

Crossing fitness-valleys without Mendel



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Mendel's law of segregation



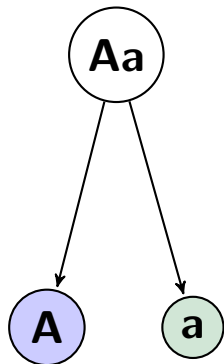
Mendel's law of segregation



Aa

Parent

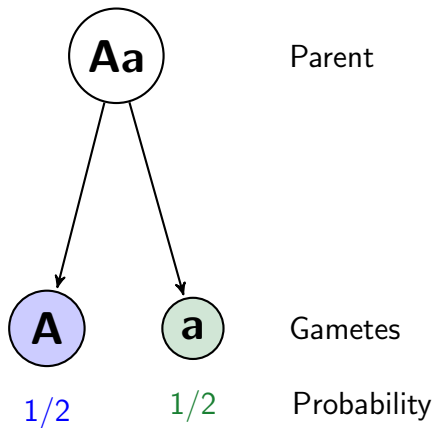
Mendel's law of segregation



Parent

Gametes

Mendel's law of segregation



Non-mendelian transmission

//**drive**// significant portion of any eukaryote genome is composed of selfish elements that gain a transmission advantage (Hurst & Werren 2001)

//**uniparental inheritance**// mitochondria and chloroplast genes often inherited from parent of one particular sex (Birky Jr. 2001)

//**non-genetic inheritance**// increasing awareness of epigenetics, parental effects, and ecological and cultural inheritance (Danchin et al. 2011)

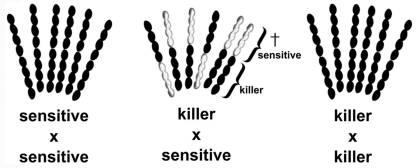
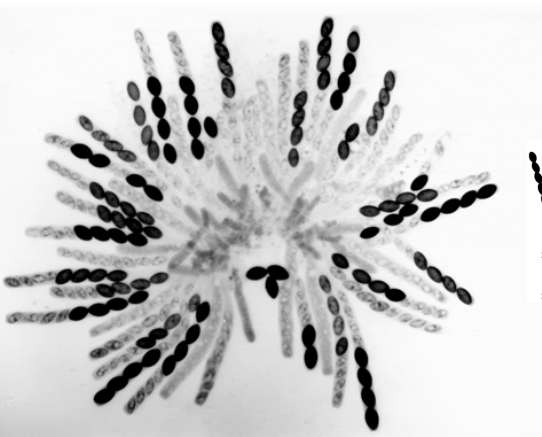
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Drive e.g.: spore killers in fungi



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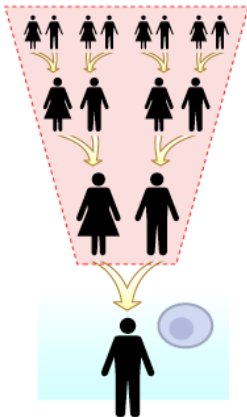
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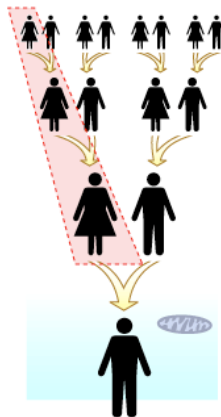
Uniparental inheritance e.g.: human mitochondria

Mitochondria is always inherited from the mother

A. Nuclear DNA is inherited from all ancestors.



B. Mitochondrial DNA is inherited from a single lineage.



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Non-genetic inheritance e.g.: culture



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	b_i		Item 1
Father \times Mother		n_i	b_i
$H \times H$	b_3	20	$60 \pm .11$
$H \times h$	b_2	67	$36 \pm .06$
$h \times H$	b_1	17	$65 \pm .12$
$h \times h$	b_0	99	$26 \pm .04$

Non-mendelian transmission is everywhere

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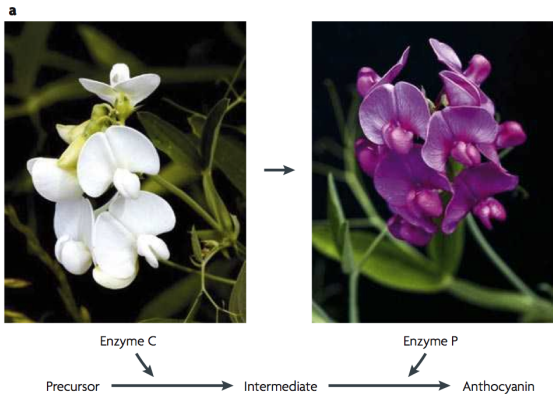
Epistasis is also everywhere

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Non-linear interactions
between traits

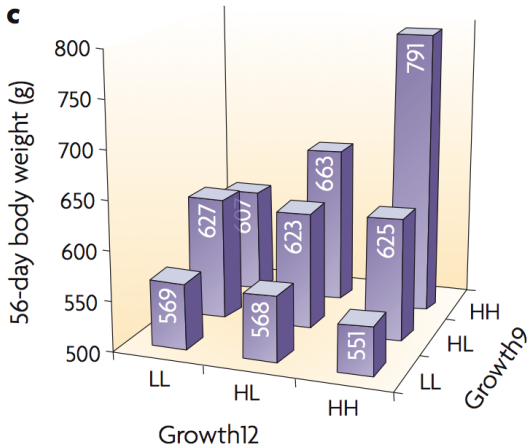
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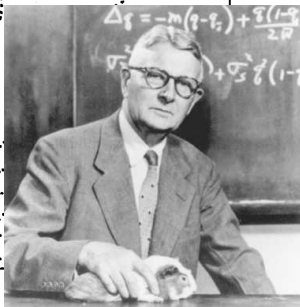
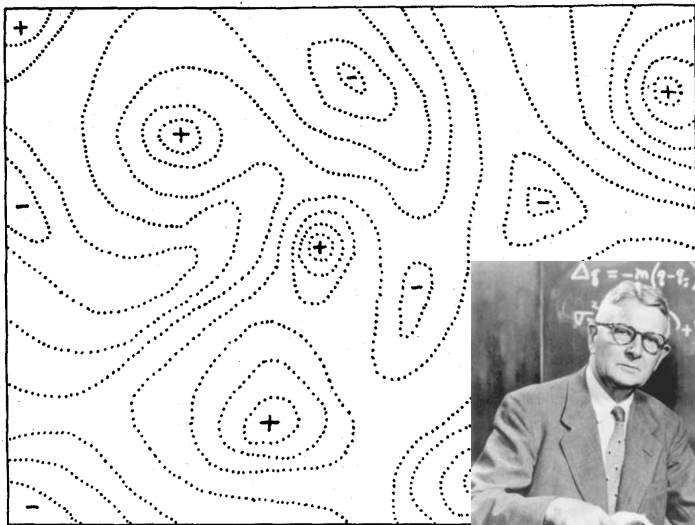
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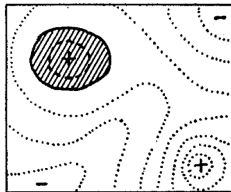


Phillips 2008

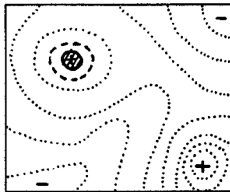
Epistasis causes peaks and valleys in fitness



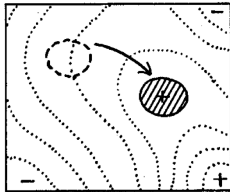
Crossing valleys: the shifting balance theory



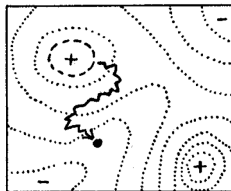
A. Increased Mutation
or reduced Selection
 $4NU, 4NS$ very large



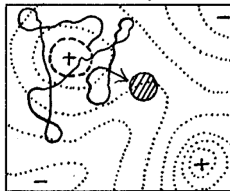
B. Increased Selection
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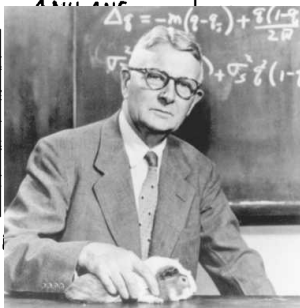
C. Qualitative Change
of Environment



D. Close Inbreeding
 $4NU, 4NS$ very small



E. Slight Inbreeding
 $4NU, 4NS$ medium



Wright 1932

The problem

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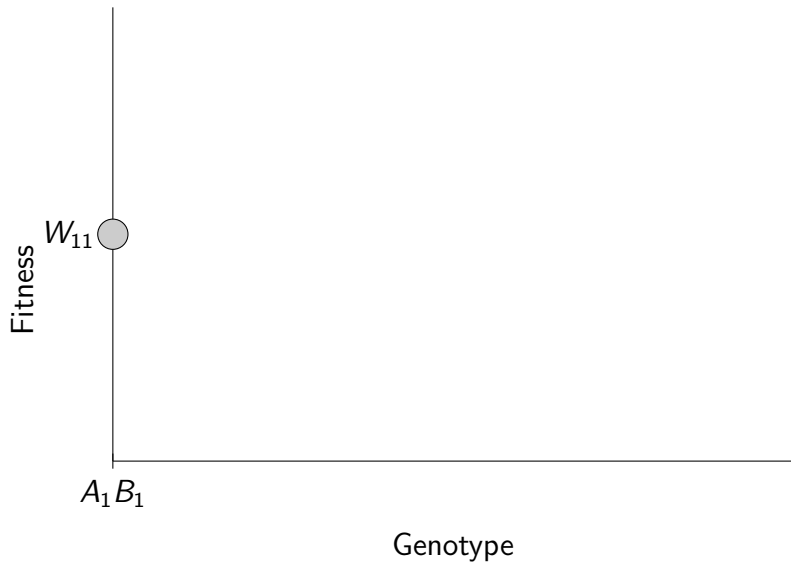
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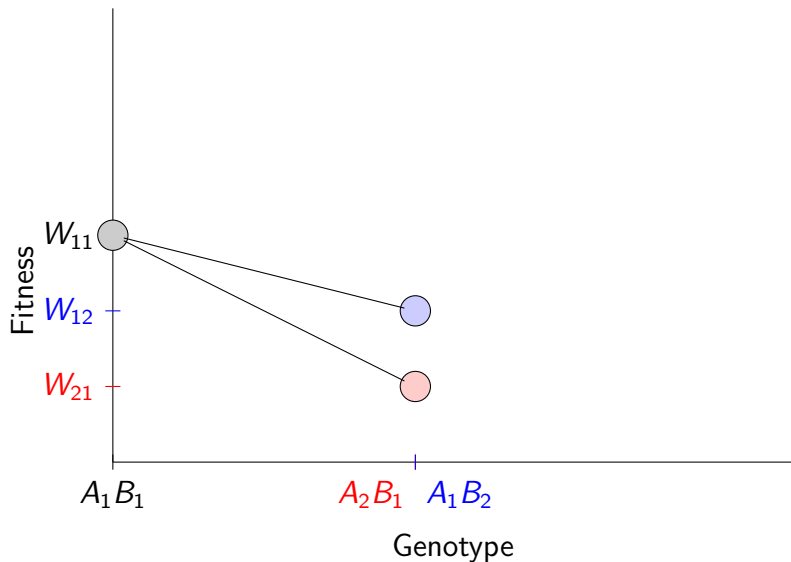
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Q. How does **non-Mendelian** inheritance affect **fitness-valley crossing**?

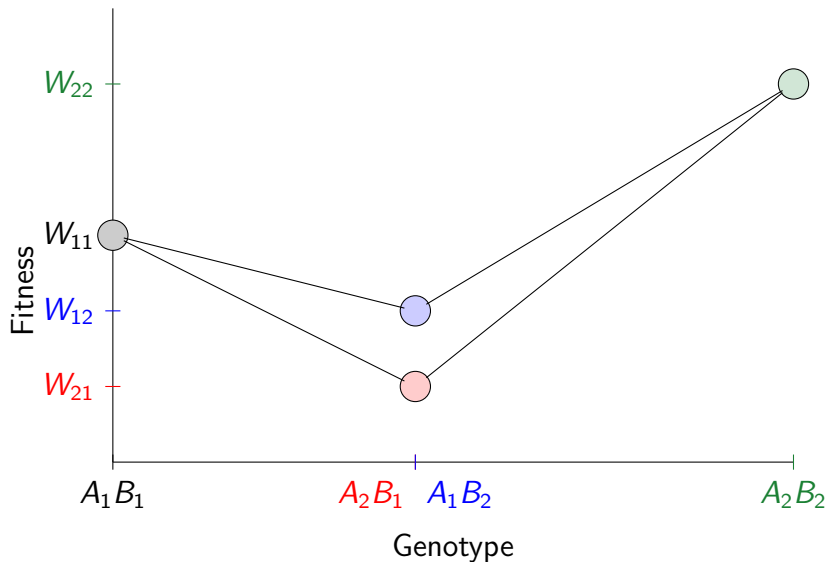
Our simple fitness valley



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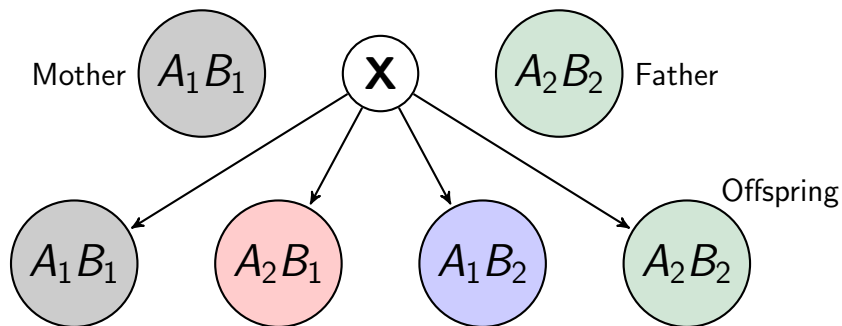
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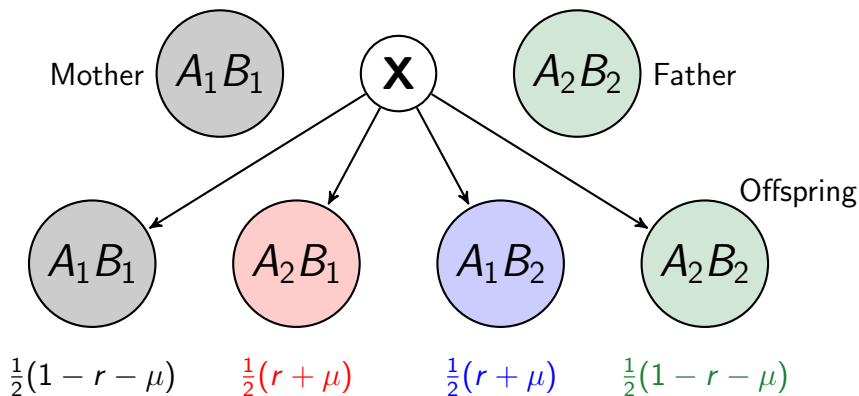
Generalized inheritance



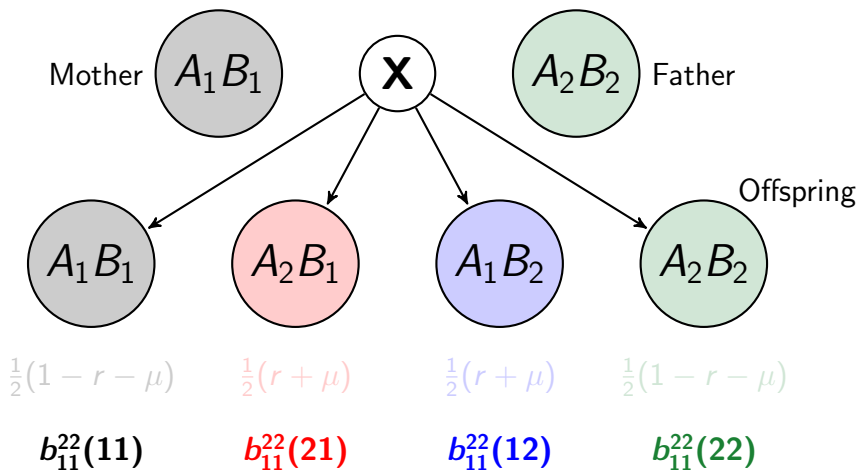
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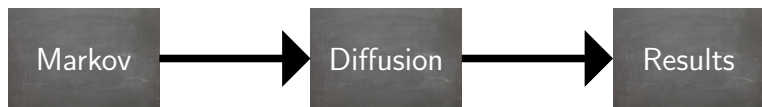
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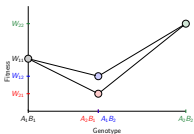
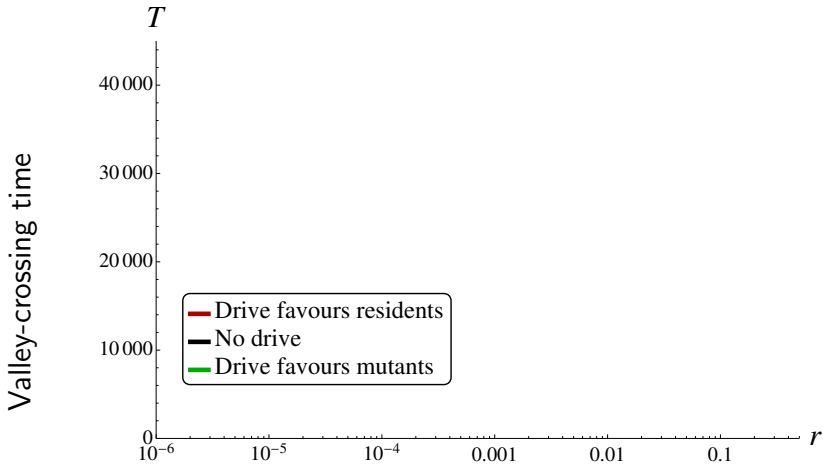
Generalized inheritance



Methods

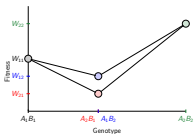
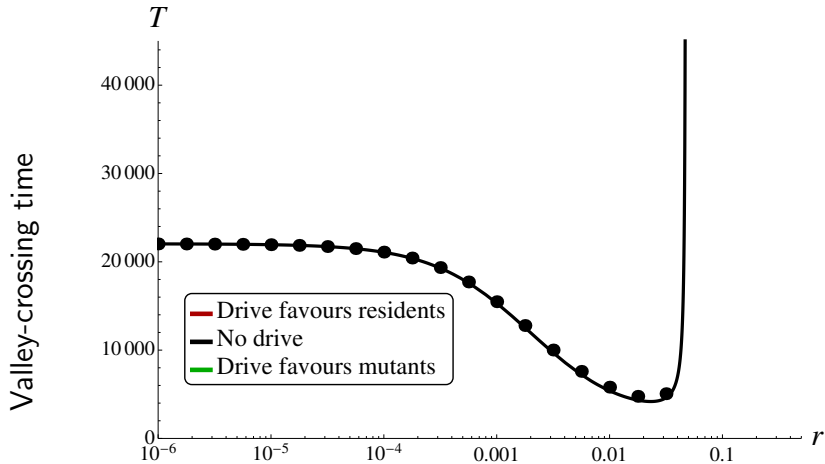


Drive



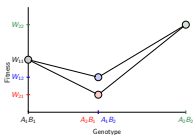
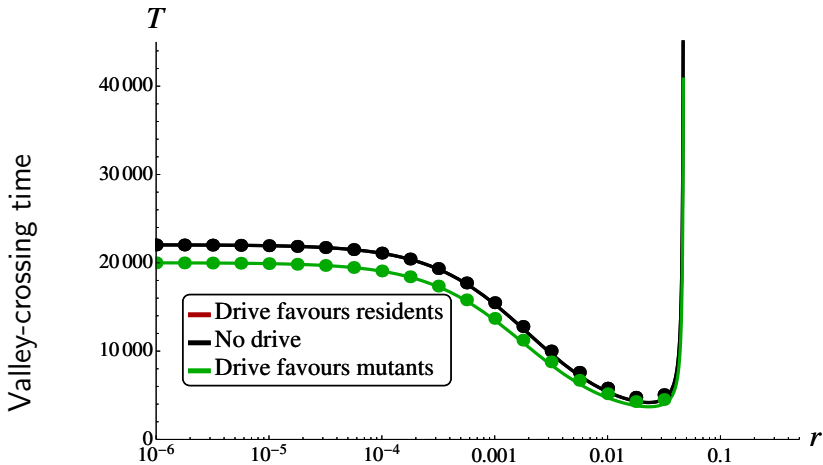
Probability of recombination

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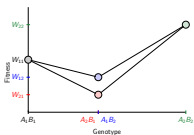
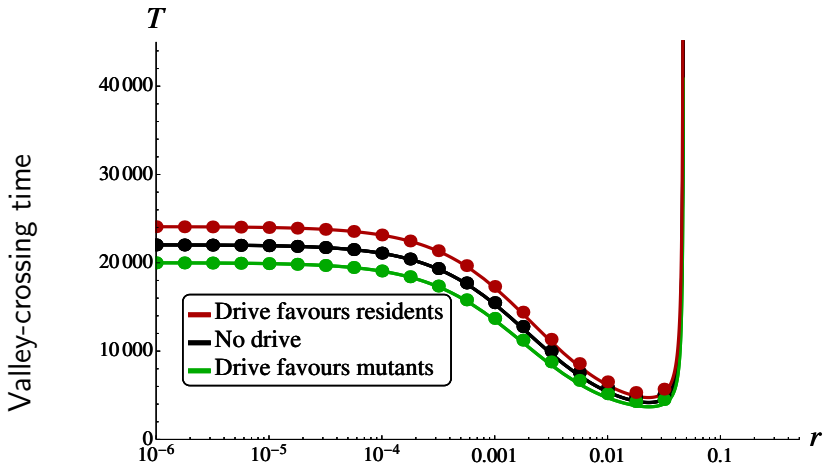
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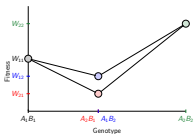
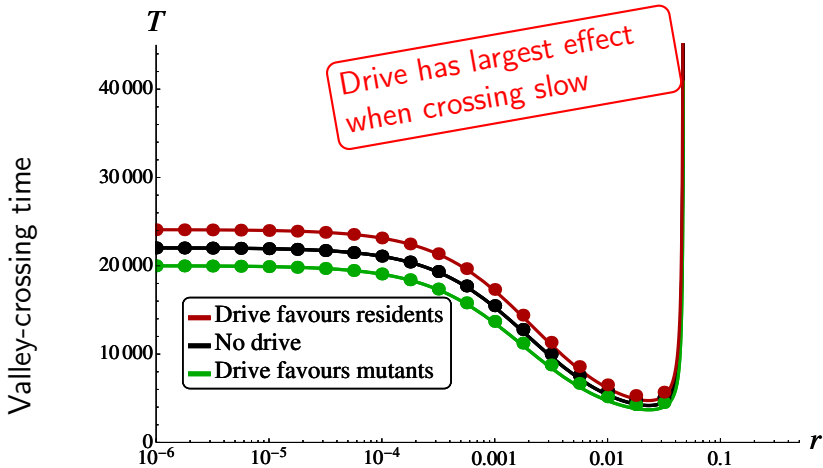
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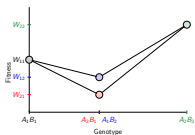
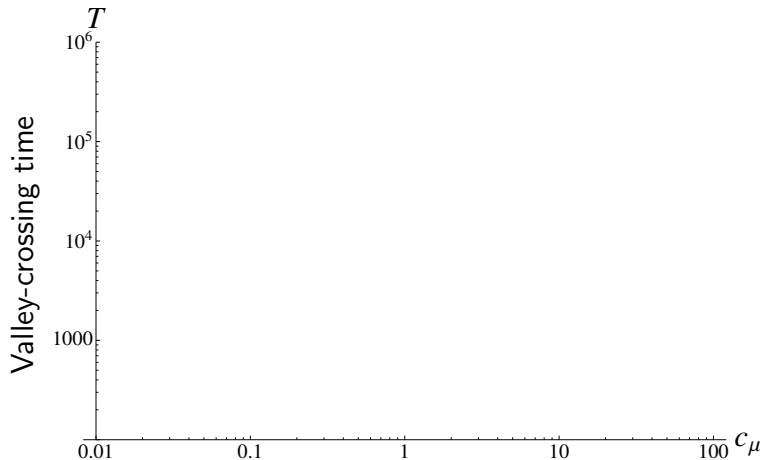
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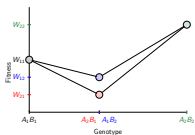
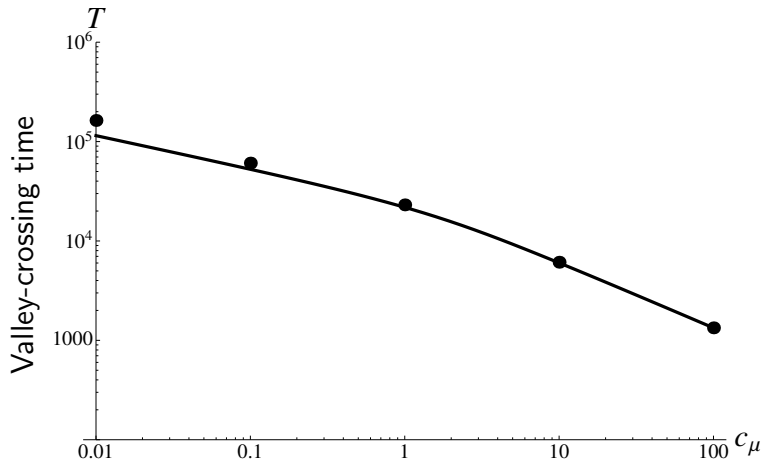
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Uniparental inheritance



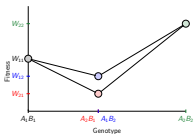
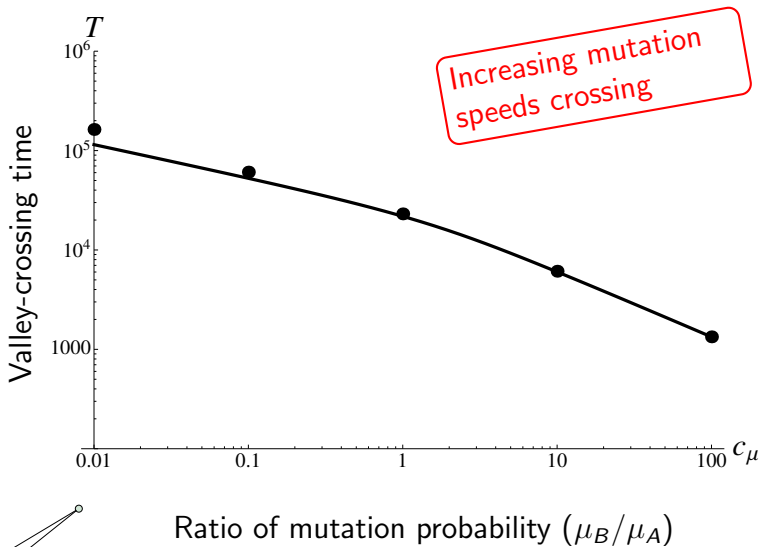
Ratio of mutation probability (μ_B/μ_A)

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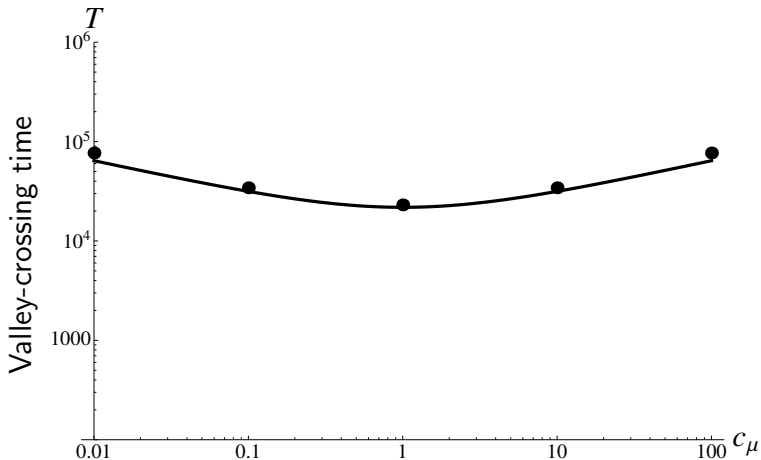


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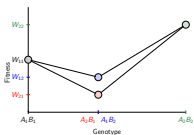
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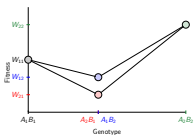
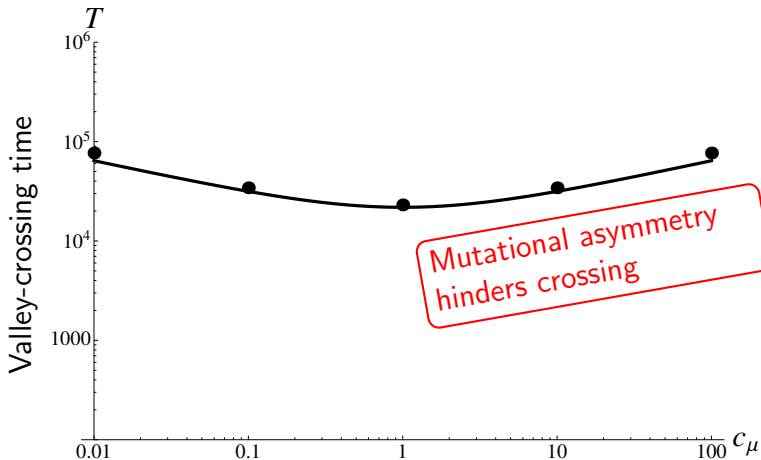
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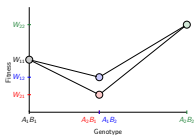
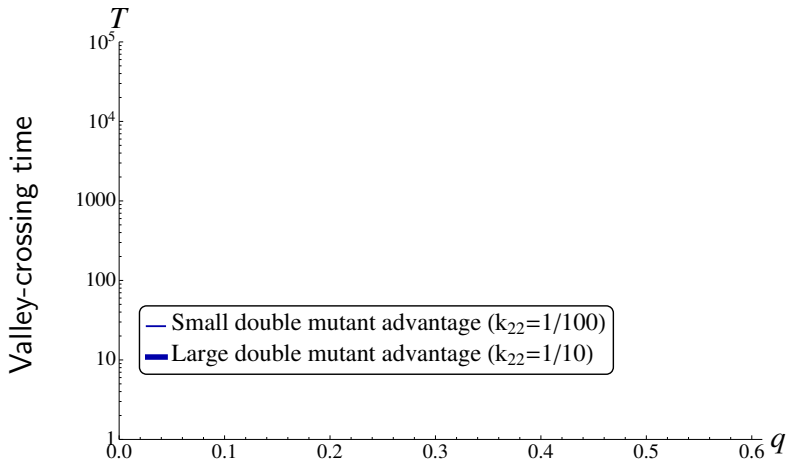


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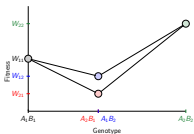
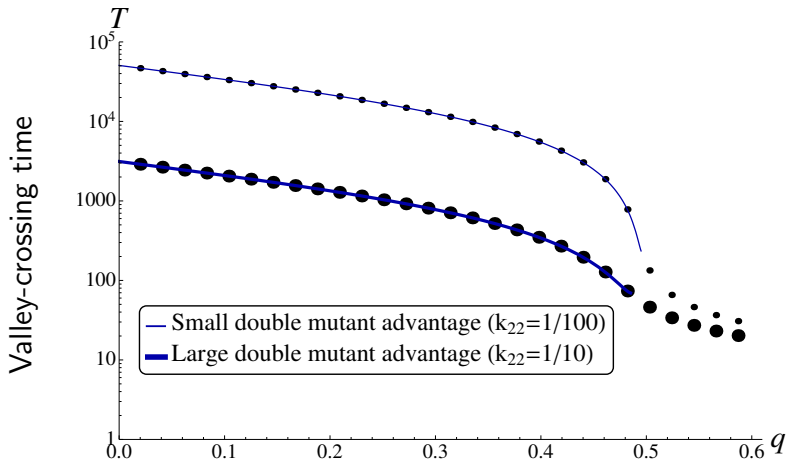
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Non-genetic inheritance



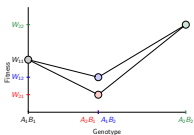
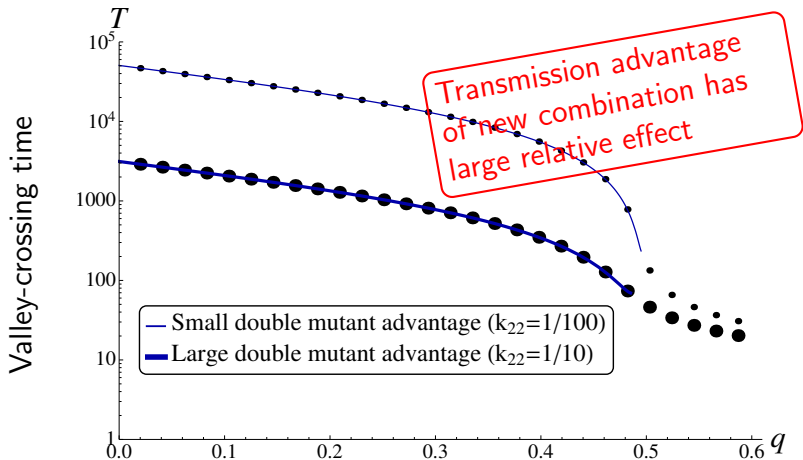
Transmission probability of single mutants

Non-genetic inheritance



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3. Non-genetic inheritance

- ▶ transmission advantage of new combination has large relative effect on valley crossing times

Thank-you!



- ▶ The Otto & Whitlock labs
- ▶ The Doebeli & Hauert labs
- ▶ The Kisdí & Geritz labs
- ▶ Mark Kirkpatrick



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