# Gametic selection, meiotic drive, sex ratio bias, and transitions b/w sex determination systems

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Evolution 2017

# Sex determination systems are remarkably dynamic

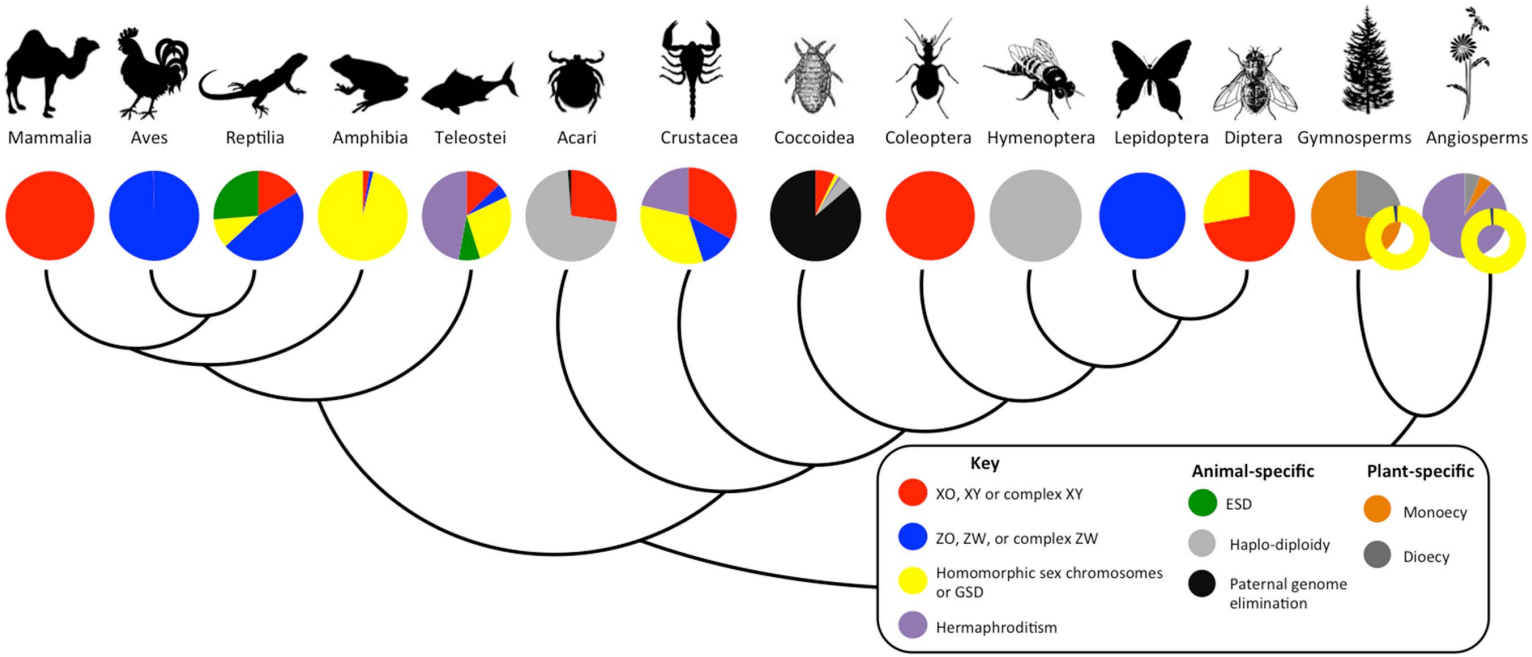


**Figure 3. Diversity of sex determination systems for representative plant and animal clades.** The bubble insert graph for the plant clades represents the relative proportion of species with documented sex chromosomes within plants with separate sexes. Vertebrates: Mammalia (placental, marsupial, and monotreme mammals), Aves (birds), Reptilia (turtles, snakes, crocodiles, lizards), Amphibia (frogs, toads, salamanders), and Teleostei (bony fishes). Invertebrates: Acari (mites and ticks), Crustacea (shrimps, barnacles, crabs), and Insects, which include Coccoidea (scale insects), Coleoptera (beetles), Hymenoptera (ants, bees, and wasps), Lepidoptera (butterflies), and Diptera (flies). Plants: Gymnosperms (non-flowering plants) and Angiosperms (flowering plants).
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## Sex Determination: Why So Many Ways of Doing It?

Bachtrog *et al.* 2014

# Sex determination systems are remarkably dynamic

2 main theories

# Theory 1: Turnover caused by sex-ratio selection

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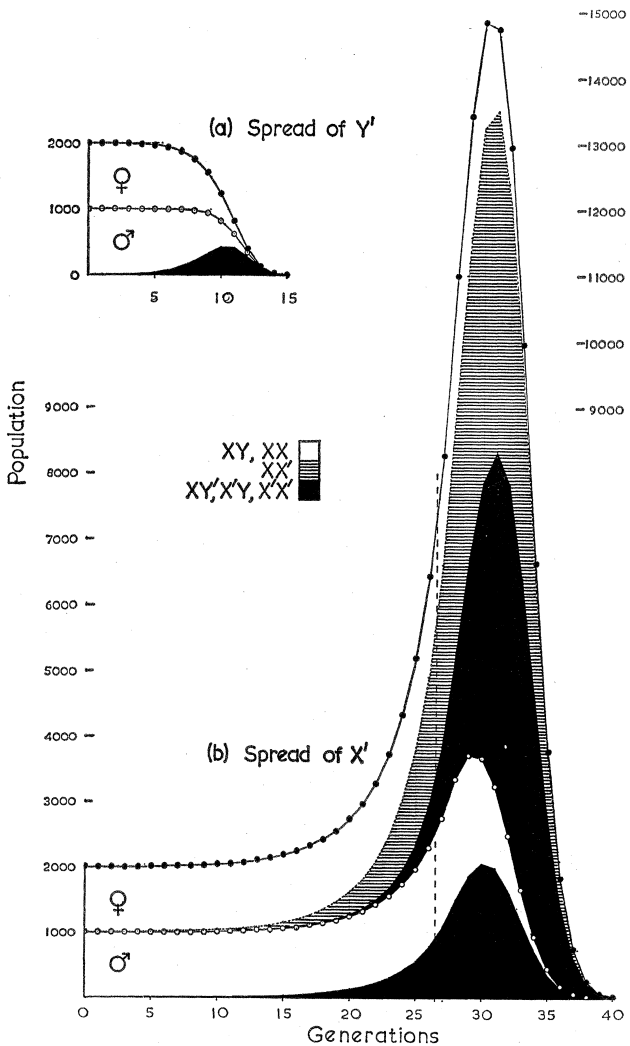
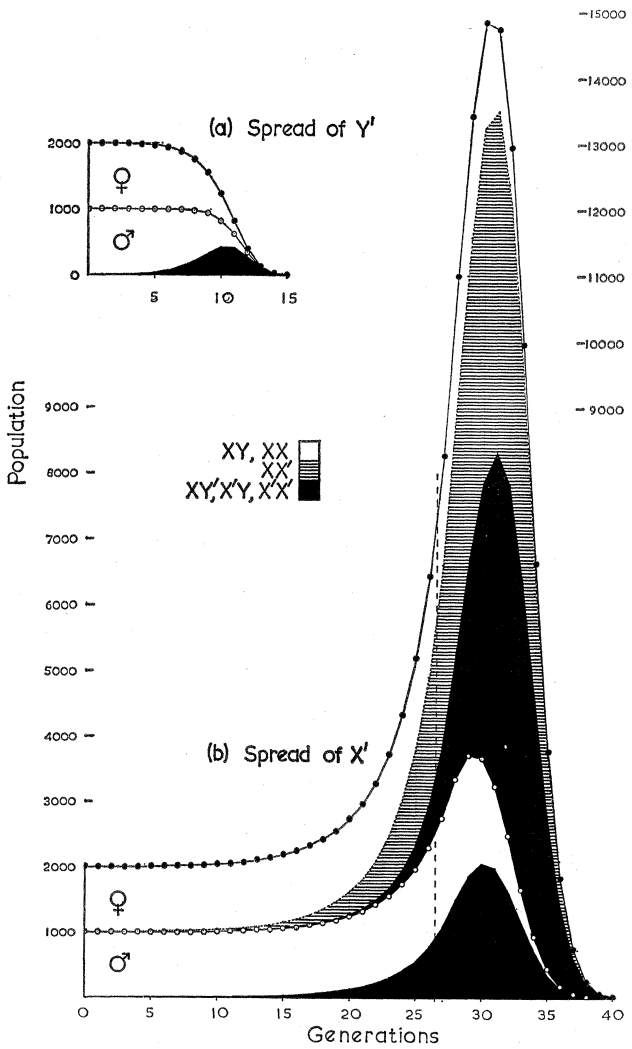



**Extraordinary Sex Ratios**

Hamilton 1967

# Theory 1: Turnover caused by sex-ratio selection

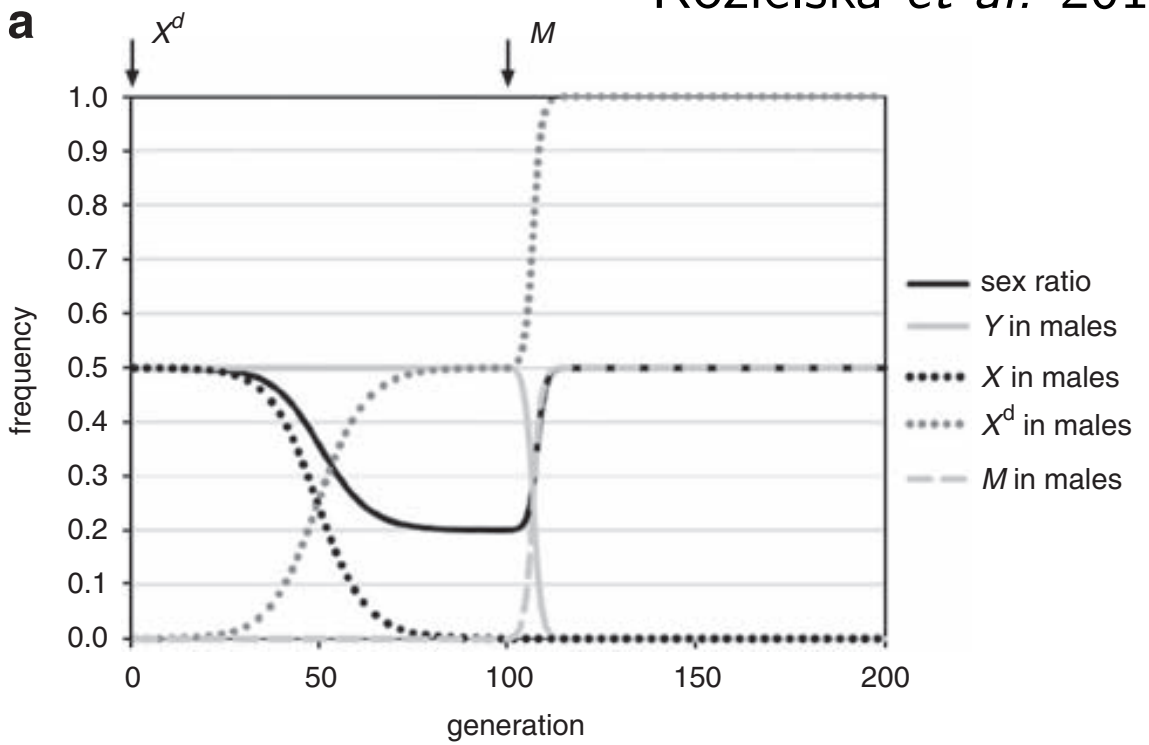



**Extraordinary Sex Ratios**

Hamilton 1967

Segregation distortion and the evolution of sex-determining mechanisms

Kozielska *et al.* 2010



# Theory 2: Turnover caused by sex-antagonistic selection

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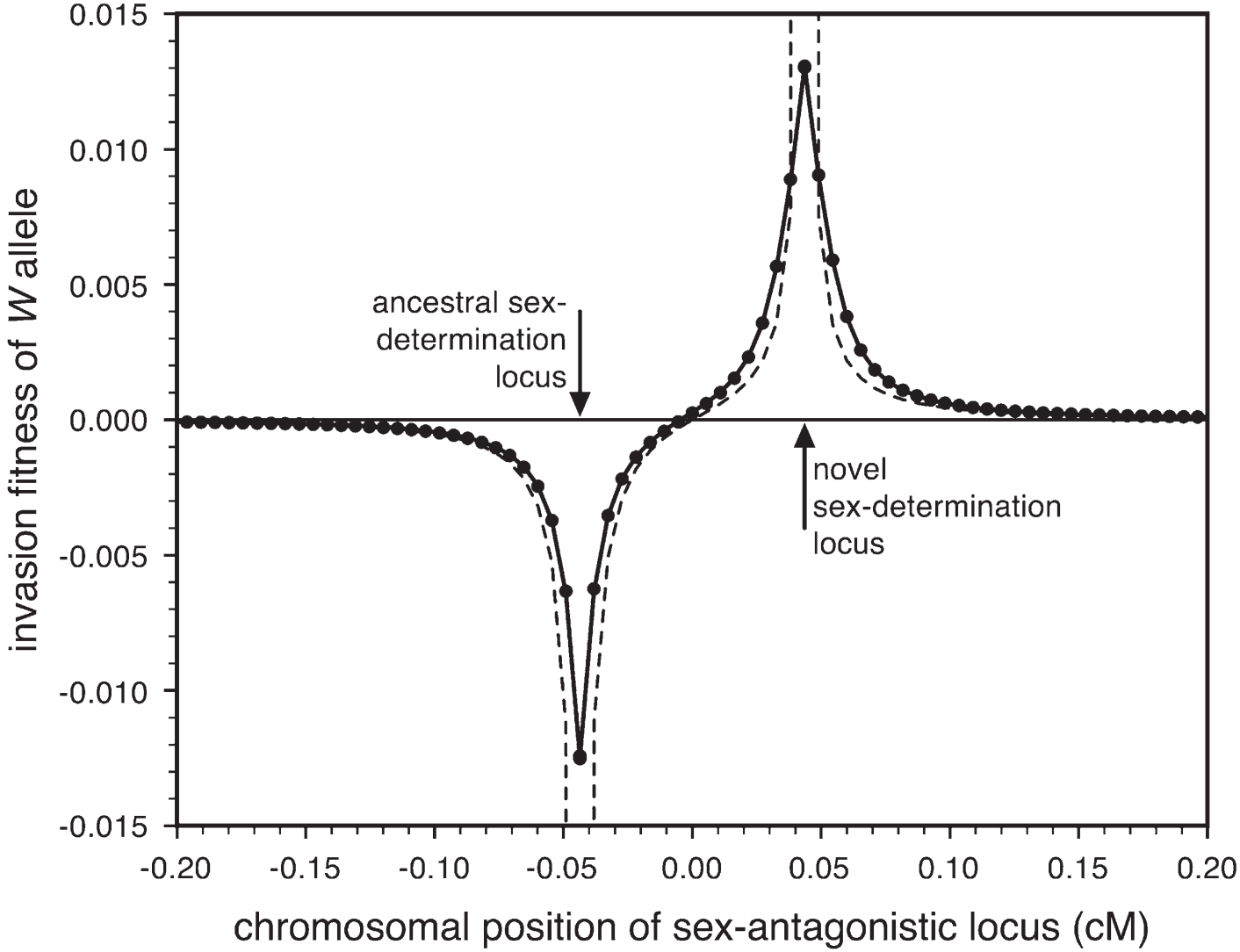


**Transitions Between Male and Female Heterogamety Caused by Sex-Antagonistic Selection**

van Doorn & Kirkpatrick 2010

# Sex-ratio **and** sex-antagonistic selection?

# Haploid-diploid life-cycles

[pictures of haploids, or life cycles]

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**Haploid selection: Gametic competition and meiotic drive**

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Biased transmission of gametes, typically sex-specific
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[pictures of haploids, or life cycles]

**Haploid selection: Gametic competition and meiotic drive**

Biased transmission of gametes, typically sex-specific
$\Longrightarrow$ can impart both sex-ratio **and** sex-antagonistic selection

**Question**

How does haploid selection influence sex-determination turnover?

*"FOR MOTION DISCOMFORT*

*AND*

*BABY DIAPER DISPOSAL"*

***Please place in waste receptacle after use***

***<u>Not for toilet disposal</u>***

***<u>Do not place in seat back pocket after use</u>***

*"FOR MOTION DISCOMFORT*

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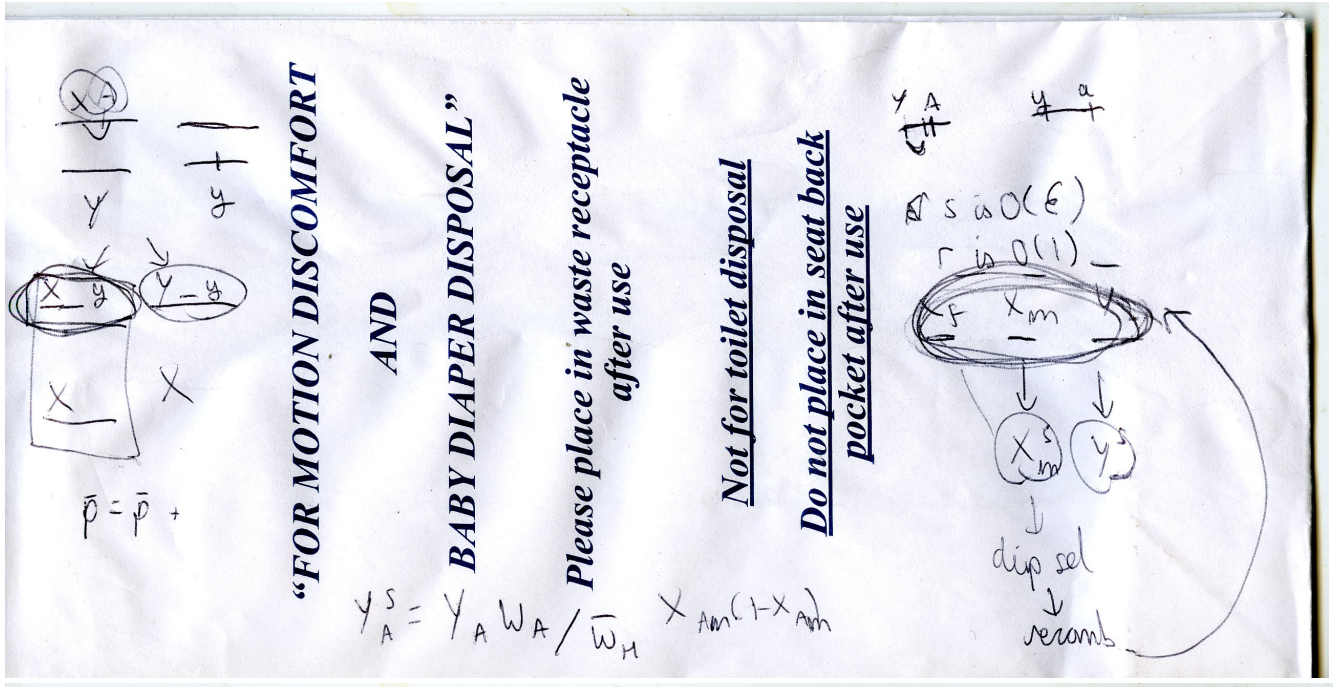
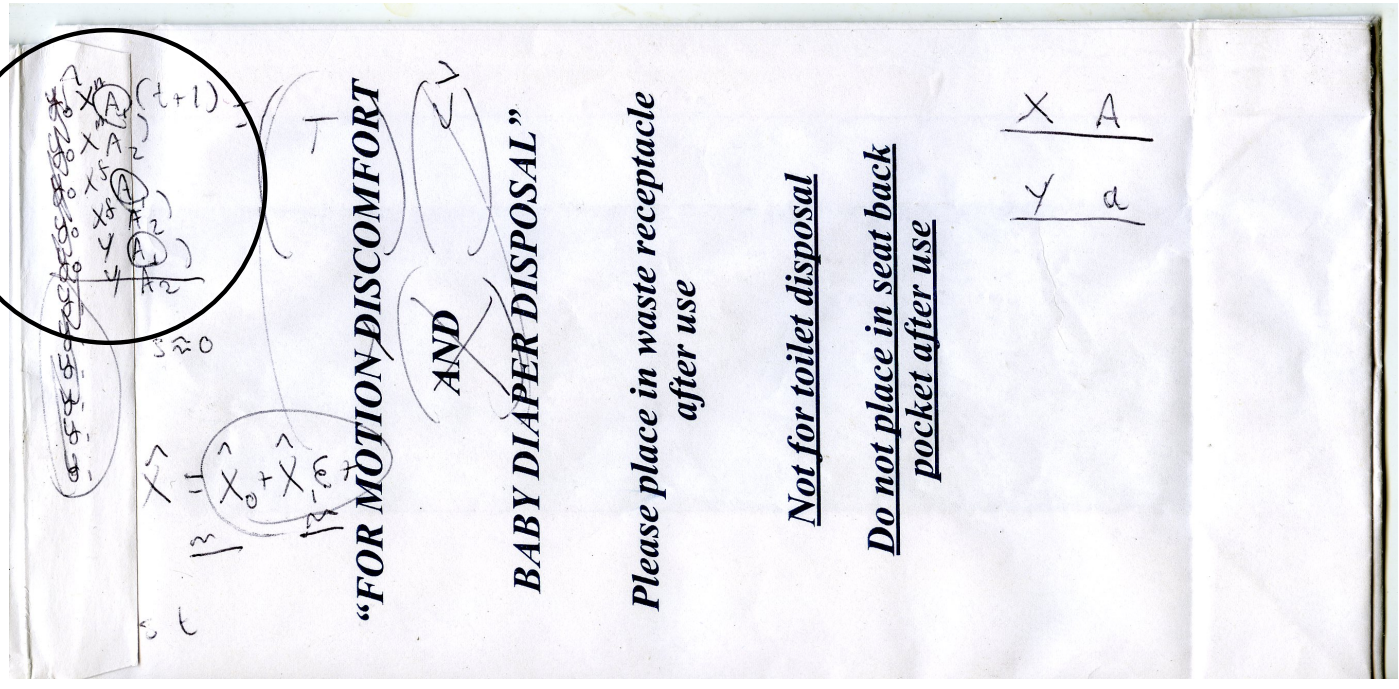
# Model

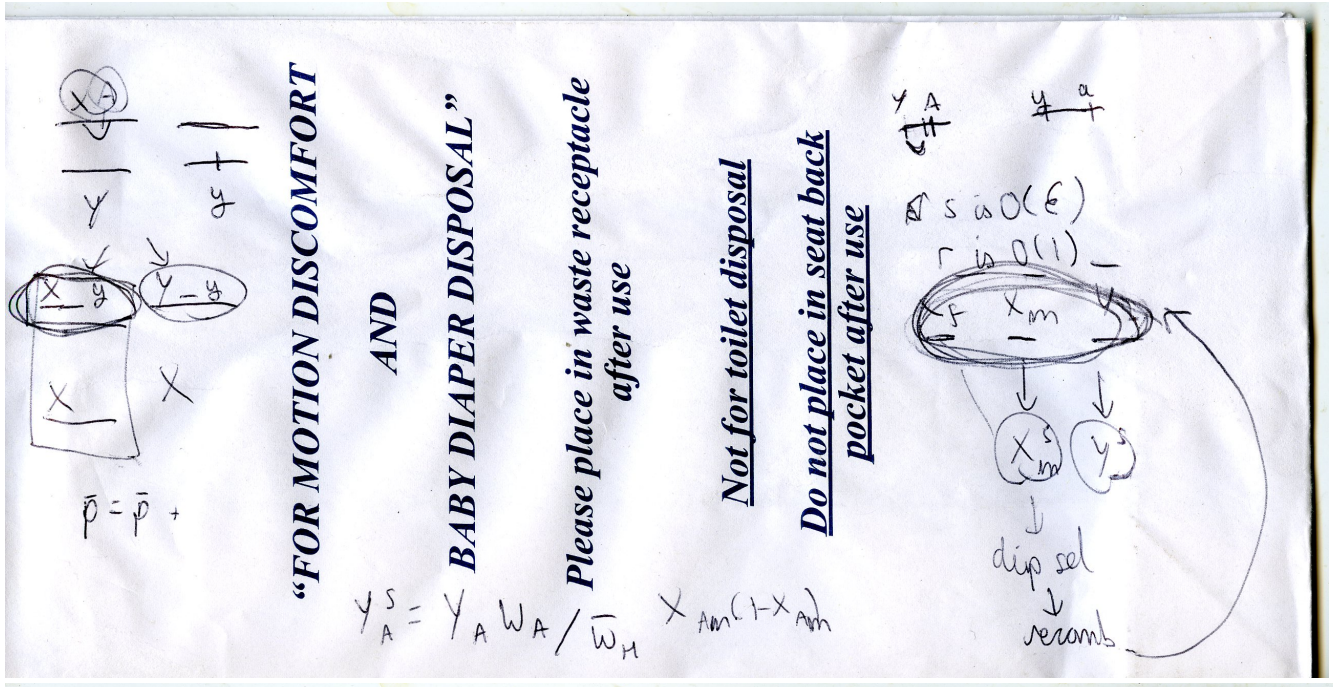
1. recursion equations

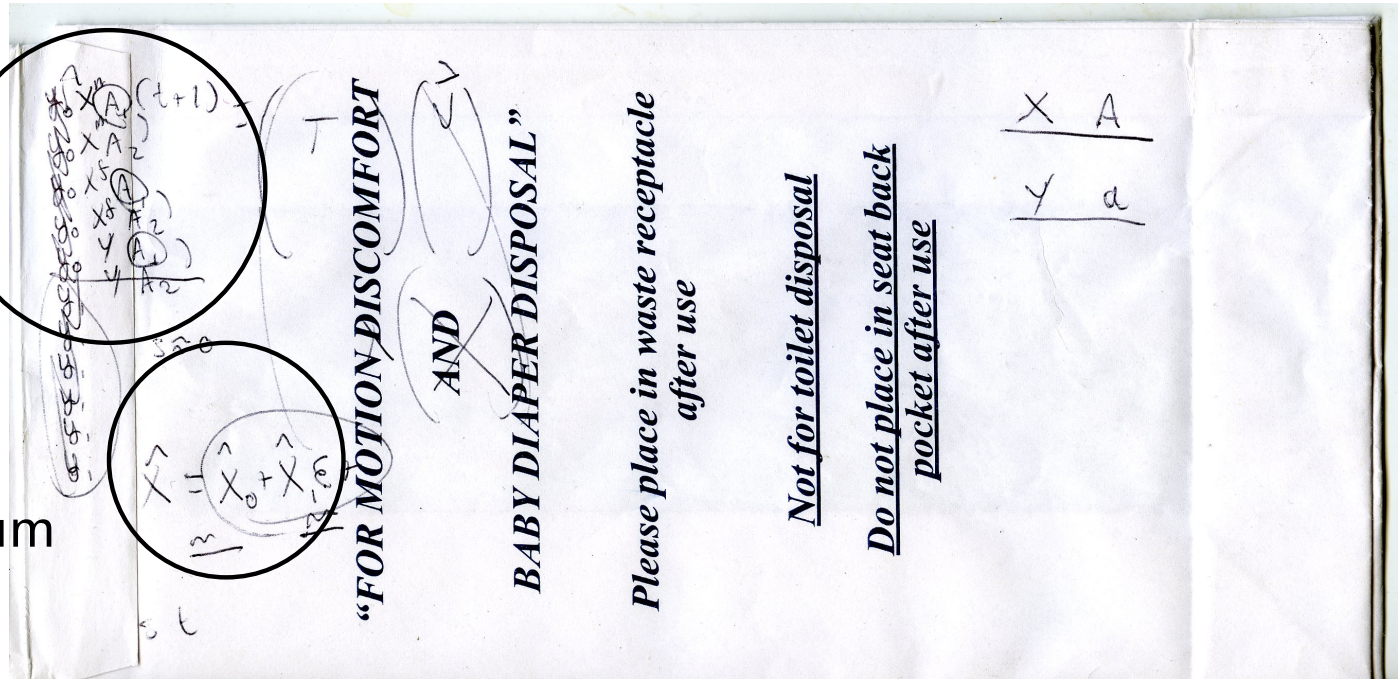


# Model

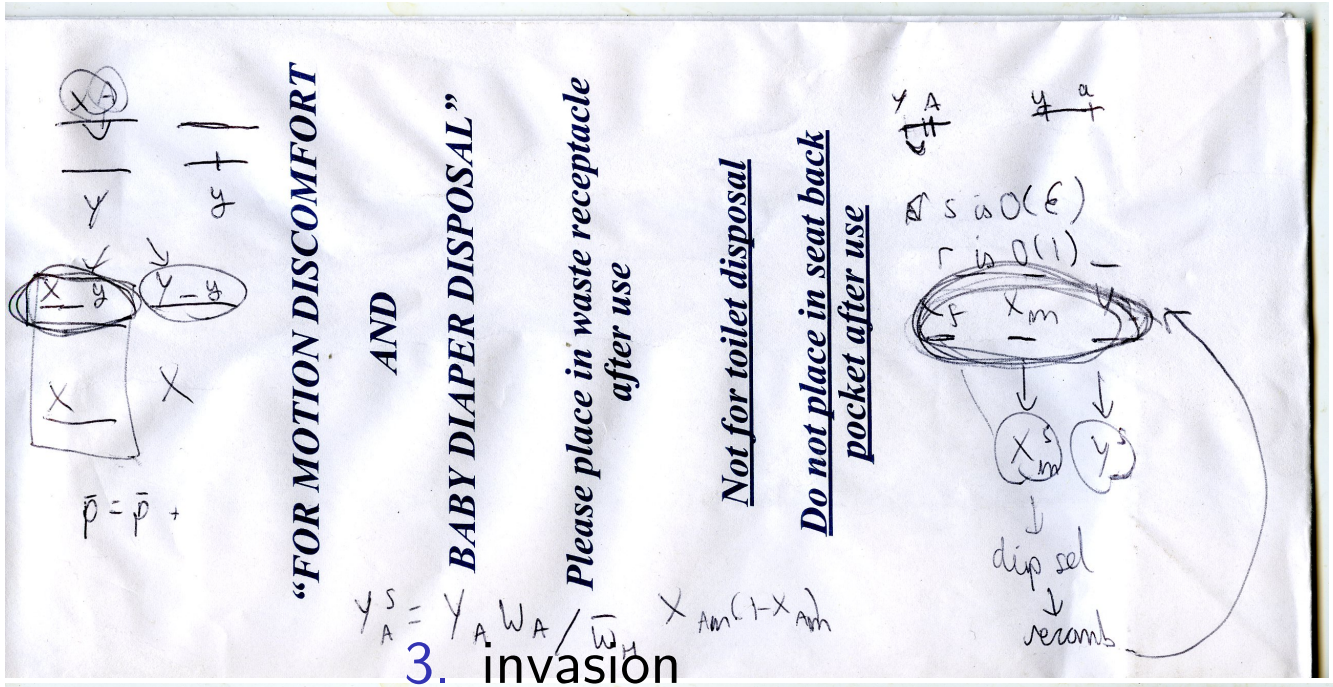
1. recursion equations
2. resident equilibrium

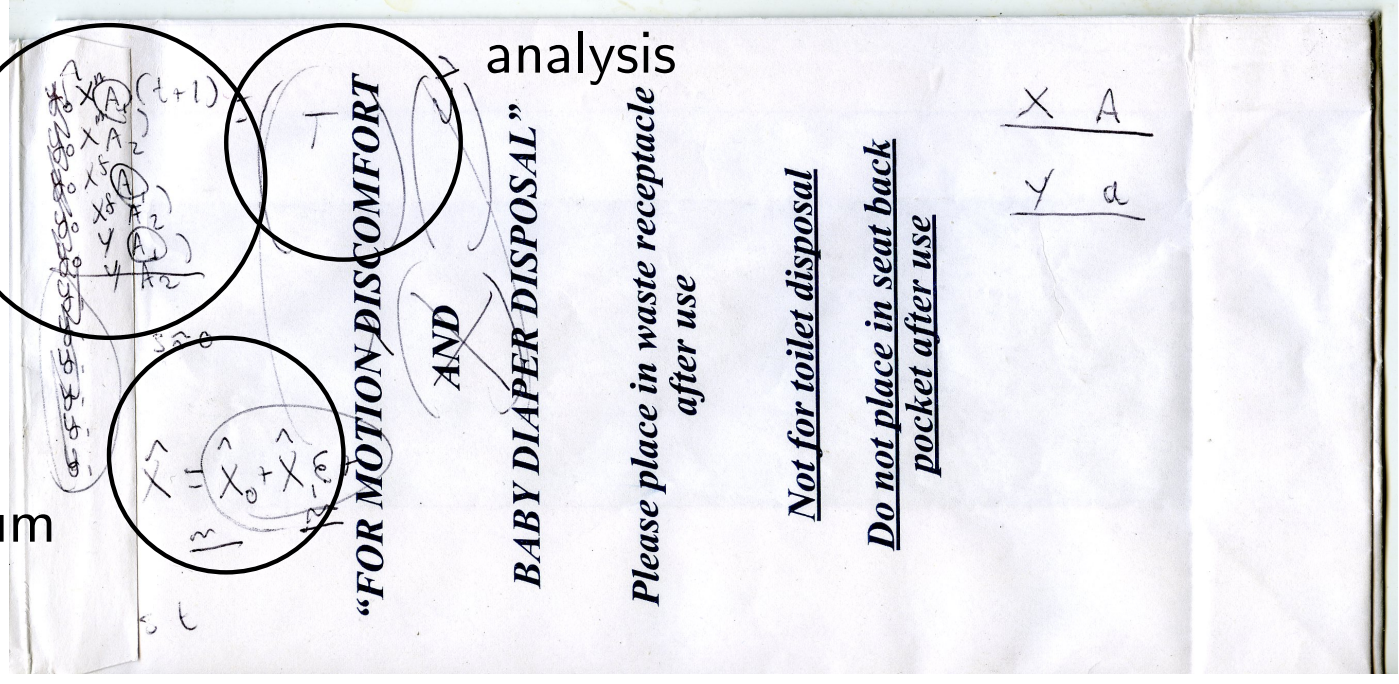


# Model

1. recursion equations
2. resident equilibrium
3. invasion analysis



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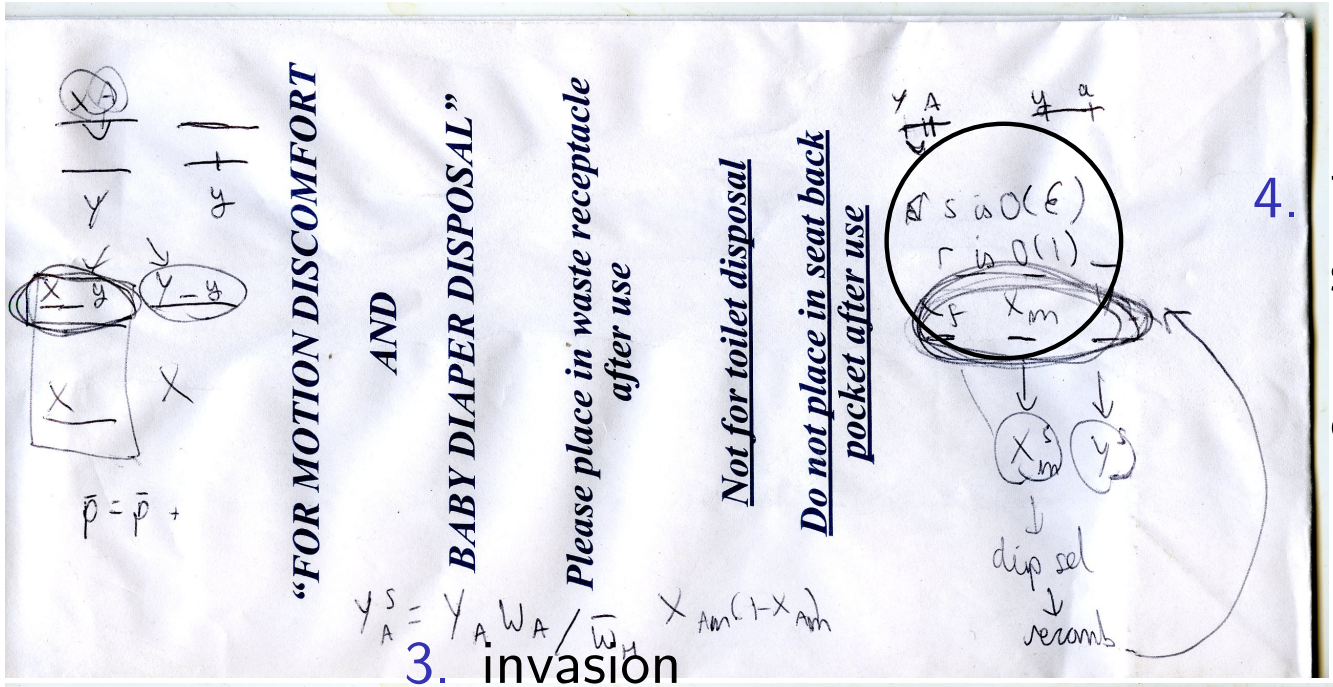
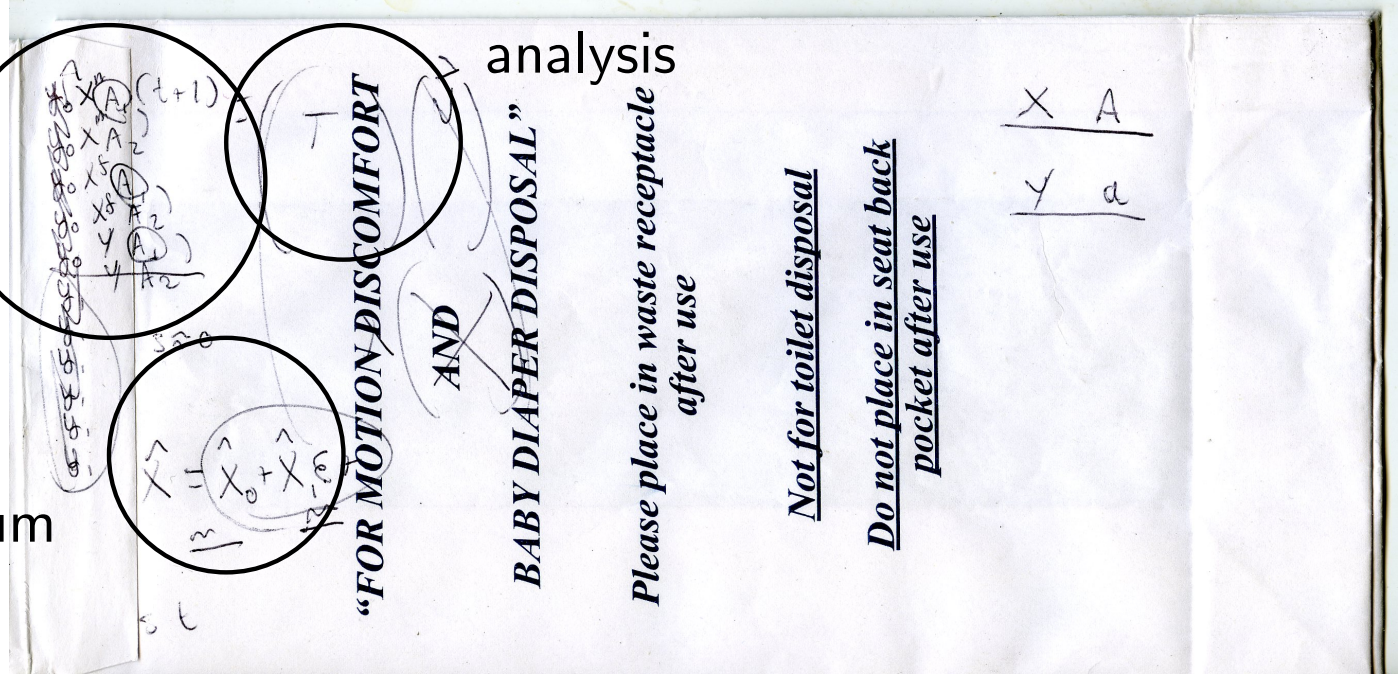
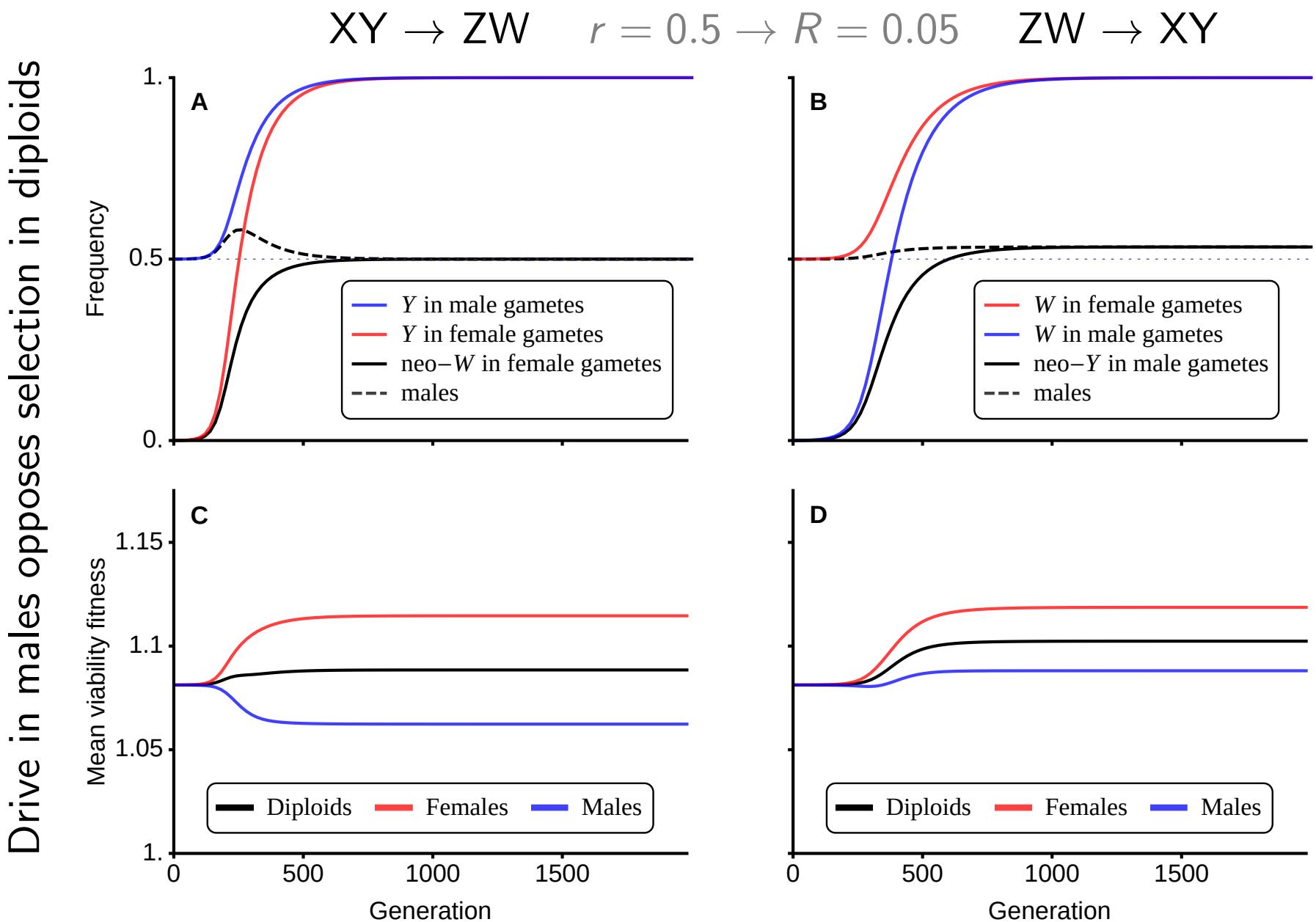



1. recursion equations
2. resident equilibrium
3. invasion analysis
4. Taylor series of leading eigenvalue

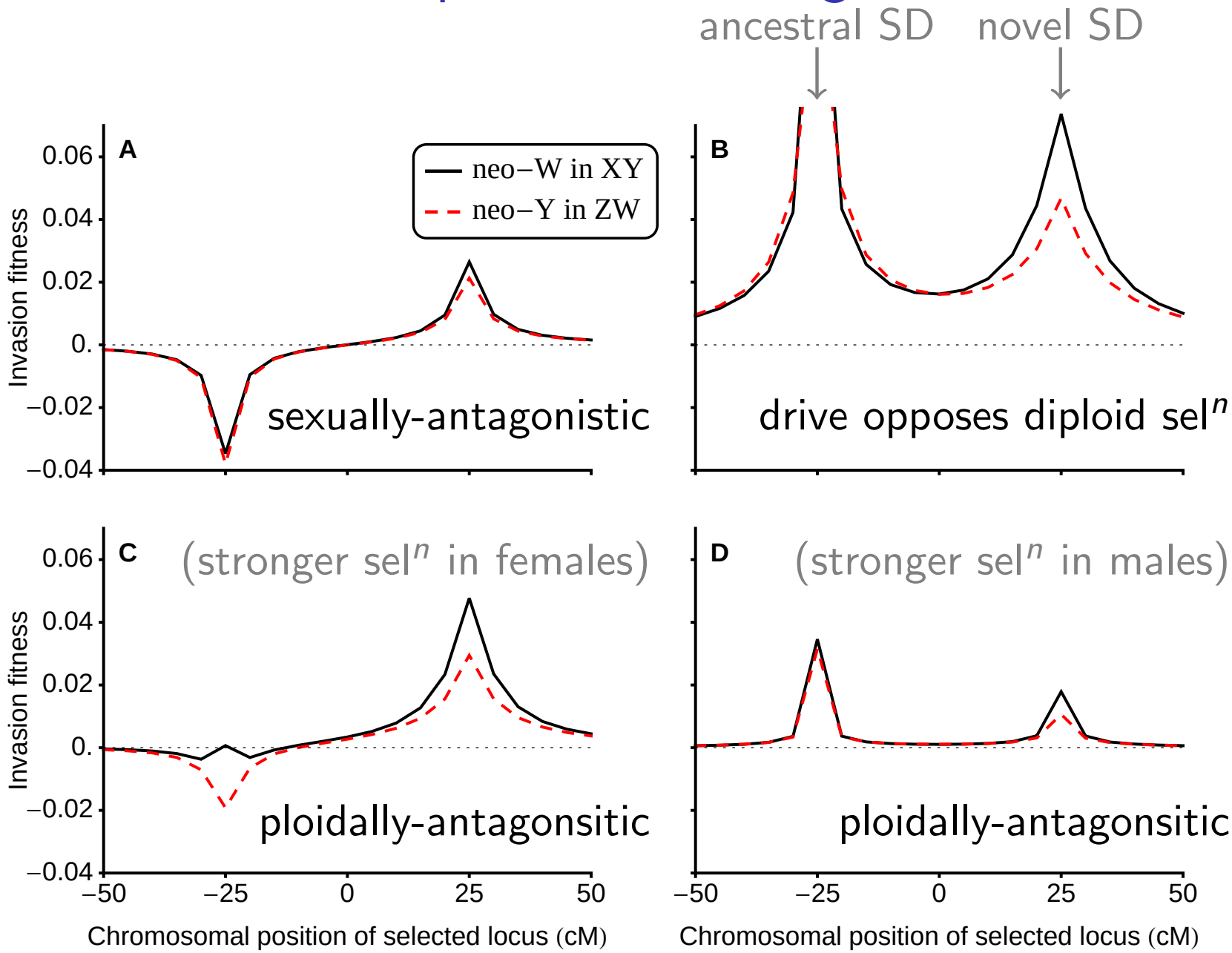


# 2 main results

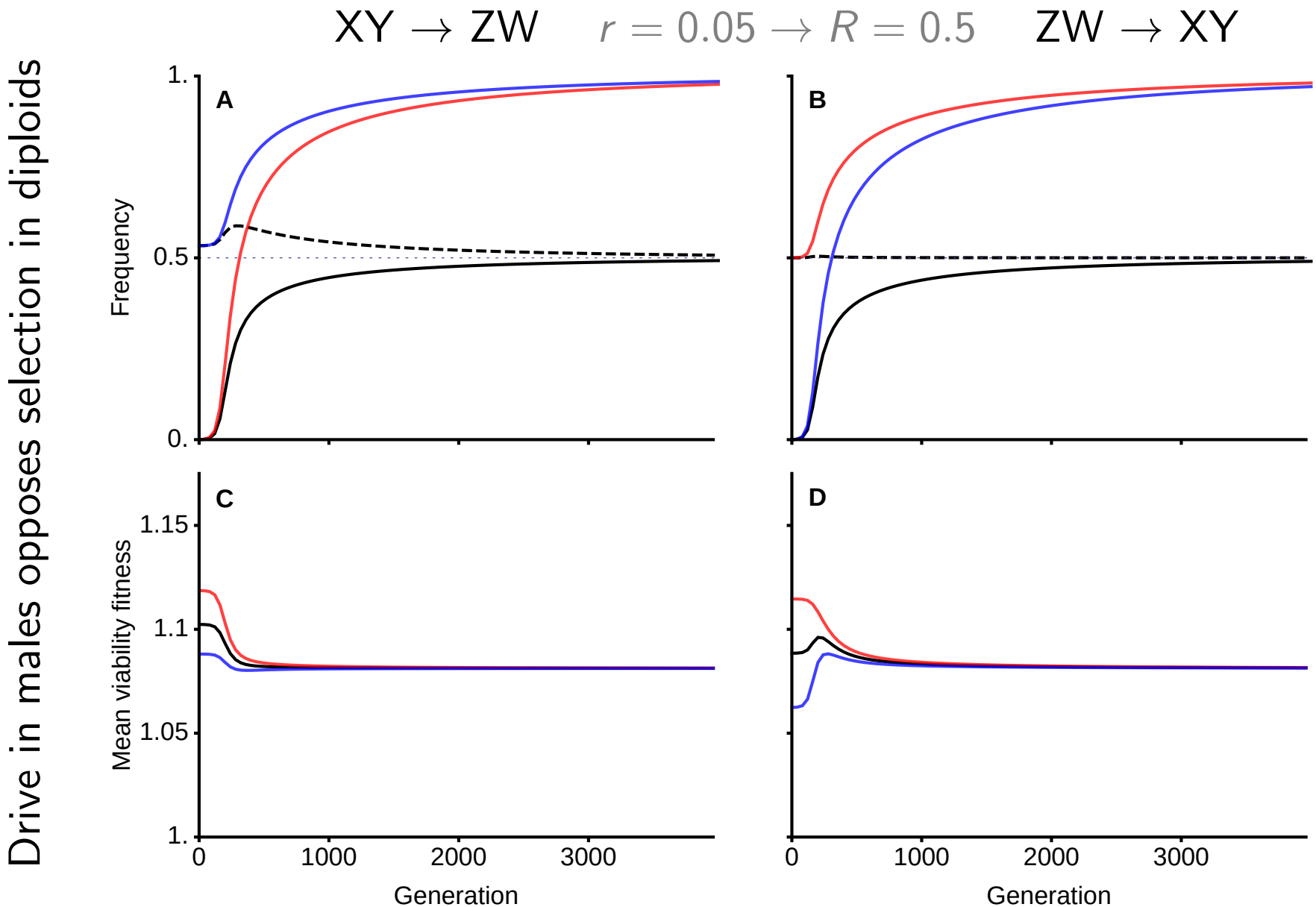
# Result 1: Turnover can *create* sex-ratio bias



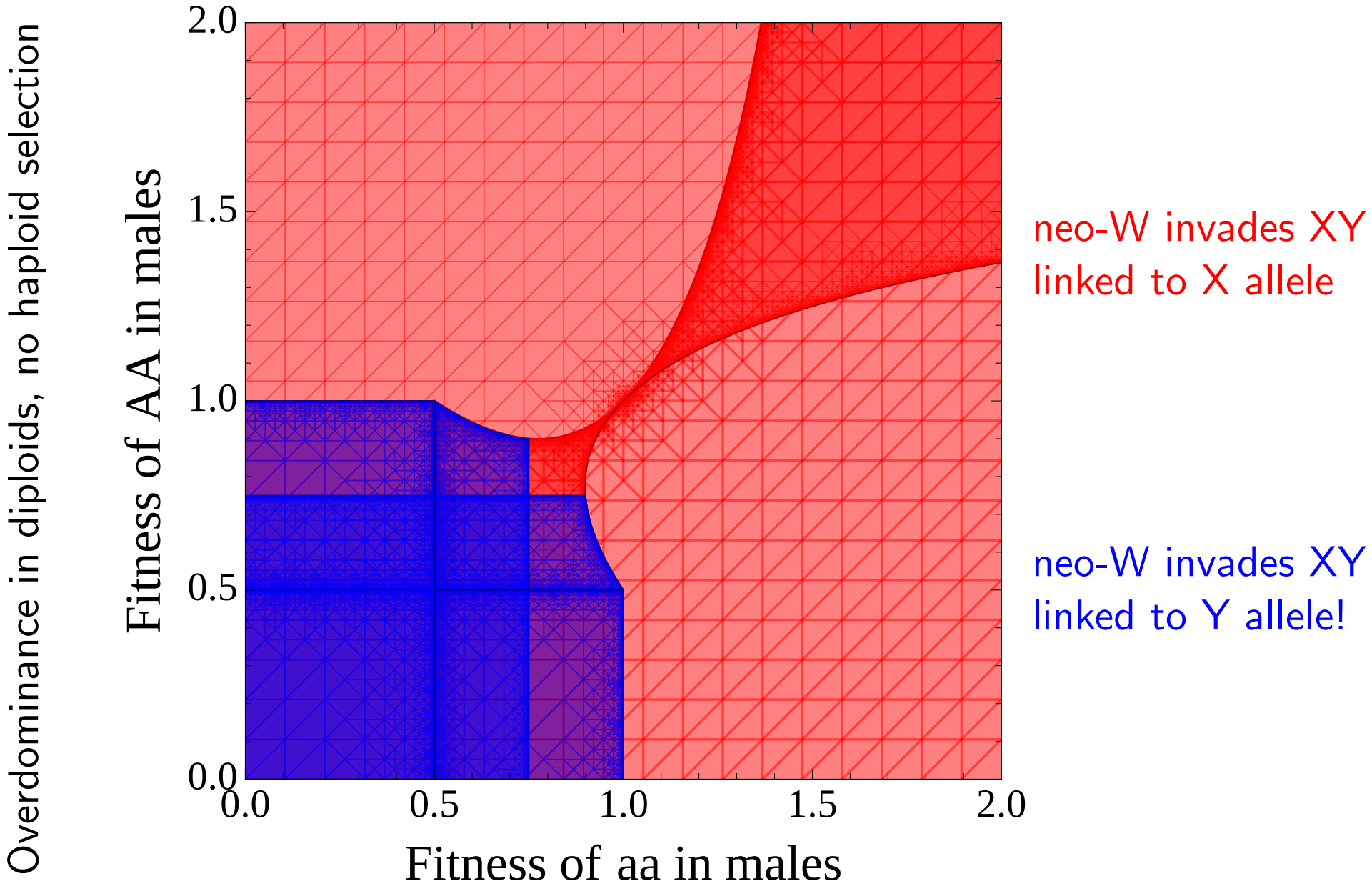
# Result 2: Turnover despite *looser* linkage



# Result 2b: Looser linkage evolves despite fitness *decline*



# Bonus result! Turnover with very tight linkage



# Summary

- Haploid selection creates new avenues for sex determination turnover
  1. Turnover can occur **regardless of sex-ratio bias**, and create it
  2. Turnover can **decrease sex-linkage**, and mean diploid fitness

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  2. Turnover can **decrease sex-linkage**, and mean diploid fitness

- Bonus result: Turnover possible with tight linkage, two mechanisms
  1. neo-W invades with X allele (female specialist)
  2. neo-W **invades with Y allele** (from 'perverse' overdominance equil.)

# Thank-you

Otto lab

Michael Scott

Sally Otto

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