

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

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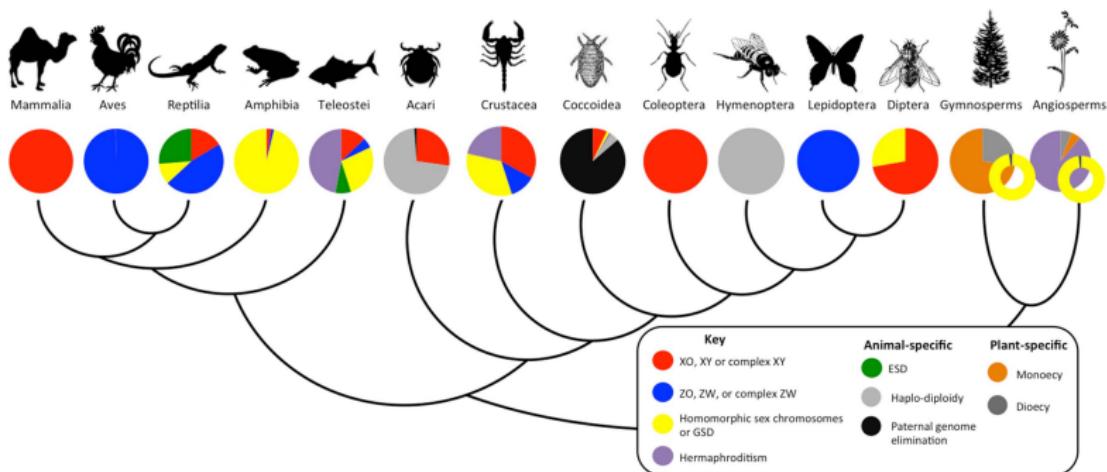


Evolution 2017

Sally Otto²



Sex determination systems are remarkably dynamic



Sex Determination: Why So Many Ways of Doing It?

Bachtrog et al. 2014

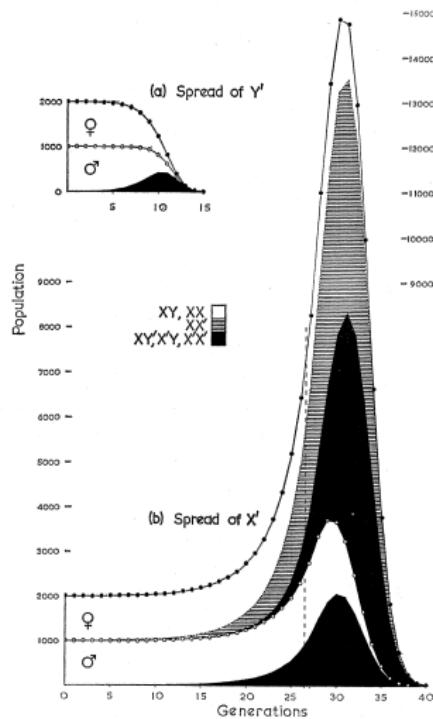
Sex determination systems are remarkably dynamic

2 theories

Theory 1: Turnover caused by sex-ratio selection

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Meiotic-drive for Y
increases $\text{♂} : \text{♀}$

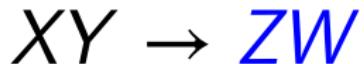


Extraordinary Sex Ratios

Theory 1: Turnover caused by sex-ratio selection

Meiotic-drive for Y
increases $\text{♂} : \text{♀}$

neo- W restores
1 : 1 sex ratio



Theory 2: Turnover caused by sex-antagonistic selection

$$XY \rightarrow ZW$$

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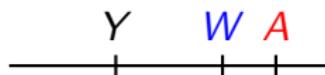
$XY \rightarrow ZW$



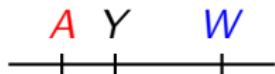
e.g., a favoured in ♂, A favoured in ♀

Theory 2: Turnover caused by sex-antagonistic selection

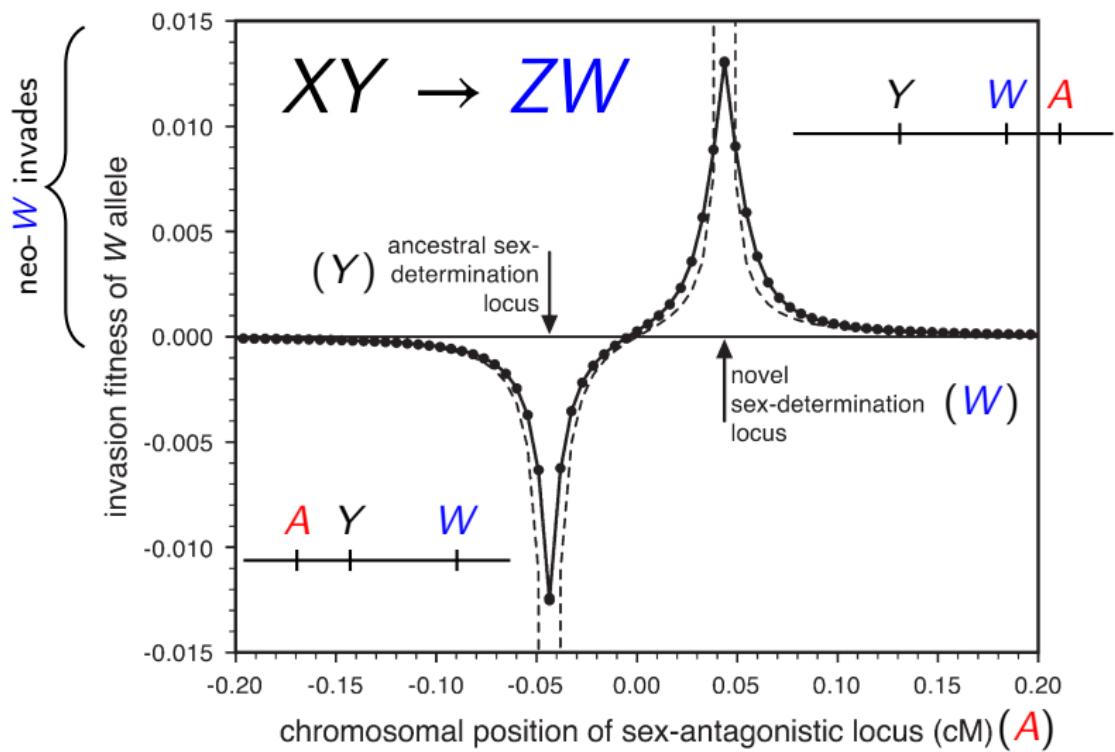
$$XY \rightarrow ZW$$



e.g., *a* favoured in ♂, *A* favoured in ♀



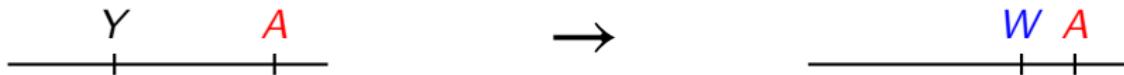
Theory 2: Turnover caused by sex-antagonistic selection



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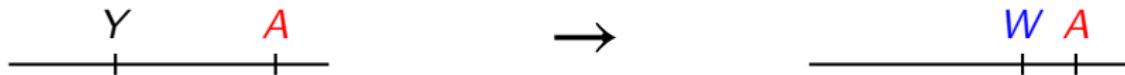
turnover increases sex-linkage



Theory 2: Turnover caused by sex-antagonistic selection

$$XY \rightarrow ZW$$

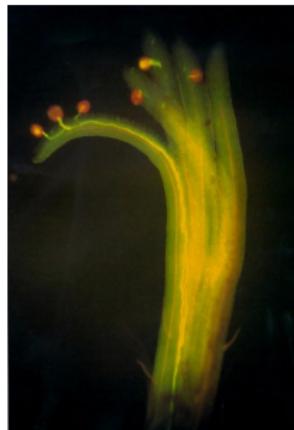
turnover increases sex-linkage



neo-*W* is a better sex-specialist

Sex-ratio **vs.** sex-antagonistic selection

Haploid-diploid life-cycles



Haploid-diploid life-cycles



Haploid selection (gametic competition & meiotic drive)

Haploid-diploid life-cycles



Haploid selection (gametic competition & meiotic drive)

Biased transmission of gametes, typically sex-specific
⇒ can impart both sex-ratio and sex-antagonistic selection

Haploid-diploid life-cycles



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Diploid selection too ⇒ ploidally-antagonistic selection possible

Haploid-diploid life-cycles



Haploid selection (gametic competition & meiotic drive)

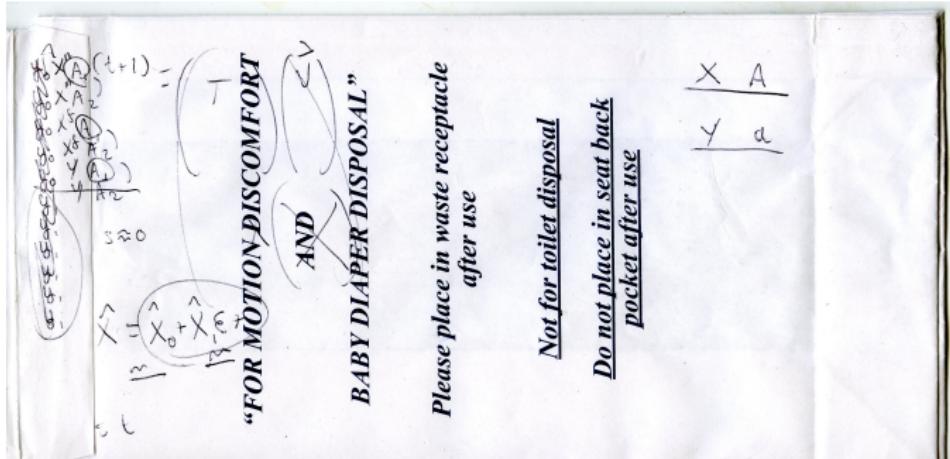
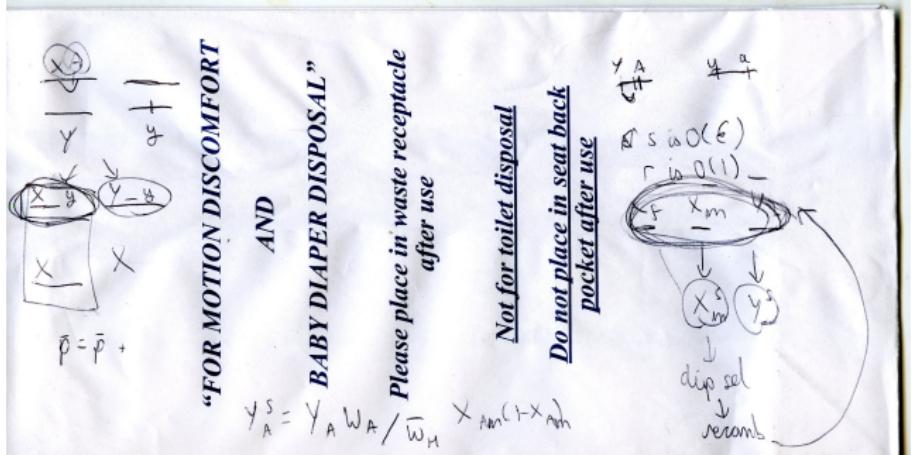
Biased transmission of gametes, typically sex-specific
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Diploid selection too ⇒ ploidally-antagonistic selection possible

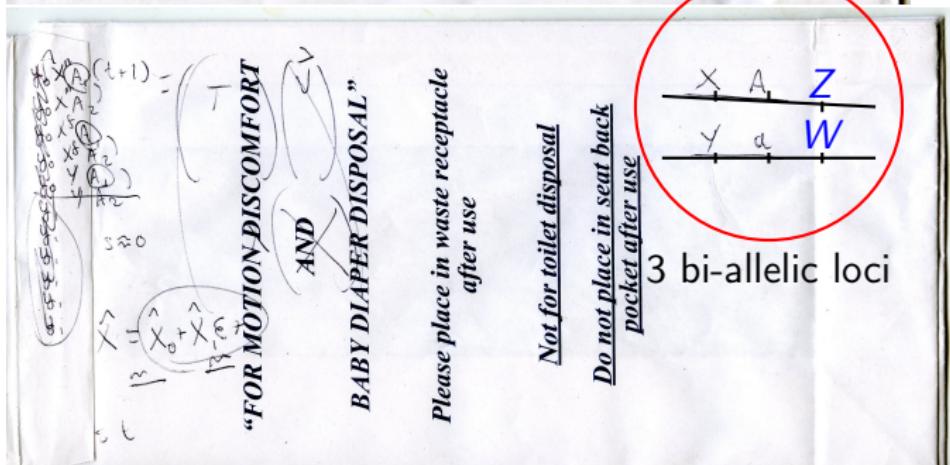
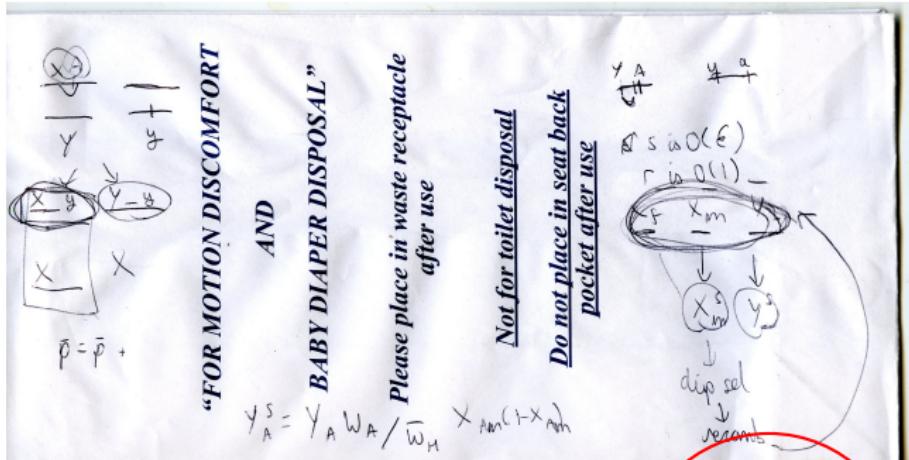
Question

How does haploid selection influence sex-determination turnover?

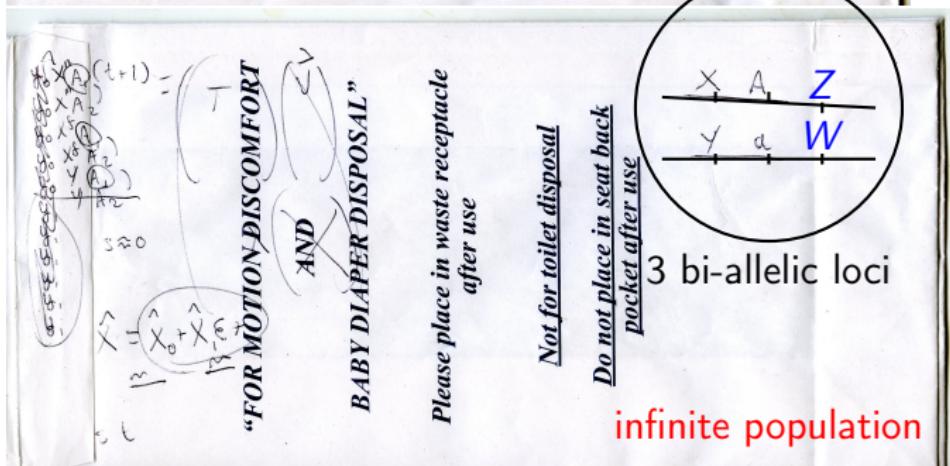
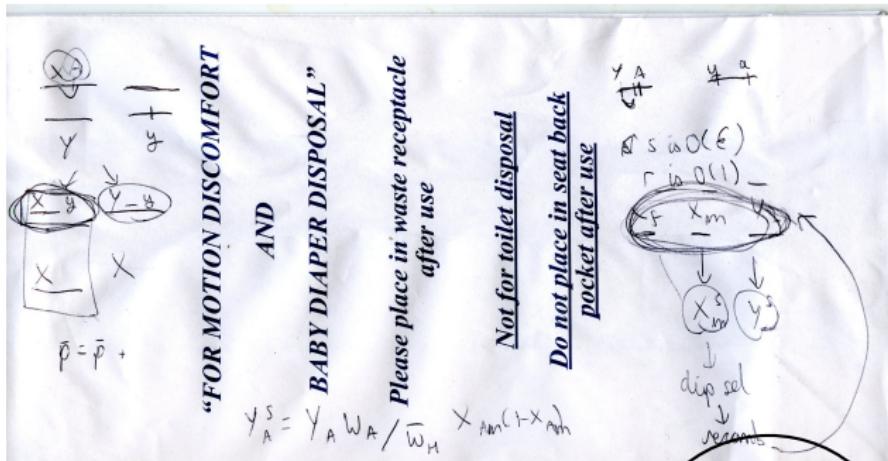
Model



Model



Model



Model

diploid selⁿ



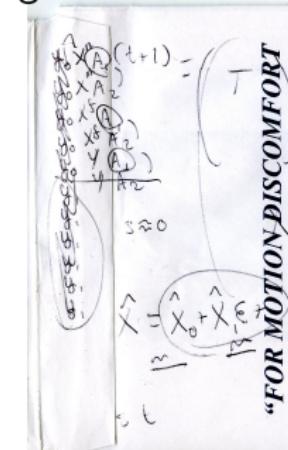
segregation



haploid selⁿ



random mating



**“FOR MOTION DISCOMFORT
AND
BABY DIAPER DISPOSAL”**

“FOR MOTION DISCOMFORT

$$y_A^S = Y_A W_A / \bar{W}_H \times m(t-x_m)$$

AND

BABY DIAPER DISPOSAL”

Please place in waste receptacle

after use

Not for toilet disposal

**Do not place in seat back
pocket after use**

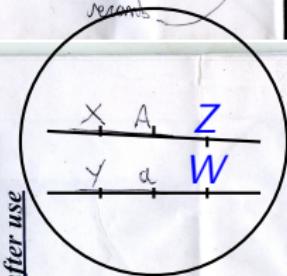
3 bi-allelic loci

infinite population



Not for toilet disposal

**Do not place in seat back
pocket after use**



Model

diploid selⁿ



segregation



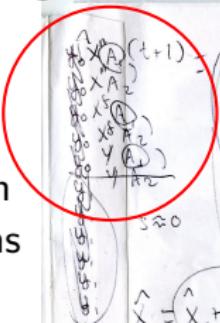
haploid selⁿ



random mating



1. recursion
equations



"FOR MOTION DISCOMFORT AND BABY DIAPER DISPOSAL"

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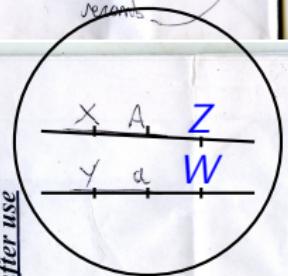
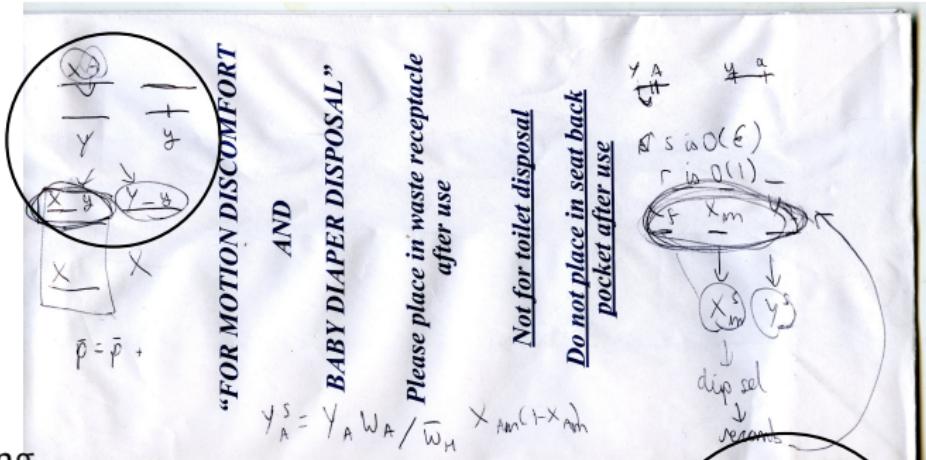
$$y_A^S = Y_A W_A / \bar{W}_H \times \lambda_H(t+1)$$

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3 bi-allelic loci

infinite population



Model

diploid selⁿ



segregation



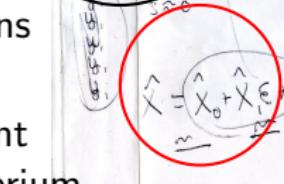
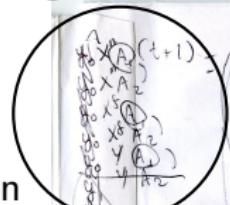
haploid selⁿ



random mating



- recursion equations



"FOR MOTION DISCOMFORT AND BABY DIAPER DISPOSAL"

$$y_A^S = Y_A W_A / \bar{W}_H \times m(t-x_m)$$

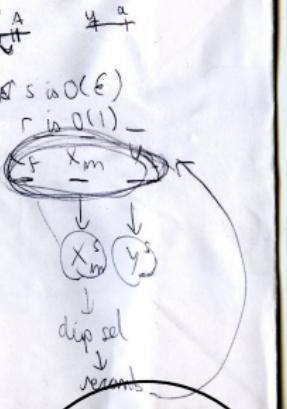
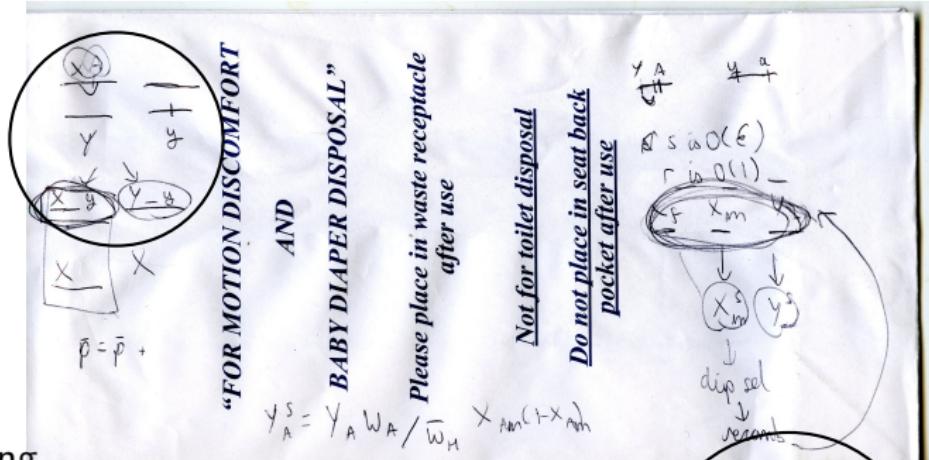
Please place in waste receptacle after use

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3 bi-allelic loci

- resident equilibrium



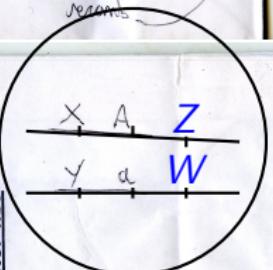
"FOR MOTION DISCOMFORT AND BABY DIAPER DISPOSAL"

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infinite population



Model

diploid selⁿ



segregation



haploid selⁿ

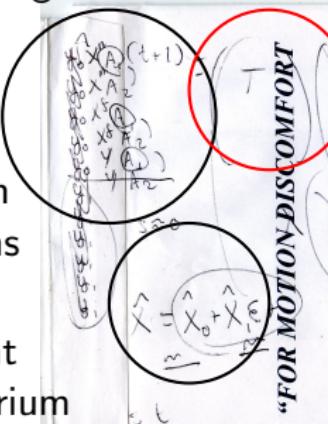


random mating



1. recursion
equations

2. resident
equilibrium



“FOR MOTION DISCOMFORT

AND

“BABY DIAPER DISPOSAL”

$$y_A^S = Y_A W_A / \bar{W} \quad 3. \text{ invasion}$$

analysis

AND

“FOR MOTION DISCOMFORT

AND

“BABY DIAPER DISPOSAL”

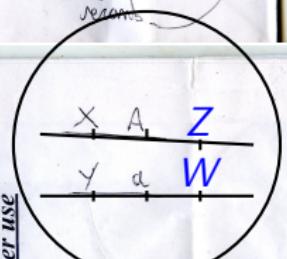
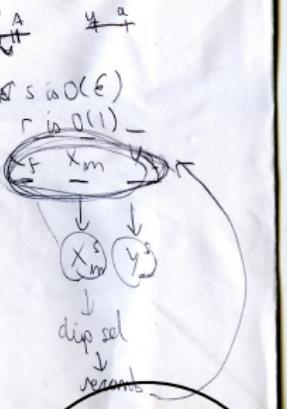
Please place in waste receptacle
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3 bi-allelic loci

infinite population

Model

diploid selⁿ



segregation



haploid selⁿ

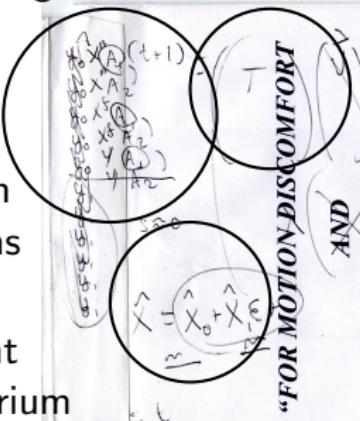


random mating



1. recursion
equations

2. resident
equilibrium



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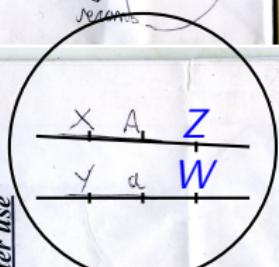
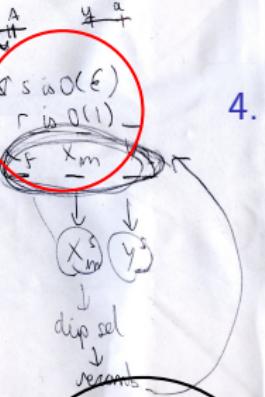
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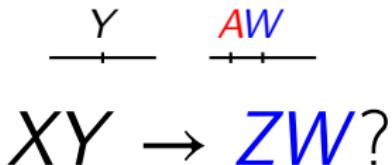
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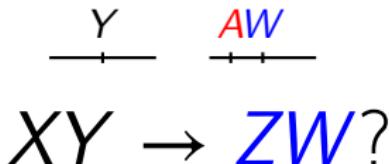
4. approximate leading eigenvalue

2 results

Scenario: Drive for a in males opposes selection for A in diploids



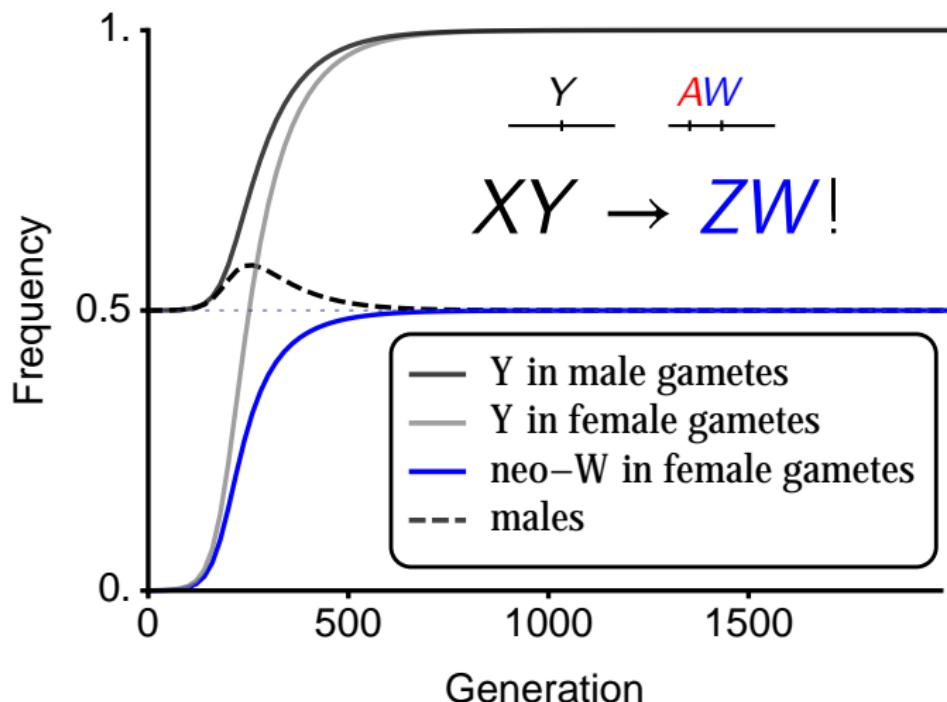
Scenario: Drive for a in males opposes selection for A in diploids



no sex-ratio bias

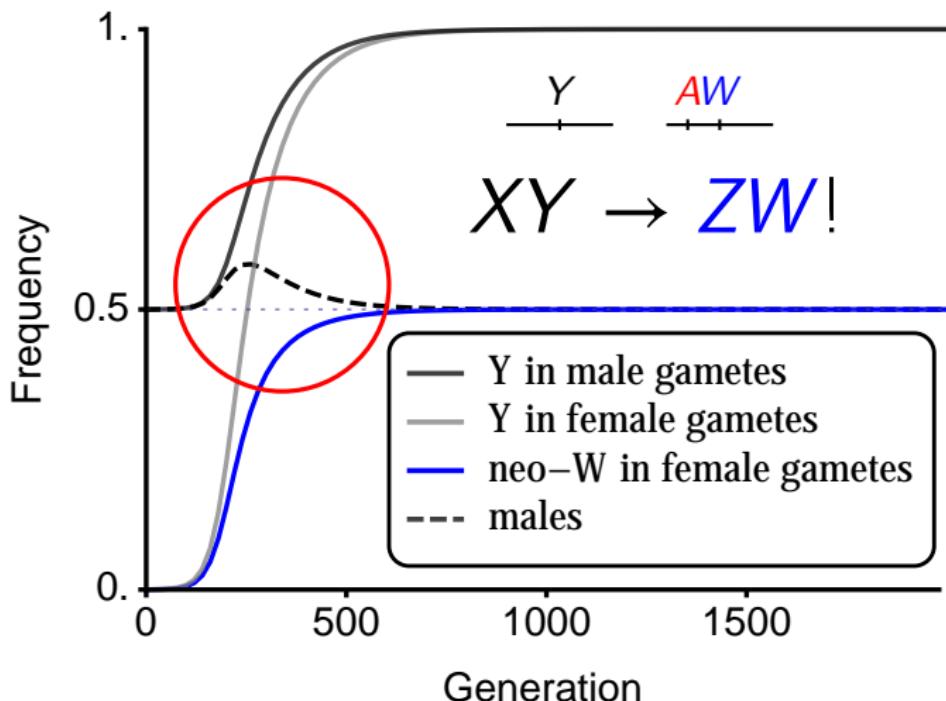
no antagonism between diploid sexes

Scenario: Drive for a in males opposes selection for A in diploids



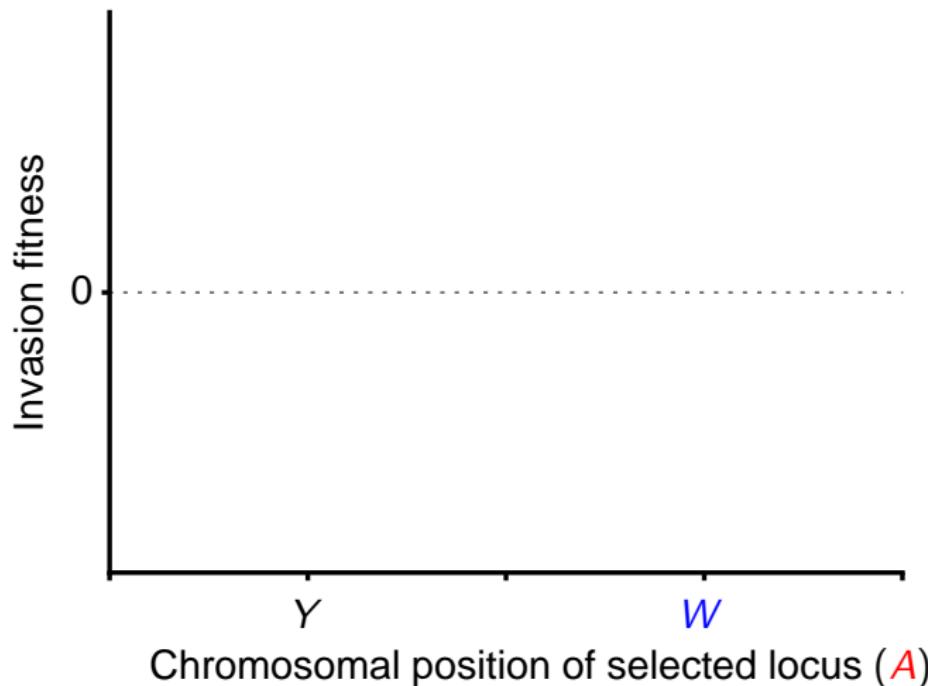
Result 1: Turnover *regardless* of sex-ratio bias

Scenario: Drive for *a* in males opposes selection for *A* in diploids

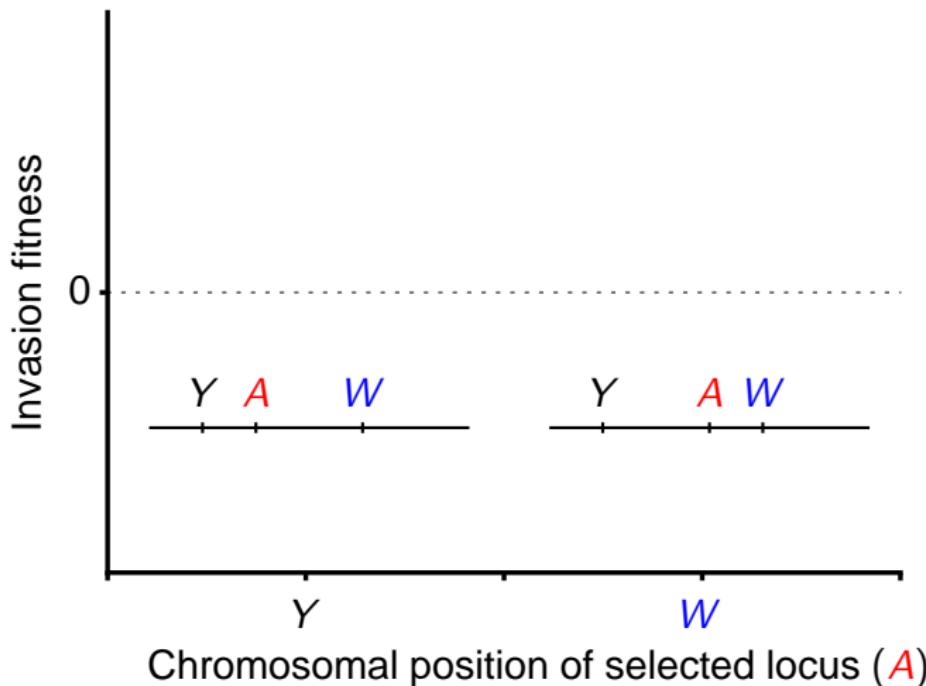


Scenario: Drive for a in males opposes selection for A in diploids

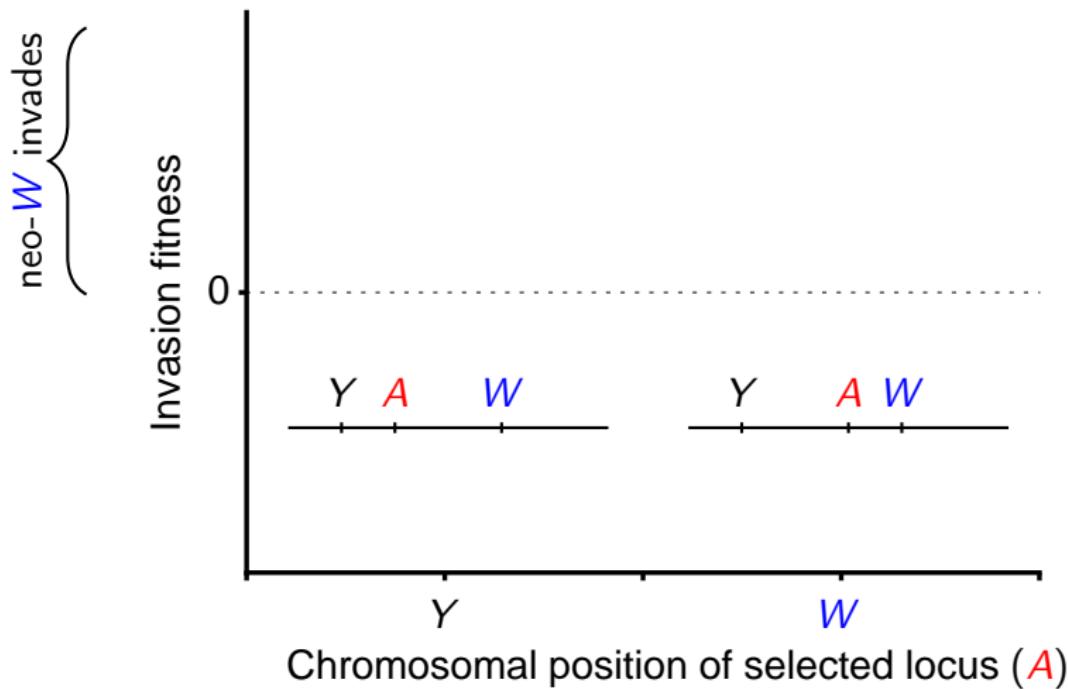
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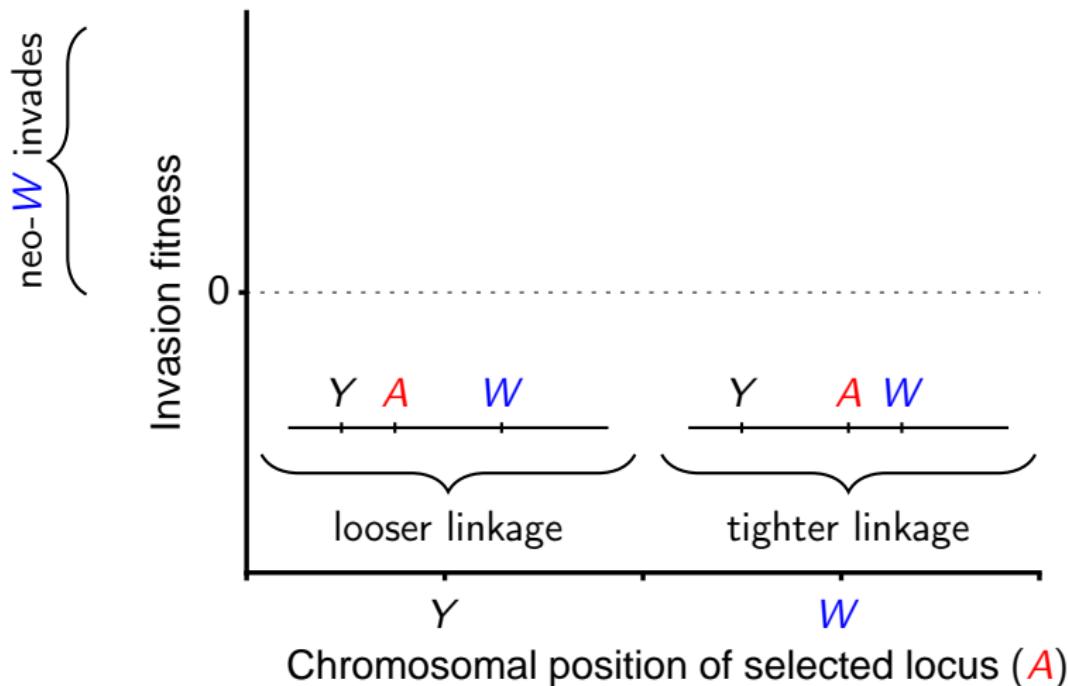
Scenario: Drive for a in males opposes selection for A in diploids



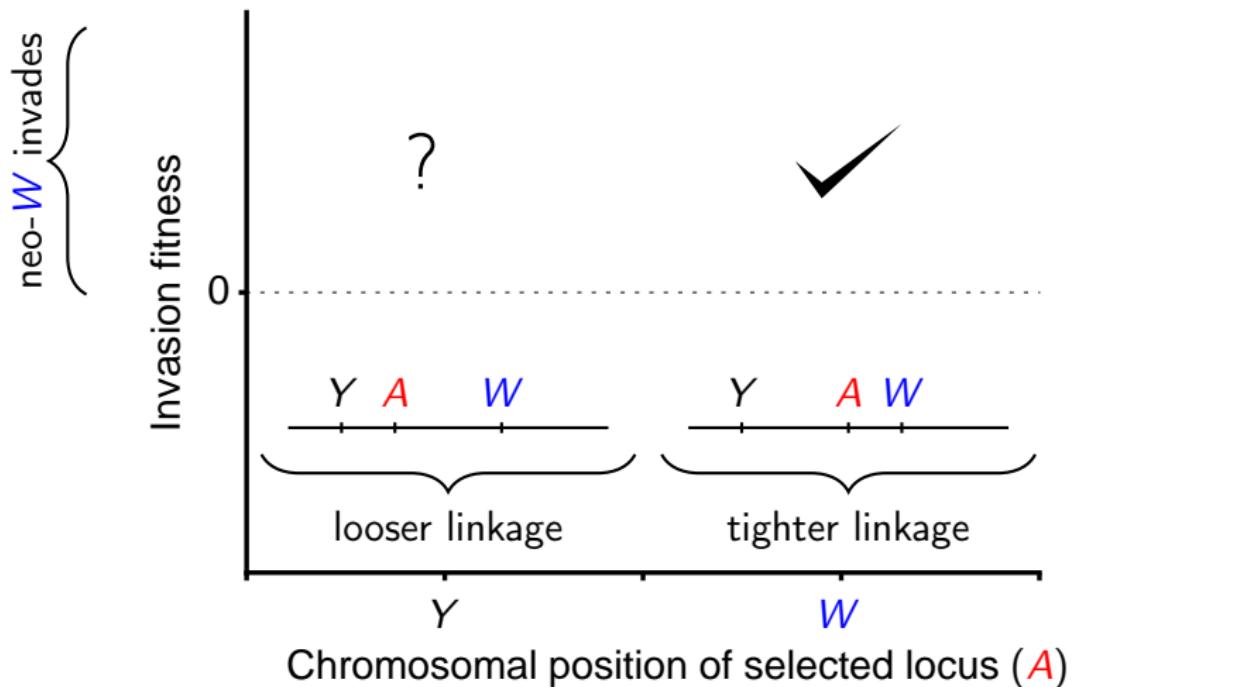
Scenario: Drive for a in males opposes selection for A in diploids



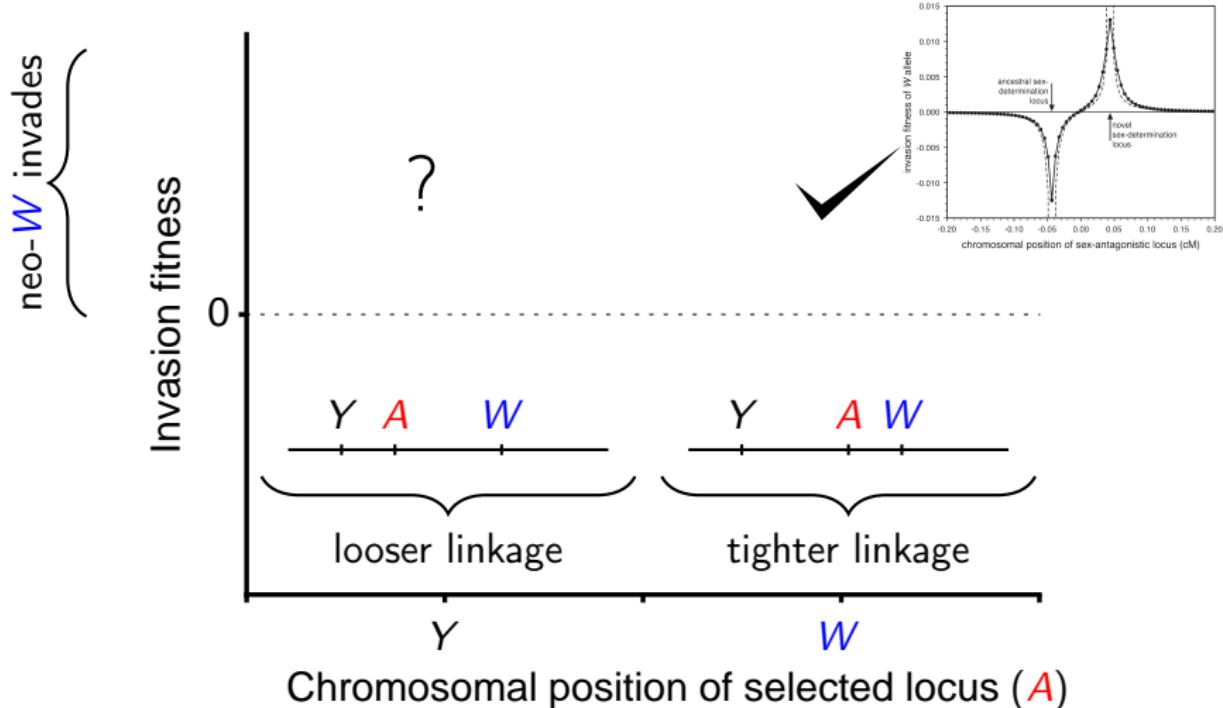
Scenario: Drive for a in males opposes selection for A in diploids



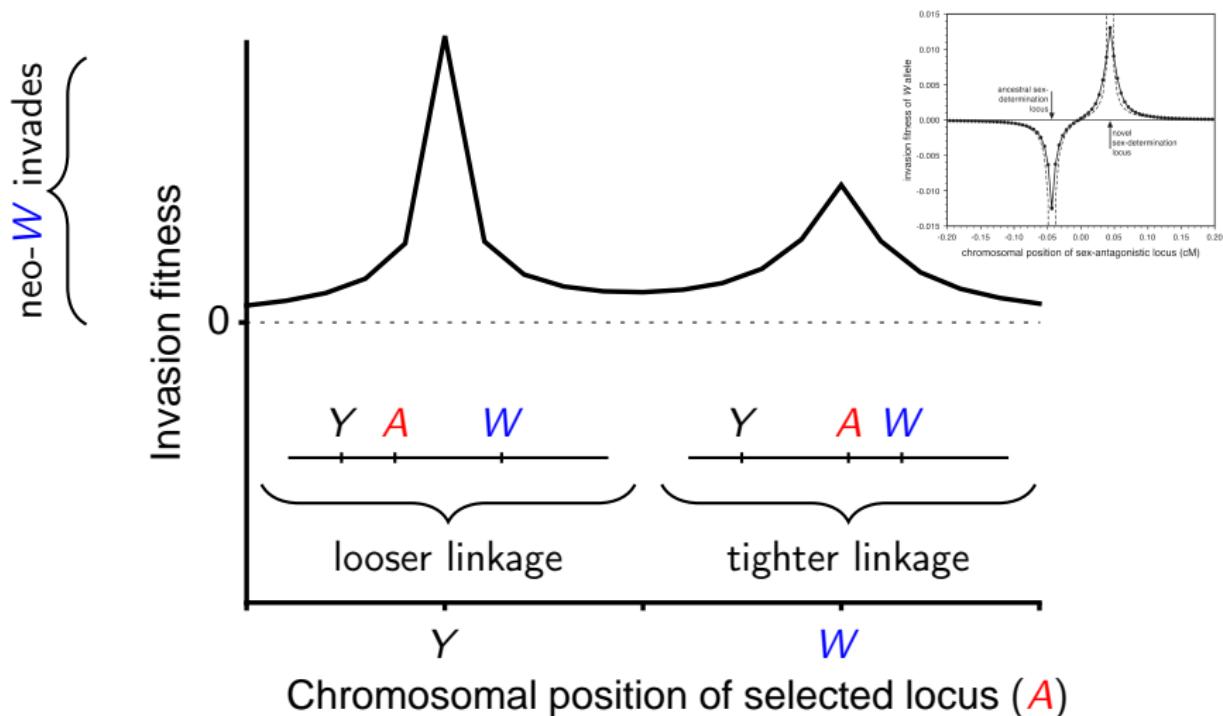
Scenario: Drive for a in males opposes selection for A in diploids



Scenario: Drive for *a* in males opposes selection for *A* in diploids

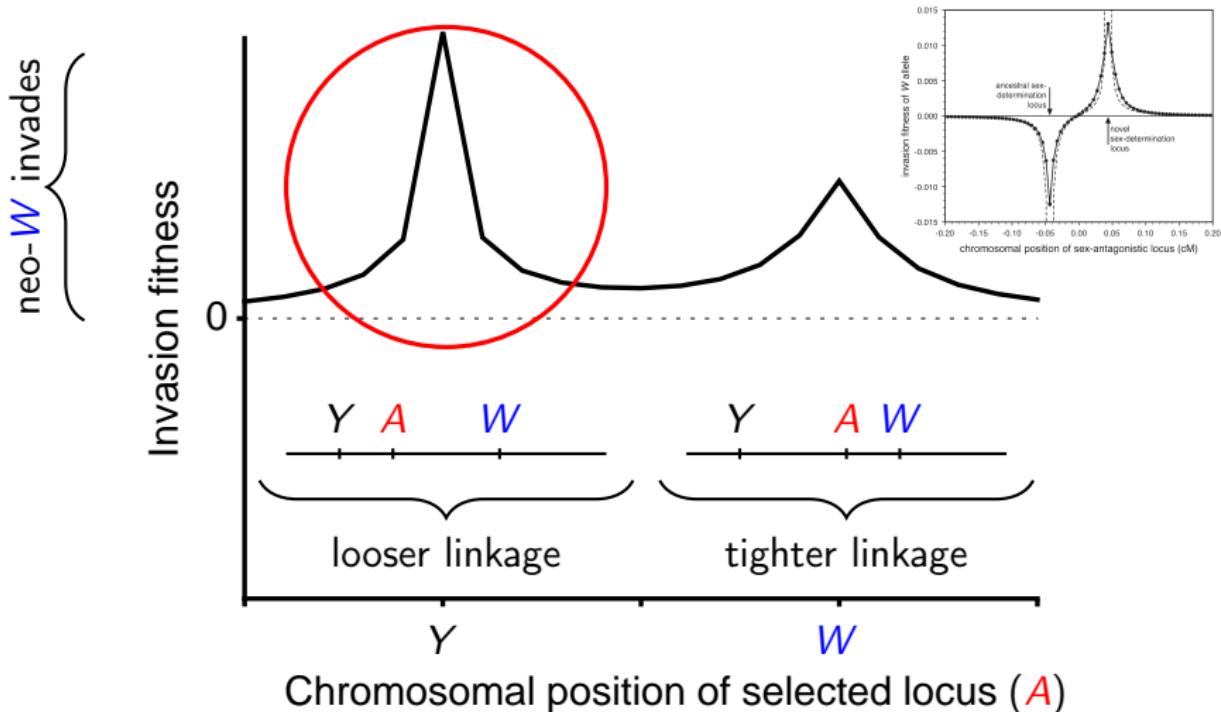


Scenario: Drive for a in males opposes selection for A in diploids



Result 2: Turnover despite *looser* sex-linkage

Scenario: Drive for *a* in males opposes selection for *A* in diploids



Summary

Haploid selection creates new avenues for sex determination turnover

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More turnover in haploid-diploid organisms?

Thank-you

Michael Scott



Sally Otto

