An evolutionary model of paternal effects

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Aim: Study the co-evolution of both maternal and paternal effects under environmental fluctutations

Key Questions

- Does the inclusion of paternal effects alter the evolution of maternal effects?
- Does the evolution of parental effects change in response to a fluctuating environment?

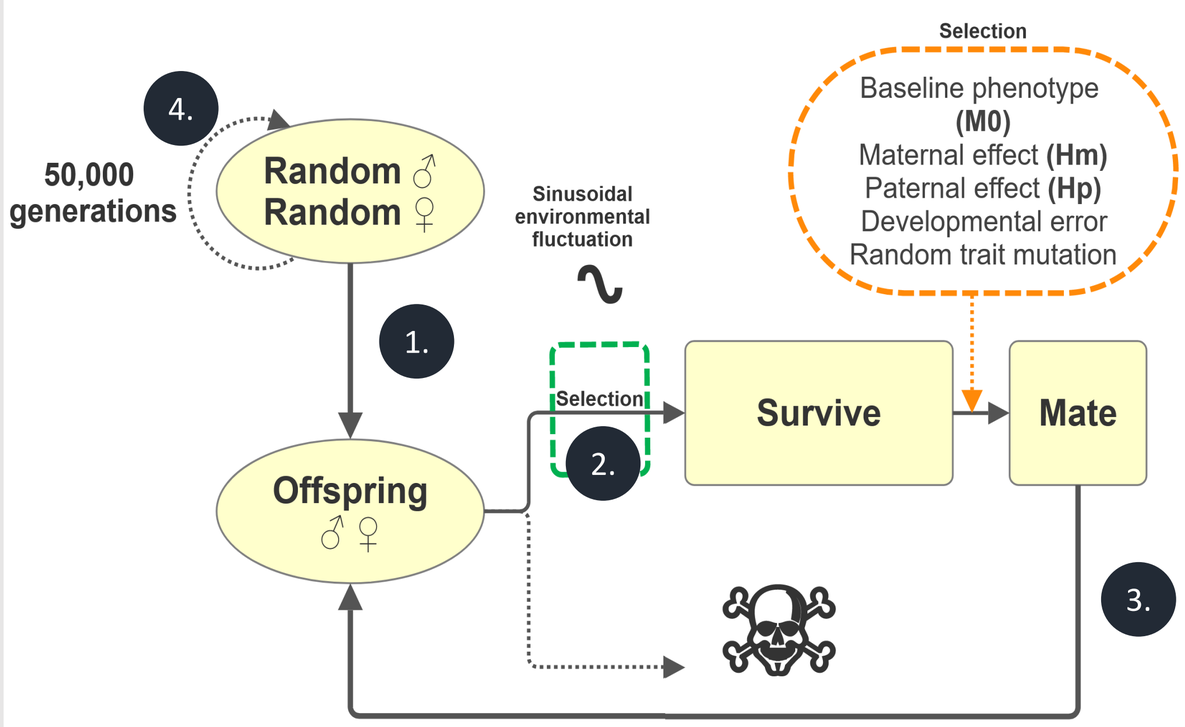
Context

- A parent's phenotype can influence their offsprings' phenotype
- ♀ Most studies focus on maternal effects only
- Mathematical models allow prediction of multi-trait co-evolution
- Adaptation of Kirkpatrick & Lande's 1989 model 'Evolution of maternal effects' with added paternal effect variable

$$z(t+1) = a(t+1) + e(t+1) + mz*(t) + pz*(t)$$

$z(t+1)$ = **Phenotype of offspring,** $a(t+1)$ = **Additive genetic component,** $e(t+1)$ = **Environmental + Epistatic component,** m = **Maternal effect,** p = **Paternal effect,** $z*(t)$ = **Phenotypic value of parent**

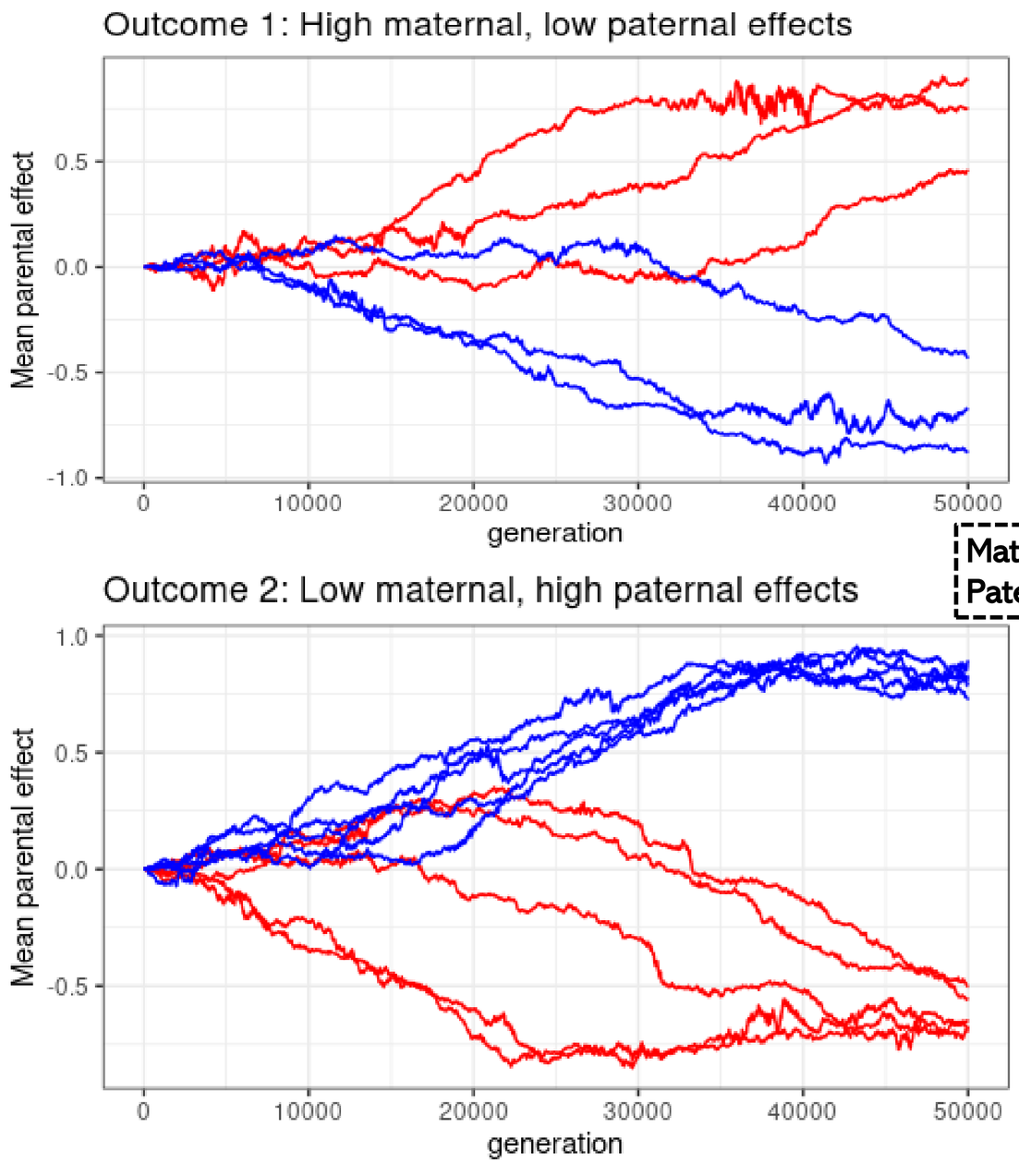
Individual based model – The evolution of parental effects



Legend

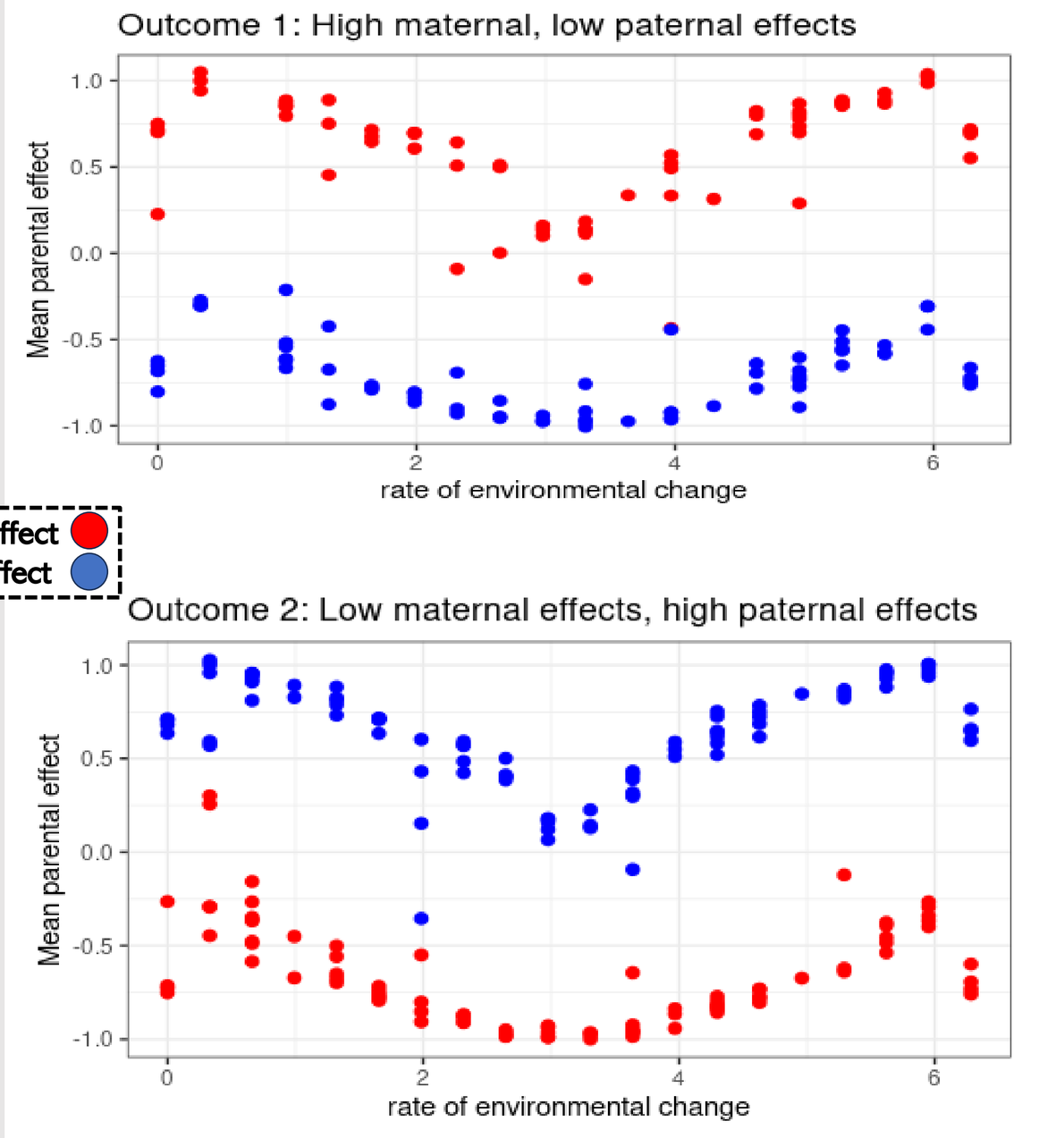
1. Random mating produces offspring
2. Offspring is subject to environmental and parental effects (selection)
3. Offspring randomly mates creating next generation
4. Process repeats for 50,000 generations

Evolution over time: Alternative stable states



Maternal and paternal effects evolve in opposite directions over time. Each graph shows 3 simulations when rate of environmental change ~1.33

Evolutionary endpoints across different rates of change



Maternal and paternal effects both show alternative stable states in a fluctuating environment. Each graph shows 160 replicates of 50,000 generations

Conclusion: Maternal and paternal effects evolve as mirror images

- The environment affects how parental effects evolve
- If one parental effect has a positive value, the other will evolve a negative value
  - \+ A positive parental effect means the offspring has more similarity with their parents
  - – A negative parental effect means the offspring phenotypically differs from their parents
- ↑↓ Alternative stable states show that offspring phenotypes can be influenced by parental effects in multiple ways
  - ≡ This allows the existence of multiple (stable) states occurring simultaneously in the population
- Whether the maternal or paternal effect is stronger depends partially on chance and partially on the initial magnitude of the effect

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