Evolution and effects of decision-making in an insect

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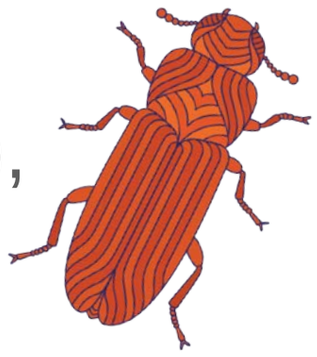


ICTS School on Decisions, Games, and Evolution | 13 March 2025

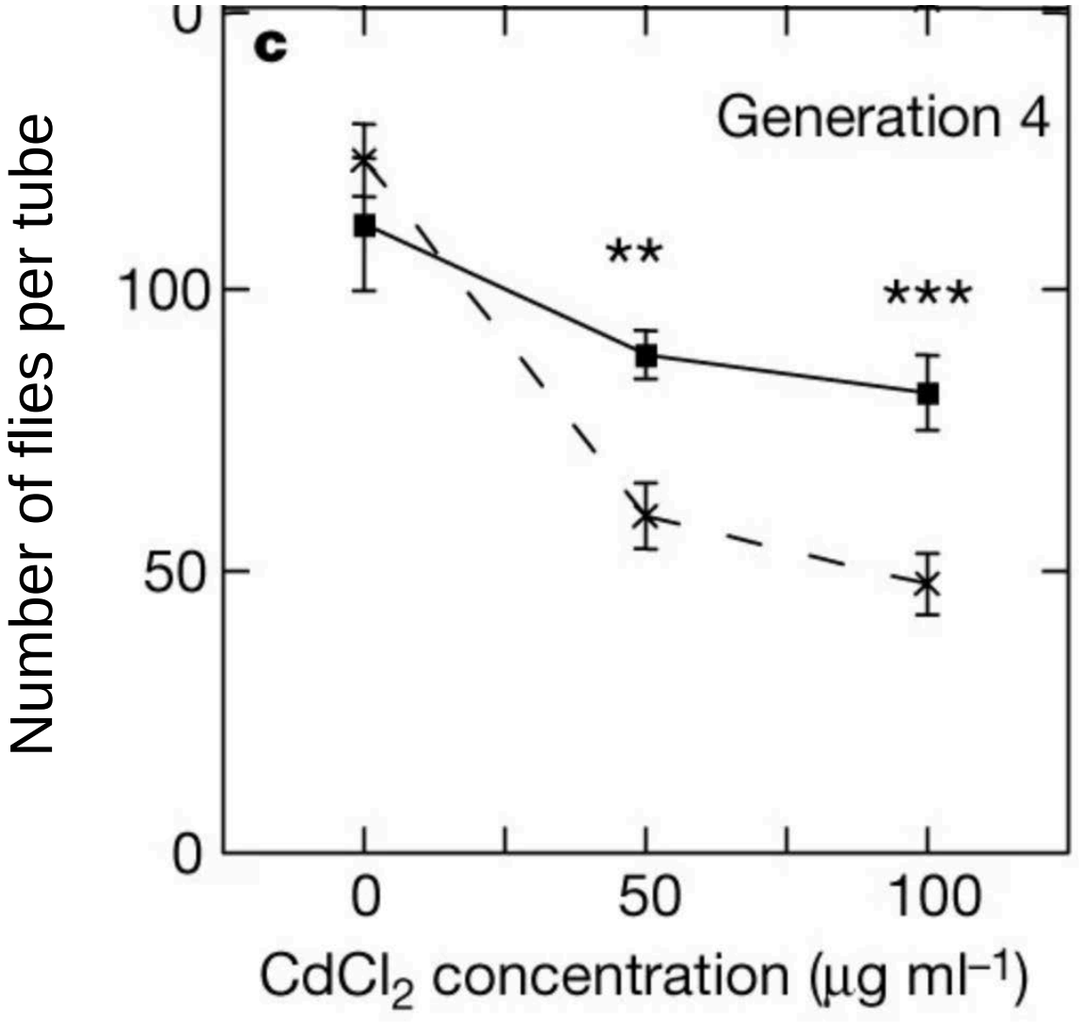
Animals are faced with potentially overwhelming food choices each day

Competition increases use of new resources

■ High competition

X Low competition

Choice of normal media (limited) and media with toxic cadmium



Bolnick 2001, *Nature*

…But sometimes, increased competition makes animals more conservative

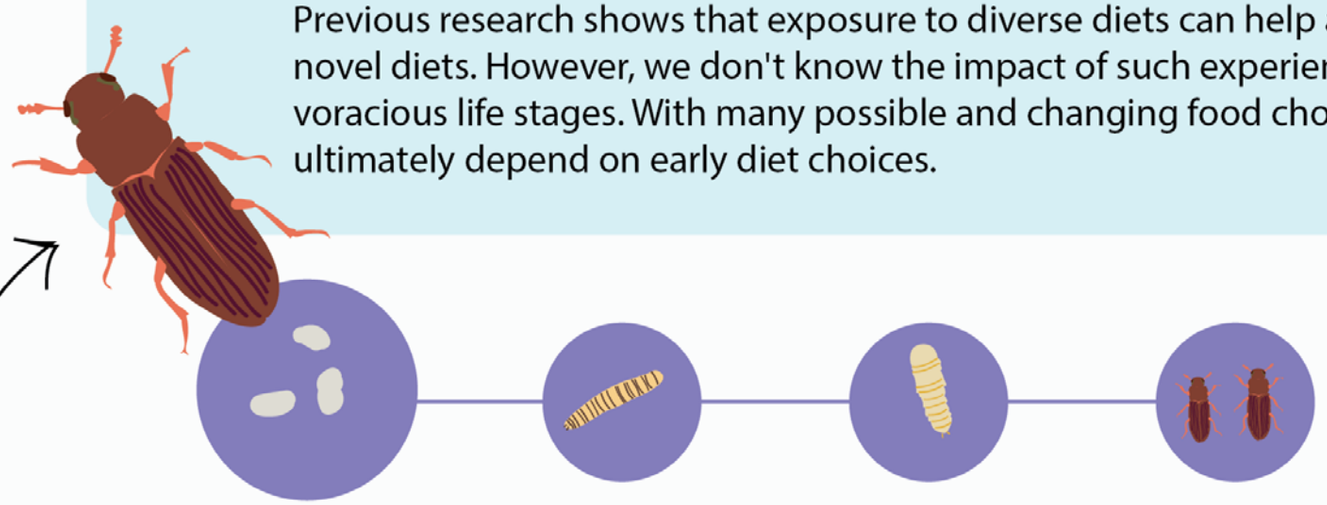
Choice of wheat flour (optimal) and corn flour (poor) resources
At varying population density (i.e., competition)

Parent & Agashe et al 2014, *Ecol & Evol*

Why do animals often make apparently suboptimal choices ?

Experience with different foods affects behaviour

Previous research shows that exposure to diverse diets can help adult insects adapt to novel diets. However, we don't know the impact of such experience at younger, more voracious life stages. With many possible and changing food choices, survival can ultimately depend on early diet choices.

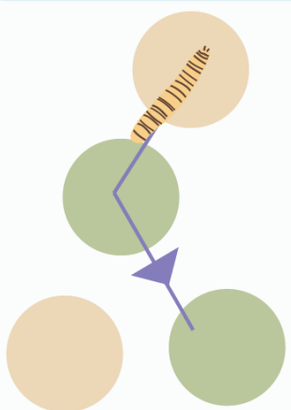


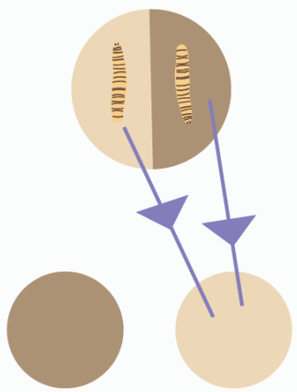
Here's the red flour beetle (*Tribolium castaneum*), a pest that can eat various stored grains - an ideal subject to study diet preferences.

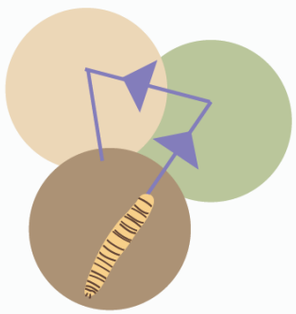
Larvae are more likely to eat a new food if they tasted it recently.

But, if the new food decreases their chance of survival, they do avoid it.

As larvae develop a taste for new foods, they can move away from their natal habitat and colonize new areas.



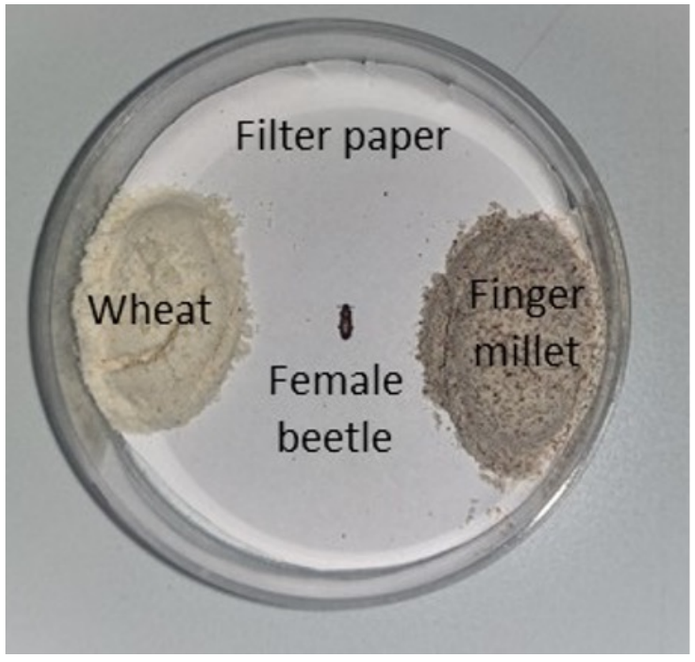


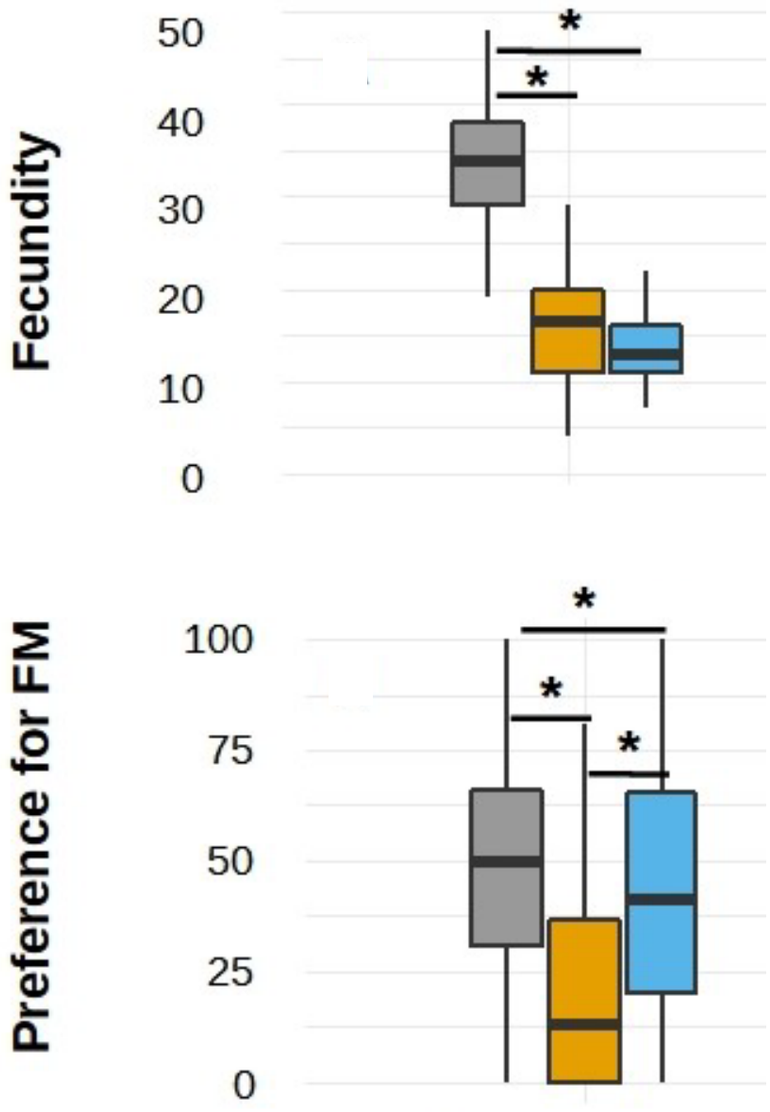


Graphic: Ipsa Jain

Ravi Kumar et al 2018, *Ecological Entomology*

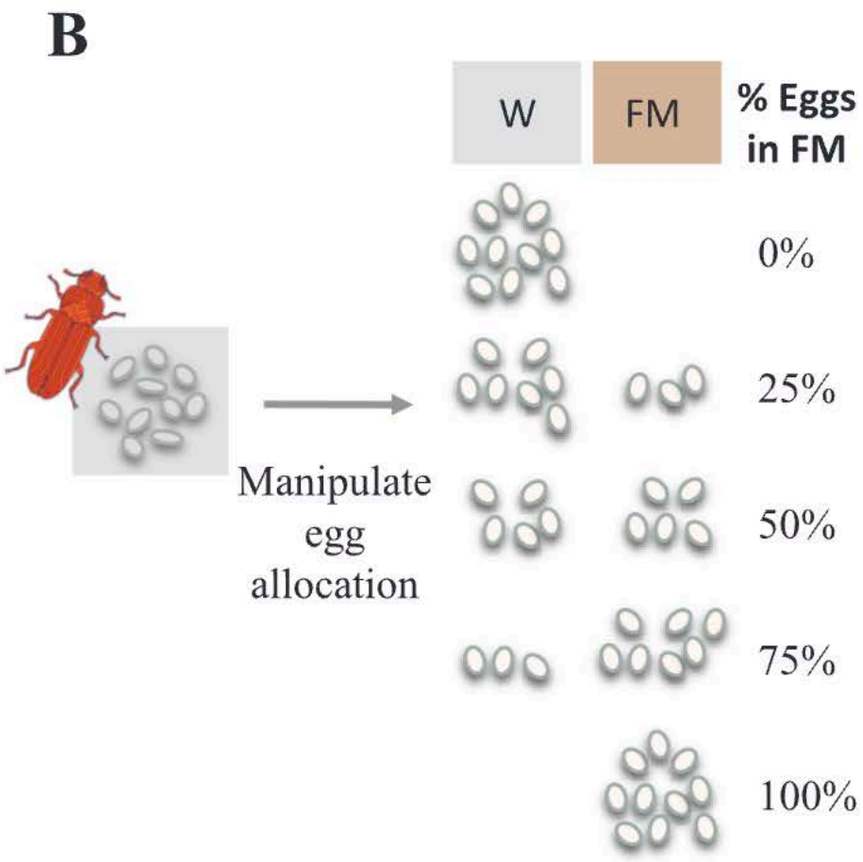
Female context alters oviposition behaviour





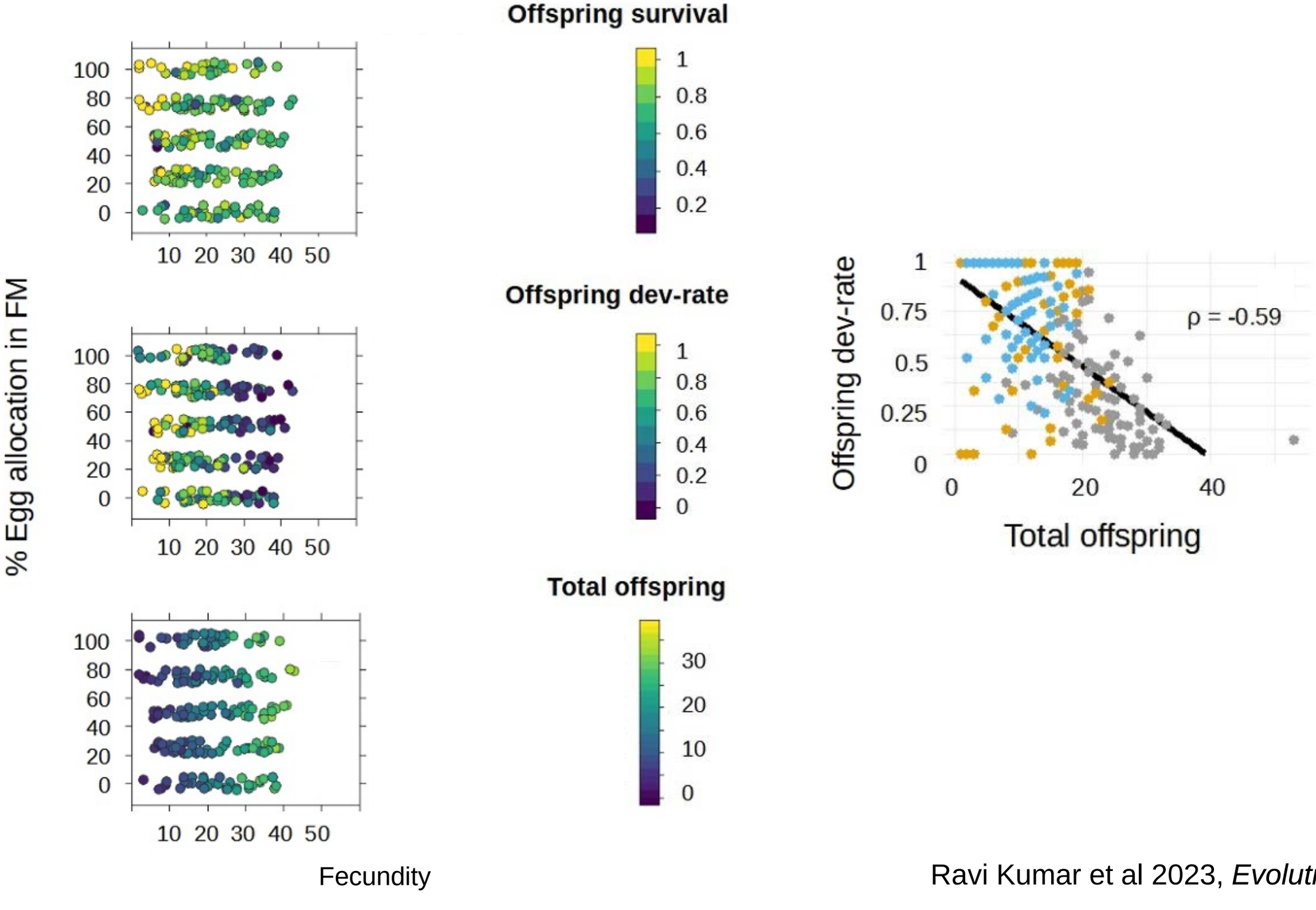
Ravi Kumar et al 2023, *Evolution*

Manipulate egg allocation
Infer fitness landscape ~ oviposition



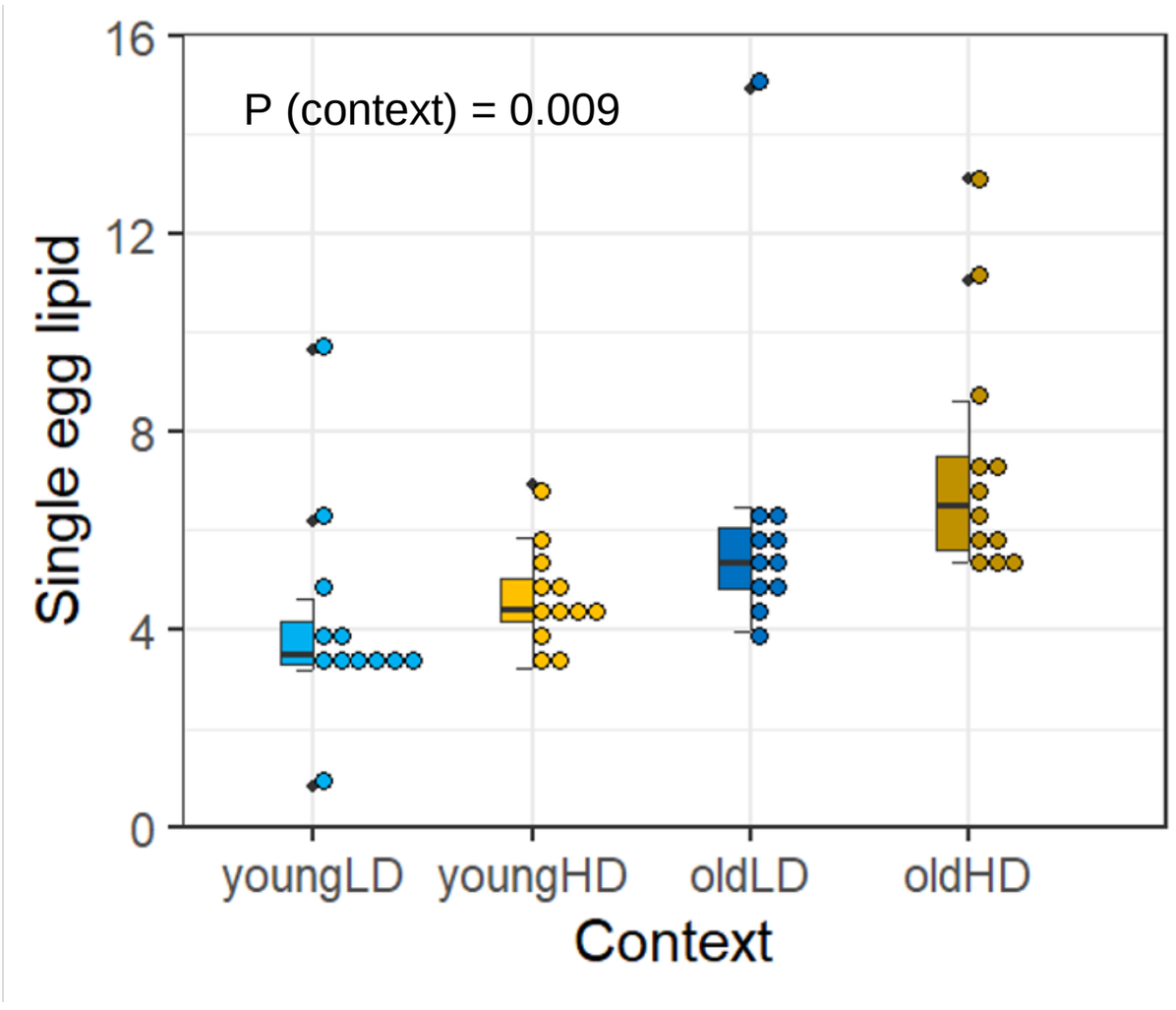
Ravi Kumar et al 2023, *Evolution*

Females optimize offspring development vs. total offspring depending on their context

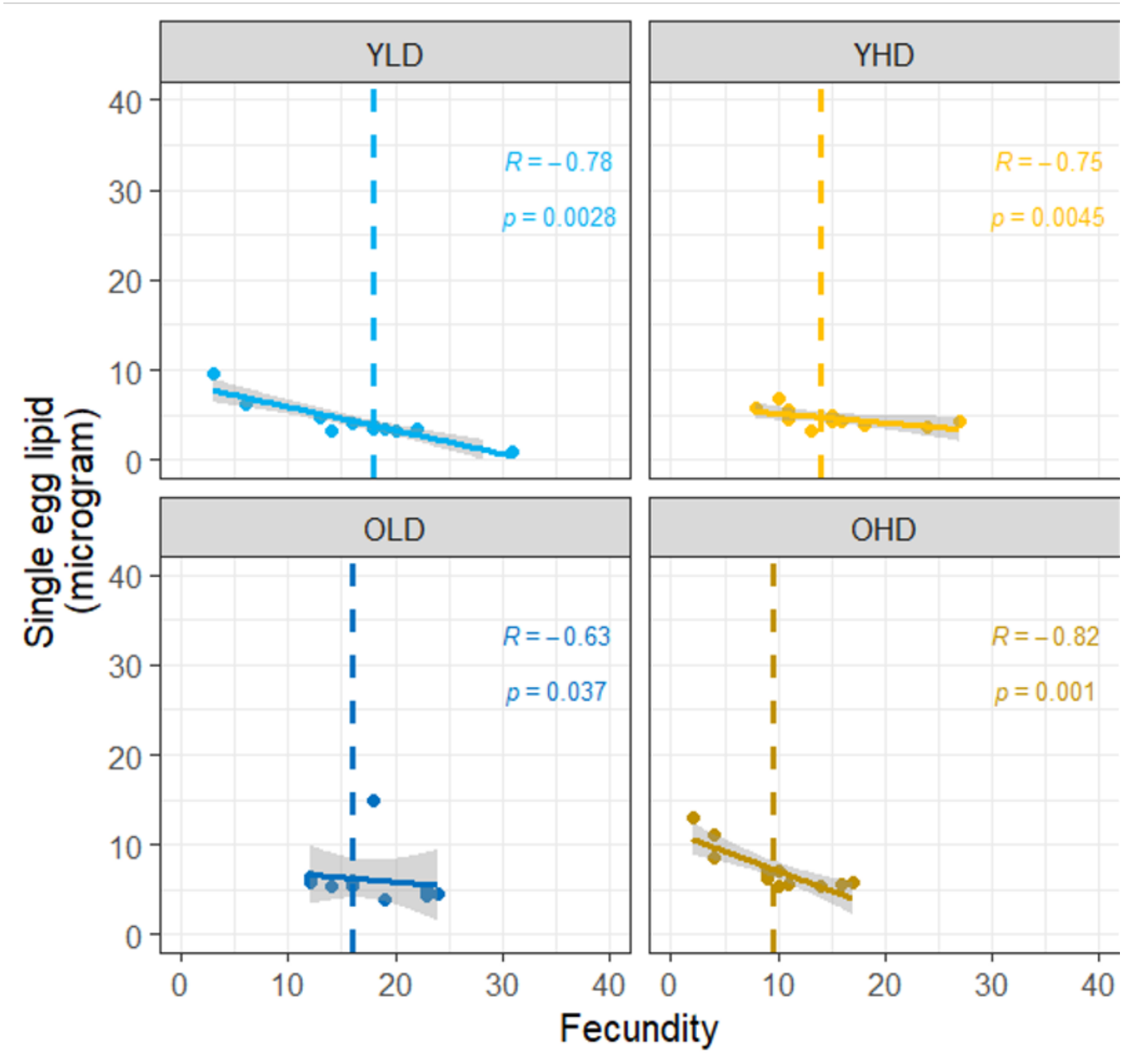


Ravi Kumar et al 2023, *Evolution*

Founder context affects provisioning of eggs



General tradeoff between egg number and egg nutrient provisioning



Summary I

- Behavioural choices shape use of new habitats

- Strong impacts of prior experience

- Context-dependent behaviours allow optimization for distinct fitness components

Does context-dependent choice alter evolutionary dynamics ?

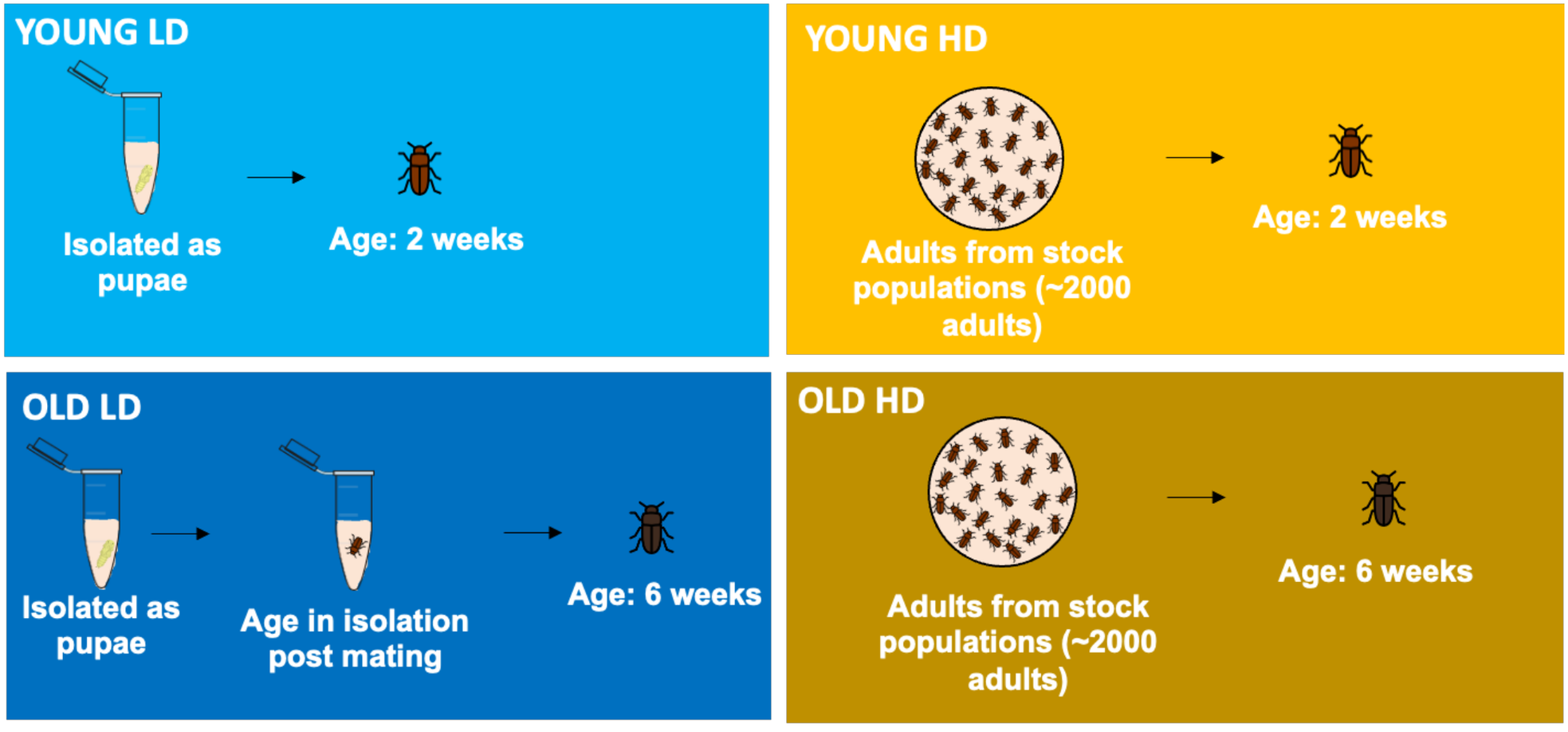
Manipulate age and density context of founders colonizing a new habitat

Age \ Density contexts	Low	High
Young	youngLD	youngHD
Old	oldLD	oldHD

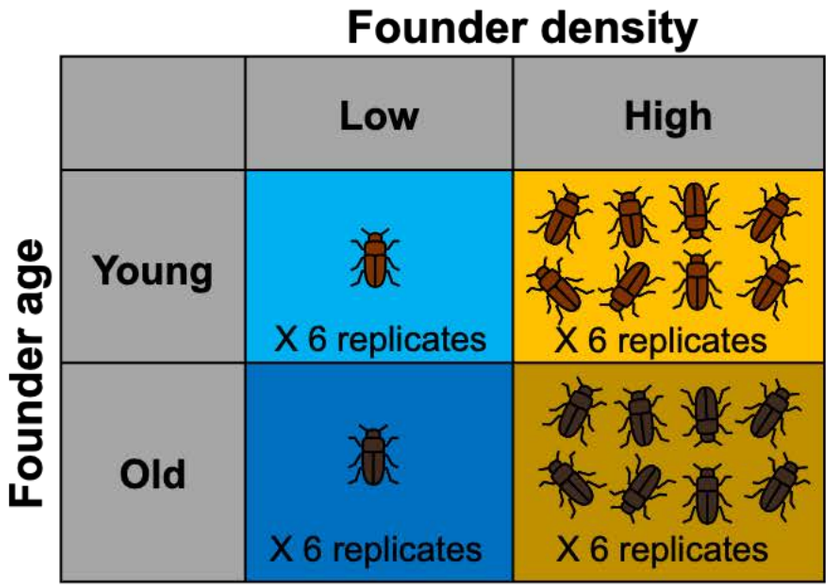
Age and density context of founders

LD: Low density
HD: High density

Manipulate age and density context of founders colonizing a new habitat

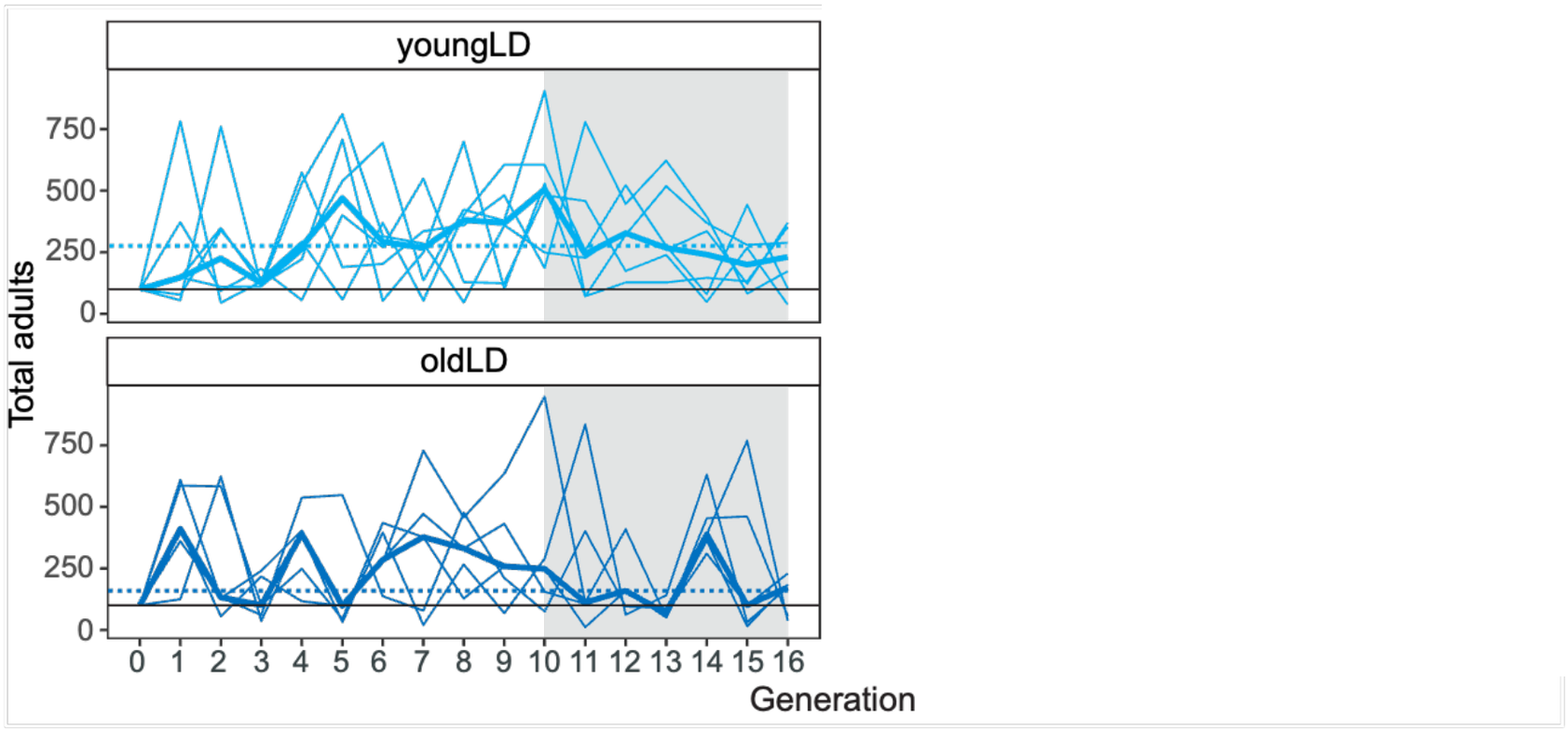


Manipulate age and density context of founders colonizing a new habitat



Context- applicable only to the founders (generation 0)

Population dynamics are similar across founder contexts



Individual populations

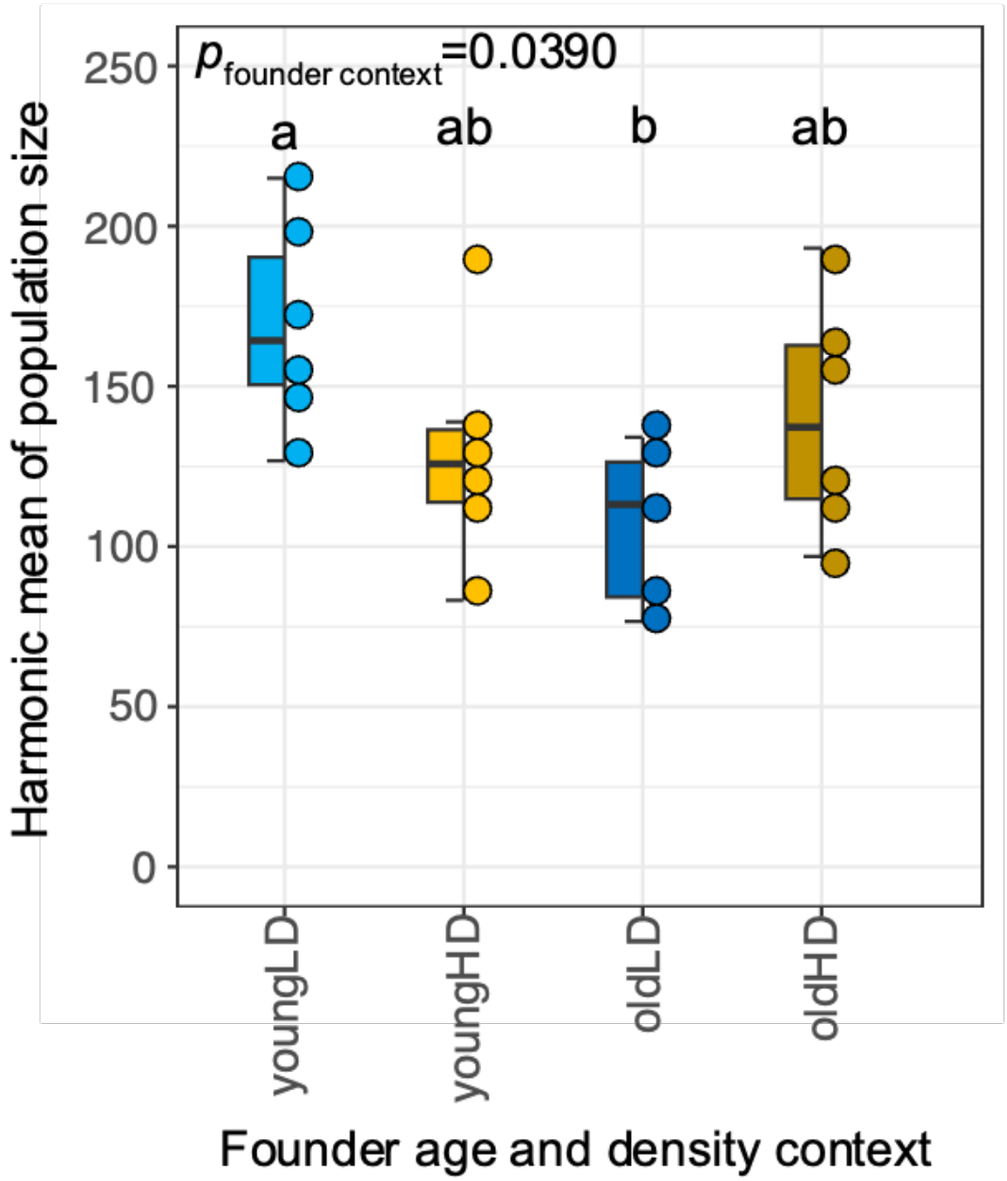
Median trajectory of a given treatment

100 adults (number to initiate next generation)

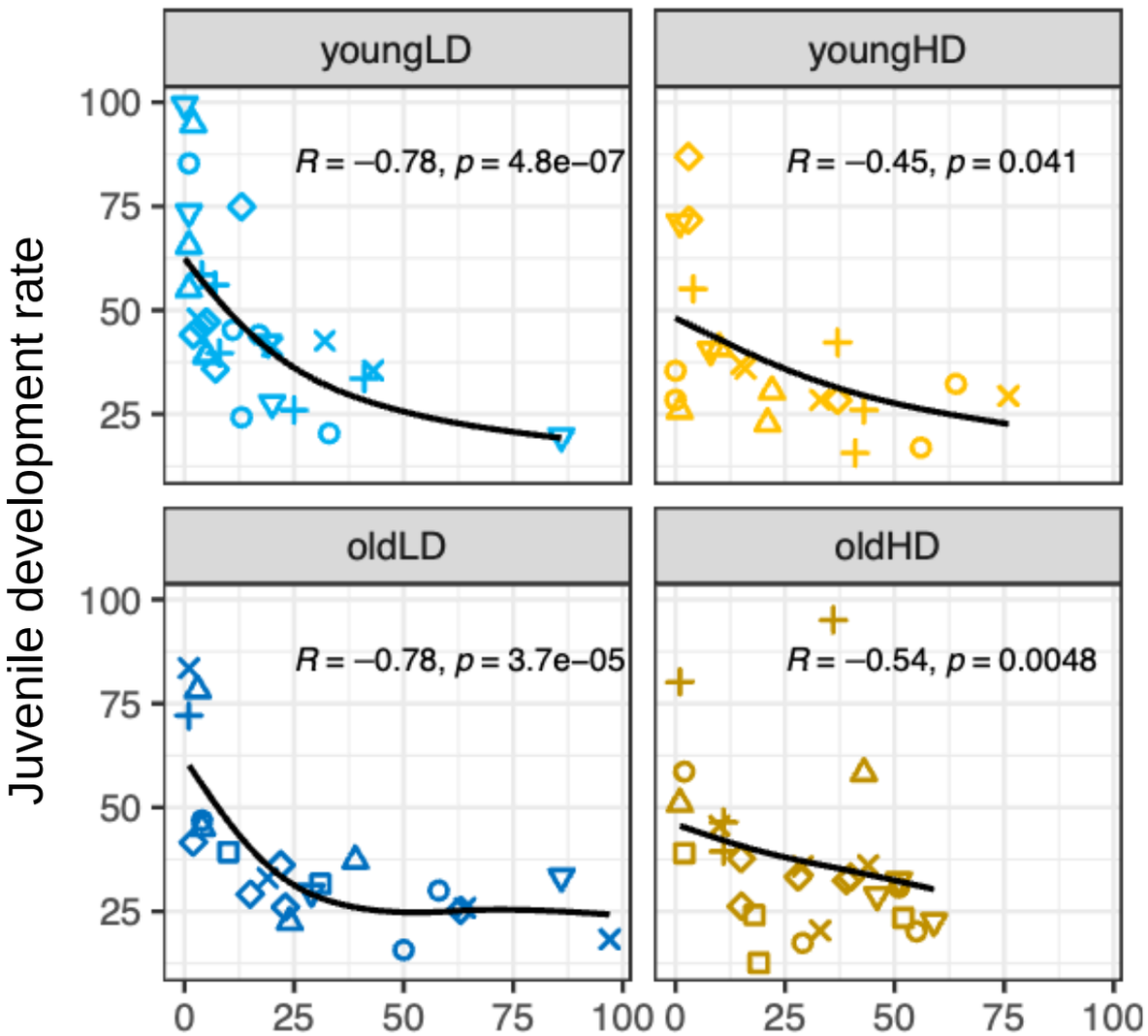
Median population size

Period of unexpected infection by a microsporidian parasite that kills larvae

But founder context does affect population size

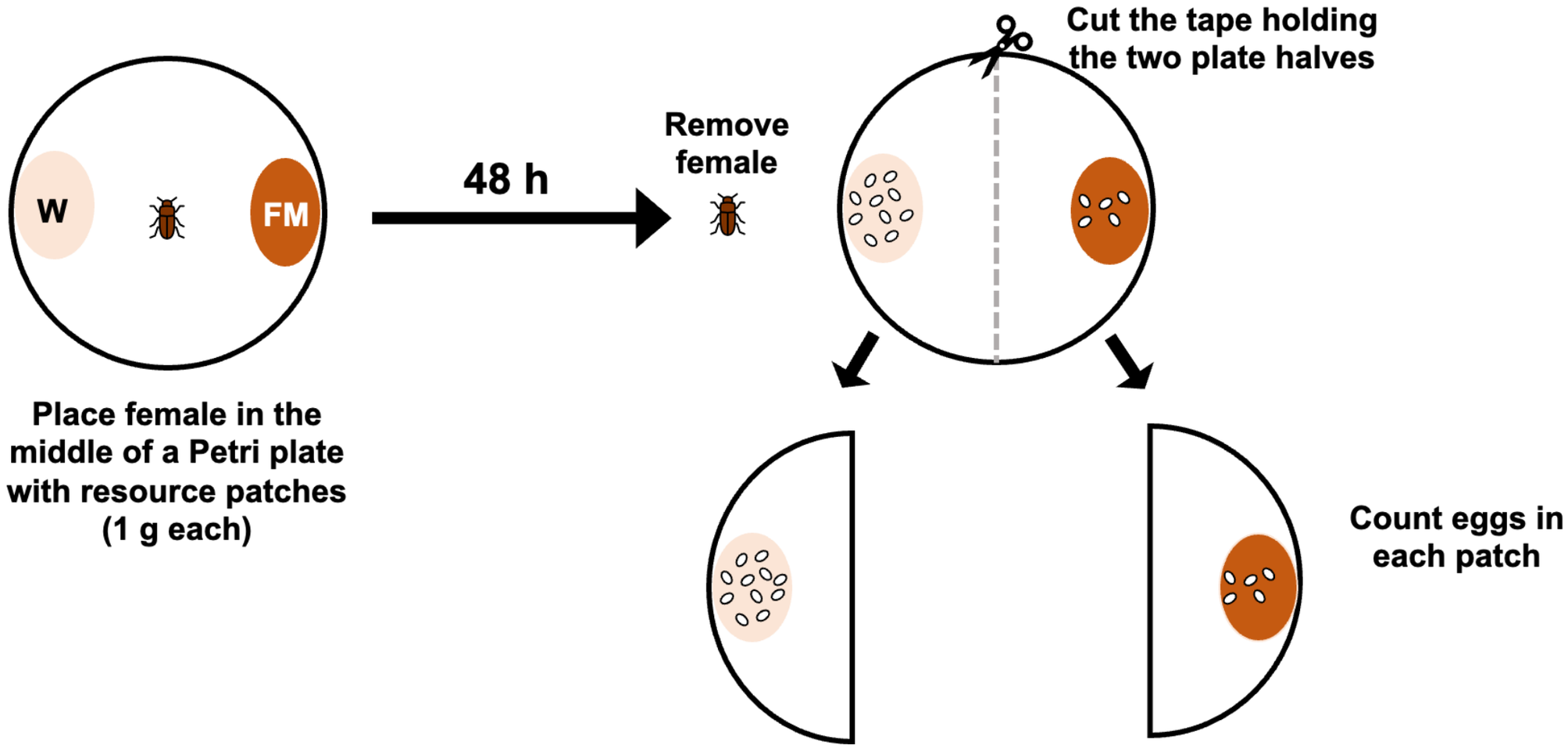


…and the deleterious effect of parasite infection

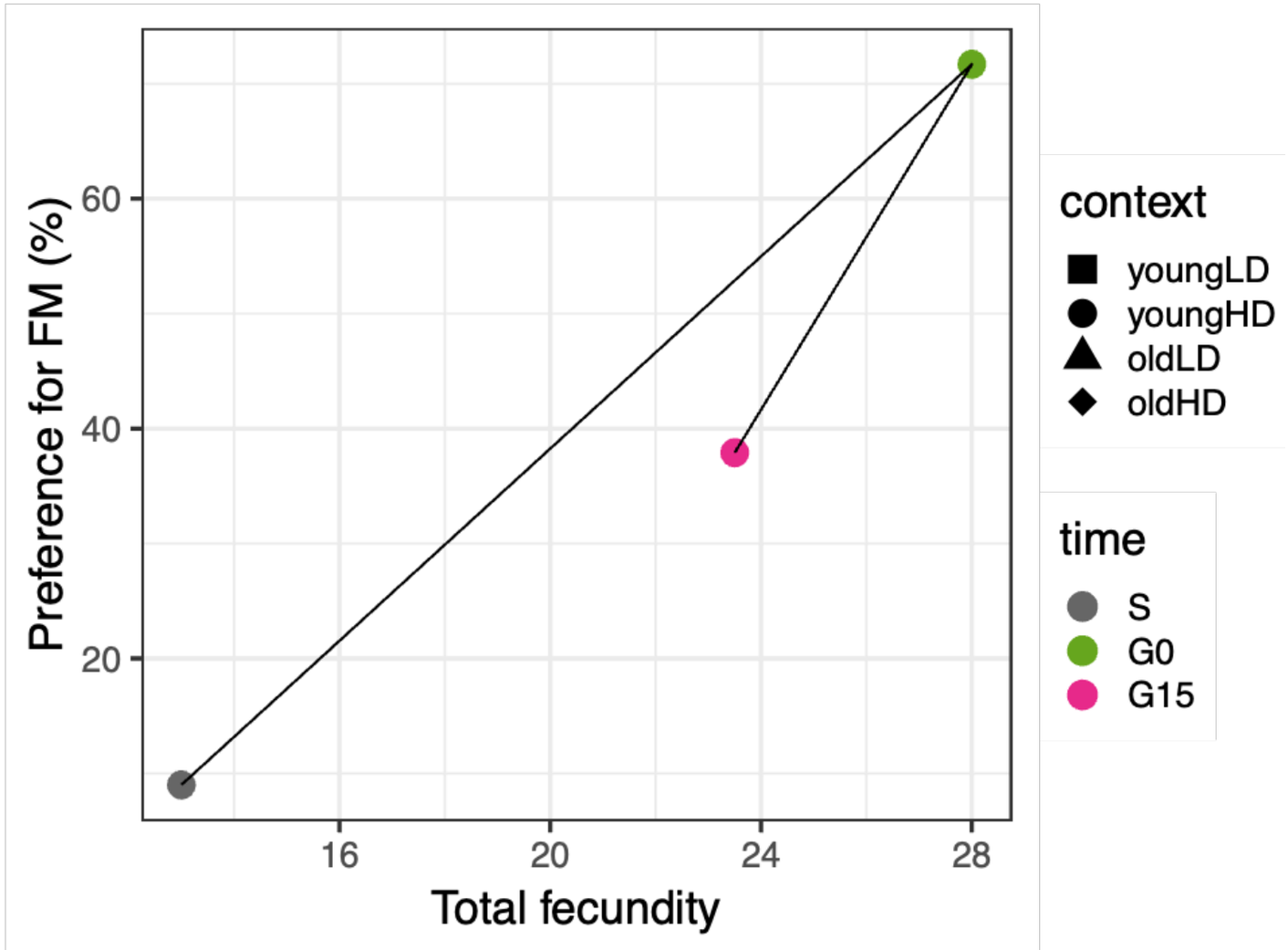


Infection x context effect: $p < 0.05$

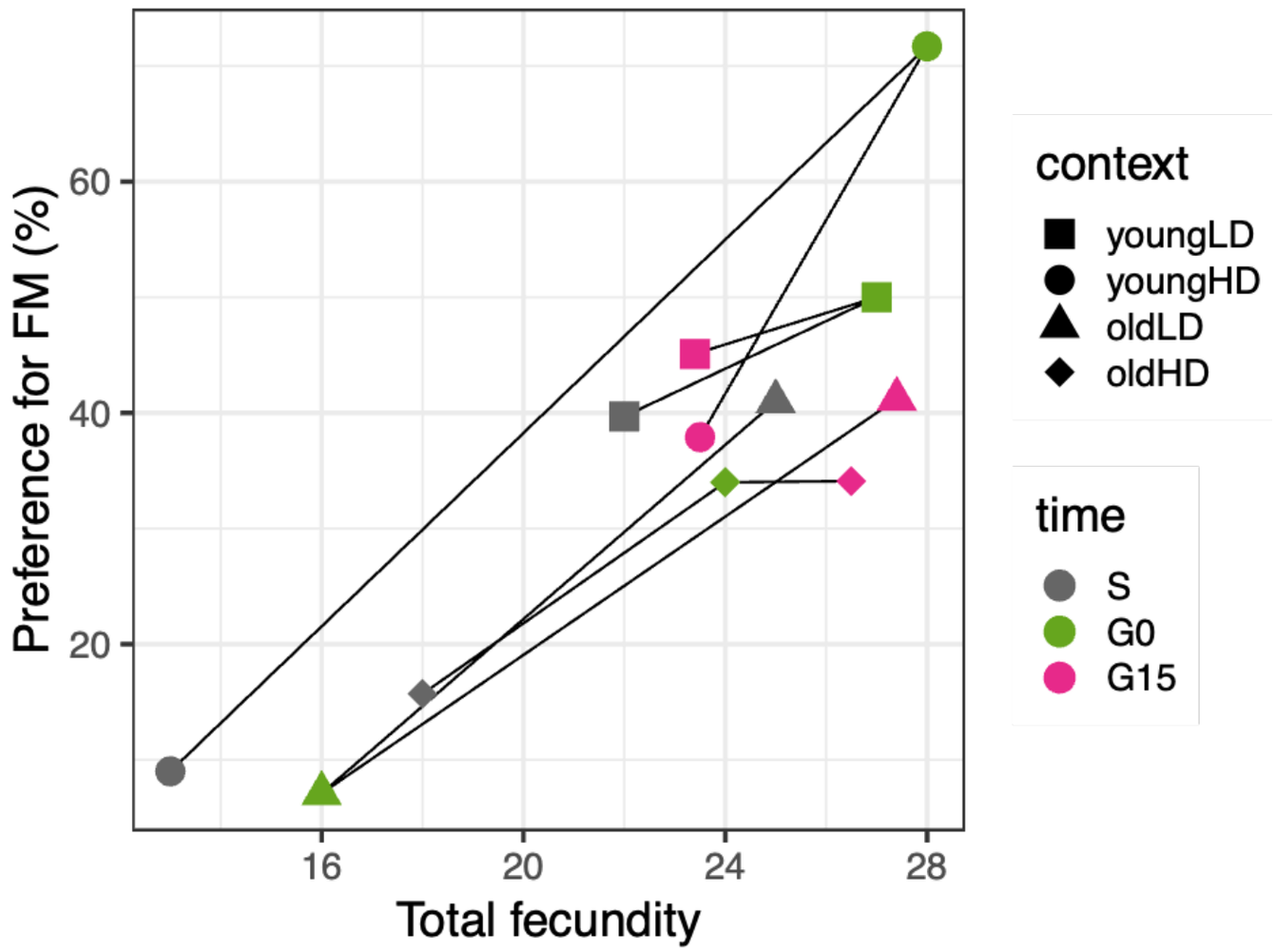
Oviposition assays to measure choice behavior



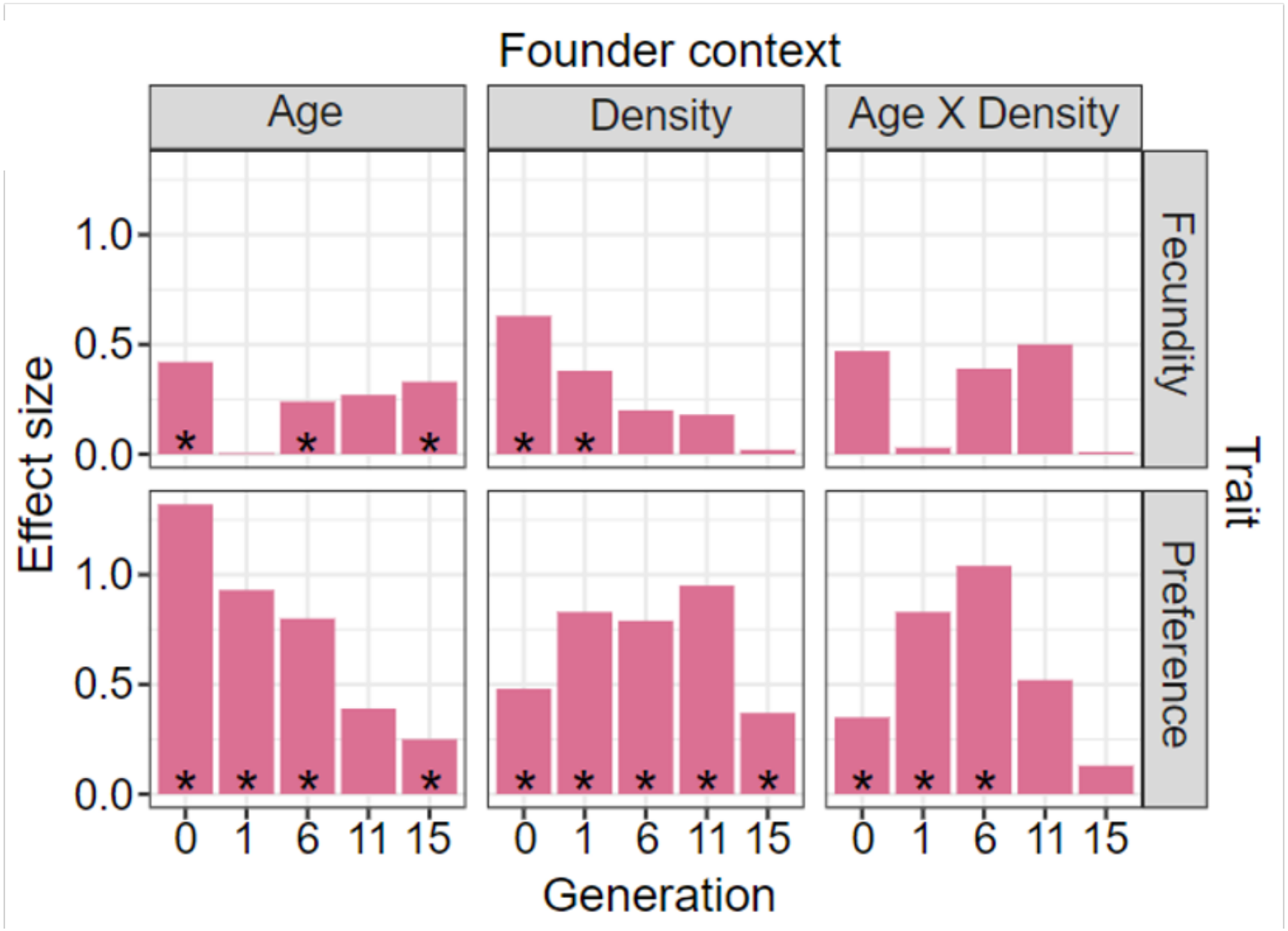
Oviposition behaviour changes immediately in the new habitat, and also during evolution



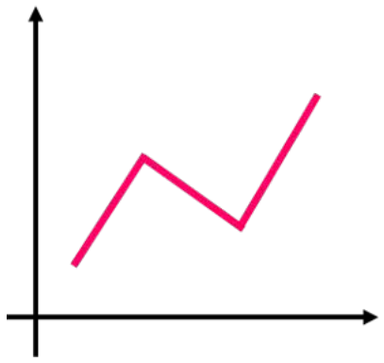
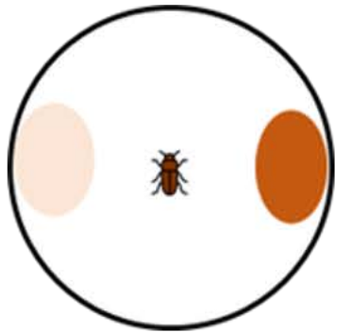
Populations initially diverge, but then converge during evolution

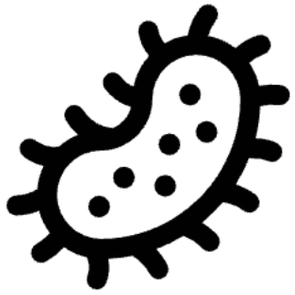


Effect of founder context declines over evolutionary time



Summary II



- Founder female context initially drives divergent oviposition behaviours
- Founder effects reduce over time, allowing convergence
- Founder context affects population size and parasite resistance

Thank you!

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