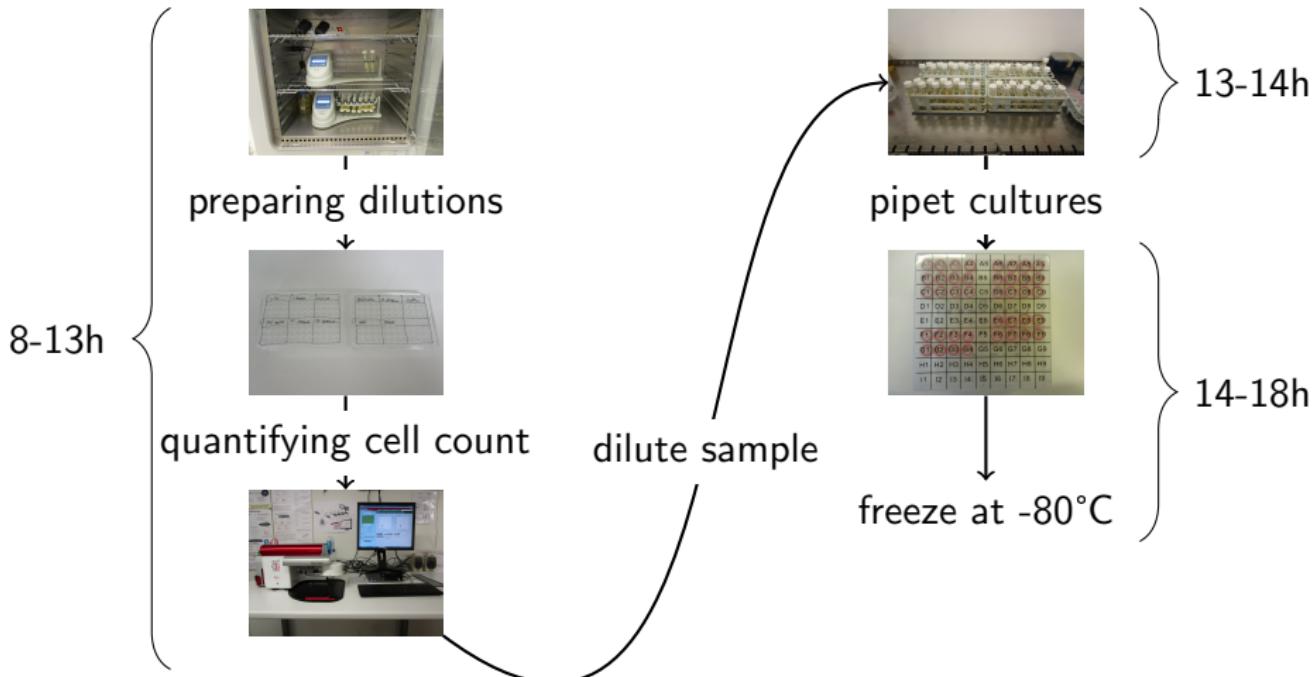
Preparatory work

- All 194 communities are prepared in advance and frozen in cryovials.
- A selection of pathogen are made strepto- and spectinomycin resistant.
- Pathogen are frozen in the freezer.

Actual experiment

- Pull communities out of freezer and introduce one pathogen.
- After 48 hours plate community on agar with antibiotics.
- 48 hours after plating count the colonies

Preparing and freezing cultures



Selecting pathogen

Reviving pathogen

- Pathogen from one phylogenetic family are chosen.
- Cultured in nutrient broth and LB broth.

Making them resistant to antibiotics

- Subject them to a concentration gradient of Streptomycin.
- Subject them to a concentration gradient of Spectinomycin.

Results obtained

Overall progress

Task	Progress
Freeze all 194 communities	✓
Make pathogen streptomycin resistant	±
Pathogen frozen	2
Invade community and count colonies	1 pathogen

Statistics

Definition model: Poisson Regression

$$\log(\lambda) = \beta_0 + \beta_1 \times \log(\text{cellcount}) + \beta_2 \times \text{evenness} + \epsilon$$

Coefficients	estimate	Pr(> z)	significance
(Intercept)	5.19089	<2e-16	***
evenness	-0.83349	<2e-16	***
log(cellcount)	-0.20031	<2e-16	***

No interaction between evenness and log (cellcount): (p-value = 0.185)

Future work

End of January

Invade communities with 3 to 6 pathogen

Next semester

Apply predictive modeling to dataset

Possible objectives

- Modeling the pathogen growth after 48h.
- Clustering the communities that are most resilient to pathogen invasion.

What's in my dataset?

Variables

- id
- cell count of each bacteria
- evenness, gini-coefficient and other diversity indices
- phylogenetic data
- replica
- pathogen count

References I

Lieven Wittebolle, Massimo Marzorati, Lieven Clement, Annalisa Ballo, Daniele Daffonchio, Kim Heylen, Paul De Vos, Willy Verstraete, and Nico Boon. Initial community evenness favours functionality under selective stress. *Nature*, 458(7238):623–626, 2009.