Empirical and theoretical opportunities in host-symbiont community ecology

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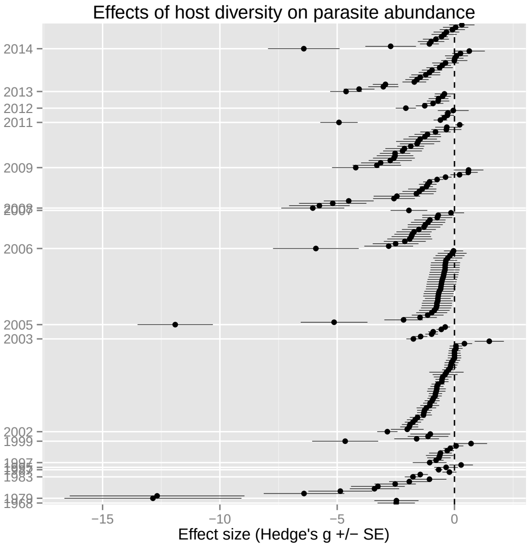
Dilution or amplification?

Contention

1. `generality'

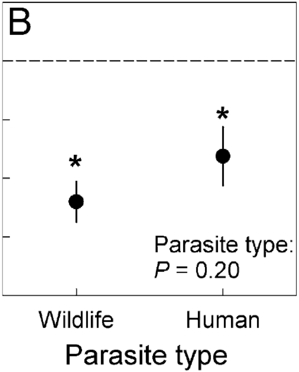
Civitello et al. 2015



Contention

1. ‘generality’
2. applicability to human disease

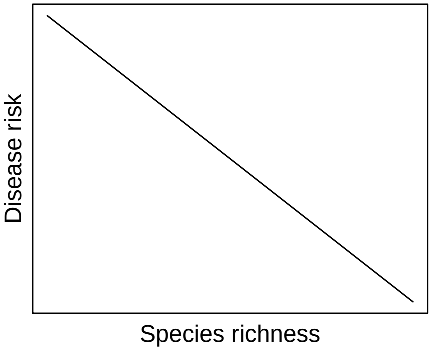
Applicability to human disease



Contention

1. `generality'
2. applicability to human disease
3. justification for conservation

Assume that we know $\mu_{\beta_{diversity}} < 0$

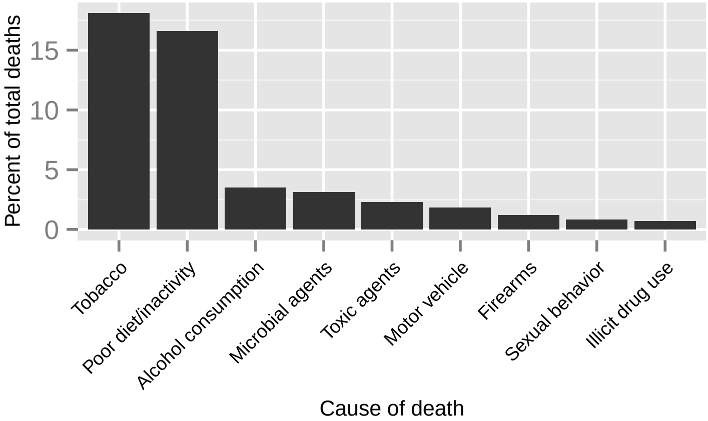


Thought experiment

Biodiversity on average is good for our health.

Would we conserve biodiversity?

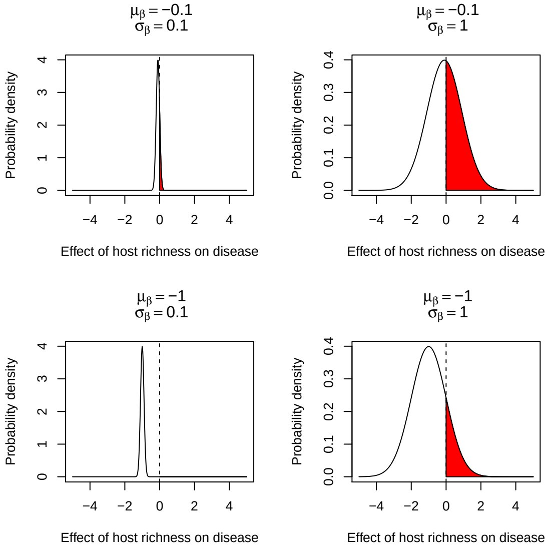
Would we conserve biodiversity?



Mokdad et al. 2004. Actual causes of death in the U.S.

Not just the mean

Assuming biodiversity reduces disease on average:



Regardless of the mean

We all care about variation

1. **Thinking beyond the mean effect**

- What explains the variance?

Challenges and opportunities

1. **Thinking beyond the mean effect**
   - What explains the variance?
2. **Transmission dynamics**

Transmission dynamics

Density-dependent:

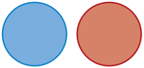
$$\beta S I$$

Frequency-dependent:

$$\beta SI/N$$

Contact rate independent from N

Tranmission dynamics, diversity, and disease

	Frequency-dependent transmission	Density-dependent transmission
Additive 	Less disease	More disease
Substitutive 	Less disease	Less disease

Other transmission functions

Constant risk:

$$\frac{dI}{dt} = \beta S$$

Power law:

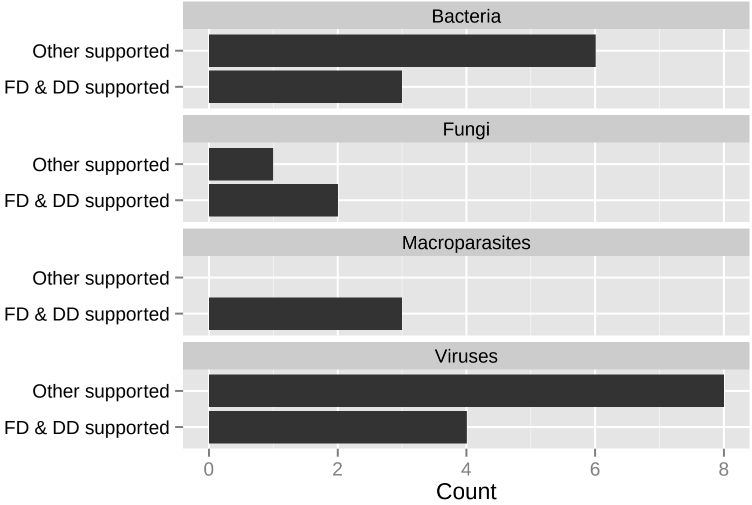
$$\frac{dI}{dt} = \beta S^p I^q$$

Negative binomial:

$$\frac{dI}{dt} = (kS) log(1 + \frac{\beta I}{k})$$

Support for other transmission functions

(Orlofske, Joseph, et al. *in prep*)

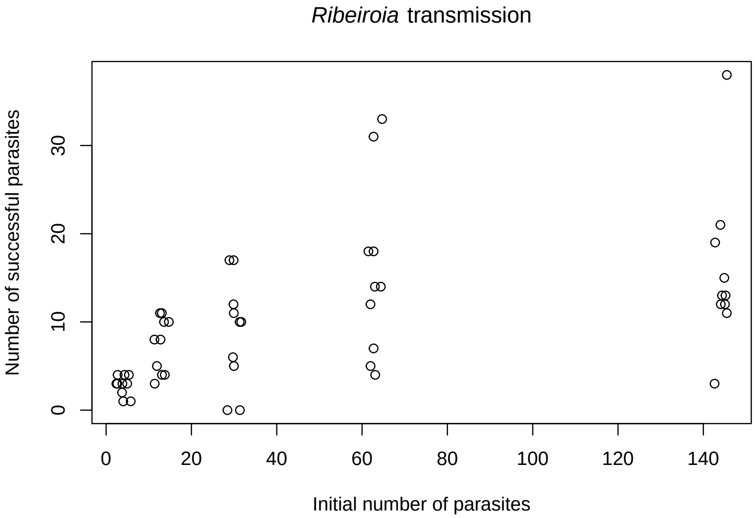


Evaluating support for different models

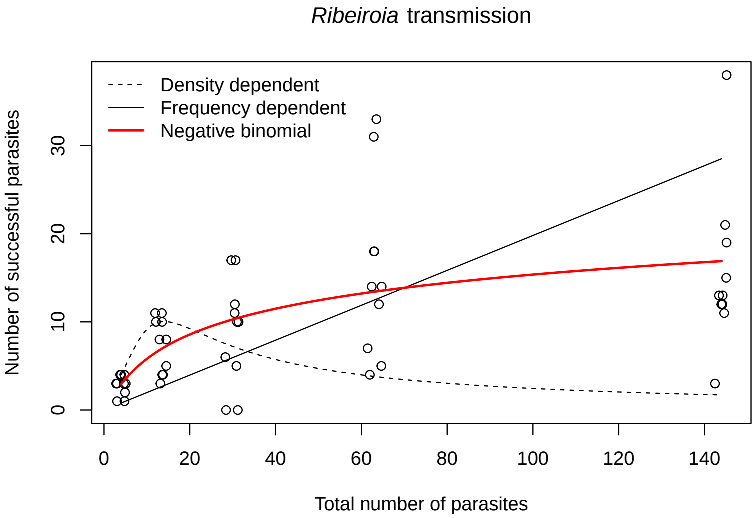
1. Build set of transmission functions (DD, FD, etc.)
2. Design experiments varying:

- P: number of parasites
- H: number of hosts
- t: exposure time
- $\frac{P}{v}$: parasite density

Evaluating support for different models



Evaluating support for different models



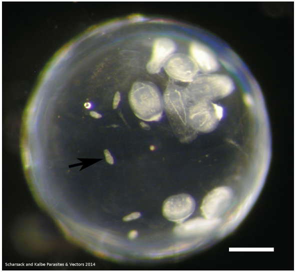
Summary of support

Ribeiroia:

- P: neg. binom.
- H: power law
- t: power law
- $\frac{P}{v}$: uninformative

Diplostomum spathaceum (Karvonen et al. 2003):

- $\frac{P}{v}$: neg. binom. and power law
- P: power law



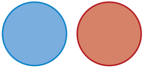
Summary of support

Centrocestus armatus experiments (Paller et al. 2007):

- $\frac{P}{v}$: neg. binom.
- P: neg. binom.

What else might we expect theoretically?

Where are we empirically?

	Frequency-dependent transmission	Density-dependent transmission
Additive 	Less disease	More disease
Substitutive 	Less disease	Less disease

1. **Thinking beyond the mean effect**
   - What explains the variance?
2. **Transmission dynamics**
   - What models have support?
   - How to our predictions change?

Challenges and opportunities

1. **Thinking beyond the mean effect**
   - What explains the variance?
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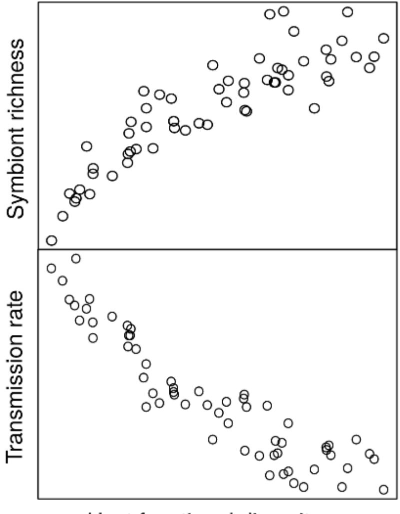
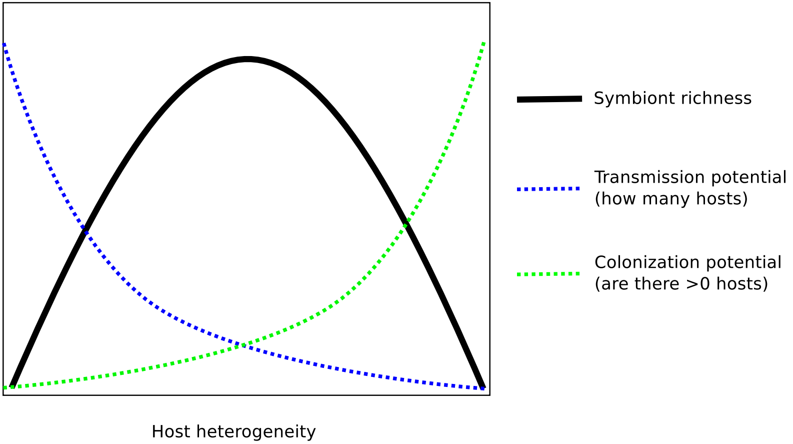
3. **Biodiversity and symbionts**

Most processes non-specific to parasites

- how does host diversity affect symbiont diversity?

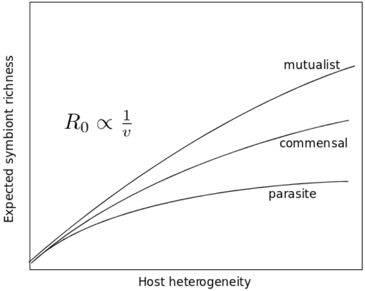


Similar to habitat area-heterogeneity trade-off in free living species

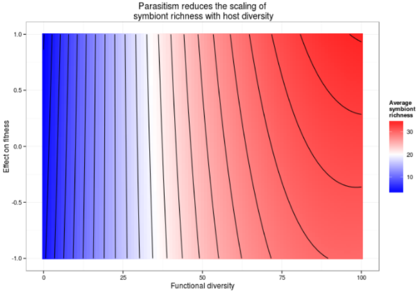


Role of parasitism vs. mutualism

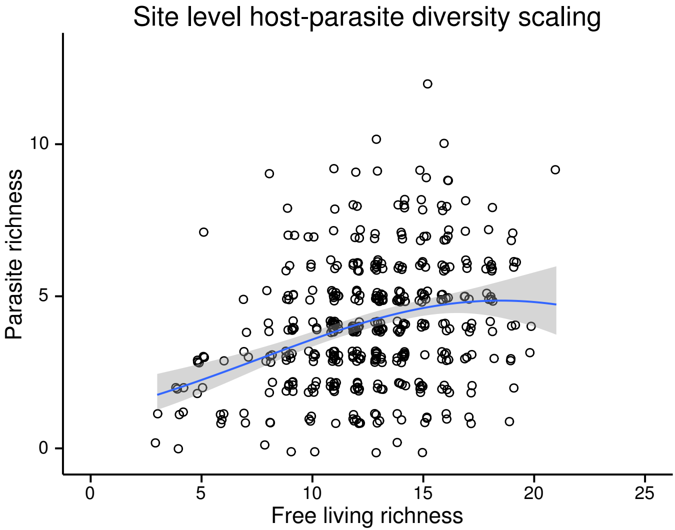
Expectation:



Results:



San Francisco Bay Area amphibian parasites



Why symbionts in general?

- More data
- Many parasites are facultative
- Broader class of species interactions

-/-	-/0	-/+
	0/0	0/+
		+/+

Challenges and opportunities

1. **Linking existing theory and data**
   - Competence, extirpation risk, and life history
   - Modes of transmission
   - Competition
2. **Extending the framework**
   - Biodiversity and symbionts
   - *Scale transitions*

Local dynamics

Local dynamics $\rightarrow$ regional dynamics

Scale transitions: theoretical results

Local dynamics $\neq$ regional dynamics if

- local dynamics are non-linear
- densities vary spatially
- conditions vary spatially

(Chesson et al. 2005)

Temporal scale discrepancies

Most theory (but see Roche et al. 2012): short term

- instantaneous rates
- R_0
- force of infection

Most data: long-run

- prevalence
- seroprevalence
- density of infected hosts

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Closing thoughts

Acknowledgements