Estimating the effects of parasites on the maintenance of sex

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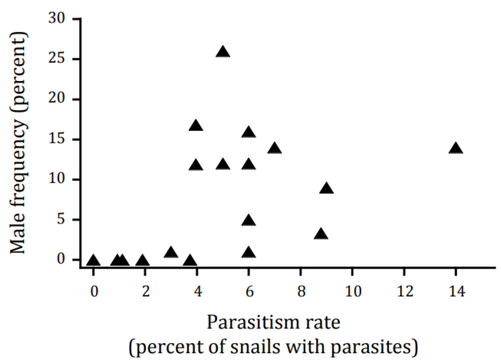
Summary

Why must **sexual reproduction** persist in nature given its **twofold cost**? The **Red Queen Hypothesis** predicts sexually reproducing individuals to overcome the cost of sex by escaping infection more easily under strong parasite selection. Here, we tried to quantify the effect of the Red Queen and perform a power analysis.

Evolution of sex

- **Two fold cost of sex**: (1) cost of producing males and (2) cost of meiosis
- the two fold cost of cost of sex asumes that **all else is equal**
- only 0.01% eukaryotes conform to purely asexual reproduction. How?

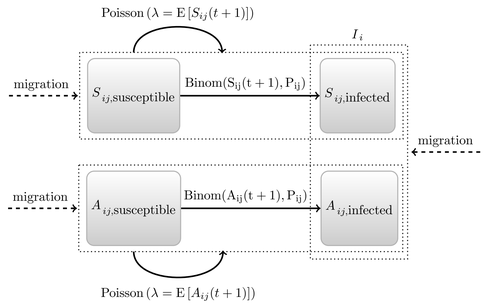
Red Queen Hypothesis



McKone *et al.* [3]

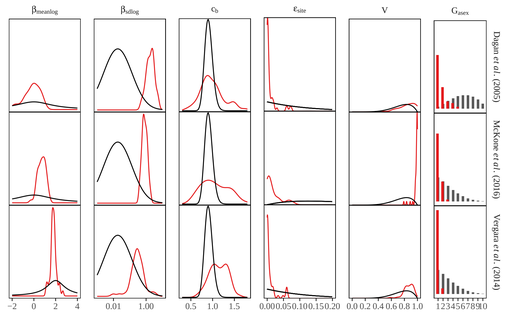
- sexual reproduction creates rare genotypes that can escape infection (**negative frequncy dependence**)
- snail population in New Zealand (host for sterilizing trematode infection) is believed to support the hypothesis [5]
- prevalence of sex should be **positively correlated** with prevalence of infection
- unable to detect any correlation in a similar snail-trematode system [1]

Mathematical model



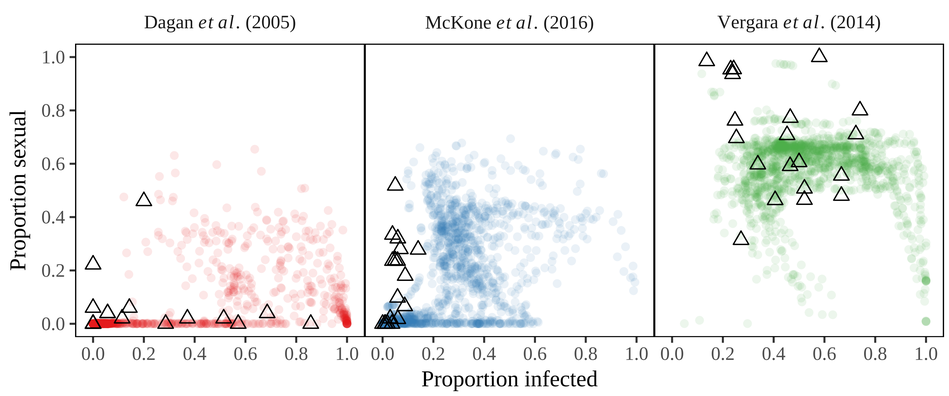
- extension of [2]; the figure represents a dynamic of a single site at each generation
- solid lines represent dynamics with spatial feature (i.e., mixing between sites)
- dashed lines represent stochastic migration from an external source

Approximate Bayesian Computation (ABC)



- Bayes' theorem: $p(\theta|X) \propto p(X|\theta)p(\theta)$
- relies on difference between observed and simulated data rather than explicit likelihood
- **Sequential Monte Carlo** method allows for efficient approximation of the posterior [4]
- summary statistics: mean proportion infection/sexual and variation in mean proportion across generation/site

Simulated data v.s. observed data



- lorem ipsum

Cycles and spatial structure

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Discussion and conclusion

- Red queen dynamics is hard to measure from spatial data

Reference

[1] Y Dagan, K Liljeroos, J Jokela, and F Ben-Ami. Clonal diversity driven by parasitism in a freshwater snail. *Journal of evolutionary biology*, 26(11):2509–2519, 2013.

[2] Curtis M Lively. An epidemiological model of host–parasite coevolution and sex. *Journal of evolutionary biology*, 23(7):1490–1497, 2010.

[3] Mark J McKone, Amanda K Gibson, Dan Cook, Laura A Freymiller, Darcy Mishkind, Anna Quinlan, Jocelyn M York, Curtis M Lively, and Maurine Neiman. Fine-scale association between parasites and sex in potamopyrgus antipodarum within a new zealand lake. *New Zealand Journal of Ecology*, 40(3):1, 2016.

[4] Brandon M Turner and Trisha Van Zandt. A tutorial on approximate bayesian computation. *Journal of Mathematical Psychology*, 56(2):69–85, 2012.

[5] Daniela Vergara, Jukka Jokela, and Curtis M Lively. Infection dynamics in coexisting sexual and asexual host populations: support for the red queen hypothesis. *The American naturalist*, 184(S1):S22–S30, 2014.