

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

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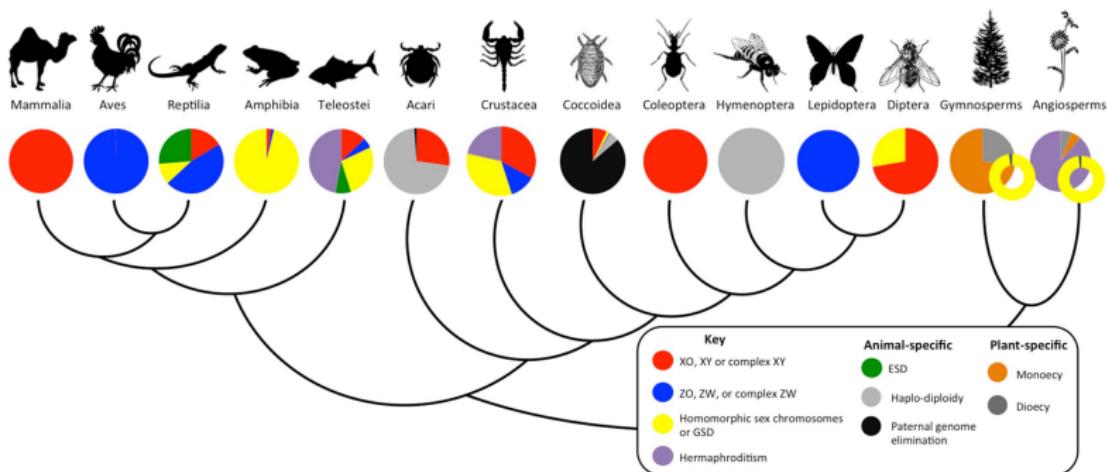


Evolution 2017

Sally Otto²



Sex determination systems are remarkably dynamic



Sex Determination: Why So Many Ways of Doing It?

Bachtrog et al. 2014

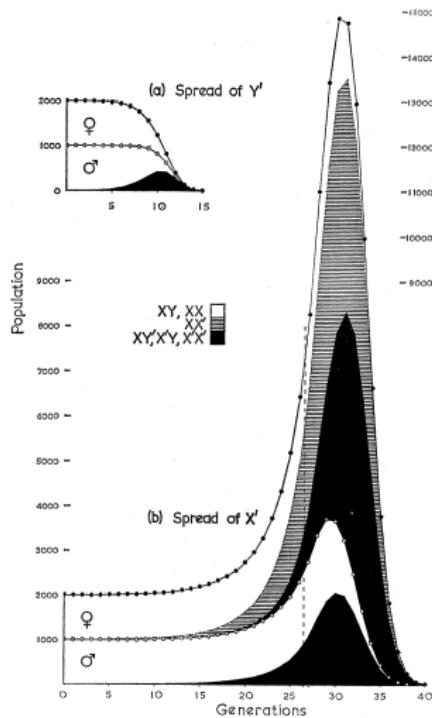
Sex determination systems are remarkably dynamic

2 theories

Theory 1: Turnover caused by sex-ratio selection

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

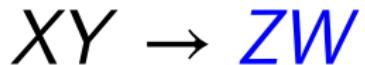


Extraordinary Sex Ratios

Theory 1: Turnover caused by sex-ratio selection

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

neo- W restores
1 : 1 sex ratio

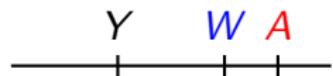


Theory 2: Turnover caused by sex-antagonistic selection

$$XY \rightarrow ZW$$

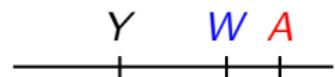
Theory 2: Turnover caused by sex-antagonistic selection

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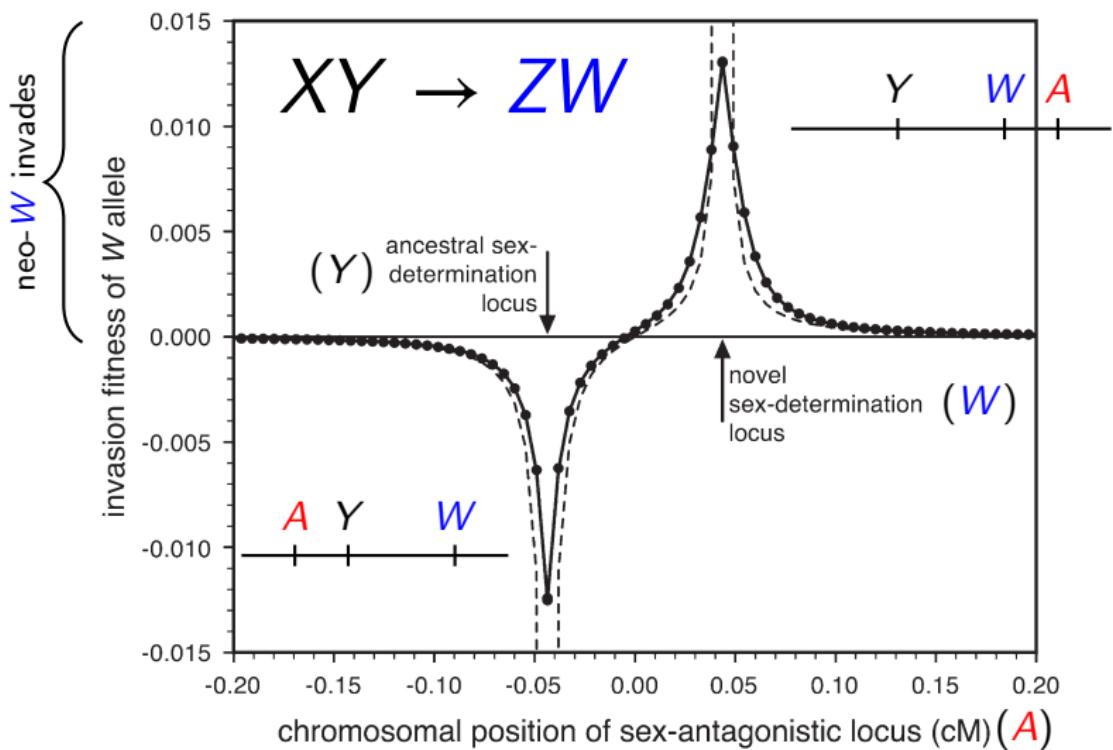


Theory 2: Turnover caused by sex-antagonistic selection

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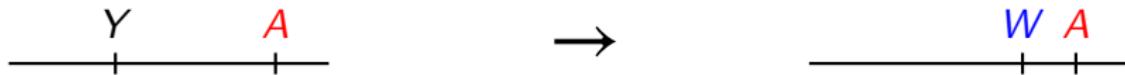
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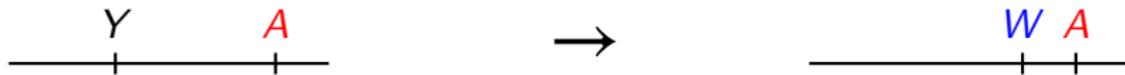
turnover increases sex-linkage



Theory 2: Turnover caused by sex-antagonistic selection

$$XY \rightarrow ZW$$

turnover increases sex-linkage



reduces sexual tension

Turnover caused by
haploid **or** diploid selection

Haploid-diploid life-cycles



Haploid-diploid life-cycles



Haploid selection: Gametic competition and meiotic drive

Haploid-diploid life-cycles



Haploid selection: Gametic competition and meiotic drive

Sex-specific biased transmission of gametes

⇒ can impart both sex-ratio and sex-antagonistic selection

Haploid-diploid life-cycles



Haploid selection: Gametic competition and meiotic drive

Sex-specific biased transmission of gametes

⇒ can impart both sex-ratio and sex-antagonistic selection

Question

How does haploid selection influence sex-determination turnover?

Model

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

*Please place in waste receptacle
after use*

Not for toilet disposal

Do not place in seat back
pocket after use

$$y_A^S = Y_A W_A / \bar{W}_H \times x_{Am} (1 - x_{Am})$$

Model

Not for toilet disposal

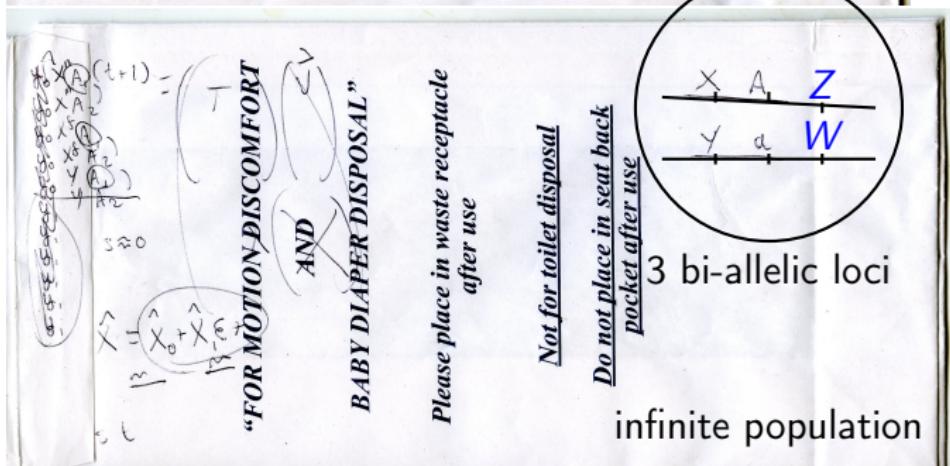
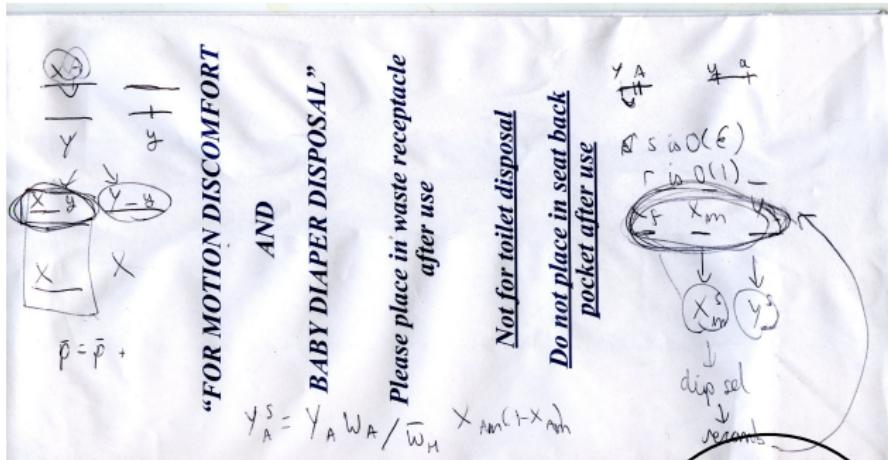
Do not place in seat back pocket after use

“FOR MOTION DISCOMFORT
AND
BABY DIAPER DISPOSAL”

Please place in waste receptacle
after use

3 bi-allelic loci

Model



Model

diploid selⁿ



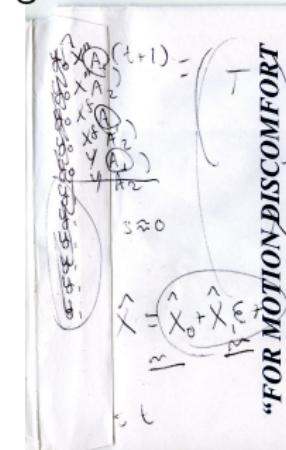
segregation



haploid selⁿ



random mating



“FOR MOTION DISCOMFORT AND BABY DIAPER DISPOSAL”

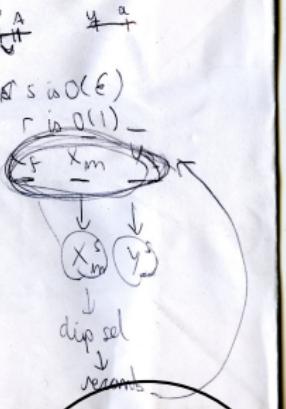
$$y_A^S = Y_A W_A / \bar{W}_H \times m(t-x_m)$$

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3 bi-allelic loci

infinite population



*y_A
r_C
q_B*

*r_C is O(ε)
q_B is O(1) -*

X_m

x_m

y_m

z_m

w_m

dip sel

segm

s

t

m

t+1

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+1

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+2

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+3

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+4

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+5

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+6

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+7

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+8

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+9

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+10

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+11

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+12

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+13

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+14

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+15

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+16

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+17

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+18

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+19

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+20

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+21

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+22

s ≈ 0

X_m

x_m

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t+23

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X_m

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t+24

s ≈ 0

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x_m

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t+25

s ≈ 0

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t+26

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t+27

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z_m

w_m

t+31

s ≈ 0

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x_m

y_m

z_m

w_m

t+32

s ≈ 0

X_m

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z_m

w_m

t+33

s ≈ 0

X_m

x_m

y_m

z_m

w_m

t+34

s ≈ 0

X_m

x_m

y_m

z_m

Model

diploid selⁿ

1

segregation

1

haploid selⁿ

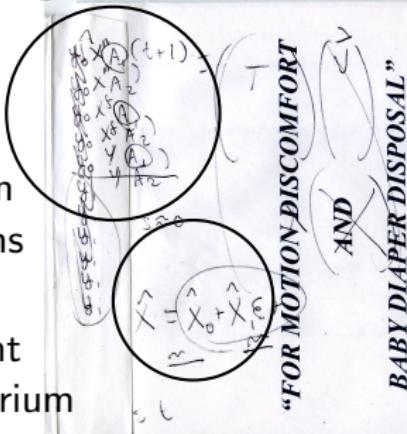
1

random mating

1

- ## 1. recursion equations

2. resident equilibrium



"FOR MOTION DISCOMFORT

"FOR UNION DISCOMFORT"

~~AND~~

BABY DIAPER DISPOSAL

Please place in waste receptacle

*Please place in waste receptacle
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Do not place in seat back pocket after use

pocket after use

bi-allelic loci

infinite population

Model

diploid selⁿ



segregation



haploid selⁿ

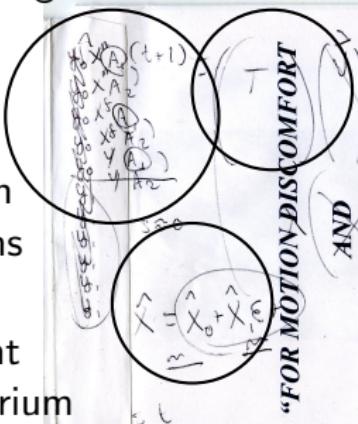


random mating



1. recursion
equations

2. resident
equilibrium



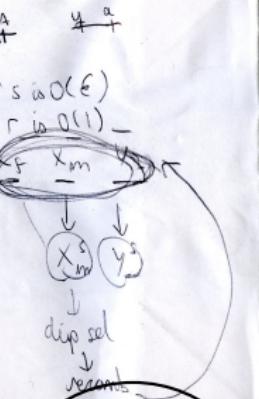
**“FOR MOTION DISCOMFORT
AND
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analysis
**“FOR MOTION DISCOMFORT
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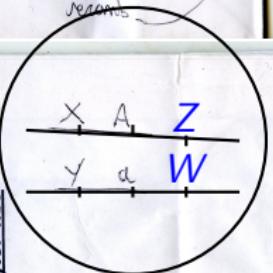


$$y_A^S = Y_A W_A / \bar{w} \quad x_m(t+x_m)$$

3. invasion

3 bi-allelic loci

infinite population



Model

diploid selⁿ



segregation



haploid selⁿ

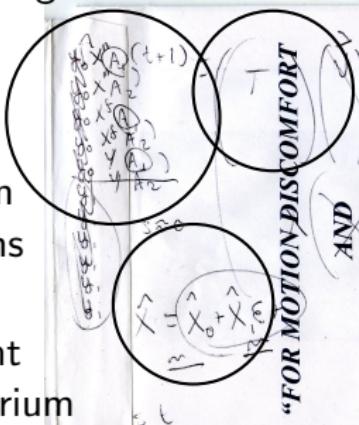


random mating



1. recursion
equations

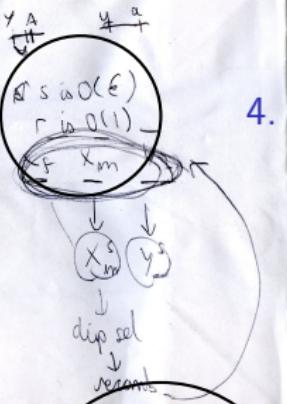
2. resident
equilibrium



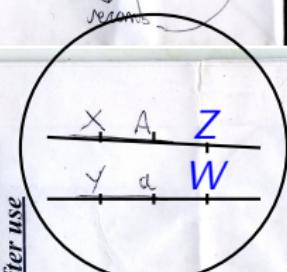
analysis
 "FOR MOTION DISCOMFORT"
 AND
 "BABY DIAPER DISPOSAL"

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4. approximate
leading
eigenvalue

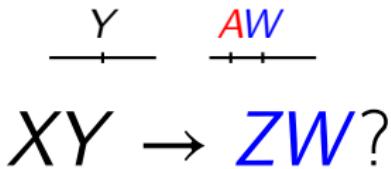


3 bi-allelic loci

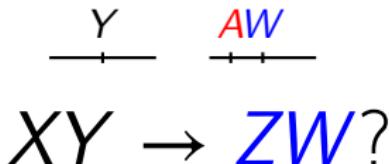
infinite population

2 results

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



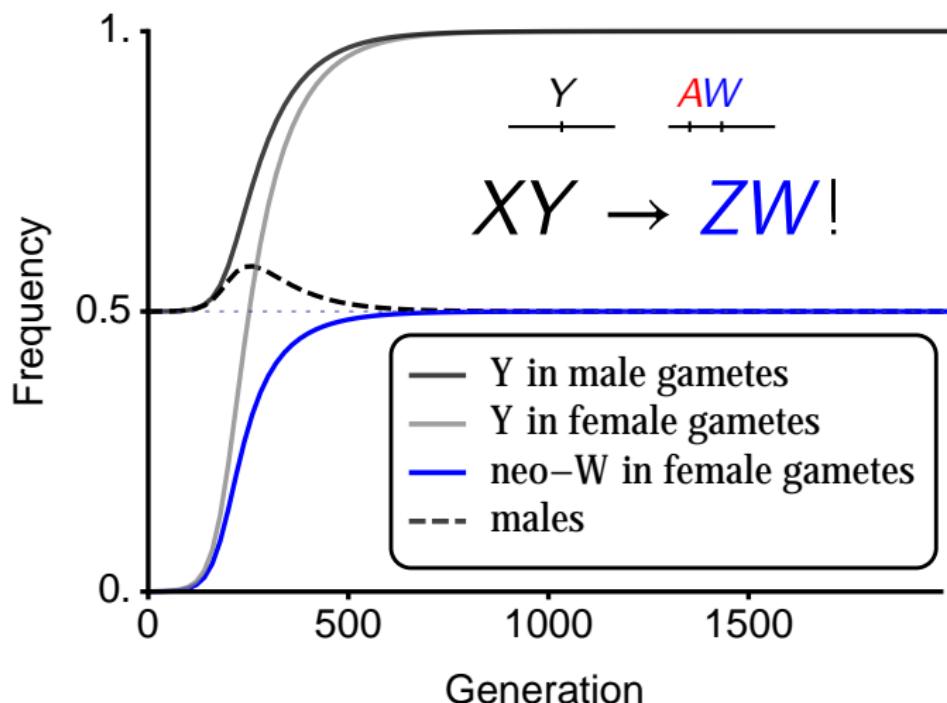
Scenario: Drive for a in males opposes selection for A in diploids



no sex-ratio bias

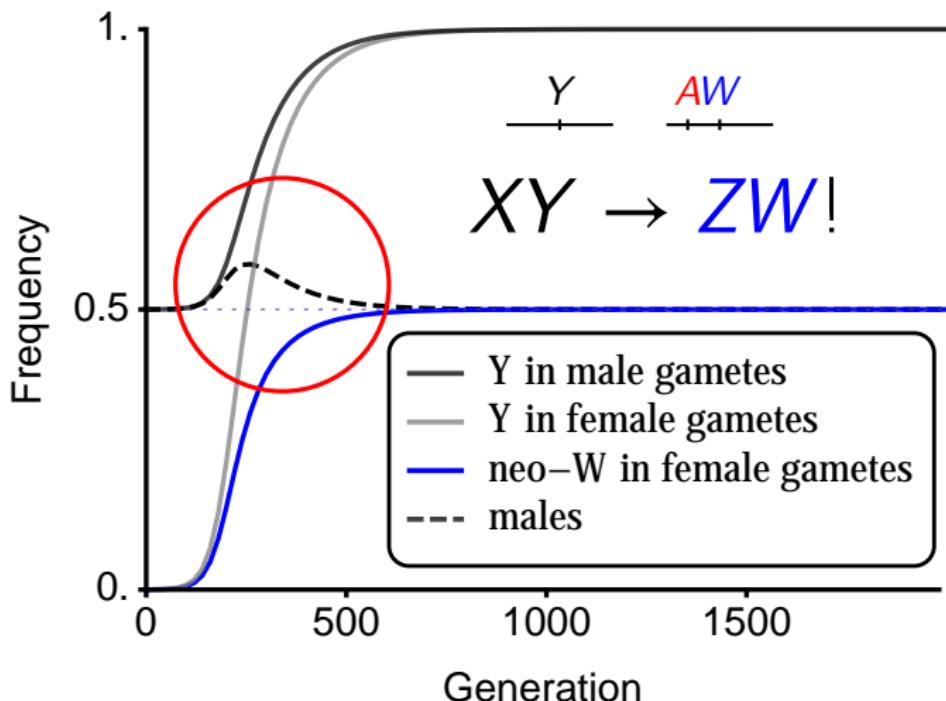
no antagonism between diploid sexes

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



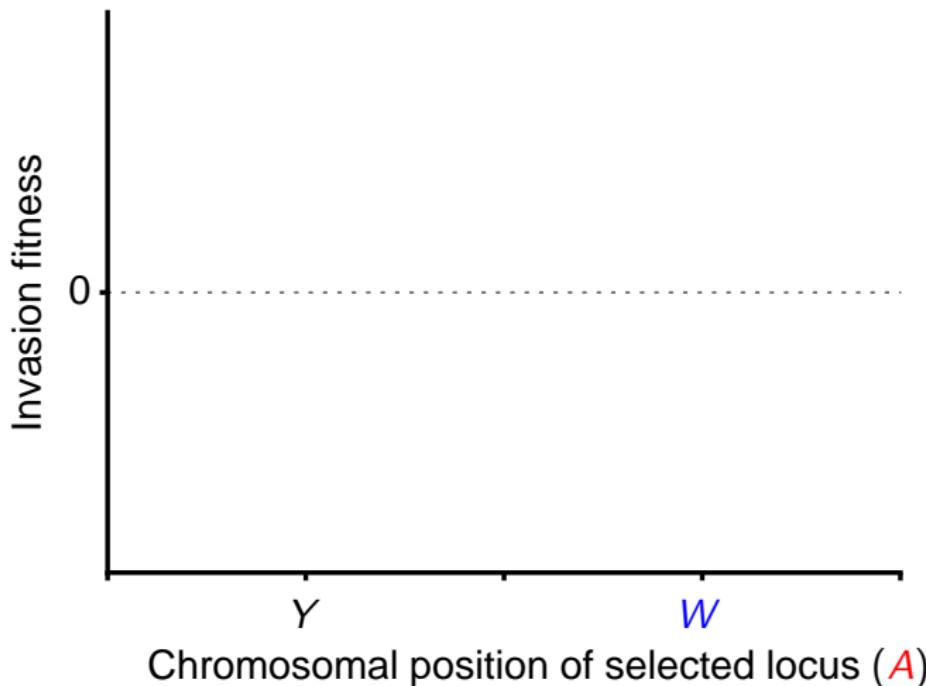
Result 1: Turnover *regardless* of sex-ratio bias

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

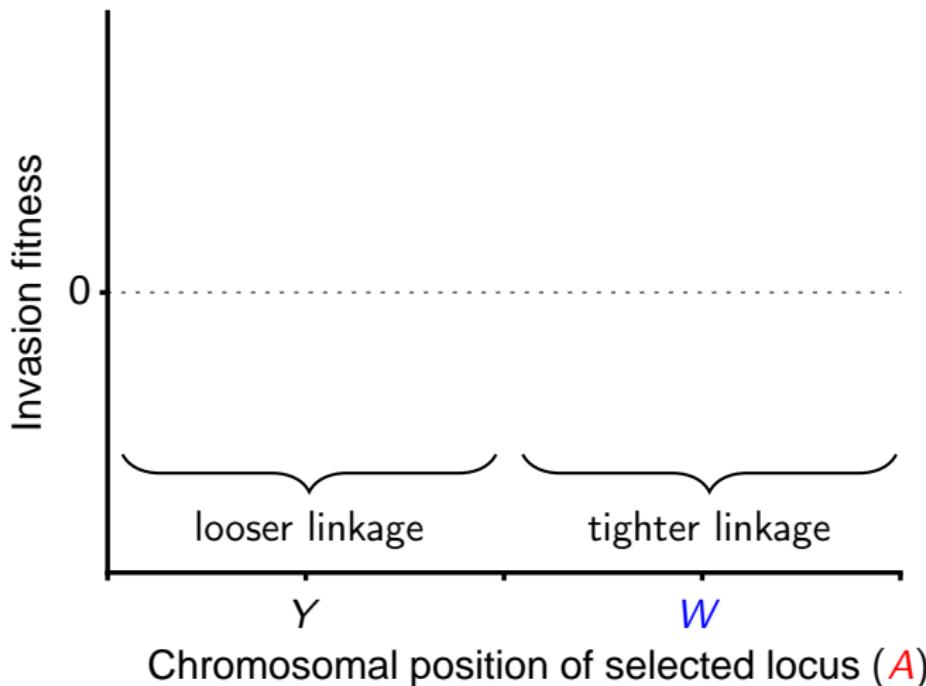


Scenario: Drive for a in males opposes selection for A in diploids

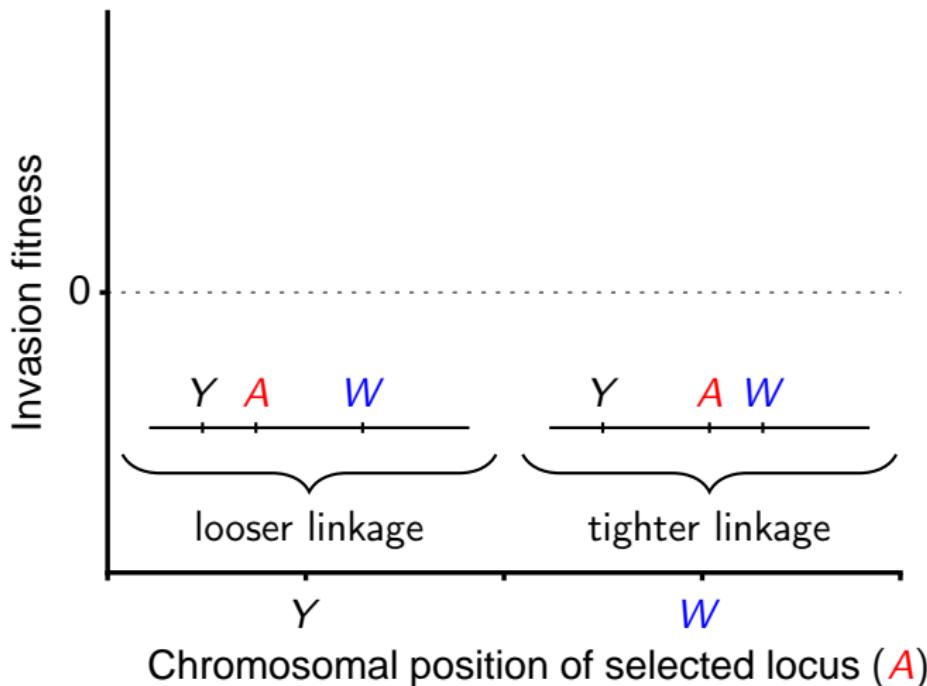
Scenario: Drive for a in males opposes selection for A in diploids



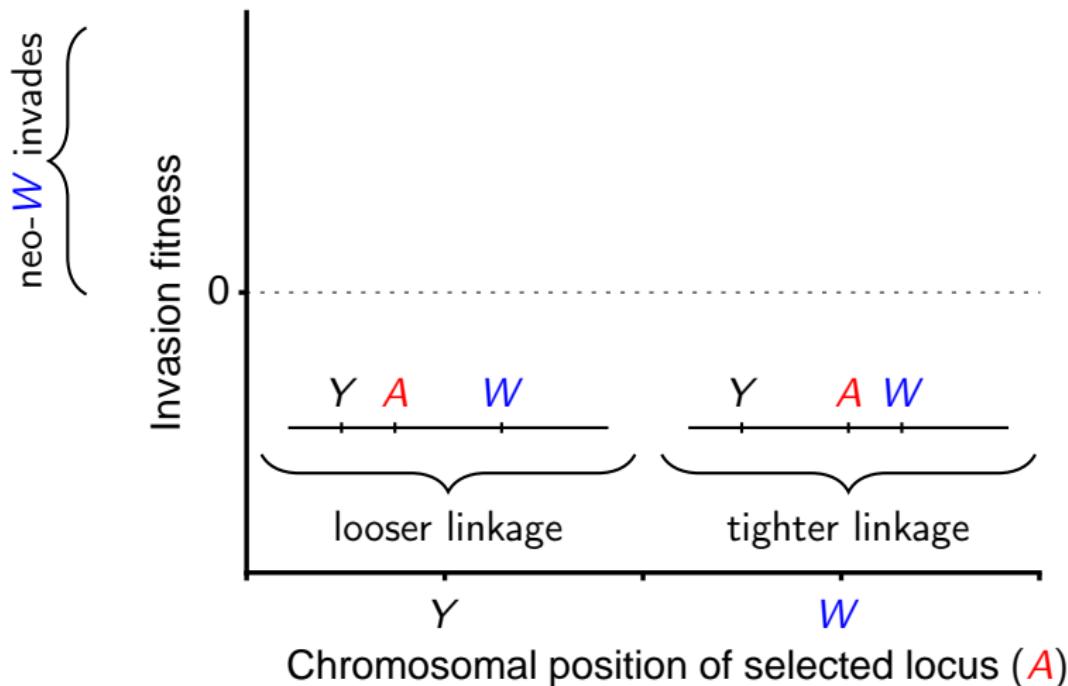
Scenario: Drive for a in males opposes selection for A in diploids



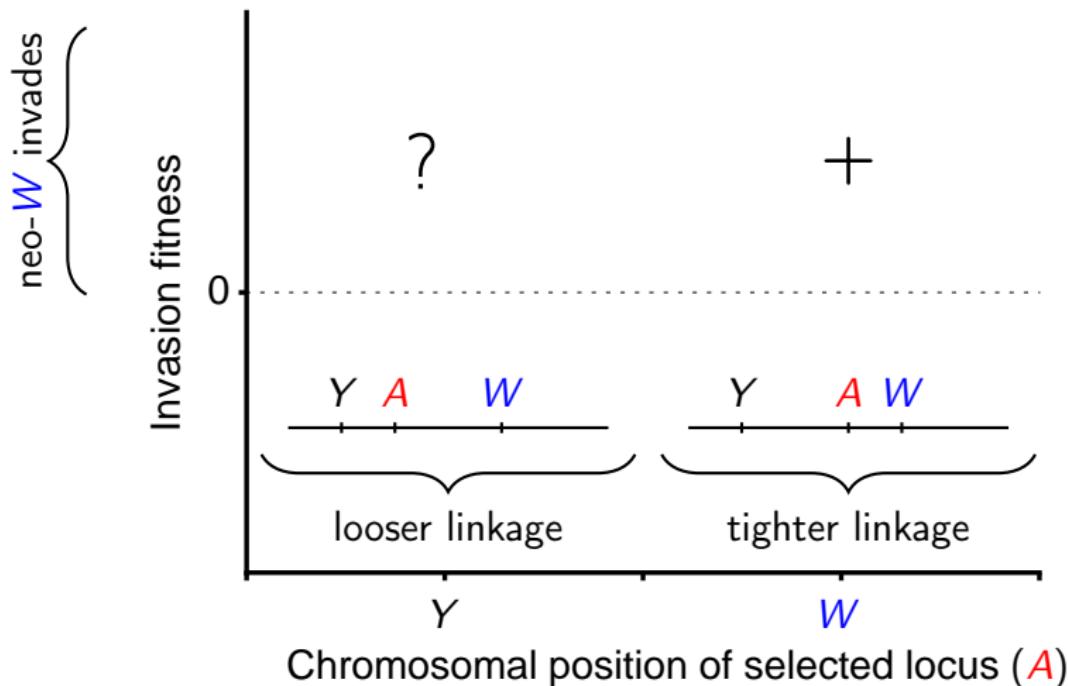
Scenario: Drive for a in males opposes selection for A in diploids



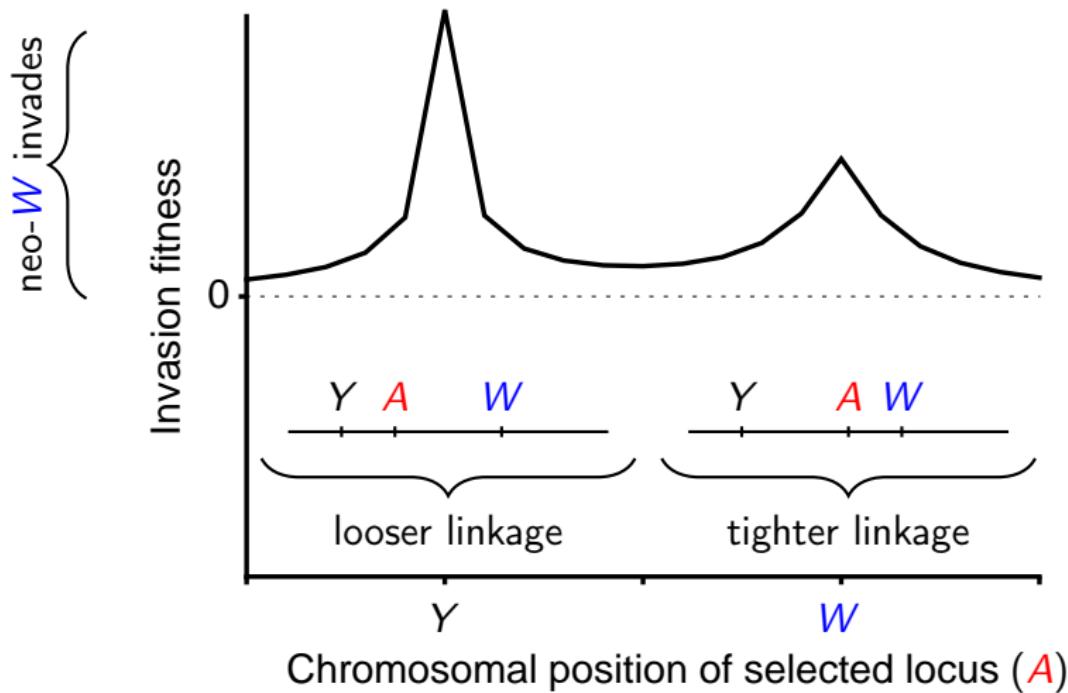
Scenario: Drive for a in males opposes selection for A in diploids



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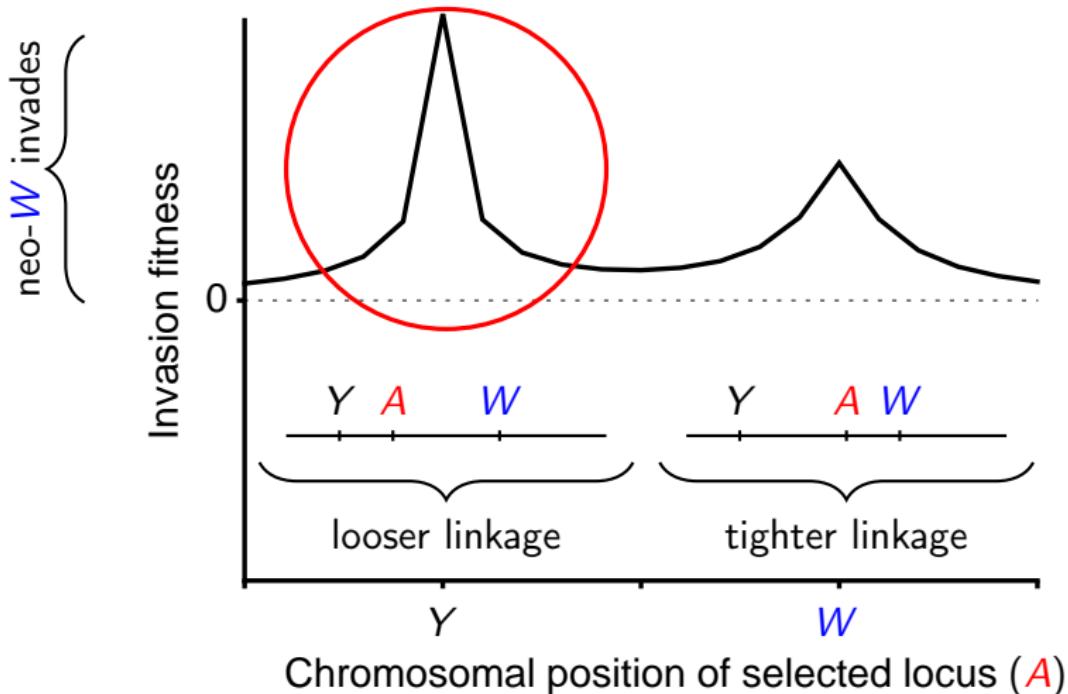


Scenario: Drive for a in males opposes selection for A in diploids



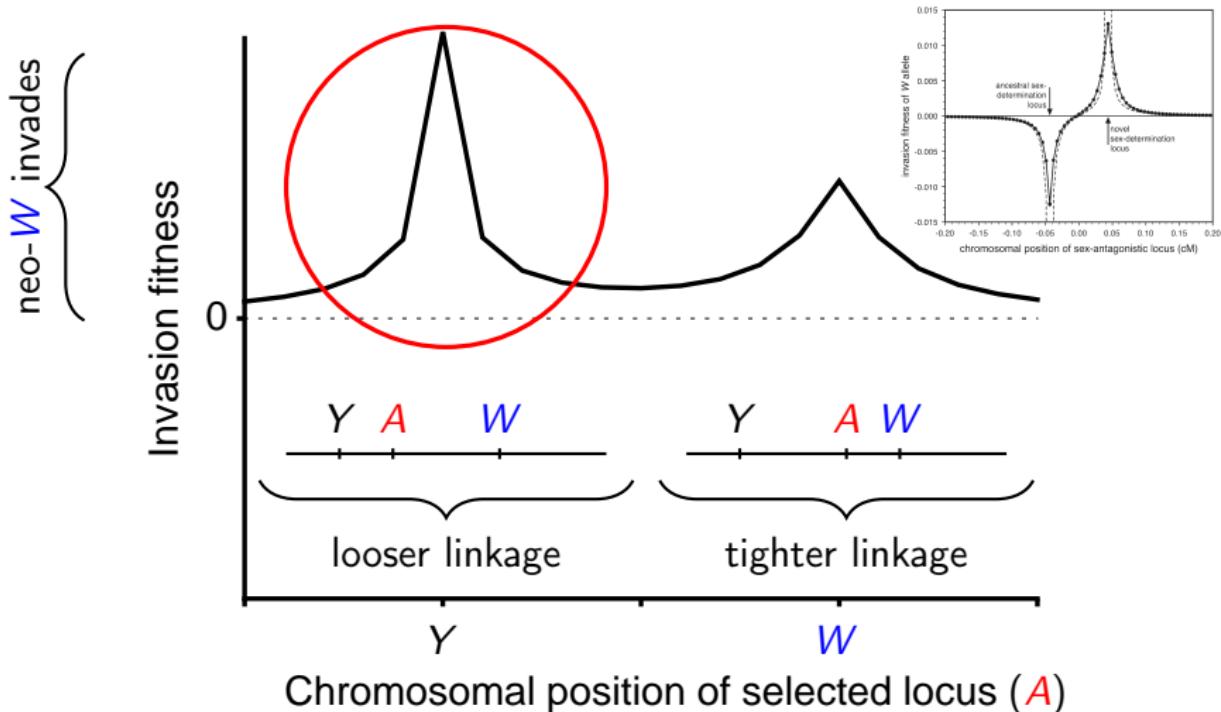
Result 2: Turnover despite *looser* sex-linkage

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



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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Haploid selection creates new avenues for sex determination turnover

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

Summary

Haploid selection creates new avenues for sex determination turnover

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

Result 2: Turnover despite *looser* sex-linkage

Summary

Haploid selection creates new avenues for sex determination turnover

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

Result 2: Turnover despite *looser* sex-linkage

More turnover in haploid-diploid organisms?

Thank-you

Michael Scott



Sally Otto

