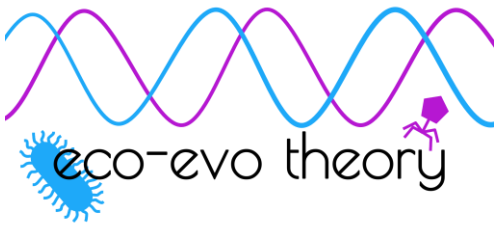
Tolerance-conferring defensive symbionts and the evolution of parasite virulence

Cameron Smith
University of Bath

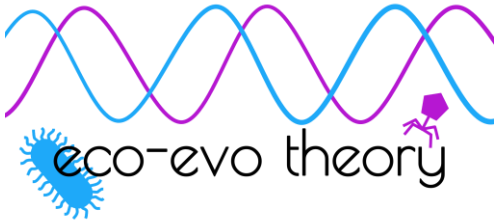


Outline

Introduction

Coevolution modelling

Results



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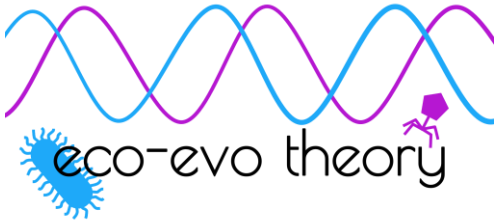
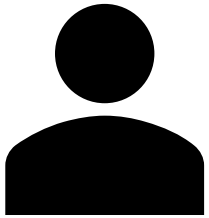


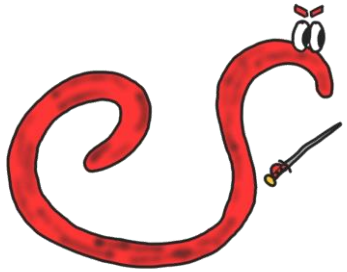
Aims of the paper

Our protagonists



Hosts, can be infected by one or both of…

Defensive symbiont, able to invest resources to protect its host from…



Parasite, very harmful to the host.

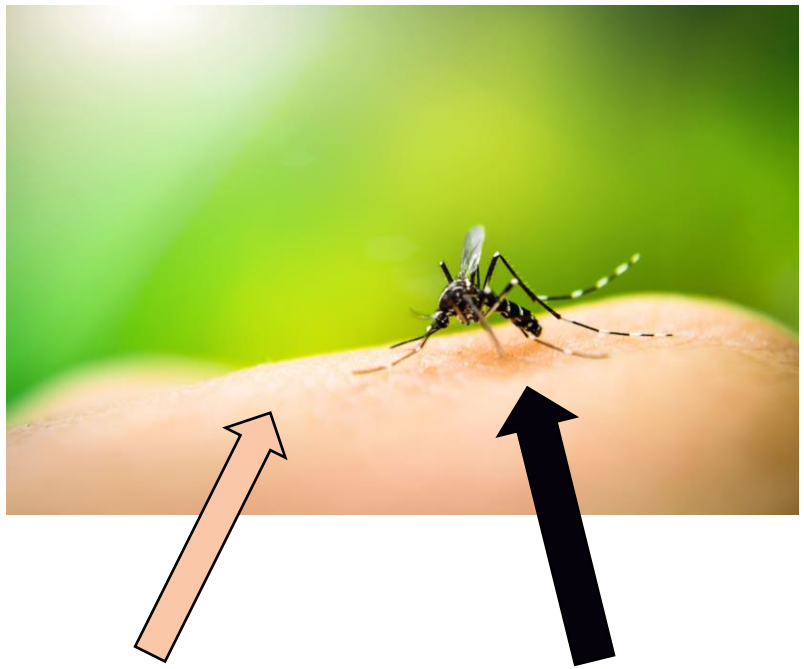
Main questions:

How does the parasite behave in the presence of the defensive symbiont?

How does the defensive symbiont react to changes with the parasite?

What effect does this coevolution have on the host population?

Defensive symbiont: an example



Human host

Mosquito

Protective bacteria: *Wolbachia*

Any males with *Wolbachia* which mate with females result in the eggs not hatching.

Recent trials have taken place in Brazil.

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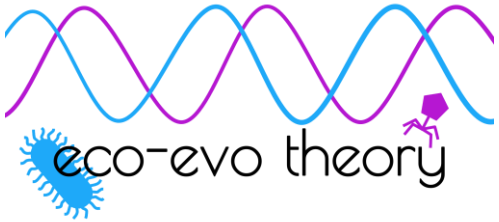

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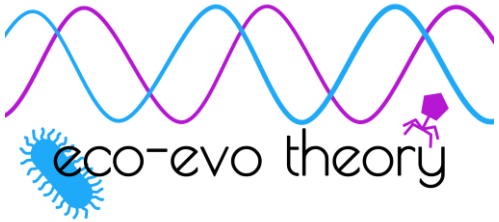
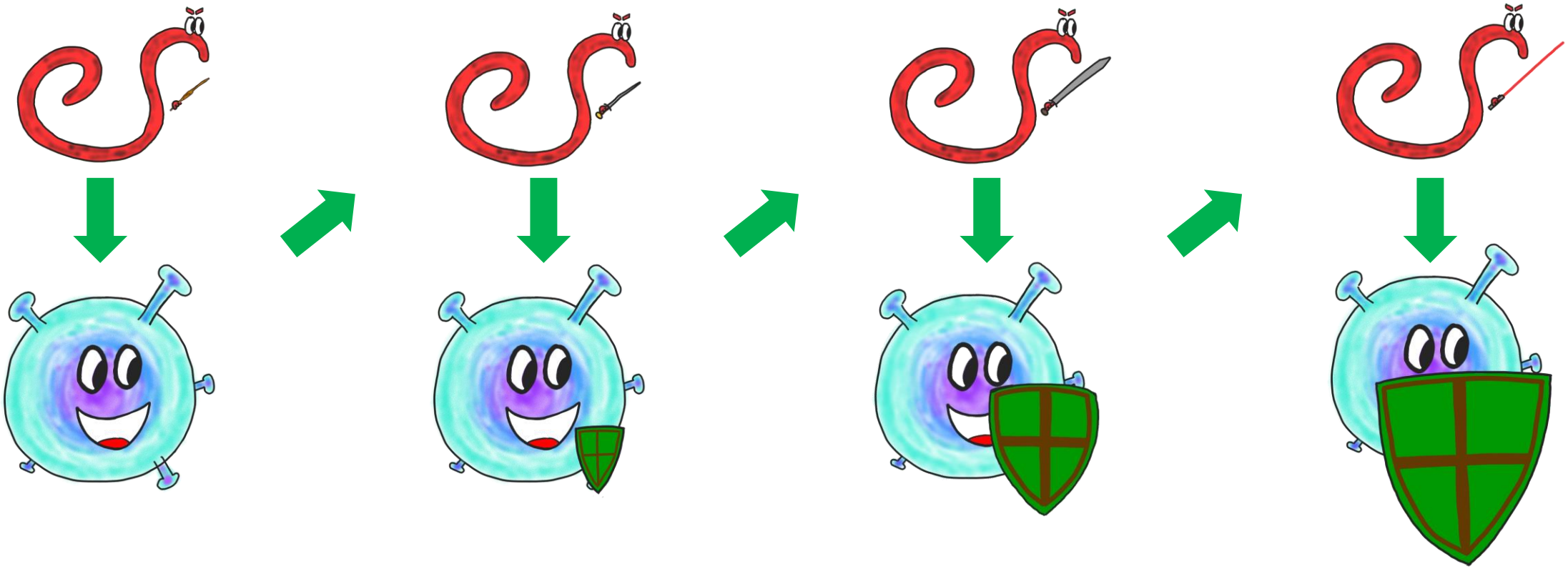


Coevolution modelling

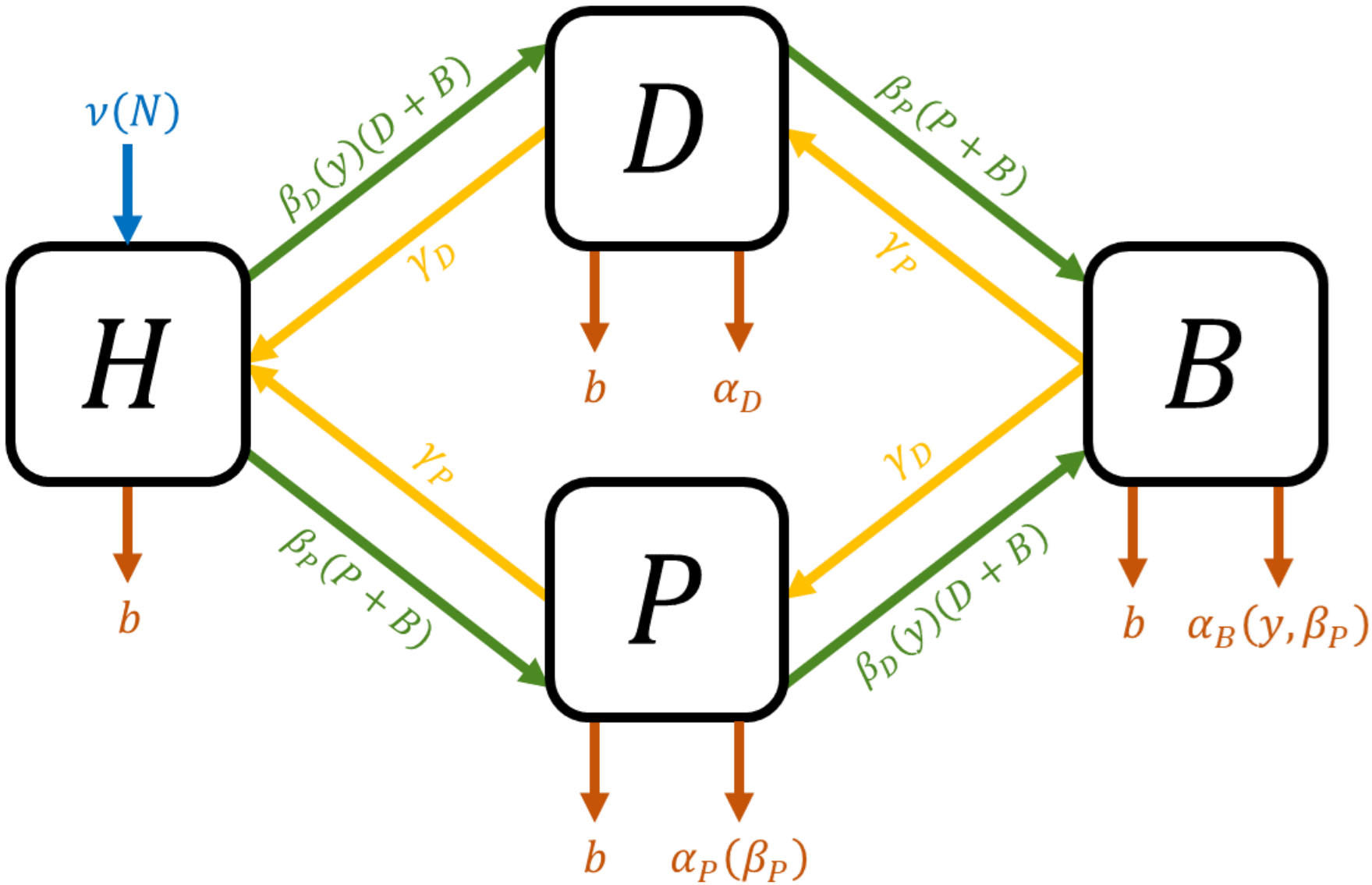
Coevolution

The response and counter-response between more than one organism.

We want to see how a defensive symbiont affects the host-parasite interaction.



Coevolution: Ecological dynamics



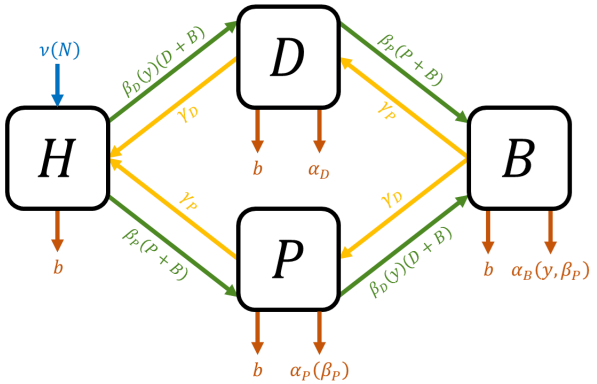
Blue: Births

Green: Transmission

Red: Deaths

Yellow: Recovery

Coevolution: Evolutionary dynamics



Evolving parameters

"Effort"
$y \in (0,1)$

Transmissibility
$\beta_P > 0$

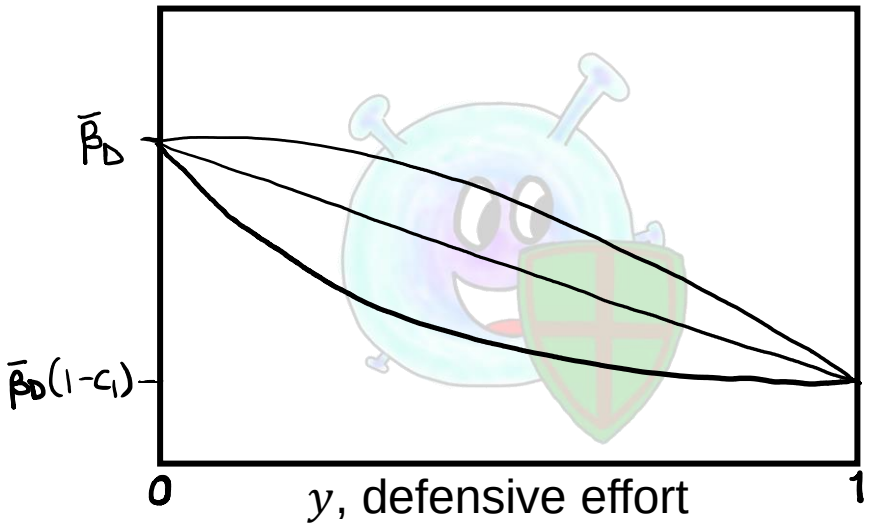
Protection

Mortality tolerance

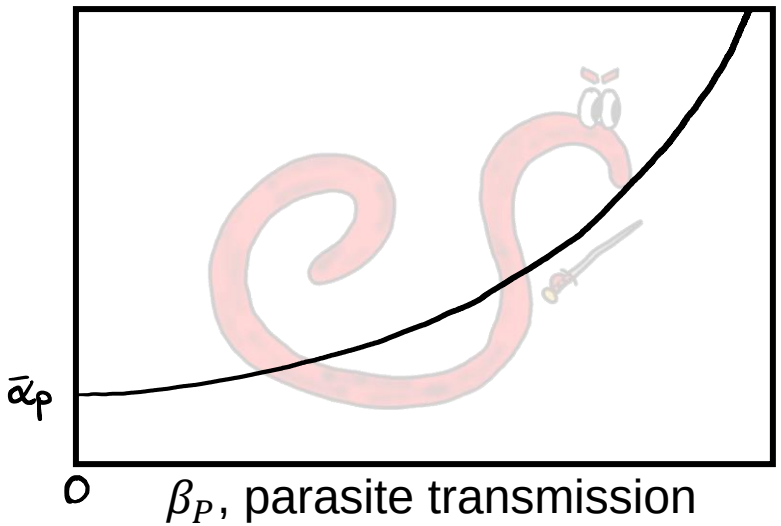
$\alpha_B(y,\beta_P) = \alpha_D + (1-y)\alpha_P(\beta_P)$

Trade-offs

$\beta_D(y)$, transmission



$\alpha_P(\beta_P)$, virulence



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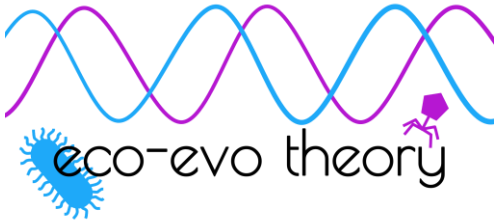

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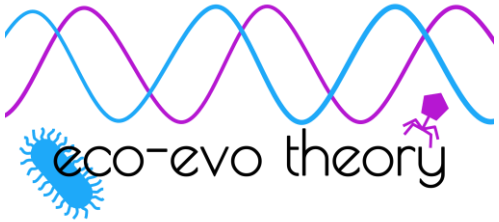

Results

Main results

1. Defensive symbionts that confer tolerance always select for higher virulence parasites.

2. Symbiont-parasite coevolution can be detrimental to the host population.

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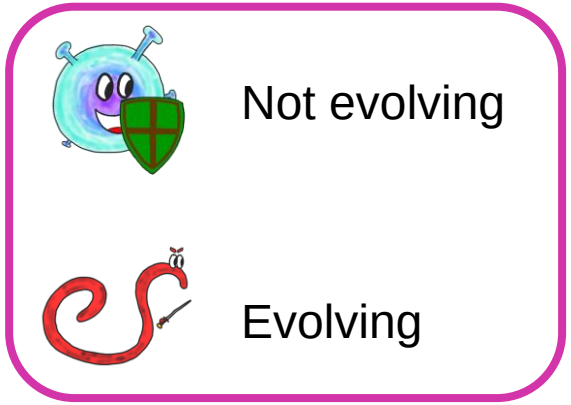

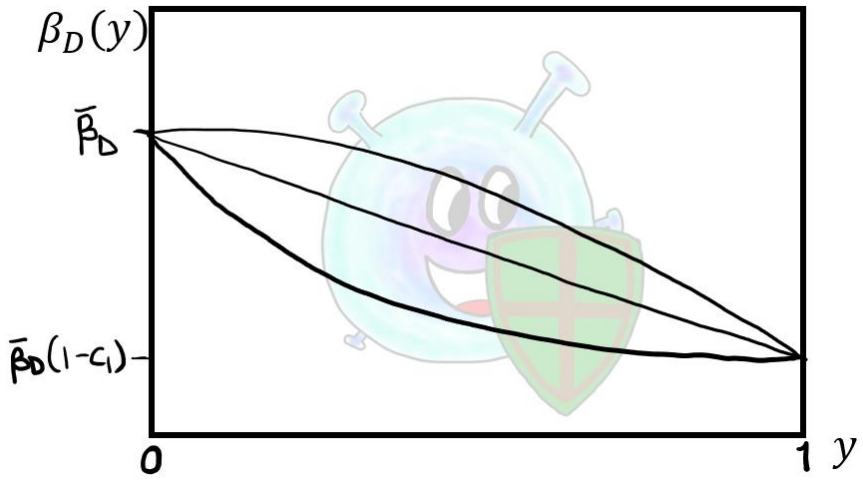

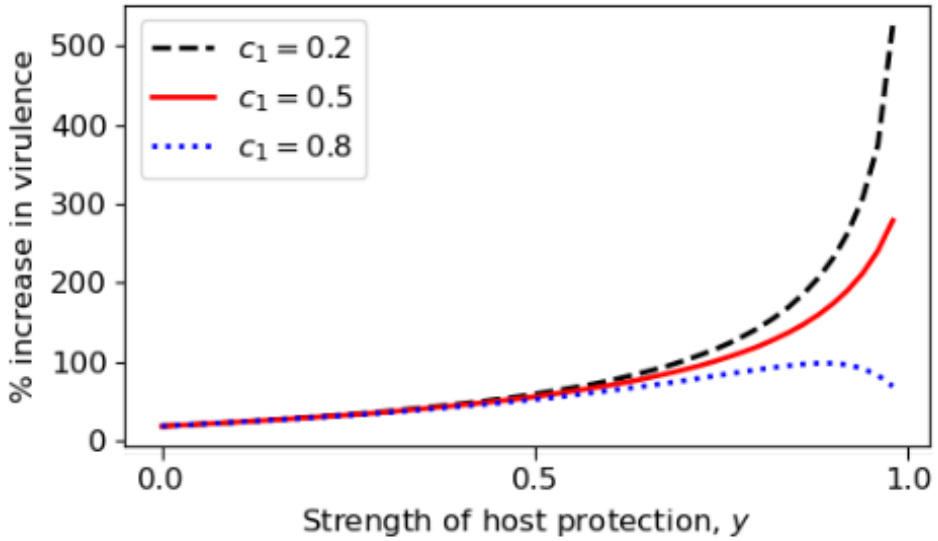

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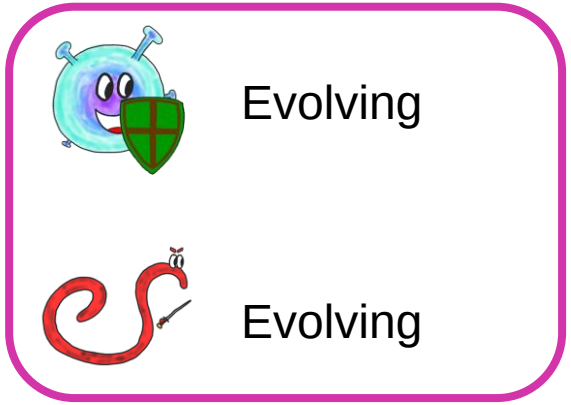

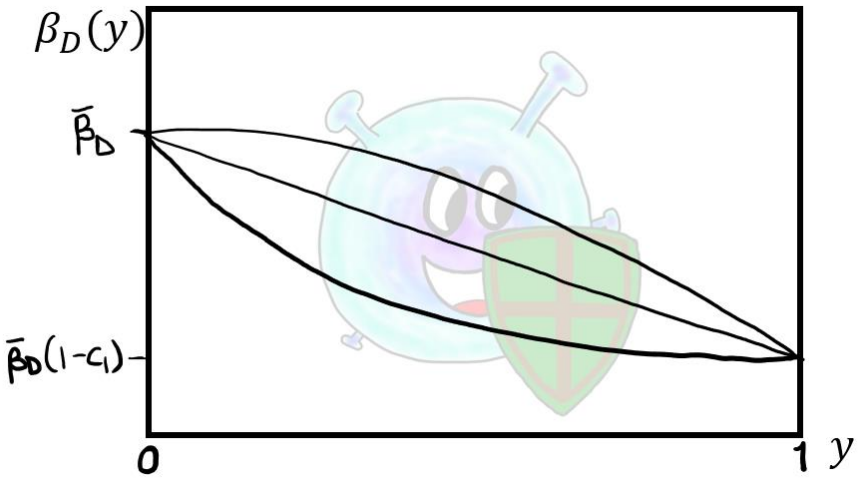

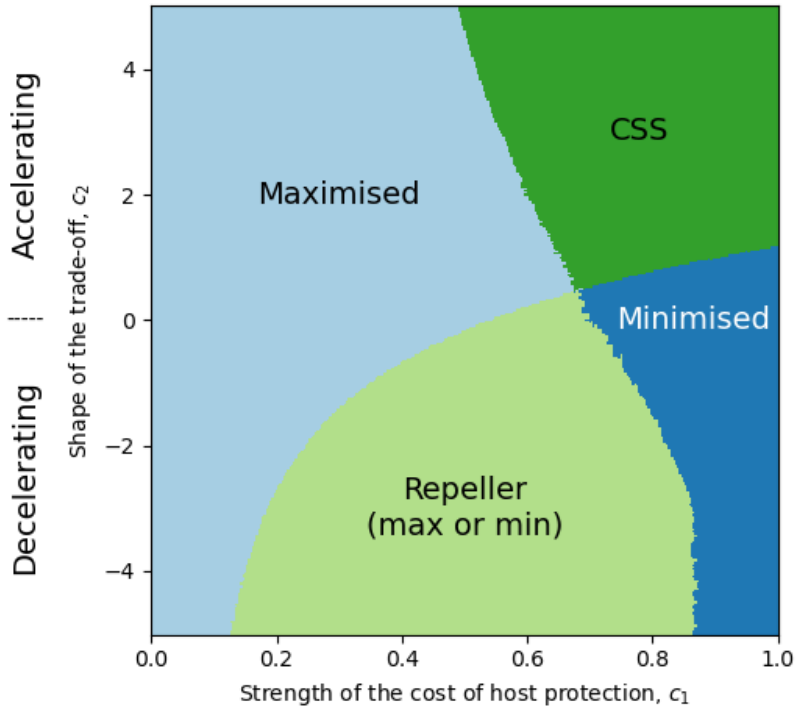

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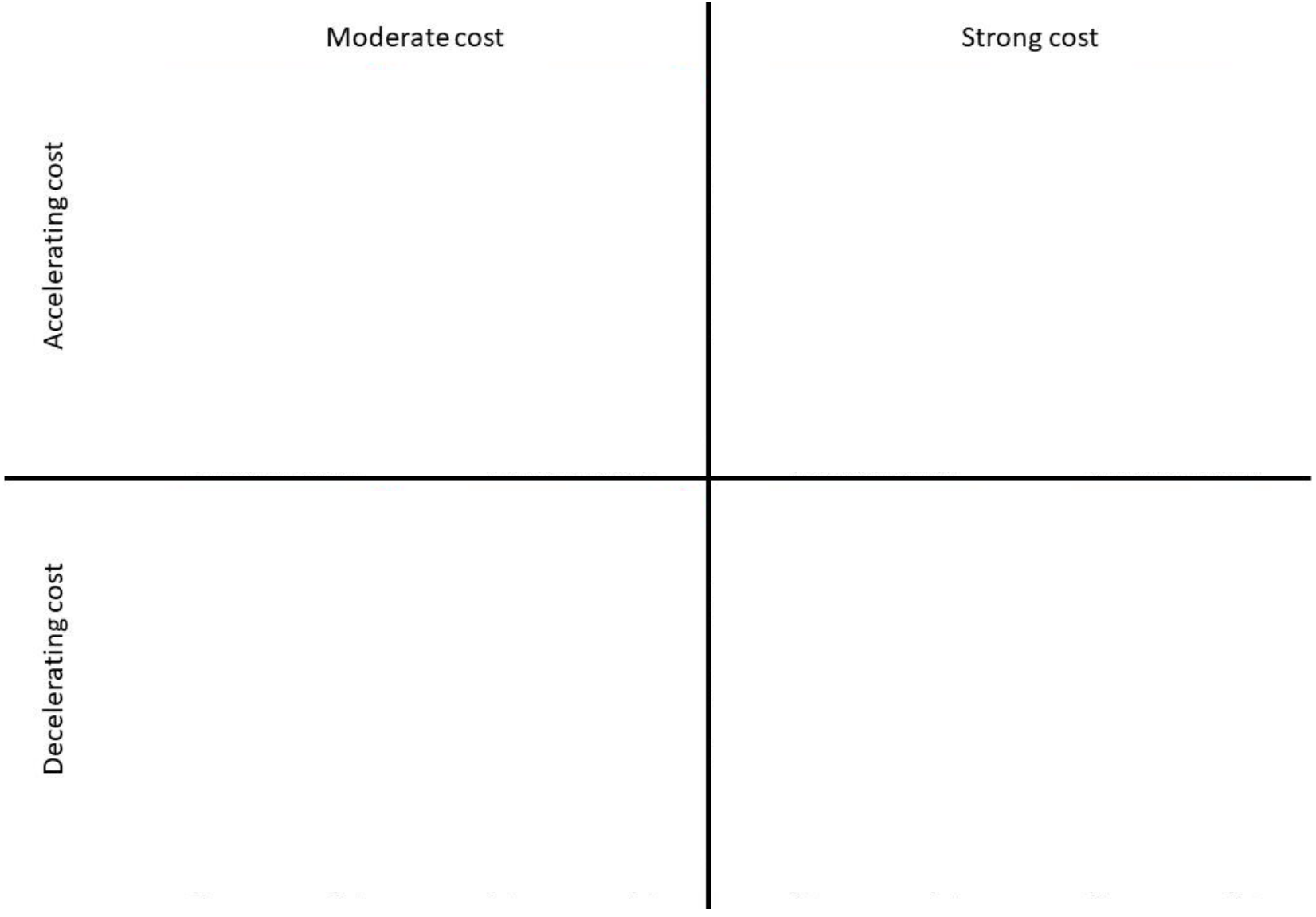

Thank you!

This is joint work with **Ben Ashby** at Simon Fraser University, Canada.

eco-evo theory

bioRxiv link

Natural Environment Research Council

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Types of defence

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Tolerance

Tolerance shields the host from the harmful effects of the parasite.

Two forms of tolerance – “Fecundity tolerance” and “mortality tolerance”.

Fecundity tolerance prevents new births with the parasite, mortality tolerance reduces virulence.

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Resistance

Resistance reduces the rate at which the parasite is transmitted to new hosts.

There are a few experimental organisms which demonstrate resistance.

Modelling coevolution

What do we need?

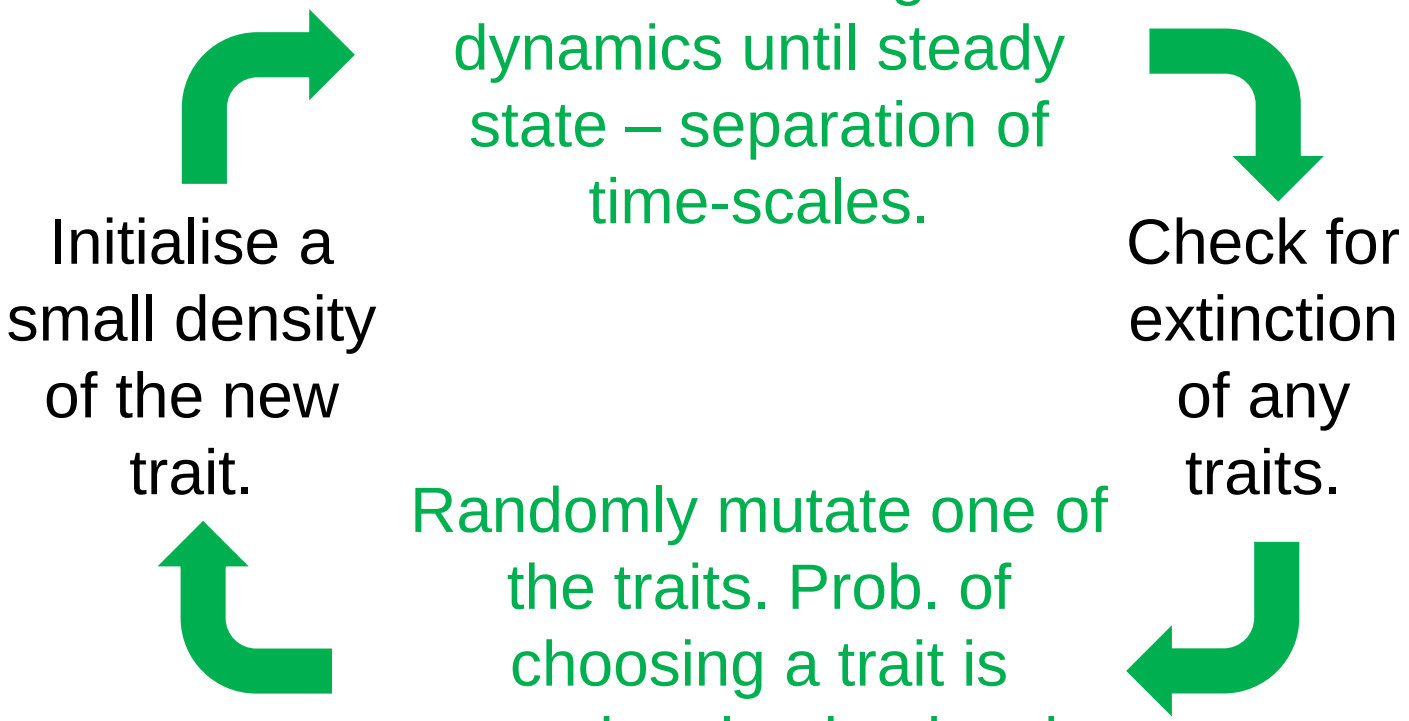
Ecological dynamics – describes the spread of microbes in a population of hosts.

Evolving traits – what can each microbe change?

Trade-offs – what are the consequences of evolving their parameters?

Type of defence – tolerance or resistance?

What's the idea?



Main results

1. Defensive symbionts that confer tolerance always select for higher virulence parasites.

2. Defensive symbionts can drive parasite diversity.

3. Symbiont-parasite coevolution can be detrimental to the host population.