

# Finding the “Drivers”: Exploring Population-Level Selective Pressures Favouring Transposable Element (TE) Carriage Using Agent-Based Modelling

Nicholas Brady, Supervised by Dr. Joseph Bielawski

## Background

One Core Goal Evolutionary Biology is the **ORIGIN OF COMPLEXITY**

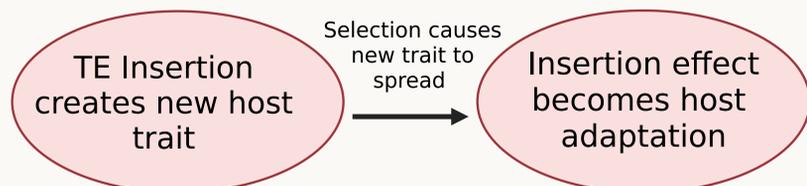
Transposable Elements (TEs) are selected for selfish replication within host

**BUT:** TEs show a pattern of being repurposed into host adaptations and complex systems

**Cross-Level selection** lets us describe TEs as **simultaneously** selfish and beneficial for adaptive host evolution

**Objective:** use agent-based modelling to explore how cross-level effects affect TE and Host Evolution

## The Co-option Process



Beneficial Insertions can be Co-Opted by hosts

## Example Adaptation from TE Activity



Melanized Peppered Moth

22 kb Insert



Speckled Peppered Moth

No Insertion

A TE insertion in an intron increases *cortex* gene expression causing the adaptive melanistic phenotype

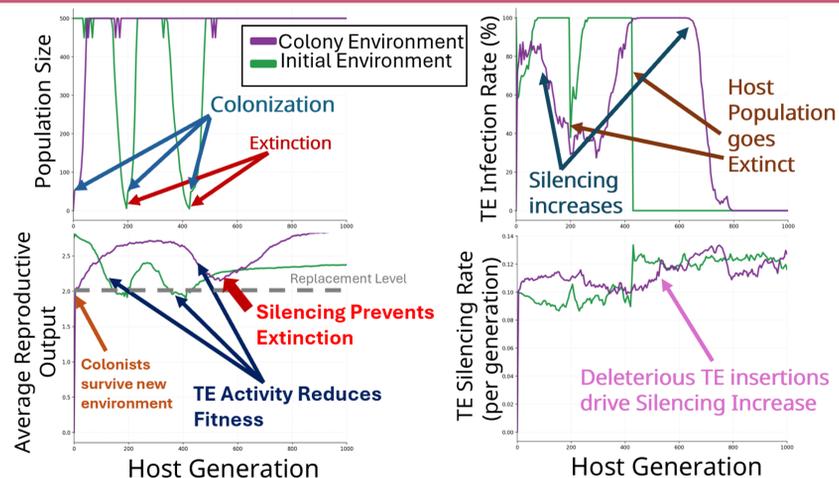
## TEs as Drivers - Cross-Level Selection

Gene-centric models ignore the role of cross-level selective benefits

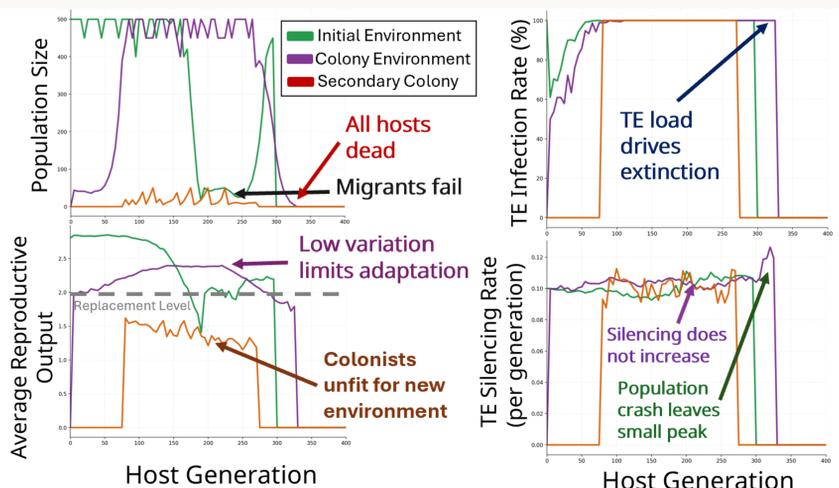
Exploring Cross-level Selection can help us explain the ubiquity of TEs if:

1. Populations are **more likely** to spread or persist when infected with individually deleterious TEs
2. Transposable Elements with cross-level benefits are more common than those with none

## Agent-Based Model shows TE activity aids spread of population



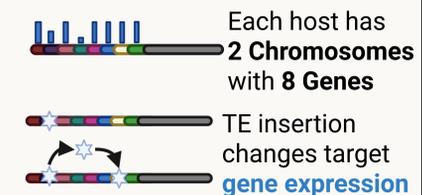
Above: TEs with a large insertion effect allow host populations to adapt to different environments while being individually harmful.



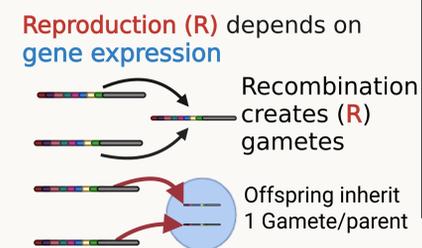
Above: TEs with smaller insertion effects do not increase host adaptability but still reduce the fitness of their hosts.

## Model Elements

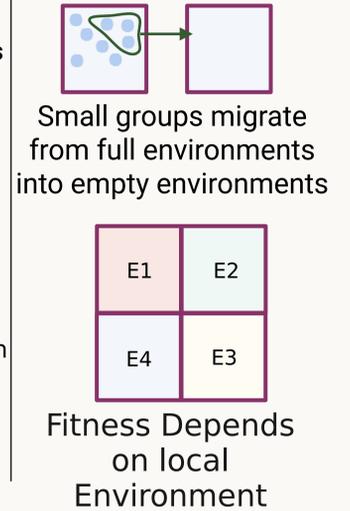
### Level 1: Genes and TEs



### Level 2: Hosts



### Level 3: Populations



## Questions

## Parameters

How does TE insertion affect gene expression?	TE Insertion Effect
How often TEs copy/insert?	TE Transposition Rate
How fast can silencing evolve?	Silencing Mutation Rate
How much variation exists between environments?	Environmental Heterogeneity

Table: Relevant features affecting cross-level selection explored in the model

## Key Takeaways

Host Populations with TEs generating variation can better adapt to new environments than those without

Transposable Element evolution is affected by selection at a minimum of three levels

Research on TE Evolution needs to incorporate Cross-Level Selection and Multi-Level Selection Theory

## ACKNOWLEDGEMENTS

Dr. Joseph Bielawski  
Yuri Kulish,  
Leticia Magpali

